Simple and Light Interfaces for C and C++ users

SLLIB – Script-Like C-language library
Basic User Reference Guide

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Contents

1 Introduction 11
  1.1 What is SLLIB? 11
  1.2 The Reason why SLLIB was created 14
  1.3 Development policies for SLLIB — Following the manner of the libc and leveraging the advantages of the libc 14
  1.4 All you need is the knowledge of the C language 15
  1.5 What is object-orientation for end-users? 15
    1.5.1 Object-orientation is nothing special 16
    1.5.2 Benefits of object-orientation 17
    1.5.3 Definitions of the terms and conception on codes 18

2 Installation 19
  2.1 Supported operating systems 19
  2.2 Building and installing SLLIB 19
    2.2.1 Method 1—A method using just only make 19
    2.2.2 Method 2—A method using configure and make 20

3 Tutorial 21
  3.1 Hello World 21
  3.2 Opening and reading files 21
    3.2.1 When standard streams are used 21
    3.2.2 When the most powerful “versatile” streams are used (Strongly recommended) 22
    3.2.3 Correspondence relationships with the functions of the libc 24
    3.2.4 Endianness conversion of complex binary data 25
    3.2.5 Collaborations with GNUPlot 25
  3.3 Operating strings 26
    3.3.1 Basics 26
    3.3.2 Accessing characters one by one 27
    3.3.3 Applications for reading text files from a stream 27
    3.3.4 Editing strings 28
    3.3.5 Leveraging strings 28
    3.3.6 Applications of the extended regular expressions (Back reference is also available) 29
  3.4 Operating string arrays 29
    3.4.1 Immediate assignment 30
    3.4.2 Using dprint() for debugging 30
    3.4.3 Swiftly passing on to execv() and execvp() 31
    3.4.4 Editing strings on all the elements 31
    3.4.5 Editing arrays 31
    3.4.6 Making arguments for main() easy to use 32
    3.4.7 Splitting white space-delimited and CSV-format strings to put into an array—split() member function 32
    3.4.8 Storing the result of regular expression matches 33
  3.5 Operating associative arrays 34
    3.5.1 Immediate assignment 34
    3.5.2 Using dprint() for debugging 34
    3.5.3 Editing strings on all the elements 34
    3.5.4 Editing 34
3.5.5 Easily accessing data files using split_keys() and split_values() 35
3.6 Handling multidimensional arrays without effort 36
3.6.1 Immediate assignment (Auto-resizing mode: One-dimensional arrays through three-dimensional arrays) 36
3.6.2 Updating number of dimension and elements 37
3.6.3 Resizing for each dimension 37
3.6.4 Operations on arrays 37
3.6.5 Non-auto resizing mode (For image buffers) 38
3.6.6 Fastest access to array elements 38
3.6.7 Copy and operation of images using IDL/Python-like expression 39
3.6.8 Statistics for array elements 40
3.6.9 Combine images 41
3.6.10 Conversion of endianness 41

4 Assumptions that users should comprehend before using SLLIB 43
4.1 NAMESPACE 43
4.2 NULL and 0 43
4.3 const char *, char *const *, const char *const * 44
4.4 References 44
4.5 Pointer variables for an object and arguments/return values for a function 45

5 FAQ 46
5.1 Frequent warnings and errors in compiling 46
5.1.1 warning: cannot pass objects of non-POD type 46
5.1.2 error: ‘xxx’ was not declared in this scope 46
5.1.3 error: call of overloaded ‘xxx’ is ambiguous 46
5.1.4 error: invalid conversion from ‘const char*’ to ‘char*’ 46
5.1.5 error: passing ‘xxx’ as ‘yyy’ argument of ‘zzz’ discards qualifiers 46

6 Information for advanced users 47
6.1 Instructions for creating objects in the heap 47
6.2 When you want to create an array of objects in the heap 47
6.3 Collaborations between structures and classes 47
6.4 Handling of the exceptions, try {} & catch () 48

7 The CSTREAMIO class and a summary of its inherited classes 49
7.1 A summary of the inherited classes 49
7.2 Overview of the implementation of the member functions for the base classes and inherited classes 49

8 References for the CSTREAMIO class and its inherited classes 51
8.1 Member functions for the CSTREAMIO class 51
8.1.1 open(), openf(), vopenf() 51
8.1.2 close() 53
8.1.3 read(), write() 54
8.1.4 bread() 54
8.1.5 bwrite() 55
8.1.6 rskip() 57
8.1.7 wskip() 58
8.1.8 getchr() 59
8.1.9 getstr() 60
8.1.10 getline() .......................................................... 61
8.1.11 scanf(), vscanf() ................................................. 62
8.1.12 putchr() ............................................................ 65
8.1.13 putstr() ............................................................. 65
8.1.14 printf(), vprintf() ................................................. 66
8.1.15 flush() ............................................................... 69
8.1.16 eof(), error(), reseterr() ....................................... 69
8.1.17 seek(), rewind() ................................................... 70
8.1.18 tell() ................................................................. 71
8.1.19 is_seekable() ...................................................... 71

8.2 The STDSTREAMIO class ........................................ 73
  8.2.1 How to create an object ........................................ 73
  8.2.2 open(), openf(), vopenf() ..................................... 74
  8.2.3 printf(), vprintf() .............................................. 75
  8.2.4 elflush() ......................................................... 76
  8.2.5 seek(), rewind() ............................................... 76
  8.2.6 tell() ............................................................. 77
  8.2.7 content_length() ............................................... 78

8.3 GZSTREAMIO class ................................................. 79
  8.3.1 open(), openf(), vopenf() ..................................... 79
  8.3.2 sync() ............................................................. 82

8.4 The BZSTREAMIO class ........................................... 83
  8.4.1 open(), openf(), vopenf() ..................................... 83

8.5 The HTTPSTREAMIO class ........................................ 86
  8.5.1 open(), openf(), vopenf() ..................................... 86
  8.5.2 content_length() .............................................. 87
  8.5.3 user_agent().assign() ......................................... 88

8.6 The FTPSTREAMIO class ........................................... 89
  8.6.1 open(), openf(), vopenf() ..................................... 89
  8.6.2 content_length() ............................................... 91
  8.6.3 username().assign() ........................................... 92
  8.6.4 password().assign() .......................................... 92

8.7 The PIPESTREAMIO class ........................................ 93
  8.7.1 open(), openf(), vopenf() ..................................... 93

8.8 The DIGESTSTREAMIO class ..................................... 97
  8.8.1 open(), openf(), vopenf() ..................................... 98
  8.8.2 openp(), openpf(), vopenp() .................................. 99
  8.8.3 is_write_mode() ............................................... 101
  8.8.4 content_length() ............................................... 102
  8.8.5 user_agent().assign() ......................................... 102
  8.8.6 username().assign() .......................................... 103
  8.8.7 password().assign() .......................................... 103

8.9 The TERMLEXIO class ............................................. 104
  8.9.1 open() ........................................................... 105
  8.9.2 set_prompt(), setf_prompt(), vsetf_prompt() ................. 106
  8.9.3 automate_history() ............................................ 107
  8.9.4 add_history() .................................................. 108
  8.9.5 clear_history() ................................................ 109
  8.9.6 stiffle_history() .............................................. 109
  8.9.7 unstiffle_history() ........................................... 110
9 The TSTRING class

9.1 Creating an object — three operating modes

9.1.1 Normal mode

9.1.2 NULL-free mode

9.1.3 Fixed-length buffer mode

9.1.4 Restriction with fixed-length buffer mode

9.2 Regularity of arguments for member functions

9.3 List of member functions

9.4 Operators

9.4.1 []

9.4.2 =

9.4.3 +=

9.4.4 ==

9.4.5 !=

9.5 Member functions

9.5.1 length()

9.5.2 max_length()

9.5.3 cstr(), c_str()

9.5.4 str_ptr(), str_ptr_cs()

9.5.5 cchr()

9.5.6 at(), at_cs()

9.5.7 update_length()

9.5.8 dprintf()

9.5.9 getstr()

9.5.10 copy()

9.5.11 swap()

9.5.12 init()

9.5.13 printf(), vprintf(), assign(), assignf(), vassignf()

9.5.14 implode()

9.5.15 import_binary()

9.5.16 put(), putf(), vputf()

9.5.17 strcat(), strncat(), append(), appendf(), vappendf()

9.5.18 insert(), insertf(), vinsertf()

9.5.19 replace(), replacef(), vreplacef()

9.5.20 erase()

9.5.21 clean()

9.5.22 resize()

9.5.23 resizeby()

9.5.24 crop()

9.5.25 chomp()
10 TARRAY, TSTRING class

10.1 Creating objects

10.2 List of member functions

10.3 Operators

10.4 The member functions
11.4.7 swap() ................................................................. 214
10.4.8 init() ..................................................................... 215
10.4.9 assign(), assignf(), vassignf() .............................. 216
10.4.10 assign(), vassign() ............................................. 217
10.4.11 explode() ............................................................ 218
10.4.12 split() ................................................................. 219
10.4.13 regassign() .......................................................... 221
10.4.14 put(), putf(), vputf() ......................................... 223
10.4.15 put(), vput() ....................................................... 224
10.4.16 append(), appendf(), vappendf() ......................... 226
10.4.17 append(), vappend() ........................................... 227
10.4.18 insert(), insertf(), vinserf() ............................... 228
10.4.19 insert(), vinser() ............................................... 229
10.4.20 replace(), replacef(), vreplacef() ....................... 231
10.4.21 replace(), vreplace() ......................................... 232
10.4.22 erase() ............................................................... 234
10.4.23 clean() ............................................................... 235
10.4.24 resize() ............................................................... 236
10.4.25 resizeby() ........................................................... 237
10.4.26 crop() ................................................................. 237
10.4.27 chomp() ............................................................. 238
10.4.28 trim() ................................................................. 238
10.4.29 ltrim() ............................................................... 239
10.4.30 rtrim() .............................................................. 239
10.4.31 strreplace() ........................................................ 240
10.4.32 regreplace() ....................................................... 241
10.4.33 tolower() ........................................................... 242
10.4.34 toupper() ........................................................... 242
10.4.35 expand_tabs() .................................................... 243
10.4.36 contract_spaces() ............................................. 243
10.4.37 find_elem() ........................................................ 244
10.4.38 rfind_elem() ...................................................... 245
10.4.39 find() ................................................................. 246
10.4.40 rfind() ............................................................... 248
10.4.41 find_matched_str() ............................................. 249
10.4.42 find_matched_fn() ............................................. 251
10.4.43 find_matched_pn() ............................................. 252
10.4.44 regmatch() [Normal edition] ............................... 253
10.4.45 regmatch() [Advanced edition] ......................... 254

11 ASARRAY_TSTRING class .............................................. 258
11.1 Creating objects ...................................................... 259
11.2 List of member functions ......................................... 260
11.3 Operators ................................................................ 262
11.3.1 [] ..................................................................... 262
11.3.2 = ..................................................................... 263
11.4 Member functions .................................................... 263
11.4.1 length() ............................................................. 263
11.4.2 cstrarray() ......................................................... 264
11.4.3 cstr(), c_str(), cstrf(), vestrif() ......................... 265
12 MDARRAY * Class

12.1 How to Create an Object

12.1.1 Method in which any Arguments are not Specified

12.1.2 Method in which the Size of the Array is Specified

12.1.3 Method in which the Size of the Array and the Default Value are Specified

12.2 Mathematic Functions

12.3 List of Member Functions

12.3.1 []

12.3.2 ()

12.3.3 =

12.3.4 +=

12.3.5 -=

12.3.6 *=

12.3.7 /=

12.3.8 <<=

12.3.9 >>=

12.3.10 *=
12.3.11 /=
12.3.12 /=
12.3.13 +
12.3.14 +
12.3.15 -
12.3.16 -
12.3.17 *
12.3.18 *
12.3.19 /
12.3.20 /
12.3.21 ==
12.3.22 !=
12.3.23 size_type()
12.3.24 bytes()
12.3.25 dim_length()
12.3.26 length()
12.3.27 byte_length()
12.3.28 col_length()
12.3.29 row_length()
12.3.30 layer_length()
12.3.31 at(), at_cs()
12.3.32 dvalue()
12.3.33 lvalue(), llvalue()
12.3.34 default_value(), assign_default()
12.3.35 auto_resize(), set_auto_resize()
12.3.36 rounding(), set_rounding()
12.3.37 dprint()
12.3.38 carray(), array_ptr()
12.3.39 get_elements()
12.3.40 put_elements()
12.3.41 getdata()
12.3.42 putdata()
12.3.43 reverse_endian()
12.3.44 init()
12.3.45 assign()
12.3.46 put()
12.3.47 swap()
12.3.48 move()
12.3.49 cpy()
12.3.50 insert()
12.3.51 crop()
12.3.52 erase()
12.3.53 resize()
12.3.54 resizeby()
12.3.55 increase_dim()
12.3.56 decrease_dim()
12.3.57 swap()
12.3.58 convert()
12.3.59 ceil()
12.3.60 floor()
12.3.61 round() ................................................................. 350
12.3.62 trunc() ................................................................. 351
12.3.63 abs() ................................................................. 352
12.3.64 compare() ........................................................... 352
12.3.65 copy() ................................................................. 353
12.3.66 copy() ................................................................. 354
12.3.67 cut() ................................................................. 356
12.3.68 cut() ................................................................. 356
12.3.69 clean() ............................................................... 358
12.3.70 fill() ................................................................. 359
12.3.71 add() ................................................................. 360
12.3.72 multiply() ........................................................... 361
12.3.73 paste() ............................................................... 362
12.3.74 add() ................................................................. 364
12.3.75 subtract() ........................................................... 365
12.3.76 multiply() ........................................................... 366
12.3.77 divide() ............................................................. 367


1 Introduction

1.1 What is SLLIB?

SLLIB (pronounced es el lib; Script-Like C-language library) is the library that adds the practical APIs to the C language that enable users to handle “streams,” “character strings,” “multidimensional arrays” as though they were doing so in any of the various scripting languages (Perl, PHP, Python, IDL, etc). SLLIB minimizes the weaknesses of the C language that become manifest during the processes frequently occurring on a routine basis, enabling reduced efforts of coding and debugging and improved development efficiencies.

For example, take a look at the following code:

```c
#include <sli/tarray_tstring.h>
using namespace sli;

int main()
{
    tarray_tstring arr;
    arr[0] = "foo";  /* Assign "foo" to arr[0] */
    arr[1] = "bar";  /* Assign "bar" to arr[1] */
}
```

This example shows how SLLIB is used to write a code that assigns the character strings "foo" and "bar" each to the character string array. Where is this code different from codes that you use in the C language? The difference is that this code contains no descriptions about securing arrays of pointer and string buffers. The reason why it contains no such descriptions is that required memory areas are automatically secured and managed on the library side, so that the user's code do not need to have such descriptions written into it (Obviously, the release of memory areas is also automatically performed).

The following code is an example of using a stream through a network and a regular expression:

```c
#include <sli/digeststreamio.h>
#include <sli/tstring.h>
using namespace sli;

int main()
{
    tstring line;
    digeststreamio f_in;
    f_in.open("r", "http://www.foo.bar/data/foo.txt.gz");  /* Open the file */
    while ( (line=f_in.getline()) != NULL ) { /* Read lines one by one */
        line.chomp();  /* Delete the newline char */
        if ( 0 <= line.regmatch("^[a-zA-Z]",NULL) ) { /* Try reg. expression matching */
            printf("%s\n",line.cstr());  /* Display */
        }
    }
    f_in.close();  /* Close the file */
}
```

This example is a code that opens the gzip-compressed text file foo.txt.gz stored at the Web server http://www.foo.bar/ and while extracting the file displays only the lines that begin with an alphabetic character. SLLIB also enables editing of character strings and matching of regular expressions —operations that you are familiar with in scripting languages—to be performed easily.

Here is the other code that handles multidimensional arrays. This is a code that selects a section, divides by 2 all elements of double-precision floating point type, logs those arrays, and displays them:
```c
#include <sli/mdarray.h>
#include <sli/mdarray_math.h>
using namespace sli;

int main()
{
    const double arr0_src[] = {0.02, 0.2, 2.0, 20.0, 200.0, 2000.0, 1, 2, 3};
    mdarray_double arr0, arr1;
    /* Set length of array (x,y) */
    arr0.resize_2d(3,3);
    arr0.put_elements(arr0_src, 3*3);
    /* Select first 2 rows in arr0, and copy it into arr1 */
    arr1 = arr0.sectionf("*, 0:1");
    /* Operate log10() for all elements that are divided by 2 */
    arr1 = log10(arr1 / 2);
    for ( size_t j=0 ; j < arr1.length(1) ; j++ ) {
        for ( size_t i=0 ; i < arr1.length(0) ; i++ ) printf("[%g]", arr1(i,j));
        printf("\n");
    }
}
```

When this code is executed, you have the following result:

```
[-2] [-1] [0]
[1] [2] [3]
```

SLLIB enables a selection of elements using IDL/Python-like expression such as "*,0:1" and an operation of all the elements of an array to have operators and mathematical functions applied to it so that codes for operating arrays can significantly be simplified. In addition, 2-d or 3-d pointer array can be automatically generated in array objects, therefore, users can write their code for high performance tools without any unnecessary effort.

As described above, SLLIB is a powerful library that compensates the weaknesses of the C language in applications that frequently occur on a routine basis, and provides the primary features that include:

- APIs that enable users to handle various streams (compressed file, network, etc.) readily and in a unified manner.
- Enhancing the processing of character strings. APIs for regular expressions, string arrays and string associative arrays.
- APIs that enable users to easily handle multidimensional arrays.

Supports selections of elements using IDL/Python-like expression, operations of operators and mathematical functions for all the elements of an array, functions for basic statistics, automatic generation of 2-d or 3-d pointer arrays, etc.

SLLIB enhances the underlying portion of the C-language development environment so that efforts of coding and debugging are reduced and development efficiencies are improved.

Table II shows overview of SLLIB’s APIs for streams. You will understand that users can handle various streams in a unified manner.
### Table 1:

List of the member functions that the base class cstreamio and its inherited classes provide. The symbol, “⇐”, indicates that a member function for the base class is inherited. The member functions with a § symbol indicate that they are redefined or are additionally defined.

<table>
<thead>
<tr>
<th>Member functions for the base class cstreamio</th>
<th>stdstreamio</th>
<th>filestreamio</th>
<th>httpstreamio</th>
<th>ftpstreamio</th>
<th>pipestreamio</th>
<th>digeststreamio</th>
<th>terminio</th>
<th>termscreenio</th>
<th>inetstreamio</th>
</tr>
</thead>
<tbody>
<tr>
<td>open(), etc.</td>
<td>§8.1.1</td>
<td>§8.2.2</td>
<td>§8.3.1</td>
<td>§8.4.1</td>
<td>§8.5.1</td>
<td>§8.6.1</td>
<td>§8.7.1</td>
<td>§8.8.1</td>
<td>§8.9.1</td>
</tr>
<tr>
<td>close()</td>
<td>§8.1.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>read()</td>
<td>§8.1.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>write()</td>
<td>§8.1.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>bread()</td>
<td>§8.1.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>bwrite()</td>
<td>§8.1.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>rskip()</td>
<td>§8.1.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>wskip()</td>
<td>§8.1.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>getchr()</td>
<td>§8.1.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>getstr()</td>
<td>§8.1.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>getline()</td>
<td>§8.1.10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>scanf()</td>
<td>§8.1.11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>putchr()</td>
<td>§8.1.12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>putstr()</td>
<td>§8.1.13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>printf()</td>
<td>§8.1.14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>eprintf()</td>
<td>§8.2.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>efflush()</td>
<td>§8.2.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>sync()</td>
<td>§8.2.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>content_length()</td>
<td>§8.2.6</td>
<td>§8.3.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>user_agent.assign()</td>
<td>§8.3.3</td>
<td></td>
<td></td>
<td>§8.3.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>username.assign()</td>
<td>§8.3.5</td>
<td></td>
<td></td>
<td>§8.3.6</td>
<td></td>
<td></td>
<td></td>
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<td>password.assign()</td>
<td>§8.3.7</td>
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<td>§8.3.8</td>
<td></td>
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<tr>
<td>openp(), etc.</td>
<td>§8.3.9</td>
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<td>is_write_mode()</td>
<td>§8.3.10</td>
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<td>set_prompt()</td>
<td>§8.3.11</td>
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<td>automate_history()</td>
<td>§8.3.12</td>
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<td>add_history()</td>
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<td>§8.3.14</td>
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<td>§8.3.15</td>
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<td>§8.3.16</td>
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<tr>
<td>stifled_history()</td>
<td>§8.3.17</td>
<td></td>
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<td>§8.3.18</td>
<td></td>
<td></td>
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<tr>
<td>unstifled_history()</td>
<td>§8.3.19</td>
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<td>read_history()</td>
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<td>write_history()</td>
<td>§8.3.23</td>
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<td>§8.3.24</td>
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<td>§8.3.25</td>
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<td>host()</td>
<td>§8.3.27</td>
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</table>

The new member functions for the inherited classes:

<table>
<thead>
<tr>
<th>Member functions for the inherited classes</th>
<th>§8.1.17</th>
<th>§8.2.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>eprintf()</td>
<td>§8.2.3</td>
<td></td>
</tr>
<tr>
<td>efflush()</td>
<td>§8.2.4</td>
<td></td>
</tr>
<tr>
<td>sync()</td>
<td>§8.2.5</td>
<td></td>
</tr>
<tr>
<td>content_length()</td>
<td>§8.2.6</td>
<td>§8.3.2</td>
</tr>
<tr>
<td>user_agent.assign()</td>
<td>§8.3.3</td>
<td></td>
</tr>
<tr>
<td>username.assign()</td>
<td>§8.3.5</td>
<td></td>
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<tr>
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<td>§8.3.7</td>
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<tr>
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<tr>
<td>host()</td>
<td>§8.3.27</td>
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</tbody>
</table>
1.2 The Reason why SLLIB was created

We said in §1.1 that SLLIB compensates the weaknesses of the C language, and compensating the weaknesses of the C language is one of the purposes for which the C++ standard library was created.

Now, let me ask you a question, have ever seen the code “cout << "foo" << endl;”? This description of the code shows how “printf("foo");” is written according to the manner of the C++ standard library. There is a reason why this notation was made available to use in the C++ standard library, and it is also a fact that this compensates the weaknesses of the C language1). However, many users seem to feel that it makes no sense redefining the bit shift operators with a totally different meaning, or that it is difficult to presume what action is to occur with the code.

The C++ standard library provides a large number of new APIs (chiefly for algorithms) not found in the libc (the standard library for the C language), while it has incorporated as the specifications for APIs a “new manner” that every user will not find easily acceptable. We suppose that learning this “manner” has proved an obstacle that has caused unexpectedly numerous developers to distance themselves from using the C++.

However, if such an obstacle makes developers unable to leverage the advantages provided in the C++ that help to minimize the efforts of coding, it would be a waste of resources. In fact, the APIs such as the scripting language that we discussed in §1.1 can take on a natural form only when the C++ is used.

For this reason, in order to do something about this “waste of resources” situation, we have decided to create a basic library that is useful and leverages the advantages of the C++ while at the same time following the manner of the libc, rather than to build the APIs with the “new manner.” Thus, as we reorganized most of the functions in the libc slowly and steadily, we came up with the basic form of SLLIB which has developed into the library that has various scripting language-like APIs.

1.3 Development policies for SLLIB — Following the manner of the libc and leveraging the advantages of the libc

<table>
<thead>
<tr>
<th>Feature</th>
<th>C++ standard library</th>
<th>SLLIB</th>
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<tbody>
<tr>
<td>Feature</td>
<td>Covers a wide range</td>
<td>Limited to applications that occur routinely</td>
</tr>
<tr>
<td>libc-like functions</td>
<td>Excluded</td>
<td>Acquired to a full extent</td>
</tr>
<tr>
<td>printf() notations</td>
<td>Excluded</td>
<td>Utilized to a full extent</td>
</tr>
<tr>
<td>Types of variable</td>
<td>Numerous unique types</td>
<td>Uses only the types defined in libc</td>
</tr>
<tr>
<td>Operators</td>
<td>Strong uniqueness</td>
<td>Minimum uniqueness</td>
</tr>
<tr>
<td>Ease of use</td>
<td>Not so good</td>
<td>Good</td>
</tr>
</tbody>
</table>

Table 2: Conceptual differences between the C++ standard library and SLLIB

In §1.2 we explained that the C++ standard library made a break with the significant portion of the manner of the libc. In contrast, SLLIB is the library that takes the course of following the footsteps of the manner of the libc.

Table 2 shows the comparison of SLLIB’s concepts with those of the C++ standard library, put together in an easy-to-understand manner. As shown in the table, SLLIB limits its features to the applications that occur frequently and makes the APIs close to the C language-like manner to

1) However, Google’s coding conventions suggest that both the printf() function and the stream in C++ have advantages and disadvantages. In the end, the conventions recommend that the streams in the C++ standard library are not used.
ensure that what users must learn freshly is kept to a minimum. Therefore, **SLLIB can be used easily even by users who are completely unfamiliar with C++**. Also, the uniqueness of the operators is kept to a minimum so that it is unlikely to occur like in the C++ standard library that users who are not familiar with the library cannot read the codes.

A typical example of the C language-like manner is, more than any others, the format of the printf() function and its variable-length arguments. In the arguments of the printf() function, you can describe quite briefly and easily how strings are converted, concatenated, etc. using a wealth of format specifiers. Recognizing that printf() is the most powerful as expected, SLLIB makes the notations of printf() available for use in various APIs.

For example, as there was a function called `f_in.open()` in §1.1 there is also a function called `openf()`, and, like the arguments of the printf() function in the libc, you can also write as follows:

```c
f_in.openf("r", "http://%s/%s", "www.foo.bar", "data/foo.txt.gz");
```

In the string processing of SLLIB, a wealth of the APIs are available that follow the manner and function names seen in string.h, ctype.h, etc. in the libc (e.g. atof() and strchr()), making SLLIB a library accessible to C-language programmers.

Also, SLLIB supplements the libc features that the C++ standard library does not have, so it can help users who already use C++ to further refine their codes. Since SLLIB implements most of the libc functions in the member functions of classes, users can move from the conventional libc + C++ standard library, or the mixed codes of “procedures” and “object-orientation,” to SLLIB + C++ standard library, or the more purely “object-oriented” codes.

### 1.4 All you need is the knowledge of the C language

Reading the sections through to the above, you may have realized that SLLIB has been written using C++. Now, if you think “No way! I never use C++!!”, you don’t need to worry. **C++ is upward-compatible with C, so when you write “#include <stdio.h>”, “printf(...);” etc. like the C-language codes as you previously did, you can compile the codes with the C++ compiler.** Using C++ does not mean that you need to follow the manner of the C++ standard library, “cout << "foo" << endl;”.

As we discussed in §1.3 SLLIB is designed to be able to utilize the manner of the C language to a maximum extent. Obviously, the C++-like aspects of SLLIB are addressed by making the descriptions in the manual similar to the C language, so that even users who have no experience in using C++ can easily understand how to use it. Therefore, SLLIB can be easily used by anyone who has knowledge of the C language. Please use SLLIB and find how easy it is like scripting languages to use it.

### 1.5 What is object-orientation for end-users?

As we discussed a bit about it in §1.3 have you ever heard of the term “object-orientation”? The “object-orientation” approach is useful when realizing in the C language the implementation of scripting language variables, etc. Many books of the world describe the “object-orientation for library developers” using the terms such as “modeling” and “message passing,” but it is sufficient for end-users who simply use the library to understand that “this approach helps minimize the efforts of coding.”

In this chapter, we will discuss object-orientation focusing on the knowledge that end-users are required to have. The descriptions proceed based on what you have experienced, so don’t be afraid of reading the chapter.
1.5.1 **Object-orientation is nothing special**

SLLIB is an object-oriented library. Looking at the term of object-orientation, you might think that we are going to discuss a challenging topic. But there is no need to worry at all. The reason is that the object-oriented writing manner appears also in C and FORTRAN. Undoubtedly you already have experience of writing object-oriented codes.

Table 3 shows the conceptual diagram of the “procedural” and “object-oriented” types, and examples of codes in the C language and FORTRAN. As shown in the examples, both the C language and FORTRAN have both the “procedural” and “object-oriented” types of grammar. The “procedural” type is a “command-driven” writing manner as seen in commands such as calling of functions (subroutines), while the “object-oriented” type, although it has the common operation of calling functions, gives the major object of processing at a given time a special grammatical treatment. When you move one of the arguments for the “procedural” type in the conceptual diagram to the left of the function, you have the same diagram as the object-oriented type.

Let us take a look at the examples in Table 3. In the examples for the “procedural” type, that is, “fprintf(fp,"foo");”, and “call sub(x,y,z)”, either of the arguments for the function (subroutine) might have the major object of the processing, but all the arguments are grammatically equal. On the other hand, in the examples for the “object-orientated” type, that is, “a += b;” and “x .gt. y”, the major object of the processing is always the variable located to the leftmost, and also is grammatically given a special treatment.

Thus the languages with a high frequency of using the “object-orientation type” of writing manner that clearly defines a major object of processing (object) are called an “object-oriented language,” and, on the contrary, the languages with a high frequency of using the “command-driven” writing manner as seen in “fprintf(fp,"foo");” are called a “procedural language.” The C language and FORTRAN are classified as a “procedural language” because they eventually create and combine functions (subroutines) to achieve the processing.

Then, what kind of language is an “object-oriented language”? Should you be writing only the symbols and abbreviations such as “+=” and “.gt.” in all occasions? That is not the case. The “object-oriented languages” such as C++ have the extended language specifications to enable the codes to be written in the format of “string (argument . . .)” by generalizing the parts like these “+=” and “.gt.” so you can write the following code 2):

```
(a.add(b); /* Add b to a */
```

This is the typical manner of writing codes in object-oriented languages. You might notice that

---

2) In reality, the code may not necessarily be able to be written.
it is quite similar to the case of writing “\texttt{a += b;}”. The major object of the processing, “\texttt{a}”, is placed at the beginning of the string, and is followed by the verb. Thus object-oriented languages refer to a language in which codes are written mainly using the format of “\texttt{string (argument . . . )}”, which is a generalization of the writing manner of “\texttt{+=}” and “\texttt{.gt.}.” A look at this basic concept reveals that object-oriented languages are not a special language. The only difference is that you mainly use the concepts on the right side of Table 3.

In the scripting language of Perl, there are also the symbols such as “\texttt{=~}” and “\texttt{.=}”. You may have used them before. Obviously, these are in an object-oriented writing manner, and have the major object of the processing located to the left. Depending on the language, symbols such as “\texttt{#=}” and “\texttt{;=}” might possibly exist. However, users who do not have knowledge of the language specifications may not necessarily understand the meaning of these symbols. This lets us to understand that the writing manner of object-oriented languages as in “\texttt{a.add(b);}” also provides a superior approach in securing the readability of codes.

\subsection{1.5.2 Benefits of object-orientation}

Thus writing codes in an object-oriented manner makes the major object of processing clear and the codes readable. Moreover, writing codes in an object-oriented manner provides greater benefits.

In C, for the “\texttt{types}” only the codes of fixed byte length such as int and double were able to be used. For that reason, when you write variable length strings or variable length arrays, you must use \texttt{malloc()}, \texttt{realloc()} and \texttt{free()} to operate, secure and release the area, and as a result you have too large codes for the processing you want. As the areas that are secured are accessed using the pointer variable, any of you must have experienced the situation in which accessing the outside of the area resulted in a segmentation violation. The most annoying thing would be a memory leak caused by a missing \texttt{free()} statement. If the “\texttt{types}” have a mechanism equipped with it that manages variable length strings and arrays, basically all of these problems are solved. Certainly, object-orientation is here to achieve this. It is for this reason that C++ has the extended language specifications to enable the format of “\texttt{string (argument . . . )}” to be used by generalizing the writing manner of “\texttt{=}” and “\texttt{+=}”, and by library developers designing the “\texttt{add()}” part of “\texttt{a.add(c);}”, that appeared in §1.5.1 users will be able to handle variable length strings and arrays more easily and safely. For example, when you concatenate the two strings, “\texttt{abc}” and “\texttt{012}”, using SLLIB, you can write as follows:

\begin{verbatim}
tstring str;
str.printf("abc");    /* Assign "abc" to str */
str.append("012");    /* Add "012" to str */
\end{verbatim}

Fortunately, all of the processing of securing the area using \texttt{malloc()} and \texttt{realloc()} is performed by \texttt{.printf()} and \texttt{.append()}. Furthermore, the area that are secured by \texttt{malloc()}, etc. is automatically released when \texttt{str} disappears, so you do not need to worry about memory leak. This means that users simply write what they want to do following the object \texttt{str}, allowing them to focus their thoughts on the content of the processing. As a matter of course, this makes the volume of the codes overwhelmingly small.

These are not all the benefits that object-orientation provides. The greatest benefit is that \textbf{users should learn can be minimized}. Object-oriented languages use the rule called “inheritance” to disable library developers to create APIs of non-unified specifications. In APIs for SLIB’s stream input/output, “inheritance” plays a highly active role, and when you are able to use an API of a specific type of stream, then you can also use the other types of streams in exactly the same manner.

Here is an example of user codes that uses SLIB. On the left is a code that opens and displays \texttt{foo.txt}, and on the right is a code that opens and displays \texttt{foo.txt.gz} while extracting it.
#include <sli/istream.h>
using namespace sli;

int main()
{
    stdstreamio f_in;
    int status = -1;
    char buf[256];
    /* Open the file */
    status = f_in.open("r", "foo.txt");
    if ( status != 0 ) goto quit;
    /* Read and display lines one by one */
    while ( f_in.getstr(buf,256) != NULL ) {
        printf("%s",buf);
    }
    f_in.close();
    quit:
    return status;
}

#include <sli/ostream.h>
using namespace sli;

int main()
{
    gzstreamio f_in;
    int status = -1;
    char buf[256];
    /* Open the file */
    status = f_in.open("r", "foo.txt.gz");
    if ( status != 0 ) goto quit;
    /* Read and display lines one by one */
    while ( f_in.getstr(buf,256) != NULL ) {
        printf("%s",buf);
    }
    f_in.close();
    quit:
    return status;
}

The parts that differ between the left and right are underscored. There are only the three locations where there is a difference between the left and right. The codes do not have any difference at all in how the APIs such as `getstr()` are used. Simply put, that users are able to use standard input/output automatically means in SLLIB that users also are able to use compressed files and files on a network.

Thus object-orientation provides the advantage of enabling users to learn a number of APIs one after another once they learn one API.

### 1.5.3 Definitions of the terms and conceptions on codes

In object-oriented languages such as C++, what is formerly referred to as “type” is called “class,” and what is formerly referred to as “variable” is called “object” or “instance.” And the “append()” part of `str.append("012");` as appeared in [1.5.2] called a “member function.”

SLLIB is an object-oriented library. Therefore, when you, the user, use the APIs of SLLIB, you first create the objects (instances) that are the major object of processing and use the member functions (`printf()` and `append()` as in the examples above) in the classes to create the codes. When writing codes for the conventional procedures, you needed to suppose “do something, to something” because the verb (command) must precede the object. In object-oriented languages, you should just instinctively suppose “to something, do something” and simply write it down into the codes.
2 Installation

2.1 Supported operating systems

The operating systems that SLLIB supports include Linux, FreeBSD, MacOSX, Solaris and Cygwin. All of these operating systems support both the 32 bit versions and 64 bit versions.

The compiler required is GCC g++ version 3 series or higher, or Intel® C++ Compiler (The author of this document used g++ 3.3.2 or higher to verify the capabilities of the system operation).

2.2 Building and installing SLLIB

SLLIB provides two methods for building. Choose one of the following:

- **Method 1**—A method using just only make (§2.2.1)
  
  Ordinary programmers and science researchers recommend this method.

  This method allows the change of compilers and paths of a library, but basically it assumes that users use the default preferences to build libraries, and is not designed to set detailed preferences.\(^3\)

  Installs only static libraries. When you need a shared library to be installed, use Method 2.

- **Method 2**—A method using configure and make (§2.2.2)

  This method is recommended when you are a professional software developer or hacker, or when you need to set detailed preferences.

  You can use the options of configure to indicate that zlib, bzip2 or readline is not used.

  Installs both static and shared libraries.

  When you use an operating system other than those supported, try to use this method.

In either of the methods above, the build system automatically detects the operating system you use, and gives the compiler appropriate options to build.

2.2.1 Method 1—A method using just only make

The zlib, bzlib, ncurses and readline libraries are required for building, and must be installed in advance. (In many cases, the name for rpm can be zlib-devel, bzip2-devel, ncurses-devel, readline-devel, etc.\(^4\)) The following is an example for the Redhat series:

```bash
# yum install zlib-devel
# yum install bzip2-devel
# yum install ncurses-devel
# yum install readline-devel
```

Expand the archive and make it.

```bash
$ gzip -dc sllib-x.xx.tar.gz | tar xvf -
$ cd sllib-x.xx
$ make
```

Here, when you want to use Intel® C++ Compiler or to create a library for 64-bit (or 32-bit), you can write as follows, to change the compiler or to add the options for the compiler:

```bash
$ make CXX=icc
```

---

\(^3\) Editing config.h allows you to enable/disable external libraries.

\(^4\) For the Debian series, the package name is zlib1g-dev, libbz2-dev, ncurses5-dev or libreadline5-dev.
If you use 32-bit OS, gcc might not turn SSE2 on by default\textsuperscript{5).} You can append options for SSE2 to improve performance as follows:

\begin{verbatim}
$ make CCFLAGS="-msse2 -mfpmath=sse"
\end{verbatim}

Also, when you need to change PREFIX, you can give the value in like manner. For example, do as follows:

\begin{verbatim}
$ make CCFLAGS="-msse2 -mfpmath=sse" PREFIX="/home/guest/local"
\end{verbatim}

Install it.

\begin{verbatim}
$ su
# make install32
\end{verbatim}

This example is for the 32-bit operating system. For the 64-bit operating system, it should be “make install64”. By default, for “install32” libsllib.a is installed at /usr/local/lib, and for “install64” it is installed at /usr/local/lib64. Concurrently, the set of header files is copied to /usr/local/include/sli, and the wrapper script s++ of the C++ compiler is installed at /usr/local/bin.

### 2.2.2 Method 2—A method using configure and make

The zlib, bzlib, ncurses and readline libraries are required for building the SLLIB that has all the classes available to use, and must be installed in advance. (In many cases, the name for rpm can be zlib-devel, bzip2-devel, ncurses-devel, readline-devel, etc.\textsuperscript{6)} The following is an example for the Redhat series:

\begin{verbatim}
# yum install zlib-devel
# yum install bzip2-devel
# yum install ncurses-devel
# yum install readline-devel
\end{verbatim}

Expand the archive, and configure and make it.

\begin{verbatim}
$ gzip -dc sllib-x.xx.tar.gz | tar xvf -
$ cd sllib-x.xx
$ sh configure
$ make
\end{verbatim}

As the options for configure, “--disable-readline” “--disable-bzlib” “--disable-zlib” are available. However, when these options are added, you cannot use the classes that are dependent on the library.

Install the library.

\begin{verbatim}
$ su
# make install
\end{verbatim}

By default, the library files are copied to /usr/local/lib, and the set of header files are copied to /usr/local/include/sli, and the wrapper script s++ of the C++ compiler is installed at /usr/local/bin.

For the 64-bit operating system, you may need to specify the path for the library using configure, as follows:

\textsuperscript{5)} It is enabled by default on 64-bit OS.
\textsuperscript{6)} For the Debian series, the package name is zlib1g-dev, libbz2-dev, ncurses5-dev or libreadline5-dev.
3 Tutorial

3.1 Hello World

Here is a familiar program, Hello World.

```c
#include <sli/stdstreamio.h>
using namespace sli;

int main()
{
    stdstreamio sio; /* Create the object (for standard output) */
    sio.printf("Hello World\n"); /* Write to standard output */
    return 0;
}
```

Let us create the above code using the `s++` command.

```bash
$ s++ hello.cc
```

Following this, you are asked whether you want to create the template code, and then answer "y" to create the code.

Compile and execute the code. When you use `s++`, you can compile the code easily.

```bash
$ g++ -I/usr/local/include -L/usr/local/lib -Wall -O -o hello hello.cc -lsllib -lz
   -lbz2 -lreadline -lcurses
$ ./hello
Hello World
```

Thus, `s++` enables the `-o` option for the C++ compiler to be automatically added when users do not specify the output file.

In addition, when `s++` has the "/" option specified to it, the program is executed immediately after compiling the code.

```bash
$ s++ hello.cc /
Hello World
```

When you add arguments following "/", they are given to the program as an argument.

Thus, `s++` enables you to create user programs as though you were using a scripting language.

3.2 Opening and reading files

3.2.1 When standard streams are used

Like in Hello World, use the stdstreamio class ([§8.2](#8-2)). This time, use the open() member function ([§8.1.1](#8-1-1)) to open the file for reading.
#include <sli/stdstreamio.h>
using namespace sli;

int main()
{
    stdstreamio sio, fin; /* Create the object */
    char buf[512];
    if ( fin.open("r","foo.txt") < 0 ) { /* Open foo.txt as read-only */
        Error handling
    }
    fin.getstr(buf,512); /* Read the first line and put it in buf */
    sio.printf("%s",buf); /* Output it to the standard output */
    fin.close();
    return 0;
}

In SLLIB, open() is used instead of fopen(), and getstr() is used instead of fgets().

Additionally, in SLLIB there is a member function called getline() ([§8.110]). This is a function that reads lines up to a newline character '\n' and stores them into a buffer inside the object to acquire its beginning address, enabling users to handle text files almost as though they were using Perl. The following example is a code that displays all the content of a text file using getline() (The error handling with open() is omitted).

const char *line;
fin.open("r","foo.txt");
while ( (line=fin.getline()) != NULL ) {
    sio.printf("%s",line);
}

Please note that the buffer area to be returned using getline() is managed inside the object, and must not released by users at their discretion (Even if you try to release the area using free(), the code cannot be compiled).

Combining the getline() and tstring classes ([§9.5] enables users to easily edit strings on a per-line basis and match patterns using regular expressions, so that users can analyze text files quite readily. The descriptions for this feature are provided in [§3.3.3], so please also see the section.

### 3.2.2 When the most powerful “versatile” streams are used (Strongly recommended)

Next, we will use the digeststreamio class ([§8.8] that supports compressing and extracting of files, networks and pipes. The digeststreamio class is the most powerful class for stream input/output, and should be strongly recommended.
The code opens the gzip-compressed file, foo.txt.gz, and reads the extracted content using `getstr()`. The suffix of a path name specified when opening the file is used to automatically determine whether or not it needs to be extracted. Also, when you want to access files through a network, you just simply write:

```c
if ( fin.open("r", "http://www.foo.bar/data/foo.txt.gz") < 0 ) {
```

When a path has http:// at the beginning of it, the code connects to a Web server, and, when it is determined based on the analysis results of the MIME header and the suffix of the path that the file needs to be extracted, reads the file utilizing zlib or bz2lib.

The following is an example of writing into an FTP server. A user and password can be specified. When a user and password are omitted, the server is accessed anonymously. Compression is also performed depending on the suffix of a path.

```c
fout.open("w", "ftp://username@passwd:ftp.foo.bar/data/foo.txt.gz")
```

Using `openf()` instead of `open()`, you can set the path name in a similar manner to using the arguments for the `printf()` function. (other classes also have `openf()`)

```c
for ( i=0 ; i < N ; i++ ) {
    fin.openf("r", "ftp://foo.ac.jp/file_%d.txt.gz", i);
    ;
    fin.close();
}
```

Thus, `openf()` is convenient when handling numbered file names or when specifying arguments for a cgi script on a Web server.

Unlike the stdstreamio class, the digeststreamio class has a member function called `openp()` (§8.8.2). The `openp()` member function is a member function specific to the digeststreamio class that can be used in a similar manner to Perl. For example, `fin.openp(...) in the first example can be written as follows:

```c
fin.openp("< foo.txt.gz")
```

`openp()` is extremely useful as it actually allows a wider variety of usages.

The following is an example of inputting using a pipe:

```c
pin.openp("cat /etc/hosts | egrep -v -e '^[#-e '^[$]' |")
```

The following is an example of outputting using a pipe:
3.2.3 Correspondence relationships with the functions of the libc

openp() and openpf() that appeared in §3.2.2 are the member functions specific to the digest-streamio class, but getstr() and getline(), etc. can be used for the digest-streamio class in exactly the same manner as for the std-streamio class, so that users do not need to learn new APIs. What is more, most of the member functions for the stream input/output in SLLIB all correspond to the standard functions of the libc, so they can be used without feeling challenged. Table 4 shows the correspondence relationships between the stream input/output APIs of the libc and SLLIB.

<table>
<thead>
<tr>
<th>libc</th>
<th>SLLIB</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>fopen(path, mode)</td>
<td>open(mode, path), openf(mode, path_fmt, ...)</td>
<td>8.1.1</td>
</tr>
<tr>
<td>fclose(fp)</td>
<td>close()</td>
<td>8.1.2</td>
</tr>
<tr>
<td>fread(buf, size, nmemb, fp)</td>
<td>read(buf, size)</td>
<td>8.1.3</td>
</tr>
<tr>
<td>fwrite(buf, size, nmemb, fp)</td>
<td>write(buf, size)</td>
<td>8.1.3</td>
</tr>
<tr>
<td>fgetc(fp)</td>
<td>getchr()</td>
<td>8.1.8</td>
</tr>
<tr>
<td>fgets(buf, size, fp)</td>
<td>getstr(buf, size)</td>
<td>8.1.8</td>
</tr>
<tr>
<td>fscanf(fp, format, ...)</td>
<td>scanf(format, ...)</td>
<td>8.1.11</td>
</tr>
<tr>
<td>fputc(ch, fp)</td>
<td>putchr(ch)</td>
<td>8.1.12</td>
</tr>
<tr>
<td>fputs(buf, fp)</td>
<td>putstr(buf)</td>
<td>8.1.12</td>
</tr>
<tr>
<td>fprintf(fp, format, ...)</td>
<td>printf(format, ...)</td>
<td>8.1.14</td>
</tr>
<tr>
<td>fflush(fp)</td>
<td>flush()</td>
<td>8.1.15</td>
</tr>
</tbody>
</table>

Table 4: Correspondence relationships between the stream input/output APIs of the libc and SLLIB

SLLIB has the different specifications for the function names and some of the arguments from those in the libc, and this is because the inconsistency of the APIs seen in the libc has been resolved. For example, looking into the function names of the libc reveals that the libc has the ill-defined naming conventions for function names. In the libc, the functions that contain the meaning of “character” include getchar(), fgetc() and strchr(), and their multiple abbreviations such as “char”, “c” and “chr” coexist, making it difficult for the function names to be remembered. Concerning these parts, SLLIB’s naming conventions state:

“character” is abbreviated as “chr”, “string” is abbreviated as “str”

And determine the member function names according to this convention. In addition to the member functions listed in Table 4, the APIs for strings (Table 18), etc. have this convention applied to them, so SLLIB’s member function names as a whole should be able to be easily remembered.

When you are able to use the standard input/output stream (the std-streamio class; §8.2) or the versatile input/output stream (the digest-streamio class; §8.3) then you can also use the gzip-compressed input/output stream (the gz-streamio class; §8.4), bzip2-compressed input/output stream (the bz-streamio class; §8.4), the http input stream (the http-streamio class; §8.5), the ftp input/output stream (the ft-streamio class; §8.6), the pipe input/output stream (the pipe-streamio class; §8.7), the per-terminal line input/output (the termlineio class; §8.9), etc. in exactly the same manner. When you want to use these input/output streams, you can specify in the #include <sli/...> part a class name you want to use, create the object with a class you want to use, and likewise read and write files, etc. using open() and other functions.

The brief summary of the c-streamio class and its derived classes is provided in §7 where Table 6 shows which member function can be used for which class, helping users have an overview of those classes. Please see the section.
3.2.4 Endianness conversion of complex binary data

The bread() member function and bwrite() member function enable binary streams to be read and written while performing the endianness conversion according to the binary data structure defined by the user.

In the following example, a data block of one four-byte integer number, three double types and 64 char types is read twice and stored into the buffer buf.

```c
stdstreamio f_in;
bsstream_info binfo[] = { {4,1}, {-8,3}, {1,64}, {0} };
char buf[512];
ssize_t len;
/* Open the file */
if ( f_in.open("r","binary.dat") < 0 ) {
    Error handling
}
/* Reading of the binary stream (big endian) */
len = f_in.bread(buf, binfo, 2, false);
```

The last argument for bread() specifies the endianness of the binary data. In this example, a big endian is specified.

When you define in this code a structure representing the data block, and add the code that assigns the address for the buf to the pointer variable, then you can easily access the elements of each data. (In reality, the binfo array should be generated from its structure.)

3.2.5 Collaborations with GNUPLOT

When you are doing an operation and you want the results of the operation displayed in a real time, you may usually combine the use of a shell script.

The popen() function of the libc enables commands to be sent from the C language to gnuplot. In SLLIB, you also can do the same thing with the pipestreamio class.

The following code is a code that connects to gnuplot with pipes and sends a draw command to gnuplot to display the undulating animation.

```c
#include <sli/pipestreamio.h>
using namespace sli;

int main()
{
    pipestreamio pout;
    int i;

    pout.open("w", "gnuplot");
pout.printf("set isosamples 48\n");
    for ( i=0 ; i < 1000 ; i++ ) {
        pout.printf("splot sin(%g + sqrt(x*x+y*y))\n", i/10.0);
pout.flush()
    }
pout.close();

Fig. 1 shows how it appears when the code is executed.
3.3 Operating strings

In this section, we will discuss how strings are operated using SLLIB. Looking over Table 18 to have an overview of what sort of APIs are available will help make it easier to understand the discussions in the section.

3.3.1 Basics

Operating strings in C requires time and efforts. Using the tstring class (§9.5) in SLLIB makes it much easier to operate strings.

First, here is how it seems the class is most typically used.

```cpp
#include <sli/istreamio.h>
#include <sli/tstring.h>
using namespace sli;

int main(int argc, char *argv[]) {
    stdstreamio sio; /* Object for the standard output */
    tstring my_str; /* Create the string object */
    my_str = "Hello World"; /* Assign "Hello World" to my_str */
    sio.printf("my_str = '\%s\n', my_str.cstr()); /* write it into STDOUT */
}
```

As shown above, strings can be assigned using the "=" operator. "=" for the const char *type enables the address of a string constant to be assigned, while "=" for the tstring class enables the object to have a buffer automatically secured in the inside of it and the entire string to be copied in the buffer. The beginning address of the internal buffer can be acquired using the cstr() member function (§9.5.3). Obviously, the end of the string that is acquired using cstr() finishes with \n, so the string can be swiftly given to printf(), etc. as seen above.

And, just all the same, printf() is essential. The printf() member function enables formatted strings to be assigned to an object without having to worry about the size of a buffer.
tstring my_str;  /* Create the object */
my_str.printf("filesize is \%d", size);  /* Assign the result of printf() to my_str */

Also in this case, the object has the required buffer automatically secured in the inside of it.

The following is an example of creating a string that combines argv[1] and argv[2]. This time, the code is written without using the operator “=”.

```c
int main( int argc, char *argv[] )
{
    tstring my_str;  /* Create the object */
    my_str.assign(argv[1]);  /* Assign argv[1] to my_str */
    sio.printf("my_str = '%s'
",my_str.cstr());  /* Write it into STDOUT */
    return 0;
}
```

Also in the process of editing strings such as append(), the internal buffer for the object my_str is automatically adjusted. (When the object disappears, then the area of the internal buffer also is automatically released.) In this example, the string that combines argv[1] and argv[2] is put into the internal buffer for my_str.

### 3.3.2 Accessing characters one by one

When you want to read the buffer inside the object one character by one, write as follows:

```c
for ( i=0 ; i < my_str.length() ; i++ ) {
    sio.printf("[\%c]",my_str.cchr(i));
}
```

length() returns the length of the string (§9.5.1), and cchr(i) returns the character code (int type) for the i th character (§9.5.5).

To edit this buffer with a single character, write:

```c
my_str.at(i) = 'a';
```

or

```c
my_str[i] = 'a';
```

(§9.5.6, §9.4.1). In this case, the i th character of the internal buffer is changed to 'a'. i can be any given value, and if there is not a sufficient area for the internal buffer, the buffer is automatically secured again. The same can be done using the put() member function (§9.5.16).

### 3.3.3 Applications for reading text files from a stream

The operator “=” (§9.4.2) for the tstring class returns the const char *type to const char * inputs, so that short codes can be written that handle text files from a stream.

The following code is a typical example of how text files are handled in SLLIB.
#include <sli/digeststreamio.h>
#include <sli/tstring.h>

digeststreamio fin;  // Object for inputting the stream */
tstring line;    // Use it as a line buffer */
if ( fin.open("r", "foo.txt.gz") < 0 ) { /* Open as read only */
   Error handling
}
while ( (line=fin.getline()) != NULL ) {
   line.trim("\n");  // Delete the newline character */
   /* Various handling */
   sio.printf("%s\n", line.cstr()); // Display it */
}

In this example, the trim() member function is used to delete the newline character, but you can also use the chomp() member function.

### 3.3.4 Editing strings

The member functions for editing strings include `append()`, `insert()`, `replace()`, `erase()`, `crop()`, `chomp()`, `trim()`, `toupper()`, `tolower()`, etc. so that addition, insertion, replacement and other operations can be performed easily (§9.5.17 and thereafter).

Many of the member functions have “f” as the ending character of their function name. Examples include `insertf()` and `replacef()`, and these can be given an argument to use, like `printf()`.

```cpp
my_str.insertf(0, "ID:%d \n", id);  // Insert the formatted string into the position 0 */
```

As appeared in §3.3.3, `trim()` is one of the functions that are used in many occasions.

```cpp
my_str = " Hello World \n";
my_str.trim(" \n"); // Delete the white spaces to the right and left */
```

When you write as above, the object `my_str` has "Hello World" put into it. (The white space in the center remains.)

In addition to the “=” operator that appeared in §3.3.1, the operator “+=” is also available to use. “+=” is a member function that has the same features as “append()”, so when you want to combine two strings, you can also write:  `my_str = argv[1];
my_str += argv[2];`

### 3.3.5 Leveraging strings

The member functions for converting strings into other forms include `atof()`, `atoi()`, `scanf()`, etc. (§9.5.35 and thereafter). For example, you write:

```cpp
double my_value;
my_value = my_str.atof();
```

and then the string of the internal buffer for `my_str` can be converted into an actual numerical value.

The member functions for comparing or searching for strings include `strcmp()`, `strcascomp()`, `strchr()`, `strstr()`, `strpbrk()`, `strspn()`, `regmatch()`, etc. (§9.5.41 and thereafter).

For example, to look into whether a string matches the string "sllib", you can write:
if ( my_str.strcmp("sllib") == 0 ) {
}
or
if ( my_str == "sllib" ) {
To compare a string with "sllib" case-independently, you can write:
if ( my_str.strcasecmp("sllib") == 0 ) {

The tstring class has a wealth of member functions. Most of the features provide by the string-related APIs in libc and the member functions of the string class in the C++ standard library are available to use. For details, refer to the reference attached.

3.3.6 Applications of the extended regular expressions (Back reference is also available)

You can search for or replace strings using the POSIX extended regular expressions (the regmatch() member function; §9.5.59, the regreplace() member function; §9.5.30).

First, here is the simplest example. A regular expression is used to look into whether a string is prefixed with a number:

```c
stdstreamio sio;
tstring my_str = "123abc";
if ( 0 <= my_str.regmatch("^[0-9]", NULL) ) {
    sio.printf("Matched the string\n");
}
```

When a string is matched, regmatch() returns the position of the string that is matched.

Obviously, you can retrieve back reference information. To do so, use the regassign() member function of the tarray tstring class. See the descriptions in §3.4.8.

This time, a regular expression is used to perform conversion, as though the sed command is used.

```c
stdstreamio sio;
tstring my_url = "http://darts.isas.jaxa.jp/foo/";
my_url.regreplace("([a-z]+://)\([^/]+\)((.*)", "\2");
sio.printf("hostname = %s\n", my_url.cstr());
```

Using the back reference, the host name “darts.isas.jaxa.jp” is retrieved from the URL.

When regreplace() has its third argument set with true, it does not just replace a string of the first run but replace the whole string (like ‘s/././g’ in sed).

3.4 Operating string arrays

As shown below, you can create an array of the tstring class in the same manner as normal types.

```c
tstring my_arr[32];
my_arr[0] = "abc";
```

However, this way of use does not offer a degree of freedom to edit the arrays.

The tarray tstring class (§10) provides more flexibility with which to handle string arrays. It enables you to perform various operations that include resizing of arrays, edit strings on any string element (chomp(), trim() etc.) and search (find(), regmatch(), etc.), all with much less effort. Obviously, like the tstring class, the size of an internal buffer is automatically adjusted to provide much ease of operation. Acquisition from and conversion to pointer arrays can be done easily to ensure the compatibility with C-language-like codes.
Looking over Table 22 to have an overview of what sort of APIs are available will make it easier to understand the discussions hereinafter.

### 3.4.1 Immediate assignment

Since the memory management is entirely automatic, you do not need to write codes like “First, 10 objects are secured, and then ...” Once you have created objects, you can assign them immediately.

The most frequently used methods of substituting objects are substituting a null-terminated pointer array and substituting a constant string, as shown in the following example:

```c
#include <sli/stdstreamio.h>
#include <sli/tarray_tstring.h>
using namespace sli;

int main()
{
    stdstreamio sio;
    const char *group1[] = {"sakura", "mizuho", NULL};
    tarray_tstring my_arr = group1;
    size_t i;
    my_arr[2] = "fuji";
    my_arr[3] = "hayabusa";
    for ( i=0; i < my_arr.length() ; i++ ) { /* Display it */
        sio.printf("%zu: [%s]\n", i, my_arr[i].cstr());
    }
}
```

The result of the execution is as follows:

| 0 | [sakura]  |
| 1 | [mizuho]  |
| 2 | [fuji]    |
| 3 | [hayabusa]|

You can also assign values when you create objects, as shown below. (Do not forget to add NULL at the end.)

```c
tarray_tstring my_arr("sakura", "mizuho", NULL);
```

For the information about how to initialize objects, refer to §10.1.

### 3.4.2 Using dprint() for debugging

Inserting `fprintf(stderr, ... );` into codes for debugging is an operation that is commonly seen on a routine basis. However, for arrays you must always take a somewhat cumbersome step of looping the array with a for statement, etc. to display all the elements of the array.

In cases like this, you can output the list of arrays to the standard error output only by using the dprint() member function (§10.4.5). For example, you write:

```c
tarray_tstring my_arr("nEC", "Fujitsu", "Toshiba", NULL);
my_arr.dprint();
```

and then you have the following displayed:

```c
sli::tarray_tstring[obj=0x7fbfffff230] = {"nEC", "Fujitsu", "Toshiba"}
```

The address for the object is displayed, which is obviously a value that is dependent on the
environment.

The `dprint()` member function can also be used in the asarray_tstring class (a class that handles associative arrays; §11) and mdarray_* class (multidimensional arrays; §12). See also §11.4.10 and §12.3.37.

### 3.4.3 Swiftly passing on to `execv()` and `execvp()`

The `cstrarray()` member function (§10.4.2) enables you to acquire a null-terminated pointer array for the string buffer inside an object, so that it can be simply given to arguments for the char *[] type such as `execv()` in the libc.

```cpp
tarray_tstring cmd;
  :
  execvp(cmd[0].cstr(), (char *const *)cmd.cstrarray());
```

### 3.4.4 Editing strings on all the elements

For example, you use `split()` as below to split a string in csv format and store it into an array (`split()` is described hereinafter in §3.4.7):

```cpp
const char *line = "Z-80,, 8086, 6800";
tarray_tstring my_arr;
my_arr.split(line, ",", true);
my_arr.dprint();
```

When this code is executed, the following is displayed:

```
sli::tarray_tstring[obj=0x7fbffff4d0] = {"Z-80", "", "8086", "6800"}
```

In this case, the white space characters to the right and left of the split strings are unnecessary. When you want to remove these unnecessary white space characters from all the elements, you only need to write as follows:

```cpp
my_arr.trim();
```

The member functions that are capable of operating a string on all the elements in a stroke in this way include `trim()` as well as `chomp()`, `strreplace()`, `regreplace()`, `tolower()`, `toupper()`, etc. (For the complete list, refer to Table 22). For details, refer to the Reference part, §10.4.27 and thereafter.

### 3.4.5 Editing arrays

As you see `erase()` in the example in §3.4.6, there are also other member functions such as `append()`, `insert()`, `replace()`, etc., which can be used to easily edit arrays in the same manner as in the tstring class (§10.4.16 and thereafter).

The following example shows that elements are inserted and added to the array:

```cpp
tarray_tstring arr;
arr[0] = "SUICA";
arr.insert(0, "ICOCA", 1);  /* Insert it */
const char *others[] = {"PASPY", "PASMO", NULL};
arr.append(others);  /* Append it */
```

The result of this is the arr object that has the four elements contained in it in an order of "ICOCA", "SUICA", "PASPY" and "PASMO".
3.4.6 Making arguments for main() easy to use

A well-known argument for main() is the getopt() function in the libc, but the tarray_tstring class may be convenient when you do not necessarily need to use getopt().

As shown in §3.4.1, the objects of the tarray_tstring class can have all the string elements of a null-terminated pointer array of the char *[] type copied to them using just only the “=” symbol. After the elements are copied, they can be freely edited and applied using the member functions that are provided.

```cpp
#include <sli/stdstreamio.h>
#include <sli/tarray_tstring.h>
using namespace sli;

int main( int argc, char *argv[] )
{
    size_t i;
    double x = 0, y = 0;
    stdstreamio sio;
    /* Make arguments available to use in args */
    tarray_tstring args = argv;

    /* Delete args[0] */
    args.erase(0,1);

    /* Analyze and edit the argument */
    for ( i=0 ; i < args.length() ; i++ )
    {
        if ( args[i] == "-x" ) {
            x = args[i+1].atof();
            args.erase(i,2);
        }
        else if ( args[i] == "-y" ) {
            y = args[i+1].atof();
            args.erase(i,2);
        }
    }

    /* Display the arguments that could not be analyzed */
    for ( i=0 ; i < args.length() ; i++ )
    {
        sio.printf("%s\n",args[i].cstr());
    }
}
```

The == operator, .atof() and .cstr() appearing in this example are the member functions of the tstring class. This means that any of the member functions of the tstring class can be used following args[i]. Processes using regular expressions can be performed quite easily.

3.4.7 Splitting white space-delimited and CSV-format strings to put into an array—split() member function

The split() member function enables you to split a white space-delimited or CSV-format one-line string into elements and handles them as arrays (§10.4.12). The split() member function provides the remarkably powerful features such as supporting special processing of parts parenthesized with quotation marks, and can switch its behaviors for splitting strings depending on the user’s application. The options include:

- Whether or not to allow elements with a string length of zero such as those in CSV format
(When allowed: "abc,,xyz" → "abc", "", "xyz") (When not allowed: "abc  xyz" → "abc", "xyz")

- To indicate that areas parenthesized with quotation marks and brackets are not allowed to be split (By default, those areas are not given special treatment.)
  (Example: "abc[ ] 'x y z?" → "abc[ ]", "'x y z?"")

- To specify escape characters (Example: "; By default, those characters are not specified.)
  (Example: "winnt program\ files" → "winnt", "program\ files")

First, the basic form. In this case, the behavior is the same as split in scripting languages.

```c
const char *line = "abc def wxyz ";
tarray_tstring my_arr;
my_arr.split(line, " ", false); /* Split it into "abc","def","wxyz" */
for ( i=0 ; i < my_arr.length() ; i++ ) { /* Display the split strings */
   sio.printf("%s
",my_arr.cstr(i));
}
```

The next shows a case in which strings are in CSV format. The third argument is set to `true` to allow elements with a string length of zero.

```c
const char *line = "JAN,,MAR,";
tarray_tstring my_arr;
my_arr.split(line, ",", true); /* Split it into "JAN","","MAR","" */
```

The following is a case in which parts parenthesized with quotation marks and parentheses are not split.

```c
const char *line = "winnt( ) program\ files 'mary\'s music';
tarray_tstring my_arr;
/* Split it into "winnt( )", "program\ files", "mary\'s music'" */
my_arr.split(line, " ", false, "'" , "'", false);
```

Thus, split() of SLIB is quite powerful.

### 3.4.8 Storing the result of regular expression matches

The result of matching regular expressions against a certain string can be stored into an array including back reference information (The regassign() member function; [§ 10.4.13]).

The following example shows that a keyword and a value are retrieved for the string "OS = linux".

```c
stdstreamio sio;
tarray_tstring my_elms;
tstring my_str = "OS = linux";
my_elms.regassign(my_str, "([\- ]+[ ]*[ ]*[\- ]+)+");
if ( my_elms.length() == 4 ) {
   sio.printf("keyword=[%s] value=[%s]\n",
              my_elms.cstr(1), my_elms.cstr(3));
}
```

When this code is executed, it is displayed as "keyword=[OS] value=[linux]". The string of a part that matches the whole of `my_pat` is put in `my_elms.cstr(0)` and the partial string of the back reference is put in `my_elms.cstr(1)` and thereafter.
3.5 Operating associative arrays

The asarray_tstring class ([11]) is a class for handling associative arrays of strings, and can be used quite easily in the same manner as the tarray_tstring class ([11]).

Looking over Table [23] to have an overview of what sort of APIs are available will help make it easier to understand the discussions hereinafter.

3.5.1 Immediate assignment

Associative arrays also can be assigned immediately (The operator “[]”; [11.3.1]).

```
#include <sli/asarray_tstring.h>
using namespace sli;

asarray_tstring my_arr;
my_arr["JR-EAST"] = "SUICA";
my_arr["JR-CENTRAL"] = "TOICA";
my_arr["JR-WEST"] = "ICOCA";
/* Display it */
for (i=0 ; i < my_arr.length() ; i++ ) {
    const char *key = my_arr.key(i);
    sio.printf("%s: [%s]\n", key, my_arr[key].cstr());
}
```

The result of executing the code is as follows:

```
JR-EAST: [SUICA]
JR-CENTRAL: [TOICA]
JR-WEST: [ICOCA]
```

3.5.2 Using dprint() for debugging

Like for the tarray_tstring class, dprint() can be used for the asarray_tstring.

You can output the list of associative arrays to the standard error output only by using the dprint() member function ([11.4.10]). For example, you write:

```
asarray_tstring my_arr("PKG","IDL", "VENDOR","ITT", NULL);
my_arr.dprint();
```

and then you have the following displayed:

```
sli::asarray_tstring[obj=0x7fbffff1f0] = { {"PKG", "IDL"}, {"VENDOR", "ITT"} }
```

The address for the object is displayed, which is obviously a value that is dependent on the environment.

3.5.3 Editing strings on all the elements

Also for associative arrays, the member functions for editing strings on all the elements are available. For example, you can set all the element values lowercase only by writing as follows:

```
asarray_tstring my_arr("OS","SOLARIS", "VENDOR","Sun", NULL);
my_arr.tolower();
my_arr.dprint();
```

Then you have the following displayed:
The member functions that are capable of operating a string on all the elements in a stroke in this way include `trim()`, `chomp()`, `strreplace()`, `regreplace()`, `toupper()`, etc. (For the complete list, refer to Table 23) For details, refer to the Reference part, §11.4.26 and thereafter.

### Editing

For associative arrays, it is supposedly less likely that the order of elements needs to be addressed. However, since the asarray_tstring class has the implementation requirements that the string arrays are indexed, users can operate the order of the elements. Like for the tarray_tstring class, the member functions such as `append()`, `insert()`, `erase()` are available (§11.4.19 and thereafter).

For example, to insert a set of key and value prior to the key, "JR–EAST", you can write as follows:

```c
my_arr.insert("JR-EAST", "JR-HOKKAIDO","KITACA");
```

### Easily accessing data files using `split_keys()` and `split_values()`

For example, suppose that you have a data file (with the file name of data.txt.gz) as below:

<table>
<thead>
<tr>
<th>NAME</th>
<th>FROM</th>
<th>TO</th>
<th>DISTANCE</th>
<th>LOCOMOTIVE</th>
<th>CARRIAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hokuriku</td>
<td>Ueno</td>
<td>Kanazawa</td>
<td>517.4</td>
<td>EF64,EF81</td>
<td>14-series</td>
</tr>
<tr>
<td>Akebono</td>
<td>Ueno</td>
<td>Aomori</td>
<td>772.8</td>
<td>EF64,EF81</td>
<td>24-series</td>
</tr>
<tr>
<td>Cassiopeia</td>
<td>Ueno</td>
<td>Sapporo</td>
<td>1214.9</td>
<td>EF81,ED79,DD51</td>
<td>E26-series</td>
</tr>
<tr>
<td>Hokutosei</td>
<td>Ueno</td>
<td>Sapporo</td>
<td>1214.9</td>
<td>EF81,ED79,DD51</td>
<td>24-series</td>
</tr>
</tbody>
</table>

Let us acquire the content of data.txt.gz into an associative array. When doing this, you can use `split()` for both the keys and values for the associative array (split_keys(); §11.4.17, split_values(); §11.4.18).

```c
#include <sli/stdstreamio.h>
#include <sli/digeststreamio.h>
#include <sli/asarray_tstring.h>

stdstreamio sio;
digeststreamio fin; /* Object for the stream input */
tstring line_buf; /* Line buffer */
asarray_tstring vals;
if ( fin.open("r", "data.txt.gz") < 0 ) { /* Open as read only */
  Error handling
}
if ( (line_buf=fin.getline()) == NULL ) { /* Read the column name */
  Error handling
}
vals.split_keys(line_buf.cstr(), " \n", false); /* Get the key */
while ( (line_buf=fin.getline()) != NULL ) {
  vals.split_values(line_buf.cstr(), " \n", false); /* Get the value */
  sio.printf("%s: %skm\n", vals["NAME"].cstr(), vals["DISTANCE"].cstr());
}
```

The text data file, data.txt.gz, is opened, and the column name on the first line of the data file is assigned to the key for the associative array using the `split_keys()` member function. The
data values on the second line and later are set to the values for the associative array using the split_values() member function. Of all the values, the columns for NAME and DISTANCE are output to the standard output.

The result of executing the code is as follows:

<table>
<thead>
<tr>
<th>Name</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hokuriku</td>
<td>517.4km</td>
</tr>
<tr>
<td>Akebono</td>
<td>772.8km</td>
</tr>
<tr>
<td>Cassiopeia</td>
<td>1214.9km</td>
</tr>
<tr>
<td>Hokutosei</td>
<td>1214.9km</td>
</tr>
</tbody>
</table>

split_keys() and split_values() support the processing of double quotation marks and escape characters, like for the tarray_tstring class. For details, refer to the Reference.

3.6 Handling multidimensional arrays without effort

Using the inherited classes for the mdarray class helps you to easily handle the one-dimensional and multidimensional arrays of the types in the C language (§12). The selections of elements using IDL/Python-like expression, mathematical functions (log10(), sin(), cos(), etc. See Table 25), operators (+, -, *, /; §??) for operating arrays on all their elements, functions for basic statistics, etc. are available. Obviously, users do not need to have codes to secure the memory.

The mdarray class has two operation modes: Users can select the “Auto-resizing mode” that resizes objects automatically, or the “Non-auto resizing mode” that resizes objects based on the user’s specifications. These operations modes can be selected when creating objects or when initializing objects using the init() member function. (When nothing is specified, the mode is the “Auto-resizing mode.”)

3.6.1 Immediate assignment (Auto-resizing mode: One-dimensional arrays through three-dimensional arrays)

Also for mdarray, you can assign objects immediately.

```cpp
#include <sli/mdarray.h>
using namespace sli;

mdarray_double arr; /* Use it in 8-byte double */
arr[0] = 1.57079632679489661923;
arr[1] = 3.14159265358979323846;
/* Display it */
for ( i=0 ; i < arr.length() ; i++ ) {
    sio.printf("[%f]\n", arr[i]);
}
```

This example uses the mdarray_double class, and the other classes include the mdarray_float class, the mdarray_uchar class (the unsinged char type), the mdarray_short class, the mdarray_int class, the mdarray_long class, the mdarray_llong class (the long long type), the mdarray ssize class (the ssize_t type) and the classes that support several types defined by stdint.h7).

For example, to handle arrays of the long type, you write:

```cpp
mdarray_long larr;
```

Also for the Auto-resizing mode, when you want to use an array as a two-dimensional or three-dimensional array, you write:

This example uses the mdarray_double class, and the other classes include the mdarray_float class, the mdarray_uchar class (the unsinged char type), the mdarray_short class, the mdarray_int class, the mdarray_long class, the mdarray_llong class (the long long type), the mdarray ssize class (the ssize_t type) and the classes that support several types defined by stdint.h7).

7) The byte size for the short type, the int type, the long type and the long long type is implementation-dependent. When the byte size for a single element needs to be exact, you can use the mdarray_int16 class, the mdarray_int32 class and the mdarray_int64 class.
arr(0,1) = 0.31830988618379067154;
arr(0,0,1) = 1.41421356237309504880;
and then the array is extended to a two-dimensional or three-dimensional array. For two-dimensional and three-dimensional arrays, “()” is used instead of “[]” (§12.3.1 and §12.3.2). When the number of dimensions for arrays each is \(n_0, n_1, n_2\), as many internal buffers as \(n_0 \times n_1 \times n_2\) are secured. At this time, the value for undefined elements has 0 assigned to it by default, and that default value can also be specified by the user.

If you want to have objects always read using double regardless of the type registered in the object, you can use the dvalue() member function (§12.3.32) and the assign() member function (§12.3.45), as follows:

```c
double value;
value = arr.dvalue(x0,y0,z0);
arr.assign(value, x1,y1,z1);
```

Assignments to and operations of objects that are initialized with the integer number type default to “truncating all the decimal places,” but can be set to “rounding to the nearest.” You can specify which of these two you want to use by using the set_rounding() member function.

### 3.6.2 Updating number of dimension and elements

Basic method to update number of dimension and elements is to use resize_1d(), resize_2d(), or resize_3d() (§??? and thereafter).

Here is an example:

```c
mdarray_double arr;
arr.resize_2d(1024, 768); /* 2d-array of 1024x768 */
```

### 3.6.3 Resizing for each dimension

The member functions that are available for the resizing process for each dimension include resize(), resizeby(), insert(), crop(), erase(), etc. (§12.3.50 and thereafter). For example, The resize() member function (§12.3.53). resizes objects on a per-dimension basis, as follows:

```c
arr.resize(0, 1024); /* One-dimensional */
arr.resize(1, 768); /* Two-dimensional */
```

In addition, you write:

```c
arr.insert(1, 128, 256);
```

and then the position 128 in the two-dimensional object (The index for dimensions also begins with 0) can have 256 elements inserted into it. The parts in which elements are inserted are initialized.

### 3.6.4 Operations on arrays

The operators, “+”, “-”, “*”, “/”, “+=”, “-=”, “=*”, “/=”, can be used for the objects or scalar values for the mdarray class (§12.3.3 and thereafter). Most of the mathematical functions defined by math.h in the libc can be used for the objects or scalar values for the mdarray class (Table 25). The manner of use such as `arr=pow(arr,2.0)` is possible.

The types of the multiple objects used in the operation do not need to be matched. For example, you can operate as follows:

```c

In this case, the larr object that handles the long type and the darr object that handles the double type are created, and all the elements for the darr object are multiplied by 10.0, and finally all the elements of darr appended with larr are logged, and the result is assigned to darr.

As shown at the end of this example, the type of the result of operating two objects with different types is the same as when normally operating scalar values.

### 3.6.5 Non-auto resizing mode (For image buffers)

Like image buffers, applications that the automatic resizing does not suit may exist. In that case, you can specify `false` to the first argument when initializing an object. (Concurrently, you can specify the initial size for each dimension.)

The following example shows that three 1920 x 1080 images where one of the elements is unsigned char (8-bit).

```cpp
mdarray_uchar arr(false);
arr.resize_3d(1920,1080,3);
```

Also in this case, each element is accessed as in:

```cpp
arr(x,y,z) = value;
```

but specifying values outside the range to x, y, z does not result in errors. When a value is out of the range and when you write the value, it is simply discarded, and when you read the value, `INDEF_UCHAR` is returned.

When you want to change the number of dimensions along the way, utilize the `increase_dim()` member function (§12.3.55) and the `decrease_dim()` member function (§12.3.56), and when you want to resize the buffer, utilize `resize_1d()`, `resize_2d()`, and `resize_3d()` or the `resize()` member function (§12.3.53), the `resizeby()` member function (§12.3.54), etc.

We do not recommend that using both auto resizing mode and non-auto resizing mode in an application, since “=” operator copies not only elements but also such attributes.

### 3.6.6 Fastest access to array elements

The code `arr(x,y,z) = ...;` shown in §3.6.1 and §3.6.5 is safe but not very fast, since values of arguments are always tested to prevent buffer overrun. If you want fastest access to array elements, the pointer arrays for 2-d or 3-d data are available that are automatically generated in the mdarray object. Use `array_ptr_2d()` or `array_ptr_3d()` (§?? and §??) to obtain a pointer array like this:

---

8) This is not slower than mathematical functions such as `sin()`, etc.
mdarray_float arr0(false);
arr0.resize_2d(8,4);
float *const *arr0_ptr = arr0.array_ptr_2d(true);
size_t i, j;
for ( i=0 ; i < arr0.row_length() ; i++ ) { /* Y */
    for ( j=0 ; j < arr0.col_length() ; j++ ) { /* X */
        arr0_ptr[i][j] = 100 + 10*i + j;
    }
}
arr0.dprint();

The result of executing the code is as follows:

sli::mdarray[obj=0xbffff4f0, sz_type=-4, dim=(8,4)] = {
    { 100, 101, 102, 103, 104, 105, 106, 107 },
    { 110, 111, 112, 113, 114, 115, 116, 117 },
    { 120, 121, 122, 123, 124, 125, 126, 127 },
    { 130, 131, 132, 133, 134, 135, 136, 137 }
}

The value of argument of array_ptr_2d() and array_ptr_3d() is a switch to turn on/off for the pointer array generation in the object. Setting false will disable it.

The mdarray class manages an internal buffer for an n-dimensional array on a 1-d buffer. Therefore, you can obtain first address of the internal buffer using array_ptr() (§12.3.38), and access each element after calculating address of it in your code.

### 3.6.7 Copy and operation of images using IDL/Python-like expression

Using IDL/Python-like expression, you can easily copy a part of an image to the copy buffer, and paste the image in that copy buffer to any given position. Also, image operations of addition, subtraction, multiplication and division can be performed only by using member functions, and complex image operations can also be performed by collaborating with statistical functions (§?? and thereafter). Here, we will discuss the simple example for them continued from 3.6.6.

Next code copies a part of float-type array arr0 shown in 3.6.6 into double-type array arr1 (including type conversion):

```cpp
mdarray_double arr1(false);
arr1 = arr0.sectionf("4:7, *");
arr1.dprint();
```

The result of executing the code is as follows:

sli::mdarray[obj=0xbffff2d0, sz_type=-8, dim=(4,4)] = {
    { 104, 105, 106, 107 },
    { 114, 115, 116, 117 },
    { 124, 125, 126, 127 },
    { 134, 135, 136, 137 }
}

For “=” operator used in “arr1 = arr0.sectionf(...);”, shallow copy is applied when types of input and output are identical. Note that argument "4:7,*" and "(4:7,*)" are interpreted as 0-indexed. If you want to use 1-indexed, expression like "[...]" is allowed. That is, "4:7,*" is equivalent to "[5:8,*]".

Next code pastes array arr1 onto 2 <= y of array arr0:

```cpp
mdarray_double arr1(false);
arr1 = arr0.sectionf("4:7, *");
arr1.dprint();
```
The result is as follows:

```cpp
sli::mdarray[obj=0xbffff4f0, sz_type=-4, dim=(8,4)] = {
  { 100, 101, 102, 103, 104, 105, 106, 107 },
  { 110, 111, 112, 113, 114, 115, 116, 117 },
  { 104, 105, 106, 107, 124, 125, 126, 127 },
  { 114, 115, 116, 117, 134, 135, 136, 137 }
}
```

When you use `addf()`, `subtractf()`, `multiplyf()` and `dividef()` instead of `pastef()`, you can do image operations of addition, subtraction, multiplication and division. Next code divides elements of `arr0` by that of `arr1` on the same place:

```cpp
arr0.dividef(arr1, "*, 2:3");
arr0.dprint();
```

The result is as follows:

```cpp
sli::mdarray[obj=0xbffff4f0, sz_type=-4, dim=(8,4)] = {
  { 100, 101, 102, 103, 104, 105, 106, 107 },
  { 1, 1, 1, 1, 124, 125, 126, 127 },
  { 1, 1, 1, 1, 134, 135, 136, 137 }
}
```

In member functions that have "f" as the ending character of their function name such as `sectionf()`, you can set the argument in a similar manner to using the arguments for the printf() function. For example, you can set a section using some variables like this:

```cpp
arr1 = arr0.sectionf("%d:%d, %d:%d",
  x, x + width - 1, y, y + height - 1);
```

### 3.6.8 Statistics for array elements

SLLIB provides functions to calculate statistics (mean, variance, median, etc.) of elements in mdarray objects. The header file for statistics `sli/mdarray_statistics.h` exists in installed directory (e.g., `/usr/local/include/`), and you can find that the raw code for statistics in the header file, i.e., functions for statistics have ‘inline’ attributes. This means that you can easily confirm and reuse the routines without using original SLLIB source package.

We show a code to calculate mean, variance, skewness, and kurtosis for last `arr0` in example in §3.6.7:

```cpp
/* get mean, variance, skewness, kurtosis */
mdarray_double moment = md_moment(arr0, false, NULL, NULL);
moment.dprint();
```

The result is as follows:

```cpp
sli::mdarray[obj=0xbfffee90, sz_type=-8, dim=(4)] = {
  87.125, 2657.919355, -0.967679358, -0.8964442873
}
```

Functions only for mean, only for median, etc. are also available, and there are different version of these functions that take statistics of x-direction, y-direction, and z-direction. For example, you
want obtain median\(^9\), the code is written like this:

```
arr1 = md_median_y(arr0);
arr1.dprint();
```

The result is as follows:

```
sli::mdarray[obj=0xbffff2d0, sz_type=-8, dim=(8,1)] = {
  { 50.5, 51, 51.5, 52, 119, 120, 121, 122 }
}
```

### 3.6.9 Combine images

When performing combine of images with mean, median, etc., you can create a 3-d array and use the function to obtain statistics for \(z\)-direction. Here is an example code:

```
/* Prepare a 3-d array for 10 images */
arr0.resize_3d(1024, 512, 10);

/* Paste each image onto each plane of 3d array */
mdarray_float arr_tmp;
arr_tmp.resize_2d(1024, 512);
for ( i=0 ; i < 10 ; i++ ) {
  arr0.pastef(arr_tmp, "*,*,%d", i);
}

/* Obtain median for z-direction */
arr1 = md_median_small_z(arr0);
```

When the number of images to combine is large, you can use \texttt{md\_median\_z()} instead of \texttt{md\_median\_small\_z()}. \texttt{md\_median\_small\_z()} uses temporary buffer for each \(zx\)-plane, therefore, it is good for performance but larger memory is required. \texttt{md\_median\_z()} uses temporary buffer for each pixel, therefore, the memory consumption is small. However, it is not good for performance, since there is some overhead of calling internal functions.

### 3.6.10 Conversion of endianness

The endianness can be converted using the \texttt{bread()} member function and \texttt{bwrite()} member function for the cstreamio class, but when you cannot properly apply these functions, you can use the \texttt{reverse\_endian()} member function (§12.3.43) of \texttt{mdarray} to perform the endianness processing.

```
mdarray_short arr1;

arr1.reverse_endian(false);
```

To the first argument for \texttt{reverse\_endian()}, specify \texttt{true} when the data to be stored in a file is a little endian, and specify \texttt{false} when otherwise. For example, specify \texttt{false} for the FITS files that are utilized in astronomy because they are a big endian. Although it is omitted in the example,

\(^9\) SLLIB calculates \texttt{true} median using fast algorithm. This is not IRAF’s \texttt{midpt} (an approximate value of median).
you can specify to the second and third arguments to perform partial endian conversion of array elements. For details, refer to the Reference.
4 Assumptions that users should comprehend before using SLLIB

Since SLLIB is a library for C++, you the users will use the C++ compilers. C++ basically has upward compatibility with C so you can write codes in the same manner as you did in C, and there is no need to worry.

However, there are several assumptions that users should comprehend before using SLLIB, and they are entirely not difficult to understand. The assumptions include the aspects of C++ that subtly lacks the compatibility with C as a result of extending C++, and the extended features of C++ that are less difficult to use and helpful. These assumptions are discussed in this chapter.

4.1 NAMESPACE

One of the things that are introduced in C++ is a namespace. It is designed to prevent it from occurring that different persons creating functions or types with the same name results in a trouble, and, simply put, it’s like a name for category. In SLLIB, a namespace called “sli” is added. For example, when you use some class, formally you use it with sli:: prefixed, as in “sli::stdstreamio sio;”. But if you are going to use SLLIB mainly, you will not want to write sli:: every time. In that case, you write:

```cpp
using namespace sli;
```

and then you can omit sli:: thereafter. In the examples of use described in this manual, sli:: is omitted. Users learning C++ for the first time are encouraged to remember that when they write “#include <sli/...>”, then they should write “using namespace sli;”.

4.2 NULL and 0

In many processing systems, null for C is defined as:
```
define NULL ((void*)0)
```

However, null for C++ is defined as:
```
define NULL (0)
```

In C++, NULL is 0 because in C++ the types of pointer variables are checked more strictly than in C. For example, there are two pointer variables, char *ptr0; and void *ptr1; and
```
ptr0 = ptr1;
```
results in an error. However, 0 is defined as “the address of nowhere”, so ptr0 = 0; does not result in an error. For this reason, NULL is 0 in C++.

Now, in C++ the member functions that a class has may have the same name but have different arguments. For example,
```
int foo( int a );
int foo( char *p );
```
are such cases. Here, if you write hoge.foo(NULL) or hoge.foo(0), the compiler would not understand which of the functions you want to use. In this case, when you want to use NULL or 0, you must cast it to explicitly indicate the type. Therefore, you must write as follows:

```cpp
hoge.foo((char *)NULL);
```

You can remember securely that in C++, “when you want to use NULL or 0, you must always cast it.” Or, in another way, you can discard NULL and “cast 0 to use it in all cases.”
4.3 const char *, char *const *, const char *const *

“const” is covered by the C language, but unexpectedly many users are not using it properly. Especially, in the pointer variables such as char *p and char **pp, const is important to make the specifications of the functions clear.

In SLLIB, as the arguments and return values for functions, there are expressions such as:

const char *p0
char *const *p1
const char *const *p2

We will discuss what is const in each of these.

For p0, changes such as p0[0] = c; are forbidden. Operations such as p0++; are not forbidden.

For p1, changes such as p1[0][0] = c; are not forbidden, but changes such as p1[0] = p; are forbidden.

For p2, changes such as p2[0][0] = c; and changes such as p2[0] = p; are both forbidden.

As seen above, the specifications of functions are made clear by using const.

Also, for other than functions, you will not mistakenly alter areas that are not allowed to be changed by using const as follows, for example:

```c
const char *name = "My Name";
```

You the users are encouraged to use const properly in C or C++ from today on.

4.4 References

References are a new type similar to the pointer type that was introduced in C++, but actually it can do only the simpler things than the pointer type does. For that reason, it can be used easily.

For example, when you create a reference for the variable called int a; with the name of alias_of_a, you write:

```c
int &alias_of_a = a;
```

References are also called “alias”, and behave in the manner just as indicated by this name. References are like symbolic links in a file system. For example, when you write

```c
alias_of_a = 10;
```

then a has 10 assigned to it, and when you write

```c
int b = alias_of_a;
```

then b has the value of a assigned to it. Also, when you write

```c
int *p = &alias_of_a;
```

then p has the address of a assigned to it.

As seen above, references are simply designed to provide an “alias” for variables, and do not have a number of “*” added to them like pointer variables so that you do not take time identifying them, or do not have NULL put in them. References do not have NULL put in them because it is forbidden to create a reference of which object does not exist, such as:

```c
int &alias_of_a;
```

In SLLIB, references are used when making an object for a structure or class an argument or return value for the member function. The reason why references are used is that since implementing references is to copy an address just the same, making an object for a structure or class an argument using a reference increases efficiency, and “does not let arguments or return values be treated/treat themselves as an array.” (For example, when the argument for a function is foo *p;, it is not clear whether p[n] is accessed or not.) As you may have already understood it, references are called by an address, so when an object is used as an argument for a function, the object referenced may be altered. However, when const is attached to the argument, the object will not
be altered. For example, when you have:

```c
int strcmp( const tstring &str, size_t pos2 = 0 );
```

then you can use as follows:

```c
  tstring foo;
  if ( hoge.strcmp(foo) == 0 ) {
    ...
  }
```

and `foo` will not be altered depending on `strcmp()`. (In SLIB, most of the arguments for references are attached with `const`.)

Unlike pointers, references can do only the simple things, so they can only be used for the limited applications such as handing over arguments for functions as seen above, and are dispensable. Therefore, you the users should not need to use references proactively. You can just remember that when you come across an argument for a reference, you should simply write an object in the argument, without attaching anything to it.

### 4.5 Pointer variables for an object and arguments/return values for a function

Pointer variables for an object can be created in the same manner as the types in the C language. Here is an example:

```c
  tstring foo = "abc";
  tstring *str_ptr = &foo;
  printf("%s\n", str_ptr->cstr());
```

To call a member function from a pointer variable, `"->"` is used instead of `"."`. This rule is the same as the one for structures.

This also applies when using pointer variables as an argument for a function.

```c
  int my_function( const tstring *str_ptr )
  {
    printf("%s\n", str_ptr->cstr());
  }
```

However, when you use a pointer variable as an argument for a function, and when the object for the argument is not altered, make sure that `"const"` is attached as an indication of that.

In C++, you also can use references ([§4.4](#4.4)) instead of pointer variables, except in specific cases. References will not have `NULL` put in them, so using references is more secure in this respect. Here is an example:

```c
  int my_function( const tstring &str_ref )
  {
    printf("%s\n", str_ref.cstr());
  }
```

As shown above, for references, `".cstr()"` is used instead of `"->cstr()"`.

You can also make objects a return value for a function.

```c
  tstring my_function( int a )
  {
    tstring ret;
    :
    :
    return ret;
  }
```

However, this has some disadvantage in the operation speed, so when you want a speed, you can have an argument for the pointer variable or an argument for the reference returned.

There are some arguments as to whether pointer variables or references should be used as an
argument for a function. For example, Google’s conventions state that “when you want to alter an object inside a function (i.e., when it is not const), a pointer variable must be used as an argument.” The author of this manual understands that the readers can create rules themselves and follow them.

5 FAQ

5.1 Frequent warnings and errors in compiling

5.1.1 warning: cannot pass objects of non-POD type

When a variable argument is given an object itself, this warning occurs in compiling. Simply executing this mostly results in a segmentation violation.

```cpp
#define tstring string

int main(){
tstring foo = "abc";
printf("%s\n",foo);  /* You forgot to attach .cstr() */
}
```

Add .cstr(), etc.

5.1.2 error: ‘xxx’ was not declared in this scope

Make sure that you have not forgotten to write “#include <sli/...>” or “using namespace sli;”.

5.1.3 error: call of overloaded ‘xxx’ is ambiguous

This error occurs when the types of the argument on the user program side and on the library side are not completely matched, and it can not be determined which of the member functions the user program is attempting to use.

Especially, you must be careful when you have given NULL or 0 to the argument. Remember that in C++ NULL is zero itself. For NULL and 0, also refer to §4.2.

When this error occurs, try to cast the argument.

5.1.4 error: invalid conversion from ‘const char*’ to ‘char*’

Writing the code as below results in this error:

```cpp
#define tstring string

int main(){
tstring foo = "abc";
char *p = foo.cstr();  /* You forget to attach const */
}
```

The second line should be “const char *p = ...” Also, you must not cast it forcefully.

5.1.5 error: passing ‘xxx’ as ‘yyy’ argument of ‘zzz’ discards qualifiers

Writing the code as below results in this error:

```cpp
int my_function( const tstring &my_arg )
{
    my_arg.append("abc");
}
```

The code is attempting to alter the object foo inside the function, but the argument for the function has the “const” attribute, so this results in an error.
6 Information for advanced users

6.1 Instructions for creating objects in the heap

In all the examples of code shown earlier in the manual, objects for a class were created in the stack. That is satisfying in most cases, but there may be cases in which you want to create objects in the heap by any means.

When you want to create objects in the heap, you must be careful. In that case, you cannot create an object using the malloc() function and the realloc() function. You must always use the “new” operator. And objects that are created using the “new” operator must always be deleted using the “delete” operator.

Here is an example of using new and delete to create and delete an object.

```c
#include <sli/asarray_tstring.h>
#include <sli/asarray.h>

asarray<asarray_tstring> my_config;
my_config["TEST"]["HOST"] = "www.foo.com";
printf("%s\n", my_config["TEST"]["HOST"].cstr());
```

You can also give an argument for the constructor, as in “new tstring(64);”.

Obviously, when you forget to write delete after new, a memory leak occurs. For this reason, you should minimize the use of new and delete.

6.2 When you want to create an array of objects in the heap

Also when you want to create an array of objects in the heap, you cannot use the malloc() function and the realloc() function. You must use the tarray template class or the asarray template class described in the SL LIB Advanced Course Manual, or the vector template class, etc. in STL.

The following example is a code that uses the asarray template class that is capable of creating the associative array for any given class. It manages the object for the asarray_tstring class using the associative array:

```c
#include <sli/asarray_tstring.h>
#include <sli/asarray.h>

asarray<asarray_tstring> my_config;
my_config["TEST"]["HOST"] = "www.foo.com";
printf("%s\n", my_config["TEST"]["HOST"].cstr());
```

6.3 Collaborations between structures and classes

Classes can also be used to define members for a structure. For example, you can use a class as follows:
struct mytag {
    int id;
    tstring name;
};
:
:
struct mytag foo;
foo.id = 0;
foo.name = "gates";
sio.printf("%s\n", foo.name.cstr());

Or, you can also use a class as an array, as follows:

struct mytag foo_arr[256];

As shown above, when you create an object for a structure from the stack, you do not need
to take care at all. However, when you create an object from the heap, you must do so in the
manners described in §6.1 and §6.2.

6.4 Handling of the exceptions, try {} & catch ()

SLLIB does not provide exceptions save “failed to secure the memory” and only a few other cases.
Therefore, if you do not wish to learn full-fledged coding, you may skip this section.

try{} and catch{} are the syntax for handling the “exceptions” that were introduced in
C++. SLLIB generates an “exception” when a fatal problem occurs which is not related to
any of the user-given arguments, such as “failed to secure the memory”10. This “exception”
can be captured using try{} and catch{} in the user’s code. For SLLIB, exceptions that are
generated always have a message of the err_rec type, so when you want to capture them, you
write as follows:

try {
    /* Resize the buffer for the array */
    array.resize(0,very_big_size);
    return_status = 0;
}
catch ( err_rec msg ) {
    sio.eprintf("[EXCEPTION] function=[%s::%s] message=[%s]\n",
                msg.class_name, msg.func_name, msg.message);
    return_status = -1;
}

Please note that if an exception occurs when you are not using try{} and catch( err_rec msg ){},
the abort() function is called, and the program terminates.

Normally, when a fatal error such as this occurs, in most cases the program are no longer able
to be continued. Therefore, you do not need to use try{} and catch( err_rec msg ){} if you
allow for the specifications that enable the abort() function to be called when an exception occurs.

---

10) The new operator described in §6.1 causes the bad_alloc exception to occur when you fail to assign the memory.
For the bad_alloc exception, please look into the details on Google, etc.
7 The CSTREAMIO class and a summary of its inherited classes

The cstreamio class is the abstract base class (a class in which the specifications for the basic member functions are formulated) that provides the file input/output APIs that are extremely similar with \texttt{stdio.h} in the libc. Understanding the specifications of the member functions for the cstreamio class enables users to handle a variety of streams that are supported by the inherited classes, without learning the APIs again from the scratch.

As shown in Table 5, there are the inherited classes that support the various streams, and the inherited classes have the member functions additionally defined in them that specialize in their respective streams. This section provides a summary of the CSTREAMIO class and its inherited classes, organized mainly on the tables.

For the examples of their use, refer to the examples in §3.2 of the Tutorial or in the Reference (§8.1 and thereafter).

7.1 A summary of the inherited classes

Table 5 shows a list of the cstreamio class and its inherited classes.

<table>
<thead>
<tr>
<th>Class name</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>stdstreamio</td>
<td>Standard input/output, standard error output, standard file input/output (corresponds to \texttt{stdio.h})</td>
</tr>
<tr>
<td>gzstreamio</td>
<td>gzip File input/output that supports compressions and extractions</td>
</tr>
<tr>
<td>bzstreamio</td>
<td>bzip2 File input/output that supports compressions and extractions</td>
</tr>
<tr>
<td>httpstreamio</td>
<td>http Input from servers (download)</td>
</tr>
<tr>
<td>ftpstreamio</td>
<td>ftp Input from servers (download) and output to ftp servers (upload)</td>
</tr>
<tr>
<td>pipestreamio</td>
<td>Input from pipes and output to pipes</td>
</tr>
<tr>
<td>digeststreamio</td>
<td>Automatically switches and uses {std, gz, bz, http, ftp} streamio depending on the path name</td>
</tr>
<tr>
<td>termlineio</td>
<td>Helpful command input (Wrapper to readline)</td>
</tr>
<tr>
<td>termscreenio</td>
<td>Input/output to the terminal screens (Starts the pager or editor)</td>
</tr>
<tr>
<td>inetstreamio</td>
<td>Low-level Internet client for the one- or two-way sequential connection</td>
</tr>
</tbody>
</table>

Table 5: List of the inherited classes of the cstreamio classes that users actually use

The member functions that are common to the inherited classes shown above are described in §8.1 and thereafter, and the member functions that are additionally defined in the inherited classes are described in §8.2 and thereafter. For the overview of those classes, refer to Table 6.

7.2 Overview of the implementation of the member functions for the base classes and inherited classes

Table 6 show a list of the member functions that indicates which of the member functions can be used for each class, or how it is implemented. The member functions on the upper half of the table are those formulated in the abstract base classes cstreamio, and the member functions on the lower half of the table are those additionally defined in the inherited classes.
Table 6: List of the member functions that the base class cstreamio and its inherited classes provide. The symbol, “⇐”, indicates that a member function for the base class is inherited. The member functions with a § symbol indicate that they are redefined or are additionally defined.
8 References for the CSTREAMIO class and its inherited classes

8.1 Member functions for the CSTREAMIO class

Table 7 shows a list of the member functions. For the member functions that have the same feature as in the libc, the functions that correspond are shown.

<table>
<thead>
<tr>
<th>cstreamio class Feature</th>
<th>Corresponding function in libc</th>
</tr>
</thead>
<tbody>
<tr>
<td>open(), openf(), vopenf() Opens a stream</td>
<td>fopen()</td>
</tr>
<tr>
<td>close() Closes a stream</td>
<td>fclose()</td>
</tr>
<tr>
<td>read() Input of a binary stream</td>
<td>fread()</td>
</tr>
<tr>
<td>write() Output of a binary stream</td>
<td>fwrite()</td>
</tr>
<tr>
<td>bread() Input of a binary stream (With endian conversion)</td>
<td>—</td>
</tr>
<tr>
<td>bwrite() Output of a binary stream (With endian conversion)</td>
<td>—</td>
</tr>
<tr>
<td>rskip() Seek forward (if possible) or read n bytes to skip data stream</td>
<td>—</td>
</tr>
<tr>
<td>wskip() Seek forward (if possible) or write n bytes of blank data</td>
<td>—</td>
</tr>
<tr>
<td>getchr() Input of a character</td>
<td>fgetc()</td>
</tr>
<tr>
<td>getstr() Input of strings</td>
<td>fgets()</td>
</tr>
<tr>
<td>getline() Input of a line</td>
<td>—</td>
</tr>
<tr>
<td>scanf() Converts an input with a format and assigns it to an argument</td>
<td>fscanf()</td>
</tr>
<tr>
<td>putchr() Output of a character</td>
<td>fputc()</td>
</tr>
<tr>
<td>putstr() Output of strings</td>
<td>fputs()</td>
</tr>
<tr>
<td>printf() Outputs a value of an argument after format-converted</td>
<td>fprintf()</td>
</tr>
<tr>
<td>flush() Outputs the content of a buffer forcefully</td>
<td>fflush()</td>
</tr>
<tr>
<td>eof(), error(), reseterr() Check and reset stream status</td>
<td>feof(), etc.</td>
</tr>
<tr>
<td>seek() Change position of streams</td>
<td>fseek()</td>
</tr>
<tr>
<td>rewind() Changes position of streams to the beginning</td>
<td>rewind()</td>
</tr>
<tr>
<td>tell() Value of stream position indicator</td>
<td>ftell()</td>
</tr>
<tr>
<td>is_seekable() Test for seekable stream or not</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 7: List of the member functions that the cstreamio class provides

8.1.1 open(), openf(), vopenf()

NAME
open(), openf(), vopenf() — Opens a stream

SYNOPSIS
int open( const char *mode ); ................................................................. 1
int open( const char *mode, int fd ); .................................................. 2
int open( const char *mode, cstreamio &sref ); ..................................... 3
int open( const char *mode, const char *path ); .................................. 4
int openf( const char *mode, const char *path_fmt, ... ); ..................... 5
int vopenf( const char *mode, const char *path_fmt, va_list ap ); ........ 6

DESCRIPTION
Opens the file shown in path or path_fmt, or connects to a stream the descriptor specified by
fd or the object for an inherited class of the cstreamio class specified by sref. As for mode, for the member functions 1 and 2, specify "r" when reading and "w" when writing. Also for the member functions 3 through 6, basically the same applies, but the available values differ depending on the inherited class, so refer to the descriptions for each inherited class.

The member function 3 is used in cases such as the one in which, when an object for an inherited class of the cstreamio class has any stream opened by it, the stream is changed during the course of the stream to a stream that is gzip- or bzip2-compressed (Refer to EXAMPLE-2).

For the member functions 5 and 6, the arguments for path_fmt and thereafter can be specified in the same manner as the ones for printf() and vprintf() in the libc. For the format for printf() and vprintf(), refer to the descriptions in §8.1.14.

**PARAMETER**

*I* | mode | File opening mode  
|-----|------|-----------------  
*I* | fd   | File descriptor  
*I* | sref | Object for inherited class of cstreamio class  
*I* | path | File name  
*I* | path_fmt | Specifications for file name format  
*I* | ... | Each element of a file name  
*I* | ap | All the elements of a file name  


**RETURN VALUE**

0 : Normal termination.

Negative value (error) : If the system failed to open the stream because the file does not exist etc.

: If the system failed to open the stream because the mode specified was inappropriate etc.

: If the system failed to open the stream because the relationship between the mode specified and fd is incorrect etc (Member function 2).

: If the system failed to open the stream because it cannot access the stream in the specified mode etc.

: If the string indicating the path for path_fmt exceeds PATH_MAX.

: If the stream has already been opened by any of the member functions detailed in this section.

**EXCEPTION**

If the system fails to copy a file or descriptor for the standard input/output.

**EXAMPLE-1**

The following code opens file.txt in directory in read mode:

```c
stdstreamio f_in;

if (f_in.openf("r", ",%s/%s", "directory", "file.txt") < 0) {
  Error handling
}

f_in.close();
```
EXAMPLE-2
The following code reads complex_file.dat made up of a one-line text header and gzip-compressed binary data, and then prints it to standard output:

```c
stdafxio f_in_text;
gzstreamio f_in_gz;
char c_buf[256];

if (f_in_text.open("r", "complex_file.dat") < 0) {
    Error handling
}

/* Read and display header */
printf("Header: %s", f_in_text.getline());

/* Read compressed data */
if (f_in_gz.open("r", f_in_text) < 0) {
    Error handling
}

/* Read and display compressed data line by line */
while (f_in_gz.getstr(c_buf, 256) != NULL) {
    printf("%s", c_buf);
}

f_in_gz.close();
f_in_text.close();
```

WARNING
The cstreamio class is an abstract class and hence cannot be directly used by users. It must be used as a member function for the classes shown in Table 5.

Refer to the descriptions for the class you actually use with the member functions of 3 to 6. The classes are described below:

- stdstreamio::open()
- gzstreamio::open()
- bzstreamio::open()
- httpstreamio::open()
- ftpstreamio::open()
- digeststreamio::open()
- pipestreamio::open()
- termlineio::open()
- termscreenio::open()
- inetstreamio::open()

8.1.2 close()

NAME
    close() — Closes a stream

SYNOPSIS
    int close();

DESCRIPTION
    Closes a stream opened by open().
RETURN VALUE

- 0 : Normal termination
- Non-zero : Error

EXAMPLE

The following code opens file.txt in directory in read mode and then closes it:

```cpp
stdstreamio f_in;

if (f_in.openf("r", "%s/%s", "directory", "file.txt") < 0) {
    Error handling
}

f_in.close();
```

WARNING

The cstreamio class is an abstract class and hence cannot be directly used by users. It must be used as a member function for the classes shown in Table

8.1.3 read(), write()

NAME

read(), write() — Input/output of streams

SYNOPSIS

```cpp
ssize_t read( void *buf, size_t size );
ssize_t write( const void *buf, size_t size );
```

DESCRIPTION

read() reads size bytes of data from the stream opened by open(), and then stores it in a buffer given by buf.

write() writes size bytes of data acquired from the buffer specified by buf to the stream opened by open().

PARAMETER

- [I] buf A buffer used to store data (For read())
- [O] buf A buffer used to store data (For write())
- [I] size Size of data

RETURN VALUE

- Positive value : Number of bytes successfully read and written.
- 0 : If the EOF of a stream to be read is reached. (read())
- : If the size specified is 0. (read())
- : If the stream is not opened. (read())
- : If open mode for the input/output stream is inconsistent.
- : If the stream to be read is abnormal before using the member function. (read())
- : If the system failed to read and write a stream for any other operating environment reason than described above. [For example, if a stream referenced by a file descriptor does not have enough space.]
EXAMPLE

The following code reads 512 bytes of data from the file file.txt in the directory of directory, opens it in read mode, and then stores it in the buffer given by buf:

```c
stdstreamio f_in;
char c_buf[1024];

if (f_in.openf("r", "%s/%s", "directory", "file.txt") < 0) {
    Error handling
}

if (f_in.read(c_buf, 512) < 0) {
    Error handling
}

printf("%s", c_buf);

f_in.close();
```

WARNING

cstreamio class is an abstract class and hence cannot be directly used by users. It must be used as a member function for the classes shown in Table 5.

If the size of a buffer specified by buf is smaller than size, the program may terminate abnormally or be forcefully terminated.

8.1.4 bread()

NAME

bread() — Input of binary streams

SYNOPSIS

```c
ssize_t bread( void *buf, ssize_t sz_type, size_t n,
    bool little_endian ); ...................................................... 1

ssize_t bread( void *buf, const bstream_info binfo[], size_t n,
    bool little_endian ); ...................................................... 2
```

DESCRIPTION

bread() reads binary data from the stream opened by open(), and then stores it in the buffer given by buf. Converts the order of the bytes, depending on the endian specifications provided by little_endian, and the operating system for the stream data.

With member function 1, n integer numbers or floating-point values of |sz_type| bytes are read. With floating-point values, sz_type is assigned a negative number.

With member function 2, the structure of binary data can be given by a bstream_info structure array, thus allowing even complex data to be handled. Data blocks defined by array bstream_info are read n times.

A bstream_info structure is defined as follows:

```c
typedef struct {
    ssize_t sz_type;
```
ssize_t length;
} bstream_info;

The member sz_type is given the number of bytes and type of data (a floating-point value if negative) of an element, while length is provided by the number of data. To indicate the end of the definition, sz_type must have 0 set at the end of the array.

**PARAMETER**

- **[O]** buf Buffer used to store data (For bread())
- **[I]** sz_type Number of bytes and type of data of element
  (Negative value: For floating-point values, Positive value: For integer numbers)
- **[I]** binfo Definition of the structure of a block of binary data
- **[I]** n Number of data or data blocks
- **[I]** little_endian Endian specifications for stream data
  (true : Little endian, false : Big endian)


**RETURN VALUE**

- Positive value : Number of bytes successfully read.
  - 0 : If the EOF of a stream to be read is reached.
- Negative value (error) : If the specified buf is inappropriate.
  - : If the stream is not opened.
  - : If the open mode for the input/output stream is inconsistent.
  - : If the stream to be read is abnormal before the member function is used.
  - : If the system has failed to read and write a stream for any other operating environment reason than described above. [For example, if a stream referenced by a file descriptor encounters an abnormal operation.]

**EXAMPLE**

The following code reads 4 bytes of data from the binary file of file.dat in the directory of directory, and stores it in a buffer given by ui_buf. It then prints the content of ui_buf to standard output in the hexadecimal format. In this case the binary file file.dat described as a little endian.

```c
stdstreamio f_in;
unsigned int ui_buf;

if (f_in.openf("r", "%s/%s", "directory", "file.dat") < 0) {
    Error handling
}

if (f_in.bread(&ui_buf, sizeof(ui_buf), 1, true) < 0) {
    Error handling
}

printf("%X\n", ui_buf);

f_in.close();
```
For more examples of using member function 2 refer to EXAMPLE in §8.1.5.

**WARNING**
The cstreamio class is an abstract class and hence cannot be directly used by users. It must be used as a member function for the classes shown in Table 5.

If the size of a buffer specified by `buf` is smaller than specified by the argument, the running program may terminate abnormally or be forcefully terminated.

## 8.1.5 bwrite()

**NAME**
bwrite() — Output of binary streams

**SYNOPSIS**

```c
ssize_t bwrite( const void *buf, ssize_t sz_type, size_t n,
                bool little_endian );                        1
ssize_t bwrite( const void *buf, const bstream_info binfo[], size_t n,
                bool little_endian );                        2
```

**DESCRIPTION**

bwrite() writes binary data provided by `buf` to a stream opened by `open()`, and converts the byte order depending on the endian specifications provided by `little_endian` and the operating system for the stream data.

With member function 1, `n` integer numbers or floating-point values of `|sz_type|` bytes are written. With floating-point values, `sz_type` is given a negative number.

With member function 2, the structure of binary data can be provided with a bstream_info structure array, thus allowing even complex data to be handled. Data blocks defined by the bstream_info array get written `n` times.

The bstream_info structure is defined as follows:

```
typedef struct {
    ssize_t sz_type;
    ssize_t length;
} bstream_info;
```

The member `sz_type` is given the number of bytes and type of data (a floating-point value if negative) of an element, and `length` is the number of data. To indicate the end of the definition, `sz_type` at the end of the array must have 0 set to it.

**PARAMETER**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>[I]</td>
<td><code>buf</code></td>
</tr>
<tr>
<td>[I]</td>
<td><code>sz_type</code></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>[I]</td>
<td><code>binfo</code></td>
</tr>
<tr>
<td>[I]</td>
<td><code>n</code></td>
</tr>
<tr>
<td>[I]</td>
<td><code>little_endian</code></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**RETURN VALUE**
Positive value : Number of bytes successfully written.
0 : If writing 0 byte is specified by an argument.
Negative value (error) : If the buf specified is inappropriate.
: If the stream is not opened.
: If the open mode for the input/output stream is inconsistent.
: If the stream to be written is abnormal before using the member function.
: If the system failed to read or write a stream for any other operating environment reason than described above. [For example, if a stream referenced by a file descriptor does not have enough space.]

**EXCEPTION**
If the system failed to secure a temporary buffer for use in converting an endian.

**EXAMPLE**
The following code writes the data blocks defined by binfo once to the binary file of file.dat in the directory of directory. A data block is defined as having three double types and 32 char types. In this case the binary file file.dat is described as big endian.

```c
stdafxio f_out;
bstream_info binfo[] = { {-8,3}, {1,32}, {0} };
char buffer[256];
: Register data to buffer :
if (f_out.openf("w", "%s/%s", "directory", "file.dat") < 0) {
    Error handling
}
if (f_out.bread(buffer, binfo, 1, false) < 0) {
    Error handling
}

f_out.close();
```

**WARNING**
The cstreamio class is an abstract class and hence cannot be directly used by users. It must be used as a member function for the classes shown in Table 5.

If the size of a buffer specified by buf is smaller than that specified by the argument the running program may terminate abnormally or be forcefully terminated.

---

### 8.1.6 rskip()

**NAME**
rskip() — Seek forward (if possible) or read \( n \) bytes to skip data stream

**SYNOPSIS**

```c
ssize_t rskip( size_t n );
```
DESCRIPTION
To skip data of readable stream, \texttt{rskip()} performs a seek forward for seekable stream. If seek is not possible, it reads \(n\) bytes and throws the data away.

PARAMETER
\begin{itemize}
  \item [I] \(n\) Byte length to be skipped
\end{itemize}

RETURN VALUE
\begin{itemize}
  \item Non-negative value : Byte length successfully sought or read.
  \item negative value : Error.
\end{itemize}

EXCEPTION
If the system failed to secure a temporary buffer for use in reading data stream.

WARNING
The \texttt{cstreamio} class is an abstract class and hence cannot be directly used by users. It must be used as a member function for the classes shown in Table 5.

8.1.7 \texttt{wskip()}

NAME
\texttt{wskip()} — Seek forward (if possible) or write \(n\) bytes of blank data

SYNOPSIS
\begin{verbatim}
ssize_t wskip( size_t n, int ch );
\end{verbatim}

DESCRIPTION
To skip data of writable stream, \texttt{wskip()} performs a seek forward for seekable stream. If seek is not possible, it writes \(n\) bytes of blank data.

PARAMETER
\begin{itemize}
  \item [I] \(n\) Byte length to be skipped
  \item [I] \(ch\) Blank character to be written
\end{itemize}

RETURN VALUE
\begin{itemize}
  \item Non-negative value : Byte length successfully sought or written.
  \item negative value : Error.
\end{itemize}

EXCEPTION
If the system failed to secure a temporary buffer for use in writing data stream.

WARNING
The \texttt{cstreamio} class is an abstract class and hence cannot be directly used by users. It must be used as a member function for the classes shown in Table 5.

8.1.8 \texttt{getchr()}

NAME
\texttt{getchr()} — Input of characters

SYNOPSIS
\begin{verbatim}
int getchr();
\end{verbatim}
DESCRIPTION
getchr() reads a character from a stream opened by open(), and returns it as the int type.

RETURN VALUE
Non-negative value : A value of a read character of the unsigned char type cast to the int type.
EOF : If the end of a stream is reached.
EOF (error) : If the stream is not opened.
: If the open mode for the input/output stream is inconsistent.

EXAMPLE
The following code opens file.txt in directory in read mode, reads a character from it, and then prints it to standard output:

```c
#include <stdio.h>

int main() {
    stdstreamio f_in;
    int i_chr;

    if (f_in.openf("r", "%s/%s", "directory", "file.txt") < 0) {
        Error handling
    }

    if ((i_chr = f_in.getchr()) == EOF) {
        printf("EOF\n");
    } else {
        printf("%c\n", i_chr);
    }

    f_in.close();
    return 0;
}
```

WARNING
The cstreamio class is an abstract class and hence cannot be directly used by users. It must be used as a member function for the classes shown in Table 5.

8.1.9 getstr()

NAME
gestr() — Input of character strings

SYNOPSIS
```
char *getstr( char *s, size_t size );
```

DESCRIPTION
gestr() reads a maximum of size-1 characters from a stream opened by open(), and stores them in a buffer specified by s. Reading terminates after reading the EOF or newline character. The newline character read is also stored in the buffer specified by s.

PARAMETER

```
[[O]] s A buffer to store the read characters
[[I]] size Number of characters to be read
```

RETURN VALUE
Non-NULL value : Address of storage buffer.
NULL : If the end of a stream is reached.
NULL (error) : If the specified buf or size is inappropriate.
: If the stream is not opened.
: If the open mode for the input/output stream is inconsistent.

EXCEPTION
If the system fails to secure a buffer for use in reading the data. (getstr())

WARNING
The cstreamio class is an abstract class and hence cannot be directly used by users. It must be used as a member function for the classes shown in Table 5.

8.1.10 getline()

NAME
ggetline() — Input of characters and character strings

SYNOPSIS
const char *getline(); ................................................................. 1
const char *getline( size_t nchars ); .............................................. 2

DESCRIPTION
Reads strings up to the newline character from a stream opened by open() in the buffer inside the object, and then returns the address of that internal buffer. This address will be invalid if the member function for the object is called next. If the number of characters needs to be limited specify nchars. In this case the characters are read until the newline character appears or the nchars nth character is reached.

PARAMETER
[I] nchars Limit value for the number of characters to be read

RETURN VALUE
Non-NULL value : Address of internal buffer.
NULL : If the end of a stream is reached.
NULL (error) : If the stream is not opened.
: If the open mode for the input/output stream is inconsistent.

EXCEPTION
If the system fails to secure a buffer for use in reading the data.

EXAMPLE
The following code opens file.txt in directory in read mode, reads lines one by one from it, and then prints them to standard output:

```c
stdafxio f_in;
const char *line_ptr;

if (f_in.openf("r", "%s/%s", "directory", "file.txt") < 0) {
    Error handling
}
```
```c
while ((line_ptr = f_in.getline()) != NULL) {
    printf("%s", line_ptr);
}

f_in.close();
```

**WARNING**

The cstreamio class is an abstract class and hence cannot be directly used. It must be used as a member function for the classes shown in Table 5.

---

### 8.1.11 `scanf()`, `vscanf()`

#### NAME

`scanf()`, `vscanf()` — Formatted input conversion

#### SYNOPSIS

```c
int scanf( const char *format, ... ); .............................................. 1
int vscanf( const char *format, va_list ap ); ................................. 2
int scanf( size_t nchars, const char *format, ... ); ......................... 3
int vscanf( size_t nchars, const char *format, va_list ap ); ............... 4
```

#### DESCRIPTION

Reads data from a stream that is opened by `open()` according to the conversion specifications provided in `format`, and then stores them in the arguments after `format`.

The results of the conversion that took place according to the conversion specifications provided in `format` are read for each element data of member functions 1 and 3, and as provided by the list of variable length arguments in `ap` for member functions 2 and 4.

The string buffer to be input-converted utilizes that returned by the `getline()` member function ([8.1.10]). This then means that if `nchars` was not specified, the input conversion always gets performed on a per-line basis. The conversion characters that follow the `%` inside `format` and their features are provided in the table below:
<table>
<thead>
<tr>
<th>Conversion character</th>
<th>Content of conversion</th>
<th>Type of argument</th>
</tr>
</thead>
<tbody>
<tr>
<td>hhd</td>
<td>Converts inputs to signed decimal number</td>
<td>char type</td>
</tr>
<tr>
<td>hd</td>
<td>Converts inputs to signed decimal number</td>
<td>short type</td>
</tr>
<tr>
<td>d</td>
<td>Converts inputs to signed decimal number</td>
<td>int type</td>
</tr>
<tr>
<td>ld</td>
<td>Converts inputs to signed decimal number</td>
<td>long type</td>
</tr>
<tr>
<td>lld</td>
<td>Converts inputs to signed decimal number</td>
<td>long long type</td>
</tr>
<tr>
<td>zd</td>
<td>Converts inputs to signed decimal number</td>
<td>ssize_t type</td>
</tr>
<tr>
<td>hhu</td>
<td>Converts inputs to unsigned decimal number</td>
<td>unsigned char type</td>
</tr>
<tr>
<td>hu</td>
<td>Converts inputs to unsigned decimal number</td>
<td>unsigned short type</td>
</tr>
<tr>
<td>u</td>
<td>Converts inputs to unsigned decimal number</td>
<td>unsigned int type</td>
</tr>
<tr>
<td>lu</td>
<td>Converts inputs to unsigned decimal number</td>
<td>unsigned long type</td>
</tr>
<tr>
<td>luu</td>
<td>Converts inputs to unsigned decimal number</td>
<td>unsigned long long type</td>
</tr>
<tr>
<td>zu</td>
<td>Converts inputs to unsigned decimal number</td>
<td>ssize_t type</td>
</tr>
<tr>
<td>hhho</td>
<td>Converts inputs to unsigned octal number</td>
<td>(unsigned) char type</td>
</tr>
<tr>
<td>hho</td>
<td>Converts inputs to unsigned octal number</td>
<td>(unsigned) short type</td>
</tr>
<tr>
<td>ho</td>
<td>Converts inputs to unsigned octal number</td>
<td>(unsigned) int type</td>
</tr>
<tr>
<td>oo</td>
<td>Converts inputs to unsigned octal number</td>
<td>(unsigned) long type</td>
</tr>
<tr>
<td>llu</td>
<td>Converts inputs to unsigned octal number</td>
<td>(unsigned) long long type</td>
</tr>
<tr>
<td>zu</td>
<td>Converts inputs to unsigned octal number</td>
<td>ssize_t type and ssize_t type</td>
</tr>
<tr>
<td>hhx, hhX</td>
<td>unsigned hexadecimal number</td>
<td>(unsigned) char type</td>
</tr>
<tr>
<td>hx, hX</td>
<td>unsigned hexadecimal number</td>
<td>(unsigned) short type</td>
</tr>
<tr>
<td>x, X</td>
<td>unsigned hexadecimal number</td>
<td>(unsigned) int type</td>
</tr>
<tr>
<td>lx, lX</td>
<td>unsigned hexadecimal number</td>
<td>(unsigned) long type</td>
</tr>
<tr>
<td>llx, llX</td>
<td>unsigned hexadecimal number</td>
<td>(unsigned) long long type</td>
</tr>
<tr>
<td>zx, zX</td>
<td>unsigned hexadecimal number</td>
<td>ssize_t type and ssize_t type</td>
</tr>
<tr>
<td>c</td>
<td>Stores the string of the width specified in “maximum field width” (default value of 1) of an argument</td>
<td>char * type</td>
</tr>
<tr>
<td>s</td>
<td>Stores a string comprised of non-white space characters in an argument</td>
<td>char * type</td>
</tr>
<tr>
<td>f</td>
<td>Converts inputs to signed floating-point real number</td>
<td>float type</td>
</tr>
<tr>
<td>lf</td>
<td>Converts inputs to signed floating-point real number</td>
<td>double type</td>
</tr>
<tr>
<td>e, E</td>
<td>Converts inputs to signed floating-point real number</td>
<td>float type</td>
</tr>
<tr>
<td>le, lE</td>
<td>Converts inputs to signed floating-point real number</td>
<td>double type</td>
</tr>
<tr>
<td>g, G</td>
<td>Converts inputs to signed floating-point real number</td>
<td>float type</td>
</tr>
<tr>
<td>lg, lG</td>
<td>Converts inputs to signed floating-point real number</td>
<td>double type</td>
</tr>
<tr>
<td>a, A</td>
<td>Converts inputs to signed floating-point real number</td>
<td>float type</td>
</tr>
<tr>
<td>la, lA</td>
<td>Converts inputs to signed floating-point real number</td>
<td>double type</td>
</tr>
<tr>
<td>p</td>
<td>Converts inputs to void* pointer</td>
<td>void* type</td>
</tr>
<tr>
<td>n</td>
<td>Saves the number of characters consumed thus far from the input to the integer referenced by the int* pointer argument</td>
<td>int* type</td>
</tr>
</tbody>
</table>
The maximum field width can also be specified between \% and a conversion character.

\[
f\text{.in}.\text{scanf("\%_f",si\_value);}\]

\[
↑\text{[m]}
\]

<table>
<thead>
<tr>
<th>Option</th>
<th>Meaning</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>\text{m}</td>
<td>(Input of number of digits)</td>
<td>\text{scanf(&quot;%10d...}}</td>
</tr>
</tbody>
</table>

\text{PARAMETER}

- \text{[I]} \text{format} \quad \text{Reading format specifications}
- \text{[O]} \ldots \quad \text{Each element of data in which to write data}
- \text{[O]} \text{ap} \quad \text{List of variable length arguments in which to write data}
- \text{[I]} \text{nchars} \quad \text{Limit value for number of characters to be read}
  
  (\text{[I]} : \text{Input}, \text{[O]} : \text{Output})

\text{RETURN VALUE}

- \text{Non-negative value} \quad \text{Number of input elements successfully read and converted.}
- \text{EOF (error)}
  - \text{If the stream is not opened.}
  - \text{If the open mode for the input/output stream is inconsistent.}
  - \text{If the byte array read was an invalid number.}
  - \text{If the argument was too small or the format NULL.}
  - \text{If the memory was insufficient.}
  - \text{If, being converted to the integer type specified in format, the value was too large to be stored in the integer type.}

\text{EXCEPTION}

If the system fails to secure the buffer used for reading the data.

\text{EXAMPLE}

The following code opens \text{file.txt} in \text{directory} in read mode, reads space-separated numerical values according to the format, and then stores them in \text{i\_YY}, \text{i\_MM} and \text{i\_DD}. The stored values are then written to standard output according to the specified format. Please note that this example assumes that \text{directory/file.txt} has a year, month and date described in it in the format of YYYY\_MM\_DD.

\[
\text{stdstreamio f\_in;}
\text{int i\_YY = 0, i\_MM = 0, i\_DD = 0;}
\]

\[
\text{if (f\_in.open("r", "%s/%s", "directory", "file.txt") < 0) {}
\text{\quad Error handling}
}
\]

\[
\text{if (f\_in.scanf("%d %d %d", &i\_YY, &i\_MM, &i\_DD) < 0) {}
\text{\quad Error handling}
}
\]

\[
\text{printf("%04d / %02d / %02d\n", i\_YY, i\_MM, i\_DD);}
\]

\[
f\text{.in.close();}
\]
WARNING
The cstreamio class is an abstract class and hence cannot be directly used. It must be used as a member function for the classes shown in Table 5.

When specifying "This problem can be avoided by specifying a maximum field width and then reading the string as follows. If you do not wish for any characters or newline characters that are not read to remain in the buffer, skip the strings up to the newline character in the manner shown below, and then skip the newline character.

```c
stdstreamio f_in;
char c_buf[20];

f_in.scanf("%19s%[^\n]",c_buf);
f_in.getchr();
```

8.1.12 putchr()

NAME
putchr() — Output of characters

SYNOPSIS
```c
int putchr( int c );
```

DESCRIPTION
putchr() writes character c to stream opened by open().

PARAMETER
- [I] c Character to be written

RETURN VALUE
- Non-negative value : Normal termination, with the written unsigned char type character being cast to the int type.
- EOF (error) : If the open mode for the input/output stream is inconsistent.
  : If the system fails to write a stream for any other operating environment reason than described above. [For example, a stream referenced by a file descriptor not having enough space.]

WARNING
The cstreamio class is an abstract class and hence cannot be directly used. It must be used as a member function for the classes shown in Table 5.

8.1.13 putstr()

NAME
putstr() — Output of strings

SYNOPSIS
```c
int putstr( const char *s );
```

DESCRIPTION
putstr() writes string s to stream opened by open().
PARAMETER

[I] s String to be written

RETURN VALUE

Non-negative value : If a string is successfully written. (putstr())
EOF (error) : If the open mode for the input/output stream is inconsistent.
: If the system fails to write a stream for any other operating environment reason than described above. [For example, a stream referenced by a file descriptor not having enough space.]

EXAMPLE

The following code opens file.txt in directory in write mode, and then writes the string c_sentence to it:

```c
#include <stdio.h>

int main() {
    stdstreamio f_out;
    const char *c_sentence = "This is an example code for the USER";

    if (f_out.openf("w", "%s/%s", "directory", "file.txt") < 0) {
        Error handling
    }

    if (f_out.putstr(c_sentence) < 0) {
        Error handling
    }

    f_out.close();
}
```

WARNING

The cstreamio class is an abstract class and hence cannot be directly used. It must be used as a member function for the classes shown in Table 5.

8.1.14 printf(), vprintf()

NAME

printf(), vprintf() — Function that convert data to the set format

SYNOPSIS

```c
int printf( const char *format, ... );
int vprintf( const char *format, va_list ap );
```

DESCRIPTION

 Writes the content stored in arguments after format to a stream opened by open() according to the conversion specifications provided in format.

printf() converts each element of data, while vprintf() converts the list of variable length arguments in ap, depending on the conversion specifications provided in format.

The conversion characters that follow % inside format and their features are shown in the table below. Please note that if you want to output % itself you must type %%.
<table>
<thead>
<tr>
<th>Conversion character</th>
<th>Content of conversion</th>
<th>Type of argument</th>
</tr>
</thead>
<tbody>
<tr>
<td>hhd</td>
<td>Converts arguments to signed decimal number</td>
<td>char type</td>
</tr>
<tr>
<td>hd</td>
<td>Converts arguments to signed decimal number</td>
<td>short type</td>
</tr>
<tr>
<td>d</td>
<td>Converts arguments to signed decimal number</td>
<td>int type</td>
</tr>
<tr>
<td>ld</td>
<td>Converts arguments to signed decimal number</td>
<td>long type</td>
</tr>
<tr>
<td>lld</td>
<td>Converts arguments to signed decimal number</td>
<td>long long type</td>
</tr>
<tr>
<td>zd</td>
<td>Converts arguments to signed decimal number</td>
<td>ssize_t type</td>
</tr>
<tr>
<td>hhu</td>
<td>Converts arguments to unsigned decimal number</td>
<td>unsigned char type</td>
</tr>
<tr>
<td>hu</td>
<td>Converts arguments to unsigned decimal number</td>
<td>unsigned short type</td>
</tr>
<tr>
<td>u</td>
<td>Converts arguments to unsigned decimal number</td>
<td>unsigned int type</td>
</tr>
<tr>
<td>lu</td>
<td>Converts arguments to unsigned decimal number</td>
<td>unsigned long type</td>
</tr>
<tr>
<td>llu</td>
<td>Converts arguments to unsigned decimal number</td>
<td>unsigned long long type</td>
</tr>
<tr>
<td>zu</td>
<td>Converts arguments to unsigned decimal number</td>
<td>size_t type</td>
</tr>
<tr>
<td>hho</td>
<td>Converts arguments to unsigned octal number</td>
<td>(unsigned) char type</td>
</tr>
<tr>
<td>ho</td>
<td>Converts arguments to unsigned octal number</td>
<td>(unsigned) short type</td>
</tr>
<tr>
<td>o</td>
<td>Converts arguments to unsigned octal number</td>
<td>(unsigned) int type</td>
</tr>
<tr>
<td>lo</td>
<td>Converts arguments to unsigned octal number</td>
<td>(unsigned) long type</td>
</tr>
<tr>
<td>llo</td>
<td>Converts arguments to unsigned octal number</td>
<td>(unsigned) long long type</td>
</tr>
<tr>
<td>zo</td>
<td>Converts arguments to unsigned octal number</td>
<td>size_t type and ssize_t type</td>
</tr>
<tr>
<td>hhx, hhX</td>
<td>Converts arguments to unsigned hexadecimal number</td>
<td>(unsigned) char type</td>
</tr>
<tr>
<td>hx, hX</td>
<td>Converts arguments to unsigned hexadecimal number</td>
<td>(unsigned) short type</td>
</tr>
<tr>
<td>x, X</td>
<td>Converts arguments to unsigned hexadecimal number</td>
<td>(unsigned) int type</td>
</tr>
<tr>
<td>lx, lX</td>
<td>Converts arguments to unsigned hexadecimal number</td>
<td>(unsigned) long type</td>
</tr>
<tr>
<td>llx, llX</td>
<td>Converts arguments to unsigned hexadecimal number</td>
<td>(unsigned) long long type</td>
</tr>
<tr>
<td>zx, zX</td>
<td>Converts arguments to unsigned hexadecimal number</td>
<td>size_t type and ssize_t type</td>
</tr>
<tr>
<td>c</td>
<td>Outputs arguments as single character</td>
<td>int type</td>
</tr>
<tr>
<td>s</td>
<td>Outputs the string referenced by an argument.</td>
<td>const char * type</td>
</tr>
<tr>
<td></td>
<td>Characters up to the one before the null character or as many characters as the maximum number of characters indicated are output</td>
<td></td>
</tr>
<tr>
<td>f</td>
<td>Receives arguments as float or double, and converts it to a decimal notation in the style [-]ddddd.dd</td>
<td>Floating-point type</td>
</tr>
<tr>
<td>e, E</td>
<td>Receives arguments as float or double, and converts it to a decimal notation in the style [-]d.ddde[±]dd</td>
<td>Floating-point type</td>
</tr>
<tr>
<td>g, G</td>
<td>Uses the conversion with the smaller number of characters in conversion with %e or %f</td>
<td>Floating-point type</td>
</tr>
<tr>
<td>a, A</td>
<td>Receives arguments as float or double, and converts it to a hexadecimal notation in the style [-]0xz.hlllhp[±]dd</td>
<td>Floating-point type</td>
</tr>
<tr>
<td>p</td>
<td>Receives arguments as the void* pointer, and outputs it as a hexadecimal number</td>
<td>void* type</td>
</tr>
<tr>
<td>n</td>
<td>Saves the number of characters written thus far to the integer referenced by the int* pointer argument</td>
<td>int* type</td>
</tr>
</tbody>
</table>
More detailed formatting specifications can also be made using the option specifiers between \% and the conversion character as shown below:

\[
sio.printf("\%\_f...\n",x);
\]

<table>
<thead>
<tr>
<th>Option</th>
<th>Meaning</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>− (Minus sign)</td>
<td>Outputs a converted argument left-aligned.</td>
<td>%−6d</td>
</tr>
<tr>
<td>+</td>
<td>Always prefixes a signed, converted numerical value with a sign (+ or −).</td>
<td>%+6d</td>
</tr>
<tr>
<td>m (Input of number of digits)</td>
<td>Specifies a minimum field width of m characters. If the converted value has fewer characters than specified, it will be padded with spaces on the left. Adding 0 results in zero padding.</td>
<td>%10d</td>
</tr>
<tr>
<td>. (Period)</td>
<td>Separates a minimum filed width and the number of characters or the number of digits after the decimal point.</td>
<td>%10.5f</td>
</tr>
<tr>
<td>n (Input of number of digits)</td>
<td>If f is specified, number of digits after the decimal point. If e, E, g or G is specified, the accuracy. For strings, the width they require (including the beginning of the characters)</td>
<td>%10.5s</td>
</tr>
</tbody>
</table>

PARAMETER

[\texttt{I}] format Writing format specifications
[\texttt{I}] ... Each element of the data to be written
[\texttt{I}] ap List of variable length arguments to be written
([\texttt{I}] : Input, [\texttt{O}] : Output)

RETURN VALUE

Non-negative value : Number of characters written.
Negative value (error) : If the system failed to write the data for an operating environment reason.

EXCEPTION

If the system failed to secure the buffer used for writing the data.

EXAMPLE

The following code writes the string \texttt{c\_sentence} to a stream (standard output) in the

\[
\texttt{stdstreamio s\_io; const char *c\_sentence = "This is an example code for the USER";}
\]
if (s_io.printf("%s\n", c_sentence) < 0) {
    Error handling
}

WARNING
The cstreamio class is an abstract class and hence cannot be directly used. It must be used as a member function for the classes shown in Table 5.

8.1.15 flush()

NAME
flush() — Forcefully outputs content of a stream.

SYNOPSIS
int flush();

DESCRIPTION
flush() forcefully writes all the data stored in the buffer inside a stream opened by open().

RETURN VALUE
0 : Normal termination
EOF (error) : If the stream is not opened.
: If the open mode for the input/output stream is inconsistent.
: If the system failed to forcefully output the data for any other operating environment reason than described above. [For example, a stream referenced by a file descriptor not having enough space.]

EXAMPLE
The following code writes the string c_sentence to standard output stream in the

```c
stdstreamio s_io;
const char *c_sentence = "This is an example code for the USER";

if (s_io.printf("%s\n", c_sentence) < 0) {
    Error handling
}

if (s_io.flush() < 0) {
    Error handling
}
```

WARNING
The cstreamio class is an abstract class and hence cannot be directly used. It must be used as a member function for the classes shown in Table 5.

8.1.16 eof(), error(), reseterr()

NAME
eof(), error(), reseterr() — Check and reset stream
SYNOPSIS

```cpp
int eof();
int error();
cstreamio &reseterr();
```

DESCRIPTION

eof() tests the end-of-file indicator for the stream opened by `open()`, returning non-zero if it is set.

error() tests the error indicator for the stream opened by `open()`, returning non-zero if it is set.

reseterr() clears the end-of-file and error indicators for the stream opened by `open()`, and returns the object.

The corresponding functions in libc is `feof()`, `ferror()` and `clearerr()`, respectively.

WARNING

The cstreamio class is an abstract class and hence cannot be directly used. It must be used as a member function for the classes shown in Table 8.1.17 seek(), rewind()

NAME

`seek()`, `rewind()` — Changes the position of streams

SYNOPSIS

```cpp
int seek( long offset, int whence );
int rewind();
```

DESCRIPTION

`seek()` sets the stream position indicator on a per-byte basis of a stream opened by `open()`. The position to be set can be acquired by adding `offset` bytes to the position specified by `whence`.

`rewind()` sets a stream position indicator to the beginning of a file of a stream opened by `open()`.

PARAMETER

- [I] `offset` Offset for stream position indicator
- [I] `whence` Standard position for stream position indicator
  
  (SEEK_SET : Beginning of stream, SEEK_CUR : Present position indicator, SEEK_END : End of stream)


RETURN VALUE

- 0 : Normal termination
- Negative value (error) : If the stream is not seekable.
  - If the `whence` argument is inappropriate.
  - If the system failed to process data for any other operating environment reason than described above. [For example, when there is insufficient memory for the kernel.]

EXAMPLE

The following code opens `file.txt` in `directory` in read mode and changes the position of read operation to 40 bytes from the beginning of the file.
The cstreamio class is an abstract class and hence cannot be directly used by users. It must be used as a member function for the classes shown in Table [5].

8.1.18 tell()
NAME
tell() — Current value of the stream position indicator

SYNOPSIS
long tell();

DESCRIPTION
tell() returns the current value of the stream position indicator for the stream opened by open().

RETURN VALUE
Non-negative value : Present offset
Negative value (error) : If the stream is not seekable.
: If the system failed to process data for any other operating environment reason than described above. [For example, when there is insufficient memory for the kernel.]

WARNING
The cstreamio class is an abstract class and hence cannot be directly used by users. It must be used as a member function for the classes shown in Table [5].

8.1.19 is_seekable()
NAME
is_seekable() — test for seekable stream or not

SYNOPSIS
bool is_seekable();

DESCRIPTION
is_seekable() returns true when disk seek is possible on the stream opened by open().

RETURN VALUE
true : Disk seek is possible
false : Disk seek is impossible
WARNING
The cstreamio class is an abstract class and hence cannot be directly used by users. It must be used as a member function for the classes shown in Table 5.
8.2 The STDSTREAMIO class

Like `printf()` and `fopen()` in libc, the stdstreamio class is used to handle standard input/output, standard error output, and normal file input/output. As it also inherits cstreamio basically all the member functions in §8.1 are available for use in the class, with only `open( const char *mode, cstreamio &sref )` not being usable. The class can be used without having to use `open()` and `close()` for standard input/output and standard error output.

If you use the stdstreamio class you must add “#include &lt;sli/stdstreamio.h&gt;” to the code. If you need to declare a namespace (§4.1), you must also add “using namespace sli;” to the code. Table 8 lists the member functions. The “Corresponding function in libc” in Table 8 shows the corresponding functions in libc with the same feature as each of the member functions.

<table>
<thead>
<tr>
<th>The stdstreamio class</th>
<th>Feature</th>
<th>Corresponding function in libc</th>
</tr>
</thead>
<tbody>
<tr>
<td>§8.2.2 open(), openf(), vopenf()</td>
<td>Opens a stream</td>
<td><code>fopen()</code></td>
</tr>
<tr>
<td>§8.1.2 close()</td>
<td>Closes a stream</td>
<td><code>fclose()</code></td>
</tr>
<tr>
<td>§8.1.3 read()</td>
<td>Input of binary streams</td>
<td><code>fread()</code></td>
</tr>
<tr>
<td>§8.1.3 write()</td>
<td>Output of binary streams</td>
<td><code>fwrite()</code></td>
</tr>
<tr>
<td>§8.1.4 bread()</td>
<td>Input of binary streams (With endian conversion)</td>
<td>—</td>
</tr>
<tr>
<td>§8.1.5 bwrite()</td>
<td>Output of binary streams (With endian conversion)</td>
<td>—</td>
</tr>
<tr>
<td>§8.1.6 rskip()</td>
<td>Seek forward (if possible) or read n bytes to skip data stream</td>
<td>—</td>
</tr>
<tr>
<td>§8.1.7 wskip()</td>
<td>Seek forward (if possible) or write n bytes of blank data</td>
<td>—</td>
</tr>
<tr>
<td>§8.1.8 getchr()</td>
<td>Input of character</td>
<td><code>fgetc()</code></td>
</tr>
<tr>
<td>§8.1.9 getstr()</td>
<td>Input of strings</td>
<td><code>fgets()</code></td>
</tr>
<tr>
<td>§8.1.10 getline()</td>
<td>Input of line</td>
<td>—</td>
</tr>
<tr>
<td>§8.1.11 scanf()</td>
<td>Converts inputs using format and assigns to an argument</td>
<td><code>fscanf()</code></td>
</tr>
<tr>
<td>§8.1.12 putchr()</td>
<td>Output of character</td>
<td><code>fputc()</code></td>
</tr>
<tr>
<td>§8.1.13 putstr()</td>
<td>Output of strings</td>
<td><code>fputs()</code></td>
</tr>
<tr>
<td>§8.1.14 printf()</td>
<td>Outputs value of an argument after being format-converted</td>
<td><code>fprintf()</code></td>
</tr>
<tr>
<td>§8.1.15 flush()</td>
<td>Forcefully outputs content of buffer</td>
<td><code>fflush()</code></td>
</tr>
<tr>
<td>§8.1.16 eof(), error(), reseterr()</td>
<td>Check and reset stream status</td>
<td><code>feof()</code>, etc.</td>
</tr>
<tr>
<td>§8.2.3 sprintf(...)</td>
<td>Outputs to standard error output</td>
<td><code>fprintf(stderr, ...)</code></td>
</tr>
<tr>
<td>§8.2.4 eflush()</td>
<td>Flush for standard error output</td>
<td><code>fflush(stderr)</code></td>
</tr>
<tr>
<td>§8.2.5 seek()</td>
<td>Change position of streams</td>
<td><code>fseek()</code></td>
</tr>
<tr>
<td>§8.2.5 rewind()</td>
<td>Changes position of streams to the beginning</td>
<td><code>rewind()</code></td>
</tr>
<tr>
<td>§8.2.6 tell()</td>
<td>Value of stream position indicator</td>
<td><code>ftell()</code></td>
</tr>
<tr>
<td>§8.1.19 is_seekable()</td>
<td>Test for seekable stream or not</td>
<td>—</td>
</tr>
</tbody>
</table>

Table 8: List of the member functions available with stdstreamio class.

How to use the member functions that have been redefined and added with the stdstreamio class is described below.

8.2.1 How to create an object

With the stdstreamio class if you do not provide an argument when creating an object, the object gets output to standard output when generated, as revealed in the example below:
#include <sli/stdstreamio.h>
using namespace sli;

int main()
{
    stdstreamio sio;
    sio.printf("Hello\n");

    stdstreamio eout(true);
eout.printf("This is STDERR\n");

8.2.2 open(), openf(), vopenf()

NAME
open(), openf(), vopenf() — Opens stream

SYNOPSIS

int open( const char *mode ); ......................................................... 1
int open( const char *mode, int fd ); ........................................... 2
int open( const char *mode, const char *path ); ............................. 3
int openf( const char *mode, const char *path_fmt, ... ); ............... 4
int vopenf( const char *mode, const char *path_fmt, va_list ap ); ...... 5

DESCRIPTION
Opens the file indicated by path or path_fmt, or attaches the descriptor specified by fd to a stream. If path or path_fmt is NULL, the standard input or standard output is used.

With the mode for member functions 1 and 2, "r" is specified when reading data, and "w" when writing data. In addition, either "r", "r+", "w", "w+", "a" or "a+" can be specified for member functions 3 to 5. Details on the mode that can be specified are provided in the table below:

<table>
<thead>
<tr>
<th>mode</th>
<th>Processing</th>
<th>If the file does not exist</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;r&quot;</td>
<td>Only reading</td>
<td>Abnormal termination</td>
</tr>
<tr>
<td>&quot;r+&quot;</td>
<td>Reading and writing</td>
<td>Abnormal termination</td>
</tr>
<tr>
<td>&quot;w&quot;</td>
<td>Only writing</td>
<td>Creation of new file</td>
</tr>
<tr>
<td>&quot;w+&quot;</td>
<td>Reading and writing</td>
<td>Creation of new file</td>
</tr>
<tr>
<td>&quot;a&quot;</td>
<td>Only appending</td>
<td>Creation of new file</td>
</tr>
<tr>
<td>&quot;a+&quot;</td>
<td>Reading and appending</td>
<td>Creation of new file</td>
</tr>
</tbody>
</table>

For more details on member functions 4 and 5 refer to the descriptions provided in §8.1.1.

PARAMETER

[I] mode  File opening mode
[I] fd    File descriptor
[I] path  File name
[I] path_fmt File name format specifications
[I] ...  Each element of data for file name
[I] ap    List of variable length arguments for file name
RETURN VALUE

0 : Normal termination.
Negative value (error) : If the system failed to open the stream because the file does not exist etc.
: If the system failed to open the stream because the specified mode is inappropriate etc.
: If the system failed to open the stream because it is not allowed to access the stream by the specified mode etc.
: If the string indicates the path of path_fmt exceeds PATH_MAX.
: If the stream has already been opened by any of the member functions shown in this section.

EXCEPTION

If the system fails to copy a file descriptor for the standard input/output and standard error output.

EXAMPLE

The following code opens in read mode file.txt in directory.

```c
stdstreamio f_in;
if (f_in.openf("r", "%s/%s", "directory", "file.txt") < 0) {
    Error handling
}
f_in.close();
```

8.2.3 eprintf(), veprintf()

NAME

eprintf(), veprintf() — Converts data to the set format, and then outputs it to standard error

SYNOPSIS

```c
int eprintf( const char *format, ... );
int veprintf( const char *format, va_list ap );
```

DESCRIPTION

Writes the content stored in arguments after format to the standard error output stream according to the conversion specifications provided in format.
eprintf() converts each element of data, while veprintf() converts the list of variable length arguments in ap, depending on the conversion specifications provided in format.
The conversion characters that follow % inside format and their features are provided in the table in §8.1.14. Please note that if you wish to output % you must type %%.

PARAMETER

[I] format Writing format specifications
[I] ... Each element of data to be written
[I] ap List of variable length arguments to be written

RETURN VALUE

Non-negative value : Number of characters written
Negative value (error) : If the system failed to write data for an operating environment reason.
EXAMPLE

The following code writes the string `c_error` to the standard error output in the `%s` format:

```c
stdstreamio s_io;
const char *c_error = "This example code doesn’t work correctly";

if (s_io.eprintf("%s\n", c_error) < 0) {
    Error handling
}
```

8.2.4 `eflush()`

NAME
`eflush()` — Forcefully outputs the content of standard error output

SYNOPSIS
```c
int eflush();
```

DESCRIPTION
`eflush()` forcefully writes all the data stored in the buffer inside the standard error output stream.

RETURN VALUE
- 0 : Normal termination.
- EOF (error) : If the system failed to forcefully output data for an operating environment reason.

EXAMPLE

The following code writes the string `c_error` to the standard error output stream in the `%s` format, and then forcefully outputs the buffer.

```c
stdstreamio s_io;
const char *c_error = "This example code doesn’t work correctly";

if (s_io.eprintf("%s\n", c_error) < 0) {
    Error handling
}

if (s_io.eflush() < 0) {
    Error handling
}
```

8.2.5 `seek()`, `rewind()`

NAME
`seek()`, `rewind()` — Changes the position of streams

SYNOPSIS
```c
int seek( long offset, int whence );
int rewind();
```
**DESCRIPTION**

seek() sets the stream position indicator on a per-byte basis of a stream opened by open(). The position to be set can be acquired by adding offset bytes to the position specified by whence.

rewind() sets a stream position indicator to the beginning of a file of a stream opened by open().

**PARAMETER**

- **offset** Offset for stream position indicator
- **whence** Standard position for stream position indicator

(SEEK_SET : Beginning of stream, SEEK_CUR : Present position indicator, SEEK_END : End of stream)


**RETURN VALUE**

- 0 : Normal termination
- Negative value (error) : If the stream is not seekable.
  - If the whence argument is inappropriate.
  - If the system failed to process data for any other operating environment reason than described above. [For example, when there is insufficient memory for the kernel.]

**EXAMPLE**

The following code opens *file.txt* in *directory* in read mode and changes the position of read operation to 40 bytes from the beginning of the file.

```c
stdstreamio f_in;

if (f_in.openf("r", "%s/%s", "directory", "file.txt") < 0) {
    Error handling
}

if (f_in.seek(40, SEEK_SET) < 0) {
    Error handling
}

f_in.close();
```

---

8.2.6  **tell()**

**NAME**
tell() — Current value of the stream position indicator

**SYNOPSIS**

```c
long tell();
```

**DESCRIPTION**
tell() returns the current value of the stream position indicator for the stream opened by open().
RETURN VALUE
- Non-negative value : Present offset
- Negative value (error) : If the stream is not seekable.
- : If the system failed to process data for any other operating environment reason than described above. [For example, when there is insufficient memory for the kernel.]

8.2.7 content_length()

NAME
content_length() — Calls for the length of streams

SYNOPSIS
long long content_length() const;

DESCRIPTION
Returns the byte length of a stream opened by open().

RETURN VALUE
- Non-negative value : Byte length of stream
- Negative value (error) : If length of stream cannot be obtained.
8.3 GZSTREAMIO class

The gzstreamio class is used to handle standard input/output and normal file input/output while also performing gzip compression/expansion. It inherits cstreamio and hence all the member functions detailed in §8.1 are available for use with the class. open(), close() must always be used with the gzstreamio class.

If you wish to use the gzstreamio class, you must add “#include <sli/gzstreamio.h>” to the code. If you need to declare a namespace (§4.1), you must also add “using namespace sli;” to the code.

Table 9 lists the member functions. The “Corresponding function in libc” column in Table 9 shows the corresponding functions in libc with the same feature as each of the member functions.

<table>
<thead>
<tr>
<th>The gzstreamio class</th>
<th>Feature</th>
<th>Corresponding function in libc</th>
</tr>
</thead>
<tbody>
<tr>
<td>§8.3.1 open(), openf(), vopenf()</td>
<td>Opens streams</td>
<td>fopen()</td>
</tr>
<tr>
<td>§8.1.2 close()</td>
<td>Closes streams</td>
<td>fclose()</td>
</tr>
<tr>
<td>§8.1.3 read()</td>
<td>Input of binary streams</td>
<td>fread()</td>
</tr>
<tr>
<td>§8.1.3 write()</td>
<td>Output of binary streams</td>
<td>fwrite()</td>
</tr>
<tr>
<td>§8.1.4 bread()</td>
<td>Input of binary streams (With endian conversion)</td>
<td>—</td>
</tr>
<tr>
<td>§8.1.4 bwrite()</td>
<td>Output of binary streams (With endian conversion)</td>
<td>—</td>
</tr>
<tr>
<td>§8.1.5 rskip()</td>
<td>Read n bytes to skip data stream</td>
<td>—</td>
</tr>
<tr>
<td>§8.1.6 wskip()</td>
<td>Write n bytes of blank data</td>
<td>—</td>
</tr>
<tr>
<td>§8.1.7 getchar()</td>
<td>Input of character</td>
<td>fgetc()</td>
</tr>
<tr>
<td>§8.1.8 getstr()</td>
<td>Input of strings</td>
<td>fgets()</td>
</tr>
<tr>
<td>§8.1.9 getline()</td>
<td>Input of line</td>
<td>—</td>
</tr>
<tr>
<td>§8.1.10 scanf()</td>
<td>Converts inputs using format and assigns to an argument</td>
<td>fscanf()</td>
</tr>
<tr>
<td>§8.1.12 putchr()</td>
<td>Output of character</td>
<td>fputc()</td>
</tr>
<tr>
<td>§8.1.13 putstr()</td>
<td>Output of strings</td>
<td>fputs()</td>
</tr>
<tr>
<td>§8.1.14 printf()</td>
<td>Outputs value of an argument after being format-converted</td>
<td>fprintf()</td>
</tr>
<tr>
<td>§8.1.15 flush()</td>
<td>Forcefully outputs content of buffer</td>
<td>fflush()</td>
</tr>
<tr>
<td>§8.1.16 eof(), error(), reseterr()</td>
<td>Check and reset stream status</td>
<td>feof(), etc.</td>
</tr>
<tr>
<td>§8.3.2 sync()</td>
<td>Forcefully outputs content of buffer</td>
<td>fflush()</td>
</tr>
</tbody>
</table>

Table 9: List of member functions available for use with gzstreamio class.

How to use the member functions redefined and added in the gzstreamio class is described below.

8.3.1 open(), openf(), vopenf()

NAME

open(), openf(), vopenf() — Opens streams

SYNOPSIS

int open( const char *mode ); ................................................. 1
int open( const char *mode, int fd ); ................................................... 2
int open( const char *mode, cstreamio &sref ); ................................. 3
int open( const char *mode, const char *path ); ................................................ 4
int openf( const char *mode, const char *path_fmt, ... ); ...................... 5
int vopenf( const char *mode, const char *path_fmt, va_list ap ); ....... 6
DESCRIPTION

Opens the gzip format file indicated by `path` or `path_fmt` or attaches a file descriptor in the gzip format specified by `fd` or the object for an inherited class of the cstreamio class specified by `sref` to a gzip format stream. If `path` or `path_fmt` is NULL, the standard input or standard output is used.

With the `mode` for the member functions of 1, 2, 4, 5 or 6, "rb" is specified when reading data and "wb" when writing data. Specifying "b" in this manner enables the mode to be forcefully switched to binary mode. It is strongly recommended that users specify "b" when binary files will be handled as otherwise problems could occur such as damage to image files. With the `mode` for the member function of 3, "r" must be specified when reading data and "w" when writing data.

When writing data, you can specify the level and method of compression using the `mode`. In this case the mode needs to be be specified in the `[fopen mode][level of compression [method of compression]]` format, as in "wb6f". The levels of compression and methods are provided in the table below. The default value for the compression level, which is the average speed and compression ratio, is 6.

<table>
<thead>
<tr>
<th>Character specified</th>
<th>Level of compression</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No compression</td>
</tr>
<tr>
<td>1</td>
<td>The speed of processing is of primary concern</td>
</tr>
<tr>
<td>...</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>The efficiency of compression is of primary concern</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Character specified</th>
<th>Method of compression</th>
</tr>
</thead>
<tbody>
<tr>
<td>f</td>
<td>Filter data</td>
</tr>
<tr>
<td>h</td>
<td>Compression using only the Huffman method (For data with many of the same binary sets such as word)</td>
</tr>
<tr>
<td>R</td>
<td>Run length encoding (For data with sequential binaries such as images)</td>
</tr>
</tbody>
</table>

The member function 1 is used in cases such as the standard input/output needing to be redirected to a gzip-formatted file (Refer to EXAMPLE).

The member function 3 is used in cases such as when an object for an inherited class of the cstreamio class has had a stream already opened by it, or the stream gets changed during the course of the stream to a gzip-compressed stream (Refer to EXAMPLE-2 in §8.1.1).

For more details on the arguments used with `path_fmt` and thereafter for member functions 5 and 6 refer to the descriptions in §8.1.1.

PARAMETER

[I] `mode` File opening mode
[I] `fd` File descriptor
[I] `sref` Object for an inherited class of the cstreamio class
[I] `path` Name of file
[I] `path_fmt` Specifications for file name format
[I] ... Each element of data of a file name
[I] `ap` All the elements of data of a file name

RETURN VALUE

0 : Normal termination
Negative value (error) : If the system failed to open the stream because the file does not exist etc.
: If the system failed to open the stream because the mode specified was inappropriate, etc.
: If the system failed to open the stream because the relationship between the mode specified and fd was incorrect etc (Member function 2).
: If the system failed to open the stream because cannot access the stream in the mode specified.
: If the string indicating the path for path_fmt exceeds PATH_MAX.
: If the stream has already been opened by any of the member functions detailed in this section.
: If the system failed to open the stream for the reason that a compression method that is not supported is specified, etc.
: When the end of the stream is reached unexpectedly.

EXCEPTION

If the system fails to copy a file descriptor for the standard input/output (Member functions 1 and 4).
If the system fails to secure a temporary buffer for the compression algorithm (Member function 3).
If the system fails to initialize the compression algorithm (Member function 3).
If the system fails to secure output buffer (Member function 3).

EXAMPLE

The following code redirects the standard input to the gzip-formatted file.txt.gz, opens it in read mode, and then print the content to standard output. If gzstreamio_open is the name of the executable file for this code, run the following command:

$ ./gzstreamio_open < file.txt.gz

```c
#include <sli/gzstreamio.h>
using namespace sli;

int main()
{
    gzstreamio s_io;
    const char *line_ptr;

    if (s_io.open("rb") < 0) {
        Error handling
    }

    while ((line_ptr = s_io.getline()) != NULL) {
        printf("%s", line_ptr);
    }

    s_io.close();

    return 0;
}
```
WARNING
The functions can also open files that are not gzip-formatted, but be aware that writing and reading those files may not allow the intended processing to be performed.

8.3.2 sync()

NAME
sync() — Forcefully outputs the content, and adjusts it so that it terminates at a byte boundary.

SYNOPSIS
int sync();

DESCRIPTION
With flush() (§8.1.15), the outputs does not necessarily get terminated at a byte boundary. sync() calls flush(), and then adjusts the output so that it terminates at a byte boundary. Use of this member function therefore often reduces the compression ratio. Most applications do not require the sync() member function.

RETURN VALUE
0 : Normal termination
Negative value (error) : If the system fails to gzip-compress any data.

EXAMPLE
The following code writes binary data, gzip-compressed from the string c_sentence, to file.txt.gz in directory.

    gzstreamio f_out;
    const char *c_sentence = "This is an example code for the USER";

    if (f_out.openf("wb", "%s/%s", "directory", "file.txt.gz") < 0) {
        Error handling
    }

    if (f_out.printf("%s", c_sentence) < 0) {
        Error handling
    }

    if (f_out.sync() < 0) {
        Error handling
    }

    f_out.close();
8.4 The BZSTREAMIO class

The bzstreamio class is used to handle the standard input/output and normal file input/output while also performing bzip2 compression/expansion. It inherits cstreamio and hence all the member functions in §8.1 are available for use with the class. With the bzstreamio class, open() and close() must always be used.

If you wish to use the bzstreamio class you must add “#include <sli/bzstreamio.h>” to the code. If you need to declare a namespace (§4.1) you must also add “using namespace sli;” to the code.

Table 10 lists the member functions. The “Corresponding function in libc” column in Table 10 provides the functions in libc with the same feature as each of the member functions.

bzip2 is inferior to gzip in terms of processing speed, but has a data compression algorithm that supports a higher ratio of compression.

<table>
<thead>
<tr>
<th>The bzstreamio class</th>
<th>Feature</th>
<th>Corresponding function in libc</th>
</tr>
</thead>
<tbody>
<tr>
<td>§8.1.1 open(), openf(), vopenf()</td>
<td>Open streams</td>
<td>fopen()</td>
</tr>
<tr>
<td>§8.1.2 close()</td>
<td>Close streams</td>
<td>fclose()</td>
</tr>
<tr>
<td>§8.1.3 read()</td>
<td>Input of binary streams</td>
<td>fread()</td>
</tr>
<tr>
<td>§8.1.3 write()</td>
<td>Output of binary streams</td>
<td>fwrite()</td>
</tr>
<tr>
<td>§8.1.4 bread()</td>
<td>Input of binary streams (With endian conversion)</td>
<td>—</td>
</tr>
<tr>
<td>§8.1.5 bwrite()</td>
<td>Output of binary streams (With endian conversion)</td>
<td>—</td>
</tr>
<tr>
<td>§8.1.6 rskip()</td>
<td>Read n bytes to skip data stream</td>
<td>—</td>
</tr>
<tr>
<td>§8.1.7 wskip()</td>
<td>Write n bytes of blank data</td>
<td>—</td>
</tr>
<tr>
<td>§8.1.8 getchar()</td>
<td>Input of character</td>
<td>fgetc()</td>
</tr>
<tr>
<td>§8.1.9 getstr()</td>
<td>Input of strings</td>
<td>fgets()</td>
</tr>
<tr>
<td>§8.1.10 getline()</td>
<td>Input of line</td>
<td>—</td>
</tr>
<tr>
<td>§8.1.11 scanf()</td>
<td>Converts inputs with a format and assigns them to an argument</td>
<td>fscanf()</td>
</tr>
<tr>
<td>§8.1.12 putchr()</td>
<td>Output of character</td>
<td>fputc()</td>
</tr>
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<td>§8.1.13 putstr()</td>
<td>Output of strings</td>
<td>fputs()</td>
</tr>
<tr>
<td>§8.1.14 printf()</td>
<td>Outputs the value of an argument after being format-converted</td>
<td>fprintf()</td>
</tr>
<tr>
<td>§8.1.15 flush()</td>
<td>Forcefully outputs the content of buffer</td>
<td>fflush()</td>
</tr>
<tr>
<td>§8.1.16 eof(), error(), reseterr()</td>
<td>Check and reset stream status</td>
<td>feof(), etc.</td>
</tr>
</tbody>
</table>

Table 10: bzstreamio List of member functions available for use with the bzstreamio class.

How to use the member functions redefined and added in the bzstreamio class is described below.

8.4.1 open(), openf(), vopenf()

NAME

open(), openf(), vopenf() — Open streams

SYNOPSIS

```c
int open( const char *mode ); .................................................. 1
int open( const char *mode, int fd ); .......................................... 2
int open( const char *mode, cstreamio &sref ); .............................. 3
int open( const char *mode, const char *path ); ................................ 4
int openf( const char *mode, const char *path_fmt, ... ); ................. 5
int vopenf( const char *mode, const char *path_fmt, va_list ap ); ....... 6
```
**DESCRIPTION**

Opens a bzip2-formatted file indicated by `path` or `path_fmt`, or attaches a bzip2-formatted file descriptor specified by `fd` or the object for an inherited class of the cstreamio class specified by `sref` to a bzip2-formatted stream. If `path` or `path_fmt` is `NULL`, the standard input or standard output is used.

With the `mode` for the member functions of 1, 2, 4, 5 or 6, "rb" is specified when reading data and "wb" when writing data. Specifying "b" in this manner enables the mode to be forcefully switched to binary mode. It is strongly recommended that users specify "b" when handling binary files as otherwise problems could occur such as damage to image files. With the `mode` for the member function of 3, "r" must be specified when reading data and "w" when writing data.

Member function 1 is used in cases such as the standard input/output being redirected to a bzip2-formatted file (Refer to EXAMPLE-1).

The member function 3 is used when an object for an inherited class of the cstreamio class has had a stream already opened by it, or the stream gets changed during the course of the stream to a bzip2-compressed stream (Refer to EXAMPLE-2 in §8.1.1).

For more details on the arguments for `path_fmt` and thereafter for member functions 5 and 6, refer to the descriptions provided in §8.1.1.

**PARAMETER**

- `[I] mode`  File opening mode
- `[I] fd`  File descriptor
- `[I] sref`  Object for inherited class of cstreamio class
- `[I] path`  Name of file
- `[I] path_fmt`  File name format specifications
- `[I] ...`  Each element of data of a file name
- `[I] ap`  All the elements of data of a file name


**RETURN VALUE**

- `0`  : Normal termination
- Negative value (error)  : If the system failed to open the stream because the file does not exist etc.
  - If the system failed to open the stream because the `mode` specified was inappropriate etc.
  - If the system failed to open the stream because the relationship between the `mode` specified and `fd` was incorrect etc (Member function 2).
  - If the system failed to open the stream because it cannot access the stream in the mode specified etc.
  - If the string indicating `path_fmt` exceeds `PATH_MAX`.
  - If the stream has already been opened by any of the member functions detailed in this section.

**EXCEPTION**

If the system failed to copy a file descriptor for the standard input/output (Member functions 1 and 4).

If the system failed to secure a temporary buffer for the compression algorithm (Member function 3).

If the system failed to initialize the compression algorithm (Member function 3).

If the system failed to secure the output buffer (Member function 3).
EXAMPLE-1
The following code redirects the standard input to the bzip2-formatted file.txt.bz2, opens it in read mode, and then print the content to standard output. If bzstreamio_open is the name of the executable file for this code, run the following command:
$ ./bzstreamio_open < file.txt.bz2

```c
#include <sli/bzstreamio.h>
using namespace sli;

int main()
{
    bzstreamio s_io;
    const char *line_ptr;

    if (s_io.open("rb") < 0) {
        Error handling
    }

    while ((line_ptr = s_io.getline()) != NULL) {
        printf("%s", line_ptr);
    }

    s_io.close();

    return 0;
}
```

EXAMPLE-2
The following code opens the bzip2-formatted file.txt.bz2 in directory in read and binary mode, and then prints the content to standard output.

```c
bzstreamio f_in;
const char *line_ptr;

if (f_in.open("rb", "directory/file.txt.bz2") < 0) {
    Error handling
}

while ((line_ptr = f_in.getline()) != NULL) {
    printf("%s", line_ptr);
}

f_in.close();
```

WARNING
The functions can also open files that are not bzip2-formatted but be aware that writing and reading them may not allow the intended processing to be performed.
8.5 The HTTPSTREAMIO class

The httpstreamio class uses the GET method of an http server to perform stream inputs from that http server. It can also input streams while performing gzip expansion or bzip2 expansion.

The class inherits cstreamio, but some of the member functions in § 8.1 are not available. For the member functions available with the httpstreamio class refer to the list of member functions in Table 11. With the httpstreamio class, open() and close() must always be used. With the open() member function, "r" or "r%" is specified as the mode, and a URL that begins with http:// is specified as the path. Connections through a proxy server are not supported.

If you wish to use the httpstreamio class, you must add "#include <sli/httpstreamio.h>" to the code. If you need to declare a namespace (§ 4.1), you must also add “using namespace sli;” to the code.

The “Corresponding function in libc” column in Table 11 provides the corresponding functions in libc with the same feature as each of the member functions.

<table>
<thead>
<tr>
<th>The httpstreamio class Feature</th>
<th>Corresponding function in libc</th>
</tr>
</thead>
<tbody>
<tr>
<td>§8.5.1 open(), openf(), vopenf()</td>
<td>Open streams</td>
</tr>
<tr>
<td>§8.1.2 close()</td>
<td>Closes streams</td>
</tr>
<tr>
<td>§8.1.3 read()</td>
<td>Input of binary streams</td>
</tr>
<tr>
<td>§8.1.4 bread()</td>
<td>Input of binary streams (With endian conversion)</td>
</tr>
<tr>
<td>§8.1.6 rskip()</td>
<td>Read n bytes to skip data stream</td>
</tr>
<tr>
<td>§8.1.8 getchr()</td>
<td>Input of character</td>
</tr>
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<td>§8.1.9 getstr()</td>
<td>Input of strings</td>
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<td>§8.1.10 getline()</td>
<td>Input of line</td>
</tr>
<tr>
<td>§8.1.11 scanf()</td>
<td>Converts inputs with a format and assigns to an argument</td>
</tr>
<tr>
<td>§8.1.16 std::error()</td>
<td>Check and reset stream status</td>
</tr>
<tr>
<td>§8.1.12 std::reseterr()</td>
<td>Calls for the length of streams</td>
</tr>
<tr>
<td>§8.5.3 user_agent().assign()</td>
<td>Sets user agent</td>
</tr>
</tbody>
</table>

Table 11: List of member functions available for use with the httpstreamio class.

How to use the member functions redefined and added in the httpstreamio class is described below.

8.5.1 open(), openf(), vopenf()

NAME
open(), openf(), vopenf() — Open streams

SYNOPSIS

```c
int open( const char *mode, const char *path );
int openf( const char *mode, const char *path_fmt, ... );
int vopenf( const char *mode, const char *path_fmt, va_list ap );
```

DESCRIPTION
Opens a URL indicated by path or path_fmt. "r" or "r%" is specified as the mode. If "r%" is specified as the mode, gzip- or bzip2-compressed streams are expanded when read if necessary. The header information (MIME) that a server returns and the suffix (".gz" or "bz2") of a file name for path or path_fmt determine whether gzip or bzip2 is used.

For more details on the arguments for path_fmt and thereafter for openf() and vopenf(), refer to the descriptions provided in [§8.1.1].
PARAMETER

|  [I] mode  | URL opening mode |
|  [I] path  | Path for URL     |
|  [I] path_fmt  | URL format specifications |
|  [I] ...  | Each element of data of URL |
|  [I] ap  | All the elements of data of URL |


RETURN VALUE

0 : Normal termination

Negative value (error) : If the system failed to open the stream because the URL specified was inappropriate etc.

- If the system failed to open the stream because the mode was not specified etc.
- If the system failed to open the stream because the mode specified was inappropriate etc.
- If the system failed to open the stream because it cannot access the stream in the mode specified.
- If the string indicating path_fmt exceeds PATH_MAX.
- If the stream has already been opened by any of the member functions detailed in this section.
- If the system failed to open the gzip- or bzip2-formatted stream.

EXCEPTION

If the system fails to allocate enough memory.

EXAMPLE

The following code opens the URL of http://www.jaxa.jp/ in read mode, and then prints the content of the linked source code (html) to standard output.

```c
httpstreamio net_in;
const char *line_ptr;
if (net_in.open("r", "http://www.jaxa.jp/") < 0) {
    Error handling
}
while ((line_ptr = net_in.getline()) != NULL) {
    printf("%s", line_ptr);
}
net_in.close();
```

8.5.2 content_length()

NAME

ccontent_length() — Calls for the length of streams

SYNOPSIS

```c
long long content_length() const;
```
DESCRIPTION
Returns the byte length of a stream opened by `open()`. With compressed streams, it returns the byte length of a compressed stream.

RETURN VALUE
- Non-negative value : Byte length of stream
- Negative value (error) : If Content-Length information does not exist in the MIME header.

EXAMPLE
The following code opens the URL of `http://www.jaxa.jp/` in read mode, and then prints the byte length of the stream to standard output.

```c
httpstreamio net_in;
long long l_ret;

if (net_in.open("r", "http://www.jaxa.jp/") < 0) {
    Error handling
}

if ((l_ret = net_in.content_length()) < 0) {
    printf("No information about stream byte size\n");
}
else {
    printf("Stream Byte Size = %lld \n", l_ret);
}

net_in.close();
```

8.5.3 `user_agent().assign()`

NAME
`user_agent().assign()` — Sets user agent

SYNOPSIS
```c
const char *user_agent().assign( const char *uagent );
tstring &user_agent().assignf( const char *uagent_fmt, ... );
```

DESCRIPTION
Sets the user agent to be transmitted when connecting to a Web server. If a user agent is not set, “hostname SLLIB-x.x::httpstreamio” will be transmitted.
8.6 The FTPSTREAMIO class

The ftpstreamio class connects to an ftp server and performs the stream input from that ftp server or stream output to the ftp server in passive mode. The class can also input/output streams while performing gzip expansion/compression or bzip2 expansion/compression.

As the class inherits cstreamio basically all the member functions in §8.1 are available for the class, with only open( const char *mode, cstream &sref ) not being usable. With the ftpstreamio class open() and close() must always be used. With the open() member functions, "r", "r%", "w" or "w%" is specified as the mode, and a URL that begins with ftp:// is specified as the path. Connections through a proxy server are not supported.

If you wish to use the ftpstreamio class you must add “#include <sli/ftpstreamio.h>” to the code. If you need to declare a namespace (§4.1), you must also add “using namespace sli;” to the code.

Table 12 lists the member functions. The “Corresponding function in libc” column in Table 12 provides the corresponding functions in libc with the same feature as each of the member functions.

<table>
<thead>
<tr>
<th>The ftpstreamio class</th>
<th>Feature</th>
<th>Corresponding function in libc</th>
</tr>
</thead>
<tbody>
<tr>
<td>§8.6.1 open(), openf(), vopenf()</td>
<td>Open streams</td>
<td>fopen()</td>
</tr>
<tr>
<td>§8.1.2 close()</td>
<td>Closes streams</td>
<td>fclose()</td>
</tr>
<tr>
<td>§8.1.3 read()</td>
<td>Input of binary streams</td>
<td>fread()</td>
</tr>
<tr>
<td>§8.1.3 write()</td>
<td>Output of binary streams</td>
<td>fwrite()</td>
</tr>
<tr>
<td>§8.1.4 bread()</td>
<td>Input of binary streams (With endian conversion)</td>
<td>—</td>
</tr>
<tr>
<td>§8.1.5 bwrite()</td>
<td>Output of binary streams (With endian conversion)</td>
<td>—</td>
</tr>
<tr>
<td>§8.1.6 rskip()</td>
<td>Read n bytes to skip data stream</td>
<td>—</td>
</tr>
<tr>
<td>§8.1.7 wskip()</td>
<td>Write n bytes of blank data</td>
<td>—</td>
</tr>
<tr>
<td>§8.1.8 getchr()</td>
<td>Input of character</td>
<td>fgetc()</td>
</tr>
<tr>
<td>§8.1.9 getstr()</td>
<td>Input of strings</td>
<td>fgets()</td>
</tr>
<tr>
<td>§8.1.10 getline()</td>
<td>Input of line</td>
<td>—</td>
</tr>
<tr>
<td>§8.1.11 scanf()</td>
<td>Converts inputs with format and assigns to an argument</td>
<td>fscanf()</td>
</tr>
<tr>
<td>§8.1.12 putchr()</td>
<td>Output of character</td>
<td>fputc()</td>
</tr>
<tr>
<td>§8.1.13 putstr()</td>
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</tr>
<tr>
<td>§8.1.14 printf()</td>
<td>Outputs the value of an argument after being format-converted</td>
<td>fprintf()</td>
</tr>
<tr>
<td>§8.1.15 flush()</td>
<td>Forcefully outputs the content of buffer</td>
<td>fflush()</td>
</tr>
<tr>
<td>§8.1.16 eof(), error(), reseterr()</td>
<td>Check and reset stream status</td>
<td>feof(), etc.</td>
</tr>
<tr>
<td>§8.2.2 content_length()</td>
<td>Calls for the length of streams</td>
<td>—</td>
</tr>
<tr>
<td>§8.3.3 username().assign()</td>
<td>Sets the name of FTP user</td>
<td>—</td>
</tr>
<tr>
<td>§8.6.4 password().assign()</td>
<td>Sets the password for FTP user</td>
<td>—</td>
</tr>
</tbody>
</table>

Table 12: List of the member functions available for use with the ftpstreamio class.

How to use the member functions redefined and added in the httpstreamio class is described below.

8.6.1 open(), openf(), vopenf()

NAME
open(), openf(), vopenf() — Open streams

SYNOPSIS

int open( const char *mode, const char *path );
int openf( const char *mode, const char *path_fmt, ... );
int vopenf( const char *mode, const char *path_fmt, va_list ap );

DESCRIPTION
Opens a URL indicated by path or path_fmt. path must always begin with ftp://. A
user name and password can be included in path by making the appropriate setting in the
ftp://username:password@ftp.com/... format. If a user name and password were not in-
cluded in path, they can also be set using user name().assign() and password().assign()
(§8.6.3 and 8.6.4). If a user name and password are set, connections will be made to the
ftp server anonymously.

"r", "r%", "w" or "w%" is specified as the mode. When "r%" is specified as the mode, gzip-
or bzip2-compressed streams are expanded when read if necessary. When "w%" is specified as
the mode, gzip or bzip2 is used to compresses a stream if necessary and then send it to the
ftp site. The suffix (".gz" or ".bz2") used for the file name with path determines whether
gzip or bzip2 is used.

For more details on the arguments for path_fmt and thereafter for openf() and vopenf(),
refer to the descriptions provided in §8.1.1.

PARAMETER
[I] mode URL opening mode
[I] path Path for URL
[I] path_fmt URL format specifications
[I] ... Each element of data of a URL
[I] ap All the elements of data of a URL

RETURN VALUE
0 : Normal termination
Negative value (error) : If the system failed to open the stream because the URL was
not specified etc.
: If the system failed to open the stream because the URL spec-
ified was inappropriate etc.
: If the system failed to open the stream because the mode spec-
ified was inappropriate etc.
: If the string indicating path_fmt exceeds PATH_MAX.
: If the system failed to open the stream because the mode was
not specified etc.
: If the system failed to open the stream because it cannot access
the stream in the mode specified etc.
: If the stream has already been opened by any of the member
functions detailed in this section.
: If the system failed to open the stream because the system failed
to connect to an ftp server etc.
: If the system failed to open the gzip- or bzip2-formatted stream.

EXCEPTION
If the system failed to allocate enough memory.

EXAMPLE
The following code opens the URL of ftp://ftp.boof.com/file.txt in read mode, and then
prints the content to standard output. Please note that the URL provided on the left does
not actually exist and hence execution the code will result in open() abnormally terminating. If an actual in use URL were used the code would operate normally.

```c++
ftpstreamio f_in;
const char *line_ptr;

if (f_in.open("r", "ftp://ftp.boof.com/file.txt") < 0) {
  // Error handling
}

while ((line_ptr = f_in.getline()) != NULL) {
  printf("%s", line_ptr);
}

f_in.close();
```

8.6.2 content_length()

NAME
ccontent_length() — Calls for the length of streams

SYNOPSIS

```c
long long content_length() const;
```

DESCRIPTION
With streams opened with a read mode specification in open(), the byte length of a stream is returned. With compressed streams opened by open(), the byte length of a compressed stream is returned.

RETURN VALUE
Non-negative value : Byte length of a stream
Negative value (error) : If the stream is not opened.

EXAMPLE
The following code opens the URL of ftp://ftp.boof.com/file.txt in read mode, and then prints the byte length of the stream to standard output. Please note that the URL provided on the left does not actually exist and hence execution of the code will result in open() abnormally terminating. If an actual in use URL were to be used the code would operate normally.

```c++
ftpstreamio f_in;
long long l_ret;

if (f_in.open("r", "ftp://ftp.boof.com/file.txt") < 0) {
  // Error handling
}

if ((l_ret = f_in.content_length()) < 0) {
  printf("No information about stream byte size\n");
} else {
  printf("Stream Byte Size = %lld \n", l_ret);
}
```
8.6.3 username().assign()

NAME
username().assign() — Sets the name for FTP user

SYNOPSIS
  tstring &username().assign( const char *user );

DESCRIPTION
  By default, the open() member function (§8.6.1) enables users to log on to an FTP server anonymously, but a user name can be set using this member function.

8.6.4 password().assign()

NAME
password().assign() — Sets the password for FTP user

SYNOPSIS
  tstring &password().assign( const char *pass );

DESCRIPTION
  Sets the password for an FTP user assigned by username().assign().
8.7 The PIPESTREAMIO class

The pipestreamio class is used to execute files and then connect the process executed to input or output stream pipes. The class inherits cstreamio and therefore basically all the member functions in §8.1 except `open(const char *mode, cstreamio &sref)` are available for use. With the pipestreamio class `open()` and `close()` must always be used. With the `open()` member function, "r" or "w" is specified as the `mode`, while a command is specified as the `path`. The mode being "r" denotes input from the executed process, but when "w" denotes output to the executed process. The `open()` member function is also available that enables commands to be specified using arguments for `char *const argv[]`, for example `execvp()`, from libc.

If you wish to use the pipestreamio class you must add “#include <sli/pipestreamio.h>” to the code. In addition, if you need to declare a namespace (§4.1) you must also add “using namespace sli;” to the code.

The “Corresponding function in libc” column in Table 13 provides the corresponding functions in libc with the same feature as each of the member functions.

<table>
<thead>
<tr>
<th>pipestreamio class</th>
<th>Feature</th>
<th>Corresponding function in libc</th>
</tr>
</thead>
<tbody>
<tr>
<td>§8.7.1 open(), openf(), vopenf()</td>
<td>Opens streams</td>
<td>fopen()</td>
</tr>
<tr>
<td>§8.7.2 close()</td>
<td>Closes streams</td>
<td>fclose()</td>
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<td>Output of binary streams</td>
<td>fwrite()</td>
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<tr>
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<td>Read n bytes to skip data stream</td>
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<tr>
<td>§8.7.7 wskip()</td>
<td>Write n bytes of blank data</td>
<td>—</td>
</tr>
<tr>
<td>§8.7.9 getchr()</td>
<td>Input of single character</td>
<td>fgetc()</td>
</tr>
<tr>
<td>§8.7.9 getstr()</td>
<td>Input of strings</td>
<td>fgets()</td>
</tr>
<tr>
<td>§8.7.10 getline()</td>
<td>Input of single line</td>
<td>—</td>
</tr>
<tr>
<td>§8.7.11 scanf()</td>
<td>Converts input with a format and assigns to an argument</td>
<td>fscanf()</td>
</tr>
<tr>
<td>§8.7.12 putchr()</td>
<td>Output of single character</td>
<td>fputc()</td>
</tr>
<tr>
<td>§8.7.13 putstr()</td>
<td>Output of strings</td>
<td>fputs()</td>
</tr>
<tr>
<td>§8.7.14 printf()</td>
<td>Outputs the value of an argument after being format-converted</td>
<td>fprintf()</td>
</tr>
<tr>
<td>§8.7.15 flush()</td>
<td>Forcefully outputs the content of a buffer</td>
<td>fflush()</td>
</tr>
<tr>
<td>§8.7.16 eof(), error(), reseterr()</td>
<td>Check and reset stream status</td>
<td>feof(), etc.</td>
</tr>
</tbody>
</table>

Table 13: List of member functions available for use with the pipestreamio class.

How to use the member functions redefined and added in the pipestreamio class is described below.

8.7.1 open(), openf(), vopenf()

NAME

open(), openf(), vopenf() — Opens streams

SYNOPSIS

```c
int open( const char *mode ); .................................................. 1
int open( const char *mode, int fd ); ....................................... 2
int open( const char *mode, const char *path ); ......................... 3
```
int open( const char *mode, const char *const argv[] ); ...................... 4
int openf( const char *mode, const char *path_fmt, ... ); ................ 5
int vopenf( const char *mode, const char *path_fmt, va_list ap ); ....... 6

DESCRIPTION
Member functions 3 to 6 are used to execute the command indicated by path, argv or path_fmt, and then connect the result using a pipe to open the stream. Pipes provide unidirectional inter-process communication channels, and have both “read” and “write” sides. Data written to the write side of a pipe can then be read from the read side of the pipe. The mode being "r" results in the specified command being executed, with the output from standard output of the command being connected to a pipe so that it can then be read by the reading member function of the object (Refer to EXAMPLES 1 and 2). The mode being "w" results in the specified command being executed, with the result being written by writing member functions of the object to a pipe so that it can then be read as the standard input for the command (Refer to EXAMPLE 3).

path or path_fmt being set results in it being executed in the “/bin/sh -c command” format, and hence path or path_fmt can include pipe and redirection symbols (|, <, >). If path or path_fmt is NULL, the standard input or standard output is used.

argv[] elements must be set in the order of “the executable file’s path name, argument 1, argument 2, ... NULL”. The end of argv[] must always be NULL.

Member functions 1 and 2 cannot be used to execute a command and connect the result with a pipe to open the stream. For more details on these member functions refer to the descriptions provided in §8.1.1.

For more details on the arguments used with path_fmt and later for member functions 5 and 6 refer to the descriptions provided in §8.1.1

PARAMETER
[I] mode Stream opening mode
[I] fd File descriptor
[I] path A command
[I] path_fmt Command format specifications
[I] ... Each element of data of a command
[I] ap All the elements of data of a command
[I] argv[] All the elements of data of a command

RETURN VALUE
0 : Normal termination
Negative value (Error) : If the system failed to open a stream because a command was not specified etc.
: If the system failed to open a stream because the mode specified was inappropriate etc.
: If the system failed to open a stream because it cannot access the stream in the specified mode etc.
: If the string indicating the path for path_fmt exceeds PATH_MAX.
: If the stream has already been opened by any of the other member functions described in this section.

EXCEPTION
If the system failed to generate a file descriptor for use in reading or writing data.
If the system failed to generate a process.
EXAMPLE-1
The following code formats the man page for the function fprintf, and then writes the content of the page to the output file opened in write mode:

```c
sstreamio f_out;
pipestreamio p_in;
const char *line_ptr;

f_out.openf("w", "%s", "file.txt");
if (p_in.open("r", argv) < 0) {
    Error handling
}
while ((line_ptr = p_in.getline()) != NULL) {
    f_out.printf("%s", line_ptr);
}
p_in.close();
f_out.close();
```

EXAMPLE-2
The following code sorts the content of file.txt in directory using the second field as the key and on a per-line basis, and then prints the result to standard output:

```c
pipestreamio p_in;
const char *line_ptr;
if (p_in.open("r", "cat directory/file.txt | sort -k 2") < 0) {
    Error handling
}
while ((line_ptr = p_in.getline()) != NULL) {
    printf("%s", line_ptr);
}
p_in.close();
```

EXAMPLE-3
The following code reads the content of file.txt in directory one line at a time. The content of each line is read and the line that matches the string pattern is written to standard output:

```c
sstreamio f_in;
pipestreamio p_out;
const char *line_ptr;

if (f_in.open("r", "directory/file.txt") < 0) {
    Error handling
}"
if (p_out.open("w", "grep pattern") < 0) {
    Error handling
}

while ((line_ptr = f_in.getline()) != NULL) {
    p_out.printf("%s", line_ptr);
}

p_out.close();
f_in.close();
8.8 The DIGESTSTREAMIO class

The digeststreamio class is used to handle the stream input/output of the URL or file indicated by the path argument of the open() member function while performing gzip- or bzip2-compression/expansion if necessary. The openp() member function added in this class also additionally enables input from commands and output to commands using a pipe. The digeststreamio class is therefore an extremely versatile class of the inherited cstreamio classes. The header information (MIME) returned by a server and the suffix of the file name in path provided to open() can be used to determine whether any compression/expansion is necessary. The class inherits cstreamio and hence basically all the member functions in §8.1 are available for use, apart from open(const char *mode, cstreamio &sref). With the digeststreamio class open() and close() must always be used. "r" or "w" must always be specified as the mode for the open() member function. Output to an http server is currently not supported, along with connections through a proxy server.

If you wish to use the digeststreamio class you must add "#include <sli/digeststreamio.h>" to the code. In addition, if you need to declare a namespace (§4.1) you must also add "using namespace sli;" to the code.

Table 14 lists the member functions. The “Corresponding function in libc” column in Table 14 provides the corresponding functions in libc with the same feature as each of the member functions.

<table>
<thead>
<tr>
<th>digeststreamio class</th>
<th>Feature</th>
<th>Corresponding function in libc</th>
</tr>
</thead>
<tbody>
<tr>
<td>§8.8.1 open(), openf(), vopenf()</td>
<td>Opens streams</td>
<td>fopen()</td>
</tr>
<tr>
<td>§8.8.2 openp(), openpf(), openpf()</td>
<td>Opens streams (perl-like)</td>
<td>—</td>
</tr>
<tr>
<td>§8.1.2 close()</td>
<td>Closes streams</td>
<td>fclose()</td>
</tr>
<tr>
<td>§8.1.3 read()</td>
<td>Input of binary streams</td>
<td>fread()</td>
</tr>
<tr>
<td>§8.1.3 write()</td>
<td>Output of binary streams</td>
<td>fwrite()</td>
</tr>
<tr>
<td>§8.1.4 bread()</td>
<td>Input of binary streams (With endian conversion)</td>
<td>—</td>
</tr>
<tr>
<td>§8.1.5 bwrite()</td>
<td>Output of binary streams (With endian conversion)</td>
<td>—</td>
</tr>
<tr>
<td>§8.1.6 rskip()</td>
<td>Seek forward (if possible) or read n bytes to skip data stream</td>
<td>—</td>
</tr>
<tr>
<td>§8.1.7 wskip()</td>
<td>Seek forward (if possible) or write n bytes of blank data</td>
<td>—</td>
</tr>
<tr>
<td>§8.1.8 getchr()</td>
<td>Input of single character</td>
<td>fgetc()</td>
</tr>
<tr>
<td>§8.1.9 getstr()</td>
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<td>Converts inputs with a format and assigns to an argument</td>
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<td>fputs()</td>
</tr>
<tr>
<td>§8.1.14 printf()</td>
<td>Outputs the value of an argument after being format-converted</td>
<td>fprintf()</td>
</tr>
<tr>
<td>§8.1.15 flush()</td>
<td>Forcefully outputs the content of a buffer</td>
<td>fflush()</td>
</tr>
<tr>
<td>§8.1.16 eof(), error(), reseterr()</td>
<td>Check and reset stream status</td>
<td>feof(), etc.</td>
</tr>
</tbody>
</table>

Table 14: List of the member functions available for use with the digeststreamio class.

How to use the member functions redefined and added in the digeststreamio class is described below.
8.8.1 open(), openf(), vopenf()

NAME
open(), openf(), vopenf() — Opens streams

SYNOPSIS
int open( const char *mode ); .............................................. 1
int open( const char *mode, int fd ); ........................................ 2
int open( const char *mode, const char *path ); .......................... 3
int openf( const char *mode, const char *path_fmt, ... ); ................. 4
int vopenf( const char *mode, const char *path_fmt, va_list ap ); ........ 5

DESCRIPTION
Opens the file or URL indicated by path or path_fmt. With URLs a string that begins with file://, http:// or ftp:// can be specified. If path or path_fmt is NULL the standard input or standard output is used.

The mode being "r" performs input and when "w" output. Member functions 1 and 2 cannot execute commands and connect the result using a pipe to open the stream. For more details on these member functions refer to the descriptions provided in §8.1.1.

For more details on the argument for path_fmt and later for member functions 4 and 5 refer to the descriptions provided in §8.1.1.

PARAMETER
[I] mode File or URL opening mode
[I] fd File descriptor
[I] path File or URL
[I] path_fmt File or URL format specifications
[I] ... Each element of data of a file or URL
[I] ap All the elements of data of a file or URL

RETURN VALUE
0 : Normal termination
Negative value (Error) : If the system failed to open a stream because the mode specified was inappropriate etc.
: If the system failed to open a stream because the relationship between the mode specified and fd was incorrect etc (Member function 2).
: If the system failed to open a stream because it cannot access the stream in the specified mode etc.
: If the string indicating the path for path_fmt exceeds PATH_MAX.
: If the stream has already been opened by any of the other member functions described in this section.
: If the system failed to open the file or URL.

EXCEPTION
If the system failed to generate an object.

EXAMPLE
The following code first opens the URL of http://www.jaxa.jp/ in read mode and then writes the binary data from the gzip-compressed content of that stream to file.gz in directory.

digeststreamio net_in;
digeststreamio f_out;
const char *line_ptr;

if (net_in.open("r", "http://www.jaxa.jp/") < 0) {
    Error handling
}

if (f_out.openf("w", "%s/%s", "directory", "file.txt.gz") < 0) {
    Error handling
}

while ((line_ptr = net_in.getline()) != NULL) {
    if (f_out.printf("%s", line_ptr) < 0) {
        Error handling
    }
}

f_out.close();
net_in.close();

8.8.2 openp(), openpf(), vopenpf()

NAME
openp(), openpf(), vopenpf() — Opens streams (Perl-like)

SYNOPSIS
int openp( const char *path );
int openpf( const char *path_fmt, ... );
int vopenpf( const char *path_fmt, va_list ap );

DESCRIPTION
These member functions are similar to open() in the scripting language Perl, with path or path_fmt indicating the file or URL to be opened. If it used to indicate a command it executes that command and then connects the result using a pipe to open the stream.

Whether read or write mode is used is expressed by adding “<” or “>”, as in "< infile.txt" and "> outfile.txt", when path or path_fmt is used indicate the file or URL. If “<” is used the stream is opened in read mode (Refer to EXAMPLE 1), and if “>” is used the stream is opened in write mode. If neither “<” or “>” is specified the stream is opened in read mode. If a compressed file is specified the file gets automatically compressed/expanded.

If path or path_fmt is used to indicate a command, “|” needs to be placed before or after path to express the command, as in "command |" or "| command". “|” being placed after pathresults in the command specified being executed, and the output from standard output of the command being connected with a pipe so that it can be read by reading member functions of the object (Refer to EXAMPLE 2). “|” being placed before “path results in the specified command being executed, and the result written by writing member functions of the object is then connected with a pipe so that it can be read from the standard input for the command (Refer to EXAMPLE 3). path or path_fmt being the command results in execution in the “/bin/sh -c command" format, and hence path can include pipe or redirection symbols (1,.<,>) (Refer to EXAMPLE 2).

When path or path_fmt is NULL the standard input is used.
For more details on the arguments for path_fmt and later for openpf() and vopenpf(), refer to the descriptions provided in §8.1.1

PARAMETER

[I] path  File, URL or command
[I] path_fmt  File, URL or command format specifications
[I] ...  Each element of data of a file, URL or command
[I] ap  All the elements of data of a file, URL or command

RETURN VALUE

0 : Normal termination
Negative value (Error) : If the stream has already been opened by any of the other member functions described in this section.
: If the string indicating the path for path_fmt exceeds PATH_MAX.
: If the system failed to open a file, URL or command.

EXCEPTION

If the system failed to generate an object.

EXAMPLE-1

Connects to the path using port number port for server name server in read only mode with http protocol, and then writes the content of that stream to standard output:

```c
digeststreamio net_in;
digeststreamio s_io;
const char *line_ptr;

if (net_in.openpf("< http://%s:%d%s",server,port,path) < 0) {
    Error handling
}

if (s_io.open("w") < 0) {
    Error handling
}

while ((line_ptr = net_in.getline()) != NULL) {
    if (s_io.printf("%s", line_ptr) < 0) {
        Error handling
    }
}

s_io.close();
net_in.close();
```

EXAMPLE-2

The following code sorts the content of file.txt in directory using the second field as the key and on a per-line basis, and then prints the result to standard output through the open process.

The argument for openp() is specified in the "command |" format, where the first "|" indicates a pipe and the second "|" that the argument is a command.

This code does the same thing as in EXAMPLE-2 in §8.7.1 but with "|" placed after command.
digeststreamio p_in;
const char *line_ptr;

if (p_in.openp("cat directory/file.txt | sort -k 2 |") < 0) {
    Error handling
}

while ((line_ptr = p_in.getline()) != NULL) {
    printf("%s", line_ptr);
}

p_in.close();

EXAMPLE-3
The following code reads the content of file.txt in directory line by line, and then displays it on the screen using the less command:

stdstreamio f_in;
digeststreamio p_out;
const char *line_ptr;

if (f_in.open("r", "directory/file.txt") < 0) {
    Error handling
}

if (p_out.openp("| less") < 0) {
    Error handling
}

while ((line_ptr = f_in.getline()) != NULL) {
    p_out.printf("%s", line_ptr);
}

p_out.close();
f_in.close();

8.8.3 is_write_mode()

NAME
is_write_mode() — Returns mode of opened stream

SYNOPSIS
bool is_write_mode() const;

DESCRIPTION
This member function returns true for opened stream in write mode, otherwise returns false.
8.8.4 content_length()

NAME
content_length() — Calls for the length of streams

SYNOPSIS
long long content_length() const;

DESCRIPTION
If the stream opened by open() has information about length of stream, content_length() returns the byte length of the stream. With compressed streams, it returns the byte length of a compressed stream.

RETURN VALUE
Non-negative value : Byte length of stream
Negative value (error) : If information of length does not exist.

EXAMPLE
The following code opens the URL of http://www.jaxa.jp/ in read mode, and then prints the byte length of the stream to standard output.

```c
DigestStreamio net_in;
long long l_ret;

if (net_in.open("r", "http://www.jaxa.jp/") < 0) {
    Error handling
}

if ((l_ret = net_in.content_length()) < 0) {
    printf("No information about stream byte size\n");
} else {
    printf("Stream Byte Size = %lld \n", l_ret);
}

net_in.close();
```

8.8.5 user_agent().assign()

NAME
user_agent().assign() — Sets user agent

SYNOPSIS
tstring &user_agent().assign( const char *uagent );
tstring &user_agent().assignf( const char *uagent_fmt, ... );

DESCRIPTION
Sets the user agent to be transmitted when connecting to a Web server. If a user agent is not set, “hostname SLLIB-x.x::httpstreamio” will be transmitted.
8.8.6  username().assign()

NAME
username().assign() — Sets the name for FTP user

SYNOPSIS

tstring &username().assign( const char *user );

DESCRIPTION
By default, the open() member function enables users to log on to an FTP server anonymously, but a user name can be set using this member function.

8.8.7  password().assign()

NAME
password().assign() — Sets the password for FTP user

SYNOPSIS

tstring &password().assign( const char *pass );

DESCRIPTION
Sets the password for an FTP user assigned by username().assign().
8.9 The TERMLINEIO class

The termlineio class is used to help users input commands from the GNU readline library. It supports a cursor key and history function etc when commands are input. It inherits cstreamio and hence all the member functions in §8.1 are available for use (You do not need to learn the GNU readline APIs). With the termlineio class open() and close() must always be used. With the open() member function "r" or "w" is specified as the mode. The mode being "r" results in commands being input on a per-line basis, and if "w" commands are output to the pager. The pager specified by the environment variable PAGER is utilized.

If you wish to use the termlineio class you must add "#include <sli/termlineio.h>" to the code. In addition, if you need to declare a namespace (§4.1) you must also add "using namespace sli;" to the code.

Table 15 lists the member functions. The following table provides the member functions with the same corresponding features as in libc.

<table>
<thead>
<tr>
<th>The termlineio class</th>
<th>Feature</th>
<th>Corresponding function in libc</th>
</tr>
</thead>
<tbody>
<tr>
<td>§8.9.1 open(), openf(), vopenf()</td>
<td>Opens streams</td>
<td>fopen()</td>
</tr>
<tr>
<td>§8.1.2 close()</td>
<td>Closes streams</td>
<td>fclose()</td>
</tr>
<tr>
<td>§8.1.3 read()</td>
<td>Input of binary streams</td>
<td>fread()</td>
</tr>
<tr>
<td>§8.1.3 write()</td>
<td>Output of binary streams</td>
<td>fwrite()</td>
</tr>
<tr>
<td>§8.1.4 bread()</td>
<td>Input of binary streams (With endian conversion)</td>
<td>—</td>
</tr>
<tr>
<td>§8.1.5 bwrite()</td>
<td>Output of binary streams (With endian conversion)</td>
<td>—</td>
</tr>
<tr>
<td>§8.1.6 rskip()</td>
<td>Read n bytes to skip data stream</td>
<td>—</td>
</tr>
<tr>
<td>§8.1.7 wskip()</td>
<td>Write n bytes of blank data</td>
<td>—</td>
</tr>
<tr>
<td>§8.1.8 getchr()</td>
<td>Input of single character</td>
<td>fgetc()</td>
</tr>
<tr>
<td>§8.1.9 getstr()</td>
<td>Input of strings</td>
<td>fgets()</td>
</tr>
<tr>
<td>§8.1.10 getline()</td>
<td>Input of single line</td>
<td>—</td>
</tr>
<tr>
<td>§8.1.11 scanf()</td>
<td>Converts inputs with a format and assigns to an argument</td>
<td>fscanf()</td>
</tr>
<tr>
<td>§8.1.12 putchr()</td>
<td>Output of single character</td>
<td>fputc()</td>
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<td>Output of strings</td>
<td>fputs()</td>
</tr>
<tr>
<td>§8.1.14 printf()</td>
<td>Outputs the value of an argument after being format-converted</td>
<td>fprintf()</td>
</tr>
<tr>
<td>§8.1.15 flush()</td>
<td>Forcefully outputs the content of a buffer</td>
<td>fflush()</td>
</tr>
<tr>
<td>§8.1.16 eof(), error(), reseterr()</td>
<td>Check and reset stream status</td>
<td>feof(), etc.</td>
</tr>
<tr>
<td>§8.9.2 set_prompt()</td>
<td>Sets prompt</td>
<td>—</td>
</tr>
<tr>
<td>§8.9.3 automate_history()</td>
<td>Specifies whether to automatically save histories</td>
<td>—</td>
</tr>
<tr>
<td>§8.9.4 add_history()</td>
<td>Adds command histories to history buffer</td>
<td>—</td>
</tr>
<tr>
<td>§8.9.5 clear_history()</td>
<td>Initialization of history buffers</td>
<td>—</td>
</tr>
<tr>
<td>§8.9.6 stifle_history()</td>
<td>Restricts number of history buffers</td>
<td>—</td>
</tr>
<tr>
<td>§8.9.7 unstifle_history()</td>
<td>Removes restriction on number of history buffers</td>
<td>—</td>
</tr>
<tr>
<td>§8.9.8 read_history()</td>
<td>Reads histories from a file</td>
<td>—</td>
</tr>
<tr>
<td>§8.9.9 write_history()</td>
<td>Writes histories to a file</td>
<td>—</td>
</tr>
</tbody>
</table>

Table 15: List of the member functions available for use with the termlineio class.

How to use the member functions redefined and member added in the termlineio class is described below.
8.9.1 open()

NAME
open(), openf(), vopenf() — Opens streams

SYNOPSIS
int open( const char *mode ); .................................................. 1
int open( const char *mode, int fd ); ........................................ 2
int open( const char *mode, const char *path ); ............................. 3
int open( const char *mode, const char *const argv[] ); ..................... 4
int openf( const char *mode, const char *path_fmt, ... ); ................... 5
int vopenf( const char *mode, const char *path_fmt, va_list ap ); ......... 6

DESCRIPTION
The mode being "r" or "r+" results in the input from the terminal using the GNU readline.
path can be used to specify the file in which the history is saved. The "r" specification can be
used to specify that the content of the history buffer is not saved to the file upon close(),
while with the "r+" specification the history is saved to the file upon close().

The mode being "w" performs output to the pager. The pager is specified by path or argv,
but if not specified the pager specified by the environment variable PAGER is utilized.

path or path_fmt being set results in execution in the “/bin/sh -c command” format, and
hence path or path_fmt can include the pipe or redirection symbols (|,<,>).
The elements of argv[] must be set in the order of “executable file’s path name, argument
1, argument 2, ... NULL”. The end of argv[] must always be NULL.

Member functions 1 and 2 cannot execute commands and connect the result using a pipe
to open the stream. For more details on these member functions refer to the descriptions
provided in §8.1.1.

For more details on the arguments for path_fmt and later for member functions 5 and 6 refer
to the descriptions provided in §8.1.1.

PARAMETER
[I] mode File or pager opening mode
[I] fd File descriptor
[I] path File or pager
[I] argv[] All the elements of data of a file or pager
[I] path_fmt File or pager format specifications
[I] ... All the elements of data of a file or pager
[I] ap All the elements of data of a file or pager

RETURN VALUE
0 : Normal termination
Negative value (Error) : If open mode was not set.
: If the system failed to open a stream
: If the system failed to open a stream because it cannot access
  the stream in the specified mode etc.
: If the system failed to open a stream because the relationship
  between the mode specified and fd was incorrect etc (Member
  function 2).
: If the string indicating the path for path_fmt exceeds PATH_MAX.
: If the stream has already been opened by any of the other
  member functions described in this section.
EXCEPTION
If the system failed to secure the buffer for reading data (Member functions 1, 3, 5, and 6).
If the system failed to generate a process (Other than member function 2).
If the system failed to generate a file descriptor for reading and writing data (Other than
member function 2).
If any of the elements of data of a file or pager does not meet the format specifications
(Member functions 5, and 6).

EXAMPLE
The following code opens command_history.txt in read and write mode, and reads it to the
history buffer. It then reads to the history buffer the line that is input from the command
line, and writes it to command_history.txt:

```c
termlineio t_in;
if ( t_in.open("r+", "command_history.txt") < 0 ) {
    Error handling
}
t_in.getline();
t_in.close();
```

8.9.2 set_prompt(), setf_prompt(), vsetf_prompt()

NAME
set_prompt(), setf_prompt(), vsetf_prompt() — Sets a prompt

SYNOPSIS
```c
termlineio &set_prompt( const char *prompt ); ........................................ 1
termlineio &setf_prompt( const char *prompt_fmt, ... ); .......................... 2
termlineio &vsetf_prompt( const char *prompt_fmt, va_list ap ); ........... 3
```

DESCRIPTION
Sets the prompt displayed when inputting commands.
Member function 1 sets prompt.
Member functions 2 and 3 set to the prompt a string that is converted depending on the
conversion specifications provided in format. For more details on the arguments for format
and later refer to the descriptions provided in §8.1.14.

PARAMETER
```c
[I] prompt        Prompt
[I] prompt_fmt    Prompt format specifications
[I] ...           Each element of data for a prompt
[I] ap            All the elements of data for a prompt
```

RETURN VALUE
Reference to itself
EXCEPTION
If the system failed to secure the buffer for setting a prompt.
If each element of data of a prompt does not meet the format specified for the prompt
(Member functions 2 and 3).

EXAMPLE
Sets the string that displays the prompt. When this code is executed, you will be prompted
by "prompt> " for one-line command input:

```c
    termlineio t_in;
    const char *cmd;
    if ( t_in.open("r") < 0 ) {
        Error handling
    }
    cmd = t_in.set_prompt("prompt> ").getline();
    printf("Your command is '%s'", cmd);
    t_in.close();
```

8.9.3 automate_history()

NAME
automate_history() — Specifies whether to automatically save histories

SYNOPSIS

```c
    termlineio &automate_history( bool tf );
```

DESCRIPTION
If the Auto-save History flag `tf` is `true`, all non-empty input lines are added to the history
buffer. If `tf` is `false`, no input lines are registered to the history buffer. To register input lines
to the history buffer after instructing not to register input lines to the history buffer using
this member function, you will need to use the `add_history()` member function (§8.9.4).
Please note that the default value for `tf` is `true`.

PARAMETER
[I] `tf` Auto-save History flag (true/false)
([I]: Input, [O]: Output)

RETURN VALUE
Reference to itself

EXAMPLE
The following code sets the Auto-save History flag to false and then reads the command
line three times. The up-arrow key can be pressed while it is being read to verify that the
input command has not been registered, and that only the strings included in the read file of
`command_history.txt` have been registered:

```c
    termlineio t_in;
    int i_count = 0;
```
if ( t_in.open("r", "command_history.txt") < 0 ) {
    Error handling
}

/* Does not auto-save histories */
t_in.automate_history( false );

for (i_count = 0 ; i_count < 3 ; i_count++){
    t_in.getline();
}

t_in.close();

8.9.4 add_history()

NAME
add_history() — Adds commands to history buffer

SYNOPSIS
termlineio &add_history( const char *line );

DESCRIPTION
Adds a command line to history buffer. This member function can be used after instructing
not to automatically save histories using the automate_history() member function (§8.9.3).

PARAMETER
[I] line Name of command

RETURN VALUE
Reference to itself

EXCEPTION
If the system failed to secure the buffer for copying a command.
If the system failed to store a command to the history buffer.

EXAMPLE
This code sets the Auto-save History flag to false, and then executes the input command
with system() function. The command must have normally terminated for the command to
be added to the history buffer using the add_history() member function.
The content of the history buffer is saved in command_history.txt.

termlineio t_in;
const char *cmd;

if ( t_in.open("r+", "command_history.txt") < 0 ) {
    Error handling
}

/* Does not auto-save histories */
t_in.automate_history( false );

/* Accept the command until Ctrl-D is pressed */
while ( (cmd=t_in.getline()) != NULL ) {
    /* Execute the command using system(), and saves the history only when the command has terminated normally */
    if ( system(cmd) == 0 ) {

/* Other code */
}}
8.9.5 clear_history()

NAME
clear_history() — Initialization of history buffers

SYNOPSIS
termlineio &clear_history();

DESCRIPTION
Deletes all the content of a history buffer.

RETURN VALUE
Reference to itself

EXAMPLE
This code clears all the histories that have been registered. It first reads the input from the command line three times and then registers it to the history buffer. Upon "check history> " being output the up-arrow key can be pressed to verify that all the history buffers have been cleared.

```c
    termlineio t_in;
    int     i_count = 0;

    if ( t_in.open("r") < 0 ) {
        Error handling
    }

    for (i_count = 0 ; i_count < 3 ; i_count++){
        t_in.getline();
    }

    t_in.clear_history();
    t_in.set_prompt("check history >").getline();
    t_in.close();
```

8.9.6 stifle_history()

NAME
stifle_history() — Restricts the number of history buffers

SYNOPSIS
termlineio &stifle_history( int num_lines );

DESCRIPTION
Restricts the number of history buffers to the maximum of num_lines. This restriction can be removed using the unstifle_history() member function (§8.9.7).
PARAMETER

<table>
<thead>
<tr>
<th>[I]</th>
<th>num_lines</th>
<th>Number of history buffers</th>
</tr>
</thead>
</table>

RETURN VALUE

Reference to itself

EXAMPLE

This code restricts the history buffers that can be registered, with the maximum number of history buffers that can be registered being 3. The command line is then read five times, and the command registered to the history buffer. Upon "check history> " being output the up-arrow key can be pressed to verify that the first two histories registered have been cleared.

```c
termlineio t_in;
int i_count = 0;
if ( t_in.open("r") < 0 ) {
    Error handling
}

/* Restrict the history buffers to 3 */
t_in.stifle_history(3);
for (i_count = 0 ; i_count < 5 ; i_count++){
    t_in.getline();
}

t_in.set_prompt("check history >").getline();

t_in.close();
```

8.9.7 unstifle_history()

NAME

unstifle_history() — Removes restriction on number of history buffers

SYNOPSIS

```
termlineio &unstifle_history();
```

DESCRIPTION

Removes the restriction on the number of history buffers that can be set using `stifle_history()` (§8.9.6).

RETURN VALUE

Reference to itself

EXAMPLE

This code removes the history buffer restriction. It first performs the same processing as in the EXAMPLE provided in §8.9.6, then removes the history buffer restriction, and registers the command to the history buffer again. Upon "check history2> " being output the up-arrow key can be pressed to verify that eight command histories have been registered.
termlineio t_in;
int i_count = 0;

if ( t_in.open("r") < 0 ) {
    Error handling
}

/* Restrict the history buffers to 3 */
t_in.stifle_history(3);

for ( i_count = 0 ; i_count < 5 ; i_count++){
    t_in.getline();
}

t_in.set_prompt("check history1 >").getline();
t_in.set_prompt("");

/* Remove restriction on history buffers */
t_in.unstifle_history();

for ( i_count = 0 ; i_count < 5 ; i_count++){
    t_in.getline();
}

t_in.set_prompt("check history2 >").getline();

t_in.close();

---

8.9.8 read_history(), readf_history(), vreadf_history()

NAME
read_history(), readf_history(), vreadf_history() — Reading of histories from a file

SYNOPSIS
read_history( const char *path ); .............................................................. 1
readf_history( const char *path_fmt, ... ); ........................................... 2
vreadf_history( const char *path_fmt, va_list ap ); ............................. 3

DESCRIPTION
Reads the file specified by path and then adds the content of the file to the history buffer. Member functions 2 and 3 are used to convert the file depending on the conversion specifications in format, and creates a name for the file to read. For more details on the arguments for format and later refer to the descriptions provided in [8.1.11].

PARAMETER
[I] path    Name of file
[I] path_fmt File name format specifications
[I] ...    Each element of data of a file name
[I] ap    All the elements of data of a file name
RETURN VALUE

0 : Normal termination
Other than 0 (Error) : If the system failed to add a command to the history buffer because the file etc specified does not exist etc.

EXCEPTION

If each element of data of a file path does not meet the format specifications (Member functions 2 and 3).

EXAMPLE

This code adds commands that are read from temporary_file.txt to the history buffer. Upon the "push ^ button >" prompt being output the up-arrow key can be pressed to verify that the content of temporary_file.txt has been saved in the history buffer. As a precondition, strings in command_history.txt and temporary_file.txt must be included in advance.

```cpp
termlineio t_in;
if (t_in.open("r", "command_history.txt") < 0) {
    Error handling
}
if (t_in.read_history("temporary_file.txt") != 0) {
    Error handling
} else {
    t_in.set_prompt("push ^ button >").getline();
}
t_in.close();
```

8.9.9 write_history(), writef_history(), vwritef_history()

NAME

write_history(), writef_history(), vwritef_history() — Writing of histories to a file

SYNOPSIS

```cpp
int write_history( const char *path ); ............................................. 1
int writef_history( const char *path_fmt, ... ); .................................. 2
int vwritef_history( const char *path_fmt, va_list ap ); ......................... 3
```

DESCRIPTION

Writes the content of a history buffer to the file specified by path. Creates a new file if the file does not exist. If the file specified already exists, it is overwritten. If NULL is specified as the file name it saves histories to ~/.history.

Member functions 2 and 3 create a name for the file to write to, converted depending on the conversion specifications provided in format. For more details of the arguments for format and later refer to the descriptions in §8.1.14.

PARAMETER

| I | path | Name of file |
| I | path_fmt | File name format specifications |
| I | ... | Each element of data of a file name |
| I | ap | All the elements of data of a file name |

**RETURN VALUE**
- 0 : Normal termination
- Other than 0 (Error) : If the system failed to write a history to the file because you do not have the authority to execute the file etc specified etc.

**EXCEPTION**
If each element of data of a file path does not meet the format specifications (Member functions 2, 3)

**EXAMPLE**
This code writes the content of a history buffer to `new_file.txt`. The content of the file `command_history.txt` that is read to the history buffer is written to `new_file.txt`. As a precondition, strings in the file `command_history.txt` must be included in advance.

```cpp
termlineio t_in;

if (t_in.open("r", "command_history.txt") < 0) {
    Error handling
}

if (t_in.write_history("new_file.txt") != 0) {
    Error handling
}

t_in.close();
```
8.10 The TERMSCREENIO class

The termscreen class is used to perform input (using temporary files) through an editor and output to a pager on a terminal. The environment variables EDITOR and PAGER are referenced internally. It inherits cstreamio and hence all the member functions in §8.1 are available for use with the class. With the termscreen class, open() and close() must always be used.

If you wish to use the termscreen class, you must add "#include <sli/termdrawio.h>" to the code. In addition, if you need to declare a namespace (§4.1) you must also add "using namespace sli;" to the code.

Table 16 lists the member functions. Member functions that have the same functions as in the libc are provided in the table.

<table>
<thead>
<tr>
<th>The termscreen class Feature</th>
<th>Corresponding function in libc</th>
</tr>
</thead>
<tbody>
<tr>
<td>open(), openf(), vopenf()</td>
<td>opens()</td>
</tr>
<tr>
<td>close()</td>
<td>fclose()</td>
</tr>
<tr>
<td>read()</td>
<td>fread()</td>
</tr>
<tr>
<td>write()</td>
<td>fwrite()</td>
</tr>
<tr>
<td>bread()</td>
<td>—</td>
</tr>
<tr>
<td>bwrite()</td>
<td>—</td>
</tr>
<tr>
<td>rskip()</td>
<td>—</td>
</tr>
<tr>
<td>wskip()</td>
<td>—</td>
</tr>
<tr>
<td>getchar()</td>
<td>fgetc()</td>
</tr>
<tr>
<td>getstr()</td>
<td>fgets()</td>
</tr>
<tr>
<td>getline()</td>
<td>—</td>
</tr>
<tr>
<td>scanf()</td>
<td>fscanf()</td>
</tr>
<tr>
<td>putchr()</td>
<td>fputc()</td>
</tr>
<tr>
<td>putstr()</td>
<td>fputs()</td>
</tr>
<tr>
<td>printf()</td>
<td>fprintf()</td>
</tr>
<tr>
<td>flush()</td>
<td>fflush()</td>
</tr>
<tr>
<td>eof(), error(), reseterr()</td>
<td>—</td>
</tr>
</tbody>
</table>

Table 16: List of the member functions available for use with the termscreen class.

How to use the member functions redefined and added in the termscreen class is described below.

8.10.1 open()

NAME
open() — Opens streams

SYNOPSIS

```
int open( const char *mode ); ................................. 1
int open( const char *mode, int fd ); ............................ 2
int open( const char *mode, const char *path ); .................... 3
int open( const char *mode, const char *const argv[] ); .............. 4
int openf( const char *mode, const char *path_fmt, ... ); ............. 5
int vopenf( const char *mode, const char *path_fmt, va_list ap ); ...... 6
```

DESCRIPTION
The **mode** being "r" results in a temporary file being created and the editor activated. Closing the editor then results in the edited temporary file being opened as a stream. The editor can be specified by **path** or **argv**, and if not specified is activated as indicated by the environment variable **EDITOR**. If the environment variable is not set, `vi` is activated.

The **mode** being "w" results in the stream being opened by the pager. The pager can be specified by **path** or **argv**, and if not specified is activated as indicted by the environment variable **PAGER**. If the environment variable is not set, `more` is activated.

The elements of **argv[]** must be set in the order of *executable file's path name argument 1, argument 2, ... NULL*. The end of **argv[]** must always be **NULL**.

Member functions 1 and 2 cannot open streams through an editor or pager. For more details on these member functions refer to the descriptions provided in §8.1.1.

For more details on the arguments for **path_fmt** and later for member functions 5 and 6, refer to the descriptions provided in §8.1.1.

**PARAMETER**

| [I] mode | Editor or pager opening mode |
| [I] fd | File descriptor |
| [I] path | Editor or pager |
| [I] argv[] | All the elements of data of an editor or pager |
| [I] path_fmt | Editor or pager format specifications |
| [I] ... | Each element of data of an editor or pager |
| [I] ap | All the elements of data of an editor or pager |


**RETURN VALUE**

0 : Normal termination

Negative value (Error) : If open mode was not set.

: If the system failed to open a stream.

: If the string indicating the path for **path_fmt** exceeds **PATH_MAX**.

: If the stream has already been opened by any of the other member functions described in this section.

**EXCEPTION**

If the system failed to secure the buffer for reading data (Member functions 1, 3, 5, and 6).

If the system failed to generate a process (Other than member function 2).

If the system failed to generate a file descriptor for reading and writing data (Other than member function 2).

If each element of data of an editor or pager does not meet the format specifications (Member functions 5 and 6).

**EXAMPLE**

The following code performs input from the editor `vi` activated in binary mode, and then displays the first line input as standard output:

```c
int main() {
    termscreenio t_in;
    if (t_in.open("r", "vi -b") < 0) {
        Error handling
    }
    printf("%s\n", t_in.getline());
    return 0;
}
```
t_in.close();
8.11 The INETSTREAMIO class

It inherits cstreamio and hence all the member functions in §8.1 are available for use with the class. This class is used to implement the httpstreamio (§8.5) and ftpstreamio (§8.6) classes.

With the inetstreamio class, open() and close() must always be used. With the open() member function, "r+" is specified as the mode and a URL, for example "http://www.jaxa.jp/" specified as the path. Resolves the port number and host name to use with the URL, and then connects to the server. Connections through a proxy server are not supported.

If you wish to use the inetstreamio class you must add "#include <sli/inetstreamio.h>" to the code. In addition, if you need to declare a namespace (§4.1) you must also add "using namespace sli;" to the code.

Table 17 lists the member functions. Member functions that have the same feature as in libc are provided in the table.

<table>
<thead>
<tr>
<th>The inetstreamio class</th>
<th>Feature</th>
<th>Corresponding function in libc</th>
</tr>
</thead>
<tbody>
<tr>
<td>§8.11.1 open(), openf(), vopenf()</td>
<td>Opens streams</td>
<td>fopen()</td>
</tr>
<tr>
<td>§8.11.2 close()</td>
<td>Closes streams</td>
<td>fclose()</td>
</tr>
<tr>
<td>§8.11.3 read()</td>
<td>Input of binary streams</td>
<td>fread()</td>
</tr>
<tr>
<td>§8.11.4 write()</td>
<td>Output of binary streams</td>
<td>fwrite()</td>
</tr>
<tr>
<td>§8.11.5 bread()</td>
<td>Input of binary streams (With endian conversion)</td>
<td>—</td>
</tr>
<tr>
<td>§8.11.6 bwrite()</td>
<td>Output of binary streams (With endian conversion)</td>
<td>—</td>
</tr>
<tr>
<td>§8.11.7 rskip()</td>
<td>Read n bytes to skip data stream</td>
<td>—</td>
</tr>
<tr>
<td>§8.11.8 wskip()</td>
<td>Write n bytes of blank data</td>
<td>—</td>
</tr>
<tr>
<td>§8.11.9 getchar()</td>
<td>Input of single character</td>
<td>fgetc()</td>
</tr>
<tr>
<td>§8.11.10 getstr()</td>
<td>Input of strings</td>
<td>fgets()</td>
</tr>
<tr>
<td>§8.11.11 getline()</td>
<td>Input of single line</td>
<td>—</td>
</tr>
<tr>
<td>§8.11.12 scanf()</td>
<td>Converts inputs with a format and assigns to an argument</td>
<td>fscanf()</td>
</tr>
<tr>
<td>§8.11.13 putchr()</td>
<td>Output of single character</td>
<td>fputc()</td>
</tr>
<tr>
<td>§8.11.14 putstr()</td>
<td>Output of strings</td>
<td>fputs()</td>
</tr>
<tr>
<td>§8.11.15 printf()</td>
<td>Outputs the value of an argument after being format-converted</td>
<td>fprintf()</td>
</tr>
<tr>
<td>§8.11.15 flush()</td>
<td>Forcefully outputs the content of a buffer</td>
<td>fflush()</td>
</tr>
<tr>
<td>§8.11.16 eof(), error(), reseterr()</td>
<td>Check and reset stream status</td>
<td>feof(), etc.</td>
</tr>
<tr>
<td>§8.11.12 path()</td>
<td>Returns the path specified by a URL</td>
<td>—</td>
</tr>
<tr>
<td>§8.11.13 host()</td>
<td>Returns the path specified by a URL</td>
<td>—</td>
</tr>
</tbody>
</table>

Table 17: List of the member functions available for use with the inetstreamio class.

How to use the member functions redefined and added in the inetstreamio class is described below.

8.11.1 open()

NAME
open() — Opens streams

SYNOPSIS

```c
int open( const char *mode, const char *path ); ........................................ 1
int openf( const char *mode, const char *path_fmt, ... ); .......................... 2
int vopenf( const char *mode, const char *path_fmt, va_list ap ); .......... 3
```
DESCRIPTION
Opens the URL indicated by path or path_fmt. If path or path_fmt is NULL, the standard input or standard output is used.

"r", "r+", "w" or "w+" can be specified as the mode. "r" and "w" result in a read-only and write-only one-way connection, respectively. "r+" and "w+" result in two-way connections that allow both reading and writing. "r+" and "w+" result in the same behavior as each other.

For more details on the arguments for path_fmt for the member functions 2 and 3 refer to the descriptions provided in §8.1.1

PARAMETER
[I] mode URL opening mode
[I] path Path of URL
[I] path_fmt URL format specifications
[I] ... Each element of data of a URL
[I] ap All the elements of data of a URL

RETURN VALUE
0 : Normal termination
Negative value (Error) : If the system failed to open a stream because a URL was not specified etc.
: If the system failed to open a stream because the specified URL was inappropriate etc.
: If the string indicating the path for path_fmt exceeds PATH_MAX.
: If the system failed to open a stream because the mode was not specified etc.
: If the system failed to open a stream because the specified mode was appropriate etc.
: If the system failed to open a stream because it cannot access the stream in the specified mode etc.
: If the stream has already been opened by any of the other member functions described in this section.

EXCEPTION
If the system failed to allocate enough memory.
If the system failed to establish a socket connection.
If the system failed to open a socket in the specified mode.
If all the elements of data of a URL do not meet the format specifications (Member functions 2 and 3).

EXAMPLE
For an EXAMPLE refer to §8.1.4

8.11.2 path()

NAME
path() — Returns the path specified by a URL

SYNOPSIS
const char *path();
DESCRIPTION
Returns a string for the path part extracted from path as specified by the open() member function (§8.11.1).

RETURN VALUE
Path for URL

EXAMPLE
For an EXAMPLE refer to §8.11.4

8.11.3 host()

NAME
host() — Returns the host name specified by a URL

SYNOPSIS
const char *host();

DESCRIPTION
Returns a string for the host name extracted from path as specified by the open() member function (§8.11.1).

RETURN VALUE
Host name specified by URL

EXAMPLE
For an EXAMPLE refer to §8.11.4

8.11.4 Sample code

Here is an example of a simple HTTP client.
#include <sli/stdstreamio.h>
#include <sli/inetstreamio.h>
using namespace sli;

int main()
{
    int status = -1;
    stdstreamio sio;
    inetstreamio isio;
    const char *line_ptr;
    /* Connects to http server */
    if ( isio.open("r+","http://www.jaxa.jp/") < 0 ) {
        sio.eprintf("[ERROR] isio.open() failed\n");
        goto quit;
    }
    /* Send request to http server */
    isio.printf("GET %s HTTP/1.0\r\n",isio.path());
    isio.printf("User-Agent: My Program\r\n");
    isio.printf("Host: %s\r\n",isio.host());
    isio.printf("Connection: close\r\n");
    isio.printf("\r\n");
    isio.flush();
    /* Receive data from http server */
    while ( (line_ptr=isio.getline()) != NULL ) {
        sio.printf("%s",line_ptr);
    }
    /* Terminate connection */
    isio.close();
    status = 0;
quit:
    return status;
The TSTRING class

The tstring class provides APIs that enable users to execute the string processing seen in scripting languages such as Perl, PHP and Ruby, along with the string processing that is extremely similar to the functions provided by stdio.h, string.h, strings.h, stdlib.h and ctype.h in libc.

A wealth of APIs are available for use, ranging from a member function that sets characters to a given position character by character to a member function that allows users to use POSIX extended regular expressions. tstring class member functions use a very regular order in their arguments, and hence can be learned quite easily.

String buffers and their size are automatically managed internally and hence when editing a string users do not need to create a buffer or worry about the size of a buffer. For example, you can assign a string immediately after creating an object, as shown below:

```cpp
#include <sli/tstring.h>

int main()
{
    tstring my_str; /* Create object */
    my_str.printf("Hello World"); /* Assign "Hello World" to my_str */
    sio.printf("%s\n",my_str.cstr()); /* Output content of my_str to STDOUT */
}
```

If you wish to use the tstring class you must add "#include <sli/tstring.h>" to the code. In addition, if you need to declare a namespace (§ 4.1) you must also add “using namespace sli;” to the code.

The following provides an example that is close to an actual case of it being used.

```cpp
#include <sli/stdstreamio.h>
#include <sli/tstring.h>
using namespace sli;

int main()
{
    stdstreamio sio;
    stdstreamio fin;
    const char *line;

    fin.open("r","infile.txt");
    while ( (line=fin.getline()) != NULL ) {
        tstring str0;
        /* Store a line, and remove spaces, tabs and newline chars from both ends */
        str0.assign(line).trim(" 	\n");
        /* When there is one or more character, ... */
        if ( 0 < str0.length() ) {
            if ( str0.cchr(0) == '#' ) {
                /* Display comment */
                sio.printf("%s\n",str0.cstr());
            }
            else {
                /* Convert to integer value */
                int n, a=0, b=0;
                n = str0.scanf("%d %d",&a,&b);
                sio.printf("n=%d a=%d b=%d\n",n,a,b);
            }
        }
    }
    fin.close();
    return 0;
}
```

In this example infile.txt is opened, the line beginning with # displayed as a comment, and if
there is anything else but a space, tab or newline character it is input in the format to retrieve the value, and then displayed.

Please note that in this section the cstreamio class ([8]) is used in the EXAMPLES, as in the example above.

9.1 Creating an object —three operating modes

There are three operating modes for use with tstring class objects. The operating mode must be carefully selected depending on the purpose. Please note that the operating mode can only be determined when an object is first created.

9.1.1 Normal mode

If nothing is specified when an object is created, as in the following example:

```
    tstring my_str;
```

The string inside does not have a buffer for the object created, and the return value for the cstr() member function ([9.5.3]) is NULL. This will be referred to as the **normal mode**. However, when a member function (except init()) is used to modify a strings the object needs to always retain a string ("", at minimum length). If you do wish to to make an object with the string “empty” or NULL, the init() member function ([9.5.12]) can be used or NULL assigned using the operator "=" ([9.4.2]).

In normal mode an initial value can also be provided, as in the following:

```
    tstring my_str("Hello");
```

9.1.2 NULL-free mode

Problems can occur when the string inside is NULL, but to avoid that you can set the flag to be **true** when creating an object, as in the following:

```
    tstring my_str(true);
```

The object always retains a string with this, and NULL will not be returned by the cstr() member function ([9.5.3]). This will be referred to as the **NULL-free mode**.

9.1.3 Fixed-length buffer mode

Another use is **fixed-length buffer mode**, which provides a method of specifying the maximum length of strings of an argument that you wish to handle and when creating an object, as in the following:

```
    tstring my_str(64);
```

In the above example the object can handle strings with a maximum of 64 characters. In this mode only strings equal to or shorter than the string length initially specified can be handled, with the member functions for editing strings being designed to maintain the memory to be secured again at a minimum and allow code to run at high speed. With the fixed-length buffer mode NULL will not be returned by the cstr() member function ([9.5.3]).

9.1.4 Restriction with fixed-length buffer mode

With the normal and NULL-free modes, member functions that modify strings inside an object can have arguments provided with a reference to the object itself or the address returned by cstr(),
whereas the fixed-length buffer mode does not allow for this type of use as it assigns the highest priority to operating speed.

9.2 Regularity of arguments for member functions

When the position and number of characters for a string inside an object are provided in the argument specifications they should always appear at the front of an argument. For example, with the `strtol()` member function (§9.5.37) pos and n appear on the left and show the position and length of the string inside the object, as in the following:

```cpp
long strtol( int base, size_t *endpos ) const;
long strtol( size_t pos, int base, size_t *endpos ) const;
long strtol( size_t pos, size_t n, int base, size_t *endpos ) const;
```

It could also be said that the arguments on the left provide the specifications for objects, while the arguments on the right provide specifications for anything but an object.

9.3 List of member functions

Table 18 lists the member functions. Member functions that have the same feature as in libc are provided in the table.
<table>
<thead>
<tr>
<th>Name of member function</th>
<th>Feature</th>
<th>Corresponding function in libc</th>
</tr>
</thead>
<tbody>
<tr>
<td>[]</td>
<td>Reference to characters in a specified position</td>
<td></td>
</tr>
<tr>
<td>=</td>
<td>Assigns strings</td>
<td></td>
</tr>
<tr>
<td>+=</td>
<td>Addition of strings</td>
<td></td>
</tr>
<tr>
<td>==</td>
<td>Comparison of strings</td>
<td></td>
</tr>
<tr>
<td>!=</td>
<td>Comparison of strings</td>
<td></td>
</tr>
<tr>
<td>length()</td>
<td>Length of a string</td>
<td>strlen()</td>
</tr>
<tr>
<td>max_length()</td>
<td>Maximum length of a string</td>
<td></td>
</tr>
<tr>
<td>cstr(), c_str()</td>
<td>Beginning address for a string (read-only)</td>
<td></td>
</tr>
<tr>
<td>str_ptr(), str_ptr_cs()</td>
<td>Beginning address for a string</td>
<td></td>
</tr>
<tr>
<td>cchr()</td>
<td>Reading of characters in a specified position</td>
<td></td>
</tr>
<tr>
<td>at(), at_cs()</td>
<td>Reference to characters in a specified position</td>
<td></td>
</tr>
<tr>
<td>update_length()</td>
<td>Update internal information (Use this when directly writing data to internal buffer of fixed-length buffer mode)</td>
<td></td>
</tr>
<tr>
<td>dprint()</td>
<td>Outputs object information to standard error output</td>
<td></td>
</tr>
<tr>
<td>getstr()</td>
<td>Copies (sub)string to external buffer</td>
<td></td>
</tr>
<tr>
<td>copy()</td>
<td>Copies (sub)string to external object</td>
<td>strdup()</td>
</tr>
<tr>
<td>swap()</td>
<td>Swaps objects</td>
<td></td>
</tr>
<tr>
<td>init()</td>
<td>Complete initialization of objects</td>
<td></td>
</tr>
<tr>
<td>printf(), assignf()</td>
<td>Initialization of objects</td>
<td>sprintf()</td>
</tr>
<tr>
<td>implode()</td>
<td>Sets a string that elements of a string array joined with delimiter</td>
<td></td>
</tr>
<tr>
<td>import_binary()</td>
<td>Import of binary data</td>
<td></td>
</tr>
<tr>
<td>put(), putf()</td>
<td>Sets characters or strings to a given position</td>
<td></td>
</tr>
<tr>
<td>strcat(), append()</td>
<td>Addition of characters or strings</td>
<td>strcat()</td>
</tr>
<tr>
<td>strncat(), append()</td>
<td>Addition of characters or strings</td>
<td>strncat()</td>
</tr>
<tr>
<td>insert(), insertf()</td>
<td>Insertion of characters or strings</td>
<td></td>
</tr>
<tr>
<td>replace(), replacef()</td>
<td>Replacement of strings</td>
<td></td>
</tr>
<tr>
<td>erase()</td>
<td>Erasure of strings</td>
<td></td>
</tr>
<tr>
<td>clean()</td>
<td>Pads existing whole strings with a given character</td>
<td></td>
</tr>
<tr>
<td>resize()</td>
<td>Changes the length of strings</td>
<td></td>
</tr>
<tr>
<td>resizeby()</td>
<td>Changes the relative length of strings</td>
<td></td>
</tr>
<tr>
<td>crop()</td>
<td>Crops strings</td>
<td></td>
</tr>
<tr>
<td>chomp()</td>
<td>Elimination of newline characters</td>
<td></td>
</tr>
<tr>
<td>trim()</td>
<td>Elimination of spaces on both ends of a string</td>
<td></td>
</tr>
<tr>
<td>ltrim()</td>
<td>Elimination of a space to the left of a string</td>
<td></td>
</tr>
<tr>
<td>rtrim()</td>
<td>Elimination of a space to the right of a string</td>
<td></td>
</tr>
<tr>
<td>streplace()</td>
<td>Searches and replaces strings</td>
<td></td>
</tr>
<tr>
<td>regreplace()</td>
<td>Replaces parts that match an extended regular expression</td>
<td></td>
</tr>
<tr>
<td>tolower()</td>
<td>Converts lowercase to uppercase characters</td>
<td>tolower()</td>
</tr>
<tr>
<td>toupper()</td>
<td>Converts lowercase to uppercase characters</td>
<td>toupper()</td>
</tr>
<tr>
<td>expand_tabs()</td>
<td>Replaces TAB characters with white space characters</td>
<td></td>
</tr>
<tr>
<td>contract_spaces()</td>
<td>Replaces white space characters with TAB characters</td>
<td></td>
</tr>
<tr>
<td>atoi()</td>
<td>Converts to integer value</td>
<td>atoi()</td>
</tr>
<tr>
<td>atol()</td>
<td>Converts to integer value</td>
<td>atol()</td>
</tr>
<tr>
<td>atoll()</td>
<td>Converts to integer value</td>
<td>atoll()</td>
</tr>
<tr>
<td>atof()</td>
<td>Converts to real value</td>
<td>atof()</td>
</tr>
</tbody>
</table>

Table 18: List of the member functions available for use with the tstring class (Continued on next page).
<table>
<thead>
<tr>
<th>Name of member function</th>
<th>Feature</th>
<th>Corresponding function in libc</th>
</tr>
</thead>
<tbody>
<tr>
<td>§9.5.37 strtol()</td>
<td>Converts to integer value</td>
<td>strtol()</td>
</tr>
<tr>
<td>§9.5.37 strtoll()</td>
<td>Converts to integer value</td>
<td>strtoll()</td>
</tr>
<tr>
<td>§9.5.38 strtoul()</td>
<td>Converts to unsigned integer value</td>
<td>strtoul()</td>
</tr>
<tr>
<td>§9.5.38 strtoull()</td>
<td>Converts to unsigned integer value</td>
<td>strtoull()</td>
</tr>
<tr>
<td>§9.5.39 strtod()</td>
<td>Converts to real value</td>
<td>strtod()</td>
</tr>
<tr>
<td>§9.5.40 scanf()</td>
<td>Formatted input conversion</td>
<td>sscanf()</td>
</tr>
<tr>
<td>§9.5.41 sscanf().compare()</td>
<td>Comparison of strings</td>
<td>sscanf()</td>
</tr>
<tr>
<td>§9.5.42 sscanf().compare()</td>
<td>Partially compares strings</td>
<td>sscanf()</td>
</tr>
<tr>
<td>§9.5.43 strcasecmp()</td>
<td>Comparison of strings (Case-independent)</td>
<td>strcasecmp()</td>
</tr>
<tr>
<td>§9.5.43 strncasecmp()</td>
<td>Comparison of strings (Case-independent)</td>
<td>strncasecmp()</td>
</tr>
<tr>
<td>§9.5.44 isalnum()</td>
<td>Inquires whether alphabetical or numerical character</td>
<td>isalnum()</td>
</tr>
<tr>
<td>§9.5.44 isalpha()</td>
<td>Inquires whether alphabetical character</td>
<td>isalpha()</td>
</tr>
<tr>
<td>§9.5.44 iscntrl()</td>
<td>Inquires whether control character</td>
<td>iscntrl()</td>
</tr>
<tr>
<td>§9.5.44 isdigit()</td>
<td>Inquires whether numerical character (0 to 9)</td>
<td>isdigit()</td>
</tr>
<tr>
<td>§9.5.44 isgraph()</td>
<td>Inquires whether displayable character</td>
<td>isgraph()</td>
</tr>
<tr>
<td>§9.5.44 islower()</td>
<td>Inquires whether lowercase character</td>
<td>islower()</td>
</tr>
<tr>
<td>§9.5.44 isupper()</td>
<td>Inquires whether uppercase character</td>
<td>isupper()</td>
</tr>
<tr>
<td>§9.5.44 isxdigit()</td>
<td>Inquires whether hexadecimal number</td>
<td>isxdigit()</td>
</tr>
<tr>
<td>§9.5.45 strchr().find()</td>
<td>Searches for character from left</td>
<td>strchr()</td>
</tr>
<tr>
<td>§9.5.46 strchr().find()</td>
<td>Searches for a string from the left side</td>
<td>strchr()</td>
</tr>
<tr>
<td>§9.5.47 strrchr().rfind()</td>
<td>Searches for a character from the right side</td>
<td>strrchr()</td>
</tr>
<tr>
<td>§9.5.48 strrchr().rfind()</td>
<td>Searches for a string from right</td>
<td>strrchr()</td>
</tr>
<tr>
<td>§9.5.49 find_first_of()</td>
<td>Detects from the left any characters contained in a character set</td>
<td>strpbrk()</td>
</tr>
<tr>
<td>§9.5.50 find_last_of()</td>
<td>Detects from the right any characters contained in a character set</td>
<td>strpbrk()</td>
</tr>
<tr>
<td>§9.5.51 find_first_not_of()</td>
<td>Detects from the left any characters not contained in a character</td>
<td>strpbrk()</td>
</tr>
<tr>
<td>§9.5.52 find_last_not_of()</td>
<td>Detects from the right any characters not contained in a character</td>
<td>strpbrk()</td>
</tr>
<tr>
<td>§9.5.53 strpbrk()</td>
<td>Detects from the left any characters contained in a character set</td>
<td>strpbrk()</td>
</tr>
<tr>
<td>§9.5.53 strpbrk()</td>
<td>Detects from the right any characters contained in a character set</td>
<td>strpbrk()</td>
</tr>
<tr>
<td>§9.5.54 strspn()</td>
<td>Inquires the length of characters contained in a character set run from the left</td>
<td>strspn()</td>
</tr>
<tr>
<td>§9.5.55 strspn()</td>
<td>Inquires the length of characters contained in a character set run from the right</td>
<td>strspn()</td>
</tr>
<tr>
<td>§9.5.56 strcspn()</td>
<td>Inquires the length of characters not contained in a character set run from the left</td>
<td>strcspn()</td>
</tr>
<tr>
<td>§9.5.57 strcspn()</td>
<td>Inquires the length of characters not contained in a character set run from the right</td>
<td>strcspn()</td>
</tr>
<tr>
<td>§9.5.58 fnmatch()</td>
<td>Attempts Shell-like string matching</td>
<td>fnmatch()</td>
</tr>
<tr>
<td>§9.5.59 fnmatch()</td>
<td>Attempts string matching with extended regular expression</td>
<td>regexec()</td>
</tr>
</tbody>
</table>

Table 18: List of member functions available for use with the tstring class (Continued from previous page).
9.4 Operators

Overuse of operators may reduce the readability of codes, and hence only the minimum have been made available in the library.

9.4.1 []

NAME
[] — Reference to the character in specified position

SYNOPSIS

unsigned char &operator[]( size_t pos ); ................................. 1
const unsigned char &operator[]( size_t pos ) const; ...................... 2

DESCRIPTION

Returns reference to characters in position specified by[].

Member function 1 can be used for both reading and writing and has the same behavior as at(), while member function 2 can only be used for reading and has the same behavior as at_cs().

pos having a value longer than the string length specified to it results in the length of the string being automatically extended with member function 1, but with member function 2 an exception occurs.

Whether member function 1 or member function 2 is used is automatically determined by the presence or absence of the “const” attribute for an object. Member function 1 is automatically selected when the object does not have a “const” attribute and member function 2 when it does.

For more details on at() and at_cs() refer to the descriptions provided in §9.5.6.

PARAMETER

[I] pos Position of string

RETURN VALUE

Reference to the character in specified position

EXCEPTION

If pos has a value longer than the maximum string length specified to it in fixed-length buffer mode (Member function 1).

If pos has a value longer than the string length specified to it (Member function 2).

EXAMPLE

The following code reads the sixth character in a string that the object my_str includes, and then prints the result to standard output.

The character X is then written into the ninth position of the characters in my_str, and the result is printed to standard output:

```c
stdstreamio sio;
tstring my_str = "abcdefg";
unsigned char c_read;

c_read = my_str[6];
sio.printf("%c\n", c_read);
```
my_str[9] = 'X';
sio.printf("%s\n", my_str.cstr());

Result of execution

```
go
abcdefgh X (⊔ refers to white space character.)
```

9.4.2 =

NAME
--- Assigns strings

SYNOPSIS

```
tstring &operator=(const tstring &obj);
const char *operator=(const char *str);
```

DESCRIPTION

Assigns the object or string specified to the right (argument) of the operator.

PARAMETER

- **[I]** `obj` tstring class object
- **[I]** `str` Address of string

RETURN VALUE

- Reference to itself (Member function 1).
- Address for internal buffer (Member function 2).

EXCEPTION

If the system failed to secure an internal buffer.
If the system encountered any corrupt memory (Member function 1).

EXAMPLE

The following code assigns the string *Hello SLLIB User !* to a string that the object `my_str` includes, and prints the result to standard output. For more information on `c_str()` refer to the descriptions provided in §9.5.3.

```
stdstreamio sio;
tstring my_str;

my_str = "Hello SLLIB User !";

sio.printf("%s\n", my_str.c_str());
```

Result of execution

```
Hello SLLIB User !
```

9.4.3 +=

NAME
--- Addition of strings
SYNOPSIS

```c
    tstring &operator+=(const tstring &obj); 
    const char *operator+=(const char *str); 
```

DESCRIPTION

Adds to a string the string specified to the right (argument) of the operator.

PARAMETER

[|] obj    tstring class object
[|] str    Address of string

RETURN VALUE

Reference to itself (Member function 1).
Address for internal buffer (Member function 2).

EXCEPTION

If the system failed to secure an internal buffer.

EXAMPLE

The following code connects a string that the object `my_str` includes with the content of the string `c_sentence`, and then prints the result to standard output. For more information on `c_str()` refer to the descriptions provided in §9.5.3:

```c
    stdstreamio sio;
    tstring my_str = "User ID : ";
    const char *c_sentence = "1234";

    my_str += c_sentence;

    sio.printf("%s\n", my_str.c_str());
```

Result of execution

User ID : 1234

---

9.4.4 ==

NAME

`==` — Comparison of strings

SYNOPSIS

```c
    bool operator===(const tstring &obj) const;
    bool operator===(const char *str) const;
```

DESCRIPTION

Compares a string with the string specified to the right (argument) of the operator to verify whether they match.

PARAMETER

[|] obj    tstring class object
[|] str    Address of string

RETURN VALUE

true : If the strings match.
false : If the strings do not match.
EXAMPLE
The following compares a string that the object my_str includes with the string User ID : 1234, and then prints the results to standard output:

```c++
stdstreamio sio;
tstring my_str = "User ID : 1234";
if (my_str == "User ID : 1234") {
    sio.printf("Character string same.\n");
} else {
    sio.printf("Character string different.\n");
}
```

Result of execution
Character string same.

9.4.5 !=

NAME
!= — Comparison of strings

SYNOPSIS

```
bool operator!=(const tstring &obj) const;
bool operator!=(const char *str) const;
```

DESCRIPTION
Compares a string with a string specified to the right (argument) of the operator to verify whether they differ.

PARAMETER


[I] obj tstring class object
[I] str Address of string

RETURN VALUE

true : If the strings differ.
false : If the strings match.

EXAMPLE
The following code compares a string that the object my_str includes with the string c_sentence, and then prints the results to standard output:

```c++
stdstreamio sio;
tstring my_str = "User ID : 1234";
const char *c_sentence = "User name : SUZUKI";
if (my_str != c_sentence) {
    sio.printf("Character string different.\n");
} else {
    sio.printf("Character string same.\n");
}
9.5 Member functions

General information
The `size_t` type handles numerical values as unsigned integers. Setting a negative value to a function with a `size_t` type argument will increase the likelihood of the program aborting. Ensure to avoid setting any negative values.

9.5.1 length()

NAME
`length()` — Length of string

SYNOPSIS
```
size_t length() const;
```

DESCRIPTION
Returns the length of a string (`'\0'` not included).

RETURN VALUE
A string length

EXAMPLE
The following codes prints to standard output the length of a string that the object `my_str` includes:
```
#include <iostream>

int main()
{
    stdstreamio sio;
    tstring my_str = "User'sFile.txt";

    sio.printf("%zu\n", my_str.length());

    return 0;
}
```

Result of execution
14

9.5.2 max_length()

NAME
`max_length()` — Maximum value for the length of string that an object can handle

SYNOPSIS
```
size_t max_length() const;
```

DESCRIPTION
Returns the maximum string length in fixed-length buffer mode. If not in fixed-length buffer mode returns 0.
9.5.3 cstr(), c_str()

NAME
cstr(), c_str() — Beginning address for a string (read-only)

SYNOPSIS
const char *cstr() const;
const char *c_str() const;

DESCRIPTION
Returns the beginning address for a string inside an object.
If the string inside an object gets modified the modified string address is then acquired (Refer to EXAMPLE 2).

RETURN VALUE
Beginning address for a string

EXAMPLE-1
The following code creates the object my_str in NULL-free mode, and then prints it to standard output in verifying that the storage buffer for the internal string immediately after the object is created is not NULL. The string This is a pen. is assigned to my_str, and then prints the result to standard output:

```c
stdstreamio sio;
tstring my_str(true);

if (my_str.c_str() != NULL) {
    sio.printf("The address of the character string is not NULL.\n");
} else {
    sio.printf("The address of the character string is NULL.\n");
}

my_str = "This is a pen.";
sio.printf("%s\n", my_str.cstr());
```

Result of execution
The address of the character string is not NULL.
This is a pen.

EXAMPLE-2
With the following code if a string that the object my_str includes is modified printts the result to standard output in order to verify that the new string address has been acquired:

```c
stdstreamio sio;
tstring my_str = "JAXA";

sio.printf("%s\n", my_str.cstr());

my_str = "ISAS";
sio.printf("%s\n", my_str.cstr());
```
9.5.4 str_ptr(), str_ptr_cs()

NAME
str_ptr(), str_ptr_cs() — Beginning address for string

SYNOPSIS
char *str_ptr(); ................................................................. 1
const char *str_ptr() const; .................................................... 2
const char *str_ptr_cs() const; ............................................ 3

DESCRIPTION
Returns the beginning address for a string that is managed by the object.

Member function 1 is used if you wish to directly write into a string buffer inside the object.
The size of the internal buffer using the resize() member function (§ 9.5.22) etc. must be
adjusted to the length of the string you wish to write.

Member functions 2 and 3 have the same behavior as the cstr() member function (§ 9.5.3).

With the str_ptr() member function whether member function 1 or member function 2 is
used is automatically determined by the presence or absence of the “const” attribute for an
object. Member function 1 is automatically selected if the object does not have a “const”
attribute and member function 2 if it does.

RETURN VALUE
Beginning address of string

WARNING
Ensure to avoid use of this member function unless absolutely necessary.

9.5.5 cchr()

NAME
cchr() — Reading of characters in specified position

SYNOPSIS
int cchr( size_t pos ) const;

DESCRIPTION
Returns the characters in position pos in a string inside an object. Please note that the lead
position in strings is 0.

PARAMETER
[I] pos Position in string

RETURN VALUE
Character in specified position : Normal termination
Negative value (Error) : If pos has a value longer than the length of a string
inside an object specified to it.
EXAMPLE

The following code assigns the string *User’s*File3.txt to a string that the object *my_str* includes, and then prints the 10th character in *my_str* to standard output:

```cpp
stdstreamio sio;
tstring my_str = "User'sFile3.txt";
int i_ret;

if ((i_ret = my_str.cchr(10)) < 0){
    Error handling
}
sio.printf("%c\n", i_ret);
```

Result of execution
3

9.5.6 at(), at_cs()

NAME

at(), at_cs() — Reference to characters in specified position

SYNOPSIS

<table>
<thead>
<tr>
<th>Function</th>
<th>Synopsis</th>
</tr>
</thead>
<tbody>
<tr>
<td>at()</td>
<td>unsigned char &amp;at( size_t pos );</td>
</tr>
<tr>
<td>at_cs()</td>
<td>const unsigned char &amp;at( size_t pos ) const;</td>
</tr>
<tr>
<td>const at_cs()</td>
<td>const unsigned char &amp;at_cs( size_t pos ) const;</td>
</tr>
</tbody>
</table>

DESCRIPTION

Returns a reference to characters in position *pos* in a string inside an object. Please note that the lead position in strings is always 0.

Member function 1 can be used to both read and write characters whereas member functions 2 and 3 are used in reading only.

With the at() member function whether member function 1 or member function 2 is used is automatically determined by the presence or absence of a “const” attribute for an object. Member function 1 is automatically selected if the object does not have a “const” attribute and member function 2 if it does.

With member function 1 if the operating mode for an object is normal mode or NULL-free mode the string length is adjusted to make it *pos*+1 and reading and writing performed even if *pos* is longer than the string length specified.

The same thing also occurs in fixed-length buffer mode, but if you specify a value for *pos*is longer than the maximum string length set when the object is created an exception occurs.

If a *pos* value is specified that is longer than the string length for member functions 2 and 3 an exception will occur in all the operating modes.

PARAMETER

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>pos</td>
<td>Position in string</td>
</tr>
</tbody>
</table>

RETURN VALUE

Reference to characters in a specified position
EXCEPTION
If in fixed-length buffer mode pos has a longer value than the maximum string length specified for it (Member function 1).
If pos has a longer value than the string length specified for it (Member functions 2 and 3).

EXAMPLE
The following code reads sixth character in a string that object my_str includes, and then prints the result to standard output.
The character X is written into the ninth character position in my_str, and then prints the result to standard output:

```cpp
stringstream sio;
tstring my_str = "abcdefgh";
unsigned char c_read;

c_read = my_str.at(6);
sio.printf("%c\n", c_read);

my_str.at(9) = 'X';
sio.printf("%s\n", my_str.cstr());
```

Result of execution

g
abcde

9.5.7 update_length()

NAME
update_length() — Update length information in object (only for fixed-length buffer mode)

SYNOPSIS
```cpp
tstring &update_length();
```

DESCRIPTION
When fixed-length buffer mode, this member function finds the terminating ‘\0’ character in internal buffer, and updates internal information of object.
Because object of fixed-length mode manages both buffer length and length of string, update_length() should be used when characters are directly written to internal buffer of fixed-length mode.

9.5.8 dprint()

NAME
dprint() — Outputs object information to standard error output (For use in debugging)

SYNOPSIS
```cpp
void dprint() const;
```

DESCRIPTION
Outputs information on an object to standard error output.
Member function designed for use in debugging user programs.
EXAMPLE
The following code outputs information on the object my_str to standard error output. The address for the object can be seen to be displayed in [], which depends on the execution environment:

```cpp
tstring my_str = "X68000 PRO";
my_str.dprint();
```

Result of execution
sli::tstring[obj=0xbffff640] = "X68000 PRO"

9.5.9  getstr()

NAME
getstr() — Copies (sub)string to an external buffer

SYNOPSIS
```cpp
ssize_t getstr( char *dest_str, size_t buf_size ) const;
ssize_t getstr( size_t pos, char *dest_str, size_t buf_size ) const;
```

DESCRIPTION
Copies a string inside an object to external buffer dest_str.

The size of dest_str is specified using buf_size. The number of characters written if sufficient buffer exists for dest_str is returned as the return value. A return value being larger than the size of dest_str therefore means that the buffer was insufficient.

Member function 1 copies an object to dest_str.

Member function 2 copies characters starting from position pos in a string inside an object to dest_str. Please note that the lead position in strings is always 0.

If the size of a buffer is insufficient for a string inside an object the string to which dest_str refers is to still terminates at ‘\0’. In this case member function 1 copies buf_size-1characters from the beginning of the string inside an object, whereas member function 2 copies buf_size-1characters from position pos in the string inside an object.

PARAMETER
| [O]  | dest_str | Address for external buffer to copy to |
| [I]  | buf_size | Size of external buffer |
| [I]  | pos      | Position to start copying from |


RETURN VALUE
Non-negative value : Number of characters that can be copied if there is sufficient buffer length (‘\0’ not included).

Negative value (Error) : If NULL is set to dest_str, and a value other than 0 is set to buf_size.
                        : If pos has a value larger than the length of a string inside the object specified to it.

EXAMPLE
The following code copies characters from the beginning of the string that object my_str includes to external buffer c_sentence, and then prints the result to standard output:
```cpp
stdstreamio sio;
tstring my_str = "JAXA/ISAS";
char c_sentence[10];
int i_ret = 0;

if ((i_ret = my_str.getstr(0, c_sentence, sizeof(c_sentence))) < 0 ) {
    Error handling
} else if ( sizeof(c_sentence) < i_ret ) {
    sio_printf("The length of buffer is insufficient. \n");
} else {
    sio_printf("%s\n", c_sentence);
}
```

Result of execution
JAXA/ISAS

9.5.10 copy()

NAME

`copy()` — Copies (sub)string to an external object

SYNOPSIS

```
ssize_t copy( tstring *dest ) const; ............................................. 1
ssize_t copy( size_t pos, tstring *dest ) const; ................................. 2
ssize_t copy( size_t pos, size_t n, tstring *dest ) const; .................... 3
```

DESCRIPTION

Copies all or part of a string inside an object to external buffer `dest`.
If the operating mode used with `dest` is the fixed-length buffer mode strings are copied within
the range of the maximum string length of `dest`. Please note the return value in this case is
the number of characters returned that is written if there is a sufficient buffer for `dest`. A
return value being larger than the size of the buffer for `dest` therefore means that the buffer
was insufficient.

Member functions 1 copies objects to `dest`.

Member functions 2 and 3 copy a string starting from position `pos` in a string inside an object.
Please note that the lead position in strings is always 0. In addition, member functions 3
enables you to specify the length `n` of a string to copy.

Member function that corresponds to the `substr()` function in Perl and PHP.

PARAMETER

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>[I]</td>
<td><code>pos</code></td>
</tr>
<tr>
<td>[I]</td>
<td><code>n</code></td>
</tr>
<tr>
<td>[O]</td>
<td><code>dest</code></td>
</tr>
</tbody>
</table>

([I]: Input, [O]: Output)
## RETURN VALUE

- **Non-negative value**: Number of characters that can be copied if there is sufficient buffer.
- **Negative value (Error)**: If `pos` has a value larger than the length of a string inside the object specified to it.
- : If `dest` is NULL.

## EXCEPTION

If the system failed to secure an internal buffer.

## EXAMPLE

The following code copies characters from the beginning of a string that object `my_str` includes to external object `my_id`, and then prints the result to standard output:

```cpp
stdstreamio sio;
tstring my_id(4);
tstring my_str = "User ID : 1234";
int i_ret = 0;

if ((i_ret = my_str.copy(10, 4, &my_id)) < 0 ) {
    Error handling
} else if ( 4 < i_ret ) {
    sio.printf("The length of buffer is insufficient. \n");
} else {
    sio.printf("%s
", my_id.cstr());
}
```

Result of execution

```
1234
```

### 9.5.11 swap()

## NAME

`swap()` — Swaps objects

## SYNOPSIS

```
tstring &swap( tstring &sobj );
```

## DESCRIPTION

Swaps the content of object `sobj` with the content of itself. The operating mode (Refer to §9.1) is not swapped when this takes place (Refer to EXAMPLE).

## PARAMETER

- **[I/O]** `sobj` Object for tstring class to swap the content with

## RETURN VALUE

Reference to itself

## EXCEPTION

If the system failed to secure an internal buffer.
If the system encountered any corrupt memory.
EXAMPLE
The following code creates objects `my_str1` and `my_str2` in normal mode along with also object `my_str3` in fixed-length buffer mode that then has the maximum string length of 4 specified to it. It then prints the result to standard output in order to verify that the strings these objects include have been swapped by `swap()`:

```cpp
stdstreamio sio;
tstring my_str1;
tstring my_str2;
tstring my_str3(4);

my_str1 = "ISS/Kibo";
my_str2 = "JAXA/ISAS";
my_str3 = "NASA";

my_str1.swap(my_str2);
sio.printf("%s
", my_str1.c_str());
sio.printf("%s
", my_str2.c_str());

my_str1.swap(my_str3);
sio.printf("%s
", my_str1.c_str());
sio.printf("%s
", my_str3.c_str());
```

Result of execution
JAXA/ISAS
ISS/Kibo
NASA
JAXA

9.5.12 init()

NAME
init() — Complete initialization of objects

SYNOPSIS
```
tstring &init(); ................................................................. 1
tstring &init( const tstring &src ); ..................................... 2
```

DESCRIPTION
Initializes objects.

Member function 1 completely initializes objects. The operating mode being NULL-free mode or fixed-length buffer mode results in initialization of the string buffer with the memory area maintained as is. With normal mode the memory area allocated to the string buffer inside an object is entirely released, and hence execution of the `cstr()` member function returns `NULL`.

Member function 2 initializes objects with the content of `src`.

PARAMETER
```
[I] src Object for tstring class that has the string to be sourced
```
RETURN VALUE
Reference to itself

EXCEPTION
If the system failed to secure an internal buffer.
If the system encountered any corrupt memory (Member function 2).

EXAMPLE-1
The following code standard-outputs the result of execution to verify that a string that the
object my_str includes has been changed by init():

```cpp
stdstreamio sio;
tstring my_str = "User’sFile01.txt";
const tstring my_sentence = "JaxaData.txt";

sio.printf("%s\n", my_str.cstr());
my_str.init(my_sentence);

sio.printf("%s\n", my_str.cstr());
```

Result of execution
User’sFile01.txt
JaxaData.txt

EXAMPLE-2
The following code prints the result of execution to standard output in order to verify that
a string that the object my_str includes has been changed by init():

```cpp
stdstreamio sio;
tstring my_str = "User’sFile01.txt";

sio.printf("%s\n", my_str.cstr());
my_str.init();

sio.printf("%s\n", my_str.cstr());
```

Result of execution
User’sFile01.txt
(null)

9.5.13 printf(), vprintf(), assign(), assignf(), vassignf()

NAME
printf(), vprintf(), assign(), assignf(), vassignf() — Initialization of objects

SYNOPSIS
```cpp
tstring &printf( const char *format, ... ); ................................. 1
tstring &vprintf( const char *format, va_list ap ); .......................... 2
tstring &assign( int ch, size_t n ); ............................................ 3
tstring &assign( const char *str ); .............................................. 4
```
tstring &assign( const char *str, size_t n ); .......................... 5
        tstring &assignf( const char *format, ... ); .......................... 6
        tstring &vassignf( const char *format, va_list ap ); ...................... 7
        tstring &assign( const tstring &src, size_t pos2 = 0 ); .................. 8
        tstring &assign( const tstring &src, size_t pos2, size_t n2 ); .......... 9

DESCRIPTION
Initializes a string inside an object with the string specified with the arguments.

Member functions 1, 2, 6, and 7 initialize objects using strings created according to format.
Member functions 1 and 6 convert each element of data of a variable-length argument,
whereas member functions 2 and 7 convert the list ap of variable-length arguments, each
depending on the format specified in format however. For more information on format refer
to the descriptions provided in §8.1.14.

Member function 3 initializes the buffer for a string inside an object with the n characters
provided by ch.

Member functions 4 and 5 initialize the buffer for a string inside an object with string str.
Member function 5 also enables you to specify the length n of str used in initialization to
be specified. n being larger than the string length of str results in the entire string in str
being the target of initialization.

Member functions 8 and 9 initialize objects using the string in and after position pos2 in
object src. Please note that the lead position in strings is always 0. Member function 8 can
be used without having specified pos2. In that case, however, the function is processed as
though 0 had been specified. Member function 9 enables the length n2 of the string used in
initialization to be specified.

PARAMETER
[1] format Format specifications for string to be sourced
[1] ... Each element of data of the variable-length argument supporting format
[1] ap List of variable-length arguments supporting format
[1] ch Character to be sourced
[1] str String to be sourced
[1] n Number of ch or length of str
[1] src Object for tstring class that includes the string to be sourced
[1] pos2 Starting position of the string in src (If a substring of src is assigned)
[1] n2 Length of string to be written (If a substring of src is assigned)

RETURN VALUE
Reference to itself

EXCEPTION
If the system failed to secure an internal buffer.
If each element of data of a variable-length argument is a value that cannot be converted
using the specified conversion format (Member functions 1, 2, 6, and 7).

EXAMPLE-1
The following code prints the result of execution to standard output in order to verify that
the string the object my_str includes has been initialized by printf():

```cpp
stringstream sio;
tstring     my_str;
```
EXAMPLE-2
This code initializes `my_str` using the five characters that start from the eleventh character `e` in the string `my_sentence` of the string which the object `my_str` includes, and then prints the result to standard output:

```cpp
std::iostream  sio;
tstring  my_str;
const tstring my_sentence = "This is an eraser.";

sio.printf("%s\n", my_str.cstr());
my_str.printf("%s", "TEST_OK");
sio.printf("%s\n", my_str.cstr());
```

Result of execution
(null)
TEST_OK

9.5.14 implode()

NAME
implode() — Sets a string that elements of a string array joined with delimiter

SYNOPSIS
```
tstring &implode( const char *const *arr, const char *delim );
```

DESCRIPTION
`implode()` joins all elements of a string array specified by argument `arr` with delimiter string `delim`, and store the result into the object.

This member function does not change object when `arr` is NULL.

PARAMETER
- `[I]` `arr` String array (pointer array with NULL termination)
- `[I]` `delim` Delimiter string
  

RETURN VALUE
Reference to itself

EXCEPTION
If the system failed to secure an internal buffer.
EXAMPLE
This code prepares a string array `arr`, joins all elements of it with delimiter ",", and then
prints the result to standard output:

```cpp
stdstreamio sio;
const char *arr[] = {"X1", "MZ2861", "X68k", NULL};
tstring my_str;

my_str.implode(arr, ",");
sio.printf("%s\n", my_str.cstr());
```

Result of execution
X1,MZ2861,X68k

9.5.15 import_binary()

NAME
`import_binary()` — Import of binary data

SYNOPSIS
`tstring &import_binary( const char *buf, size_t bufsize, int altchr = \0 );`

DESCRIPTION
This member function calls `this->resize(bufsize)`, and then reads `bufsize` bytes from
the buffer specified by `buf`, and then stores it in an object. If `altchr` has anything else but
`\0` specified and the buffer includes the character `\0` in it, then replaces the character
with `altchr` before storing the buffer.

If `altchr` is omitted the character `\0` inside the buffer can be stored as is, but the member
functions that search strings and perform pattern matching will not necessarily operate
properly.

PARAMETER

- `[I] buf` Address for user buffer
- `[I] bufsize` Size of user buffer
- `[I] altchr` Character that replaces the character `\0` if the character exists in the user
  buffer

(\[I\] : Input, [O] : Output)

RETURN VALUE
Reference to itself

EXCEPTION
If the system failed to secure a buffer inside an object.

9.5.16 put(), putf(), vputf()

NAME
`put(), putf(), vputf()` — Sets characters or strings to a given position
SYNOPSIS

```cpp
tstring &put( size_t pos1, int ch, size_t n ); ................................. 1
ntstring &put( size_t pos1, const char *str ); .................................. 2
tstring &put( size_t pos1, const char *str, size_t n ); ......................... 3
tstring &putf( size_t pos1, const char *format, ... ); .......................... 4
tstring &vputf( size_t pos1, const char *format, va_list ap ); ............... 5
tstring &put( size_t pos1, const tstring &src, size_t pos2 = 0 ); .......... 6
tstring &put( size_t pos1, const tstring &src, size_t pos2, size_t n2 ); 7
```

DESCRIPTION

Writes to position `pos1` in a string inside an object with the string specified with the arguments. Please note that the lead position in strings inside an object and in the string specified is always 0.

`pos1` can take any given value. When the string buffer inside an object is smaller than that specified by the argument the size of the buffer gets automatically increased, with the added buffer being padded with the white space character `' '`, and then the string specified with the arguments written into the position of `pos1`. However, if the operating mode is fixed-length buffer mode the size does not get increased to any larger than the maximum string length set when the object is created. For example, if a `pos1` is specified that is longer than the maximum string length, a white space character is padded to the area from the end of the string to the full limit of the buffer size, with the characters and strings specified by the argument not being written.

Member function 1 writes `n` characters of `ch` to position `pos1` in the string inside an object.

Member functions 2 and 3 write string `str` to position `pos1` in the string inside an object. Member function 3 also enables length `n` of the `str` to be written to be specified. If `n` is larger than the length of string `str`, the whole string of `str` will be written.

Member functions 4 and 5 write strings that are created according to `format`. Member function 4 converts each element of data of a variable-length argument, whereas member function 5 converts list `ap` of variable-length arguments, each depending on the conversion specifications set in `format`. For more information on `format` refer to the descriptions provided in §8.1.14.

Member functions 6 and 7 write a string from position `pos2` in `src` to the string inside an object. Member function 6 can be used without specifying `pos2`. In that case, however, the function is processed as though 0 had been specified. Member function 7 enables the length `n2` of the `src` to be written to be specified.

PARAMETER

```cpp
[I] pos1   Position to start string inside an object
[I] ch     Character to be sourced
[I] n      Number of ch or length of str
[I] str    String to be sourced
[I] format Format specifications for string to be sourced
[I] ...    Each element of data of variable-length argument supporting `format`
[I] ap     List of variable-length arguments supporting `format`
[I] src    Object for tstring class that includes the string to be sourced
[I] pos2   Starting position of the string in `src` (If substring of `src` is assigned)
[I] n2     Length of string to be written (If substring of `src` is assigned)
```
RETURN VALUE
Reference to itself

EXCEPTION
If the system failed to secure an internal buffer.
If each element of data of a variable-length argument is a value that cannot be converted with the specified conversion format (Member functions 4 and 5).

EXAMPLE
The following code writes the four characters from the beginning of my_sentence to the sixth character position in the string that the object my_str includes, and then prints the result to standard output:

```c++
stdstreamio  sio;
tstring my_str = "User'sFile01.txt";
const tstring my_sentence = "Data"

my_str.put(6, my_sentence, 0, 4);
sio.printf("%s\n", my_str.cstr());
```

Result of execution
User'sData01.txt

9.5.17 strcat(), strncat(), append(), appendf(), vappendf()

NAME
strcat(), strncat(), append(), appendf(), vappendf() — Addition of characters or strings

SYNOPSIS
```c++
tstring &strcat( const char *str ); .................................................. 1
tstring &strcat( const char *str, size_t n ); ............................................. 2
tstring &strcat( const tstring &src, size_t pos2 = 0 ); ..................................... 3
tstring &strcat( const tstring &src, size_t pos2, size_t n2 ); ....................... 4
tstring &append( int ch, size_t n ); .......................................................... 5
tstring &append( const char *str ); ............................................................ 6
tstring &append( const char *str, size_t n ); ................................................. 7
tstring &append( const char *format, ... ); ................................................ 8
tstring &append( const char *format, va_list ap ); ....................................... 9
tstring &append( const tstring &src, size_t pos2 = 0 ); .................................. 10
tstring &append( const tstring &src, size_t pos2, size_t n2 ); ..................... 11
```

DESCRIPTION
Adds the string specified with the arguments to a string inside an object.

The operating mode being fixed-length buffer mode results in the strings not being increased to any longer than the maximum string length set when the object was created. The string reaching the maximum string length or reaching the maximum string length while being added results in no further processing being performed.

Member functions 1, 2, 6 and 7 add the string str to the end of a string inside an object. In addition, member function 2 and 7 enable the length n of the str to be added to be specified.
n being larger than the string length of \texttt{str} results in the entire string being the target of addition.

Member functions 3, 4, 10, and 11 add a string in and after position \texttt{pos2} in string \texttt{src} to the end of a string inside the object. Please note that the lead position in strings is always 0. Member function 3 and 10 can be used without specifying \texttt{pos2}. In that case, however, the functions are processed as though 0 was specified. Member functions 4 and 11 enable the length \texttt{n2} of the \texttt{src} to be added to be specified.

Member function 5 adds \texttt{n} characters of \texttt{ch} to the end of a string inside an object.

Member functions 8 and 9 add strings created according to \texttt{format}. Member function 8 converts each element of data of a variable-length argument, whereas member function 9 converts the list \texttt{ap} of variable-length arguments, each depending on the conversion specifications set in \texttt{format}. For more information on \texttt{format} refer to the descriptions provided in \S 8.1.14.

**PARAMETER**

\begin{tabular}{|l|}
\hline
\texttt{str} & String to be sourced \\
\texttt{n} & Number of \texttt{ch} or length of \texttt{str} \\
\texttt{src} & Object for \texttt{tstring} class that includes string to be sourced \\
\texttt{pos2} & Starting position of the string in \texttt{src} (If substring of \texttt{src} is added) \\
\texttt{n2} & Length of string to be added (If substring of \texttt{src} is added) \\
\texttt{ch} & Character to be sourced \\
\texttt{format} & Format specifications for string to be sourced \\
\texttt{...} & Each element of data of variable-length argument supporting \texttt{format} \\
\texttt{ap} & List of variable-length arguments supporting \texttt{format} \\
\hline
\end{tabular}

\begin{tabular}{|l|}
\hline
\hline
\end{tabular}

**RETURN VALUE**

Reference to itself

**EXCEPTION**

If the system failed to secure an internal buffer.
If each element of data of a variable-length argument is a value that cannot be converted with the specified conversion format (Member functions 8 and 9).

**EXAMPLE**

The following code adds the content of \texttt{my\_suffix} to a string that the object \texttt{my\_str} includes, and then prints the result to standard output:

```c
stdstreamio  sio;
tstring      my_str = "200X1231";
const tstring my_suffix = ".txt";

my_str.append(my_suffix);
sio.printf("%s\n", my_str.cstr());
```

Result of execution

200X1231.txt
9.5.18  insert(), insertf(), vinsertf()

NAME
insert(), insertf(), vinsertf() — Insertion of characters or strings

SYNOPSIS

\begin{verbatim}
tstring &insert( size_t pos1, int ch, size_t n );  .......... 1
  tstring &insert( size_t pos1, const char *str ); .......... 2
  tstring &insert( size_t pos1, const char *str, size_t n ); .......... 3
  tstring &insertf( size_t pos1, const char *format, ... ); .......... 4
  tstring &vinsertf( size_t pos1, const char *format, va_list ap ); .......... 5
  tstring &insert( size_t pos1, const tstring &src, size_t pos2 = 0 ); .......... 6
  tstring &insert( size_t pos1, const tstring &src, size_t pos2, size_t n2 ); .......... 7
\end{verbatim}

DESCRIPTION

Inserts the string specified with the arguments to position \texttt{pos1} in a string inside an object. Please note that the lead position in strings inside an object or in the string specified is always 0.

Member function 1 inserts \texttt{n} characters of \texttt{ch} to position \texttt{pos1} in the string inside an object. Member functions 2 and 3 insert the string \texttt{str} to the position \texttt{pos1} in a string inside an object. Member function 3 also enables the length \texttt{n} of the \texttt{str} to be inserted to be specified.

Member functions 4 and 5 insert strings created according to \texttt{format}. Member function 4 converts each element of data of a variable-length argument, whereas member function 5 converts the list \texttt{ap} of variable-length arguments, each depending on the conversion specifications set in \texttt{format}. For more information on \texttt{format} refer to the descriptions provided in \S 8.1.14

Member functions 6 and 7 insert a string in and after position \texttt{pos2} in the string \texttt{src} that is added to position \texttt{pos1} in the string inside an object. Member function 6 can be used without specifying \texttt{pos2}. In that case, however, the function is processed as though 0 was specified. Member function 7 enables the length \texttt{n2} of the \texttt{src} to be inserted to be specified.

PARAMETER

\begin{itemize}
  \item [I] \texttt{pos1} Position to start string inside object
  \item [I] \texttt{ch} Character to be sourced
  \item [I] \texttt{n} Number of \texttt{ch} or length of \texttt{str}
  \item [I] \texttt{str} String to be sourced
  \item [I] \texttt{format} Format specifications for string to be sourced
  \item [I] ... Each element of data of variable-length argument supporting \texttt{format}
  \item [I] \texttt{ap} List of variable-length arguments supporting \texttt{format}
  \item [I] \texttt{src} Object for tstring class that includes string to be sourced
  \item [I] \texttt{pos2} Starting position of the string inside \texttt{src} (If substring of \texttt{src} is assigned)
  \item [I] \texttt{n2} Length of string to be inserted (If substring of \texttt{src} is assigned)
\end{itemize}


RETURN VALUE

Reference to itself

EXCEPTION

If the system failed to secure an internal buffer.

If each element of data of a variable-length argument is a value that cannot be converted with the specified conversion format (Member functions 4 and 5).
EXAMPLE

The following code inserts characters to a string that the object my_str includes according to format, and then prints the result to standard output:

```cpp
stdstreamio sio;
tstring my_str = "123";

sio.printf("%s\n", my_str.cstr());

my_str.insertf(1,"%c","+");

sio.printf("%s\n", my_str.cstr());

my_str.insertf(3,"%c","=");

sio.printf("%s\n", my_str.cstr());
```

Result of execution

```
123
1+23
1+2=3
```

9.5.19 replace(), replacef(), vreplacef()

NAME

replace(), replacef(), vreplacef() — Replacement of strings

SYNOPSIS

```cpp
tstring &replace( size_t pos1, size_t n1, int ch, size_t n2 ); ............... 1
   tstring &replace( size_t pos1, size_t n1, const char *str ); ............... 2
   tstring &replace( size_t pos1, size_t n1, const char *str, size_t n2 ); . 3
   tstring &replacef( size_t pos1, size_t n1, const char *format, ... ); .... 4
   tstring &vreplacef( size_t pos1, size_t n1,
                     const char *format, va_list ap ); ......................... 5
   tstring &replace( size_t pos1, size_t n1,
                     const tstring &src, size_t pos2 = 0 ); ..................... 6
   tstring &replace( size_t pos1, size_t n1, const tstring &src,
                    size_t pos2, size_t n2 ); .................................. 7
```

DESCRIPTION

Replaces n1 characters from position pos1 in a string inside an object with the specified string. Please note that the lead position in strings inside an object and in the string specified is always 0.

pos1 having a value larger than the length of the string inside an object specified to it results in the same processing as the stacat() member function (9.5.17). The sum of pos1 and n1 being larger than the length of the string inside, an object or the string needing to be expanded or contracted because of the size difference with n1 and n2 results in the string being automatically adjusted. However, the operating mode being fixed-length buffer mode results in the strings not being expanded to any longer than the maximum string length set when the object was created.
Member function 1 replaces \( n_1 \) characters from the position of \( \text{pos1} \) in a string inside an object with \( n_2 \) characters of \( \text{ch} \).

Member function 2 and 3 replace \( n_1 \) characters from position \( \text{pos1} \) in a string inside an object with the string \( \text{str} \). Member function 3 also enables the length \( n_2 \) of the \( \text{str} \) to be replaced with to be specified.

Member functions 4 and 5 perform conversions using strings created according to \( \text{format} \). Member function 4 converts each element of data of a variable-length argument, whereas member function 5 converts the list \( \text{ap} \) of variable-length arguments, each depending on the conversion specification set in \( \text{format} \). For more information on \( \text{format} \) refer to the descriptions provided in \[8.1.13\].

Member functions 6 and 7 convert \( n_1 \) characters from position \( \text{pos1} \) in a string inside an object with a string from position \( \text{pos2} \) in \( \text{src} \). Member function 6 can be used without specifying \( \text{pos2} \). In that case, however, the function is processed as though 0 was specified. Member function 7 enables the length \( n_2 \) of the \( \text{src} \) to be replaced with to be specified.

**PARAMETER**

| I  | pos1 | Position to start string inside object |
| I  | n1   | Number of characters to be replaced   |
| I  | ch   | Character to be sourced               |
| I  | n2   | Number of \( \text{ch} \) or length of string in \( \text{str} \) or \( \text{src} \) |
| I  | str  | String to be sourced                 |
| I  | format | Format specifications for string to be sourced |
| I  | ...  | Each element of data of a variable-length argument supporting \( \text{format} \) |
| I  | ap   | List of variable-length arguments supporting \( \text{format} \) |
| I  | pos2 | Starting position of the string inside \( \text{src} \) (If substring of \( \text{src} \) is assigned) |
| I  | src  | Object for \text{tstring} class that includes string to be sourced |

(\( I \) : Input, \( O \) : Output)

**RETURN VALUE**

Reference to itself

**EXCEPTION**

If the system failed to secure an internal buffer.

If each element of data of a variable-length argument is a value that cannot be converted with the specified conversion format (Member functions 4 and 5).

**EXAMPLE-1**

The following code replaces eight characters from the eighth character \( Y \) in a string that object \( \text{my}\_\text{str} \) includes according to the specified format, and then prints the result to standard output:

```c
stdstreamio sio;
tstring my_str = "UserNameYYYYMMDD.txt";
time_t jikoku;
struct tm *lt;

time(&jikoku);
lt = localtime(&jikoku);

my_str.replacef(8, 8, "%d%d%d", 1900+lt->tm_year, lt->tm_mon, lt->tm_mday);
sio.printf("\%s\n", my_str.cstr());
```
Result of execution
UserName2009219.txt

EXAMPLE-2
The following code replaces two characters from the eleventh character \text{2} in a string that the object \text{my\_str} includes with 4 \text{X} characters, and then prints the result to standard output:

```c
stdstreamio sio;
tstring my_str = "User ID : 1234";
int i_ch = 'X';

my_str.replace(11, 2, i_ch, 4);
sio.printf("%s\n", my_str.cstr());
```

Result of execution
User ID : 1XXXX4

EXAMPLE-3
The following code replaces five characters from the eleventh character \text{S} in a string that the object \text{my\_str} includes with the string \text{Akar}, and then prints the result to standard output:

```c
stdstreamio sio;
tstring my_str = "My name is Suzuki.";

my_str.replace(11, 5, "Akar", 4);
sio.printf("%s\n", my_str.cstr());
```

Result of execution
My name is Akari.

9.5.20 erase()

NAME
erase() — and then prints the result to standard output:

SYNOPSIS
`tstring &erase();`                                                                                   1  
`tstring &erase( size_t pos, size_t n = 1 );`                                                        2

DESCRIPTION
Erases characters in a string inside an object.
Member function 1 erases all the characters (String length becomes zero).
Member function 2 erases \text{n} characters from position \text{pos}. Please note that the lead position in strings is always 0. If \text{n} is not specified one character is erased.

PARAMETER
[I] \text{pos} Position to start erasing  
[I] \text{n} Number of characters to be erased  
RETURN VALUE
Reference to itself

EXCEPTION
If the system failed to secure an internal buffer.

EXAMPLE
The following code erases the first character in a string that the object my_str includes, and then prints the result to standard output:

```cpp
stdstreamio sio;
tstring my_str(7);
my_str.init("sibuki");
sio.printf("%s\n", my_str.cstr());
my_str.erase(0);
sio.printf("%s\n", my_str.cstr());
```

Result of execution
sibuki
ibuki

9.5.21 clean()

NAME
clean() — Pads existing entire strings with a given character

SYNOPSIS
tstring &clean( int ch = ' ' );

DESCRIPTION
Pads the entire string inside an object with the character ch. The function can also be used without specifying ch. In that case, however, the function is processed as though the white space character ' ' was specified. Executing clean() does not change the length of strings.

PARAMETER
[I] ch Character to pad a string with

RETURN VALUE
Reference to itself

EXCEPTION
If the system failed to secure an internal buffer.

EXAMPLE
The following code pads a string that the object my_str includes with the character *, and then standard-outputs the result:

```cpp
clean('*');
```
```c++
stdstreamio sio;
tstring my_str = "Akari20060222.txt";

my_str.clean('*');
sio.printf("%s\n", my_str.cstr());
```

**Result of execution**

```
**************
```

### 9.5.22 resize()

**NAME**
resize() — Changes the length of strings

**SYNOPSIS**

```c++
tstring &resize( size_t len );
```

**DESCRIPTION**
Changes the length of a string inside an object to `len`.

- If the string length is increased a string comprised of the white space character ‘ ’ is added.
- If the string length is contracted the string after `len` is deleted.

**PARAMETER**

<table>
<thead>
<tr>
<th>I</th>
<th>len</th>
<th>String length after being changed</th>
</tr>
</thead>
</table>

**RETURN VALUE**
Reference to itself

**EXCEPTION**

If the system failed to secure an internal buffer.

**EXAMPLE**
The following code assigns a string of eight characters to a string that the object `my_str` includes, changes the string length to 3, and then prints the result to standard output:

```c++
stdstreamio sio;
tstring my_str;

my_str = "USR TEST";
sio.printf("%s\n", my_str.cstr());

my_str.resize(3);
sio.printf("%s\n", my_str.cstr());
```

**Result of execution**

```
USR TEST
USR
```
9.5.23 resizeby()

NAME

resizeby() — Changes the relative length of strings

SYNOPSIS

tstring &resizeby( ssize_t len );

DESCRIPTION

Changes the length of a string inside an object by the length in \( \text{len} \).

If the string length is increased a string comprised of the white space character ' ' is added.

If the string length is contracted the string of the last \( \text{abs}(\text{len}) \) characters is deleted.

PARAMETER

[I] \( \text{len} \) Increase/decrease in string length
((I) : Input, (O) : Output)

RETURN VALUE

Reference to itself

EXCEPTION

If the system failed to secure an internal buffer.

9.5.24 crop()

NAME

crop() — Cropping of strings

SYNOPSIS

ststring &crop( size_t pos ); ................................. 1
ststring &crop( size_t pos, size_t n ); .......................... 2

DESCRIPTION

Crops a string inside an object into \( n \) characters from position \( \text{pos} \). Please note that the lead position in strings is always 0.

Member function 1 crops characters from \( \text{pos} \) to the end of a string inside an object.

Member function 2 crops \( n \) characters from \( \text{pos} \) in a string inside an object. The sum of \( \text{pos} \) and \( n \) being larger than the string length results in characters being cropped from the string in and after \( \text{pos} \).

If a value larger than the string length is specified to \( \text{pos} \) the string length becomes 0.

PARAMETER

[I] \( \text{pos} \) Position to start cropping
[I] \( n \) Number of characters to be cropped
((I) : Input, (O) : Output)

RETURN VALUE

Reference to itself

EXCEPTION

If the system failed to secure an internal buffer.
EXAMPLE
The following code crops eight characters from the fifth character 2 in a string that the object my_str includes, and then prints the result to standard output:

```cpp
sstream sio;
tstring my_str = "Akari20060222.txt";
my_str.crop(5,8);
sio.printf("%s\n", my_str.cstr());
```

Result of execution
20060222

9.5.25 chomp()

NAME
chomp() — Elimination of newline characters

SYNOPSIS
tstring &chomp( const char *rs = "\n" );
tstring &chomp( const tstring &rs );

DESCRIPTION
Eliminates the newline character to the right of a string inside an object. Newline characters are specified by rs.

For example, with DOS-format text files “str.chomp("\r\n");” would need to be added, and with the supported UNIX, Mac and DOS formats “str.chomp("\n").chomp("\r");” would need to be added.

PARAMETER
[I] rs Newline string
([I]: Input, [O]: Output)

RETURN VALUE
Reference to itself

EXCEPTION
If the system failed to secure an internal buffer.

9.5.26 trim()

NAME
trim() — Elimination of arbitrary characters at both ends of a string

SYNOPSIS
tstring &trim( int side_space ); .............................................................. 1
tstring &trim( const char *side_spaces = " \t\n\r\f\v" ); ................................ 2
tstring &trim( const tstring &side_spaces ); ........................................ 3

DESCRIPTION
Eliminates arbitrary characters at both ends of a string inside an object. Arbitrary characters are specified by the character side_space or string side_spaces.
Member function 1 eliminates side_space at both ends of a string inside an object.

Member function 2 can be used without specifying side_spaces. In that case, however, the white space character, horizontal tabulation character, newline character, carriage return character, file separator character or vertical tabulation character are eliminated as though "\t\n\r\f\v" had been specified (\ refers to white space character).

Member functions 2 and 3 enable side_spaces to be specified as a simple list of characters, for example " \t" as well as values like "[A-Z]" or "[^A-Z]", as used in regular expressions. In addition, the character classes provided in Table[19] can also be specified inside "[ . . . ]".

<table>
<thead>
<tr>
<th>Character class</th>
<th>Corresponding character</th>
<th>Corresponding function in libc</th>
</tr>
</thead>
<tbody>
<tr>
<td>[:alnum:]</td>
<td>Alphabetical or numerical character</td>
<td>isalnum()</td>
</tr>
<tr>
<td>[:alpha:]</td>
<td>Alphabetical character</td>
<td>isalpha()</td>
</tr>
<tr>
<td>[:cntrl:]</td>
<td>Control character</td>
<td>iscntrl()</td>
</tr>
<tr>
<td>[:digit:]</td>
<td>Decimal number character</td>
<td>isdigit()</td>
</tr>
<tr>
<td>[:graph:]</td>
<td>Print character (White space character excluded)</td>
<td>isgraph()</td>
</tr>
<tr>
<td>[:lower:]</td>
<td>Lowercase alphabetical character</td>
<td>islower()</td>
</tr>
<tr>
<td>[:print:]</td>
<td>Print character for printing (White space character included)</td>
<td>isprint()</td>
</tr>
<tr>
<td>[:punct:]</td>
<td>Punctuation character</td>
<td>ispunct()</td>
</tr>
<tr>
<td>[:space:]</td>
<td>White space character</td>
<td>isspace()</td>
</tr>
<tr>
<td>[:upper:]</td>
<td>Uppercase alphabetical character</td>
<td>isupper()</td>
</tr>
<tr>
<td>[:xdigit:]</td>
<td>Hexadecimal number character</td>
<td>isxdigit()</td>
</tr>
</tbody>
</table>

Table 19: List of character classes available for use with [ . . . ].

For example, "[[:digit:]]" is equivalent to "[0-9]". For the other possibilities refer to the functions manual for the corresponding functions in libc, as some of them depend on the locale.

Please note that you cannot use expressions like "[0-9]abcdef" but instead "[0-9a-f]" or "0123456789abcdef". This then means that when side_spaces begins with '[' it must end with ']'.

PARAMETER
[I] side_space Arbitrary character
[I] side_spaces Arbitrary string

RETURN VALUE
Reference to itself

EXCEPTION
If the system failed to secure an internal buffer.

EXAMPLE
The following code eliminates from a string that the object my_str includes arbitrary characters at both ends of the string, and then prints the result to standard output:

```cpp
#include <iostream>
#include <sstream>
#include <string>

int main() {
    stdstreamio sio;
tstring my_str = "\tThis is a pen. \n";

    my_str.trim();
sio.printf("%s\n", my_str.cstr());
    return 0;
}
```
Result of execution
This is a pen.

9.5.27 ltrim()

NAME
ltrim() — Elimination of space on left end of a string

SYNOPSIS

```cpp
sl::string &ltrim( int side_space );
sl::string &ltrim( const char *side_spaces = " \t\n\r\f\v" );
sl::string &ltrim( const sl::string &side_spaces );
```

DESCRIPTION

Eliminates a white space character on the left end of a string inside an object. White space characters are specified by `side_space` or `side_spaces`.

`side_spaces` can be specified as a simple list of characters, for example " \t" as well as values like "[A-Z]" or "[^A-Z]", as used in regular expressions. In addition, the character classes provided below can also be specified inside "[...]":

```
[:alnum:], [:alpha:], [:cntrl:], [:digit:], [:graph:], [:lower:],
[:print:], [:punct:], [:space:], [:upper:], [:xdigit:].
```

For example, "[[[:digit:]]]" is equivalent to "[0-9]". For other possibilities refer to the manual for the `isalpha()` function in libc as some of them depend on the locale.

Please note that you cannot use expressions like "[0-9]abcdef", but instead "[0-9a-f]" or "0123456789abcdef" This then means that when `side_spaces` begins with ‘[‘ it must end with ‘]’.

RETURN VALUE

Reference to itself

9.5.28 rtrim()

NAME
rtrim() — Elimination of space on the right end of a string

SYNOPSIS

```cpp
sl::string &rtrim( int side_space );
sl::string &rtrim( const char *side_spaces = " \t\n\r\f\v" );
sl::string &rtrim( const sl::string &side_spaces );
```

DESCRIPTION

Eliminates white space character on the right end of a string inside an object. White space characters are specified by `side_space` or `side_spaces`.

`side_spaces` can be specified as a simple list of characters, for example " \t" as well as values like "[A-Z]" or "[^A-Z]", as used in regular expressions. In addition, the character classes provided below can also be specified inside "[...]":

```
[:alnum:], [:alpha:], [:cntrl:], [:digit:], [:graph:], [:lower:],
[:print:], [:punct:], [:space:], [:upper:], [:xdigit:].
```

For example, "[[[:digit:]]]" is equivalent to "[0-9]". For other possibilities refer to the manual for the `isalpha()` function in libc as some of them depend on the locale.
Please note that you cannot use expressions like "[0-9]abcdef" but instead "[0-9a-f]" or "0123456789abcdef". This then means that when side_spaces begins with '[' it must end with ']'.

RETURN VALUE
Reference to itself

9.5.29  strreplace()

NAME
strreplace() — Search for and replace strings

SYNOPSIS
ssize_t strreplace( const char *org_str, const char *new_str, bool all = false );
ssize_t strreplace( size_t pos, const char *org_str, const char *new_str,
        bool all = false );
ssize_t strreplace( const tstring &org_str, const char *new_str,
        bool all = false );
ssize_t strreplace( size_t pos, const tstring &org_str, const char *new_str,
        bool all = false );
ssize_t strreplace( const char *org_str, const tstring &new_str,
        bool all = false );
ssize_t strreplace( size_t pos, const char *org_str, const tstring &new_str,
        bool all = false );
ssize_t strreplace( const tstring &org_str, const tstring &new_str,
        bool all = false );
ssize_t strreplace( size_t pos, const tstring &org_str, const tstring &new_str,
        bool all = false );

DESCRIPTION
Searches for the string org_str from the left side of a string inside an object, and when
found replaces it with the string new_str.

If a string is replaced the member functions return the position next to the string that was
replaced. If that return value is then provided to pos the next part in which org_str is
found can be replaced.

If the last argument all is true all the parts that match are replaced with the new_str.

If more advanced search processing is required replacement can be executed with extended
regular expressions for the regreplace() member function (§9.5.30).

PARAMETER
[I]  org_str  String to be detected
[I]  new_str  String to be sourced for replacement
[I]  pos     Position to start string search
[I]  all     Replace all flags

RETURN VALUE
Non-negative value : If the string specified is found the position next to the string replaced.
Negative value (Error) : If the character or string specified is not found.
: If there is no string inside an object.
: If org_str or new_str is NULL.
: If pos has a value larger than the length of a string inside an object specified to it.

EXCEPTION
If the system failed to secure an internal buffer.

EXAMPLE
The following code replaces the host name part, darts.isas.jaxa.jp, of the URL string that the object my_url includes:

```cpp
stdstreamio sio;
tstring my_url = "http://darts.isas.jaxa.jp/foo/";

my_url.strreplace("darts.isas.jaxa.jp", "darts.jaxa.jp");
sio.printf("my_url = %s\n", my_url.cstr());
```

Result of execution
http://darts.jaxa.jp/foo/

9.5.30 regreplace()

NAME
regreplace() — Replaces parts that match an extended regular expression

SYNOPSIS

```
ssize_t regreplace( const char *pat,
const char *new_str, bool all = false ); ............... 1
ssize_t regreplace( size_t pos, const char *pat,
const char *new_str, bool all = false ); ............... 2
ssize_t regreplace( const tstring &pat,
const char *new_str, bool all = false ); ............... 3
ssize_t regreplace( size_t pos, const tstring &pat,
const char *new_str, bool all = false ); ............... 4
ssize_t regreplace( const tregex &pat,
const char *new_str, bool all = false ); ............... 5
ssize_t regreplace( size_t pos, const tregex &pat,
const char *new_str, bool all = false ); ............... 6
ssize_t regreplace( const char *pat,
const tstring &new_str, bool all = false ); ............ 7
ssize_t regreplace( size_t pos, const char *pat,
const tstring &new_str, bool all = false ); ............ 8
ssize_t regreplace( const tstring &pat,
const tstring &new_str, bool all = false ); ............ 9
ssize_t regreplace( size_t pos, const tstring &pat,
const tstring &new_str, bool all = false ); ............ 10
ssize_t regreplace( const tregex &pat,
```
const tstring &new_str, bool all = false );  .......... 11
ssize_t regreplace( size_t pos, const tregex &pat,
          const tstring &new_str, bool all = false );  .......... 12

DESCRIPTION

Replaces with the string new_str any parts of a string inside an object that match the POSIX extended regular expression (hereinafter referred to as regular expression) specified by pat. With a new_str back references "\0" through "\9" ("\0" refers to the entire part that matches) can be used. If you want to provide the backslash itself specify "\\\".

The regreplace() member function updates the buffer inside an object that stores the result of regular expression matching. If the argument all is false information on the result can be acquired using reg_elem_length(), reg_pos(), reg_length(), reg_cstr() and reg_cstrarray(). The functions respectively return the number of elements in a result, the position of the matching string, the string length of the matching string, the string of characters in the matching string, and the pointer array for the string of characters in a string that matches. The prototypes for these member functions are as follows:

size_t reg_elem_length() const;
size_t reg_pos( size_t idx ) const;
size_t reg_length( size_t idx ) const;
const char *reg_cstr( size_t idx ) const;
const char *const *reg_cstrarray() const;

The element numbers starting from 0 are specified in the argument idx. In the 0th information on the entire matching string is stored, while in the first and later information on a substring that matches the regular expressions “(...)” is individually stored (i.e. back reference information). The return value for the reg_cstrarray() member function can also be assigned to an object for the tarray_tstring class (§10) using the = operator.

If the argument all is true information on the result cannot be acquired because the result of regular expression matching is reset.

With member functions 1 through 4 and 7 through 10 the regular expression pat is compiled, the result saved to the internal buffer that the functions themselves include, and matching then performed (If pat is the same as the one previously compiled it is not recompiled again).

With member functions 5, 6, 11 and 12 the object for the tregex class that holds the result of compiling the regular expression is specified. Regular expressions therefore need to be compiled in advance using the compile() member function of the tregex class before using the regmatch() member function (Refer to EXAMPLE 2 in §9.5.59).

In both cases if the regular expression fails to be compiled the content is output to the standard error output.

Attempts string matching from position pos in a string inside an object to the right. String matching is attempted within a range of up to where \0 at the end of the string appears (Processing does not terminate when the newline character \n appears). If pos is not specified searches are made from the left end of a string inside an object. Please note that the lead position in strings is always 0.

If a string is replaced the member functions return the position of the string next to the string that was replaced. If this return value is then provided to pos the next part that matches can be replaced.

If the last argument all is true all the parts that match are replaced with new_str.

For more details on regular expressions refer to §9.5.59.
If you wish to execute replacement using a simpler search use of the strreplace() member function ([9.5.29]) is recommended as it provides advantages in processing speed.

**PARAMETER**

- **[I]** pat  Character pattern (regular expression) or compiled object for the tregex class
- **[I]** new_str  String after being replaced
- **[I]** pos  Position to start string matching
- **[I]** all  Replace all flags

*(Input, Output)*

**RETURN VALUE**

- Non-negative value  : Position next to string replaced
- Negative value (Error)  : If no string matches pat.
  - If there is no string inside an object.
  - If pos has a value larger than the length of a string inside an object specified to it.
  - If pat or new_str is NULL.
  - If the interval operators { } are not closed.
  - If the list operators [ ] are not closed.
  - If an unknown character class is set. [For example use of /up:].
  - If a regular expression ends with a backslash.
  - If the group operators () are not closed.
  - If operators are used with an invalid range. [For example use of /9-0/:]
  - If there is an invalid back reference to the sub-expression \(...\).
  - If an invalid back reference operator is used.
  - If invalid use of pattern operators such as a group or list is made. [For example use of /[0-9].]
  - If an invalid repetition operator is used in that ‘*’ is the first character. [For example use of pat="*.txt"].

**EXCEPTION**

- If the regex routine exhausted the memory space.
- If the system failed to secure an internal buffer.
- If the system encountered any corrupt memory.

**EXAMPLE**

The following code only replaces the host name part of the URL string that the object my_url includes:

```cpp
stdstreamio sio;
tstring my_url = "http://darts.isas.jaxa.jp/foo/";

if ( my_url.regreplace("(http://)([^/]+)\", "\\darts.jaxa.jp") < 0 ) {
    Error handling
}
else {
    sio.printf("my_url = \%s\n", my_url.cstr());
}
```
Result of execution
http://darts.jaxa.jp/foo/

9.5.31 tolower()

NAME
ttolower() — Converts uppercase to lowercase characters

SYNOPSIS

tstring &tolower( size_t pos = 0 );                      1

            tstring &tolower( size_t pos, size_t n );        2

DESCRIPTION
Converts uppercase alphabetical characters in a string inside an object to lowercase characters. Please note that the lead position in strings is always 0.

Member function 1 processes from position pos in a string inside an object through to the right. The function can be used without specifying pos. In that case, however, the function is processed as though 0 was specified.

Member function 2 converts uppercase characters from pos to the nth character in a string inside an object to lowercase characters.

PARAMETER
[I] pos Position to start conversion
[I] n Number of characters to be converted

RETURN VALUE
Reference to itself

EXAMPLE
The following code converts a string that the object my_str includes to lowercase, and then prints the result to standard output:

    stdstreamio sio;
    tstring my_str = "JAXA/ISAS";

    my_str.tolower();

    sio.printf("%s\n", my_str.cstr());

Result of execution
jaxa/isas

9.5.32 toupper()

NAME
toupper() — Converts lowercase to uppercase characters

SYNOPSIS

tstring &toupper( size_t pos = 0 );                      1

            tstring &toupper( size_t pos, size_t n );        2
DESCRIPTION
Converts lowercase alphabetical characters in a string inside an object to uppercase characters. Please note that the lead position in strings is always 0.

Member function 1 processes from position \texttt{pos} in a string inside an object through to the right. The function can be used without specifying \texttt{pos}. In that case, however, the function is processed as though 0 was specified.

Member function 2 converts lowercase characters from \texttt{pos} to the \texttt{n}th character in a string inside an object to uppercase characters.

PARAMETER
\begin{itemize}
\item \texttt{pos} Position to start conversion
\item \texttt{n} Number of characters to be converted
\end{itemize}
\texttt{[I]} : Input, \texttt{[O]} : Output

RETURN VALUE
Reference to itself

EXAMPLE
The following code converts to uppercase characters four characters from the fifth character in a string that the object \texttt{my\_str} includes, and then prints the result to standard output:

\begin{verbatim}
stdstreamio sio;
tstring my_str = "jaxa/isas";

my_str.toupper(5,4);
sio.printf("%s
", my_str.cstr());
\end{verbatim}

Result of execution
\begin{verbatim}
jaxa/ISAS
\end{verbatim}

9.5.33 expand\_tabs()

NAME
expand\_tabs() — Replaces horizontal tabulation characters with white space characters

SYNOPSIS
\begin{verbatim}
tstring &expand\_tabs( size\_t tab\_width = 8 );
\end{verbatim}

DESCRIPTION
Replaces horizontal tabulation characters ‘\texttt{\textbackslash t}’ in a string inside an object with a white space character by tabulating the characters to the value in \texttt{tab\_width}. Replacement is performed within the range of up to where ‘\texttt{\textbackslash 0}’ at the end of the string appears (When the newline character ‘\texttt{\textbackslash n}’ appears the internal column numbers used for tabulation are reset, and processing continues to be performed). If characters do not need to be tabulated the \texttt{tab} characters can also be replaced using the \texttt{strreplace()} member function (\S 9.5.29) or the \texttt{regreplace()} member function (\S 9.5.30).

If \texttt{tab\_width} is not specified or 0 is specified as \texttt{tab\_width}, the function is processed as though 8 had been specified as \texttt{tab\_width}.

If the change in \texttt{tab\_width} increases the length of a string inside an object the size of the buffer gets automatically increased. However, the operating mode being fixed-length buffer
mode results in the string not being expanded to any longer than the maximum string length set when the object was created (Refer to EXAMPLE).

For example, with the string "a\tbc\tdef" execution of \texttt{expand_tabs()} with \texttt{tab_width=3} results in the string being converted to "a\⊔\⊔bc\⊔def" (⊔). In this example the first horizontal tabulation character is replaced by two white space characters because the sum of the number of characters in the string up to before the horizontal tabulation character 1 ("a") and therefore the number of white space characters is tabulated to \texttt{tab_width}. In a similar manner, to tabulate to \texttt{tab_width} the sum of the number of characters in the string up to before the second horizontal tabulation character, which is 5 ("a\⊔\⊔bc") and the number of white space characters, requires a white space character. For this reason the second horizontal tabulation character is replaced with a white space character.

\textbf{PARAMETER}

\begin{itemize}
  \item \texttt{[I]} \hspace{1em} \texttt{tab_width} \hspace{1em} A TAB width
  \begin{itemize}
    \item \texttt{[I]}: Input, \texttt{[O]}: Output
  \end{itemize}
\end{itemize}

\textbf{RETURN VALUE}

Reference to itself

\textbf{EXCEPTION}

If the system failed to secure an internal buffer.

\textbf{EXAMPLE}

The following code creates the object \texttt{my\_str1} in normal mode, with the object \texttt{my\_str2} in fixed-length buffer mode that has the maximum string length of 11 being specified to it. The result is then printed to standard output in order to verify that the strings were adjusted with a TAB width when the horizontal tabulation characters inside the strings that the objects include were replaced using \texttt{expand_tabs()} with white space characters:

\begin{verbatim}
ostreamio sio;
tstring my_str1;
tstring my_str2(11);
my_str1 = "Akari\tIbuki";
my_str2 = "Akari\tIbuki";
sio.printf("%s, %zu\n", my_str1.cstr(), my_str1.length());
sio.printf("%s, %zu\n", my_str2.cstr(), my_str2.length());
my_str1.expand_tabs();
my_str2.expand_tabs();
sio.printf("%s, %zu\n", my_str1.cstr(), my_str1.length());
sio.printf("%s, %zu\n", my_str2.cstr(), my_str2.length());
\end{verbatim}

\textbf{Result of execution}

Akari Ibuki,11
Akari Ibuki,11
Akari Ibuki,13(Akari⊔⊔⊔Ibuki)
Akari Ib,11(Akari⊔⊔⊔Ibu)

(⊔ refers to a white space character.)
9.5.34 contract_spaces()

NAME
contract_spaces() — Replaces white space characters with TAB characters

SYNOPSIS
```cpp
#include <string>

std::string &contract_spaces( size_t tab_width = 8 );
```

DESCRIPTION
Replaces white space characters with TAB characters in a string inside an object that tabulates to the specified TAB width of `tab_width`. However, replacement is performed within the range of up to where '
' appears at the end of the string (When the newline character '
' appears, the internal column numbers used for tabulation are reset, and the processing continues). This member function performs the reverse operation to the operation described in §9.5.33 If characters do not need to be tabulated, the white space characters can also be replaced using the `strreplace()` member function (§9.5.29) or the `regreplace()` member function (§9.5.30).

The function can be used without specifying `tab_width`. In that case, however, and when 0 is specified as `tab_width`, the function is processed as though 8 had been specified to `tab_width`.

For example, with the string "abc⊔⊔⊔⊔⊔⊔⊔⊔de" (⊔ refers to s white space) executing `contract_spaces()` with `tab_width=4` results in the string being converted to "abc⊔\t⊔⊔⊔de". In this example, to tabulate to `tab_width` the sum of the number of characters up to before the white space character of 3 ("abc") and the number of white space characters requires a white space character. The first white space character is therefore not replaced, and remains as is. The four white space characters before replacement are then replaced with a horizontal tabulation character. Following those characters there are less white space characters than in `tab_width`, and hence the white space characters are not replaced with horizontal tabulation characters. The breakdown after conversion of the white space characters, which totaled 8 before replacement, reveals that white space characters + horizontal tabulation characters (for the four white space characters before replacement) + three white space characters (Refer to EXAMPLE).

PARAMETER
- `tab_width` A TAB width
  (I : Input, O : Output)

RETURN VALUE
Reference to itself

EXAMPLE
The following code prints the result to standard output in order to verify that the contiguous white space characters in the string that the object `my_str` includes were adjusted using `contract_spaces()` with a TAB width of 4:

```cpp
#include <iostream>

int main() {
    std::string sio;
    std::string my_str = "abc   de";
    sio.printf("%s\n", my_str.cstr());
    return 0;
}
```
my_str.contract_spaces(4);

sio.printf("%s\n", my_str.cstr());

**Result of execution**

```
abc de(abc	de)
abc
de(abc\tde)
```

**WARNING**

Operation with `tab.width=1` cannot be defined.

### 9.5.35 atoi(), atol(), atoll()

**NAME**

`atoi()`, `atol()`, `atoll()` — Converts to integer value

**SYNOPSIS**

```c
int atoi( size_t pos = 0 ) const; ........................................ 1
int atoi( size_t pos, size_t n ) const; .................................. 2
long atol( size_t pos = 0 ) const; ...................................... 3
long atol( size_t pos, size_t n ) const; ............................... 4
long long atoll( size_t pos = 0 ) const; ................................ 5
long long atoll( size_t pos, size_t n ) const; .......................... 6
```

**DESCRIPTION**

Converts characters in and after position `pos` in a string inside an object to decimal integer values. `atoi()` converts strings to an integer number of `int` type. In a similar manner `atol()` and `atoll()` convert strings to an integer number of `long` type and integer number of `long long` type, respectively. If a string inside an object includes any character other than `[0-9]` (excluding signs at the beginning) the characters after that character will not be processed. Please note that the lead position in strings is always 0.

Member functions 1, 3, 5 can be used without specifying the position `pos`. In that case, however, the functions are processed as though 0 was specified.

Member functions 2, 4, 6 convert `n` characters from position `pos` in a string inside an object to integer values.

**PARAMETER**

- `[I]` `pos` Position in a string inside an object to be converted to integer value
- `[I]` `n` Number of characters to be converted to integer values
  

**RETURN VALUE**

- Integer number : Integer value converted

**EXCEPTION**

If the system failed to secure an internal buffer (Member functions 2, 4, and 6).

**EXAMPLE**

The following code converts the second and following characters in a string that the object `my_str` includes to integer numbers of the `int` type, and then prints the result to standard output:
**SLLIB Reference: sli:tstring (class that handles strings)**

```c
stdstreamio sio;
tstring my_str = "1234abc567";

sio.printf("%d\n", my_str.atoi(2));
```

Result of execution

34

**WARNING**

Once a character other than [0-9] appears conversion terminates. If you wish to verify whether all the characters have been converted, use the `strtol()` member function (§9.5.37) that includes the `endpos` argument.

---

9.5.36 **atof()**

**NAME**

`atof()` — Converts to real value

**SYNOPSIS**

```c
double atof( size_t pos = 0 ) const; ................................. 1
double atof( size_t pos, size_t n ) const; ............................ 2
```

**DESCRIPTION**

Converts characters in and after position `pos` in a string inside an object to real values. If a string inside an object includes any character that cannot be handled as a real value the characters after that character will not be processed. Please note that the lead position in strings is always 0.

Strings that can be converted to real values include decimal numbers, hexadecimal numbers, infinity or `NAN` (an incalculable number). Decimal numbers consist of a decimal string of one or more characters, and can include a decimal point. The exponential part of a decimal number can consist of 'E' or 'e' with a positive or negative symbol (omissible) placed after it and followed by a decimal numerical string of one or more characters that reveal to what power of 10 the number is. The function also supports FORTRAN-format double-precision exponent representation (e.g., `1.2345D-10`) (Refer to EXAMPLE 2).

Hexadecimal numbers consist of "0x" or "0X" followed by a hexadecimal numerical string of one or more characters, and can include a decimal point. The binary exponential part can then be specified. The binary exponential part consists of 'P' or 'p' with a positive or negative symbol (omissible) placed after it followed by a decimal numerical string of one or more characters that reveal to what power of 2 the number is (Refer to EXAMPLE 3). Only a decimal point or a binary exponential can be used.

Infinity is referred to by "INF" or "INFINITY", both being case-independent.

`NANs` are referred to by "NAN" (case-independent), and may be followed by '('.

Member function 1 can be used without specifying the position `pos`. In that case, however, the function is processed as though 0 was specified.

Member function 2 converts to a real value `n` characters from position `pos` in a string inside an object.

**PARAMETER**

- `[I] pos` Position in a string inside an object to be converted to real value
- `[I] n` Number of characters to be converted to real values

RETURN VALUE
Real number : Value of double converted

EXCEPTION
If the system failed to secure an internal buffer.

EXAMPLE-1
The following code converts the second and following characters in a string that the object
my_str includes to a real number of the double type, and then prints the result to standard output:

```c
stdstreamio sio;
tstring my_str = "1234abc567";

sio.printf("%f\n", my_str.atof(2));
```

Result of execution
34.000000

EXAMPLE-2
The following code converts to a real number of the double type five characters from the
first character of 2 in a string that the object my_str includes, and then prints the result to standard output:

```c
stdstreamio sio;
tstring my_str = "123D-456";

sio.printf("%f\n", my_str.atof(1,5));
```

Result of execution
0.002300

EXAMPLE-3
The following code converts to a real number of the double type a string that the object
my_str includes, and then prints the result to standard output:

```c
stdstreamio sio;
tstring my_str = "0xabp2";

sio.printf("%f\n", my_str.atof());
```

Result of execution
684.000000

WARNING
Once an invalid number for the radix appears the conversion terminates. If you wish to verify
whether all the characters were converted, use the `strtod()` member function ([9.5.39](#)) that
includes the `endpos` argument.
9.5.37  strtol(), strtoll()

NAME
strtol(), strtoll() — Converts to integer value

SYNOPSIS

long strtol( int base, size_t *endpos ) const; ......................... 1
long strtol( size_t pos, int base, size_t *endpos ) const; ............ 2
long strtol( size_t pos, size_t n, int base, size_t *endpos ) const; ... 3
long long strtoll( int base, size_t *endpos ) const; ..................... 4
long long strtoll( size_t pos, int base, size_t *endpos ) const; .......... 5
long long strtoll( size_t pos, size_t n, int base, size_t *endpos ) const; 6

DESCRIPTION
Converts a string inside an object to an integer value using the base number in base.
strtol() converts strings to an integer number of the long type, with strtoll() similarly converting strings to an integer number of the long long type. Values of 2 to 36 or 0 can be specified in base. If 0 or 16 is specified the string can be prefixed with '0x’, and is then handled as a hexadecimal number. If base is 0 for any other strings than this the strings are handled as an octal number when they begin with '0’ or as a decimal number if otherwise (Refer to EXAMPLE-2). In addition, returns to endpos the position of any character that is not converted.

Member functions 1 and 4 convert a string inside an object to an integer number.

Member functions 2, 3, 5 and 6 convert characters from position pos in a string inside an object to an integer number. Please note that the lead position in strings is always 0. Member functions 3 and 6 also enable the length n of a string to be converted to an integer value to be specified.

PARAMETER
[I]  pos  Position in a string inside an object to be converted to an integer value
[I]  n    Number of characters to be converted to an integer value
[I]  base Base number
[O]  endpos  Position of a character in a string inside an object that is not converted

RETURN VALUE
Integer number  :  Integer value that is converted

EXCEPTION
If the system failed to secure an internal buffer (Member functions 3, and 6)

EXAMPLE-1
The following code converts a string that object my_str includes to an integer number of the long type, and then prints the result to standard output:

```c
stringstream sio;
tstring my_str = "01234F57";
long l_ret = -1;
size_t endpos = 0;

l_ret = my_str.strtol(0, 0, &endpos);
if (endpos == 0) {
```
Error handling
}
else {
    sio.printf("%ld,%zu\n", l_ret, endpos);
}

Result of execution
668,5

EXAMPLE-2
The following code converts the second and later characters in a string that object my_str
includes to an integer number of the long type, and then prints the result to standard output:

    stdstreamio sio;
    tstring my_str = "1234F57";
    long l_ret = -1;
    size_t endpos = 0;

    l_ret = my_str.strtol(2, 10, &endpos);
    if ( endpos == 0 ) {
        Error handling
    }
    else {
        sio.printf("%ld, %zu\n", l_ret, endpos);
    }

Result of execution
34,4

9.5.38  strtoul(), strtoull()

NAME
    strtoul(), strtoull() — Converts to an unsigned integer value

SYNOPSIS
    unsigned long strtoul( int base, size_t *endpos ) const; ................. 1
    unsigned long strtoul( size_t pos, int base, size_t *endpos ) const; ..... 2
    unsigned long long strtoull( size_t pos, size_t n, int base, size_t *endpos ) const; 3
    unsigned long long strtoull( int base, size_t *endpos ) const; ............ 4
    unsigned long long strtoull( size_t pos, int base, size_t *endpos ) const; 5
    unsigned long long strtoull( size_t pos, size_t n, int base, size_t *endpos ) const; ............ 6

DESCRIPTION
    Converts a string inside an object to an unsigned integer value using the base number in
    base. strtoul() converts strings to an integer number of the unsigned long type, while
    strtoull() converts strings to an integer number of the unsigned long long type. Values
    of 2 to 36 or 0 can be specified in base. If 0 or 16 is specified the string can be prefixed with
    '0x', and is then handled as a hexadecimal number. If base is 0 for any other strings than
    this the strings are handled as an octal number when they begin with '0', and as a decimal
number if otherwise. In addition, returns to endpos the position of any character that is not converted.

Member functions 1 and 4 convert a string inside an object to an unsigned integer number.
Member functions 2, 3, 5 and 6 convert characters from position pos in a string inside an object to an unsigned integer number. Please note that the lead position in strings is always 0. Member functions 3 and 6 also enable the length of a string to be converted to an unsigned integer value to be specified.

**PARAMETER**
- [I] pos: Position in a string inside an object to be converted to an integer value
- [I] n: Number of characters to be converted to an integer value
- [I] base: Base number
- [O] endpos: Position of a character in a string inside an object that is not converted
  ([I]: Input, [O]: Output)

**RETURN VALUE**
- Integer number: Integer value that is converted

**EXCEPTION**
- If the system failed to secure an internal buffer (Member functions 3 and 6)

**EXAMPLE**
The following code converts a string that the object my_str includes to an integer number of the unsigned long type using a decimal number, and then prints the result to standard output:

```c
#include <iostream>
#include <sstream>
#include <tstring>

int main() {
    tstring my_str = "-1abc";
    unsigned long ul_ret = 0;
    size_t endpos = 0;

    ul_ret = my_str.strtoul(10, &endpos);
    if (endpos == 0) {
        // Error handling
    } else {
        std::printf("%lu,%zu\n", ul_ret, endpos);
    }
}
```

**Result of execution**
4294967295,2

---

**9.5.39 strtod()**

**NAME**
- `strtod()` — Converts to real value

**SYNOPSIS**
- `double strtod( size_t *endpos ) const;` ................................. 1
- `double strtod( size_t pos, size_t *endpos ) const;` .................. 2
- `double strtod( size_t pos, size_t n, size_t *endpos ) const;` .......... 3
DESCRIPTION
Converts a string inside an object to a real value. In addition, returns to endpos the position in a string inside an object that is not converted.

The function also supports FORTRAN-format double-precision exponent representation (e.g., 1.2345D-10). For further information refer to the descriptions provided in §9.5.36 on the strings that can be converted.

Member function 1 converts a string inside an object to a real number.

Member functions 2 and 3 convert characters from position pos in a string inside an object to a real number. Please note that the lead position in strings is always 0. In addition, the member function enables the length n of a string to be converted to a real value to be specified.

PARAMETER
[I] pos Position in a string inside an object to be converted to a real value
[I] n Number of characters to be converted to a real value
[O] endpos Position of a character in a string inside an object that is not converted

RETURN VALUE
Real number : The value for double that is converted

EXCEPTION
If the system failed to secure an internal buffer.

EXAMPLE-1
The following code converts the string -12.3D-4X56 that the object my_str includes to a real number of the double type, and then prints the result to standard output:

```c
stdstreamio sio;
tstring my_str = "-12.3D-4X56";
double d_ret = 0;
size_t endpos = 0;
d_ret = my_str.strtod(&endpos);
if ( endpos == 0 ) {
   Error handling
} else {
   sio.printf("%f, %zu\n", d_ret, endpos);
}
```

Result of execution
-0.001230,8

EXAMPLE-2
The following code converts the string infinity that the object my_str includes to a real number of the double type, and then standard-outputs the result:

```c
stdstreamio sio;
tstring my_str = "infinity";
double d_ret = 0;
```
size_t endpos = 0;

d_ret = my_str.strtod(&endpos);
if ( endpos == 0 ) {
    Error handling
} else {
    sio.printf("%f, %zu\n", d_ret, endpos);
}

Result of execution
inf,8

9.5.40 scanf(), vscanf()

NAME
scanf(), vscanf() — Formatted input conversion

SYNOPSIS
int scanf( const char *format, ... ) const;
int vscanf( const char *format, va_list ap ) const;

DESCRIPTION
Reads a string inside an object according to the conversion specifications in format, and
then stores it in the arguments after format.

The result of the conversion depending on the conversion specifications in format is read by
scanf() to each element data of a variable-length argument, and by vscanf() to the list
ap of variable-length arguments. For more on format refer to the descriptions provided in
§8.1.11.

PARAMETER
[I] format  Format specifications for reading
[O] ...  Each element data of a variable-length argument to which to write
[O] ap  List of variable-length arguments to which to write

RETURN VALUE
Non-negative value : Number of input elements successfully read and converted.
EOF (Error) : If an argument is insufficient or format is NULL.
    : If there is no string inside an object.
    : If the input converted to the integer type specified by format exceeds the size of the allowable storage of the appropriate integer
type.

EXAMPLE
The following code converts a string that the object my_str includes to the string buffers
c_name and c_id, according to the format NAME ID : %9s %9s. It then prints the result to
standard output:

stdinstreamio sio;
tstring my_str = "NAME ID : SATO 1234";
char c_name[10];
char c_id[10];
int i_ret = 0;

if ((i_ret = my_str.scanf("NAME ID : %9s %9s", c_name, c_id)) == EOF) {
    Error handling
} else {
    sio.printf("%s, %s, %d\n", c_name, c_id, i_ret);
}

Result of execution
SAT0, 1234, 2

WARNING
The input when specifying "%s" in format of a string being larger than the size of the buffer used to store it will result in a buffer overrun occurring. For the method of avoiding this problem refer to the WARNING in §8.1.11

9.5.41 strcmp(), compare()

NAME
strcmp(), compare() — Comparison of strings

SYNOPSIS
int strcmp( const char *str ) const; ................................. 1
int strcmp( size_t pos1, const char *str ) const; .................. 2
int strcmp( const tstring &str, size_t pos2 = 0 ) const; ........ 3
int strcmp( size_t pos1, const tstring &str, size_t pos2 = 0 ) const; .... 4
int compare( const char *str ) const; ............................... 5
int compare( size_t pos1, const char *str ) const; .................. 6
int compare( const tstring &str, size_t pos2 = 0 ) const; .......... 7
int compare( size_t pos1, const tstring &str, size_t pos2 = 0 ) const; .. 8

DESCRIPTION
strcmp() and compare() are member functions with different names that operate in the same manner.

The strcmp() member function and compare() member function both compare a string inside an object with the string str in a dictionary-like manner. The comparison is based on the character code for each of the characters in a string. Unlike the strncmp() member function (§9.5.42), however, these functions compare all the characters from the start position of a string.

The start position of a string inside an object is specified using pos1, while the position to start the external character string str is specified using pos2. Please note that the lead position in a string inside an object and in external character strings is always 0.

Member functions 3, 4, 7 and 8 can be used without specifying pos2. In that case, however, the functions are processed as though 0 was specified.

PARAMETER
[I] str String to be used in comparison
[I] pos1 Position to start a string inside an object
[I] pos2 Position to start a string in str (When comparing with a substring in str)
RETURN VALUE

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>If a string inside an object is equal to \texttt{str}.</td>
</tr>
<tr>
<td>Positive</td>
<td>If a string inside an object is larger in a dictionary-like manner than \</td>
</tr>
<tr>
<td></td>
<td>\texttt{str}.</td>
</tr>
<tr>
<td>Negative</td>
<td>If a string inside an object is smaller in a dictionary-like manner than \</td>
</tr>
<tr>
<td></td>
<td>\texttt{str}.</td>
</tr>
<tr>
<td>256 (Error)</td>
<td>If a string inside an object has a buffer and NULL specified to \texttt{str}</td>
</tr>
<tr>
<td>-256 (Error)</td>
<td>If a string inside an object does not have a buffer and \texttt{str}</td>
</tr>
<tr>
<td></td>
<td>is specified.</td>
</tr>
<tr>
<td></td>
<td>: If \texttt{pos1} has a value larger than the length of a string inside an</td>
</tr>
<tr>
<td></td>
<td>object specified to it.</td>
</tr>
<tr>
<td></td>
<td>: If \texttt{pos2} has a value larger than the string length of \texttt{str}</td>
</tr>
<tr>
<td></td>
<td>specified to it.</td>
</tr>
</tbody>
</table>

EXAMPLE

The following code compares a string that the object \texttt{my\_str} includes with the external character string \texttt{Akari20090303.txt}, and then prints the result to standard output:

```cpp
stdstreamio sio;
tstring my_str = "Akari20060222.txt";

if (my_str.compare("Akari20090303.txt") == 0) {
    sio.printf("The same file\n");
} else {
    sio.printf("Different file\n");
}
```

Result of execution

Different file

9.5.42 \texttt{strncmp()}, \texttt{compare()}

NAME

\texttt{strncmp()}, \texttt{compare()} — Partially compares strings

SYNOPSIS

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>int \texttt{strncmp}</td>
<td>const char *\texttt{str}, size_t \texttt{n} const;</td>
</tr>
<tr>
<td>int \texttt{strncmp}</td>
<td>size_t \texttt{pos1}, const char *\texttt{str}, size_t \texttt{n} const;</td>
</tr>
<tr>
<td>int \texttt{strncmp}</td>
<td>const tstring &amp;\texttt{str}, size_t \texttt{pos2}, size_t \texttt{n} const;</td>
</tr>
<tr>
<td>int \texttt{strncmp}</td>
<td>size_t \texttt{pos1}, const tstring &amp;\texttt{str}, size_t \texttt{pos2},</td>
</tr>
<tr>
<td></td>
<td>size_t \texttt{n} const;</td>
</tr>
<tr>
<td>int \texttt{compare}</td>
<td>const char *\texttt{str}, size_t \texttt{n} const;</td>
</tr>
<tr>
<td>int \texttt{compare}</td>
<td>size_t \texttt{pos1}, const char *\texttt{str}, size_t \texttt{n} const;</td>
</tr>
<tr>
<td>int \texttt{compare}</td>
<td>const tstring &amp;\texttt{str}, size_t \texttt{pos2}, size_t \texttt{n} const;</td>
</tr>
<tr>
<td>int \texttt{compare}</td>
<td>size_t \texttt{pos1}, const tstring &amp;\texttt{str}, size_t \texttt{pos2},</td>
</tr>
<tr>
<td></td>
<td>size_t \texttt{n} const;</td>
</tr>
</tbody>
</table>

DESCRIPTION

\texttt{strncmp()} and \texttt{compare()} are member functions with different names that operate in the same manner.

The \texttt{strncmp()} member function and the \texttt{compare()} member function compare a string inside an object with the string \texttt{str} in a dictionary-like manner. The comparison is based on the character code of each of the characters in a string.
The position to start a string inside an object is specified using \texttt{pos1}, while the position to start the external character string \texttt{str} is specified using \texttt{pos2}. Please note that the lead position in a string inside an object and in external character strings is always 0.

Unlike the \texttt{strcmp()} member function (§9.5.41) these functions compare the first \texttt{n} characters from the position to start a string.

**PARAMETER**

\begin{itemize}
  \item \texttt{str} String to be used in comparison
  \item \texttt{pos1} Position to start a string inside an object
  \item \texttt{pos2} Position to start a string in \texttt{str} (When comparing with a substring in \texttt{str})
  \item \texttt{n} Number of characters to be compared
\end{itemize}

\begin{itemize}
  \item [I] : Input, [O] : Output
\end{itemize}

**RETURN VALUE**

\begin{itemize}
  \item 0 : If a string inside an object is equal to \texttt{str}.
  \item Positive value : If a string inside an object is larger in a dictionary-like manner than \texttt{str}.
  \item Negative value : If a string inside an object is smaller in a dictionary-like manner than \texttt{str}.
  \item 256 (Error) : If a string inside an object has a buffer and NULL specified to \texttt{str}.
  \item -256 (Error) : If a string inside an object does not have a buffer and \texttt{str} is specified.
  \item : If a string inside an object does not have a buffer and \texttt{n} is specified.
  \item : If \texttt{pos1} has a value larger than the length of a string inside an object specified to it.
  \item : If \texttt{pos2} has a value larger than the string length of \texttt{str} specified to it.
\end{itemize}

**EXAMPLE**

The following code compares eight characters from the fifth character of \texttt{2} in a string that the object \texttt{my\_str} includes with the external character string \texttt{Akari20060222.txt}, and then prints the result to standard output:

```c
stdstreamio sio;
tstring my_str = "Akari20060222.txt";

if (my_str.strncmp(5, "20060222", 8) == 0) {
    sio.printf("The same date\n");
} else {
    sio.printf("Different date\n");
}
```

Result of execution

The same date

9.5.43 strcasecmp(), strncasecmp()

**NAME**

\texttt{strcasecmp()}, \texttt{strncasecmp()} — Comparison of strings (Case-independent)

**SYNOPSIS**

\begin{verbatim}
int strcasecmp( const char *str ) const; ........................................ 1
int strncasecmp( size_t pos1, const char *str ) const; ....................... 2
\end{verbatim}
int strcasecmp( const tstring &str, size_t pos2 = 0 ) const; .............. 3
int strcasecmp( size_t pos1, const tstring &str, size_t pos2 = 0 ) const; 4
int strncasecmp( const char *str, size_t n ) const; ...................... 5
int strncasecmp( size_t pos1, const char *str, size_t n ) const; ........ 6
int strncasecmp( const tstring &str, size_t pos2, size_t n ) const; ...... 7
int strncasecmp( size_t pos1, const tstring &str, size_t pos2, size_t n ) const; ..................... 8

DESCRIPTION

Compares a string inside an object with the string str in a dictionary-like manner and without discriminating between uppercase and lowercase alphabetical characters. Processing results in both the string inside an object and the string str being converted to lowercase characters and then compared. The comparison after the strings are converted to lowercase characters is based on the character code of each of the characters inside the strings.

The position to start a string inside an object is specified using pos1, while the position to start the external character string str is specified using pos2. Please note that the lead position in a string inside an object and in external character strings is always 0.

strcasecmp() compares all the characters from the position to start a string, while strncasecmp() inquires whether the first n characters from the position to start a string match.

Member functions 3 and 4 can be used without specifying pos2. In that case, however, the functions are processed as though 0 was specified.

PARAMETER

[I] str   String to be used for comparison
[I] pos1  Position to start a string inside an object
[I] pos2  Position to start a string in str (When comparing with a substring in str)
[I] n     Number of characters to be compared


RETURN VALUE

0       : If a string inside an object is equal to str.
Positive value : If a string inside an object is larger in a dictionary-like manner than str.
Negative value : If a string inside an object is smaller in a dictionary-like manner than str.
256 (Error) : If a string inside an object has a buffer and NULL specified to str.
-256 (Error) : If a string inside an object does not have a buffer and str is specified.
             : If a string inside an object does not have a buffer and n is specified (Member functions 5 to 8).
             : If pos1 has a value larger than the length of a string inside an object specified to it (Member functions 2, 4, 6, and 8).
             : If pos2 has a value larger than the string length of str specified to it (Member functions 3, 4, 7, and 8).

EXAMPLE

The following code compares a string that the object my_str includes with the external character string suzuki using strcmp() and strcasecmp(). It then prints the result to standard output in order to verify that the uppercase and lowercase alphabetical characters were not discriminated in strcasecmp():

```c
stdafxio sio;
```
tstring  my_str = "SUZUKI";

if (my_str.strcmp("suzuki") == 0 ) {
    sio.printf("The same name\n");
} else {
    sio.printf("Different name\n");
}

if (my_str.strcasecmp("suzuki") == 0 ) {
    sio.printf("The same name\n");
} else {
    sio.printf("Different name\n");
}

Result of execution
Different name
The same name

9.5.44  isalpha(), isalnum(), isdigit(), islower(), isupper(), etc.

NAME
isalpha(), isalnum(), isdigit(), islower(), isupper(), etc. — Classification of characters

SYNOPSIS

bool isalnum( size_t pos ) const;
bool isalpha( size_t pos ) const;
bool iscntrl( size_t pos ) const;
bool isdigit( size_t pos ) const;
bool isgraph( size_t pos ) const;
bool islower( size_t pos ) const;
bool isprint( size_t pos ) const;
bool ispunct( size_t pos ) const;
bool isspace( size_t pos ) const;
bool isupper( size_t pos ) const;
bool isxdigit( size_t pos ) const;

DESCRIPTION
Classifies a character in position pos in a string inside an object according to the present locale. Please note that the lead position in strings is always 0. All the member functions correspond with the functions in libc. For the correspondence between these member functions and their characters refer to Table 18.

PARAMETER

[I]  pos  Position of character to be classified

RETURN VALUE

true  :  If a character in pos matches a character that the member function corresponds to.
false :  If a character in pos does not match a character that the member function corresponds to.
        :  If pos has a value larger than the length of a string inside an object specified to it.
EXAMPLE
The following code prints the result of execution to standard output in order to verify that a character is located fifth of the characters in a string that the object my_str includes is alphabetical or numerical.

```cpp
std::ostream sio;
tstring my_str = "JAXA/ISAS";

if ((my_str.isalnum(5)) == true ) {
    sio.printf("It is alphabetical or a figure.\n");
} else {
    sio.printf("It is neither alphabetical nor a figure.\n");
}
```

Result of the execution
It is alphabetical or a figure.

9.5.45 strchr(), find()

NAME
strchr(), find() — Searches for characters from the left

SYNOPSIS
```cpp
ssize_t strchr( int ch ) const; .............................. 1
ssize_t strchr( size_t pos, int ch ) const; ...................... 2
ssize_t strchr( size_t pos, int ch, size_t *nextpos ) const; .... 3
ssize_t find( int ch ) const; ...................................... 4
ssize_t find( size_t pos, int ch ) const; .......................... 5
ssize_t find( size_t pos, int ch, size_t *nextpos ) const; ...... 6
```

DESCRIPTION
strchr() and find() have different names but operate in the same manner.

Searches a string inside an object from the left to the right for the character ch, and then returns the position in which the character first appears.

pos being specified results in the search starting from position pos in a string inside an object. Please note that the lead position in strings is always 0.

If you wish to continuously search for characters or strings nextpos can be used to acquire the value that should be provided to pos in the next iteration. With the variable referred to by nextpos when a character is found the position one character to the right of the position in which the character was found is returned, and if no character is found the length of the string itself is returned. If you do not need to acquire a value using nextpos NULL can also be used.

PARAMETER
```cpp
[I] ch Character to be detected
[I] pos Position to start a string inside an object
[O] nextpos pos for the next search (Used in continuous searches)
```
RETURN VALUE

Non-negative value: If the character specified is found the position of the beginning of the string.
Negative value (Error): If the character specified is not found.
: If there is no string inside an object.
: If pos has a value larger than the length of a string inside an object (Member functions 2, 3, 5, and 6).

EXAMPLE
Refer to EXAMPLE in §9.5.46

9.5.46 strstr(), find()

NAME
strstr(), find() — Searches for strings from the left

SYNOPSIS

ssize_t strstr( const char *str ) const; .............................................. 1
ssize_t strstr( size_t pos, const char *str ) const; ............................ 2
ssize_t strstr( size_t pos, const char *str, size_t *nextpos ) const; ... 3
ssize_t strstr( const tstring &str ) const; ........................................ 4
ssize_t strstr( size_t pos, const tstring &str ) const; .......................... 5
ssize_t strstr( size_t pos, const tstring &str, size_t *nextpos ) const; 6
ssize_t find( const char *str ) const; ............................................... 7
ssize_t find( const char *str, size_t n ) const; ..................................... 8
ssize_t find( size_t pos, const char *str ) const; ................................ 9
ssize_t find( size_t pos, const char *str, size_t *nextpos ) const; .......... 10
ssize_t find( size_t pos, const char *str, size_t n ) const; .................... 11
ssize_t find( size_t pos, const char *str, size_t n, size_t *nextpos ) const; ................................................................. 12
ssize_t find( const tstring &str ) const; .......................................... 13
ssize_t find( size_t pos, const tstring &str, size_t *nextpos ) const; .... 14
ssize_t find( size_t pos, const tstring &str, size_t n, size_t *nextpos ) const; ................................................................. 15

DESCRIPTION

strstr() and find() have different names but operate in the same manner.
Searches a string inside an object from the left of the string str, and then returns the position in which the string first appears.
If pos is specified the search starts from the position pos in a string inside an object. Please note that the lead position in strings is always 0.
If n is specified the function requests the position that matches the string n characters from the beginning of str.
If you wish to continuously search for characters or strings nextpos can be used to acquire the value that should be provided to pos in the next iteration. If a string that is one or more characters long is found the position of the same length as str to the right of the position in which the string is found is returned to the variable referred to by nextpos. If a string 0 characters long is found, and the position one character to the right of the position in which the string is found is equal or smaller than the string length for the function itself, that value is returned as the variable referred to by nextpos. In any other case than above the length of the string itself + 1 is returned. If you do not need to acquire a value using nextpos NULL can also be used.
**PARAMETER**

| [I] pos | Position to start a string inside an object |
| [I] str | String to be detected |
| [I] n  | Number of characters to be detected |
| [O] nextpos | \( \text{pos} \) for use in next search (Used in continuous searches) |


**RETURN VALUE**

- Non-negative value: If a string specified is found the position of the beginning of the string.
- Negative value (Error): If a string specified is not found.
- : If there is no string inside an object.
- : If \( \text{pos} \) has a value larger than the length of a string inside an object.
- : If \( \text{str} \) is NULL (Member functions 1, 2, 3, 7, 8, 9, 10, 11, and 12).

**EXAMPLE**

The following code searches a string that the object \( \text{my\_str} \) includes from the left of the position of the string \( ISAS \), and then prints the result to standard output:

```cpp
std::streamio sio;
std::string my_str = "JAXA/ISAS/AKARI";
ssize_t t_ret = 0;

if ((t_ret = my_str.strstr("ISAS")) < 0 ) {
    // Error handling
} else {
    sio.printf("%zd\n", t_ret);
}
```

Result of execution

5

---

**9.5.47 \texttt{strrchr()}, \texttt{rfind()}**

**NAME**

\texttt{strrchr()}, \texttt{rfind()} — Searches for characters from the right

**SYNOPSIS**

```
ssize_t strrchr( int ch ) const; .................................................. 1
ssize_t strrchr( size_t pos, int ch ) const; ................................ 2
ssize_t strrchr( size_t pos, int ch, size_t *nextpos ) const; .......... 3
ssize_t rfind( int ch ) const; .................................................. 4
ssize_t rfind( size_t pos, int ch ) const; .................................. 5
ssize_t rfind( size_t pos, int ch, size_t *nextpos ) const; ............ 6
```

**DESCRIPTION**

\texttt{strrchr()} and \texttt{rfind()} have different names but operate in the same manner. Searches a string inside an object from the right to the left for the character \( \text{ch} \), and then returns the position in which the character first appears. The position will be position from the left of a string. Please note that the lead position in strings is always 0.
When pos is specified the search starts from the position pos in a string inside an object to the left.
If you wish to continuously search for characters or strings nextpos can be used to acquire the value that should be provided to pos in the next iteration. With the variable referred to by nextpos, when a character is found when pos is 1 or more the position one character to the left of the position in which the character was found is returned, and otherwise the length of the string itself is returned. If you do not need to acquire a value using nextpos NULL can also be used.

PARAMETER

[I] ch Character to be detected
[I] pos Position to start a string inside an object
[O] nextpos pos for use in next search (Used in continuous searches)

RETURN VALUE

Non-negative value : If a character specified is found the position of the beginning of the string.
Negative value (Error) : If a character specified is not found.
: If there is no string inside an object.
: If pos has a value larger than the length of a string inside an object specified to it (Member functions 2, 3, 5, and 6).

EXAMPLE

Refer to EXAMPLE in §9.5.48.

9.5.48  strrstr(), rfind()

NAME

strrstr(), rfind() — Searches for strings from the right

SYNOPSIS

ssize_t strrstr( const char *str ) const; ............................... 1
ssize_t strrstr( size_t pos, const char *str ) const; .................. 2
ssize_t strrstr( size_t pos, const char *str, size_t *nextpos ) const; .. 3
ssize_t strrstr( const tstring &str ) const; ............................. 4
ssize_t strrstr( size_t pos, const tstring &str ) const; ................ 5
ssize_t strrstr( size_t pos, const tstring &str, size_t *nextpos ) const; 6
ssize_t rfind( const char *str ) const; ................................. 7
ssize_t rfind( const char *str, size_t n ) const; .......................... 8
ssize_t rfind( size_t pos, const char *str ) const; ........................ 9
ssize_t rfind( size_t pos, const char *str, size_t n ) const; ............. 10
ssize_t rfind( size_t pos, const char *str, size_t *nextpos ) const; ... 11
ssize_t rfind( size_t pos, const char *str, size_t n, size_t *nextpos ) const; ........................................... 12
ssize_t rfind( const tstring &str ) const; .................................. 13
ssize_t rfind( size_t pos, const tstring &str ) const; ...................... 14
ssize_t rfind( size_t pos, const tstring &str, size_t *nextpos ) const; 15

DESCRIPTION

strrstr() and rfind() have different names but operate in the same manner.
Searches a string inside an object from the right to the left of string \texttt{str}, and then returns the position in which the string first appears. The position will be the position from the left of a string. Please note that the lead position in strings is always 0.

If \texttt{pos} is specified the search starts from the position \texttt{pos} in a string inside an object to the left.

If \texttt{n} is specified the function requests the position that matches the string \texttt{n} characters from the beginning of \texttt{str}.

If you wish to continuously search for characters or strings \texttt{nextpos} can be used to acquire the value that should be provided to \texttt{pos} in the next iteration. If a string that is one or more characters long is found the position the same length as \texttt{str} to the left of the position in which the string was found is returned to the variable referred to by \texttt{nextpos}. If a string that is 0 characters long is found and the position one character to the left of the position in which the string was found is not a negative number, that value is returned to the variable referred to by \texttt{nextpos}. In any other case than above the length of the string itself + 1 is returned. If you do not need to acquire a value using \texttt{nextpos} \texttt{NULL} can also be used.

\textbf{PARAMETER}

| [I] pos | Position to start a string inside an object. |
| [I] str | String to be detected |
| [I] n  | Number of characters to be detected |
| [O] nextpos | \texttt{pos} for use in next search (Used in continuous searches) |

\begin{itemize}
  \item ([I] : Input, [O] : Output)
\end{itemize}

\textbf{RETURN VALUE}

- Non-negative value : If a string specified is found the position of the beginning of the string.
- Negative value (Error) : If a string that is specified is not found.
  - If there is no string inside an object.
  - If \texttt{pos} has a value larger than the length of a string inside an object specified to it.
  - If \texttt{str} is \texttt{NULL} (Member functions 1, 2, 3, 7, 8, 9, 10, 11, and 12).

\textbf{EXAMPLE}

The following code searches a string that the object \texttt{my\_str} includes from the right of the position of the string \texttt{AS}, and then prints the result to standard output:

```c
stdstreamio sio;
tstring my_str = "JAXA/ISAS/NASA";
ssize_t t_ret = 0;

if ((t_ret = my_str.rfind("AS")) < 0 ) {
  Error handling
}
else {
  sio.printf("%zd
", t_ret);
}
```

Result of execution

\begin{tabular}{|c|}
  \hline
  11 \hline
\end{tabular}
9.5.49  find_first_of()

NAME

find_first_of() — Detects from the left the characters contained in a character set

SYNOPSIS

 ssize_t find_first_of( const char *str ) const; .......................... 1
 ssize_t find_first_of( const char *str, size_t n ) const; ............. 2
 ssize_t find_first_of( size_t pos, const char *str ) const; .......... 3
 ssize_t find_first_of( size_t pos, const char *str, size_t n ) const; .... 4
 ssize_t find_first_of( size_t pos, const char *str, size_t *nextpos ) const;
 size_t *nextpos ) const; ........................................... 5
 ssize_t find_first_of( size_t pos, const char *str, size_t n, size_t *nextpos ) const; ........................................... 6
 ssize_t find_first_of( const tstring &str ) const; ..................... 7
 ssize_t find_first_of( size_t pos, const tstring &str ) const; ....... 8
 ssize_t find_first_of( size_t pos, const tstring &str, size_t *nextpos ) const;
 size_t *nextpos ) const; ........................................... 9

DESCRIPTION

The find_first_of() member function searches a string inside an object from the left to the
right of the characters contained in the character set str, and then returns the position in
which any of those characters first appears. Please note that the lead position in strings is
always 0.

If pos is specified the search starts from the position pos in a string inside an object.

If n is specified n characters from the beginning of str is a set.

Character sets are sets of characters expressed as a character string in which the order of
characters has no meaning, unlike character strings. For example, if the character set is
"ABC" the function searches for characters that match 'A', 'B' or 'C'.

With tstring.h macros in Table 20 are defined. You will find it useful to set them in str.

<table>
<thead>
<tr>
<th>Macro definition</th>
<th>Corresponding character set</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSET_ALNUM</td>
<td>&quot;0123456789abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSTUVWXYZ&quot;</td>
</tr>
<tr>
<td>CSET_ALPHA</td>
<td>&quot;abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSTUVWXYZ&quot;</td>
</tr>
<tr>
<td>CSET_LOWER</td>
<td>&quot;abcdefghijklmnopqrstuvwxyz&quot;</td>
</tr>
<tr>
<td>CSET_UPPER</td>
<td>&quot;ABCDEFGHIJKLMNOPQRSTUVWXYZ&quot;</td>
</tr>
<tr>
<td>CSET_DIGIT</td>
<td>&quot;0123456789&quot;</td>
</tr>
<tr>
<td>CSET_XDIGIT</td>
<td>&quot;0123456789abcdefABCDEF&quot;</td>
</tr>
</tbody>
</table>

Table 20: Definition of macro constants for use in character sets.

If you want to continuously search for characters or strings nextpos can be used to acquire
the value that should be provided to pos in the next iteration. With a variable referred to
by nextpos if a character is found the position one character to the right of the position in
which the character was found is returned, and if no character is found the string length of
the function itself is returned. If you do not need to acquire a value using nextpos NULL
can also be used.

Apart from the method of specifying the character sets the function operates in the same
manner as the strpbrk() member function (§9.5.53) does. strpbrk() also enables use of
expressions like "[A-Z]" in character sets, and hence you may want to consider using the function.
PARAMETER

[I]  str  Character set to be detected
[I]  n    Number of characters in the character set str
[I]  pos  Position to start detection
[O]  nextpos  pos for use in next search (Used in continuous searches)
(I) : Input, (O) : Output

RETURN VALUE

Non-negative value  :  The position of the character specified or a character contained in the character set.
Negative value (Error)  :  If a character specified or characters contained in the character set are not found.
                       :  If pos has a value larger than the length of a string inside an object specified to it.
                       :  If there is no string inside an object.
                       :  If str is NULL (Member functions 1 to 6).

EXAMPLE-1

The following code searches a string that the object my_str includes from the left for the position in which any character contained in the character set CSET_DIGIT appears, and then prints the result to standard output:

```c
stdstreamio sio;
tstring my_str = "Akari20090306.txt";
ssize_t t_ret = 0;

if ((t_ret = my_str.find_first_of(CSET_DIGIT)) < 0) {
    Error handling
} else {
    sio.printf("%zd\n", t_ret);
}
```

Result of execution

5

EXAMPLE-2

The following code searches a string that the object my_str includes from the left for the position in which any of the character of I, S, A or S appears, and then prints the result to standard output: (This result can be used to identify the difference in the EXAMPLE in §9.5.45)

```c
stdstreamio sio;
tstring my_str = "JAXA/ISAS/AKARI";
ssize_t t_ret = 0;

if ((t_ret = my_str.find_first_of("ISAS")) < 0) {
    Error handling
} else {
    sio.printf("%zd\n", t_ret);
}
```
Result of execution
1

9.5.50  find_last_of()

NAME
find_last_of() — Detects from the right characters contained in a character set

SYNOPSIS

```c
ssize_t find_last_of( const char *str ) const; .......................... 1
ssize_t find_last_of( const char *str, size_t n ) const; ............... 2
ssize_t find_last_of( size_t pos, const char *str ) const; .......... 3
ssize_t find_last_of( size_t pos, const char *str, size_t n ) const; ...... 4
ssize_t find_last_of( size_t pos, const char *str, size_t *nextpos ) const; .......................... 5
ssize_t find_last_of( size_t pos, const char *str, size_t n, size_t *nextpos ) const; ............... 6
ssize_t find_last_of( const tstring &str ) const; .......................... 7
ssize_t find_last_of( size_t pos, const tstring &str ) const; ........... 8
ssize_t find_last_of( size_t pos, const tstring &str, size_t *nextpos ) const; ...................... 9
```

DESCRIPTION

The `find_last_of()` member function searches a string inside an object from the right to the left for the character `ch` or the characters contained in the character set `str`, and returns the position in which any of those characters first appears. The position will be a position from the left of a string. Please note that the lead position in strings is always 0.

If `pos` is specified the search is performed from the position `pos` in a string inside an object to the left.

If `n` is specified `n` characters from the beginning of `str` is a set.

`tstring.h` defines the `CSET_ALNUM`, `CSET_ALPHA`, `CSET_LOWER`, `CSET_UPPER`, `CSET_DIGIT` and `CSET_XDIGIT` that can be used for character sets. For more details of those and an explanation about character sets refer to the descriptions provided in §9.5.49.

If you wish to continuously search for characters or strings `nextpos` can be used to acquire the value that should be provided to `pos` in the next iteration. With a variable referred to by `nextpos` if a character is found when `pos` is 1 or more, the position one character to the left of the position in which the character was found is returned, and otherwise the length of the string itself is returned. If you do not need to acquire a value using `nextpos` NULL can also be used.

Apart from the method of specifying character sets the function operates in the same manner as the `strrbrk()` member function (§9.5.34) does. `strrbrk()` enables use of expressions like "[A-Z]" in character sets, and hence you may want to consider using the function.

PARAMETER

| I | str  | Character set to be detected |
| I | n    | Number of characters in the character set `str` |
| I | pos  | Position to start detection |
| O | nextpos | pos for use in next search (Used in continuous searches) |

RETURN VALUE
Non-negative value : Position of the character specified or a character contained in
a character set.
Negative value (Error) : If a character specified or characters contained in a character
set are not found.
  : If `pos` has a value larger than the length of a string inside an
object specified to it.
  : If there is no string inside an object.
  : If `str` is NULL (Member functions 1 to 6)

EXAMPLE-1
The following code searches a string that the object `my_str` includes from the right for the
position in which the character of either `A`, `S` appears at the end, and then prints the result
to standard output: (This result can be used to identify the difference in the EXAMPLE in
§9.5.47)

```cpp
stdstreamio sio;
tstring my_str = "JAXA/ISAS/NASA";
ssize_t t_ret = 0;
if ((t_ret = my_str.find_last_of("AS")) < 0) {
    Error handling
} else {
    sio.printf("%zd\n", t_ret);
}
```

Result of execution
13

EXAMPLE-2
The following code searches a string that the object `my_str` includes from the right for the
position in which any character contained in the character set `CSET_DIGIT` appears, and then
prints the result to standard output: (This result can be used to identify the difference in
EXAMPLE 2 in §9.5.49)

```cpp
stdstreamio sio;
tstring my_str = "Akari20090306.txt";
ssize_t t_ret = 0;
if ((t_ret = my_str.find_last_of(CSET_DIGIT)) < 0) {
    Error handling
} else {
    sio.printf("%zd\n", t_ret);
}
```

Result of execution
12
9.5.51 find_first_not_of()

NAME

find_first_not_of() — Detects from the left the position of a character not contained in a character set

SYNOPSIS

 ssize_t find_first_not_of( const char *str ) const; ...................... 1
 ssize_t find_first_not_of( const char *str, size_t n ) const; ............. 2
 ssize_t find_first_not_of( size_t pos, const char *str ) const; .......... 3
 ssize_t find_first_not_of( size_t pos, const char *str, size_t n ) const; 4
 ssize_t find_first_not_of( size_t pos, const char *str, size_t *nextpos ) const; ....................... 5
 ssize_t find_first_not_of( size_t pos, const char *str, size_t n, size_t *nextpos ) const; ..................... 6
 ssize_t find_first_not_of( const tstring &str ) const; ................. 7
 ssize_t find_first_not_of( size_t pos, const tstring &str ) const .......... 8
 ssize_t find_first_not_of( size_t pos, const tstring &str, size_t *nextpos ) const; .................... 9
 ssize_t find_first_not_of( int ch ) const; .................................. 10
 ssize_t find_first_not_of( size_t pos, int ch ) const; .................. 11
 ssize_t find_first_not_of( size_t pos, int ch, size_t *nextpos ) const; 12

DESCRIPTION

The find_first_not_of() member function searches a string inside an object from the left to the right for the character other than ch or the characters not contained in the character set str, and then returns the position in which any of those characters first appears. Please note that the lead position in strings is always 0.

If pos is specified the search starts from the position pos in a string inside an object.

If n is specified n characters from the beginning of str is a set.

tstring.h defines the CSET_ALNUM, CSET_ALPHA, CSET_LOWER, CSET_UPPER, CSET_DIGIT and CSET_XDIGIT that can be used for character sets. For more details on those and an explanation about character sets refer to the descriptions provided in §9.5.49.

If you wish to continuously search for characters or strings nextpos can be set to acquire the value that should be provided to pos in the next iteration. With a variable referred to by nextpos if a character is found the position one character to the right of the position in which the character was found is returned, and if no character is found the string length of the function itself is returned. If you do not need to acquire a value using nextpos NULL can also be used.

A method of using the strpbrk() member function (§9.5.53) to specify a character set as expressions like "[^A-Z]" also exists. You may want to consider using the function.

PARAMETER

[I] ch Character to be excluded from detection
[I] str Character set
[I] n Number of characters in the character set str
[I] pos Position to start detection
[O] nextpos pos for use in next search (Used in continuous searches)
RETURN VALUE

Non-negative value : Position of a character other than specified or a character not contained in a character set.

Negative value (Error) : If a character other than specified or characters not contained in a character set are not found.
  : If pos has a value larger than the length of a string inside an object specified to it.
  : If there is no string inside an object.
  : If str is NULL (Member functions 1 to 6).

EXAMPLE

The following code searches a string that the object my_str includes from the left for the position in which a character which is not any of the characters A, J and X appears, and then prints the result to standard output:

```c
stdstreamio sio;
tstring my_str = "JAXA/ISAS";
ssize_t t_ret = 0;

if ((t_ret = my_str.find_first_not_of("AJX")) < 0){
  Error handling
}
else {
  sio.printf("%zd\n", t_ret);
}
```

Result of execution

4

9.5.52  find_last_not_of()

NAME

find_last_not_of() — Detects from the right the position of a character not contained in a character set

SYNOPSIS

```c
ssize_t find_last_not_of( const char *str ) const; ......................... 1
ssize_t find_last_not_of( const char *str, size_t n ) const; .............. 2
ssize_t find_last_not_of( size_t pos, const char *str ) const; .......... 3
ssize_t find_last_not_of( size_t pos, const char *str, size_t n ) const; 4
ssize_t find_last_not_of( size_t pos, const char *str, size_t *nextpos ) const; 5
ssize_t find_last_not_of( size_t pos, const char *str, size_t n, size_t *nextpos ) const; 6
ssize_t find_last_not_of( const tstring &str ) const; .................... 7
ssize_t find_last_not_of( size_t pos, const tstring &str ) const; ....... 8
ssize_t find_last_not_of( size_t pos, const tstring &str, size_t *nextpos ) const; 9
ssize_t find_last_not_of( int ch ) const; .................................. 10
ssize_t find_last_not_of( size_t pos, int ch ) const; .................... 11
ssize_t find_last_not_of( size_t pos, int ch, size_t *nextpos ) const; 12
```
DESCRIPTION

find_last_not_of() member function searches a string inside an object from the right to the left for the character other than ch or the characters not contained in the character set str, and returns the position in which any of those characters first appears. The position will be a position from the left end of a string. Please note that the lead position in strings is always 0.

If pos is specified the search starts from the position pos in a string inside an object to the left.

If n is specified n characters from the beginning of str is a set.

tstring.h defines the CSET_ALNUM, CSET_ALPHA, CSET_LOWER, CSET_UPPER, CSET_DIGIT and CSET_XDIGIT that can be used for character sets. For more details on those and an explanation about character sets refer to the descriptions provided in [9.5.49]

If you want to continuously search for characters or strings nextpos can be used to acquire the value that should be provided to pos in the next iteration. With a variable referred to by nextpos if a character is found when pos is 1 or more the position one character to the left of the position in which the character was found is returned, and otherwise the string length of the function itself is returned. If you do not need to acquire a value using nextpos NULL can also be used.

A method of using the strpbrk() member function ([9.5.51]) to specify a character set as expressions like "[^A-Z]" also exists. You may want to consider using the function.

PARAMETER

[I] ch Character to be excluded from detection
[I] str Character set not included in a string
[I] n Number of characters in the character set str
[I] pos Position to start detection
[O] nextpos pos for use in next search (Used in continuous searches)

RETURN VALUE

Non-negative value : The position of a character other than specified or a character not contained in a character set.

Negative value (Error) : If a character other than specified or characters not contained in a character set are not found.

: If pos has a value larger than the length of a string inside an object specified to it.

: If there is no string inside an object.

: If str is NULL (Member functions 1 to 6).

EXAMPLE

The following code searches a string that the object my_str includes from the right for the position in which a character which is not any of the characters N, A and S appears, and then prints the result to standard output:

```cpp
stdstreamio sio;
tstring my_str = "JAXA/ISAS";
ssize_t t_ret = 0;

if ((t_ret = my_str.find_last_not_of("NASA",3)) < 0) {
    Error handling
```
SLLIB Reference: sli::tstring (class that handles strings) 189

}  
else {  
sio.printf("%zd\n", t_ret);  
}

Result of execution  
5  

9.5.53  strpbrk()

NAME  
strpbrk() — Detects from the left characters contained in a character set

SYNOPSIS  
ssize_t strpbrk( const char *accept ) const;  
ssize_t strpbrk( size_t pos, const char *accept ) const;  
ssize_t strpbrk( size_t pos, const char *accept, size_t *nextpos ) const;  
ssize_t strpbrk( const tstring &accept ) const;  
ssize_t strpbrk( size_t pos, const tstring &accept ) const;  
ssize_t strpbrk( size_t pos, const tstring &accept,  
size_t *nextpos ) const;  

DESCRIPTION  
Searches a string inside an object from the left to the right for the characters contained in the  
character set accept, and returns the position in which any of those characters first appears.  
Please note that the lead position in strings is always 0.

If pos is specified the search starts from the position pos in a string inside an object.

In addition to the features of the find_first_of() member function (§9.5.49), these member  
functions enable accept to be specified as a simple list of characters like "xyz" as well as  
expressions like "[A-Z]" or "[^A-Z]" as in regular expressions. In addition, a character class  
can also be specified inside "[...]". For the character classes that can be specified refer to  
the descriptions provided in §9.5.26.

If you want to continuously search for characters or strings nextpos can be used to acquire  
the value that should be provided to pos in the next iteration. With a variable referred to  
by nextpos if a character is found the position one character to the right of the position in  
which the character was found is returned, and if no character is found the string length of  
the function itself is returned. If you do not need to acquire a value using nextpos NULL  
can also be used.

PARAMETER  
[I]  accept  Character set to be detected  
[I]  pos  Position to start detection  
[O]  nextpos  pos for use in next search (Used in continuous searches)  

RETURN VALUE
Non-negative value : The position of a character specified or a character contained in a character set.
Negative value (Error) : If a character specified or characters contained in a character set are not found.
: If `pos` has a value larger than the length of a string inside an object specified to it.
: If there is no string inside an object.
: If `accept` is NULL.

**EXCEPTION**
If the system failed to secure an internal buffer.

**EXAMPLE**
The following code searches a string that the object `my_str` includes from the left for the position in which any character contained in the character set `[digit:]` appears, and then prints the result to standard output: (This result can be used to verify that the same result as in EXAMPLE 1 in 9.5.49 can be obtained.)

```c
stdstreamio sio;
tstring my_str = "Akari20090306.txt";
ssize_t t_ret = 0;

if ((t_ret = my_str.strpbrk("[[:digit:]]")) < 0) {
    Error handling
} else {
    sio.printf("%zd\n", t_ret);
}
```

Result of execution 5

**9.5.54 strpbrk()**

**NAME**
strpbrk() — Detects from the right characters contained in a character set

**SYNOPSIS**
```
ssize_t strpbrk( const char *accept ) const; .......................... 1
ssize_t strpbrk( size_t pos, const char *accept ) const; .............. 2
ssize_t strpbrk( size_t pos, const char *accept, size_t *nextpos ) const; 3
ssize_t strpbrk( const tstring &accept ) const; .......................... 4
ssize_t strpbrk( size_t pos, const tstring &accept ) const; .............. 5
ssize_t strpbrk( size_t pos, const tstring &accept,
                 size_t *nextpos ) const; .................................... 6
```

**DESCRIPTION**
Searches a string inside an object from the right to the left for the characters contained in the character set `accept`, and then returns the position in which any of those characters first appears. The position will be a position from the left end of a string. Please note that the lead position in strings is always 0.

If `pos` is specified the search starts from the position `pos` in a string inside an object.
In addition to the features of the `find_last_of()` member function ([§9.5.50](#)), these member functions enable `accept` to be specified as a simple list of characters like "xyz" as well as expressions like ":[A-Z]\]" or "[^A-Z]\]" as in regular expressions. In addition, a character class can be specified inside ":[...]." For the character classes that can be specified refer to the descriptions provided in [§9.5.26](#).

If you want to continuously search for characters or strings `nextpos` can be used to acquire the value that should be provided to `pos` in the next iteration. With a variable referred to by `nextpos` if a character is found when `pos` is 1 or more the position one character to the left of the position in which the character was found is returned, and otherwise the string length of the function itself is returned. If you do not need to acquire a value using `nextpos` NULL can also be used.

**PARAMETER**

| [I] accept | Character set to be detected |
| [I] pos    | Position to start detection  |
| [O] nextpos| pos for the next search (Used in continuous searches) |


**RETURN VALUE**

- Non-negative value : The position of a character specified or a character contained in a character set.
- Negative value (Error) : If a character specified or characters contained in a character set are not found.
  - If `pos` has a value larger than the length of a string inside an object specified to it.
  - If there is no string inside an object.
  - If `accept` is NULL.

**EXCEPTION**

If the system failed to secure an internal buffer.

**EXAMPLE**

The following code searches the string `my_str` from the right for the parts with a number, and then lists any such parts found:

```c
stdstreamio sio;
/* 012345678 */
tstring my_str = "Z80A 4MHz";
size_t pos = my_str.length() - 1;
ssize_t fpos;
while ( 0 <= (fpos=my_str.strrbrk(pos, ":[0-9]\], &pos)) ) {
    sio.printf("fpos = %zd nextpos = %zu\n", fpos, pos);
}
```

Result

<table>
<thead>
<tr>
<th>fpos</th>
<th>nextpos</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Also refer to the EXAMPLE in [§9.5.53](#).
9.5.55  strspn()

NAME

strspn() — Inquires from the left side the length of continuous characters contained in a
character set

SYNOPSIS

size_t strspn( const char *accept ) const; ................................. 1
size_t strspn( size_t pos, const char *accept ) const; .................. 2
size_t strspn( size_t pos, const char *accept, size_t *nextpos ) const; . 3
size_t strspn( const tstring &accept ) const; .............................. 4
size_t strspn( size_t pos, const tstring &accept ) const; ............... 5
size_t strspn( size_t pos, const tstring &accept, size_t *nextpos ) const; 6
size_t strspn( int accept ) const; ........................................... 7
size_t strspn( size_t pos, int accept ) const; ............................. 8
size_t strspn( size_t pos, int accept, size_t *nextpos ) const; .......... 9

DESCRIPTION

Searches a string inside an object from the left to the right for the length in which the
character set accept continues, and then returns the length.

If pos is specified the search starts from the position pos in a string inside an object. Please
note that the lead position in strings is always 0.

Member functions 1 to 6 enable accept to be specified as a simple list of characters like
"xyz" as well as expressions like "[A-Z]" or "[^A-Z]" as in regular expressions. In addition,
a character class can be specified inside "[...]". For the character classes that can be
specified refer to the descriptions provided in §9.5.26.

With member functions 1 to 6 if the character set accept is NULL all the characters will be
targeted (Refer to EXAMPLE 3).

If you want to continuously search for characters or strings nextpos can be used to acquire
the value that should be provided to pos in the next iteration. If the return value of this
member function is 1 or more, the position as long as the return value to the right of pos is
returned as the variable referred to by nextpos. If the return value for this member function
is 0 and the position one character to the right of pos is smaller than the length of the string
itself, that value is returned as the variable referred to by nextpos. In any other case than
above the length of the string itself is returned. If you do not need to acquire a value using
nextpos NULL can also be used.

PARAMETER

[I]  accept  Character set to be detected
[I]  pos      Position to start detection
[O]  nextpos  pos for use in next search (Used in continuous searches)

RETURN VALUE

Positive value : The length of which characters contained in a character set continue.
0  : If a character set does not continue from the position to start counting.
    : If pos has a value larger than the length of a string inside an object
    : specified to it.
    : If there is no string inside an object.

EXCEPTION

If the system failed to secure an internal buffer.
EXAMPLE-1
The following code searches a string that the object my_str includes from the left to identify how many consecutive characters consisting of any of the characters A, J and X there are, and then prints the result to standard output:

```c
stdstreamio sio;
tstring my_str = "JAXA/ISAS";
size_t t_ret = 0;

  t_ret = my_str.strspn("AJX");
  if (t_ret == 0) {
    Error handling
  } else {
    sio.printf("%zu\n", t_ret);
  }
```

Result of execution
4

EXAMPLE-2
The following code searches a string that the object my_str includes from the left to identify how many consecutive characters consisting of the characters contained in the character set [:upper:] there are, and then prints the result to standard output:

```c
stdstreamio sio;
tstring my_str = "JAXA/ISAS";
size_t t_ret = 0;

  t_ret = my_str.strspn("[:upper:"]) ("AJX");
  if (t_ret == 0) {
    Error handling
  } else {
    sio.printf("%zu\n", t_ret);
  }
```

Result of execution
4

EXAMPLE-3
The following code performs a search for NULL character sets. It searches a string that the object my_str includes to standard output how many consecutive characters consisting of the characters contained in the character set there are from the second character in the string:

```c
stdstreamio sio;
tstring my_str = "JAXA/ISAS";
const char *c_p = NULL;
size_t t_ret = 0;

  t_ret = my_str.strspn(2, c_p);
```
if (t_ret == 0) {
    Error handling
} else {
    sio.printf("%zu\n", t_ret);
}

Result of execution
7

9.5.56 strrspn()

NAME
strrspn() — Identifies from the right the consecutive length of characters contained in a
character set

SYNOPSIS
size_t strrspn( const char *accept ) const; .......................... 1
size_t strrspn( size_t pos, const char *accept ) const; ............ 2
size_t strrspn( size_t pos, const char *accept, size_t *nextpos ) const; 3
size_t strrspn( const tstring &accept ) const; .......................... 4
size_t strrspn( size_t pos, const tstring &accept ) const; ............ 5
size_t strrspn( size_t pos, const tstring &accept, size_t *nextpos ) const; 6
size_t strrspn( int accept ) const; ................................. 7
size_t strrspn( size_t pos, int accept ) const; ........................ 8
size_t strrspn( size_t pos, int accept, size_t *nextpos ) const; ........ 9

DESCRIPTION
Searches a string inside an object from the right to the left in identifying the consecutive
length of the character set accept, and then returns the length value.

If pos is specified the search starts from the position pos in a string inside an object. Please
note that the lead position in strings is always 0.

Member functions 1 to 6 enable accept to be specified as a simple list of characters like
"xyz" as well as expressions like "[A-Z]" or "[^A-Z]" as in regular expressions. In addition,
a character class can be specified inside "[...]". For the character classes that can be
specified refer to the descriptions provided in §9.5.26.

With member functions 1 to 6 if the character set accept is NULL all the characters are
targeted (Refer to EXAMPLE 3 in §9.5.55).

If you want to continuously search for characters or strings nextpos can be used to acquire
the value that should be provided pos in the next iteration. If the return value for the
member function is 1 or more the position the same length as the return value to the left of
pos is returned as the variable referred to by nextpos. If the return value for this member
function is 0 and the position one character to the left of pos is not a negative number that
value is returned as the variable referred to by nextpos. In any other case than above the
length of the string itself is returned. If you do not need to acquire a value using nextpos
NULL can also be used.

PARAMETER
[I] accept Character set to be detected
[I] pos Position to start detection
[O] nextpos pos for use in next search (Used in continuous searches)
RETURN VALUE

- Positive value: The length of consecutive characters contained in a character set.
- 0: If a character set does not continue from the position to start counting.
- If pos has a value larger than the length of a string inside an object specified to it.
- If there is no string inside an object.

EXCEPTION

If the system failed to secure an internal buffer.

EXAMPLE

The following code searches a string that the object my_str includes from the right for the parts in which a number continues, and then prints the result to standard output:

```c
stdstreamio sio;
size_t pos, len;
/* 012345678 */
tstring my_str = "Z80A 4MHz";

pos = my_str.length() - 1;
do {
    sio.printf("curpos = %zu ", pos);
    len = my_str.strrspn(pos, "[0-9]", &pos);
    sio.printf("ret_len = %zu nextpos = %zu\n", len, pos);
} while ( pos < my_str.length() );
```

Result of execution

```
curpos = 8 ret_len = 0 nextpos = 7
curpos = 7 ret_len = 0 nextpos = 6
curpos = 6 ret_len = 0 nextpos = 5
curpos = 5 ret_len = 1 nextpos = 4
curpos = 4 ret_len = 0 nextpos = 3
curpos = 3 ret_len = 0 nextpos = 2
curpos = 2 ret_len = 2 nextpos = 0
curpos = 0 ret_len = 0 nextpos = 9
```

9.5.57 strcspn()

NAME

strcspn() — Inquires from the left the length of consecutive characters not contained in a character set

SYNOPSIS

```c
size_t strcspn( const char *reject ) const; ......................... 1
size_t strcspn( size_t pos, const char *reject ) const; .............. 2
size_t strcspn( size_t pos, const char *reject, size_t *nextpos ) const; 3
size_t strcspn( const tstring &reject ) const; .......................... 4
size_t strcspn( size_t pos, const tstring &reject, size_t *nextpos ) const; 5
size_t strcspn( size_t pos, const tstring &reject, size_t *nextpos ) const; 6
size_t strcspn( int reject ) const; ...................................... 7
```
size_t strcspn( size_t pos, int reject ) const; .......................... 8
size_t strcspn( size_t pos, int reject, size_t *nextpos ) const; ............ 9

DESCRIPTION
Searches a string inside an object from the left to the right for the length of a consecutive string until the character set `reject` first appears, and then returns the length.

If `pos` is specified the search starts from the position `pos` in a string inside an object. Please note that the lead position in strings is always 0.

Member functions 1 to 6 enable `reject` to be specified as a simple list of characters like "ijk" as well as expressions like "[A-Z]" or "[^A-Z]" as in regular expressions. In addition, a character class can be specified inside "[..]". For the character classes that can be specified refer to the descriptions provided in §9.5.26.

With member functions 1 to 6 if the character set `reject` is NULL the target character set will be all the characters.

If you want to continuously search for characters or strings `nextpos` can be used to acquire the value that should be provided to `pos` in the next iteration. If the return value for the member function is 1 or more the position the same length as the return value to the right of `pos` is returned as the variable referred to by `nextpos`. If the return value for this member function is 0 and the position one character to the right of `pos` is smaller than the length of the string itself that value is returned as the variable referred to by `nextpos`. In any other case than above the length of the string itself is returned. If you do not need to acquire a value using `nextpos` NULL can also be used.

A method of using the `strspn()` member function (§9.5.55) to specify a character set as an expression like "[^A-Z]" also exists, which may want to consider using.

PARAMETER
- [I] `reject` Character set not to be detected
- [I] `pos` Position to start detection
- [O] `nextpos` `pos` for use in next search (Used in continuous searches)

RETURN VALUE
- Positive value : The consecutive length of characters not contained in a character set.
- 0 : If characters not contained in a character set do not continue from the position to start counting.
- : If `pos` has a value larger than the length of a string inside an object specified to it.
- : If there is no string inside an object.

EXCEPTION
If the system failed to secure an internal buffer.

EXAMPLE
The following code searches a string that the object `my_str` includes from the left for the number of consecutive characters until the character '0' appears in the string, and then prints the result to standard output:

```c++
stdstreamio sio;
tstring my_str = "Akari20090309.txt";
int i_ch = '0';
size_t t_ret = 0;
```
```c
if ((t_ret = my_str.strcspn(i_ch)) == 0) {
    Error handling
} else {
    sio.printf("%zu\n", t_ret);
}
```

Result of execution
6

9.5.58  strmatch(), fnmatch(), pnmatch()

**NAME**
strmatch(), fnmatch(), pnmatch() — Attempts Shell-like string matching

**SYNOPSIS**
```c
int strmatch( const char *pat ) const; ............................................. 1
int strmatch( size_t pos, const char *pat ) const; ............................. 2
int strmatch( const tstring &pat ) const; ........................................ 3
int strmatch( size_t pos, const tstring &pat ) const; .......................... 4
int fnmatch( const char *pat ) const; ........................................... 5
int fnmatch( size_t pos, const char *pat ) const; ............................... 6
int fnmatch( const tstring &pat ) const; .......................................... 7
int fnmatch( size_t pos, const tstring &pat ) const; ............................ 8
int pnmatch( const char *pat ) const; ............................................ 9
int pnmatch( size_t pos, const char *pat ) const; ................................ 10
int pnmatch( const tstring &pat ) const; ........................................ 11
int pnmatch( size_t pos, const tstring &pat ) const; ........................... 12
```

**DESCRIPTION**
Attempts string matching on a string inside an object using Shell wild card patterns, and then returns the result.

strmatch() attempts matching with the character pattern pat, from the position pos in a string inside an object to the right. The string matching is attempted within the range of up to where '\0' appears at the end of the string (When the newline character '\n' does appear the processing still does not terminate). If pos is not specified searches are made from the left end of a string inside an object. Please note that the lead position in strings is always 0.

Wild cards available for pat can be specified using '*' and '?' and expressions like "[A-Z]" as in regular expressions\(^\text{11}\). In addition, a character class can be specified inside "\[..\]". For the character classes that can be specified refer to the descriptions provided in §9.5.26.

fnmatch() provides strmatch() with the restriction of treating the period '.' at the beginning of a string in a special manner. With this member function wild cards '*' and '?' do not match the period '.' at the beginning of a string. This member function assumes use in searches for file names. In addition, pnmatch() treats slash '/' and the period immediately following a slash in a special manner. This member function assumes use in searches for path names.

\(^\text{11}\) The interval "{}", back reference "\n", repetition expression "*" and character set "\w" cannot be used.
PARAMETER
[I]  pat  Character pattern
[I]  pos  Position to start string matching
([I]: Input, [O]: Output)

RETURN VALUE
0  :  If a string inside an object matches pat.
Negative value (Error)  :  If a string inside an object does not match pat
:  If pos has a value larger than the length of a string inside an
object specified to it (Member functions 2, 4, 6, 8, 10, and 12).
:  If there is no string inside an object.
:  If pat is NULL.

EXAMPLE
The following code inquires whether a string that the object my_str includes matches the
character pattern *.txt, and then outputs the result to standard output:

```c
stdstreamio sio;
tstring my_str = "./Akari20090309.txt";
if (my_str.strmatch("*.txt") != 0) {
    sio.printf("The character string is not shown by "/"*.txt"/./n");
} else {
    sio.printf("The character string is shown by "/"*.txt"/./n");
}
```

Result of execution
The character string is shown by "/*.txt".

9.5.59  regmatch()

NAME
regmatch() — Attempts string matching using extended regular expression

SYNOPSIS
```c
ssize_t regmatch( const char *pat, size_t *ret_span ) const; .................. 1
ssize_t regmatch( size_t pos, const char *pat, size_t *ret_span ) const; 2
ssize_t regmatch( size_t pos, const char *pat, size_t *ret_span,
    size_t *nextpos ) const; ........................................... 3
ssize_t regmatch( const tstring &pat, size_t *ret_span ) const; ........... 4
ssize_t regmatch( size_t pos, const tstring &pat, size_t *ret_span,
    size_t *nextpos ) const; ........................................... 5
ssize_t regmatch( size_t pos, const tregex &pat, size_t *ret_span ) const; 6
ssize_t regmatch( const tregex &pat, size_t *ret_span ) const; ............ 7
ssize_t regmatch( size_t pos, const tregex &pat, size_t *ret_span ) const; 8
ssize_t regmatch( size_t pos, const tregex &pat, size_t *ret_span,
    size_t *nextpos ) const; ........................................... 9
```

DESCRIPTION
Attempts string matching of a string inside an object that uses a POSIX Extended Regular
Expression (hereinafter referred to regular expression), and then returns the result.
Back reference information cannot be obtained with these member functions. If you wish to acquire the back reference information use of the regassign() member function for the tarray_tstring class §10.4.13 is recommended.

Member functions 1 to 6 compile the regular expression \texttt{pat}, saves the result to an internal buffer that the functions encompass, and then perform the matching (If \texttt{pat} is the same as that previously compiled it is not recompiled again).

Member functions 7 to 9 specify the object for the tregex class retaining the result of compiling the regular expression. The regular expression therefore needs to be compiled in advance using the compile() member function for the tregex class before using the regmatch() member function (Refer to EXAMPLE-2).

In both cases if the function fails to compile the regular expression it outputs the content to standard error output.

String matching is attempted from position \texttt{pos} in a string inside an object to the right. The string matching is attempted within the range of up to where ‘\0’ appears at the end of the string (When the newline character ‘\n’ appears processing still does not terminate). If \texttt{pos} is not specified searches are made from the left end of a string inside an object. Please note that the lead position in strings is always 0.

The length of the matching string is returned to \*\texttt{ret_span}. If you do not need information on the length of the string that matches NULLL can be used in \texttt{ret_span}.

If you want to continuously search for characters or strings \texttt{nextpos} can be used to acquire the value that should be provided to \texttt{pos} in the next iteration. If \texttt{pat} matches a string and the length \(l\) of that matching string is 1 or more the position the same length as \(l\) to the right of the position of the matching string is returned as the variable referred to by \texttt{nextpos}. If the length of the matching string is 0 and the position one character to the right of the position of the matching string that is smaller than the length of the string itself that value is returned as the variable referred to by \texttt{nextpos}. In any other case than above the length of the string itself +1 is returned. If you do not need to acquire a value using \texttt{nextpos} NULL can also be used.

The basic unit of regular expressions is a regular expression that matches a single character. The methods of expressing strings for regular expression that are available for use with the character pattern \texttt{pat} are as shown in Table 21.

A character class can be specified inside lists. For the character classes that can be specified refer to the descriptions provided in §9.5.26. If you want the character "\" to be included in the targets for matching it must be positioned at the beginning of the list. The character "\" must also be positioned other than the beginning of a list, while the character "\" must be placed at the end of a list.

A back reference, when "\" is followed by a decimal value character \(n\) that is not 0, matches the string that is the same as the sequence of characters matching the \(n\)th character in a parenthesized subexpression. The numbering for subexpressions is performed from the characters in which the position of an open parenthesis "(" is to the left toward the characters in which the position of the parenthesis is to the right. For example, the string "\texttt{abc:def::abc:deff}" matches the character pattern "((\w+):((\w+)::\1:\2)."
Table 21: List of methods of expressing strings for regular expressions.

<table>
<thead>
<tr>
<th>Expression of a string for regular expression</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;.&quot;</td>
<td>Any single character other than a newline character</td>
</tr>
<tr>
<td>&quot;[. . . ]&quot;</td>
<td>Single character contained in a list (referring to &quot;[. . . ]&quot;)</td>
</tr>
<tr>
<td>&quot;[^. . . ]&quot;</td>
<td>Single character not contained in a list</td>
</tr>
<tr>
<td>&quot;a</td>
<td>b&quot;</td>
</tr>
<tr>
<td>&quot;(ab)&quot;</td>
<td>Matches “ab” group</td>
</tr>
</tbody>
</table>
| "\w"                                         | Alphanumeric character (Equivalent to character class 
|                                               | [[:alnum:]]) |
| "\W"                                         | Other than alphanumeric character (Equivalent to ^[[:alnum:]]]) |
| "^"                                           | Beginning of a pattern line |
| "$"                                           | End of pattern line |
| "\\"                                        | Null string at the beginning of a word |
| "\\>"                                        | Null string at the end of a word |
| "\\b"                                        | Null string beside a word |
| "\\B"                                        | Null string other than beside a word |
| "?"                                           | Repetition of previous character 0 times or once |
| "*"                                           | Repetition of previous character 0 times or more |
| "+"                                           | Repetition of previous character once or more |
| "{n}"                                        | Repetition of previous character n times |
| "{n,}"                                       | Repetition of previous character more than n times |
| "{n,m}"                                      | Repetition of previous character more than n times but less than m times |
| "\\n"                                        | Back reference |

[I] pos Position to start string matching
[I] pat Character pattern (regular expression) or compiled object for the tregex class
[O] ret_span Length of matching string
[O] nextpos pos for use in next search (Used in continuous searches)
Non-negative : Position of a string inside an object that matches \textit{pat}.
Negative value (Error) : If no string matches \textit{pat}.
  : If there is not a string inside an object.
  : If \textit{pos} has a value larger than the length of a string inside an object specified to it.
  : If \textit{pat} is \texttt{NULL}.
  : If the interval operators \{\} are not closed.
  : If the list operators \[\] are not closed.
  : If an unknown character class is set. [For example use of \texttt{[:up:]}.]
  : If a regular expression ends with a backslash.
  : If the group operators (\() are not closed.
  : If operators are used with an invalid range. [For example use of \texttt{[9-0:]}.]
  : If an invalid back reference to the subexpression \(\ldots\) is used.
  : If an invalid back reference operator is used.
  : If invalid use of pattern operators such as groups and lists are made. [For example use of \texttt{[0-9].}]
  : If an invalid repetition operator is used such that \(\star\) is the first character. [For example use of \texttt{pat="*.txt"}.

\textbf{EXCEPTION}

If the \texttt{regex} routine exhausted the memory.
If the system failed to secure an internal buffer.
If the system encountered any corrupt memory.

\textbf{EXAMPLE-1}

The following code searches a string that the object \texttt{my\_str} includes for the position of a string with four consecutive numbers with the character pattern \texttt{[[[:digit:]][4]]} in performing string matching. The result is then output to standard output:

\begin{verbatim}
#include <iostream>
#include <string>
#include <regex>
#include <sstream>

std::stringstream sio;
tstring my_str = "User ID : 1234";
size_t t_span = 0;
ssize_t t_ret = 0;

if ((t_ret = my_str.regmatch("[[[:digit:]][4]]", &t_span)) < 0) {
    Error handling
} else {
    sio.printf("%zd, %zu\n", t_ret, t_span);
}
\end{verbatim}

Result of execution
10,4

\textbf{EXAMPLE-2}

The following code performs the same processing as in EXAMPLE-1 but with the difference that a regular expression is compiled in advance before \texttt{regmatch()} is used. Regular expressions are compiled using the \texttt{compile()} member function, as seen in \texttt{my\_pat.compile("[[[:digit:]][4]]").} Any errors in the compilation processing are checked for using \texttt{cregex()}.
stringstream sio;
regex  my_pat;
tstring my_str = "User ID : 1234";
size_t  t_span = 0;
ssize_t t_ret = 0;

my_pat.compile("[[:digit:]]{4}");  // The regular expression is compiled here */
if ( my_pat.cregex() == NULL ) {
    /* Error handling: Failed to compile the regular expression */
}
if ((t_ret = my_str.regmatch(my_pat, &t_span)) < 0) {
    /* Error handling */
}
else {
    sio.printf("%zd, %zu\n", t_ret, t_span);
}
my_pat.init();           // Discard the result of compilation */
10 TARRAY_TSTRING class

The tarray_tstring class enables users to easily handle string arrays. Individual elements of an array can be the object for the tstring class (§9), and combined with tstring class APIs to provide string array APIs that are easy to use.

The class has the following characteristics:

- Memory is automatically secured, so that objects can be assigned immediately after being created.

- Pointer arrays (NULL-terminated) can be acquired to a string at any time, making it easy for functions in libc such as `execvp()` to be used.

- The notation for `printf()` can be used with many of the member functions.

- A wealth of the member functions for the tstring class (§9) are available for use through [] or at() member function.

- Easily divides space-delimited, TAB-delimited or CSV-format strings and arrays them.

- Member functions that enable users to edit all the elements of strings for arrays in one stroke are also available (e.g., `chomp()`, `trim()` etc). Those functions can be used in the same manner as with the tstring class (§9).

- Provides the APIs for the search processing arrays that include POSIX Extended Regular Expressions.

If you wish to use the tarray_tstring class you must add “#include <sli/tarray_tstring.h>” to the code. In addition, if you also need to declare a namespace (§4.1) you must also add “using namespace sli;” to the code.

The following is a simple example of using the class.

```c
#include <sli/stdstreamio.h>
#include <sli/asarray_tstring.h>
using namespace sli;

int main()
{
    stdstreamio sio;
    tarray_tstring my_arr;
    size_t i=0;
    my_arr[i++] = "MacOSX"; /* Assign "MacOSX" to the element 0 */
    my_arr[i++].printf("Linux"); /* Assign "Linux" to the element 1 */
    my_arr.at(i).printf("Solaris"); /* Assign "Solaris" to the element 2 */
    for ( i=0 ; i < my_arr.length() ; i++ ) { /* Display all the elements */
        sio.printf("%zu ... [%s]\n", i, my_arr.cstr(i));
    }
}
```

Result of execution

0 ... [MacOSX]
1 ... [Linux]
2 ... [Solaris]
10.1 Creating objects

There are the three methods of providing objects with an initial value\(^\text{12)}\).

The first method does not need any arguments to be specified.

\[
\text{tarray\_tstring my\_arr0;}
\]

With this neither a buffer for the string nor a buffer for the pointer array is secured.

The second method provides objects with a default value using a variable-length argument.

\[
\text{tarray\_tstring my\_arr0("tokyo", "osaka", "nagoya", NULL);}
\]

With this the array is initialized by the string it is given provided with. NULL must always be provided at the end of the argument.

The third method provides a NULL-terminated pointer array of the \text{char *[]} type. For example, the main() function can simply be provided with \text{argv}.

\[
\text{tarray\_tstring my\_arr0(argv);}
\]

With this the array inside the object is initialized by the string array \text{argv} that is provided.

10.2 List of member functions

Table 22 lists the member functions.

<table>
<thead>
<tr>
<th>Name of member function</th>
<th>Feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>[]</td>
<td>Reference to a string object in a specified element</td>
</tr>
<tr>
<td>=</td>
<td>Assigns string arrays</td>
</tr>
<tr>
<td>+=</td>
<td>Addition of string arrays</td>
</tr>
<tr>
<td>+=</td>
<td>Addition of string elements</td>
</tr>
<tr>
<td>length()</td>
<td>Length of string array (number of strings) or length of value string</td>
</tr>
<tr>
<td>cstrarray()</td>
<td>The address of a pointer array (NULL-terminated) for a value string</td>
</tr>
<tr>
<td>cstr(), c_str()</td>
<td>Address for a value string in a specified element</td>
</tr>
<tr>
<td>at(), at_cs()</td>
<td>Reference to a string object in a specified element</td>
</tr>
<tr>
<td>dprint()</td>
<td>Outputs information on objects to standard error output (For debugging user programs)</td>
</tr>
<tr>
<td>copy()</td>
<td>Copies (part of) arrays to an external object</td>
</tr>
<tr>
<td>swap()</td>
<td>Interchange of objects</td>
</tr>
<tr>
<td>init()</td>
<td>Complete initialization of objects</td>
</tr>
<tr>
<td>assign(), assignf()</td>
<td>Initialization and assignment of objects (Specifies a single string)</td>
</tr>
<tr>
<td>assign(), vassign()</td>
<td>Initialization and assignment of objects (Specifies multiple strings or a string array)</td>
</tr>
<tr>
<td>explode()</td>
<td>Divides a string in an argument and assigns it to an array (simple &amp; fast)</td>
</tr>
<tr>
<td>split()</td>
<td>Divides a string in an argument and assigns it to an array (advanced edition)</td>
</tr>
<tr>
<td>regassign()</td>
<td>Performs regular expression matching on strings in an argument, and assigns the result to an array</td>
</tr>
<tr>
<td>put(), putf()</td>
<td>Sets n pieces of a string to any element position</td>
</tr>
<tr>
<td>put(), vput()</td>
<td>Sets multiple strings or a string array to any element position</td>
</tr>
<tr>
<td>append(), appendf()</td>
<td>Addition of elements (Specifies a single string)</td>
</tr>
<tr>
<td>append(), vappend()</td>
<td>Addition of elements (Specifies multiple strings or a string array)</td>
</tr>
</tbody>
</table>

Table 22: List of member functions available for use with the tarray\_tstring class (Continued on next page)

\(^{12)}\) The class does not include the operating modes the tstring class \((9)\) does.
<table>
<thead>
<tr>
<th>Name of member function</th>
<th>Feature</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>insert()</code>, <code>insertf()</code></td>
<td>Insertion of elements (Specifies a single string)</td>
</tr>
<tr>
<td><code>insert()</code>, <code>vinsert()</code></td>
<td>Insertion of elements (Specifies multiple strings or a string array)</td>
</tr>
<tr>
<td><code>replace()</code>, <code>replacef()</code></td>
<td>Replacement of elements (Specifies a single string)</td>
</tr>
<tr>
<td><code>replace()</code>, <code>vreplace()</code></td>
<td>Replacement of elements (Specifies multiple strings or a string array)</td>
</tr>
<tr>
<td><code>erase()</code></td>
<td>Deletion of elements</td>
</tr>
<tr>
<td><code>clean()</code></td>
<td>Pads all the element values for an existing array with any string</td>
</tr>
<tr>
<td><code>resize()</code></td>
<td>Changes the length of an array</td>
</tr>
<tr>
<td><code>resizeby()</code></td>
<td>Relatively changes the length of an array</td>
</tr>
<tr>
<td><code>crop()</code></td>
<td>Cropping of arrays</td>
</tr>
<tr>
<td><code>chomp()</code></td>
<td>Elimination of newline characters in all the elements</td>
</tr>
<tr>
<td><code>trim()</code></td>
<td>Elimination of spaces at both ends of all the elements</td>
</tr>
<tr>
<td><code>ltrim()</code></td>
<td>Elimination of a space at the left end of all the elements</td>
</tr>
<tr>
<td><code>rtrim()</code></td>
<td>Elimination of a space at the right end of all the elements</td>
</tr>
<tr>
<td><code>strreplace()</code></td>
<td>String search and replacement of all the elements</td>
</tr>
<tr>
<td><code>regreplace()</code></td>
<td>String search and replacement of all the elements using a regular expression</td>
</tr>
<tr>
<td><code>tolower()</code></td>
<td>Replaces the uppercase version of characters of all the elements with the lowercase version</td>
</tr>
<tr>
<td><code>toupper()</code></td>
<td>Replaces the lowercase version of characters of all the elements with the uppercase version</td>
</tr>
<tr>
<td><code>expand_tabs()</code></td>
<td>Replaces TAB characters in all the elements with a white space character</td>
</tr>
<tr>
<td><code>contract_spaces()</code></td>
<td>Replaces white space characters in all the elements with a TAB character</td>
</tr>
<tr>
<td><code>find_elem()</code></td>
<td>Searches from the left side (beginning) of an array element</td>
</tr>
<tr>
<td><code>rfind_elem()</code></td>
<td>Searches from the right side (end) of an array element</td>
</tr>
<tr>
<td><code>find()</code></td>
<td>Searches an array from the left side (beginning) for a string</td>
</tr>
<tr>
<td><code>rfind()</code></td>
<td>Searches an array from the right side (end) for a string</td>
</tr>
<tr>
<td><code>find_matched_str()</code></td>
<td>Searches for an element (string) that matches a pattern</td>
</tr>
<tr>
<td><code>find_matched_fn()</code></td>
<td>Searches for an element (file name) that matches a pattern</td>
</tr>
<tr>
<td><code>find_matched_pn()</code></td>
<td>Searches for an element (path name) that matches a pattern</td>
</tr>
<tr>
<td><code>regmatch()</code></td>
<td>Searches for a string using an extended regular expression</td>
</tr>
<tr>
<td><code>regmatch()</code></td>
<td>Searches for a string using an extended regular expression</td>
</tr>
</tbody>
</table>

Table 22: List of member functions available for use with the tarray_tstring class (Continued from previous page)
10.3 Operators

10.3.1 []

NAME
[] — Reference to a string object in a specified element

SYNOPSIS

tstring &operator[]( size_t index ); ......................................................... 1
const tstring &operator[]( size_t index ) const; ........................................ 2

DESCRIPTION

Returns a reference to an array element (tstring class object (§9)) specified by an index. “[]” can be immediately followed by “.” to enable use of the tstring class member functions (§9) (In the EXAMPLE the “=” operator and the tstring class cstr() member function are used).

Member function 1 is for both reading and writing, and operates in the same manner as at() does. Member function 2 is for reading only, and operates in the same manner as at_cs() does.

If index has a value larger than the length of an array specified to it, with member function 1 the length of the array is automatically extended, but with member function 2 an exception occurs. Please note that the element number for the first element of arrays is always 0.

Whether member function 1 or 2 is used is automatically determined by the presence or absence of the “const” attribute of an object. Member function 1 is automatically selected if the object does not have a “const” attribute and member function 2 if it does.

For more details on at(), and at_cs() refer to §10.4.1.

PARAMETER

[I] index Element numbers starting from 0

RETURN VALUE

Reference to the array element specified by an index

EXCEPTION

If the system failed to secure an internal buffer (Member function 1).
If index has a value larger than the length of an array specified to it (Member function 2).

EXAMPLE

The following code adds the string "camellia" to the string array object my_arr using the operators “[]”, and then prints the result to standard output. Refer to the descriptions provided in §10.4.1 for more details on length().

```c
stdinstreamio sio;

tarray_tstring my_arr("hawthorn", "oak", NULL);
my_arr[2] = "camellia";

/* Display */
for ( size_t i=0 ; i < my_arr.length() ; i++ ) {
    sio.printf("[%s]\n", my_arr[i].cstr());
}
```
Result of execution
[hawthorn]
[oak]
[camellia]

10.3.2 =

NAME
= — Assigns string arrays

SYNOPSIS

tarray_tstring &operator=(const tarray_tstring &obj); ...................... 1
const char *const *operator=(const char *const *elements); ................. 2

DESCRIPTION
Assignes object or string array specified on the right-hand side (argument) of the operator to itself.

PARAMETER
[I] obj tarray_tstring class object
[I] elements Address of pointer array for a string (NULL-terminated)

RETURN VALUE
Reference to itself (member function 1)
Pointer array to internal string buffer (member function 2)

EXCEPTION
If the system failed to secure an internal buffer.
If the system encountered any corrupt memory (member function 1)

EXAMPLE
The following code assigns the content of the pointer array menu as a string array to the string array object my_arr using the operator “=“, and then prints the result to standard output. Refer to the respective descriptions provided in §10.4.3 and §10.4.1 for more details on cstr() and length().

```c
stdstreamio sio;

const char *menu[] = {"rice ball", "sushi", "tofu", NULL};
tarray_tstring my_arr;
my_arr = menu; /* '=' is the operator for the tarray_tstring class */

/* Display */
for ( size_t i=0 ; i < my_arr.length() ; i++ ) {
    sio.printf("[%s]\n", my_arr.cstr(i));
}
```

Result of execution
[rice ball]
[sushi]
[tofu]
10.3.3  +=

NAME
+=  — Addition of string arrays

SYNOPSIS

tarray_tstring &operator+=(const tarray_tstring &obj); .......................... 1
const char *const *operator+=(const char *const *elements); ....................... 2

DESCRIPTION
Adds to a string array the string array specified on the right (argument) of the operator.

PARAMETER
[I]  obj         tarray_tstring class object
[I]  elements   Address of pointer array for a string (NULL-terminated)

RETURN VALUE
Reference to itself (member function 1)
Pointer array to an internal string buffer (member function 2)

EXCEPTION
If the system failed to secure an internal buffer.
If the system encountered any corrupt memory (member function 1).

EXAMPLE
The following code adds the string array addTree to the string array object my_arr using
the operator “+=”, and then prints the result to standard output. Refer to the respective
descriptions provided in §10.4.3 and §10.4.1 for more details on cstr() and length().

```c
stdafxio sio;

tarray_tstring my_arr("ginkgo", "Japanese apricot", "maple", NULL);

const char *addTree[] = {"oak", "cherry tree", NULL};
my_arr += addTree;

/* Display */
for ( size_t i=0 ; i < my_arr.length() ; i++ ) {
    sio.printf("[%s]\n", my_arr.cstr(i));
}
```

Result of execution
[ginkgo]
[Japanese apricot]
[maple]
[oak]
[cherry tree]

10.3.4  +=

NAME
+=  — Addition of string elements
SYNOPSIS

tarray_tstring &operator+=(const char *str); .................................................. 1
tarray_tstring &operator+=(const tstring &str); .................................................. 2

DESCRIPTION
Adds to a string array the string specified on the right (argument) of the operator.

PARAMETER
[1] str Address for string (Member function 1)
tstring class object (Member function 2)

RETURN VALUE
Reference to itself

EXCEPTION
If the system failed to secure an internal buffer.

EXAMPLE
The following code adds the string "wisteria" to the string array object my_arr using the operator "+=", and then prints the result to standard output. Refer to the respective descriptions provided in §10.4.3 and §10.4.1 for more details on cstr() and length().

```c
stdstreamio sio;

tarray_tstring my_arr("nandina", "elm", NULL);
my_arr += "wisteria";

/* Display */
for ( size_t i=0 ; i < my_arr.length() ; i++ ) {
    sio.printf("[%s]\n", my_arr.cstr(i));
}
```

Result of execution
[nandina]
[elm]
[wisteria]

10.4 The member functions

General information
The size_t type handles numerical values as unsigned integer numbers. Providing a negative value to a member function that has the size_t type as the argument increases the likelihood of the program aborting. Ensure not to set a negative value.

10.4.1 length()

NAME
length() — Length of a string array (number of arrays) or the length of a value string

SYNOPSIS

size_t length() const; .............................................................. 1
size_t length( size_t index ) const; ........................................... 2
DESCRIPTION
Returns the length of a string array (number of arrays) (member function 1).
If index is specified it returns the length of a string in the element corresponding to the
element number in an argument (member function 2). Please note that the element number
for the first element of arrays is always 0.

RETURN VALUE
The number of string arrays (member function 1), or length of a string in the specified
element (member function 2)

EXAMPLE
The following code prints to standard outputs the number of arrays in the string array object
my_arr, and the length of the string in each of the elements. Refer to the description provided
in §10.4.4 for more details on at().

```c
stdstreamio sio;

tarray_tstring my_arr;
my_arr.at(0).printf("Hello");
my_arr.at(1).printf("Hoge");

sio.printf("my_arr length = %zu\n",my_arr.length());
for ( size_t i = 0 ; i < my_arr.length() ; i++ ) {
    sio.printf("my_arr index%zu length = %zu\n",i, my_arr.length(i));
}
```

Result of execution
my_arr length = 2
my_arr index0 length = 5
my_arr index1 length = 4

10.4.2 cstrarray()

NAME
cstrarray() — Address of pointer array (NULL-terminated) for a value string

SYNOPSIS
const char *const *cstrarray() const;

DESCRIPTION
Returns the address of of the pointer array for a string for each element. Pointer arrays are
always NULL-terminated.

RETURN VALUE
Pointer array (NULL-terminated) to a string buffer

EXAMPLE
The following code assigns tmp to the string array object my_arr, acquires the address of the
pointer array for the string, and then prints the content of each of the elements to standard
output:
stdstreamio sio;

/* Initialization of the object */
const char *tmp[] = {"linux", "windows", "mac", NULL};
tarray_tstring my_arr(tmp);

/* Acquire the address for the pointer array for the string */
const char *const *ptr = my_arr.cstrarray();
if ( ptr != NULL ) {
    int i;
    for ( i=0 ; ptr[i] != NULL ; i++ ) {
        sio.printf("%d ... [%s]\n", i, ptr[i]);
    }
}

Result of execution
0 ... [linux]
1 ... [windows]
2 ... [mac]

An example of using the execvp function with the cstrarray() member function is provided in §3.4.3.

10.4.3 cstr(), c_str()

NAME
cstr(), c_str() — Address of value string in a specified element

SYNOPSIS
    const char *cstr( size_t index ) const; ........................................... 1
    const char *c_str( size_t index ) const; ......................................... 2

DESCRIPTION
Returns the beginning address of the element specified by index of a string array. If index has a value larger than the length of an array specified to it NULL is returned. Please note that the element number for the first element of arrays is always 0.

cstr() and c_str() have different names but operate in the same manner.

RETURN VALUE
Beginning address of an element of a string array

EXAMPLE
The following code assigns tmp to the string array object my_arr, acquires the beginning address of each element of my_arr, and then prints the content to standard output:

```c
stdstreamio sio;

/* Initialization of the object */
const char *tmp[] = {"linux", "windows", "mac", NULL};
tarray_tstring my_arr(tmp);

/* Display */
```
for ( size_t i=0 ; i < my_arr.length() ; i++ ) {
    sio.printf("[%s]\n", my_arr.cstr(i));
}

Result of execution
[linux]
[windows]
[mac]

10.4.4 at(), at_cs()

NAME
at(), at_cs() — Reference to a string object in a specified element

SYNOPSIS

```cpp
tstring &at( size_t index ); ......................................................... 1
const tstring &at( size_t index ); const ........................................ 2
const tstring &at_cs( size_t index ) const; ..................................... 3
```

DESCRIPTION

Returns a reference to the array element (tstring class object (§ 9)) specified by `index`. These member functions can be immediately followed by “.” to enable use of the tstring class member functions (§ 9) (In the EXAMPLE the tstring class cstr() member function is used). Please note that the element number for the first element of arrays is always 0.

Member function 1 is for both reading and writing strings, while member functions 2 and 3 are for reading only.

With the at() member function whether member function 1 or 2 is used is automatically determined by the presence or absence of the “const” attribute for an object. Member function 1 is automatically selected if the object does not have a “const” attribute while member function 2 is if it does.

With member function 1 `index` being larger than the length of the specified array results in a new array element being created and "" (zero-length string) being assigned. No exceptions occur unless the system fails to secure a buffer.

With member functions 2 and 3 `index` being larger than the length of the specified array results in an exception occurring.

PARAMETER

<table>
<thead>
<tr>
<th>[I]</th>
<th>index</th>
<th>Element number</th>
</tr>
</thead>
</table>

RETURN VALUE

Reference to the string (tstring) object corresponding to specified element number

EXCEPTION

- If the system failed to secure an internal buffer (Member function 1)
- If an `index` larger than the length of an array is specified (Member functions 2 and 3)

EXAMPLE

The following code assigns a string to the element with element number 0 of string array `my_arr`, and then prints the content of element numbers 0 and 1 of `my_arr` to standard output:
```cpp
std::iostream sio;

tarray_tstring my_arr;
my_arr.at(0) = "Hello";
sio.printf("my_arr[0] = %s\n", my_arr.at(0).cstr());
sio.printf("my_arr[1] = %s\n", my_arr.at(1).cstr());

Result of execution

my_arr[0] = Hello
my_arr[1] =
```

### 10.4.5 dprint()

**NAME**
dprint() — Outputs object information to standard error output (For user debugging)

**SYNOPSIS**
void dprint() const;

**DESCRIPTION**
Outputs object information to standard error output.
Member function designed for debugging user programs.

**EXAMPLE**
The following code outputs the information of the object `my_array` to standard error output. The result of execution results in the address for the object displayed in [], and will depend on the environment:

tarray_tstring my_array("MZ-80B", "MZ-2861", "X1C", "X1 turboZ", NULL);
my_array.dprint();

**Result of execution**
`sli::tarray_tstring[0x7fbffff3e0] = {"MZ-80B", "MZ-2861", "X1C", "X1 turboZ"}
```

### 10.4.6 copy()

**NAME**
copy() — Copies (part of) string arrays to another string array

**SYNOPSIS**
ssize_t copy( tarray_tstring *dest ) const; ................................. 1
ssize_t copy( size_t index, tarray_tstring *dest ) const; .................. 2
ssize_t copy( size_t index, size_t n, tarray_tstring *dest ) const; ...... 3

**DESCRIPTION**
Copies all or part of string arrays to the other string array object `dest`. The return value is the number of elements to be written to `dest`.

Member functions 1 copies all string arrays to `dest`.

Member functions 2 and 3 copy elements starting from the element number `index` of string arrays. Please note that the element number for the first element of arrays is always 0. In addition, member functions 3 enables you to specify the number `n` of elements to be copied.
If the value of `index + n` is larger than the number of elements to copy only the elements from the index position through to the last element are then copied. If the value of `index` is larger than the number of elements to copy the content of `dest` is erased, and the return value will be -1.

**PARAMETER**

- `[O] dest` tarray_tstring class object to copy to
- `[I] index` Position of an array element in an object to copy from
- `[I] n` Number of elements to be copied

**RETURN VALUE**

- Non-negative value : Number of elements copied
- Negative value (Error) : If `index` has a value larger than the length of a string array specified to it.

**EXAMPLE**

The following code copies two elements starting from element number 2 of the string array `my_menu` to the string array `dest_arr`, and then prints the content of `dest_arr` to standard output:

```cpp
stdstreamio sio;

tarray_tstring my_menu("pickles", "natto", "tempura", "sukiyaki", NULL);
tarray_tstring dest_arr;

my_menu.copy(2, 2, &dest_arr);
for ( size_t i = 0 ; i < dest_arr.length() ; i++ ) {
    sio.printf("dest_arr[%zu] = %s\n", i, dest_arr.cstr(i));
}
```

Result of execution

```
dest_arr[0] = tempura
dest_arr[1] = sukiyaki
```

---

### 10.4.7 swap()

**NAME**  
swap() — Interchanging of string array objects

**SYNOPSIS**

```cpp
tarray_tstring &swap( tarray_tstring &sobj );
```

**DESCRIPTION**

Interchanges the content of the string array object `sobj` with the content of its own.

**PARAMETER**

- `[I/O] sobj` tarray_tstring class object to be interchanged

RETURN VALUE
Reference to itself

EXAMPLE
The following code interchanges the string array myMenu_arr with the string array myTree_arr, and then prints the result to standard output:

```c
stringstream sio;

tarray_tstring myMenu_arr("rice ball", "sushi", "tofu", NULL);
tarray_tstring myTree_arr("Pine", "Ginkgo", "Magnolia", NULL);

myMenu_arr.swap(myTree_arr);
for ( size_t i = 0 ; i < myMenu_arr.length() ; i++ ) {
    sio.printf("myMenu_arr[%zu] = %s\n", i, myMenu_arr.cstr(i));
}
```

Result of execution
myMenu_arr[0] = Pine
myMenu_arr[1] = Ginkgo

10.4.8 init()

NAME
init() — Complete initialization of objects

SYNOPSIS
```c
tarray_tstring &init(); ................................................................. 1
tarray_tstring &init(const tarray_tstring &obj); ............................. 2
```

DESCRIPTION
Initializes string arrays.
Member function 1 completely initializes string arrays. The memory area allocated to the array and string buffer of a string array object then gets entirely released, and hence execution of the cstrarray() member function (§10.4.2) returns NULL.

Member function 2 initializes objects with the content of obj (copies all the content of obj to itself).

PARAMETER
[I]  obj  tarray_tstring class object

RETURN VALUE
Reference to itself

EXCEPTION
If the system failed to secure an internal buffer.
If the system encountered any corrupt memory (Member function 2).
EXAMPLE
The following code initializes the string array object \texttt{my\_arr} with \texttt{my\_treeArr}, and then prints the result to standard output. In addition, it completely initializes it with \texttt{init()}, and then prints the array length to standard output:

```c
stdstreamio sio;

tarray	exttt{tstring} my\_treeArr("pine", "willow", NULL);
tarray	exttt{tstring} my\_arr;

my\_arr.init(my\_treeArr);
/* Display */
for ( size\_t i = 0 ; i < my\_arr.length() ; i++ ) {
    sio.printf("[%s]\n", my\_arr.cstr(i));
}
/* Completely initialize */
my\_arr.init();
/* Display */
sio.printf("my\_arr.length = [%zu]\n", my\_arr.length());
```

Result of execution
\begin{verbatim}
[pine]
[willow]
my\_arr.length = [0]
\end{verbatim}

10.4.9 \texttt{assign()}, \texttt{assignf()}, \texttt{vassignf()}

NAME
\texttt{assign()}, \texttt{assignf()}, \texttt{vassignf()} — Initialization and assignment of objects (Specifies a single string)

SYNOPSIS
\begin{verbatim}
tarray\texttt{tstring} \&assign( const char \*str, size\_t n ); ................. 1
tarray\texttt{tstring} \&assign( const tstring \&str, size\_t n ); ................. 2
tarray\texttt{tstring} \&assignf( size\_t n, const char \*format, \ldots ); ........ 3
tarray\texttt{tstring} \&vassignf( size\_t n, const char \*format, va\_list ap ); .... 4
\end{verbatim}

DESCRIPTION
Sets the number of array elements in an object using \texttt{n}, and assigns to all the elements a specified string.

Member functions 1 and 2 assign the string \texttt{str} to \texttt{n} array elements.

Member functions 3 and 4 assign to \texttt{n} array elements strings created according to the format specified by \texttt{format}. Member function 3 converts each element of data of a variable-length argument using the conversion specifications in \texttt{format}. Member function 4 converts the list \texttt{ap} of variable-length arguments using the conversion specifications in \texttt{format}. For more information on \texttt{format} refer to the descriptions provided in §8.1.14.
PARAMETER

| [I]  | n     | Number of elements of an array |
| [I]  | str   | String to be sourced          |
| [I]  | format | Format specifications for string to be sourced |
| [I]  | ...   | Each element of data of a variable-length argument that supports format |
| [I]  | ap    | List of variable-length arguments that support format |


RETURN VALUE

Reference to itself

EXCEPTION

If the system failed to secure an internal buffer.
If each element of data of a variable-length argument is a value that cannot be converted into the specified conversion format (Member functions 3 and 4).

EXAMPLE

The following code initialize objects with the string “***” + “Japanese quince” using the format specifications, and creates string array my_arr with three elements. It then prints the result to standard output for use in verification:

```c
stdstreamio sio;

tarray_tstring my_arr;
my_arr.assignf(3, "***%s", "Japanese quince");
for ( size_t i = 0 ; i < my_arr.length() ; i++ ) {
    sio.printf("my_arr[%zu] = %s
", i, my_arr.cstr(i));
}
```

Result of execution

my_arr[0] = ***Japanese quince
my_arr[1] = ***Japanese quince

10.4.10 assign(), vassign()

NAME

assign(), vassign() — Initialization and assignment of objects (Specifies multiple strings or a string array)

SYNOPSIS

```c

tarray_tstring &assign( const char *el0, const char *el1, ... ); ........... 1

tarray_tstring &vassign( const char *el0, const char *el1, va_list ap ); 2

tarray_tstring &assign( const char *const *elements ); ...................... 3

tarray_tstring &assign( const char *const *elements, size_t n ); .......... 4

tarray_tstring &assign( const tarray_tstring &src, size_t idx2 = 0 ); .... 5

tarray_tstring &assign( const tarray_tstring &src, size_t idx2, size_t n2 ); .................................. 6
```

DESCRIPTION

Initializes string arrays inside an object with the multiple strings specified by el0, el1, ... or the string arrays specified by elements and src.
Member functions 1 and 2 specify \texttt{el0}, \texttt{el1} and the variable-length argument or the list \texttt{ap} of variable-length arguments. Variable-length arguments must be \texttt{NULL}-terminated.

Member functions 3 and 4 specify to the argument \texttt{elements} the pointer array for a string. Pointer arrays must be \texttt{NULL}-terminated with member function 3. With member function 4 the number of elements can be specified by \texttt{n}. If an \texttt{n} larger than the number of \texttt{elements} (until reaching \texttt{NULL}) is specified \texttt{n} is ignored.

Member functions 5 and 6 enable \texttt{idx2} to be used to specify the element position to start the string array \texttt{src} to be sourced, with the number of elements being provided by \texttt{n2}. Member function 5 can be used without specifying \texttt{idx2}. However, the function will be processed as though 0 had been specified. Member function 6 enables specification of the number \texttt{n2} of elements to be sourced. Please note that the element number for the first element of arrays is always 0.

\textbf{PARAMETER}

\begin{itemize}
\item \textbf{[I]} \texttt{el0} \hspace{1cm} \text{String that is placed in an element (0th)}
\item \textbf{[I]} \texttt{el1} \hspace{1cm} \text{String that is placed in an element (The first)}
\item \textbf{[I]} \ldots \hspace{1cm} \text{String that is placed in an element (The second and any following need to be \texttt{NULL}-terminated)}
\item \textbf{[I]} \texttt{ap} \hspace{1cm} \text{List of variable-length arguments for a string that is placed in an element (The second and any following need to be \texttt{NULL}-terminated)}
\item \textbf{[I]} \texttt{elements} \hspace{1cm} \text{Pointer array for a string that is placed in an element (With member function 3 \texttt{NULL}-terminated)}
\item \textbf{[I]} \texttt{n} \hspace{1cm} \text{Number of elements of the array \texttt{elements}}
\item \textbf{[I]} \texttt{src} \hspace{1cm} \text{\texttt{tarray\_tstring} class object that includes the string array to be sourced}
\item \textbf{[I]} \texttt{idx2} \hspace{1cm} \text{Position to start an element in \texttt{src} (When assigning a sub-array in \texttt{src})}
\item \textbf{[I]} \texttt{n2} \hspace{1cm} \text{Number of elements in \texttt{src} (When assigning a sub-array in \texttt{src})}
\end{itemize}

\textbf{RETURN VALUE}

Reference to itself

\textbf{EXAMPLE}

The following code initializes the string array \texttt{my\_arr} using two elements starting from the element number 1 of the string array \texttt{myTree}. It then prints the result to standard output for use in verification:

```cpp
#include <iostream>
#include <array>
#include <string>

int main() {
    std::string sio;
    const tarray_tstring myTree("fir", "magnolia", "dogwood", NULL);
tarray_tstring my_arr;

    /* Two elements starting from the element number 1 of the array myTree */
    my_arr.assign(myTree, 1, 2);
    for ( size_t i = 0 ; i < my_arr.length() ; i++ ) {
        sio.printf("*** my_arr[%zu] = %s
", i, my_arr.cstr(i));
    }
}
```

Result of execution

*** my\_arr[0] = magnolia
*** my\_arr[1] = dogwood
10.4.11 explode()

NAME
explore() — Divides a string and assigns it to a string array (simple edition)

SYNOPSIS
tarray_tstring &explore( const char *src_str, const char *delim ); ........ 1
tarray_tstring &explore( const tstring &src_str, const char *delim ) .... 2

DESCRIPTION
Divides the string src_str with the delimiter string delim, and then assigns it to a string array. The delimiter string should be placed between two elements, therefore, elements of zero-length string can exist in the result.

Compared with split() member function (§10.4.12), explore() works faster than it.

PARAMETER
[I] src_str String to be divided
[I] delim Delimiter string

RETURN VALUE
Reference to itself

EXAMPLE
See EXAMPLE of split() member function. (§10.4.12)

10.4.12 split()

NAME
split() — Divides a string and assigns it to a string array (advanced edition)

SYNOPSIS
tarray_tstring &split( const char *src_str, const char *delims,
    bool zero_str, const char *quotations,
    int escape, bool rm_escape ); .......................... 1
tarray_tstring &split( const tstring &src_str, const char *delims,
    bool zero_str, const char *quotations,
    int escape, bool rm_escape ); .......................... 2
tarray_tstring &split( const char *src_str, const char *delims,
    bool zero_str = false ); .................................. 3
tarray_tstring &split( const tstring &src_str, const char *delims,
    bool zero_str = false ); .................................. 4

DESCRIPTION
Divides the string src_str with the delimiter characters and then assigns it to a string array. The delimiter characters are given by character set of delims argument, and delims can be specified as a simple list of characters like " " \t" as well as expressions like "[A-Z]" or "[^A-Z]" as in regular expressions. In addition, a character class can be specified inside "[...]". For the character classes that can be specified refer to the descriptions and Table [9.5.26] provided in §10.5.26.
zero_str can be specified to indicate whether a string length of zero is allowable as an element after division. If zero_str is false elements with a string length of 0 cannot be created. If zero_str is true elements with a string length of 0 can created (used for the csv format, etc.). If zero_str is not specified it is treated as false.

If you do not want to divide strings that are parenthesized with “specific characters” such as quotation marks etc., such “specific characters” can be specified using quotations. For example, if you wanted to exclude any strings parenthesized with a single quotation from the strings to be divided "'" would be used.

An escape character can be specified using escape. If you want to delete any escape characters remaining after the division set rm_escape to true. However, any escape characters in the strings that are parenthesized by a character specified using quotations cannot be deleted.

PARAMETER

| I | src_str   | String to be divided |
| I | delims    | String that includes delimiter characters |
| I | zero_str  | Whether or not to allow string elements with a length of 0 after division (true/false) |
| I | quotations| String that includes quotation characters |
| I | escape    | Escape character |
| I | rm_escape | Flag used to indicate whether or not to delete escape characters (true/false) |


RETURN VALUE

Reference to itself

EXCEPTION

If the system failed to secure an internal buffer.

EXAMPLE

The following code divides the string line with the string " ", assigns the result to the object my_arr, and then prints the result to standard output:

```c
stdstreamio sio;

const char *line = "Fragrant olive is 'KINMOKUSEI'. It is good smelling.";
tarray_tstring my_arr;
my_arr.split(line, " ", false);
for ( size_t i = 0 ; i < my_arr.length() ; i++ ) {
    sio.printf("my_arr[%zu] ===> %s\n", i, my_arr.cstr(i));
}
```

Result of execution

my_arr[0] ===> Fragrant
my_arr[1] ===> olive
my_arr[2] ===> is
my_arr[3] ===> 'KINMOKUSEI'.
my_arr[4] ===> It
my_arr[5] ===> is
my_arr[6] ===> good
An example of using member function 1 is provided in §3.4.7.
An example of dividing CSV-format strings is described in the EXAMPLE provided in §10.4.28.

10.4.13 regassign()

NAME

regassign() — Performs regular expression matching on strings in an argument, and then assigns the result to an array.

SYNOPSIS

```c
// for const char *src_str, const char *pat
array_tstring &regassign( const char *src_str, const char *pat ); .... 1

// for const char *src_str, size_t pos,
// const char *pat
array_tstring &regassign( const char *src_str, size_t pos,
const char *pat ); ................................. 2

// for const char *src_str, size_t pos,
// const char *pat, size_t *nextpos
array_tstring &regassign( const char *src_str, size_t pos,
const char *pat, size_t *nextpos ); .............. 3

// for const tstring &src_str, const char *pat
array_tstring &regassign( const tstring &src_str, const char *pat ); .... 4

// for const tstring &src_str, size_t pos,
// const char *pat
array_tstring &regassign( const tstring &src_str, size_t pos,
const char *pat ); ................................. 5

// for const tstring &src_str, size_t pos,
// const char *pat, size_t *nextpos
array_tstring &regassign( const tstring &src_str, size_t pos,
const char *pat, size_t *nextpos ); .............. 6

// for const char *src_str, const tstring &pat
array_tstring &regassign( const char *src_str, const tstring &pat ); .... 7

// for const char *src_str, size_t pos,
// const tstring &pat
array_tstring &regassign( const char *src_str, size_t pos,
const tstring &pat ); ................................. 8

// for const char *src_str, size_t pos,
// const tstring &pat, size_t *nextpos
array_tstring &regassign( const char *src_str, size_t pos,
const tstring &pat, size_t *nextpos ); .......... 9

// for const tstring &src_str, const tstring &pat
array_tstring &regassign( const tstring &src_str, const tstring &pat ); 10

// for const tstring &src_str, size_t pos,
// const tstring &pat
array_tstring &regassign( const tstring &src_str, size_t pos,
const tstring &pat ); ................................. 11

// for const tstring &src_str, size_t pos,
// const tstring &pat, size_t *nextpos
array_tstring &regassign( const tstring &src_str, size_t pos,
const tstring &pat, size_t *nextpos ); .......... 12

// for const char *src_str, const tregex &pat
array_tstring &regassign( const char *src_str, const tregex &pat ); .... 13

// for const char *src_str, size_t pos,
// const tregex &pat
array_tstring &regassign( const char *src_str, size_t pos,
const tregex &pat ); ................................. 14

// for const char *src_str, size_t pos,
// const tregex &pat, size_t *nextpos
array_tstring &regassign( const char *src_str, size_t pos,
const tregex &pat, size_t *nextpos ); .......... 15

// for const tstring &src_str, const tregex &pat
array_tstring &regassign( const tstring &src_str, const tregex &pat ); 16

// for const tstring &src_str, size_t pos,
// const tregex &pat
array_tstring &regassign( const tstring &src_str, size_t pos,
const tregex &pat ); ................................. 17

// for const tstring &src_str, size_t pos,
// const tregex &pat, size_t *nextpos
array_tstring &regassign( const tstring &src_str, size_t pos,
const tregex &pat, size_t *nextpos ); .......... 18
```

DESCRIPTION

Attempts string matching on the string src_str that uses a POSIX Extended Regular Expression (hereinafter referred to as regular expression) specified by pat, and if a string matches the expression stores a substring that can be back-referenced to an array inside the object (length of the array is 1 or more). If no string matches the expression or the processing encountered an error due to the reason that the regular expression was incorrect etc. (for more details refer to the RETURN VALUE item in §9.5.59) the array is initialized, and no string assigned to the array (length of the array is 0).
The position of the matching string can be acquired using the `reg_pos()` member function. The prototype for that is as follows:

```c++
size_t reg_pos( size_t idx ) const;
```

The element numbers starting from 0 are specified using the `idx` argument. The element with element number 0 is used to store the information on the entire matching string, while the elements with the element number 1 and later are used to individually store the information of the substring that matches the regular expressions (\ldots) (i.e. back reference information).

Member functions 1 to 12 compile the regular expression `pat`, save the result to an internal buffer that the functions encompass, and then perform the matching (When `pat` is the same as previously compiled it is not recompiled again).

Member functions 13 and 18 specify an object for the `tregex` class to hold the result of compiling the regular expression. The regular expression therefore needs to be compiled in advance using the `compile()` member function of the `tregex` class before use of the `regassign()` member function (Refer to EXAMPLE).

In both cases if the function fails to compile the regular expression it outputs the content to standard error output.

If `pos` is not specified matching is attempted from the left end of the string `src_str`, while if `pos` is specified matching is attempted from the position `pos` in the string `src_str`. The string matching is attempted within the range of up to where `\0` appears at the end of the string (If the newline character `\n` appears the processing still does not terminate). Please note that the lead position in strings is always 0.

If you want to continuously search for characters or strings `nextpos` can be used to acquire the value that should be provided to `pos` in the next iteration. If a string matches the expression the position the same length as the matching string (the same length as the character if the length of the matching string is 0) to the right of that position is returned as the variable referred to by `nextpos`, and if no string matches the expression the length of the string `src_str` + 1 is returned. If you do not need `nextpos` NULL can also be used.

For more details on regular expressions refer to §9.5.59.

### PARAMETER

<table>
<thead>
<tr>
<th>I</th>
<th>src_str</th>
<th>String on which to perform matching</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>pos</td>
<td>Position to start string matching</td>
</tr>
<tr>
<td>I</td>
<td>pat</td>
<td>Character pattern (regular expression) or compiled object for the <code>tregex</code> class</td>
</tr>
<tr>
<td>O</td>
<td>nextpos</td>
<td>pos for use in next search (Used in continuous searches)</td>
</tr>
</tbody>
</table>


### RETURN VALUE

Reference to itself

### EXCEPTION

- If the `regex` routine exhausted the memory.
- If the system failed to secure an internal buffer.
- If the system encountered any corrupt memory.

### EXAMPLE

The following code retrieves the keyword and value for the string "OS = linux". The part of the string that matches all of `my_pat` is placed in `my_elms.cstr(0)`, and the back-referenced substrings are stored in `my_elms.cstr(1)` and thereafter. Regular expressions are compiled using the `compile()` member function, as seen in
my_pat.compile("([\^ ]\*)(( \*=[ ]\*)\([\^ ]\+)\)"). Any errors in the compilation process are identified using `cregex()`.

```cpp
std::iostream sio;
tarray_tstring my_elms;
tstring my_str = "OS = linux";
tregex my_pat;

my_pat.compile("([\^ ]\*)(( \*=[ ]\*)\([\^ ]\+)\)\);
if ( my_pat.cregex() == NULL ) {
    /* Error handling: Failed to compile the regular expression */
}
my_elms.regassign(my_str, my_pat);
if ( my_elms.length() == 4 ) {
    sio.printf("keyword=[%s] value=[%s]\n",
                my_elms.cstr(1), my_elms.cstr(3));
}
```

Result of execution
keyword=[OS] value=[linux]

An example of using member function 4 is provided in §3.4.8

### 10.4.14 put(), putf(), vputf()

**NAME**

`put()`, `putf()`, `vputf()` — Sets n pieces of a string to any element position

**SYNOPSIS**

```cpp
tarray_tstring &put( size_t index, const char *str, size_t n ); .......... 1
```

```cpp
tarray_tstring &put( size_t index, const tstring &str, size_t n ); .......... 2
```

```cpp
tarray_tstring &putf( size_t index, size_t n, const char *format, ... ); 3
```

```cpp
tarray_tstring &vputf( size_t index, size_t n, const char *format,
                        va_list ap ); ................................. 4
```

**DESCRIPTION**

Writes n pieces of a specified string to the element number `index` position in a string array. Please note that the element number for the first element of arrays is always 0.

`index` can take any value. If the number of elements in the array is smaller than specified by the argument the size of the array is automatically increased. An array having no elements results in `my_arr.put(0,"",6)` and `my_arr.put(2,"",4)`, for example, being the same. If an array has 4 elements and `my_arr.put(2,"",4)` is used on it then the number of elements will be 6, and elements number 2 and later "".

Member functions 1 and 2 write the string `str` to n elements starting from the element number provided by `index` of an array. If the length of the array before writing is smaller than `index + n` the length of the array after writing is increased to `index + n`.

Member function 3 writes each element of data of a variable-length argument, while member function 4 writes the strings created by converting the list `ap` of variable-length arguments depending on the conversion specifications set in `format` respectively to n elements starting from the element number provided by `index`. For more details on `format` refer to the descriptions provided in §8.1.14.
PARAMETER

- **index** Position to write to in an array inside an object
- **n** Number of elements
- **str** String to be sourced
- **format** Format specifications for a string to be sourced
- **...** Each element of data of a variable-length argument supporting `format`
- **ap** List of variable-length arguments supporting `format`


RETURN VALUE

Reference to itself

EXCEPTION

- If the system failed to secure an internal buffer.
- If each element of data of a variable-length argument is a value that cannot be converted into the conversion format specified (Member functions 3 and 4).

EXAMPLE

The following code writes the string "elm" to two elements starting from the element number 1 of the string array `my_arr`, and then prints the result to standard output:

```cpp
stdstreamio sio;

tarray_tstring my_arr;

my_arr.put(1, "elm", 2);
for ( size_t i = 0 ; i < my_arr.length() ; i++ ) {
    sio.printf("my_arr[%zu] = %s\n", i, my_arr.cstr(i));
}
```

Result of execution

```plaintext
my_arr[0] = my_arr[1] = elm
my_arr[2] = elm
```

10.4.15 put(), vput()

NAME

put(), vput() — Sets multiple strings or a string array to any element position

SYNOPSIS

```cpp
tagarray_tstring &put( size_t index, const char *el0, const char *el1, ... ); .......................... 1
tagarray_tstring &vput( size_t index, const char *el0, const char *el1, va_list ap ); .......................... 2
tagarray_tstring &put( size_t index, const char *const *elements );  .......... 3
tagarray_tstring &put( size_t index, const char *const *elements, size_t n ); ................................. 4
tagarray_tstring &put( size_t index, const tagarray_tstring &src, size_t idx2 = 0 ); .......................... 5
tagarray_tstring &put( size_t index, const tagarray_tstring &src, size_t idx2, size_t n2 ); .......................... 6
```
DESCRIPTION
Writes (overwrites) the multiple strings specified by \texttt{el0}, \texttt{el1}, \ldots or the string array specified by \texttt{elements} and \texttt{src} to element position \texttt{index} and then later in a string array.

\texttt{index} can take any value. If the number of elements in the array is smaller than specified by the argument the size of the array is automatically increased.

Member functions 1 and 2 specify \texttt{el0}, \texttt{el1} and the variable-length argument or list \texttt{ap} of variable-length arguments. Variable-length arguments must be \texttt{NULL}-terminated.

Member functions 3 and 4 specify to the argument \texttt{elements} a pointer array for a string. With member function 3 pointer arrays must be \texttt{NULL}-terminated. With member function 4 the number of elements can be specified by \texttt{n}. If an \texttt{n} value larger than the number of \texttt{elements} (until reaching \texttt{NULL}) is specified \texttt{n} is ignored.

Member functions 5 and 6 enable \texttt{idx2} to be used to specify the element position to start the string array \texttt{src} to be sourced, and the number of elements by \texttt{n2}. Member function 5 can be used without specifying \texttt{idx2}. However, the function is processed as though 0 had been specified. Member function 6 enables the number \texttt{n2} of the elements to be sourced to be specified. Please note that the element number for the first element of arrays is always 0.

PARAMETER
\begin{itemize}
  \item \texttt{index} : Position to write to in an array inside an object
  \item \texttt{el0} : String to be sourced (0th)
  \item \texttt{el1} : String to be sourced (first)
  \item \texttt{...} : String to be sourced (The second and following need to be \texttt{NULL}-terminated)
  \item \texttt{ap} : List of variable-length arguments for a string to be sourced (The second and following need to be \texttt{NULL}-terminated)
  \item \texttt{elements} : Pointer array for a string to be sourced (With member function 3 must be \texttt{NULL}-terminated)
  \item \texttt{n} : Number of elements of the array \texttt{elements}
  \item \texttt{src} : tarray\_tstring class object that includes the string array to be sourced
  \item \texttt{idx2} : Position to start an element in \texttt{src} (When assigning a sub-array in \texttt{src})
  \item \texttt{n2} : Number of elements in \texttt{src} (When assigning a sub-array in \texttt{src})
\end{itemize}

(I) : Input, [O] : Output)

RETURN VALUE
Reference to itself

EXCEPTION
If the system failed to secure an internal buffer

EXAMPLE
The following code writes two elements starting from element number 1 of the string array \texttt{tree\_arr} to elements with the elements number 2 and later of the string array \texttt{my\_arr}, and then prints the result to standard output:

```c
stdstreamio sio;

tarray\_tstring my\_arr;

const char *mytree[] = {"maple", "larch", "camphor", NULL};
const tarray\_tstring tree\_arr(mytree);
```
SLIB Reference: sli::tarray_tstring (class that handles string arrays)

```cpp
my_arr.put(2, tree_arr, 1, 2);
for ( size_t i = 0 ; i < my_arr.length() ; i++ ) {
    sio.printf("my_arr[%zu] = %s\n", i, my_arr.cstr(i));
}
```

Result of execution

```cpp
my_arr[0] =
my_arr[1] =
my_arr[2] = larch
my_arr[3] = camphor
```

10.4.16  **append(), appendf(), vappendf()**

**NAME**
append(), appendf(), vappendf() — Addition of elements (Specifies a single string)

**SYNOPSIS**

```cpp
tarray_tstring &append( const char *str, size_t n ); ...................... 1
tarray_tstring &append( const tstring &str, size_t n ); .................. 2
tarray_tstring &appendf( size_t n, const char *format, ... ); .......... 3
tarray_tstring &vappendf( size_t n, const char *format, va_list ap ); .... 4
```

**DESCRIPTION**
Adds n pieces of a specified string to the end of a string array. Please note that the element number for the first element of arrays is always 0.

Member functions 1 and 2 add n pieces of the string *str* to a string array.

Member function 3 and 4 add to a string array n pieces of the string created according to the format specified in *format*. Member function 3 converts each element of data of a variable-length argument, while member function 4 converts the list *ap* of variable-length arguments depending on the format specification. For more details on *format* refer to the description in §8.1.12.

**PARAMETER**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>Number of elements to be added</td>
</tr>
<tr>
<td>str</td>
<td>String to be sourced</td>
</tr>
<tr>
<td>format</td>
<td>Format specifications for a string to be sourced</td>
</tr>
<tr>
<td>...</td>
<td>Each element of data of a variable-length argument supporting <em>format</em></td>
</tr>
<tr>
<td>ap</td>
<td>List of variable-length arguments supporting <em>format</em></td>
</tr>
</tbody>
</table>


**RETURN VALUE**
Reference to itself

**EXCEPTION**

If the system failed to secure an internal buffer.

If each element of data of a variable-length argument is a value that cannot be converted into the conversion format specified (Member functions 3 and 4).

**EXAMPLE**
The following code adds a string to the string array *my_arr*, and then prints the result to standard output:
stdstreamio sio;

tarray_tstring my_arr("maple", "larch", NULL);

const tstring mytrr = "gardenia";
my_arr.append(mytrr,2);
for ( size_t i = 0 ; i < my_arr.length() ; i++ ) {
    sio.printf("my_arr[%zu] = %s\n", i, my_arr.cstr(i));
}

Result of execution
my_arr[0] = maple
my_arr[1] = larch
my_arr[2] = gardenia
my_arr[3] = gardenia

10.4.17  append(), vappend()

NAME
append(), vappend() — Addition of elements (Specifies multiple strings or a string array)

SYNOPSIS

tarray_tstring &append( const char *el0, const char *el1, ... ); ........... 1

tarray_tstring &vappend( const char *el0, const char *el1,
    va_list ap ); .............................................. 2

tarray_tstring &append( const char *const *elements ); ...................... 3

tarray_tstring &append( const char *const *elements, size_t n ); ........... 4

tarray_tstring &append( const tarray_tstring &src, size_t idx2 = 0 ); .... 5

tarray_tstring &append( const tarray_tstring &src, size_t idx2,
    size_t n2 ); ................................................ 6

DESCRIPTION

 Adds the multiple strings specified by el0, el1, ... or the string array specified by elements and src to the end of the array and later.

 Member functions 1 and 2 specify el0, el1 and the variable-length argument or the list ap of variable-length arguments. Variable-length arguments must be NULL-terminated.

 Member functions 3 and 4 specify to the argument elements a pointer array for a string. ith member function 3 pointer arrays must be NULL-terminated. With member function 4 the number of elements can be specified by n. If n larger than the number of elements (until reaching NULL) specified then n is ignored.

 Member function 5 and 6 enable idx2 to be used to specify the element position to start the string array src to be sourced, and the number of elements by n2. Member function 5 can be used without specifying idx2. However, the function is processed as though 0 had been specified. Member function 6 enables the number n2 of elements to be sourced to be specified. Please note that the element number for the first element of arrays is always 0.

PARAMETER
SLIB Reference: sli::tarray_tstring (class that handles string arrays)

-I e10 String to be sourced (0th)
-I e11 String to be sourced (first)
-I ... String to be sourced (The second and following need to be NULL-terminated)
-I ap List of variable-length arguments for a string to be sourced (The second and following need to be NULL-terminated)
-I elements Pointer array for a string to be sourced (With member function 3 must be NULL-terminated)
-I n Number of elements of the array
-I src tarray_tstring class object that includes the string array to be sourced
-I idx2 Position to start an element in src (When assigning a sub-array in src)
-I n2 Number of elements in src (When assigning a sub-array in src)


RETURN VALUE
Reference to itself

EXCEPTION
If the system failed to secure an internal buffer.

EXAMPLE
The following code adds to the string array my_arr two elements starting from the element number 2 of the string array tree_arr, and then prints the result to standard output:

```cpp
std::stringstream sio;

tarray_tstring tree_arr("chestnut", "zelkova", "crape myrtle", "daphne", NULL);
tarray_tstring my_arr;
my_arr.at(0) = "chestnut";

my_arr.append(tree_arr, 2, 2);
for (size_t i = 0; i < my_arr.length(); i++) {
    sio.printf("my_arr[%zu] = %s\n", i, my_arr.cstr(i));
}
```

Result of execution
my_arr[0] = chestnut
my_arr[1] = crape myrtle
my_arr[2] = daphne

10.4.18 insert(), insertf(), vinsertf()

NAME
insert(), insertf(), vinsertf() — Insertion of elements (Specifies a single string)

SYNOPSIS
```cpp
tarray_tstring &insert( size_t index, const char *str, size_t n ); ....... 1
```
```cpp
tarray_tstring &insert( size_t index, const tstring &str, size_t n ); .... 2
```
```cpp
tarray_tstring &insertf( size_t index, size_t n, const char *format, ... ); 3
```
```cpp
tarray_tstring &vinsertf( size_t index, size_t n,
    const char *format, va_list ap ); ................. 4
```
DESCRIPTION
Inserts n pieces of a specified string to the position with the element number index in an string array. Please note that the element number for the first element of arrays is always 0.

If a value larger than the length of an array is specified to index the assumption is made that the length of the array for the function itself is provided to index.

Member functions 1 and 2 insert n pieces of the string str to a string array.

Member functions 3 and 4 insert into a string array n pieces of a string created according to the format specified by format. Member function 3 converts each element of data of a variable-length argument, while member function 4 converts the list ap of variable-length arguments depending on the format specification. For more details on format refer to the description in § 8.1.14.

PARAMETER

- [I] index  Position to insert to in an array inside an object
- [I] n Number of elements to be added
- [I] str String to be sourced
- [I] format Format specifications for a string to be sourced
- [I] ... Each element of data of a variable-length argument supporting format
- [I] ap List of variable-length arguments supporting format


RETURN VALUE
Reference to itself

EXAMPLE
The following code inserts the strings "palm" and "fir" to the element position with the element number 1 in the string array my_arr, and then prints the result to standard output:

```c
stdstreamio sio;

tarray_tstring my_arr("cycad", "dogwood", NULL);

my_arr.insert(1, "palm", "fir", NULL);
for ( size_t i = 0 ; i < my_arr.length() ; i++ ) {
    sio.printf("my_arr[%zu] = %s\n", i, my_arr.cstr(i));
}
```

Result of execution
my_arr[0] = cycad
my_arr[1] = palm
my_arr[2] = fir
my_arr[3] = dogwood

10.4.19 insert(), vinsert()

NAME
insert(), vinsert() — Insertion of elements (Specifies multiple strings or a string array)

SYNOPSIS
tarray_tstring &insert( size_t index, const char *el0,
                           const char *el1, ... ); ................................... 1
tarray_tstring &vinsert( size_t index, const char *el0,
    const char *el1, va_list ap ); ...................... 2

DECLARE 3, 4, 5, 6

DESCRIPTION

Inserts the multiple strings specified by el0, el1, ... or the string array specified by elements and src to the specified position index of a string array inside an object.

If a value larger than the length of the array for the function itself is specified to index the assumption is made that the length of the array for the function itself is provided to index.

Member functions 1 and 2 specify el0, el1 and the variable-length argument or the list ap of variable-length arguments. Variable-length arguments must be NULL-terminated.

Member functions 3 and 4 specify to the argument elements a pointer array for a string. With member function 3 pointer arrays must be NULL-terminated. With member function 4 the number of elements can be specified by n. If n larger than the number of elements (until reaching NULL) specified then n is ignored.

Member functions 5 and 6 enable idx2 to be used to specify the element position to start the string array src to be sourced, and the number of elements by n2. Member function 5 can be used without specifying idx2. However, the function is processed as though 0 had been specified. Member function 6 enables the number n2 of elements to be sourced to be specified. Please note that the element number for the first element of arrays is always 0.

PARAMETER

[I] index Position to insert to in an array inside an object
[I] el0 String to be sourced (0th)
[I] el1 String to be sourced (first)
[I] ... String to be sourced (The second and following need to be NULL-terminated)
[I] ap List of variable-length arguments for a string to be sourced (The second and following need to be NULL-terminated)
[I] elements Pointer array for a string to be sourced (With member function 3 must be NULL-terminated)
[I] n Number of elements of the array
[I] src tarray_tstring class object that includes the string array to be sourced
[I] idx2 Position to start an element in src (When assigning a sub-array in src)
[I] n2 Number of elements in src (When assigning a sub-array in src)


RETURN VALUE

Reference to itself

EXCEPTION

If the system failed to secure an internal buffer.
EXAMPLE
The following code inserts to the element position with the element number 1 in the string array my_arr two elements starting from the element number 0 of addTree, and then prints the result to standard output:

```cpp
ostream sio;
const char *addTree[] = {"cycad", "dogwood", NULL};
tarray_tstring my_arr("hawthorn", "oak", NULL);
my_arr.insert(1, addTree, 2);
for (size_t i = 0; i < my_arr.length(); i++) {
    sio.printf("my_arr[%zu] = %s\n", i, my_arr.cstr(i));
}
```

Result of execution
my_arr[0] = hawthorn
my_arr[1] = cycad
my_arr[2] = dogwood
my_arr[3] = oak

10.4.20 replace(), replacef(), vreplacef()

NAME
replace(), replacef(), vreplacef() — Replacement of elements (Specifies a single string)

SYNOPSIS
```cpp
tarray_tstring &replace( size_t idx1, size_t n1,
    const char *str, size_t n2 ); .......... 1

tarray_tstring &replace( size_t idx1, size_t n1,
    const tstring &str, size_t n2 ); .......... 2

tarray_tstring &replacef( size_t idx1, size_t n1,
    size_t n2, const char *format, ... ); ........ 3

tarray_tstring &vreplacef( size_t idx1, size_t n1,
    size_t n2, const char *format, va_list ap ); . 4
```

DESCRIPTION
Replaces n1 elements starting from the element position idx1 in a string array with n2 pieces of a specified string. Please note that the element number for the first element of arrays is always 0.

If idx1 has a value larger than the number of array elements specified to it the function performs the same processing as the append() member function (§10.4.16). If the sum of idx1 and n1 is larger than the number of elements of the array or the array needs to be expanded or contracted because of the size comparison between n1 and n2 the number of the elements is automatically adjusted.

Member functions 1 and 2 replace n1 elements starting from the element number idx1 in a string array with n2 pieces of the string str.

Member functions 3 and 4 replace n1 elements starting from the element number idx1 of a string array with n2 pieces of a string created according to the format specified by format.
Member function 3 converts each element of data of a variable-length argument, while member function 4 converts the list `ap` of variable-length arguments depending on the format specifications. For more details on `format` refer to the descriptions provided in §8.1.14.

**PARAMETER**

- `idx1` Position to start an array inside an object
- `n1` Number of elements to be replaced
- `n2` Number of elements to which a specified string is assigned
- `format` Format specifications for string to be sourced
- `...` Each element of data of a variable-length argument supporting `format`
- `ap` List of variable-length arguments supporting `format`
- `str` String to be sourced


**RETURN VALUE**

Reference to itself

**EXCEPTION**

- If the system failed to secure an internal buffer.
- If each element of data of a variable-length argument is a value that cannot be converted into the conversion format specified (Member functions 3 and 4).

**EXAMPLE**

The following code replaces 1 element starting from the element number 1 of the string array `my_arr` with the string "linden", and then prints the result to standard output:

```c
stdstreamio sio;

const char *tree[] = {"willow", "pine", "fir", NULL};
tarray_tstring my_arr = tree;

my_arr.replace(1, 1, "linden", 1);
for ( size_t i = 0 ; i < my_arr.length() ; i++ ) {
    sio.printf("my_arr[%zu] = %s\n", i, my_arr.cstr(i));
}
```

Result of execution

```
my_arr[0] = willow
my_arr[1] = linden
my_arr[2] = fir
```

---

10.4.21 replace(), vreplace()

**NAME**

replace(), vreplace() — Replacement of elements (Specifies multiple strings or a string array)

**SYNOPSIS**

```c
//replace
Pending
```

```c
//vreplace
Pending
```
const char *const *elements ); ................. 3

tarray_tstring &replace( size_t idx1, size_t n1,
    const char *const *elements, size_t n2 ); ...... 4

tarray_tstring &replace( size_t idx1, size_t n1,
    const tarray_tstring &src, size_t idx2 = 0 ); .. 5

tarray_tstring &replace( size_t idx1, size_t n1, const tarray_tstring &src,
    size_t idx2, size_t n2 ); ....................... 6

DESCRIPTION
Replaces \( n_1 \) elements starting from the element number \( \text{idx1} \) of a string array inside an object with the multiple strings specified by \( e_{10}, e_{11}, \ldots \) or the string array specified by \( \text{elements} \) and \( \text{src} \).

If \( \text{idx1} \) has a value larger than the number of array elements specified to it the function performs the same processing as the \texttt{append()} member function (§10.4.16). If the sum of \( \text{idx1} \) and \( n_1 \) is larger than the number of elements of the array or the array needs to be expanded or contracted because of the size comparison between \( n_1 \) and \( n_2 \) the number of the elements is automatically adjusted.

Member functions 1 and 2 specify \( e_{10}, e_{11} \) and the variable-length argument or the list \( \text{ap} \) of variable-length arguments. Variable-length arguments must be \texttt{NULL}-terminated.

Member functions 3 and 4 specify to the argument \( \text{elements} \) a pointer array for a string. With member function 3 pointer arrays must be \texttt{NULL}-terminated. With member function 4 the number of elements can be specified by \( n_2 \). If \( n_2 \) larger than the number of \( \text{elements} \) (until reaching \texttt{NULL}) specified then \( n_2 \) is ignored.

Member functions 5 and 6 enable \( \text{idx2} \) to be used to specify the element position to start the string array \( \text{src} \) to be sourced, and the number of elements by \( n_2 \). Member function 5 can be used without specifying \( \text{idx2} \). However, the function is processed as though 0 had been specified. Member function 6 enables the number \( n_2 \) of elements to be sourced to be specified. Please note that the element number for the first element of arrays is always 0.

PARAMETER
\begin{itemize}
    \item [I] \text{idx1} \hspace{1em} \text{Position to start an array inside an object}
    \item [I] \text{n1} \hspace{1em} \text{Number of elements to be replaced}
    \item [I] \text{e_{10}} \hspace{1em} \text{String to be sourced (0th)}
    \item [I] \text{e_{11}} \hspace{1em} \text{String to be sourced (first)}
    \item [I] \ldots \hspace{1em} \text{String to be sourced (The second and following need to be \texttt{NULL}-terminated)}
    \item [I] \text{ap} \hspace{1em} \text{List of variable-length arguments for a string to be sourced (The second and following need to be \texttt{NULL}-terminated)}
    \item [I] \text{elements} \hspace{1em} \text{Pointer array for a string to be sourced (With member function 3 must be \texttt{NULL}-terminated)}
    \item [I] \text{n2} \hspace{1em} \text{Number of \text{elements} of the array, or the number of elements in \text{src} (When assigning a sub-array in \text{src})}
    \item [I] \text{src} \hspace{1em} \text{tarray_tstring class object that includes the string array to be sourced}
    \item [I] \text{idx2} \hspace{1em} \text{Position to start an element in \text{src} (When assigning a sub-array in \text{src})}
\end{itemize}


RETURN VALUE
Reference to itself

EXCEPTION
If the system failed to secure an internal buffer.
EXAMPLE
The following code replaces 1 element starting from the element number 1 of the string array `my_tree` with two elements starting from the element number 1 of the string array `my_addTree`, and then prints the result to standard output:

```cpp
stdstreamio sio;

tarray_tstring my_tree("willow", "pine", "fir", NULL);
tarray_tstring my_addTree("linden", "beech", "holly", NULL);

my_tree.replace(1, 1, my_addTree, 1, 2);
for ( size_t i = 0 ; i < my_tree.length() ; i++ ) {
    sio.printf("my_tree[%zu] = %s\n", i, my_tree.cstr(i));
}
```

Result of execution
```
my_tree[0] = willow
my_tree[1] = beech
my_tree[2] = holly
my_tree[3] = fir
```

10.4.22 erase()

NAME
erase() — Deletion of elements

SYNOPSIS
```
tarray_tstring &erase(); ................................................................. 1
```
```
tarray_tstring &erase( size_t index, size_t num_elements = 1 ); ............ 2
```

DESCRIPTION
Deletes elements of a string array.

Member function 1 deletes all the array elements (The array length becomes zero).

Member function 2 deletes `num_elements` elements starting from the element with the element number `index`. Please note that the element number for the first element of arrays is always 0. When `num_elements` is not specified, an element is deleted.

The array length decreases by the length deleted.

If `index` has a value larger than the length of an array specified to it the value is simply ignored.

PARAMETER
```
[I] index Element number
[I] num_elements Number of elements
```

RETURN VALUE
Reference to itself

EXCEPTION
If the system failed to secure an internal buffer.
EXAMPLE
The following code deletes two elements from element number 1 of the string array my_menu, and then prints the result to standard output:

```c
stdstreamio sio;

tarray_tstring my_menu("rice ball", "sushi", "tofu", NULL);
my_menu.erase(1,2);
for ( size_t i = 0 ; i < my_menu.length() ; i++ ) {
    sio.printf("my_menu[%zu] = %s\n", i, my_menu.cstr(i));
}
```

Result of execution
my_menu[0] = rice ball

10.4.23 clean()

NAME
   clean() — Pads all the element values of an existing array with a string

SYNOPSIS
   tarray_tstring &clean(const char *str = ""); ................................. 1
   tarray_tstring &clean(const tstring &str); ................................. 2

DESCRIPTION
   Pads all the elements of a string array with the string str. The function can also be used without specifying the argument str. In that case, however, the function is processed as though the string "" had been specified. Executing clean() does not change the length of a string array.

PARAMETER
   [I] str String to pad a string array with

RETURN VALUE
   Reference to itself

EXCEPTION
   If the system failed to secure an internal buffer.

EXAMPLE
   The following code sets the value of tree to the string array object my_arr, and then sets paulownia to all the elements. It then prints the element values to standard output in order to verify them:

```c
stdstreamio sio;

const char *tree[] = {"katsura", "torreya", NULL};
tarray_tstring my_arr = tree;

my_arr.clean("paulownia");
for ( size_t i = 0 ; i < my_arr.length() ; i++ ) {
    sio.printf("my_arr[%zu] = %s\n", i, my_arr.cstr(i));
}
Result of execution
my_arr[0] = paulownia
my_arr[1] = paulownia

10.4.24 resize()

NAME
resize() — Changes the length of a string array

SYNOPSIS
tarray_tstring &resize( size_t new_num_elements );

DESCRIPTION
Changes the length of a string array to new_num_elements.
Increasing the length of the string array results in elements comprised of the empty string "" being added to it.
Decreasing the length of the string array results in string elements after new_num_elements being deleted.

PARAMETER
[I] new_num_elements Length of string array after being changed

RETURN VALUE
Reference to itself

EXCEPTION
If the system failed to secure an internal buffer.

EXAMPLE
The following code sets the value of tree to the string array object my_arr, and then changes the length of the string array to 2. It then prints the content of the element values to standard output in order to verify them:

```cpp
stdoutio sio;

const char *tree[] = {"andromeda", "yew", "Japanese pagoda tree", NULL};
tarray_tstring my_arr = tree;
for ( size_t i = 0 ; i < my_arr.length() ; i++ ) {
    sio.printf("my_arr[%zu] = %s\n",i, my_arr.cstr(i));
}
my_arr.resize(2);
for ( size_t i = 0 ; i < my_arr.length() ; i++ ) {
    sio.printf("my_arr[%zu] = %s\n",i, my_arr.cstr(i));
}
```

Result of execution
my_arr[0] = andromeda
my_arr[1] = yew
my_arr[0] = andromeda
my_arr[1] = yew

10.4.25 resizeby()

NAME
resizeby() — Relatively changes the length of a string array

SYNOPSIS
tarray_tstring &resizeby( ssize_t len );

DESCRIPTION
Changes the length of a string array by as much as the length of len.
Increasing the length of the string array results in elements comprised of the empty string
"" being added to it.
Decreasing the length of a string array length results in the last abs(len) string elements
being deleted.

PARAMETER
[I] len Increase/decrease in the length of an array

RETURN VALUE
Reference to itself

EXCEPTION
If the system failed to secure an internal buffer.

10.4.26 crop()

NAME
crop() — Cropping of string arrays

SYNOPSIS
tarray_tstring &crop( size_t idx, size_t len );
tarray_tstring &crop( size_t idx );

DESCRIPTION
Changes an array object to an array comprised of only len elements starting from the element
number idx. If len is omitted the array will be comprised of only the elements in and after
idx.

PARAMETER
[I] idx Position to start cropped element
[I] len Number of elements

RETURN VALUE
Reference to itself

EXCEPTION
If the system failed to secure an internal buffer.
10.4.27  chomp()

NAME
   chomp() — Elimination of newline characters in all the elements

SYNOPSIS
   tarray_tstring &chomp( const char *rs = "\n" );
   tarray_tstring &chomp( const tstring &rs );

DESCRIPTION
   Eliminates a newline character on the right end of all the elements of a string array.
   This member function executes the chomp() member function (§9.5.25) for the tstring class
   on all the elements of an array. For more details refer to §9.5.25.

PARAMETER
   [I]  rs  Newline character string

RETURN VALUE
   Reference to itself

EXCEPTION
   If the system failed to secure an internal buffer.

10.4.28  trim()

NAME
   trim() — Elimination of spaces on both ends of all the elements

SYNOPSIS
   tarray_tstring &trim( const char *side_spaces = " \t\n\r\f\v" );
   tarray_tstring &trim( const tstring &side_spaces );
   tarray_tstring &trim( int side_space );

DESCRIPTION
   Eliminates arbitrary characters on both ends of a string in all the elements of a string array.
   side_spaces can be specified as a simple list of characters like " \t" as well as expressions like
   "[A-Z]" or "[^A-Z]" as in regular expressions. In addition, a character class can be specified
   inside "[...]". For the character classes that can be specified refer to the descriptions and
   Table 19 provided in §9.5.26.
   This member function executes the trim() member function for the tstring class on all the
   elements of an array. For more details refer to §9.5.26.

PARAMETER
   [I]  side_space  Arbitrary character
   [I]  side_spaces Arbitrary character string

RETURN VALUE
   Reference to itself

EXCEPTION
   If the system failed to secure an internal buffer.
EXAMPLE

The following code divides a CSV-format string into elements using the split() member function (§10.4.12), assigns them as an array to an object, and then eliminates any unnecessary white space characters on the right and left ends of each element using trim():

```cpp
tarray_tstring my_arr;
my_arr.split(" MZ-2500, PC-8801MR2 ,FV77AV ", ",", true);
my_arr.dprint();
my_arr.trim();
my_arr.dprint();
```

Result of execution

sli::tarray_tstring[0x7fbffff470] = {" MZ-2500", " PC-8801MR2 ", "FV77AV "}
sli::tarray_tstring[0x7fbffff470] = {"MZ-2500", "PC-8801MR2", "FV77AV"}  

10.4.29 ltrim()

NAME

ltrim() — Elimination of a space on the left end of all the elements

SYNOPSIS

```cpp
tarray_tstring &ltrim( const char *side_spaces = " \t\n\r\f\v" );
tarray_tstring &ltrim( const tstring &side_spaces );
tarray_tstring &ltrim( int side_space );
```

DESCRIPTION

Eliminates an arbitrary character on the left end of a string in all the elements of a string array.

side_spaces can be specified as a simple list of characters like " \t" as well as expressions like ":[A-Z]" or ":[^A-Z]" as in regular expressions. In addition, a character class can be specified inside ":[\[]". For the character classes that can be specified refer to the descriptions and Table 19 provided in §9.5.26.

This member function executes the ltrim() member function for the tstring class on all the elements of an array. For more details refer to §9.5.27.

PARAMETER

[I] side_space Arbitrary character
[I] side_spaces Arbitrary character string

RETURN VALUE

Reference to itself

EXCEPTION

If the system failed to secure an internal buffer.

10.4.30 rtrim()

NAME

rtrim() — Elimination of a space on the right end of all the elements
SYNOPSIS

tarray_tstring &rtrim( const char *side_spaces = " \t\n\r\f\v" );
tarray_tstring &rtrim( const tstring &side_spaces );
tarray_tstring &rtrim( int side_space );

DESCRIPTION

Eliminates an arbitrary character on the right end of a string in all the elements of a string array.

side_spaces can be specified as a simple list of characters like " \t" as well as expressions like "[A-Z]" or "[^A-Z]" as in regular expressions. In addition, a character class can also be specified inside "[...]". For the character classes that can be specified refer to the descriptions and Table 19 provided in §9.5.26.

This member function executes the rtrim() member function for the tstring class on all the elements of an array. For more details refer to §9.5.28.

PARAMETER

[I] side_space Arbitrary character
[I] side_spaces Arbitrary character string

RETURN VALUE

Reference to itself

EXCEPTION

If the system failed to secure an internal buffer.

10.4.31 strreplace()

NAME

strreplace() — String search and replacement of all the elements

SYNOPSIS

tarray_tstring &strreplace( const char *org_str, const char *new_str,
bool all = false );
tarray_tstring &strreplace( const tstring &org_str, const char *new_str,
bool all = false );
tarray_tstring &strreplace( const char *org_str, const tstring &new_str,
bool all = false );
tarray_tstring &strreplace( const tstring &org_str, const tstring &new_str,
bool all = false );

DESCRIPTION

Searches all the elements of a string array from the left side of a string for the string org_str, and if the string is found replaces it with the string new_str.

This member function executes the strreplace() member function for the tstring class on all the elements of an array (0 is set to pos). For more details refer to §9.5.29.

PARAMETER

[I] org_str String to be detected
[I] new_str String to be sourced for replacement
[I] all Replace All flag
RETURN VALUE
Reference to itself

EXCEPTION
If the system failed to secure an internal buffer.

EXAMPLE
The following code replaces the uppercase character version of N in all the elements with the lowercase version:

```c
    tarray_tstring my_arr("NEC", "NVIDIA", "HYNIX", NULL);
    my_arr.strreplace("N", "n", true);
    my_arr.dprint();
```

Result of execution
`sli::tarray_tstring[0x7fbffff470] = {"nEC", "nVIDIA", "HYnIX"}`

10.4.32 regreplace()

NAME
regreplace() — String search and replacement on all the elements using a regular expression

SYNOPSIS
```c
    tarray_tstring &regreplace( const char *pat,
                                const char *new_str, bool all = false );
    tarray_tstring &regreplace( const tstring &pat,
                                const char *new_str, bool all = false );
    tarray_tstring &regreplace( const tregex &pat,
                                const char *new_str, bool all = false );
    tarray_tstring &regreplace( const char *pat,
                                const tstring &new_str, bool all = false );
    tarray_tstring &regreplace( const tstring &pat,
                                const tstring &new_str, bool all = false );
    tarray_tstring &regreplace( const tregex &pat,
                                const tstring &new_str, bool all = false );
```

DESCRIPTION
Replaces with the string new_str parts all the elements of a string array that match the POSIX Extended Regular Expression (hereinafter referred to as a regular expression) specified by pat. Back references "\0" through "\9" can be used for new_str ("\0" refers to an entire matching part). If you want to use the backslash specify "\\".

This member function executes the regreplace() member function for the tstring class on all the elements of an array (0 is set to pos). For more details refer to §9.5.30.

If you do not need to use a regular expression the strreplace() member function (§10.4.31), which operates at higher speed, can be used.

PARAMETER
| [I] pat        | Character pattern (regular expression) or compiled object for the tregex class |
| [I] new_str    | String after the replacement                                                      |
| [I] all        | Replace All flag                                                                |
| (I : Input, O : Output) |                                                                                         |
RETURN VALUE
Reference to itself

EXCEPTION
If the system failed to secure an internal buffer.

EXAMPLE
The following code replaces the parts of all the elements that match "[- ]" with an underscore:

```c
    tarray_tstring my_arr("MZ-2000", "PC-88VA", "X1 turboZ III", NULL);
    my_arr.regreplace("[- ]", "," , true);
    my_arr.dprint();
```

Result of execution
sli::tarray_tstring[objc0x7fbffff470] = {"MZ_2000", "PC_88VA", "X1_turboZ_III"}

10.4.33 tolower()

NAME
tolower() — Replaces the uppercase version of characters in all the elements with the lowercase version

SYNOPSIS
```c
    tarray_tstring &tolower();
```

DESCRIPTION
Replaces the uppercase version of alphabetical characters in all the elements of a string array with the lowercase version.

This member function executes the tolower() member function for the tstring class on all the elements of an array. For more details refer to §9.5.31

RETURN VALUE
Reference to itself

10.4.34 toupper()

NAME
toupper() — Replaces the lowercase version of characters in all the elements with the uppercase version

SYNOPSIS
```c
    tarray_tstring &toupper();
```

DESCRIPTION
Replaces the lowercase version of alphabetical characters in all the elements of a string array with the uppercase version.

This member function executes the toupper() member function for the tstring class on all the elements of an array. For more details refer to §9.5.32

RETURN VALUE
Reference to itself
10.4.35 expand_tabs()

NAME
expand_tabs() — Replaces TAB characters in all the elements with white space characters

SYNOPSIS
tarray_tstring &expand_tabs( size_t tab_width = 8 );

DESCRIPTION
Replaces horizontal tabulation characters ’\t’ in all the elements of a string array with white space characters, tabulating to the value of tab_width.

This member function executes the expand_tabs() member function for the tstring class on all the elements of an array. For more details refer to §9.5.33.

PARAMETER
[I] tab_width  A TAB width

RETURN VALUE
Reference to itself

EXCEPTION
If the system failed to secure an internal buffer.

10.4.36 contract_spaces()

NAME
contract_spaces() — Replaces white space characters in all the elements with TAB characters

SYNOPSIS
tarray_tstring &contract_spaces( size_t tab_width = 8 );

DESCRIPTION
Replaces with ’\t’ all occurrences of two or more contiguous white space characters ’ ’ in all the elements of a string array that tabulate to the specified TAB width of tab_width.

This member function executes the contract_spaces() member function for the tstring class on all the elements of an array. For more details §9.5.34.

PARAMETER
[I] tab_width  A TAB width

RETURN VALUE
Reference to itself

EXCEPTION
If the system failed to secure an internal buffer.
## 10.4.37  find_elem()

**NAME**
find_elem() — Searches from the left side (start) for an array element

**SYNOPSIS**

```c
ssize_t find_elem( const char *str ) const;
ssize_t find_elem( size_t idx, const char *str ) const;
ssize_t find_elem( size_t idx, const char *str, size_t *nextidx ) const;
ssize_t find_elem( const tstring &str ) const;
ssize_t find_elem( size_t idx, const tstring &str ) const;
ssize_t find_elem( size_t idx, const tstring &str, size_t *nextidx ) const;
```

**DESCRIPTION**
Searches array elements from the left side for an element that exactly matches the string `str`, and if an element is found returns the element number for the element but if no element is found returns a negative number.

If you want the search to start from a specific element the start position can be specified using the argument `idx`. Please note that the element number for the first element of arrays is always 0.

If you want to continuously search for elements `nextidx` can be used to acquire the value that should be provided to `idx` in the next iteration. For the variable referred to by `nextidx`, if an element is found, the position one element to the right of the position in which the element was found is returned, but if no element is found the length of an array of the function itself. If you do not need to acquire a value using `nextidx` NULL can also be used.

**PARAMETER**

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>[I]</td>
<td>idx</td>
</tr>
<tr>
<td>[I]</td>
<td>str</td>
</tr>
<tr>
<td>[O]</td>
<td>nextidx</td>
</tr>
</tbody>
</table>

**RETURN VALUE**

- **Non-negative value**: If an element that matches `str` is found the element number of the element.
- **Negative value (Error)**: If no element that matches `str` is found.
  - If there is no string inside an object.
  - If `idx` has a value larger than the length of an array specified to it.
  - If `str` is NULL.

**EXAMPLE**
The following code searches the string array `my_arr`, and then lists the elements that match "INTEL" in the order of from the beginning of the array. `idx` provides the element number from which to start detection, and these addresses are provided to the last value for the `find_elem()` member function to ensure that the appropriate values are automatically used:

```c
stdstreamio sio;
tarray_tstring my_arr;
size_t idx = 0;
ssize_t fidx;
my_arr.assign("ZILOG", "INTEL", "INTEL", "MOTOROLA", "MOS", NULL);
```
while ( 0 <= (fidx=my_arr.find_elem(idx, "INTEL", &idx)) ) {
    sio.printf("in: fidx=%zd nextidx=%zu\n", fidx, idx);
}

sio.printf("out: fidx=%zd nextidx=%zu\n", fidx, idx);

Result of execution
in : fidx=1 nextidx=2
in : fidx=2 nextidx=3
out: fidx=-1 nextidx=5

10.4.38 rfind_elem()

NAME
rfind_elem() — Searches from the right side (end) for an array element

SYNOPSIS
ssize_t rfind_elem( const char *str ) const;
ssize_t rfind_elem( size_t idx, const char *str ) const;
ssize_t rfind_elem( size_t idx, const char *str, size_t *nextidx ) const;
ssize_t rfind_elem( const tstring &str ) const;
ssize_t rfind_elem( size_t idx, const tstring &str ) const;
ssize_t rfind_elem( size_t idx, const tstring &str, size_t *nextidx ) const;

DESCRIPTION
Searches array elements from the right side for an element that exactly matches the string str, and if the element is found, returns the element number for the element but if no element is found returns a negative number.

If you want the search to start from a specific element the start position can be specified using the argument idx. Please note that the element number for the first element of arrays is always 0.

If you want to continuously search for elements nextidx can be used to acquire the value that should be provided to idx in the next iteration. With the variable referred to by nextidx, if an element is found when idx is 1 or more the position one element to the left of the position in which the element was found is returned, but otherwise the length of the array of the function itself is returned. If you do not need to acquire a value using nextidx NULL can also be used.

PARAMETER
[I] idx Position to start searching for an array element
[I] str String that matches an element value to be detected
[O] nextidx idx for use in next search (Used in continuous searches)

RETURN VALUE
Non-negative value : If an element that matches str is found the element number of the element.
Negative value (Error) : If no element that matches str is found.
: If there is no string inside an object.
: If idx has a value larger than the length of an array specified to it.
: If str is NULL.
EXAMPLE
The following code searches the string array `my_arr`, and then lists the elements that match
"INTEL" in the order of from the end of the array. `idx` is the element number from which
to start detection, and these addresses are provided to the last value for the `rfind_elem()`
member function to ensure that the appropriate values are automatically used:

```c
stdstreamio sio;
tarray_tstring my_arr;
ssize_t idx;
ssize_t fidx;
my_arr.assign("ZILOG", "INTEL", "INTEL", "MOTOROLA", "MOS", NULL);
idx = my_arr.length() - 1;
while ( 0 <= (fidx=my_arr.rfind_elem(idx, "INTEL", &idx)) ) {
    sio.printf("in : fidx=%zd nextidx=%zu\n", fidx, idx);
}
sio.printf("out: fidx=%zd nextidx=%zu\n", fidx, idx);
```

Result of execution
```
in : fidx=2 nextidx=1
in : fidx=1 nextidx=0
out: fidx=-1 nextidx=5
```

10.4.39 find()

NAME
find() — Searches an array from the left side (start) for a string

SYNOPSIS
```c
ssize_t find( const char *str, ssize_t *pos_r ) const;
ssize_t find( size_t idx, size_t pos, const char *str,
ssize_t *pos_r ) const;
ssize_t find( size_t idx, size_t pos, const char *str,
ssize_t *pos_r, size_t *nextidx, size_t *nextpos ) const;
ssize_t find( const tstring &str, ssize_t *pos_r ) const;
ssize_t find( size_t idx, size_t pos, const tstring &str,
ssize_t *pos_r ) const;
ssize_t find( size_t idx, size_t pos, const tstring &str,
ssize_t *pos_r, size_t *nextidx, size_t *nextpos ) const;
```

DESCRIPTION
Searches array elements from the left side for an element that includes the string `str`, and
if an element is found returns the element number of the element but if no element is found
returns a negative number as the return value for the member function. If an element is
found it also concurrently returns the position of the string in that element to a variable
referred to by `pos_r`.

If you want the search to start from the position of a specific string in a specific element
the start position can be specified using the arguments `idx` and `pos`. Please note that the
element number for the first element both in arrays and strings is always 0. If the arguments
`idx` and `pos` are omitted the search will start from the beginning of the strings in an element
with the element number 0.
If you want to continuously search for elements `nextidx` and `nextpos` can be used to acquire the values that should be provided to `idx` and `pos` in the next iteration. These values can be more easily understood by examining some example code than by reading a text description. Refer to EXAMPLE provided below.

If you do not need to acquire values using `pos_x`, `nextidx` and `nextpos` NULL can also be used.

**PARAMETER**

| I  | idx     | Position to start searching for an array element |
| I  | pos     | Position to start searching for a string        |
| I  | str     | String to be detected                           |
| O  | pos_r   | If an element is found the position of the string in the element |
| O  | nextidx | idx for use in next search (Used in continuous searches) |
| O  | nextpos | pos for use in next search (Used in continuous searches) |

(I : Input, [O] : Output)

**RETURN VALUE**

- Non-negative value: If the string specified is found the element number of the element.
- Negative value (Error): If a string specified is not found.
- If there is no string inside an object.
- If `idx` has a value larger than the length of an array specified to it.
- If `pos` has a value larger than the length of a string specified to it.
- If `str` is NULL.

**EXAMPLE**

The following code searches the string array `my_arr`, and the lists the parts that include "80" in the order of from the beginning of the array. `idx` and `pos` are the element number and string position from which to start detection, and these addresses are provided to the last two values for the find() member function to ensure that the appropriate values are automatically used:

```c
stdio_tstring sio;
tarray_tstring my_arr;
size_t idx = 0, pos = 0;
ssize_t fidx, fpos;
my_arr.assign("Z80", "8080", "8086", "6800", "6502", NULL);
while ( 0 <= (fidx=my_arr.find(idx, pos, "80", &fpos, &idx, &pos)) ) {
    sio.printf("in : fidx=%zd fpos=%zd nextidx=%zu nextpos=%zu\n", fidx, fpos, idx, pos);
}
sio.printf("out: fidx=%zd fpos=%zd nextidx=%zu nextpos=%zu\n", fidx, fpos, idx, pos);
```

Result of execution

```
in : fidx=0 fpos=1 nextidx=0 nextpos=3
in : fidx=1 fpos=0 nextidx=1 nextpos=2
in : fidx=1 fpos=2 nextidx=1 nextpos=4
in : fidx=2 fpos=0 nextidx=2 nextpos=2
```
10.4.40  rfind()

NAME

rfind() — Searches an array from the right side (end) for a string

SYNOPSIS

```c
ssize_t rfind( const char *str, ssize_t *pos_r ) const;
ssize_t rfind( size_t idx, size_t pos, const char *str,
              ssize_t *pos_r ) const;
ssize_t rfind( size_t idx, size_t pos, const char *str,
              ssize_t *pos_r, size_t *nextidx, size_t *nextpos ) const;
ssize_t rfind( const tstring &str, ssize_t *pos_r ) const;
ssize_t rfind( size_t idx, size_t pos, const tstring &str,
              ssize_t *pos_r ) const;
ssize_t rfind( size_t idx, size_t pos, const tstring &str,
              ssize_t *pos_r, size_t *nextidx, size_t *nextpos ) const;
```

DESCRIPTION

Searches array elements from the right side for an element that includes the string \texttt{str}, and if the element is found returns the element number of the element but if no element is found returns a negative number as the return value for the member function. If an element is found it also concurrently returns the position of the string in that element to the variable referred to by \texttt{pos_r}.

If you want the search to start from the position of a specific string in a specific element the start position can be specified using the arguments \texttt{idx} and \texttt{pos}. Please note that the element number for the first element (on the left end) both in arrays and strings is always 0. If the arguments \texttt{idx} and \texttt{pos} are omitted the search will start from the end (string length) of the strings in the last element (number of elements − 1).

If you want to continuously search for elements \texttt{nextidx} and \texttt{nextpos} can be used to acquire the values that should be provided to \texttt{idx} and \texttt{pos} in the next iteration. These values can be more easily understood by examining some example code than by reading a text description. Refer to the EXAMPLE provided below.

If you do not need to acquire values using \texttt{pos_r}, \texttt{nextidx} and \texttt{nextpos} \texttt{NULL} can also be used.

PARAMETER

[I] \texttt{idx}  Position to start searching for an array element
[I] \texttt{pos}  Position to start searching for a string
[I] \texttt{str}  String to be detected
[O] \texttt{pos_r}  If an element is found the position of the string in the element
[O] \texttt{nextidx}  idx for use in next search (Used in continuous searches)
[O] \texttt{nextpos}  pos for use in next search (Used in continuous searches)

Remarks:

(I) : Input, (O) : Output

RETURN VALUE
Non-negative value: If the string specified is found the element number of the element.

Negative value (Error): If a string that is specified is not found.
   : If there is no string inside an object.
   : If idx has a value larger than the length of an array specified to it.
   : If pos has a value larger than the length of a string specified to it.
   : If str is NULL.

EXAMPLE

The following code searches the string array my_arr, and then lists parts that include "80" in the order of from the end of the array. idx and pos are the element number and string position from which to start detection, and these addresses are provided to the last two values for the rfind() member function to ensure that the appropriate values are automatically used:

```c++
#include "tstring_tarray.h"

int main() {
    stdstreamio sio;
tarray_tstring my_arr;
size_t idx, pos;
ssize_t fidx, fpos;
my_arr.assign("Z80", "8080", "8086", "6800", "6502", NULL);
idx = my_arr.length() - 1;
pos = my_arr.length(idx);
while ( 0 <= (fidx=my_arr.rfind(idx, pos, "80", &fpos, &idx, &pos)) ) {
    sio.printf("in : fidx=%zd fpos=%zd nextidx=%zu nextpos=%zu\n",
               fidx, fpos, idx, pos);
}
sio.printf("out: fidx=%zd fpos=%zd nextidx=%zu nextpos=%zu\n",
               fidx, fpos, idx, pos);

Result of execution:

in : fidx=3 fpos=1 nextidx=2 nextpos=4
in : fidx=2 fpos=0 nextidx=1 nextpos=4
in : fidx=1 fpos=2 nextidx=1 nextpos=0
in : fidx=1 fpos=0 nextidx=0 nextpos=3
in : fidx=0 fpos=1 nextidx=5 nextpos=4
out: fidx=-1 fpos=-1 nextidx=5 nextpos=4
```

10.4.41 find_matched_str()

NAME

find_matched_str() — Searches for an element (string) that matches a pattern

SYNOPSIS

```c++
ssize_t find_matched_str( const char *pat ) const;
ssize_t find_matched_str( size_t idx, const char *pat ) const;
ssize_t find_matched_str( size_t idx, const char *pat, size_t *nextidx ) const;
ssize_t find_matched_str( const tstring &pat ) const;
ssize_t find_matched_str( size_t idx, const tstring &pat ) const;
ssize_t find_matched_str( size_t idx, const tstring &pat, size_t *nextidx ) const;
```
DESCRIPTION
Attempts string matching on array elements in the order of from the left side using Shell’s wild card patterns, and if an element matches the pattern returns the element number.

If you need to treat a period `'.'` at the beginning of a string or a slash `'/'` in a special manner use the find_matched_fn() member function ([10.4.42] or the find_matched_pn() member function ([10.4.43]).

This member function executes the strmatch() member function for the tstring class on all the elements of an array in order (0 is set to pos). For more details refer to §9.5.58.

If you want the search to start from a specific element the start position can be specified using the argument idx. Please note that the element number for the first element of arrays is always 0.

If you want to continuously search for elements nextidx can be used to acquire the value that should be provided to idx in the next iteration. With the variable referred to by nextidx, if an element that matches is found the position one element to the right of the position in which the element was found is returned but if no element is found the length of the array of the function itself is returned. If you do not need to acquire a value using nextidx NULL can also be used.

PARAMETER
[I] idx  Position to start searching for an array element
[I] pat  String that matches an element value to be detected
[O] nextidx idx for use in next search (Used in continuous searches)

RETURN VALUE
Non-negative value : If an element that matches is found the element number of the element.
Negative value (Error) : If no element that matches is found.
: If there is no string inside an object.
: If idx has a value larger than the length of an array specified to it.
: If pat is NULL.

EXAMPLE
The following code searches the string array my_arr, and then lists elements that match "MO*" in the order of from the beginning of the array. idx is the element number from which to start detection, and these addresses are provided to the last value for the find_matched_str() member function to ensure that the appropriate values are automatically used:

```c
stdstreamio sio;
tarray_tstring my_arr;
size_t idx = 0;
ssize_t fidx;
my_arr.assign("ZILOG", "INTEL", "MOTOROLA", "MOS", "AMD", NULL); while ( 0 <= (fidx=my_arr.find_matched_str(idx, "MO*", &idx)) ) {
    sio.printf("in : fidx=%zd nextidx=%zu\n", fidx, idx);
} sio.printf("out: fidx=%zd nextidx=%zu\n", fidx, idx);
```

Result of execution
in : fidx=2 nextidx=3
10.4.42 find_matched_fn()

NAME
find_matched_fn() — Searches for an element (file name) that matches a pattern

SYNOPSIS

```
ssize_t find_matched_fn( const char *pat ) const;
ssize_t find_matched_fn( size_t idx, const char *pat ) const;
ssize_t find_matched_fn( size_t idx, const char *pat, size_t *nextidx ) const;
ssize_t find_matched_fn( const tstring &pat ) const;
ssize_t find_matched_fn( size_t idx, const tstring &pat ) const;
ssize_t find_matched_fn( size_t idx, const tstring &pat, size_t *nextidx ) const;
```

DESCRIPTION
Attempts string matching on array elements in the order from the left side using Shell’s wild card patterns, and if an element matches the pattern returns the element number.

The find_matched_fn() function is assumed to be used in searches for file names, and hence treats the period ‘.’ at the beginning of a string in a special manner. In other words, the function disables the wild cards ‘*’ and ‘?’ to match the period ‘.’ at the beginning of a string.

If you need to treat a slash ‘/’ in a special manner use the find_matched_fn() member function (§10.4.43).

This member function executes the fnmatch() member function for the tstring class on all the elements of an array in order (0 is set to pos). For more details refer to §9.5.58.

If you want the search to start from a specific element the start position can be specified using the argument idx. Please note that the element number for the first element of arrays is always 0.

If you want to continuously search for elements nextidx can be used to acquire the value that should be provided to idx in the next iteration. With the variable referred to by nextidx, if an element that matches is found the position one element to the right of the position in which the element was found is returned but if no element is found the length of the array of the function itself is returned. If you do not need to acquire a value using nextidx NULL can also be used.

PARAMETER
| [I] idx   | Position to start searching for an array element |
| [I] pat   | String that matches an element value to be detected |
| [O] nextidx | idx for use in next search (Used in continuous searches) |

RETURN VALUE
Non-negative value : If an element that matches is found the element number of the element.
Negative value (Error) : If no element that matches is found.
: If there is no string inside an object.
: If idx has a value larger than the length of an array specified to it.
: If pat is NULL.
EXAMPLE
Refer to the EXAMPLE in §10.4.41.

10.4.43 find_matched_pn()

NAME
find_matched_pn() — Searches for an element (path name) that matches a pattern

SYNOPSIS

ssize_t find_matched_pn( const char *pat ) const;
ssize_t find_matched_pn( size_t idx, const char *pat ) const;
ssize_t find_matched_pn( size_t idx, const char *pat, size_t *nextidx ) const;
ssize_t find_matched_pn( const tstring &pat ) const;
ssize_t find_matched_pn( size_t idx, const tstring &pat ) const;
ssize_t find_matched_pn( size_t idx, const tstring &pat, size_t *nextidx ) const;

DESCRIPTION
Attempts string matching on array elements in the order of from the left side using Shell’s
wild card patterns, and if an element matches the pattern returns the element number.

The find_matched_pn() member function is assumed to be used in searches for path names,
and hence treats the period ’.’ at the beginning of a string, a slash ’/’ and the period that
immediately follows a slash in a special manner. The function disables the wild cards ’*’
and ’?’ to match these characters.

This member function executes the pnmatch() member function for the tstring class on all
the elements of an array in order (0 is set to pos). For more details refer to §9.5.58.

If you want the search to start from a specific element the start position can be specified
using the argument idx. Please note that the element number for the first element of arrays
is always 0.

If you want to continuously search for elements nextidx can be used to acquire the value that
should be provided to idx in the next iteration. With the variable referred to by nextidx,
if an element that matches is found the position one element to the right of the position in
which the element was found is returned but if no element is found the length of the array
in the function is returned. If you do not need to acquire a value using nextidx NULL can
also be used.

PARAMETER
[I] idx Position to start searching for an array element
[I] pat String that matches an element value to be detected
[O] nextidx idx for use in next search (Used in continuous searches)

RETURN VALUE
Non-negative value : If an element that matches is found the element number of the
element.
Negative value (Error) : If no element that matches is found.
: If there is no string inside an object.
: If idx has a value larger than the length of an array specified
to it.
: If pat is NULL.

EXAMPLE
Refer to the EXAMPLE in §10.4.41.
10.4.44  regmatch() [Normal edition]

NAME
regmatch() — Searches for a string using an extended regular expression

SYNOPSIS

ssize_t regmatch( const char *pat, ssize_t *pos_r,
                 size_t *span_r ) const; .......................... 1
ssize_t regmatch( size_t idx, size_t pos, const char *pat,
                 ssize_t *pos_r, size_t *span_r ) const; .......... 2
ssize_t regmatch( size_t idx, size_t pos, const char *pat,
                 ssize_t *pos_r, size_t *span_r,
                 size_t *nextidx, size_t *nextpos ) const; .......... 3
ssize_t regmatch( const tstring &pat, ssize_t *pos_r,
                 size_t *span_r ) const; .......................... 4
ssize_t regmatch( size_t idx, size_t pos, const tstring &pat,
                 ssize_t *pos_r, size_t *span_r ) const; .......... 5
ssize_t regmatch( size_t idx, size_t pos, const tstring &pat,
                 ssize_t *pos_r, size_t *span_r,
                 size_t *nextidx, size_t *nextpos ) const; .......... 6
ssize_t regmatch( const tregex &pat, ssize_t *pos_r,
                 size_t *span_r ) const; .......................... 7
ssize_t regmatch( size_t idx, size_t pos, const tregex &pat,
                 ssize_t *pos_r, size_t *span_r ) const; .......... 8
ssize_t regmatch( size_t idx, size_t pos, const tregex &pat,
                 ssize_t *pos_r, size_t *span_r,
                 size_t *nextidx, size_t *nextpos ) const; .......... 9

DESCRIPTION

Searches array elements from the left side for an element that includes the part that matches
the POSIX Extended Regular Expression (hereinafter referred to as a regular expression)
specified by \texttt{pat}, and if a part matches the expression returns the element number but if no
part matches the expression returns a negative number as the return value for the member
function. If a part matches the expression it also concurrently returns to the variables referred
to by \texttt{pos} and \texttt{span} the character position and length of the part of the element that
matches the expression.

If you want the search to start from the position of a specific string in a specific element
the start position can be specified using the arguments \texttt{idx} and \texttt{pos}. Please note that the
element number for the first element both in arrays and strings is always 0. If the arguments
\texttt{idx} and \texttt{pos} are omitted the search will start from the beginning of strings in an element
with the element number 0.

Member functions 1 to 6 compile the regular expression \texttt{pat}, save the result to an internal
buffer that the functions encompass, and then perform matching (If \texttt{pat} is the same as the
one previously compiled it is not recompiled again).

Member functions 7 to 9 specify an object for the tregex class that will retain the result of
compiling the regular expression. The regular expression will therefore need to be compiled in
advance using the compile() member function for the tregex class before use of the regmatch()
member function (Refer to the EXAMPLE).
In both cases if the function fails to compile the regular expression it outputs the content to standard error output.

If you want to continuously search for elements `nextidx` and `nextpos` can be used to acquire the values that should be provided to `idx` and `pos` in the next iteration. These values can be more easily understood by examining some example of the code than by reading a text description. Refer to the EXAMPLE provided below.

If you do not need to acquire values using `pos_r`, `nextidx` and `nextpos` NULL can also be used.

For more details on regular expressions refer to §9.5.59.

**PARAMETER**

[I] `idx`  Position to start searching for an array element
[I] `pos`  Position to start searching for a string
[I] `pat`  Regular expression to be used in search
[O] `pos_r`  If a part matches the expression the character position of the part of that element that matches the expression.
[O] `span_r`  If a part matches the expression the character length of the part of that element that matches the expression.
[O] `nextidx`  idx for use in next search (Used in continuous searches)
[O] `nextpos`  pos for use in next search (Used in continuous searches)


**RETURN VALUE**

Non-negative value  :  If a specified regular expression matches a part the element number of the element.
Negative value (Error)  :  If a specified regular expression does not match any part.
                        :  If there is no string inside an object.
                        :  If `idx` has a value larger than the length of an array specified to it.
                        :  If `pos` has a value larger than the length of a string specified to it.
                        :  If a regular expression specified by `pat` is invalid (For more details refer to §9.5.59).

**EXAMPLE**

The following code searches the string array `my_arr`, and then lists the parts that include the regular expression `"http://[^/]++\.jp/"` in the order of from the beginning of the array. `idx` and `pos` are the element number and string position from which to start detection, and these addresses are provided to the last two values for the regmatch() member function to ensure that appropriate values are automatically used:

```c
stdafxio sio;
tarray_tstring my_arr("http://www.jaxa.jp/", "http://www.noao.edu/", NULL);
size_t fspan, idx = 0, pos = 0;
ssize_t fidx, fpos;
tregex pat;
pat.compile("http://[^/]++\.jp/");
while ( 0 <= (fidx=my_arr.regmatch(idx,pos,pat, &fpos,&fspan,&idx,&pos)) ) {
    sio.printf("in : fidx=%zd fpos=%zd fspan=%zd nextidx=%zu nextpos=%zu\n",
                fidx, fpos, fspan, idx, pos);
}
```
sio.printf("out: fidx=%zd fpos=%zd fspan=%zd nextidx=%zu nextpos=%zu\n",
    fidx, fpos, fspan, idx, pos);
pat.init();

Result of execution
in : fidx=0 fpos=0 fspan=19 nextidx=0 nextpos=19
out: fidx=-1 fpos=-1 fspan=0 nextidx=2 nextpos=21

10.4.45  regmatch() [Advanced edition]

NAME
regmatch() — Searches for a string using an extended regular expression

SYNOPSIS

ssize_t regmatch( const char *pat, tarray_tstring *result ); .................. 1
ssize_t regmatch( size_t idx, size_t pos, const char *pat,
    tarray_tstring *result ); ........................................ 2
ssize_t regmatch( size_t idx, size_t pos, const char *pat,
    tarray_tstring *result,
    size_t *nextidx, size_t *nextpos ); .......................... 3
ssize_t regmatch( const tstring &pat, tarray_tstring *result ); .......... 4
ssize_t regmatch( size_t idx, size_t pos, const tstring &pat,
    tarray_tstring *result ); ........................................ 5
ssize_t regmatch( size_t idx, size_t pos, const tstring &pat,
    tarray_tstring *result,
    size_t *nextidx, size_t *nextpos ); ....................... 6
ssize_t regmatch( const tregex &pat, tarray_tstring *result ) const; ..... 7
ssize_t regmatch( size_t idx, size_t pos, const tregex &pat,
    tarray_tstring *result ) const; .............................. 8
ssize_t regmatch( size_t idx, size_t pos, const tregex &pat,
    tarray_tstring *result,
    size_t *nextidx, size_t *nextpos ) const; ................ 9

DESCRIPTION
Searches array elements from the left side for an element that includes the part that matches
the POSIX Extended Regular Expression (hereinafter referred to as a regular expression)
specified by pat, and if a part matches the expression returns the element number but
if no part matches the expression returns a negative number as the return value for the
member function. If a part matches the expression it also concurrently returns to the string
array object result information that includes the back reference for the part of the element
matching the expression.

These member functions perform regular expression matching using the regassign() member
function for the argument object result. The method of acquiring the result information on
the part that matches the expression is therefore the same as when the regassign() member
function is used. For more details on the method refer to §10.4.13.

If you want the search to start from the position of a specific string in a specific element
the start position can be specified using the arguments idx and pos. Please note that the
element number for the first element both in arrays and strings is always 0. If the arguments
idx and pos are omitted the search will start from the beginning of strings in an element
with the element number 0.
Member functions 1 to 6 compile the regular expression `pat`, save the result to an internal buffer that the functions encompass, and then perform the matching. (If `pat` is the same as the one previously compiled it is not recompiled again).

Member functions 7 to 9 specify an object for the `tregex` class that retains the result of compiling the regular expression. The regular expression therefore needs to be compiled in advance using the `compile()` member function for the `tregex` class before use of the `regmatch()` member function (Refer to the EXAMPLE).

In both cases if the function fails to compile the regular expression it outputs the content to standard error output.

If you want to continuously search for elements `nextidx` and `nextpos` can be used to acquire the values that should be provided to `idx` and `pos` in the next iteration. These values can be more easily understood by examining some example code than by reading a text description. For more details on regular expressions refer to §10.4.44.

If you do not need to acquire values using `nextidx` and `nextpos` NULL can also be used.

For more details on regular expressions refer to §9.5.59.

**PARAMETER**

| I   | idx       | Position to start searching for an array element |
| I   | pos       | Position to start searching for a string        |
| I   | pat       | Regular expression to be used in search        |
| O   | result    | If a part matches the expression the result information on the part of the element that matches the expression. |
| O   | nextidx   | idx for use in next search (Used in continuous searches) |
| O   | nextpos   | pos for use in next search (Used in continuous searches) |


**RETURN VALUE**

Non-negative value : If a specified regular expression matches a part the element number of the element.

Negative value (Error) : If a specified regular expression does not match any part.

: If there is no string inside an object.

: If `idx` has a value larger than the length of an array specified to it.

: If `pos` has a value larger than the length of a string specified to it.

: If a regular expression specified by `pat` is invalid (For more details refer to §9.5.59).

: If `result` is NULL.

: If the function itself is specified to `result`.

**EXAMPLE-1**

The following code searches the string array `my_arr` for an element that matches the regular expression `"\((\[\ ]+)(\[\ ]*=[\ ]*)(\[\ ]*\[\ ]*=(\[\ ]*\[\ ]*))\"`, and if an element is found then displays the back reference elements 2 and 4 as the key and value respectively:

```c++
stdstreamio sio;
tarray_tstring my_arr("HEADER",
    " ARCHITECTURE = x86_64 / CPU = AMD", "OS = Linux ",
    NULL);
tarray_tstring my_result;
```
size_t pos = 0, idx = 0;
tregex pat;
pat.compile("^[ ]*([ ]*=)+([ ])*([ ]*)$\); 
while ( 0 <= my_arr.regmatch(idx, pos, pat, &my_result, &idx, &pos) ) {
  if ( my_result.length() == 5 ) {
    sio.printf("key=[%s] value=[%s]\n",
              my_result.cstr(2), my_result.cstr(4));
  }
}
pat.init();

Result of execution
key=[ARCHITECTURE] value=[x86_64]
key=[OS] value=[Linux]

EXAMPLE-2

The following code also has the same result as in EXAMPLE-1, but in this example the
regular expression "^\" is not used and instead the method of retrieving the "part of each
element that first matches the expression". The code in EXAMPLE 1 is safer to use.

stdstreamio sio;
tarray_tstring my_arr("HEADER",
" ARCHITECTURE = x86_64 / CPU = AMD", "OS = Linux ",
NULL);
tarray_tstring my_result;
ssize_t i;
tregex pat;
pat.compile("([ ]*=)+([ ])*([ ]*)$\);
for ( i=0 ; 0 <= (i=my_arr.regmatch(i, 0, pat, &my_result)) ; i++ ) {
  if ( my_result.length() == 4 ) {
    sio.printf("key=[%s] value=[%s]\n",
              my_result.cstr(1), my_result.cstr(3));
  }
}
pat.init();
11 ASARRAY_TSTRING class

The asarray_tstring class enables users to handle associative arrays of strings more easily. The class has the implementation requirement that normal string arrays have to be indexed in ensuring that its associative arrays will provide both high-speed read access along with the benefits that normal arrays provide.

	array_tstring class (§10) is used inside objects to manage keys and values, and can be combined with array_tstring class and tstring class (§9) APIs to provide easily used string array APIs.

The class has the following characteristics:

- Memory is automatically secured and hence objects can be assigned immediately after being created.

- The printf() notation can be used with many of the member functions.

- A wealth of other tstring class member functions are available for use through [], the at() member function and the atf() member function.

- Can be used to easily divide space-delimited, TAB-delimited or CSV-format strings.

- Keys are managed by a dictionary and hence the values can be retrieved very fast.

- Member functions are available that enable users to edit the all the elements of strings in arrays in a single stroke (e.g., chomp(), trim(), etc.). The functions can be used in the same manner as with the tstring class (§9).

- The keys() member function (§11.4.8) and values() member function (§11.4.9) make the search processing APIs (regular expressions etc) that use the array_tstring class available for use with internal key arrays and value arrays.

If you use the asarray_tstring class you must add “#include <sli/asarray_tstring.h>” to the code. In addition, if you need to declare a namespace (§1.1) you must also add “using namespace sli;” to the code.

The following is a simple example of using the class.
#include <sli/stdstreamio.h>
#include <sli/asarray_tstring.h>
using namespace sli;

int main()
{
    stdstreamio sio;
    asarray_tstring my_aarr;
    /* Assign "RedHat" with a key as "VENDOR" */
    my_aarr["VENDOR"] = "RedHat";
    /* Assign "Linux" with a key as "OS" */
    my_aarr["OS"] = "Linux";
    /* Assign "2", "4" and "30" with keys as "VERSION_0", "VERSION_1" and "VERSION_2" */
    size_t i=0;
    my_aarr.atf("VERSION_%d",i++).printf("2");
    my_aarr.atf("VERSION_%d",i++).printf("4");
    my_aarr.atf("VERSION_%d",i++).printf("30");
    /* Display all the elements */
    for ( i=0 ; i < my_aarr.length() ; i++ ) {
        const char *key = my_aarr.key(i);
        sio.printf("%s ... [\%s]\n", key, my_aarr.cstr(key));
    }
    return 0;
}

Result of execution
VENDOR ... [RedHat]
OS ... [Linux]
VERSION_0 ... [2]
VERSION_1 ... [4]
VERSION_2 ... [30]

11.1 Creating objects

There are the three methods of providing objects with an initial value\textsuperscript{13}).

With the first method no arguments are specified.

\begin{quote}
asarray_tstring my_arr0;
\end{quote}

In this situation neither a buffer for the string nor a buffer for the pointer array is secured.

The second method provides objects with an initial value using a variable-length argument.

\begin{quote}
asarray_tstring my_arr0("OS","Solaris", "VENDOR","Sun", NULL);
\end{quote}

In this case an associative array is initialized using the key and value strings provided. The arguments are provided in the order of key string 0, value string 0, key string 1, value string1 ... The end of the arguments must always be NULL.

The third method provides an array of the asarrdef_tstring structure type. The following is an example of this:

\begin{quote}
    asarrdef_tstring my_def0[] = { {"OS","Solaris"}, {"VENDOR","Sun"},
                                 {NULL,NULL} };
    asarray_tstring my_arr0(my_def0);
\end{quote}

The last element of an array for the structure must always be \{NULL,NULL\}.

\textsuperscript{13}) The class does not include the operating modes the tstring class \([\textsection 9]\) does.
11.2 List of member functions

Table 23 lists the member functions.

<table>
<thead>
<tr>
<th>Name of member function</th>
<th>Feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ ]</td>
<td>Reference to the element value object (tstring class) corresponding to a specified key</td>
</tr>
<tr>
<td>=</td>
<td>Copies objects</td>
</tr>
<tr>
<td>length()</td>
<td>Length of associative array (number of arrays), and length of value string</td>
</tr>
<tr>
<td>cstrarray()</td>
<td>Pointer array (NULL-terminated) for a value string</td>
</tr>
<tr>
<td>cstr(), cstrf()</td>
<td>Value string corresponding to a specified key or element number</td>
</tr>
<tr>
<td>at(), atf()</td>
<td>Reference to the element value object (tstring class) corresponding to a specified key or element number</td>
</tr>
<tr>
<td>at_cs(), atf_cs()</td>
<td>Reference to the element value object (tstring class) corresponding to a specified key or element number (Read only)</td>
</tr>
<tr>
<td>index()</td>
<td>Acquires the element number corresponding to a key string</td>
</tr>
<tr>
<td>key()</td>
<td>Acquires the key string corresponding to an element number</td>
</tr>
<tr>
<td>keys()</td>
<td>References the array object for a key string (Read only)</td>
</tr>
<tr>
<td>values()</td>
<td>References the array object for a value string (Read only)</td>
</tr>
</tbody>
</table>

Table 23: List of member functions available for use with the asarray_tstring class (Continued on next page)
<table>
<thead>
<tr>
<th>Name of member function</th>
<th>Feature</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>dprint()</code></td>
<td>Outputs object information to standard error output (For use debugging user programs)</td>
</tr>
<tr>
<td><code>swap()</code></td>
<td>Interchanges objects</td>
</tr>
<tr>
<td><code>init()</code></td>
<td>Complete initialization of objects</td>
</tr>
<tr>
<td><code>assign()</code>, <code>assignf()</code></td>
<td>Initialization of objects and assignment of elements (Specifies a single set of a key and a value)</td>
</tr>
<tr>
<td><code>assign()</code>, <code>vassign()</code></td>
<td>Initialization of objects and assignment of elements (Specifies multiple sets of a key and a value)</td>
</tr>
<tr>
<td><code>assign_keys()</code></td>
<td>Sets multiple strings or a string array to keys</td>
</tr>
<tr>
<td><code>assign_values()</code></td>
<td>Sets multiple strings or a string array to values</td>
</tr>
<tr>
<td><code>split_keys()</code></td>
<td>Divides strings and sets them to keys</td>
</tr>
<tr>
<td><code>split_values()</code></td>
<td>Divides strings and sets them to values</td>
</tr>
<tr>
<td><code>append()</code>, <code>appendf()</code></td>
<td>Adds elements (Specifies a single set of a key and a value)</td>
</tr>
<tr>
<td><code>append()</code>, <code>vappend()</code></td>
<td>Adds elements (Specifies multiple sets of a key and a value)</td>
</tr>
<tr>
<td><code>insert()</code>, <code>insertf()</code></td>
<td>Inserts elements (Specifies a single set of a key and a value)</td>
</tr>
<tr>
<td><code>insert()</code>, <code>vinser()</code></td>
<td>Inserts elements (Specifies multiple sets of a key and a value)</td>
</tr>
<tr>
<td><code>erase()</code></td>
<td>Deletes elements</td>
</tr>
<tr>
<td><code>clean()</code></td>
<td>Pads all the element values of an existing associative array with any string</td>
</tr>
<tr>
<td><code>rename_a_key()</code></td>
<td>Changes of key strings</td>
</tr>
<tr>
<td><code>chomp()</code></td>
<td>Elimination of newline characters in all the elements</td>
</tr>
<tr>
<td><code>trim()</code></td>
<td>Elimination of spaces on both ends of all the elements</td>
</tr>
<tr>
<td><code>ltrim()</code></td>
<td>Elimination of a space on the left end of all the elements</td>
</tr>
<tr>
<td><code>rtrim()</code></td>
<td>Elimination of a space on the right end of all the elements</td>
</tr>
<tr>
<td><code>strreplace()</code></td>
<td>String search and replacement of all the elements</td>
</tr>
<tr>
<td><code>regreplace()</code></td>
<td>String search and replacement of all the elements using a regular expression</td>
</tr>
<tr>
<td><code>tolower()</code></td>
<td>Replaces the uppercase version of characters in all the elements with the lowercase version</td>
</tr>
<tr>
<td><code>toupper()</code></td>
<td>Replaces the lowercase version of characters in all the elements with the uppercase version</td>
</tr>
<tr>
<td><code>expand_tabs()</code></td>
<td>Replaces TAB characters in all the elements with a white space character</td>
</tr>
<tr>
<td><code>contract_spaces()</code></td>
<td>Replaces white space characters in all the elements with a TAB character</td>
</tr>
</tbody>
</table>

Table 23: List of member functions available for use with the asarray_tstring class (Continued from previous page)
11.3 Operators

11.3.1 []

NAME
[] — Reference to the element value object (the tstring class) corresponding to a specified key

SYNOPSIS

```c
tstring &operator[]( const char *key ); ............................................. 1
const tstring &operator[]( const char *key ) const; ......................... 2
```

DESCRIPTION

Returns a reference to the element value object (tstring class; §9) in an associative array corresponding to a key. “[]” can be immediately followed by “.” to connect to use of tstring class member functions (§9) (The EXAMPLE uses the tstring class “=” operator and assign() member function).

Member function 1 is for both reading and writing and operates in the same manner as the at() member function does. Member function 2 is for reading only and operates in the same manner as the at_cs() member function does.

A key string that does not exist being specified results in a set of the specified key string and the value “” being added to the associative array with member function 1 while with member function 2 an exception occurs.

Whether member function 1 or the member function 2 is used is automatically determined by the presence or absence of the “const” attribute for an object. Member function 1 is automatically selected if the object does not have a “const” attribute but member function 2 is if it does.

For more details on at() and at_cs() refer to §11.4.4.

PARAMETER

[I] key Key string in an associative array

RETURN VALUE

Reference to the element value object (the tstring class) in an associative array corresponding to a key

EXCEPTION

If a specified key string is NULL.
If the system failed to secure an internal buffer (Member function 1).
If a key string that does not exist is specified (Member function 2).

EXAMPLE

The following code sets a key and a value to the associative array object my_asarr. The operator “=” and assign() operate in the same manner:

```c
asarray_tstring my_asarr;
my_asarr[“google”] = "Larry Page";
my_asarr[“YouTube”].assign(“Steve Chen”);
```
11.3.2 =

NAME
   = — Copies objects for the asarray_tstring class

SYNOPSIS
   asarray_tstring &operator=(const asarray_tstring &obj);

DESCRIPTION
   Assigns to itself the object for the asarray_tstring class specified on the right (argument) of the operator.

PARAMETER
   [I] obj    asarray_tstring class object

RETURN VALUE
   Reference to itself

EXCEPTION
   If the system failed to secure an internal buffer.
   If the system encountered any corrupt memory.

EXAMPLE
   The following code assigns the associative array object my_asarr to the associative array object my_asarrObj, and then prints the result to standard output. For more details on cstr() refer to the descriptions provided in §11.4.3:

   ```
   stdstreamio sio;
   asarray_tstring my_asarr;
   my_asarr["linux"] = "Linus Torvalds";
   my_asarr["windows"] = "Bill Gates";
   my_asarr["mac"] = "Steve Jobs";

   asarray_tstring my_asarrObj;
   my_asarrObj = my_asarr;
   /* Display all the elements */
   for ( size_t i=0 ; i < my_asarrObj.length() ; i++ ) {
      const char *key = my_asarrObj.key(i);
      sio.printf("%s ... [%s]\n", key, my_asarrObj.cstr(key));
   }
   
   Result of execution
   linux ... [Linus Torvalds]
   windows ... [Bill Gates]
   mac ... [Steve Jobs]
   ```

11.4 Member functions

11.4.1 length()

NAME
   length() — Length of an associative array (the number of arrays), and the length of a value string
SYNOPSIS

size_t length() const; ......................................................... 1
size_t length( const char *key ) const; ................................ 2

DESCRIPTION

Member function 1 returns the length of an associative array (number of arrays).
Member function 2 returns the string length of a value corresponding to the key string
specified by an argument.

PARAMETER

[I] key Key string in an associative array

RETURN VALUE

Number of elements of an associative array or the string length of a value corresponding to
a specified key

EXAMPLE

The following code prints to standard output the length of arrays in the associative array
my_asarr, and the string length of the value "Larry Page" corresponding to the key "google":

```c
stdstreamio sio;

asarray_tstring my_asarr;
my_asarr["linux"] = "Linus Torvalds";
my_asarr["google"] = "Larry Page";
my_asarr["mac"] = "Steve Jobs";

sio.printf("my_asarr total length ... [%zu]\n", my_asarr.length());
sio.printf("my_asarr key='google' length ... [%zu]\n",
              my_asarr.length("google"));
```

Result of execution

my_asarr total length ... [3]
my_asarr key='google' length ... [10]

11.4.2 cstrarray()

NAME

cstrarray() — Pointer array (NULL-terminated) for a value string in an associative array

SYNOPSIS

const char *const *cstrarray() const;

DESCRIPTION

Returns the pointer array for a value string in an associative array. Pointer arrays are always
NULL-terminated.

RETURN VALUE

The pointer array (NULL-terminated) to a value string in an associative array
EXAMPLE
The following code acquires the pointer array for a value string in the associative array `my_asarr`, and then prints the value to standard output.

```c
stdstreamio sio;

asarray_tstring my_asarr;
my_asarr["MIT"] = "cambridge";
my_asarr["Princeton"] = "New Jersey";
my_asarr["Berkeley"] = "California";

const char *const *my_ptr;
my_ptr = my_asarr.cstrarray();
if ( my_ptr != NULL ) {
    for ( int i = 0 ; my_ptr[i] != NULL ; i++ ) {
        sio.printf("%d ... [%s]\n", i, my_ptr[i]);
    }
}
```

Result of execution
0 ... [cambridge]
1 ... [New Jersey]
2 ... [California]

### 11.4.3 cstr(), c_str(), cstrf(), vcstrf()

**NAME**
cstr(), c_str(), cstrf(), vcstrf() — Value string corresponding to a specified key or element number

**SYNOPSIS**

- `const char *cstr( const char *key ) const;` ................................. 1
- `const char *c_str( const char *key ) const;` ............................. 2
- `const char *cstrf( const char *fmt, ... ) const;` .......................... 3
- `const char *vcstrf( const char *fmt, va_list ap ) const;` ............... 4
- `const char *cstr( size_t index ) const;` .................................... 5

**DESCRIPTION**
Member functions 1 and 2 return the value string in an associative array corresponding to a specified key.

Member functions 3 and 4 enable the key string you want to specify to be set in the same format and with the same variable arguments as the printf() function. Member function 3 converts each element of data of a variable-length argument depending on the conversion specifications set in `fmt`. Member function 4 converts the list `ap` of variable-length arguments depending on the conversion specifications set in `fmt`. For more details on `fmt` refer to the descriptions provided in §8.1.14.

Member function 5 returns the value string in an associative array corresponding to a specified element number. Please note that the element number for the first element of arrays is always 0.

If a key is invalid or an element number has a value larger than the length of an array specified to it `NULL` is returned to indicate the error.
PARAMETER

[\[I\] key   Key string in an associative array object
[I] fmt   Format specifications for a key string
[I] ...  Each element of data of a variable-length argument supporting fmt
[I] ap    List of variable-length arguments supporting fmt
[I] index Element number

RETURN VALUE

The address for the string corresponding to a specified key or element number (Normal termination)
NULL (Error) : If a key or element number is invalid.

EXAMPLE

The following code prints to standard output the string corresponding to the key "Riyuu" for the associative array my_asarr:

```c
stdstreamio sio;

asarray_tstring my_asarr;
my_asarr["Itamu Hito"] = "Arata Tendou";
my_asarr["Kucyu Buranko"] = "Hideo Okuda";
my_asarr["Riyuu"] = "Miyuki Miyabe";

sio.printf("my_asarr c_str ... [%s]\n", my_asarr.c_str("Riyuu"));
```

Result of execution

my_asarr c_str ... [Miyuki Miyabe]

11.4.4 at(), atf()

NAME

at(), atf() — Reference to the element value object (the tstring class) corresponding to a specified key or element number

SYNOPSIS

```c
 tstring &at( const char *key ); .................................................. 1
 tstring &atf( const char *fmt, ... ); .......................................... 2
 tstring &vatf( const char *fmt, va_list ap ); .................................. 3
 tstring &at( size_t index ); ...................................................... 4
 const tstring &at( const char *key ) const; ................................... 5
 const tstring &atf( const char *fmt, ... ) const; ............................ 6
 const tstring &vatf( const char *fmt, va_list ap ) const; .................. 7
 const tstring &at( size_t index ) const; ...................................... 8
```

DESCRIPTION

Returns a reference to the element value object (tstring class; §9) corresponding to a key string (with member functions 1 to 3 and 5 to 7) or an element number (with member functions 4 and 8) in an argument. These member functions can be immediately followed by "." to connect to use of tstring class member functions (§8) (The EXAMPLE uses the tstring class “=” operator and assign() member function). Member functions 1 to 4 can be
used both for reading and writing elements while member functions 5 to 8 are for reading only.

Member functions 2, 3, 6 and 7 enable a key string that you want to specify to be set in
the same format and with the same variable arguments as the printf() function. Member
functions 2 and 6 convert each element of data of a variable-length argument depending on
the conversion specifications set in fmt. Member functions 3 and 7 convert the list ap of
variable-length arguments depending on the conversion specifications set in fmt. For more
details on fmt refer to the descriptions provided in §8.1.14.

If a key string that does not exist is specified, with member functions 1 to 3 a set of the
specified key string and the value "" is added to the associative array but with member
functions 5 to 7 an exception occurs.

With member functions 4 and 8 if index has a value larger than the length of an array
specified to it an exception occurs. Please note that the element number for the first element
of arrays is always 0.

Whether member functions 1 to 4 or member functions 5 to 8 are used is automatically
determined by the presence or absence of the “const” attribute for an object. Member
functions 1 to 4 are automatically selected if the object does not have the “const” attribute
while member functions 5 to 8 are if it does.

PARAMETER

| I | key | Key string in an associative array object |
| I | fmt | Format specifications for a key string |
| I | ... | Each element of data of a variable-length argument supporting fmt |
| I | ap | List of variable-length arguments supporting fmt |
| I | index | Element number |


RETURN VALUE

Reference to the element value object (the tstring class) corresponding to a specified key or
element number

EXCEPTION

If a specified key string is NULL.
If a key string that does not exist is specified (Member functions 5 to 7).
If a specified element number is invalid (Member functions 4 and 8).
If the system failed to secure an internal buffer (Member functions 1 to 3 and 6 and 7).

EXAMPLE

The following code adds the set of the key "Yasushi Inoue" and the value "Tougyu" to the
associative array my_asarr, and then prints the result to standard output in order to verify
it:

```cpp
stdstreamio sio;

asarray_tstring my_asarr;
my_asarr["Takeshi kaikou"] = "Hadaka no Oosama";
my_asarr["Koubou Abe"] = "Kabe";
my_asarr["Kenzaburou Ooe"] = "Shiiku";

my_asarr.at(\"Yasushi Inoue\") = \"Tougyu\";
sio.printf(\"my_asarr c_str ... [\%s]\n", my_asarr.at("Yasushi Inoue").cstr());
```
Result of execution
my_asarr c_str ... [Tougyu]

11.4.5 at_cs(), atf_cs()

NAME
at_cs(), atf_cs() — Reference to the element value object (the tstring class) corresponding to
a specified key or element number (Read only).

SYNOPSIS
const tstring &at_cs( const char *key ) const;
const tstring &atf_cs( const char *fmt, ... ) const;
const tstring &vatf_cs( const char *fmt, va_list ap ) const;
const tstring &at_cs( size_t index ) const;

DESCRIPTION
Returns a reference to the element value object (tstring class; §9) corresponding to a key.
These member functions are for reading only.

Member functions 2 and 3 enable a key string that you want to specify to be set in the same
format and with the same variable arguments as the printf() function. Member function
2 converts each element of data of a variable-length argument depending on the conversion
specifications set in fmt. Member function 3 converts the list ap of variable-length arguments
depending on the conversion specifications set in fmt. For more details on fmt refer to the
descriptions provided in [8.1.14].

Please note that the element number for the first element of arrays is always 0.

If a key string or element number that does not exist is specified an exception occurs.

PARAMETER
[I] key Key string in an associative array object
[I] fmt Format specifications for a key string
[I] ... Each element of data of a variable-length argument supporting fmt
[I] ap List of variable-length arguments supporting fmt
[I] index Element number

RETURN VALUE
A reference to the element value object (tstring class) corresponding to a specified key or
element number

EXCEPTION
If a specified key string is NULL.
If a key string that does not exist is specified (Member functions 1 to 3).
If a specified element number is invalid.
If the system failed to secure an internal buffer (Member functions 2 and 3).

11.4.6 index(), indexf(), vindexf()

NAME
index(), indexf(), vindexf() — Acquires the element number corresponding to a key string
SYNOPSIS

ssize_t index( const char *key ) const; .............................................. 1
ssize_t indexf( const char *fmt, ... ) const; .................................... 2
size_t vindexf( const char *fmt, va_list ap ) const; ......................... 3

DESCRIPTION

Acquires the element number corresponding to a key string. Please note that the element number for the first element of arrays is always 0.

Member functions 2 and 3 enable a key string that you want to specify to be set in the same format and with the same variable arguments as the printf() function. Member function 2 converts each element of data of a variable-length argument depending on the conversion specifications set in fmt. Member function 3 converts the list ap of variable-length arguments depending on the conversion specifications set in fmt. For more details on fmt refer to the descriptions provided in §8.1.14.

PARAMETER

[I ] key Key string
[I ] fmt Format specifications for a key string
[I ] ... Each element of data of a variable-length argument supporting fmt
[I ] ap List of variable-length arguments supporting fmt

RETURN VALUE

Non-negative value : If a specified key string is found the corresponding element number.
Negative value (Error) : If a specified key string is not found.

EXCEPTION

If the system failed to secure an internal buffer (Member functions 2 and 3).

EXAMPLE

The following code acquires the element number of which the key is "Muritaniya" in the associative array object my_country, and then prints the result to standard output:

```c
stdstreamio sio;

asarray_tstring my_country;
my_country["Saudi Arabia"] = "Abdullah bin Abdulaziz al-Saud";
my_country["Muritaniya"] = "Mohamed Ould Abdel Aziz";
my_country["Cyprus"] = "Demetris Christofias";

sio.printf("my_country.index("Muritaniya") ... \%zd\n", my_country.index("Muritaniya"));
```

Result of execution

```
my_country.index("Muritaniya") ... [1]
```

11.4.7 key()

NAME

key() — Acquires the key string corresponding to an element number
SYNOPSIS

    const char *key(size_t index) const;

DESCRIPTION

Acquires the key string corresponding to the element number specified by index. Please note
that the element number for the first element of arrays is always 0.
If index has a value larger than the length of an array specified to it NULL is returned.

PARAMETER

    [I] index Element number

RETURN VALUE

Address for the internal buffer for a key string (Normal termination)
NULL (Error) : If an element number that is larger than the length of an array is specified.

EXAMPLE

The following code acquires the keys for the associative array object my_city in the order of
from 0, and then prints the acquired keys and values to standard output:

    stdstreamio sio;

    asarray_tstring my_city;
    my_city["Yokohama"] = "Fumiko Hayashi";
    my_city["Osaka"] = "Kunio Hiramatsu";
    my_city["Fukuoka"] = "Hiroshi Yoshida";

    for(size_t i=0 ; i < my_city.length() ; i++) {
        const char *key = my_city.key(i);
        sio.printf("#%zx -> %s ... [%s]\n", i, key, my_city.cstr(key));
    }

Result of execution
    #0 -> Yokohama ... [Fumiko Hayashi]
    #1 -> Osaka ... [Kunio Hiramatsu]
    #2 -> Fukuoka ... [Hiroshi Yoshida]

11.4.8 keys()

NAME

keys() — References the array object for a key string (Read only)

SYNOPSIS

    const tarray_tstring &keys() const;

DESCRIPTION

Returns a reference to the array object (tarray_tstring class) for a key string managed
inside an object. This member function can be immediately followed by "." to connect to use
of tarray_tstring class member functions. The tarray_tstring class member functions available
for use are only those that do not change key strings, or that is, those that have the const
attribute.

RETURN VALUE

Reference to the array object (tarray_tstring class) for a key string
11.4.9 values()

NAME
values() — References the array object for a value string (Read only)

SYNOPSIS
const tarray_tstring &values() const;

DESCRIPTION
Returns a reference to the array object (tarray_tstring class; 
for a value string managed inside an object. This member function can be immediately followed by “.” to connect to use of tarray_tstring class member functions. The tarray_tstring class member functions available for use are only those that do not change value strings, or that is, those that have the const attribute.

RETURN VALUE
Reference to the array object (the tarray_tstring class) for a key string

11.4.10 dprint()

NAME
dprint() — Outputs object information to standard error output (For user debugging)

SYNOPSIS
void dprint() const;

DESCRIPTION
Outputs information on an object to standard error output.
Member function designed for debugging user programs.

EXAMPLE
The following code outputs the information on the object my_array to standard error output. In the result of the execution the address for the object can be seen to be displayed within [], but this does depend on the operating environment:

asarray_tstring my_array("CPU","Sparc", "OS","Solaris", NULL);
my_array.dprint();

Result of execution
sli::asarray_tstring[obj=0xbffff3d0] = { {"CPU", "Sparc"}, {"OS", "Solaris"} }

11.4.11 swap()

NAME
swap() — Interchange of objects

SYNOPSIS
asarray_tstring &swap( asarray_tstring &sobj );

DESCRIPTION
Interchanges the content of the associative array object sobj with the content of itself.
PARAMETER

[I/O]  obj  asarray_tstring class object to be interchanged

RETURN VALUE

Reference to itself

EXAMPLE

The following code interchanges the elements of the associative array objects **my_africa** and **my_amERICA**, and then prints the content of the respective objects to standard output in order to verify it:

```cpp
stdcallio sio;

asarray_tstring my_africa;
my_africa["Rwanda"] = "Kigali";
my_africa["Cameroon"] = "Yaounde";

asarray_tstring my_america;
my_america["Honduras"] = "Tegucigalpa";
my_america["Jamaica"] = "Kingston";

my_africa.swap(my_america);
for ( size_t i=0 ; i < my_africa.length() ; i++ ) {
    const char *africa_key = my_africa.key(i);
    const char *america_key = my_america.key(i);
    sio.printf("[%s]:%s <===> [%s]:%s\n", africa_key,
          my_africa.cstr(africa_key),
          america_key, my_africa.cstr(america_key));
}
```

Result of execution

[Honduras]:Tegucigalpa <===> [Rwanda]:Tegucigalpa
[Jamaica]:Kingston <===> [Cameroon]:Kingston

11.4.12 init()

NAME

init() — Complete initialization of objects

SYNOPSIS

asarray_tstring &init();  .................................................................  1
asarray_tstring &init(const asarray_tstring &obj);  ......................  2

DESCRIPTION

Initializes associative arrays.

Member function 1 completely initializes associative array objects. The memory area allocated to the array buffer and string buffer etc inside an associative array object is entirely released. If the cstrarray() member function (§11.4.2) is executed after init() is executed NULL is returned.

Member function 2 initializes objects with the content of obj (copies all the content of obj to itself).
PARAMETER

[I]  obj  asarray_tstring class object

RETURN VALUE

Reference to itself

EXCEPTION

If the system failed to secure an internal buffer.
If the system encountered any corrupt memory (Member function 2).

EXAMPLE

The following code initializes the associative array my_asarr with IgNobel_asarr, and then
prints the result to standard output in order to verify it:

```c
stdstreamio sio;

asarray_tstring IgNobel_asarr;
asarray_tstring my_asarr;
IgNobel_asarr["2008"] = "Toshiyuki Nakagaki";
IgNobel_asarr["2007"] = "Mayu Yamamoto";
IgNobel_asarr["2006"] = "Dr.Nakamatsu";

my_asarr.init(IgNobel_asarr);
for ( size_t i=0 ; i < my_asarr.length() ; i++ ) {
    const char *key = my_asarr.key(i);
sio.printf("%s ... [%s]\n", key, my_asarr.cstr(key));
}
```

Result of execution

2008 ... [Toshiyuki Nakagaki]
2007 ... [Mayu Yamamoto]
2006 ... [Dr.Nakamatsu]

11.4.13 assign(), assignf(), vassignf()

NAME

assign(), assignf(), vassignf() — Initialization of objects and assignment of elements (Specifies
a single set of a key and a value)

SYNOPSIS

asarray_tstring &assign( const char *key, const char *val );  .................. 1
asarray_tstring &assign( const char *key, const tstring &val );  .......... 2
asarray_tstring &assignf( const char *key, const char *fmt, ... ); .......... 3
asarray_tstring &vassignf( const char *key, const char *fmt, va_list ap );  4

DESCRIPTION

Initializes associative array objects with a specified single element (combination of a key and
a value).

Member functions 1 and 2 initialize objects with the key key and the value val.

Member functions 3 and 4 enable a value string that you want to specify to be set in the
same format and with the same variable arguments as the printf() function. Member function
3 converts each element of data of a variable-length argument depending on the conversion specifications set in `fmt`. Member function 4 converts the list `ap` of variable-length arguments depending on the conversion specifications set in `fmt`. For more details on `fmt` refer to the descriptions provided in §8.1.14.

**PARAMETER**
- `[I] key` Key string to be set to an associative array object
- `[I] val` Value string to be set to an associative array object
- `[I] fmt` Format specifications for a value string to be set
- `[I] ...` Each element of data of a variable-length argument supporting `fmt`
- `[I] ap` List of variable-length arguments supporting `fmt`
  
  (I : Input, O : Output)

**RETURN VALUE**
Reference to itself

**EXCEPTION**
If the system failed to secure an internal buffer.

**EXAMPLE**
The following code sets a single set of a key and a value to the associative array `my_asarr`, and then prints the result to standard output:

```c
stdstreamio sio;

asarray_tstring my_asarr;

const char *key0 = "Everest";
const char *val0 = "Nepal";
my_asarr.assign(key0, val0);
for ( size_t i=0 ; i < my_asarr.length() ; i++ ) {
    const char *key = my_asarr.key(i);
    sio.printf("%s ... [%s]\n", key, my_asarr.cstr(key));
}
```

Result of execution
Everest ... [Nepal]

11.4.14 assign(), vassign()
DESCRIPTION
Initializes associative array objects with specified multiple elements (combinations of a key and a value).

Member function 1 assigns to itself the content of the asarray_tstring class object src.
Member functions 2 and 3 set the content of asarrdef_tstring type (structure) arrays (With member function 2 elements must be terminated at {NULL,NULL}). Member function 3 sets n elements from the beginning of elements. If n is larger than the number of elements (until reaching {NULL,NULL}) is specified n is ignored.
Member functions 4 and 5 create associative arrays using multiple combinations of a key of const char * type and a value specified in key0, val0, key1 and the variable-length arguments thereafter (must be NULL-terminated).

PARAMETER
[I] src asarray_tstring class object that includes the element to be sourced
[I] elements Array of asarrdef_tstring type (structure) that includes the element to be sourced
(With member function 2 must be terminated at {NULL,NULL})
[I] n Number of array elements
[I] key0, key1 Key string to be set to an associative array
[I] val0 Value string to be set to an associative array
[I] ... Each element of data of a variable-length argument for the string that is a key/value (Needs to be NULL-terminated)
[I] ap List of variable-length arguments for the string that is a key/value (Needs to be NULL-terminated)

RETURN VALUE
Reference to itself

EXCEPTION
If the system failed to secure an internal buffer.

EXAMPLE
The following code sets the content of a structure asarrdef_tstring to the associative array my_asarr, and then prints the result to standard output. At the end of the array the key and the value are both set to NULL:

```c
streamio sio;

asarray_tstring my_asarr;
const asarrdef_tstring mount_elem[] = { {"K2","China"},
    {"Kangchenjunga","Nepal"}, {"Mount Kenya","Kenya"}, {NULL,NULL} };

my_asarr.assign(mount_elem);
for ( size_t i=0 ; i < my_asarr.length() ; i++ ) {
    const char *key = my_asarr.key(i);
    sio.printf("%s ... [%s]\n", key, my_asarr.cstr(key));
}
```

Result of execution
K2 ...  [China]
Kangchenjunga ... [Nepal]
Mount Kenya ... [Kenya]

11.4.15 assign_keys()

NAME
assign_keys() — Sets multiple strings or a string array to keys

SYNOPSIS
asarray_tstring &assign_keys( const char *key0, ... ); ................. 1
asarray_tstring &vassign_keys( const char *key0, va_list ap ); ........... 2
asarray_tstring &assign_keys( const char *const *keys ); ................. 3
asarray_tstring &assign_keys( const tarray_tstring &keys ); ............... 4

DESCRIPTION
Sets the specified multiple strings key0, ... or string array keys to keys for an associative array.
The number of keys specified in arguments becomes the number of elements in the associative array (Associative array elements of the number exceeding the number of keys specified by an argument are deleted).
Variable arguments for member functions 1 and 2 and the pointer array keys for member function 3 must be NULL-terminated.

PARAMETER
[I] key0 Key string
[I] ... Each element of data of a variable-length argument for a key string (NULL-terminated)
[I] ap List of variable-length arguments for a key string (NULL-terminated)
[I] keys String array to be set to a key string (With member function 3 must be NULL-terminated)

RETURN VALUE
Reference to itself

EXCEPTION
If the system failed to secure an internal buffer.

EXAMPLE
Refer to the EXAMPLE in §11.4.16

11.4.16 assign_values()

NAME
assign_values() — Sets multiple strings or a string array to values

SYNOPSIS
asarray_tstring &assign_values( const char *val0, ... ); ................. 1
asarray_tstring &vassign_values( const char *val0, va_list ap ); ........... 2
asarray_tstring &assign_values( const char *const *values ); ................. 3
asarray_tstring &assign_values( const tarray_tstring &values ); ............... 4
DESCRIPTION
Sets the specified multiple strings val0, ... or string array values to values for an associative array.

If the number of values specified by an argument exceeds the number for the associative array inside an object the values of the number that exceeds are discarded.

Variable arguments for member functions 1 and 2 and the pointer array values for member function 3 must be NULL-terminated.

PARAMETER

[I] val0 Value string
[I] ... Each element of data of a variable-length argument for a value string (NULL-terminated)
[I] ap List of variable-length arguments for a value string (NULL-terminated)
[I] values String array to be set to a value string (With member function 3 must be NULL-terminated)


RETURN VALUE
Reference to itself

EXCEPTION
If the system failed to secure an internal buffer.

EXAMPLE
Initializes the associative array using assign_keys() and assign_values():

```cpp
asarray_tstring my_array;
my_array.assign_keys("CPU", "OS", NULL);
my_array.assign_values("PentiumPro", "Linux", NULL);
my_array.dprint();
```

Result of execution
sli::asarray_tstring[0xbffff3d0] = { {"CPU", "PentiumPro"}, {"OS", "Linux"} }

11.4.17 split_keys()

NAME
split_keys() — Divides strings and sets them to keys

SYNOPSIS
```cpp
asarray_tstring &split_keys( const char *src_str, const char *delims,
                              bool zero_str, const char *quotations,
                              int escape, bool rm_escape ); .................. 1
asarray_tstring &split_keys( const char *src_str, const char *delims,
                              bool zero_str = false ); ...................... 2
asarray_tstring &split_keys( const tstring &src_str, const char *delims,
                              bool zero_str, const char *quotations,
                              int escape, bool rm_escape ); .................. 3
asarray_tstring &split_keys( const tstring &src_str, const char *delims,
                              bool zero_str = false ); ...................... 4
```
DESCRIPTION
Divides the string src_str with the delimiter characters and then sets them to the keys for an associative array. The delimiter characters are given by character set of delims argument, and delims can be specified as a simple list of characters like " \t" as well as expressions like ";[A-Z]\" or "[^A-Z]\" as in regular expressions. In addition, a character class can also be specified inside ";([^...])\". For the character classes that can be specified refer to the descriptions and Table provided in §9.5.26.

The number of keys obtained after dividing the string becomes the number of elements in the associative array (Associative array elements of the number exceeding the number acquired after dividing the string are deleted).

zero_str can be specified to indicate whether to allow the string length of zero for key elements after the division. If zero_str is false key elements with the string length of 0 cannot be created. If zero_str is true key elements with the string length of 0 can be created (used with csv format etc). If zero_str is not specified it is treated as false.

If you do not want to divide strings that are parenthesized with “specific characters” such as quotation marks etc., such “specific characters” can be specified using quotations. For example, if you want to exclude strings parenthesized by a single quotation from the strings to be divided specify ";\".

An escape character can be specified using escape. If you want to delete escape any characters that come after the division set rm_escape to true. However, any escape characters in the strings that are parenthesized by a character specified by quotations will not be deleted.

If you cannot successfully retrieve keys using only this member function a method of first creating a key string in a tarray_tstring class also exists, following which a key can then be set using the assign_keys() member function (§11.4.15).

PARAMETER
[I] src_str String to be divided
[I] delims String that includes delimiter characters
[I] zero_str Whether or not to allow strings with the length of 0 as a result of delimiting (true/false)
[I] quotations String that includes quotation characters
[I] escape Escape character
[I] rm_escape Flag to indicate whether or not to delete escape characters (true/false)

RETURN VALUE
Reference to itself

EXCEPTION
If the system failed to secure an internal buffer.

EXAMPLE
Refer to the EXAMPLE in §11.4.18

An example of using member function 2 is provided in §3.5.5

11.4.18  split_values()

NAME
split_values() — Divides strings and sets them to values
SYNOPSIS

```cpp
asarray_tstring &split_values( const char *src_str, const char *delims,
    bool zero_str, const char *quotations,
    int escape, bool rm_escape ); ........................ 1
asarray_tstring &split_values( const char *src_str, const char *delims,
    bool zero_str = false ); ............................ 2
asarray_tstring &split_values( const tstring &src_str, const char *delims,
    bool zero_str, const char *quotations,
    int escape, bool rmescape ); ........................ 3
asarray_tstring &split_values( const tstring &src_str, const char *delims,
    bool zero_str = false ); ............................ 4
```

DESCRIPTION

Divides the string `src_str` with the delimiter characters, and then sets them to the values for an associative array. The delimiter characters are given by character set of `delims` argument, and `delims` can be specified as a simple list of characters like " \t" as well as expressions like "]A-Z]" or "]^A-Z]" as in regular expressions. In addition, a character class can also be specified inside "][..]]". For the character classes that can be specified refer to the descriptions and Table [19] provided in §9.5.26.

If the number of values acquired after dividing the string exceeds the number for the associative array inside an object the value of the exceeding number is discarded.

`zero_str` can be used to specify whether to allow a string length of zero for value elements after the division. If `zero_str` is `false` value elements with a string length of 0 cannot be created. If `zero_str` is `true` value elements with a string length of 0 can be created (used with the csv format etc). If `zero_str` is not specified it is treated as `false`.

If you do not want to divide strings that are parenthesized by a “specific character” such as a quotation etc a “specific character” can be specified using `quotations`. For example, if you want to exclude strings parenthesized by a single quotation from the strings to be divided specify "'".

Escape characters are specified by `escape`. If you want to delete any escape characters remaining after the division set `rm_escape` to `true`. However, any escape characters in strings parenthesized by a character specified in `quotations` cannot be deleted.

PARAMETER

```cpp
[I] src_str String to be divided
[I] delims String that includes delimiter characters
[I] zero_str Whether or not to allow strings with a length of 0 as a result of delimiting (true/false)
[I] quotations String that includes a quotation character
[I] escape Escape character
[I] rm_escape Flag that indicates whether or not to delete escape characters (true/false)
```

(RETURN VALUE

Reference to itself

EXCEPTION

If the system failed to secure an internal buffer.
EXAMPLE
The following code specifies a delimiter character " " and a quotation character, divides a string, and then sets the divided string as keys to the associative array my_arr. The delimiter character "," and a quotation character are then specified, and a string divided, and divided string set as values to the associative array my_arr. It then standard-outputs the set keys and values to verify them:

```c++
std::stringstream sio;

const char *line = 
    "'Camellia sasanqua' 'Chrysanthemum morifolium' 'Cyclamen persicum'";
asarray_tstring my_arr;
my_arr.split_keys(line, " ", false, ",", 0);
for ( size_t i=0 ; i < my_arr.length() ; i++ ) {
    const char *key = my_arr.key(i);
    sio.printf("%s ... [%s]\n", key, my_arr.cstr(key));
}

const char *val = 
    "'Camellia,pink','Chrysanthemum,yellow','Cyclamen,pink'";
my_arr.split_values(val, ",", false, ",", 0);
for ( size_t i=0 ; i < my_arr.length() ; i++ ) {
    const char *key = my_arr.key(i);
    sio.printf("%s ... [%s]\n", key, my_arr.cstr(key));
}
```

Result of execution
'Camellia sasanqua' ... ['Camellia,pink']
'Chrysanthemum morifolium' ... ['Chrysanthemum,yellow']
'Cyclamen persicum' ... ['Cyclamen,pink']

Examples of using member function 2 is provided in §3.5.5 and §11.4.27.

11.4.19 append(), appendf(), vappendf()  

NAME
append(), appendf(), vappendf() — Adds elements (Specifies a single set of a key and a value)

SYNOPSIS
asarray_tstring &append( const char *key, const char *val ); .......... 1
asarray_tstring &append( const char *key, const tstring &val ); .......... 2
asarray_tstring &appendf( const char *key, const char *fmt, ... ); ....... 3
asarray_tstring &vappendf( const char *key, const char *fmt, va_list ap ); 4

DESCRIPTION
Adds a specified single element (combination of a key and a value) to an associative array object.

Member functions 1 and 2 add the key key and the value val.

Member functions 3 and 4 enable a value string that you want to specify to be set in the same format and with the same variable arguments as the printf() function. Member function 3 converts each element of data of a variable-length argument depending on the conversion
specifications set in fmt. Member function 4 converts the list ap of variable-length arguments depending on the conversion specifications set in fmt. For more details on fmt refer to the descriptions provided in §8.1.13.

If duplicate keys exist a warning is output to standard error output at the time of execution, and the function not processed.

**PARAMETER**

[I] key Key string to be added to an associative array object
[I] val Value string to be added to an associative array object
[I] fmt Format specifications for a value string to be added
[I] ... Each element of data of a variable-length argument supporting fmt
[I] ap List of variable-length arguments supporting fmt
(II : Input, [O] : Output)

**RETURN VALUE**

Reference to itself

**EXCEPTION**

If the system failed to secure an internal buffer.

**EXAMPLE**

The following code adds a single element to the associative array object my_asarr using the appendf() member function, and then prints the result to standard output:

```c
stdstreamio sio;

asarray_tstring my_asarr("rice","China","coffee","Brazil", NULL);
const char *key_cacao = "cacao";

my_asarr.appendf(key_cacao,"### No.1 is %s ###","Cote d’Ivoire");
for ( size_t i=0 ; i < my_asarr.length() ; i++ ) {
    const char *key = my_asarr.key(i);
    sio.printf("%s ... [%s]\n", key, my_asarr.cstr(key));
}
```

Result of execution

```
rice ... [China]
coffee ... [Brazil]
cacao ... [### No.1 is Cote d’Ivoire ###]
```

11.4.20 append(), vappend()

**NAME**

append(), vappend() — Adds elements (Specifies multiple sets of a key and a value)

**SYNOPSIS**

```c
asarray_tstring &append( const asarray_tstring &src ); ......................... 1
asarray_tstring &append( const asarrdef_tstring elements[] ); ............... 2
asarray_tstring &append( const asarrdef_tstring elements[], size_t n ); . 3
asarray_tstring &append( const char *key0, const char *val0,
const char *key1, ... ); ......................... 4
asarray_tstring &vappend( const char *key0, const char *val0,
const char *key1, va_list ap ); ................... 5
```
DESCRIPTION
Adds specified multiple elements (combinations of a key and a value) to an associative array object.

Member function 1 adds the content of the asarray_tstring class object src.

Member functions 2 and 3 add the content of asarrdef_tstring type (structure) arrays (With member function 2 elements must be terminated at {NULL,NULL}). Member function 3 adds n elements from the beginning of elements. If n larger than the number of elements (until reaching ({NULL,NULL}) is specified n is ignored.

Member functions 4 and 5 add multiple combinations of a key of const char * type and a value specified in key0, val0, key1 and the variable-length arguments thereafter as associative array elements (must be NULL-terminated).

If duplicate keys exist a warning is output to standard error output at the time of execution, and the function not processed.

PARAMETER
[I] src asarray_tstring class object that includes the element to be sourced
[I] elements Array of asarrdef_tstring type (structure) that includes the element to be sourced
                (With member function 2 must be terminated at {NULL,NULL})
[I] n Number of the array elements
[I] key0, key1 Key string to be added to an associative array object
[I] val0 Value string to be added to an associative array object
[I] ... Each element of data of a variable-length argument for the string that is a key/value (Needs to be NULL-terminated)
[I] ap List of variable-length arguments for the string that is a key/value (Needs to be NULL-terminated)


RETURN VALUE
Reference to itself

EXCEPTION
If the system failed to secure an internal buffer.

EXAMPLE
The following code adds to the associative array object my_asarr the string array foods that is defined using combinations of a key and a value, and then prints the result to standard output. NULL is set both to the key and the value at the end of the array foods:

```c
#include <iostream>
#include <sstream>

using namespace std;

int main()
{
  stringstream sio;

  asarray_tstring my_asarr("rice","China", "coffee","Brazil", NULL);
  const asarrdef_tstring foods[] = { 
    {"banana","India"},
    {"wheat","China"}, {NULL,NULL} 
  };

  my_asarr.append(foods);
  for ( size_t i=0 ; i < my_asarr.length() ; i++ ) {
    const char *key = my_asarr.key(i);
    sio.printf("%s ... [%s]\n", key, my_asarr.cstr(key));
  }

  return 0;
}
```
Result of execution
rice ... [China]
coffee ... [Brazil]
banana ... [India]
wheat ... [China]

11.4.21 insert(), insertf(), vinsertf()

NAME
insert(), insertf(), vinsertf() — Inserts elements (Specifies a single set of a key and a value)

SYNOPSIS

asarray_tstring &insert( const char *key,
const char *newkey, const char *newval ); ....... 1
asarray_tstring &insert( const char *key,
const char *newkey, const tstring &newval ); .... 2
asarray_tstring &insertf( const char *key,
const char *newkey, const char *fmt, ... ); .... 3
asarray_tstring &vinsertf( const char *key,
const char *newkey, const char *fmt, va_list ap ); 4

DESCRIPTION

Inserts a specified single element (combination of a key and a value) before the element position of the key key in an associative array object.

Member functions 1 and 2 insert the element of a combination of the key newkey and the value newval.

Member functions 3 and 4 enable a value string that you want to specify to be set in the same format and with the same variable arguments as the printf() function. Member function 3 converts each element of data of a variable-length argument depending on the conversion specifications set in fmt. Member function 4 converts the list ap of variable-length arguments depending on the conversion specifications set in fmt. For more details on fmt refer to the descriptions provided in §8.1.14.

If duplicate keys exist a warning is output to standard error output at the time of execution, and the function not processed.

PARAMETER

[I] key String for a key for an associative array object that is in the insert position (Inserted before the key)
[I] newkey Key string to be inserted in an associative array object
[I] newval Value string to be inserted in an associative array object
[I] fmt Format specifications for a value string to be inserted
[I] ... Each element of data of a variable-length argument supporting fmt
[I] ap List of variable-length arguments supporting fmt

RETURN VALUE
Reference to itself

EXCEPTION
If the system failed to secure an internal buffer.
EXAMPLE
The following code adds a single element to the associative array object my_asarr, and then prints the result to standard output:

```cpp
stdstreamio sio;

asarray_tstring my_asarr("Nile River","Africa","the Amazon","South America", NULL);
my_asarr.insert("the Amazon", "Chang River", "China");
for ( size_t i=0 ; i < my_asarr.length() ; i++ ) {
    const char *key = my_asarr.key(i);
    sio.printf("%s ... [%s]\n", key, my_asarr.cstr(key));
}
```

Result of execution
Nile River ... [Africa]
Chang River ... [China]
the Amazon ... [South America]

11.4.22 insert(), vinsert()

NAME
insert(), vinsert() — Inserts elements (Specifies multiple sets of a key and a value)

SYNOPSIS

```cpp
asarray_tstring &insert( const char *key,
    const asarray_tstring &src ); ....................... 1
asarray_tstring &insert( const char *key,
    const asarrdef_tstring elements[] ); .............. 2
asarray_tstring &insert( const char *key,
    const asarrdef_tstring elements[], size_t n ); . 3
asarray_tstring &insert( const char *key,
    const char *key0, const char *val0,
    const char *key1, ... ); ......................... 4
asarray_tstring &vinsert( const char *key,
    const char *key0, const char *val0,
    const char *key1, va_list ap ); ................... 5
```

DESCRIPTION
Inserts specified multiple elements (combinations of a key and a value) before the element position of the key key in an associative array object.

Member function 1 inserts the content of the asarray_tstring class object src.

Member functions 2 and 3 insert the content of asarrdef_tstring type (structure) arrays (With member function 2 elements must be terminated at {NULL,NULL}). Member function 3 inserts n elements from the beginning of elements. If n larger than the number of elements (until reaching {NULL,NULL}) is specified n is ignored.

Member functions 4 and 5 insert multiple combinations of a key of const char * type and a value specified in key0, val0, key1 and the variable-length arguments thereafter as associative array elements (must be NULL-terminated).

If duplicate keys exist a warning is output to standard error output at the time of execution, and the function not processed.
PARAMETER

- **key**: Key string for an associative array object that is in an insert position (Inserted before the key)
- **src**: asarray_tstring class object that includes the element to be sourced
- **elements**: Array of asarrdef_tstring type (structure) that includes the element to be sourced
- **n**: Number of the array elements
- **key0, key1**: Key string to be inserted in an associative array object
- **val0**: Value string to be inserted in an associative array object
- **ap**: List of variable-length arguments for the string that is a key/value (Needs to be NULL-terminated)


RETURN VALUE
Reference to itself

EXCEPTION
If the system failed to secure an internal buffer.

EXAMPLE
The following code inserts the associative array object **my_lake** in the associative array object **my_asarr**, and then prints the result to standard output. NULL is set both to the key and the value at the end of the array **lakes**:

```cpp
stdstreamio sio;

const asarrdef_tstring lakes[] = { {"Lake Superior","North America"},
                                  {"Lake Victoria","Tanzania"}, {NULL,NULL} };

asarray_tstring my_lake(lakes);
asarray_tstring my_asarr("Caspian Sea","Eurasia",
                        "Aral Sea","Kazakhstan", NULL);

my_asarr.insert("Aral Sea", my_lake);
for ( size_t i=0 ; i < my_asarr.length() ; i++ ) {
    const char *key = my_asarr.key(i);
    sio.printf("%s ... [%s]\n", key, my_asarr.cstr(key));
}
```

Result of execution
Caspian Sea ... [Eurasia]
Lake Superior ... [North America]
Lake Victoria ... [Tanzania]
Aral Sea ... [Kazakhstan]

11.4.23 erase()

NAME
erase() — Deletion of elements (sets of a key and a value)
SYNOPSIS

asarray_tstring &erase(); ......................................................... 1
asarray_tstring &erase(const char *key, size_t num_elements = 1); ...... 2

DESCRIPTION

Deletes elements of an associative array object.

Member function 1 deletes all the elements (Array length becomes zero).

Member function 2 deletes num_elements elements starting from the element corresponding to the key specified by key. If num_elements is not specified an element is deleted.

The array length becomes smaller by the same length as deleted.

PARAMETER

[I] key Key string
[I] num_elements Number of elements to be deleted

RETURN VALUE

Reference to itself

EXAMPLE

The following code deletes the key "Democratic People’s Republic of Korea" and the value for the associative array object my_asarr, and then prints to standard output the content of my_asarr that remains after the deletion:

```c
sstreamio sio;

asarray_tstring my_asarr;
my_asarr["Kingdom of Lesotho"] = "Letsie III";
my_asarr["Democratic People’s Republic of Korea"] = "Kim Jong-il";
my_asarr["Republic of Cote d’Ivoire"] = "Laurent Gbagbo";

my_asarr.erase("Democratic People’s Republic of Korea");
for ( size_t i=0 ; i < my_asarr.length() ; i++ ) {
    const char *key = my_asarr.key(i);
    sio.printf("%s ... [%s]\n", key, my_asarr.cstr(key));
}
```

Result of execution

Kingdom of Lesotho ... [Letsie III]
Republic of Cote d’Ivoire ... [Laurent Gbagbo]

11.4.24 clean()

NAME

clean() — Pads all the element values of an existing associative array with any string

SYNOPSIS

asarray_tstring &clean(const char *str = ""); ......................... 1
asarray_tstring &clean(const tstring &str); ......................... 2
DESCRIPTION
Pads all the element values of an associative array with the character string str. The function can be used without specifying str but will be then processed as though a string of length 0 had been specified. Executing clean() does not change the key or the array length.

PARAMETER

[I] str String to pad a value in an associative array with

RETURN VALUE
Reference to itself

EXCEPTION
If the system failed to secure an internal buffer.

EXAMPLE
The following code pads each of the strings that the associative array my_asarr includes with Grammy Award, and then prints the result to standard output:

```cpp
stdstreamio sio;

asarray_tstring my_asarr;
my_asarr["U2"] = "Beautiful Day";
my_asarr["Eric Clapton"] = "Tears In Heaven";
my_asarr["TOTO"] = "Rosanna";

my_asarr.clean("Grammy Award");
for ( size_t i=0 ; i < my_asarr.length() ; i++ ) {
    const char *key = my_asarr.key(i);
    sio.printf("%s ... [Grammy Award]\n", key, my_asarr.cstr(key));
}
```

Result of execution
U2 ... [Grammy Award]
Eric Clapton ... [Grammy Award]
TOTO ... [Grammy Award]

11.4.25 rename_a_key()

NAME
rename_a_key() — Changes key strings

SYNOPSIS
asarray_tstring &rename_a_key( const char *org_key, const char *new_key );

DESCRIPTION
Changes the key string org_key to the string specified by new_key.
If a key string that does not exist in an object is specified to org_key or new_key is a duplicate key string an error message output to standard error output.

PARAMETER

[I] org_key Original key string
[I] new_key Key string after being changed
RETURN VALUE
Reference to itself

EXCEPTION
If the system failed to secure an internal buffer.

11.4.26 chomp()

NAME
chomp() — Elimination of newline characters in value strings of all the elements

SYNOPSIS
asarray_tstring &chomp( const char *rs = "\n" );
asarray_tstring &chomp( const tstring &rs );

DESCRIPTION
Eliminates a newline character on the right end of value strings in all the elements of a string associative array.

This member function executes the tstring class chomp() member function on all the elements of an associative array. For more details refer to §9.5.25.

PARAMETER
[I] rs Newline character string

RETURN VALUE
Reference to itself

EXCEPTION
If the system failed to secure an internal buffer.

11.4.27 trim()

NAME
trim() — Elimination of spaces at both ends of value strings of all the elements

SYNOPSIS
asarray_tstring &trim( const char *side_spaces = "\t\n\r\f\v" );
asarray_tstring &trim( const tstring &side_spaces );
asarray_tstring &trim( int side_space );

DESCRIPTION
Eliminates arbitrary characters on both ends of value strings in all the elements of a string associative array.

side_spaces can be specified as a simple list of characters like " \t" as well as expressions like "[A-Z]" or "[^A-Z]" as in regular expressions. In addition, a character class can also be specified inside "[...]". For the character classes that can be specified refer to the descriptions and Table 19 provided in §9.5.26.

This member function executes the tstring class trim() member function on all the elements of an associative array. For more details refer to §9.5.26.
PARAMETER

[I] side_space    Arbitrary character
[I] side_spaces   Arbitrary character string

RETURN VALUE

Reference to itself

EXCEPTION

If the system failed to secure an internal buffer.

EXAMPLE

The following code divides a CSV-format string into elements using the split_values() member function (§11.4.18), assigns them each as a value for an associative array object, and then eliminates any unnecessary white space characters on the right and left ends of each element using trim():

```c
stdstreamio sio;
asarray_tstring my_arr;
size_t i;
my_arr.assign_keys("CPU", "ChipSet", NULL);
my_arr.split_values(" Pentium4, E7205 ", ",", true);
for ( i=0 ; i < my_arr.length() ; i++ ) {
    const char *key = my_arr.key(i);
    sio.printf("%s ... [%s]\n", key, my_arr.cstr(key));
}
my_arr.trim();
for ( i=0 ; i < my_arr.length() ; i++ ) {
    const char *key = my_arr.key(i);
    sio.printf("%s ... [%s]\n", key, my_arr.cstr(key));
}
```

Result of execution

CPU ... [ Pentium4]
ChipSet ... [ E7205 ]
CPU ... [Pentium4]
ChipSet ... [E7205]

11.4.28 ltrim()

NAME

ltrim() — Elimination of a space on the left end of value strings of all the elements

SYNOPSIS

```c
asarray_tstring &ltrim( const char *side_spaces = " \t\n\r\f\v" );
asarray_tstring &ltrim( const tstring &side_spaces );
asarray_tstring &ltrim( int side_space );
```

DESCRIPTION

Eliminates an arbitrary character on the left end of value strings in all the elements of a string associative array.
side_spaces can be specified as a simple list of characters like " \t" as well as expressions like "[A-Z]" or "[^A-Z]" as in regular expressions. In addition, a character class can also be specified inside ".[.]". For the character classes that can be specified refer to the descriptions and Table \[19\] provided in \[9.5.26\].

This member function executes the tstring class ltrim() member function on all the elements of an associative array. For more details refer to \[9.5.27\].

**PARAMETER**

[I] side_space Arbitrary character

[I] side_spaces Arbitrary character string


**RETURN VALUE**

Reference to itself

**EXCEPTION**

If the system failed to secure an internal buffer.

---

11.4.29 rtrim()

**NAME**

rtrim() — Elimination of a space on the right end of value strings of all the elements

**SYNOPSIS**

```cpp
asarray_tstring &rtrim( const char *side_spaces = " \t\n\r\f\v" );
asarray_tstring &rtrim( const tstring &side_spaces );
asarray_tstring &rtrim( int side_space );
```

**DESCRIPTION**

Eliminates an arbitrary character on the right end of value strings in all the elements of a string associative array.

side_spaces can be specified as a simple list of characters like " \t" as well as expressions like "[A-Z]" or "[^A-Z]" as in regular expressions. In addition, a character class can also be specified inside ".[.]". For the character classes that can be specified refer to the descriptions and Table \[19\] provided in \[9.5.26\].

This member function executes the tstring class rtrim() member function on all the elements of an associative array. For more details refer to \[9.5.28\].

**PARAMETER**

[I] side_space Arbitrary character

[I] side_spaces Arbitrary character string


**RETURN VALUE**

Reference to itself

**EXCEPTION**

If the system failed to secure an internal buffer.
11.4.30  strreplace()

NAME

strreplace() — String search and replacement of value strings in all the elements

SYNOPSIS

asarray_tstring &strreplace( const char *org_str, const char *new_str,
    bool all = false );
asarray_tstring &strreplace( const tstring &org_str, const char *new_str,
    bool all = false );
asarray_tstring &strreplace( const char *org_str, const tstring &new_str,
    bool all = false );
asarray_tstring &strreplace( const tstring &org_str, const tstring &new_str,
    bool all = false );

DESCRIPTION

Searches for value strings in all the elements of a string associative array from the left side of
a string for the string org_str, and if the string is found replaces it with the string new_str.

This member function executes the tstring class strreplace() member function on all the
elements of an associative array (0 is set to pos). For more details refer to Section §9.5.29

PARAMETER

[I]  org_str   String to be detected
[I]  new_str   String to be sourced for replacement
[I]  all       Replace All flag

RETURN VALUE

Reference to itself

EXCEPTION

If the system failed to secure an internal buffer.

EXAMPLE

The following code replaces the white space character in all the elements with the underscore “_”:

```
    stdstreamio sio;
    asarray_tstring my_arr("OS","Solaris 9",
        "VENDOR","Sun Microsystems, Inc.", NULL);
    size_t i;
    my_arr.strreplace(" ", "_", true);
    for ( i=0 ; i < my_arr.length() ; i++ ) {
        const char *key = my_arr.key(i);
        sio.printf("%s ... [%s]\n", key, my_arr.cstr(key));
    }
```

Result of execution

OS ... [Solaris_9]
VENDOR ... [Sun_Microsystems,_Inc.]
11.4.31 regreplace()

NAME
regreplace() — String search and replacement of value strings in all the elements using a regular expression

SYNOPSIS
asarray_tstring &regreplace( const char *pat,
                        const char *new_str, bool all = false );
asarray_tstring &regreplace( const tstring &pat,
                        const char *new_str, bool all = false );
asarray_tstring &regreplace( const tregex &pat,
                        const char *new_str, bool all = false );
asarray_tstring &regreplace( const char *pat,
                        const tstring &new_str, bool all = false );
asarray_tstring &regreplace( const tstring &pat,
                        const tstring &new_str, bool all = false );
asarray_tstring &regreplace( const tregex &pat,
                        const tstring &new_str, bool all = false );

DESCRIPTION
Replaces with the string new_str parts in value strings in all the elements of a string associative array that match the POSIX Extended Regular Expression (hereinafter referred to as a regular expression) specified by pat. The back references "\0" through "\9" can be used for new_str ("\0" refers to the entire matching part). If you want to use the backslash itself specify "\\\".

This member function executes the tstring class regreplace() member function on all the elements of an associative array (0 is set to pos). For more details refer to §9.5.30.

If you do not need a regular expression the strreplace() member function can be used (§11.4.30), which operates faster.

PARAMETER
[I] pat Character pattern (regular expression) or compiled object for the tregex class
[I] new_str String after the replacement
[I] all Replace All flag

RETURN VALUE
Reference to itself

EXCEPTION
If the system failed to secure an internal buffer.

EXAMPLE
The following code deletes the escape character “\" from all the element values, attempts matching of the values of all the elements using the regular expression "((\\))(\.)", and if a string matches the expression replaces it with the back reference element 2:

```
stringstream sio;
asarray_tstring my_arr("OS","Solaris",
    "VENDOR","Sun\ Microsystems\\,\\ Inc.", NULL);
```
size_t i;
my_arr.regreplace("([\\])(.)", "\\2", true);
for ( i=0 ; i < my_arr.length() ; i++ ) {
    const char *key = my_arr.key(i);
    sio.printf("%s ... [%s]\n", key, my_arr.cstr(key));
}

Result of execution
OS ... [Solaris]
VENDOR ... [Sun Microsystems, Inc.]

---

### 11.4.32 `tolower()`

**NAME**

tolower() — Replaces the uppercase version of characters in value strings in all the elements with the lowercase version

**SYNOPSIS**

```
asarray_tstring &tolower();
```

**DESCRIPTION**

Replaces the uppercase version of alphabetical characters in value strings in all the elements of a string associative array with the lowercase version.

This member function executes the tstring class `tolower()` member function on all the elements of an associative array. For more details [9.5.31](#).

**RETURN VALUE**

Reference to itself

---

### 11.4.33 `toupper()`

**NAME**

toupper() — Replaces the lowercase version of characters in value strings in all the elements with the uppercase version

**SYNOPSIS**

```
asarray_tstring &toupper();
```

**DESCRIPTION**

Replaces the lowercase version of alphabetical characters in value strings in all the elements of a string associative array with the uppercase version.

This member function executes the tstring class `toupper()` member function on all the elements of an associative array. For more details refer to S [9.5.32](#).

**RETURN VALUE**

Reference to itself
11.4.34  expand_tabs()

NAME
expand_tabs() — Replaces TAB characters in value strings in all the elements with white
space characters

SYNOPSIS
asarray_tstring &expand_tabs( size_t tab_width = 8 );

DESCRIPTION
Replaces horizontal tabulation characters '\t' in value strings in all the elements of a string
associative array with a white space character, and then tabulates the characters to the value
of tab_width.

This member function executes the tstring class expand_tabs() member function on all the
elements of an associative array. For more details refer to §9.5.33.

PARAMETER
[I]  tab_width  TAB width

RETURN VALUE
Reference to itself

EXCEPTION
If the system failed to secure an internal buffer.

11.4.35  contract_spaces()

NAME
contract_spaces() — Replaces white space characters in value strings in all the elements with
TAB characters

SYNOPSIS
asarray_tstring &contract_spaces( size_t tab_width = 8 );

DESCRIPTION
Replaces with '\t' all occurrences of two or more contiguous white space characters ' ' in
value strings in all the elements of a string array that tabulate to the specified TAB width of
tab_width.

This member function executes the tstring class contract_spaces() member function on all the
elements of an associative array. For details more refer to §9.5.34.

PARAMETER
[I]  tab_width  TAB width

RETURN VALUE
A reference to itself

EXCEPTION
If the system failed to secure an internal buffer.
12 MDARRAY_* Class

The mdarray_* class can handle multidimensional arrays of major types in C. It is possible to compute on multidimensional array in a manner similar to IDL.

It has features as follows:

- It has two operating modes: (1)“Automatic Resize Mode”, in which the memory area is allocated automatically as necessary when users access an element of arrays and (2)“Manual Resize Mode”, which is suitable for handling an image data.

- Classes (mdarray_float, mdarray_double, mdarray_int, etc.) corresponding to major numeric types (float, double, int, etc.) in C are prepared. It is possible to carry out an operation and assign values between different classes.

- Operators “+”, “-”, “*”, “/”, “+=”, “-=”, “*=” , “/=” , and “=” are available for scalar values and the whole array.

- Mathemetic functions (sin(), log(), etc.) to carry out an operation to the whole array are prepared. (Almost all functions defined in math.h of libc are available.)

A list of available classes are shown in Table 24. Every class inherits the parent class “mdarray”. (See the Advanced Version for the mdarray class.) By this implementation, operations on the whole array by operators “+”, “-”, “*”, “/”, “+=”, “-=”, “*=” , “/=” , and “=” are possible except some classes (sated as “N/A” for the Operation by Operators box in Table 24).

A brief example of use is shown as follows:

```cpp
#include <sli/mdarray.h>
#include <sli/mdarray_math.h>

mdarray_math.h is not necessary when only using classes, but it is necessary when using mathemetic functions on the whole array. Additionally, write using namespace sli; in the code when namespace declaration(§4.1) is required.

A brief example of use is shown as follows:
```
#include <sli/stdstreamio.h>
#include <sli/mdarray.h>
#include <sli/mdarray_math.h>
using namespace sli;

int main()
{
    stdstreamio sio;
    size_t i;
    mdarray_long my_larr;
    mdarray_double my_darr;
    my_larr[0] = 100;
    my_larr[1] = 10;
    my_larr[2] = 1;
    my_darr = log10(my_larr);
    for ( i=0 ; i < my_darr.length() ; i++ ) { /* print all elements of my_darr */
        sio.printf("%zu ... [%g]\n", i, my_darr[i]);
    }
}

Output:
0 ... [2]
1 ... [1]
2 ... [0]

12.1 How to Create an Object

An object can be initialized in several ways. At this time, the operating mode can be specified. You can choose the Automatic Resize Mode or Manual Resize Mode.

In the Automatic Resize Mode, the number of dimensions and size of the array are extended automatically as necessary when you access an element of the array by using the operator[] or the member function at(), etc., or carry out an operation on the array by using the operators +=, -=, etc. On the other hand, in the Manual Resize Mode, the buffer size is not changed unless expressly specified to be resized. (This mode is suitable for handling an image data.)

As for the member functions whose behavior is different depending on the operating mode, “○” is given in the Support for Operation Mode box in Table 26.

12.1.1 Method in which any Arguments are not Specified

In this case, the object is initialized in the Automatic Resize Mode.

    mdarray_double my_darr;

At this moment, any buffers are not allocated. After this, write the following code:

    my_darr[3] = 1.23;
    my_darr(3,2,1) = 4.56;

Buffers will be allocated automatically. The former case creates one dimensional array where the number of buffers is 4. The latter case creates three dimensional array of where the number of buffers is 4×3×2. The default value of an element of the array to which no value is given is 0. This default value can be changed by the assign_default() member function.

12.1.2 Method in which the Size of the Array is Specified

A size of the array can be specified when creating an object as follows:
mdarray_double my_darr(false, 1920, 1080, 3);

The operating mode has to be specified by the first argument. Give it true to initialize in the Automatic Resize Mode, otherwise give false. Specify the number of the elements of the first, second and third dimensions (up to third dimension) by the second argument. In the above example, an array size of \(1920 \times 1080 \times 3\) for the first, second and third dimensions, respectively, is allocated.

To allocate the \(n\) dimensional array, give the argument as follows:

```cpp
const size_t nelemx = {800, 600, 3, 2}
mdarray_double my_darr(false, nelemx, 4);
```

This example shows the case of four dimensions. An array size of \(800 \times 600 \times 3 \times 2\) for the first, second, third and fourth dimensions, respectively, is allocated.

### 12.1.3 Method in which the Size of the Array and the Default Value are Specified

There are two ways to give the default value to an object upon creation. One is to give the beginning address of the arbitrary buffer, and the other is to give the pointer array for the arbitrary buffer. Note that the number of dimensions is limited to 3 when the default value is given.

As shown below, the operating mode have to be given to the first argument of the constructor, followed by the number of elements of each dimension and the address of the array:

```cpp
const double my_data1[] = {0.02, 0.2, 2.0};
mdarray_double my_darr1(false, 3, my_data1);
```

```cpp
const double my_data2[][3] = {{0.02, 0.2, 2.0}, {20.0, 200.0, 2000.0}};
mdarray_double my_darr2(false, 3, 2, **my_data2);
```

```cpp
const double my_data3[][2][3] = {{{0.02, 0.2, 2.0}, {20.0, 200.0, 2000.0}},
{0.04, 0.4, 4.0}, {40.0, 400.0, 4000.0}};
mdarray_double my_darr3(false, 3, 2, 2, **my_data3);
```

These examples show how to give default value for one, two, and three dimensions, respectively.

A pointer array corresponding to an array data can be given to the argument of the constructor. The following example shows how to give default values to the array inside an object by using the user-created function.

```cpp
int my_function( const double *ptr[], int nx, int ny )
{
    mdarray_double my_darr2(false, nx, ny, ptr);
    :
    :
}
```

### 12.2 Mathematic Functions

The available mathematic functions are shown in Table 25.

The mdarray class in the prototype is the parent class of the classes shown in Table 24. Therefore, it is possible to give an object such as mdarray_double to the argument of the mdarray class, and also it is possible to receive a return value of the mdarray class by the argument of user functions such as mdarray_double.

See also the example in Tutorial §3.6.4 in which mathematic functions are used for an array.
<table>
<thead>
<tr>
<th>Function Prototype</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>mdarray cbart( const mdarray &amp;obj );</td>
<td>Cubic root</td>
</tr>
<tr>
<td>mdarray sqrt( const mdarray &amp;obj );</td>
<td>Square root</td>
</tr>
<tr>
<td>mdarray asin( const mdarray &amp;obj );</td>
<td>Arc sine</td>
</tr>
<tr>
<td>mdarray acos( const mdarray &amp;obj );</td>
<td>Arc cosine</td>
</tr>
<tr>
<td>mdarray acosh( const mdarray &amp;obj );</td>
<td>Arc hyperbolic cosine</td>
</tr>
<tr>
<td>mdarray asinh( const mdarray &amp;obj );</td>
<td>Arc hyperbolic sine</td>
</tr>
<tr>
<td>mdarray atanh( const mdarray &amp;obj );</td>
<td>Arc hyperbolic tangent</td>
</tr>
<tr>
<td>mdarray exp( const mdarray &amp;obj );</td>
<td>Exponential function with base e</td>
</tr>
<tr>
<td>mdarray exp2( const mdarray &amp;obj );</td>
<td>Exponential function with base 2</td>
</tr>
<tr>
<td>mdarray expm1( const mdarray &amp;obj );</td>
<td>Exponent of argument minus 1</td>
</tr>
<tr>
<td>mdarray log( const mdarray &amp;obj );</td>
<td>Natural logarithmic function</td>
</tr>
<tr>
<td>mdarray log1p( const mdarray &amp;obj );</td>
<td>Logarithm of 1 plus argument</td>
</tr>
<tr>
<td>mdarray log10( const mdarray &amp;obj );</td>
<td>Logarithm with base 10</td>
</tr>
<tr>
<td>mdarray sin( const mdarray &amp;obj );</td>
<td>Sine</td>
</tr>
<tr>
<td>mdarray cos( const mdarray &amp;obj );</td>
<td>Cosine</td>
</tr>
<tr>
<td>mdarray tan( const mdarray &amp;obj );</td>
<td>Tangent</td>
</tr>
<tr>
<td>mdarray sinh( const mdarray &amp;obj );</td>
<td>Hyperbolic sine</td>
</tr>
<tr>
<td>mdarray cosh( const mdarray &amp;obj );</td>
<td>Hyperbolic cosine</td>
</tr>
<tr>
<td>mdarray tanh( const mdarray &amp;obj );</td>
<td>Hyperbolic tangent</td>
</tr>
<tr>
<td>mdarray erf( const mdarray &amp;obj );</td>
<td>Error function</td>
</tr>
<tr>
<td>mdarray erfc( const mdarray &amp;obj );</td>
<td>Complementary error function</td>
</tr>
<tr>
<td>mdarray ceil( const mdarray &amp;obj );</td>
<td>Smallest integer not less than argument</td>
</tr>
<tr>
<td>mdarray floor( const mdarray &amp;obj );</td>
<td>Largest integer not less than argument</td>
</tr>
<tr>
<td>mdarray round( const mdarray &amp;obj );</td>
<td>Round a number to the nearest integer</td>
</tr>
<tr>
<td>mdarray trunc( const mdarray &amp;obj );</td>
<td>Truncate a number to the next nearest integer</td>
</tr>
<tr>
<td>mdarray fabs( const mdarray &amp;obj );</td>
<td>Absolute value</td>
</tr>
<tr>
<td>mdarray hypot( const mdarray &amp;obj, float v );</td>
<td>Euclidean distance function</td>
</tr>
<tr>
<td>mdarray hypot( const mdarray &amp;obj, double v );</td>
<td></td>
</tr>
<tr>
<td>mdarray hypot( float v, const mdarray &amp;obj );</td>
<td></td>
</tr>
<tr>
<td>mdarray hypot( double v, const mdarray &amp;obj );</td>
<td></td>
</tr>
<tr>
<td>mdarray hypot( const mdarray &amp;src0, const mdarray &amp;src1 );</td>
<td></td>
</tr>
<tr>
<td>mdarray pow( const mdarray &amp;obj, float v );</td>
<td>Power</td>
</tr>
<tr>
<td>mdarray pow( const mdarray &amp;obj, double v );</td>
<td></td>
</tr>
<tr>
<td>mdarray pow( float v, const mdarray &amp;obj );</td>
<td></td>
</tr>
<tr>
<td>mdarray pow( double v, const mdarray &amp;obj );</td>
<td></td>
</tr>
<tr>
<td>mdarray pow( const mdarray &amp;src0, const mdarray &amp;src1 );</td>
<td></td>
</tr>
<tr>
<td>mdarray fmod( const mdarray &amp;obj, float v );</td>
<td>Modulo arithmetic</td>
</tr>
<tr>
<td>mdarray fmod( const mdarray &amp;obj, double v );</td>
<td></td>
</tr>
<tr>
<td>mdarray fmod( float v, const mdarray &amp;obj );</td>
<td></td>
</tr>
<tr>
<td>mdarray fmod( double v, const mdarray &amp;obj );</td>
<td></td>
</tr>
<tr>
<td>mdarray fmod( const mdarray &amp;src0, const mdarray &amp;src1 );</td>
<td></td>
</tr>
<tr>
<td>mdarray remainder( const mdarray &amp;obj, float v );</td>
<td>Remainder</td>
</tr>
<tr>
<td>mdarray remainder( const mdarray &amp;obj, double v );</td>
<td></td>
</tr>
<tr>
<td>mdarray remainder( float v, const mdarray &amp;obj );</td>
<td></td>
</tr>
<tr>
<td>mdarray remainder( double v, const mdarray &amp;obj );</td>
<td></td>
</tr>
<tr>
<td>mdarray remainder( const mdarray &amp;src0, const mdarray &amp;src1 );</td>
<td></td>
</tr>
</tbody>
</table>

Table 25: List of Available Mathematic Functions
### 12.3 List of Member Functions

A list of member functions is shown in Table 26. It contains all of member functions both defined in the parent class `mdarray` and redefined or additionally defined in the inherited classes (such as `mdarray_double`).

<table>
<thead>
<tr>
<th>Funcion Name</th>
<th>Description</th>
<th>Operating Mode</th>
<th>Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>[]</td>
<td>A reference to the specified value of the element (1 dimension)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>()</td>
<td>A reference to the specified value of the element (1-3 dimensions)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>=</td>
<td>Substitute an array (copy the attribute, too)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>=</td>
<td>Substitute a scalar value</td>
<td></td>
<td></td>
</tr>
<tr>
<td>+=</td>
<td>Add an array to itself</td>
<td></td>
<td></td>
</tr>
<tr>
<td>+=</td>
<td>Add a scalar value to itself</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-=</td>
<td>Subtract an array from itself</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-=</td>
<td>Subtract a scalar value from itself</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*=</td>
<td>Multiply itself by an array</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*=</td>
<td>Multiply itself by a scalar value</td>
<td></td>
<td></td>
</tr>
<tr>
<td>/=</td>
<td>Divide itself by an array</td>
<td></td>
<td></td>
</tr>
<tr>
<td>/=</td>
<td>Divide itself by a scalar value</td>
<td></td>
<td></td>
</tr>
<tr>
<td>+</td>
<td>Return the object that stores the result of adding an array to itself</td>
<td></td>
<td></td>
</tr>
<tr>
<td>+</td>
<td>Return the object that stores the result of adding a scalar value to itself</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-</td>
<td>Return the object that stores the result of subtracting an array from itself</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-</td>
<td>Return the object that stores the result of subtracting a scalar value from itself</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*</td>
<td>Return the object that stores the result of multiplying itself by an array</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*</td>
<td>Return the object that stores the result of multiplying itself by a scalar value</td>
<td></td>
<td></td>
</tr>
<tr>
<td>/</td>
<td>Return the object that stores the result of dividing itself by an array</td>
<td></td>
<td></td>
</tr>
<tr>
<td>/</td>
<td>Return the object that stores the result of dividing itself by a scalar value</td>
<td></td>
<td></td>
</tr>
<tr>
<td>==</td>
<td>Compare</td>
<td></td>
<td></td>
</tr>
<tr>
<td>!=</td>
<td>Compare (negative form)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>size_type()</td>
<td>An integer representing a data type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>bytes()</td>
<td>The number of bytes of an element</td>
<td></td>
<td></td>
</tr>
<tr>
<td>dim_length()</td>
<td>The number of dimensions of an array</td>
<td></td>
<td></td>
</tr>
<tr>
<td>length()</td>
<td>The number of elements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>byte_length()</td>
<td>Total byte size of elements (in a dimension) in an array</td>
<td></td>
<td></td>
</tr>
<tr>
<td>col_length()</td>
<td>The length of the array’s column</td>
<td></td>
<td></td>
</tr>
<tr>
<td>row_length()</td>
<td>The length of the array’s row</td>
<td></td>
<td></td>
</tr>
<tr>
<td>layer_length()</td>
<td>The number of the layers of the array</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 26: List of Member Functions Available in mdarray_.* Classes (cont’d)
<table>
<thead>
<tr>
<th>Function Name</th>
<th>Description</th>
<th>Operating Mode Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>at(), at_cs()</td>
<td>A reference to the specified value of the element (1-3 dimensions)</td>
<td></td>
</tr>
<tr>
<td>dvalue()</td>
<td>The value of the element converted into the double type</td>
<td></td>
</tr>
<tr>
<td>lvalue(), llvalue()</td>
<td>The value of the element converted into the long or long long type</td>
<td></td>
</tr>
<tr>
<td>default_value()</td>
<td>Acquire and set the initial value upon size expansion</td>
<td></td>
</tr>
<tr>
<td>assign_default()</td>
<td>Acquire and set the resize mode</td>
<td></td>
</tr>
<tr>
<td>auto_resize(),</td>
<td>Acquire and set the rounding off possibility</td>
<td></td>
</tr>
<tr>
<td>set_auto_resize()</td>
<td></td>
<td></td>
</tr>
<tr>
<td>rounding()</td>
<td></td>
<td></td>
</tr>
<tr>
<td>set_rounding()</td>
<td></td>
<td></td>
</tr>
<tr>
<td>dprint()</td>
<td>Output the object information to the standard error output (for user’s debug)</td>
<td></td>
</tr>
<tr>
<td>carray(), array_ptr()</td>
<td>Acquire and set the specified element’s address</td>
<td></td>
</tr>
<tr>
<td>get_elements()</td>
<td>Copy the array itself to the user’s buffer</td>
<td></td>
</tr>
<tr>
<td>put_elements()</td>
<td>Copy the array in the user’s buffer to the array itself</td>
<td></td>
</tr>
<tr>
<td>getdata()</td>
<td>Copy the array itself to the user’s buffer</td>
<td></td>
</tr>
<tr>
<td>putdata()</td>
<td>Copy the array in the user’s buffer to the array itself</td>
<td></td>
</tr>
<tr>
<td>reverse_endian()</td>
<td>Reverse endian if necessary</td>
<td></td>
</tr>
<tr>
<td>init()</td>
<td>Initialization of the array</td>
<td></td>
</tr>
<tr>
<td>assign()</td>
<td>Substitute a value for an element</td>
<td></td>
</tr>
<tr>
<td>put()</td>
<td>Set a value to an arbitrary element’s point</td>
<td></td>
</tr>
<tr>
<td>swap()</td>
<td>Replace values between elements</td>
<td></td>
</tr>
<tr>
<td>move()</td>
<td>Copy values between elements</td>
<td></td>
</tr>
<tr>
<td>cpy()</td>
<td>Copy values between elements (with automatic expansion)</td>
<td></td>
</tr>
<tr>
<td>insert()</td>
<td>Insert an element</td>
<td></td>
</tr>
<tr>
<td>crop()</td>
<td>Extract an element</td>
<td></td>
</tr>
<tr>
<td>erase()</td>
<td>Erase an element</td>
<td></td>
</tr>
<tr>
<td>resize()</td>
<td>Change the length of the array</td>
<td></td>
</tr>
<tr>
<td>resizeby()</td>
<td>Change the length of the array relatively</td>
<td></td>
</tr>
<tr>
<td>increase_dim()</td>
<td>Expand the number of dimensions</td>
<td></td>
</tr>
<tr>
<td>decrease_dim()</td>
<td>Reduce the number of dimensions</td>
<td></td>
</tr>
<tr>
<td>swap()</td>
<td>Replace the object by another one</td>
<td></td>
</tr>
<tr>
<td>convert()</td>
<td>Convert the value of the full array element</td>
<td></td>
</tr>
<tr>
<td>ceil()</td>
<td>Raise decimals to the next whole number in a double type value</td>
<td></td>
</tr>
<tr>
<td>floor()</td>
<td>Devalue decimals in a double type value</td>
<td></td>
</tr>
<tr>
<td>round()</td>
<td>Round off decimals in a double type value</td>
<td></td>
</tr>
<tr>
<td>trunc()</td>
<td>Omit decimals in a double type value</td>
<td></td>
</tr>
<tr>
<td>abs()</td>
<td>Absolute value of all elements</td>
<td></td>
</tr>
<tr>
<td>compare()</td>
<td>Compare array objects</td>
<td></td>
</tr>
</tbody>
</table>

Table 26: List of Member Functions Available in mdarray_* Classes (cont’d)
<table>
<thead>
<tr>
<th>Funcion Name</th>
<th>Description</th>
<th>Operating Mode</th>
<th>Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>copy()</td>
<td>Copy an array into another object</td>
<td>§12.3.65</td>
<td></td>
</tr>
<tr>
<td>copy()</td>
<td>Copy a part of an array into another object</td>
<td>§12.3.66</td>
<td>(for image data)</td>
</tr>
<tr>
<td>cut()</td>
<td>Cut all values in an array and copy them into another object</td>
<td>§12.3.67</td>
<td></td>
</tr>
<tr>
<td>cut()</td>
<td>Cut a part of values in an array and copy them into another object</td>
<td>§12.3.68</td>
<td>(for image data)</td>
</tr>
<tr>
<td>clean()</td>
<td>Padding of existing values in an array by default ones</td>
<td>§12.3.69</td>
<td></td>
</tr>
<tr>
<td>fill()</td>
<td>Rewrite element values</td>
<td>§12.3.70</td>
<td>(for image data)</td>
</tr>
<tr>
<td>add()</td>
<td>Add element values</td>
<td>§12.3.71</td>
<td>(for image data)</td>
</tr>
<tr>
<td>multiply()</td>
<td>Multiply element values</td>
<td>§12.3.72</td>
<td>(for image data)</td>
</tr>
<tr>
<td>paste()</td>
<td>Paste up an array object</td>
<td>§12.3.73</td>
<td>(for image data)</td>
</tr>
<tr>
<td>add()</td>
<td>Add an array object</td>
<td>§12.3.74</td>
<td>(for image data)</td>
</tr>
<tr>
<td>subtract()</td>
<td>Subtract an array object</td>
<td>§12.3.75</td>
<td>(for image data)</td>
</tr>
<tr>
<td>multiply()</td>
<td>Multiply an array object</td>
<td>§12.3.76</td>
<td>(for image data)</td>
</tr>
<tr>
<td>divide()</td>
<td>Divide an array object</td>
<td>§12.3.77</td>
<td>(for image data)</td>
</tr>
</tbody>
</table>

Table 26: List of Member Functions Available in mdarray_* Classes
### 12.3.1 []

#### NAME

[] — A reference to the specified value of the element (1 dimension)

#### SYNOPSIS

```c
mdarray_type &operator[]( ssize_t idx0 ); ............................................. 1
const mdarray_type &operator[]( ssize_t idx0 ) const; ............................. 2
```

#### DESCRIPTION

This operator returns a reference to an element specified in the square brackets. It has one argument. For multidimensional arrays, the operator () is used. (See §12.3.2)

The member function 1 is available for read/write and corresponds to `at()`. The member function 2 is available for read only and corresponds to `at_cs()`.

When reading/writing a value with the member function 1 in the Automatic Resize Mode, the size of an array is resized according to the specified index. In the Manual Resize Mode, the substitution of a value into an element beyond the size of the array does not cause any error. The operation is ignored. In order to substitute a value into an element beyond the size of the array, the array size has to be extended by a member function (e.g. `resize()`) in advance. For more information about `resize()`, see §12.3.53

When reading the element beyond the array size in the Manual Resize Mode, `NAN` is returned for floating-point values, and any one of `INDEF UCHAR`, `INDEF INT16`, `INDEF INT32`, or `INDEF INT64` is returned for integer values according to the data type of the element, respectively. The value of each `INDEF` is the minimum integer value of the data type.

Whether the member function 1 or 2 is used depends on whether the object has the “const ” attribute. The member function 1 is used for the object without the “const ” attribute, and the function 2 is automatically used with the attribute.

For information about `at()`, `at_cs()`, see §12.3.31

#### PARAMETER

[I] `idx0` Subscript for the first dimension being designated as 0


#### RETURN VALUE

A reference to the value of the element

#### EXCEPTION

The member function 1 throws an exception when it fails to allocate a local buffer in the Automatic Resize Mode.

#### EXAMPLE

The following code substitutes values into the `mdarray_llong`-class object `my_mdarr` (the data type of array is long long):

```c
mdarray_llong my_mdarr;
my_mdarr[0] = 17090000;
my_mdarr[1] = 9980000;
my_mdarr[2] = 9620000;
```
12.3.2 ()

NAME
() — A reference to the specified value of the element (1-3 dimensions)

SYNOPSIS

```cpp
mdarray_type &operator()( ssize_t idx0, ssize_t idx1 = MDARRAY_INDEF,
                        ssize_t idx2 = MDARRAY_INDEF);
const mdarray_type &operator()( ssize_t idx0, ssize_t idx1 = MDARRAY_INDEF,
                                ssize_t idx2 = MDARRAY_INDEF) const;
```

DESCRIPTION

This operator returns a reference to an element specified by the index. Up to three arguments can be specified. The element index of each dimension is passed to the argument in a straightforward way for one, two, or three dimensional objects. For four or higher dimensional objects, after the array dimension of the object is reduced to three, pass the element index of the third dimension (dimension index: 2) to idx2 to handle n dimensional arrays.

The member function 1 is available for read/write and corresponds to `at()`. The member function 2 is available for read only and corresponds to `at_cs()`.

When reading/writing a value with the function in the Automatic Resize Mode, the size of an array is resized according to the specified index. In the Manual Resize Mode, the substitution of a value into an element beyond the array size does not cause any error. The operation is ignored. In order to substitute a value into an element beyond the array size, the array size has to be extended by a member function (e.g. `resize()`) in advance. For more information about `resize()`, see §12.3.53.

When specifying a negative number for an element index or reading the element beyond the array size in the Manual Resize Mode, `NAN` is returned for floating-point values, and `INDEF_UCHAR`, `INDEF_INT16`, `INDEF_INT32`, or `INDEF_INT64` are returned for integer values according to the data type of the element, respectively. The value of each `INDEF` is the minimum integer value of the data type.

Whether the member function 1 or 2 is used depends on whether the object has the “const” attribute. The member function 1 is used for the object without the “const” attribute, and the function 2 is used automatically with the attribute.

Do not specify `MDARRAY_INDEF` for an argument explicitly.

For more information about `at()`, `at_cs()`, see §12.3.31.

PARAMETER

- `[I] idx0` Subscript for the first dimension being designated as 0
- `[I] idx1` Subscript for the second dimension being designated as 1 (optional)
- `[I] idx2` Subscript for the third dimension being designated as 2 (optional)

RETURN VALUE

A reference to the value of the element

EXCEPTION

The member function 1 throws an exception when it fails to allocate a local buffer in the Automatic Resize Mode.

EXAMPLE

The following code substitutes values into the `mdarray` double-class object `my_mdarr` (the data type of array is double). A three-dimension array (3×2×1) is created:
mdarray_double my_mdarr;
my_mdarr(2,1,0) = 170.9;

12.3.3  =

NAME
  = — Substitute an array (copy the attribute, too)

SYNOPSIS
  mdarray_type &operator=(const mdarray_type &obj); ............................. 1
  mdarray_type &operator=(const mdarray &obj); ................................. 2

DESCRIPTION
  This operator copies all contents of obj, including the attributes such as the length of
  the array and resize settings to the object itself.

  The argument of the member function 2 is the base class (mdarray class). Thus, the object
  of the derived class different from itself can be specified to the argument. In this case, all
  variables are initialized to 0 and those of the derived class object are added by the operator
  +=(§12.3.5), and the attributes such as resize setting are copied.

PARAMETER
  [I] obj The object that belongs to a class derived from “mdarray”

RETURN VALUE
  A reference to itself

EXCEPTION
  The function throws an exception when it fails to allocate a local buffer, or it detects memory
  corruption.

EXAMPLE
  The following code substitutes the mdarray_long-class object area_mdarr into the mdarray
  llong-class object my_mdarr and prints the result to stdout. For more information about
  length(), see §12.3.26

  stdstreamio sio;

  mdarray_llong my_mdarr;
  mdarray_long area_mdarr;
  area_mdarr[0] = 17090000;
  area_mdarr[1] = 9980000;
  area_mdarr[2] = 9620000;

  my_mdarr = area_mdarr;
  for ( size_t i=0 ; i < my_mdarr.length() ; i++ ) {
    sio.printf("my_mdarr value[%zu]... [%lld]\n", i, my_mdarr[i]);
  }

  Output:
  my_mdarr value[0]... [17090000]
  my_mdarr value[1]... [9980000]
  my_mdarr value[2]... [9620000]
12.3.4   =

NAME
    = — Substitute a scalar value

SYNOPSIS
    mdarray_type &operator=(double v);
    mdarray_type &operator=(long long v);
    mdarray_type &operator=(long v);
    mdarray_type &operator=(int v);

DESCRIPTION
    This operator substitutes the value (scalar value) specified by the right side of the operator (argument) into the object itself. The array size is not extended automatically, so it is necessary to set the number of elements and reserve the buffer area in advance.

PARAMETER
    [I]  v  A real or integer scalar

RETURN VALUE
    A reference to itself

EXAMPLE
    The following code substitutes the scalar value, 125, into the object mdarr with a one-dimensional array and prints the result to stdout. For more information about length(), see §12.3.26.

    stdstreamio sio;
    mdarray_int my_mdarr(false, 2);
    my_mdarr = 125;
    for ( size_t i=0 ; i < my_mdarr.length() ; i++ ) {
        sio.printf("my_mdarr value[%zu]... [%d]\n", i, my_mdarr[i]);
    }

    Output:
        my_mdarr value[0]... [125]
        my_mdarr value[1]... [125]

12.3.5   +=

NAME
    += — Add an array to itself

SYNOPSIS
    mdarray_type &operator+=(const mdarray &obj);

DESCRIPTION
    This operator adds the object array of the mdarray (derived) class specified by the right side of the operator (argument) to the object itself. The argument is the base class (mdarray class). Thus, the object of the derived class different from itself can be specified to the argument and cast operations are executed just like a normal scalar operation.
In the Automatic Resize Mode, the array size is extended automatically if each dimension size of `obj` is larger than that of the object itself.

**PARAMETER**

- **[I]** `obj` The object that belongs to a class derived from “mdarray”
  ([I]: input, [O]: output)

**RETURN VALUE**

A reference to itself

**EXCEPTION**

The function throws an exception when it fails to allocate a local buffer, or it detects memory corruption.

### 12.3.6 +=

**NAME**

`+=` — Add a scalar value to itself

**SYNOPSIS**

```cpp
mdarray_type &operator+=(double v);
mdarray_type &operator+=(long long v);
mdarray_type &operator+=(long v);
mdarray_type &operator+=(int v);
```

**DESCRIPTION**

This operator adds the scalar value specified by the right side of the operator (argument) to all elements of the object itself. When the data type of the argument is different from that of the object itself, cast operations are executed just like a normal scalar operation.

**PARAMETER**

- **[I]** `v` A real or integer scalar
  ([I]: input, [O]: output)

**RETURN VALUE**

A reference to itself

**EXAMPLE**

The following code adds the scalar value 50 to the `mdarray_int`-class object `my_mdarr` and prints the result to stdout. For more information about `length()`, see §12.3.26.

```cpp
stdstreamio sio;

mdarray_int my_mdarr(false, 2);
my_mdarr = 25;
my_mdarr += 50;
for (size_t i=0; i < my_mdarr.length(); i++) {
    sio.printf("my_mdarr value[%zu]... [%d]\n", i, my_mdarr[i]);
}
```

**Output:**

```
my_mdarr value[0]... [75]
my_mdarr value[1]... [75]
```
12.3.7 -=

NAME

-= — Subtract an array from itself

SYNOPSIS

mdarray_type &operator-=(const mdarray &obj);

DESCRIPTION

This operator subtracts the object array of the mdarray (derived) class specified by the
right side of the operator (argument) from the object itself. The argument is the base class
(mdarray class). Thus, the object of the derived class different from itself can be specified
to the argument and cast operations are executed just like a normal scalar operation.

In the Automatic Resize Mode, the array size is extended automatically if each dimension
size of obj is larger than that of the object itself.

PARAMETER

[I] obj The object that belongs to a class derived from “mdarray”

RETURN VALUE

A reference to itself

EXCEPTION

The function throws an exception when it fails to allocate a local buffer, or it detects memory
corruption.

EXAMPLE

The following code subtracts the mdarray_int-class object subst_mdarr from the mdarray_long-class object my_mdarr and prints the result to stdout. For more information about
length(), see [12.3.26]

```c
stdstreamio sio;

mdarray_long my_mdarr(false, 2);
my_mdarr = 100;

mdarray_int subst_mdarr(false, 2);
subst_mdarr[0] = 10;
subst_mdarr[1] = 20;

my_mdarr -= subst_mdarr;
for ( size_t i=0 ; i < my_mdarr.length() ; i++ ) {
    sio.printf("my_mdarr value[%zu]... [%ld]\n", i, my_mdarr[i]);
}
```

Output:

my_mdarr value[0]... [90]
my_mdarr value[1]... [80]
12.3.8  -=

NAME
  -= — Subtract a scalar value from itself

SYNOPSIS
  mdarray_type &operator-=(double v);
  mdarray_type &operator-=(long long v);
  mdarray_type &operator-=(long v);
  mdarray_type &operator-=(int v);

DESCRIPTION
  This operator subtracts the scalar value specified by the right side of the operator (argument)
  from all elements of the object itself. When the data type of the argument is different from
  that of the object itself, cast operations are executed just like a normal scalar operation.

PARAMETER
  [I]  v  A real or integer scalar

RETURN VALUE
  A reference to itself

12.3.9  *=

NAME
  *== — Multiply itself by an array

SYNOPSIS
  mdarray_type &operator*=(const mdarray &obj);

DESCRIPTION
  This operator multiplies the object itself by the object array of the mdarray (derived) class
  specified by the right side of the operator (argument). The argument is the base class
  (mdarray class). Thus, the object of the derived class different from itself can be specified
  to the argument and cast operations are executed just like a normal scalar operation.
  In the Automatic Resize Mode, the array size is extended automatically if each dimension
  size of obj is larger than that of the object itself.

PARAMETER
  [I]  obj  The object that belongs to a class derived from “mdarray”

RETURN VALUE
  A reference to itself

EXCEPTION
  The function throws an exception when it fails to allocate a local buffer, or it detects memory
  corruption.

EXAMPLE
  The following code multiplies the mdarray_long-class object my_mdarr by the mdarray_int-
  class object mdarrPlus and prints the result to stdout. For more information about length(),
  see §12.3.26.
```cpp
stdstreamio sio;

mdarray_long my_mdarr(false, 2);
my_mdarr = 50;

mdarray_int multi_mdarr;
multi_mdarr[0] = 10;
multi_mdarr[1] = 20;
multi_mdarr[2] = 30;

my_mdarr *= multi_mdarr;
for (size_t i=0; i < my_mdarr.length(); i++) {
    sio.printf("my_mdarr value[%zu]... [%ld]\n", i, my_mdarr[i]);
}
```

**Output:**

```
my_mdarr value[0]... [500]
my_mdarr value[1]... [1000]
```

### 12.3.10 *=

**NAME**

`*=` — Multiply itself by a scalar value

**SYNOPSIS**

```cpp
mdarray_type &operator=(double v);
mdarray_type &operator=(long long v);
mdarray_type &operator=(long v);
mdarray_type &operator=(int v);
```

**DESCRIPTION**

This operator multiplies all elements of the object itself by the scalar value specified by the right side of the operator (argument). When the data type of the argument is different from that of the object itself, cast operations are executed just like a normal scalar operation.

**PARAMETER**

`v` A real or integer scalar

`[[I]]` : input, `[[O]]` : output

**RETURN VALUE**

A reference to itself

### 12.3.11 /=

**NAME**

`/=` — Divide itself by an array

**SYNOPSIS**

```cpp
mdarray_type &operator/=(const mdarray &obj);
```
DESCRIPTION
This operator divides the object itself by the object array of the mdarray (derived) class specified by the right side of the operator (argument). The argument is the base class (mdarray class). Thus, the object of the derived class different from itself can be specified to the argument and cast operations are executed just like a normal scalar operation.
In the Automatic Resize Mode, the array size is extended automatically if each dimension size of obj is larger than that of the object itself.

PARAMETER
[I] \texttt{obj} The object that belongs to a class derived from “mdarray”

RETURN VALUE
A reference to itself

EXCEPTION
The function throws an exception when it fails to allocate a local buffer, or it detects memory corruption.

EXAMPLE
The following code divides the \texttt{mdarray\_long}-class object \texttt{my\_mdarr} by the \texttt{mdarray\_int}-class object \texttt{div\_mdarr} and prints the result to stdout. For more information about \texttt{\_length()}, see §12.3.26.

```cpp
stdstreamio sio;

mdarray\_long my\_mdarr(false, 2);
my\_mdarr = 50;

mdarray\_int div\_mdarr;
div\_mdarr[0] = 1;
div\_mdarr[1] = 2;
div\_mdarr[2] = 5;

my\_mdarr /= div\_mdarr;
for (size\_t i=0 ; i < my\_mdarr\_length() ; i++ ) {
    sio.printf("my\_mdarr\_value[%zu]\... [\%ld]\n", i, my\_mdarr[i]);
}
```

Output:
my\_mdarr\_value[0]... [50]
my\_mdarr\_value[1]... [25]

12.3.12 /=

NAME
/= — Divide itself by a scalar value

SYNOPSIS
\begin{verbatim}
mdarray\_type &operator/=(double v);
mdarray\_type &operator/=(long\ long v);
mdarray\_type &operator/=(long v);
mdarray\_type &operator/=(int v);
\end{verbatim}
DESCRIPTION
This operator divides all elements of the object itself by the scalar value specified by the
right side of the operator (argument). When the data type of the argument is different from
that of the object itself, cast operations are executed just like a normal scalar operation.

PARAMETER

[I] v  A real or integer scalar

RETURN VALUE
A reference to itself

12.3.13 +

NAME
+ — Return the object that stores the result of adding an array to itself

SYNOPSIS
mdarray operator+(const mdarray &obj);

DESCRIPTION
This operator returns the object that stores the result of adding the object array of the
mdarray (derived) class specified by the right side of the operator (argument) to the object
itself. The argument is the base class (mdarray class). Thus, the object of the derived class
different from itself can be specified to the argument and cast operations are executed just
like a normal scalar operation.

The returned operation mode and rounding attribute are identical to those of the object
itself.

PARAMETER

[I] obj  The object that belongs to a class derived from “mdarray”

RETURN VALUE
An object including the calculation result

EXCEPTION
The function throws an exception when it fails to allocate a local buffer, or it detects memory
corruption.

EXAMPLE
See §3.6.4 for an example of applying operators to arrays.

12.3.14 +

NAME
+ — Return the object that stores the result of adding a scalar value to itself

SYNOPSIS
mdarray operator+(double v);
mdarray operator+(float v);
mdarray operator+(long long v);
mdarray operator+(long v);
mdarray operator+(int v);
DESCRIPTION
This operator returns the object that stores the result of adding the scalar value specified by the right side of the operator (argument) to all elements of the object itself. When the data type of the argument is different from that of the object itself, cast operations are executed just like a normal scalar operation.

The returned operation mode and rounding attribute are identical to those of the object itself.

PARAMETER
   [I] v  A real or integer scalar

RETURN VALUE
A reference to itself

EXCEPTION
The function throws an exception when it fails to allocate a local buffer.

12.3.15  -

NAME
— — Return the object that stores the result of subtracting an array from itself

SYNOPSIS
mdarray operator-(const mdarray &obj);

DESCRIPTION
This operator returns the object that stores the result of subtracting the object array of the mdarray (derived) class specified by the right side of the operator (argument) from the object itself. The argument is the base class (mdarray class). Thus, the object of the derived class different from itself can be specified to the argument and cast operations are executed just like a normal scalar operation.

The returned operation mode and rounding attribute are identical to those of the object itself.

PARAMETER
   [I] obj  The object that belongs to a class derived from “mdarray”

RETURN VALUE
An object including the calculation result

EXCEPTION
The function throws an exception when it fails to allocate a local buffer, or it detects memory corruption.

EXAMPLE
See §3.6.4 for an example of applying operators to arrays.
12.3.16 -

NAME

Return the object that stores the result of subtracting a scalar value from itself

SYNOPSIS

mdarray operator-(double v);
mdarray operator-(float v);
mdarray operator-(long long v);
mdarray operator-(long v);
mdarray operator-(int v);

DESCRIPTION

This operator returns the object that stores the result of subtracting the scalar value specified by the right side of the operator (argument) from all elements of the object itself. When the data type of the argument is different from that of the object itself, cast operations are executed just like a normal scalar operation.

The returned operation mode and rounding attribute are identical to those of the object itself.

PARAMETER

[I] v A real or integer scalar

RETURN VALUE

A reference to itself

EXCEPTION

The function throws an exception when it fails to allocate a local buffer.

12.3.17 *

NAME

∗ — Return the object that stores the result of multiplying itself by an array

SYNOPSIS

mdarray operator*(const mdarray &obj);

DESCRIPTION

This operator returns the object that stores the result of multiplying the object itself by the object array of the mdarray (derived) class specified by the right side of the operator (argument). The argument is the base class (mdarray class). Thus, the object of the derived class different from itself can be specified to the argument and cast operations are executed just like a normal scalar operation.

The returned operation mode and rounding attribute are identical to those of the object itself.

PARAMETER

[I] obj The object that belongs to a class derived from “mdarray”

RETURN VALUE

An object including the calculation result
**12.3.18 * **

**NAME**

* — Return the object that stores the result of multiplying itself by a scalar value

**SYNOPSIS**

```c
mdarray operator*(double v);
mdarray operator*(float v);
mdarray operator*(long long v);
mdarray operator*(long v);
mdarray operator*(int v);
```

**DESCRIPTION**

This operator returns the object that stores the result of multiplying all elements of the object itself by the scalar value specified by the right side of the operator (argument). When the data type of the argument is different from that of the object itself, cast operations are executed just like a normal scalar operation.

The returned operation mode and rounding attribute are identical to those of the object itself.

**PARAMETER**

- **[I]** v A real or integer scalar

**RETURN VALUE**

A reference to itself

**EXCEPTION**

The function throws an exception when it fails to allocate a local buffer.

---

**12.3.19 / **

**NAME**

/ — Return the object that stores the result of dividing itself by an array

**SYNOPSIS**

```c
mdarray operator/(const mdarray &obj);
```

**DESCRIPTION**

This operator returns the object that stores the result of dividing the object itself by the object array of the mdarray (derived) class specified by the right side of the operator (argument). The argument is the base class (mdarray class). Thus, the object of the derived class different from itself can be specified to the argument and cast operations are executed just like a normal scalar operation.

The returned operation mode and rounding attribute are identical to those of the object itself.
PARAMETER
   [I]  obj  The object that belongs to a class derived from “mdarray”

RETURN VALUE
   An object including the calculation result

EXCEPTION
   The function throws an exception when it fails to allocate a local buffer, or it detects memory
corruption.

EXAMPLE
   See §3.6.4 for an example of applying operators to arrays.

12.3.20  /

NAME
   / — Return the object that stores the result of dividing itself by a scalar value

SYNOPSIS
   mdarray operator/(double v);
   mdarray operator/(float v);
   mdarray operator/(long long v);
   mdarray operator/(long v);
   mdarray operator/(int v);

DESCRIPTION
   This operator returns the object that stores the result of dividing all elements of the object
   itself by the scalar value specified by the right side of the operator (argument). When the
data type of the argument is different from that of the object itself, cast operations are
executed just like a normal scalar operation.

   The returned operation mode and rounding attribute are identical to those of the object
   itself.

PARAMETER
   [I]  v  A real or integer scalar

RETURN VALUE
   A reference to itself

EXCEPTION
   The function throws an exception when it fails to allocate a local buffer.

12.3.21  ==

NAME
   == — Compare

SYNOPSIS
   bool operator==(const mdarray &obj) const;
DESCRIPTION
This operator compares the object of mdarray (derived) class specified by the right side of the operator (argument) with the object itself. If the array size and elements of the argument \texttt{obj} are identical to those of the object itself, it returns \texttt{true}. Otherwise, it returns \texttt{false}. This member function uses \texttt{compare()} function (§12.3.64) internally.

PARAMETER
\[ \texttt{[I]} \quad \texttt{obj} \quad \text{The object that belongs to a class derived from "mdarray"} \]
\( ([I] : \text{input}, [O] : \text{output}) \)

RETURN VALUE
\begin{itemize}
  \item \texttt{true} : If the sizes and values of the elements on the arrays are identical
  \item \texttt{false} : If the sizes and one of the values of the elements on the arrays are not identical
\end{itemize}

EXAMPLE
The following code compares the \texttt{mdarray_uchar-class} object \texttt{my_mdarr} with the \texttt{mdarray_long-class} object \texttt{comp_mdarr} and prints the result to stdout:

\begin{verbatim}
  stdstreamio sio;

  mdarray_uchar my_mdarr(false, 3);
  my_mdarr = 20;

  mdarray_long comp_mdarr;
  comp_mdarr[0] = 20;
  if (my_mdarr == comp_mdarr) {
      sio.printf("true\n");
  } else {
      sio.printf("false\n");
  }

  Output:
  false
\end{verbatim}

12.3.22 \(!=\)

NAME
\(!=\) — Compare (negative form)

SYNOPSIS
\begin{verbatim}
  bool operator!==(const mdarray &obj) const;
\end{verbatim}

DESCRIPTION
This operator compares the object of the \texttt{mdarray} (derived) class specified by the right side of the operator (argument) with the object itself. If the the argument \texttt{obj} is not identical to the object itself, it returns \texttt{true}. Otherwise, it returns \texttt{false}. This member function uses the \texttt{compare()} function (§12.3.64) internally.

PARAMETER
\begin{itemize}
  \item \texttt{[I]} \quad \texttt{obj} \quad \text{The object that belongs to a class derived from "mdarray"}
\end{itemize}
\( ([I] : \text{input}, [O] : \text{output}) \)
**RETURN VALUE**
- **true**: If the sizes and one of the values of the elements on the arrays are not identical
- **false**: If the sizes and values of the elements on the arrays are identical

**EXAMPLE**

The following code compares the mdarray_uchar-class object `my_mdarr` with the mdarray_long-class object `comp_mdarr` and prints the result to stdout:

```c
stdstreamio sio;

mdarray_uchar my_mdarr(false, 3);
my_mdarr = 20;

mdarray_long comp_mdarr;
comp_mdarr[0] = 20;
if (my_mdarr != comp_mdarr) {
    sio.printf("true\n");
} else {
    sio.printf("false\n");
}
```

Output:
true

---

**12.3.23 size_type()**

**NAME**

`size_type()` — An integer representing a data type (by data type)

**SYNOPSIS**

```c
ssize_t size_type() const;
```

**DESCRIPTION**

This member function returns an integer value that corresponds to the data type of the arrays of the object itself. The values are defined in "sli/size_types.h" as follows:
<table>
<thead>
<tr>
<th>Data Type in C</th>
<th>Constant Identifier</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>float</td>
<td>FLOAT_ZT</td>
<td>-4</td>
<td>Single-precision floating-point number</td>
</tr>
<tr>
<td>double</td>
<td>DOUBLE_ZT</td>
<td>-8</td>
<td>Double-precision floating-point number</td>
</tr>
<tr>
<td>fcomplex</td>
<td>FCOMPLEX_ZT</td>
<td>-7</td>
<td>Single-precision floating-point complex number</td>
</tr>
<tr>
<td>dcomplex</td>
<td>DCOMPLEX_ZT</td>
<td>-15</td>
<td>Double-precision floating-point complex number</td>
</tr>
<tr>
<td>unsigned char</td>
<td>UCHAR_ZT</td>
<td>1</td>
<td>Unsigned 1-byte integer</td>
</tr>
<tr>
<td>short</td>
<td>SHORT_ZT</td>
<td></td>
<td>System-dependent Signed integer</td>
</tr>
<tr>
<td>int</td>
<td>INT_ZT</td>
<td></td>
<td>System-dependent Signed integer</td>
</tr>
<tr>
<td>long</td>
<td>LONG_ZT</td>
<td></td>
<td>System-dependent Signed integer</td>
</tr>
<tr>
<td>long long</td>
<td>LONGLONG_ZT</td>
<td></td>
<td>System-dependent Signed integer</td>
</tr>
<tr>
<td>int16_t</td>
<td>INT16_ZT</td>
<td>2</td>
<td>Signed 2-byte integer</td>
</tr>
<tr>
<td>int32_t</td>
<td>INT32_ZT</td>
<td>4</td>
<td>Signed 4-byte integer</td>
</tr>
<tr>
<td>int64_t</td>
<td>INT64_ZT</td>
<td>8</td>
<td>Signed 8-byte integer</td>
</tr>
<tr>
<td>size_t</td>
<td>SIZE_ZT</td>
<td></td>
<td>System-dependent Unsigned integer</td>
</tr>
<tr>
<td>ssize_t</td>
<td>SSIZE_ZT</td>
<td></td>
<td>System-dependent Signed integer</td>
</tr>
<tr>
<td>bool</td>
<td>BOOL_ZT</td>
<td></td>
<td>System-dependent Boolean</td>
</tr>
<tr>
<td>uintptr_t</td>
<td>UINTPTR_ZT</td>
<td></td>
<td>System-dependent Unsigned integer corresponding to the address width</td>
</tr>
</tbody>
</table>

See Table 24 for the classes that are already available.

When the information of the data type is used in the code, use the constant identifier shown in the above table, not a raw number such as -4.

**RETURN VALUE**

An integer to represent its type

**EXAMPLE**

The following code creates the mdarray_int32-class object `my_mdarr` and prints the size_type of `my_mdarr` to stdout:

```c
stdstreamio sio;

mdarray_int32 my_mdarr;
    sio.printf("*** my_mdarr size_type... [%zd]\n", my_mdarr.size_type());
```

**Output:**

```
*** my_mdarr size_type... [4]
```

12.3.24 bytes()

**NAME**

`bytes()` — The number of bytes of an element

**SYNOPSIS**

```c
size_t bytes() const;
```

**DESCRIPTION**

This member function returns the byte size of an element in the array of the object itself.
RETURN VALUE
A byte length of an element

EXAMPLE
The following code creates the mdarray_double-class object `my_mdarr` and prints the byte size of an element to stdout:

```c
stdstreamio sio;

mdarray_double my_mdarr;
sio.printf("*** my_mdarr bytes... [%zu]\n", my_mdarr.bytes());
```

Output:
*** my_mdarr bytes... [8]

12.3.25 dim_length()

NAME
dim_length() — The number of dimensions of an array

SYNOPSIS
```c
size_t dim_length() const;
```

DESCRIPTION
This member function returns the number of dimensions for the array of the object itself.

RETURN VALUE
The number of dimensions of the array

EXAMPLE
The following code prints the number of dimensions for the array of the object `my_mdarr3dim` to stdout:

```c
stdstreamio sio;

mdarray_float my_mdarr3dim(false, 3, 4, 5);
sio.printf("*** my_mdarr3dim dim... [%zu]\n", my_mdarr3dim.dim_length());
```

Output:
*** my_mdarr3dim dim... [3]

12.3.26 length()

NAME
length() — The number of elements

SYNOPSIS
```c
size_t length() const; ............................................................... 1
size_t length( size_t dim_index ) const; ......................................... 2
```
DESCRIPTION
This member function returns the total number of elements in the arrays of the object itself.
When the argument is not specified, the number of elements in dimension $1 \times$ in dim. 2 \times in dim. 3 ... is returned. When $\text{dim\_index}$ is passed to the argument, the number of elements in the dimension with the index $\text{dim\_index}$ is returned. $\text{dim\_index}$ starts from 0.

PARAMETER
[I] dim\_index The integer number ($\geq 0$) that specifies one of the dimensions of the array ([I] : input, [O] : output)

RETURN VALUE
The number of elements

EXAMPLE
The following code prints the total number of elements in the object $\text{my\_mdarr3dim}$ and the number of elements in the dimension with the index 0 to stdout:

```cpp
stdstreamio sio;

mdarray\_float my\_mdarr3dim(false, 3, 4, 5);
sio.printf("*** my\_mdarr3dim length... [%zu]\n", my\_mdarr3dim.length());
sio.printf("*** my\_mdarr3dim length 1dim... [%zu]\n", my\_mdarr3dim.length(0));
```

Output:
*** my\_mdarr3dim length... [60]
*** my\_mdarr3dim length 1dim... [3]

---

12.3.27 byte\_length()

NAME
byte\_length() — Total byte size of elements (in a dimension) in an array

SYNOPSIS
```cpp
size\_t byte\_length() const; ......................................................... 1
size\_t byte\_length( size\_t dim\_index ) const; .................................. 2
```

DESCRIPTION
This member function returns the total byte size of arrays in the object itself. When $\text{dim\_index}$ is passed to the argument, the byte size of an array for the dimension with the index $\text{dim\_index}$ is returned.

PARAMETER
[I] dim\_index The integer number ($\geq 0$) that specifies one of the dimensions of the array ([I] : input, [O] : output)

RETURN VALUE
The whole byte size of the array or the byte size of the elements in the specified dimension

EXAMPLE
The following code prints the total byte size of the arrays in a three-dimension array $\text{my\_mdarr3dim}$ and the byte size of an array for the third dimension (dimension index: 2) to stdout:
stdstreamio sio;

mdarray_float my_mdarr3dim(false, 3, 4, 5);
sio.printf("*** my_mdarr3dim byte_length... [%zu]\n", my_mdarr3dim.byte_length());
sio.printf("*** my_mdarr3dim byte_length 3dim... [%zu]\n", my_mdarr3dim.byte_length(2));

Output:
*** mdarr3dim byte_length... [240]
*** mdarr3dim byte_length 3dim... [20]

12.3.28  col_length()

NAME
length() — The length of the array’s column

SYNOPSIS
size_t col_length() const;

DESCRIPTION
This member function returns the length of the columns for the array of the object itself.

RETURN VALUE
A column length of the array

EXAMPLE
The following code prints the length of the columns for a three-dimension array my_mdarr3dim to stdout:

stdstreamio sio;

mdarray_float my_mdarr3dim(false, 3, 4, 5);
sio.printf("*** my_mdarr3dim col... [%zu]\n", my_mdarr3dim.col_length());

Output:
*** my_mdarr3dim col... [3]

12.3.29  row_length()

NAME
row_length() — The length of the array’s row

SYNOPSIS
size_t row_length() const;

DESCRIPTION
This member function returns the length of the rows for the array of the object itself.

RETURN VALUE
A row length of the array
**EXAMPLE**

The following code prints the length of the rows for a three-dimension array `my_mdarr3dim` to stdout:

```cpp
stdstreamio sio;

mdarray_float my_mdarr3dim(false, 3, 4, 5);
sio.printf("*** my_mdarr3dim row... [%zu]\n", my_mdarr3dim.row_length());
```

**Output:**

```
*** my_mdarr3dim row... [4]
```

---

### 12.3.30 layer_length()

**NAME**

`layer_length()` — The number of the layers of the array

**SYNOPSIS**

```cpp
size_t layer_length() const;
```

**DESCRIPTION**

This member function returns the length of the layers for the array of the object itself. When the dimension of the array is 1 or 2, 1 is returned. When the dimension of the array is 3 or more, after the array dimension is reduced to three, the length of the layers for the third dimension (dimension index: 2) is returned.

**RETURN VALUE**

The number of dimensions of the array

**EXAMPLE**

The following code prints the length of the layers for a three-dimension array `my_mdarr3dim` to stdout:

```cpp
stdstreamio sio;

mdarray_float my_mdarr3dim(false, 3, 4, 5);
sio.printf("*** my_mdarr3dim layer... [%zu]\n", my_mdarr3dim.layer_length());
```

**Output:**

```
*** my_mdarr3dim layer... [5]
```

---

### 12.3.31 at(), at_cs()

**NAME**

`at()`, `at_cs()` — A reference to the specified value of the element (1-3 dimensions)

**SYNOPSIS**

```cpp
type &at( ssize_t idx0, ssize_t idx1 = MDARRAY_INDEF,
         ssize_t idx2 = MDARRAY_INDEF ); ................................. 1
const type &at( ssize_t idx0, ssize_t idx1 = MDARRAY_INDEF,
                ssize_t idx2 = MDARRAY_INDEF ) const; ........................ 2
const type &at_cs( ssize_t idx0, ssize_t idx1 = MDARRAY_INDEF,
                   ssize_t idx2 = MDARRAY_INDEF ) const; .................. 3
```
DESCRIPTION
This member function sets/gets the element specified by the arguments idx0, idx1, and idx2
to/from the array.

The member function 1 is available for read/write. The member functions 2 and 3 are
available for read only.

When reading/writing a value with the member function 1 in the Automatic Resize Mode,
the size of an array is resized according to the specified index. In the Manual Resize Mode,
the substitution of a value into an element beyond the array size does not cause any error.
The operation is ignored. In order to substitute a value into an element beyond the array
size, the array size has to be extended by a member function (e.g. resize()) in advance. For
more information about resize(), see \ref{123.53}.

When reading the element beyond the array size in Manual Resize Mode, \texttt{NAN} is returned
for floating-point numbers, and any one of \texttt{INDEF\_UCHAR}, \texttt{INDEF\_INT16}, \texttt{INDEF\_INT32}, or
\texttt{INDEF\_INT64} is returned for integer numbers according to the data type of the element,
respectively. The value of each \texttt{INDEF} is the minimum integer value of the data type.

For the function at(), whether the member function 1 or 2 is used depends on whether the
object has the “\texttt{const}” attribute. The member function 1 is used for the object without the
“\texttt{const}” attribute, and the function 2 is used with the attribute automatically.

Do not specify \texttt{MDARRAY\_INDEF} for an argument explicitly.

PARAMETER
\begin{itemize}
\item [I] idx0 Subscript for the first dimension being designated as 0
\item [I] idx1 Subscript for the second dimension being designated as 1 (optional)
\item [I] idx2 Subscript for the third dimension being designated as 2 (optional)
\end{itemize}

RETURN VALUE
A reference to the values of the elements

EXCEPTION
The member function 1 throws an exception when it fails to allocate a local buffer in the
Automatic Resize Mode.

All member functions throw an exception when the size of each element in this array is
greater than that of their return value.

EXAMPLE
The following code sets values to the elements of the \texttt{mdarray\_float}-class object \texttt{my\_fmdarr}
via a member function at() and prints the values of elements to stdout by the at():

\begin{verbatim}
stdstreamio sio;

mdarray\_float my\_fmdarr;

my\_fmdarr.at(0) = 1000.1;
my\_fmdarr.at(1) = 2000.2;
for ( size\_t i = 0 ; i < my\_fmdarr.length() ; i++ ) {
    sio.printf("my\_fmdarr value[%zu]... [%5.1f]\n", i, my\_fmdarr.at(i));
}
\end{verbatim}
12.3.32  dvalue()

NAME  
dvalue() — The value of the element converted into the double type

SYNOPSIS  
double dvalue( ssize_t idx0, ssize_t idx1 = MDARRAY_INDEF,  
               ssize_t idx2 = MDARRAY_INDEF ) const;

DESCRIPTION  
This member function casts the element in the array of the object itself to a double-precision  
floating-point value and returns it. When the specified index exceeds the array size, \textit{NAN} is  
returned.

Do not specify \texttt{MDARRAY\_INDEF} for an argument explicitly.

PARAMETER  
\begin{itemize}  
\item \texttt{idx0} : Subscript for the first dimension being designated as 0  
\item \texttt{idx1} : Subscript for the second dimension being designated as 1 (optional)  
\item \texttt{idx2} : Subscript for the third dimension being designated as 2 (optional)  
\end{itemize}  
(\texttt{[I]} : input, \texttt{[O]} : output)

RETURN VALUE  
\begin{itemize}  
\item A value converted to the double type : Normal end  
\item \texttt{NAN} (error) : When the type of the element is not supported
\item When the index of the elements exceeding the size of the array is specified
\end{itemize}

EXAMPLE  
The following code sets a value to the \texttt{mdarray\_float-class} object \texttt{my\_mdarry} and gets the  
value as a double-precision floating-point number, and prints it to stdout:

```cpp
ostream sio;

mdarray\_float my\_mdarry;
my\_mdarry[0] = 123.456;
sio.printf("my\_mdarry dvalue... \[\%6.3f\]\n", my\_mdarry.dvalue(0));
```

Output:  
my\_mdarry dvalue... \[123.456\]

12.3.33  lvalue(), llvalue()

NAME  
lvalue(), llvalue() — The value of the element converted into the long or long long type

SYNOPSIS  
\begin{itemize}  
\item long lvalue( ssize_t idx0, ssize_t idx1 = MDARRAY\_INDEF,  
                  ssize_t idx2 = MDARRAY\_INDEF ) const; \hfill 1  
\item long long llvalue( ssize_t idx0, ssize_t idx1 = MDARRAY\_INDEF,  
                         ssize_t idx2 = MDARRAY\_INDEF ) const; \hfill 2
\end{itemize}
DESCRIPTION
This member function casts the element in the array of the object itself to a long or long long value and returns it.

When the data type of the array is floating-point, the value is truncated to the whole number by default. In order to round it to the whole number, it requires the use of the set_rounding() function in advance. For more information about set_rounding(), see §12.3.36.

When the specified index exceeds the array size, INDEF_LONG or INDEF_LLONG is returned, respectively. The value of each INDEF is the minimum integer value of the data type.

Do not specify MDARRAY_INDEF for an argument explicitly.

PARAMETER

<table>
<thead>
<tr>
<th></th>
<th>idx0</th>
<th>Subscript for the first dimension being designated as 0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>idx1</td>
<td>Subscript for the second dimension being designated as 1 (optional)</td>
</tr>
<tr>
<td></td>
<td>idx2</td>
<td>Subscript for the third dimension being designated as 2 (optional)</td>
</tr>
</tbody>
</table>

(I : input, O : output)

RETURN VALUE

<table>
<thead>
<tr>
<th>Value converted to the long or long long type</th>
<th>Normal end</th>
</tr>
</thead>
<tbody>
<tr>
<td>INDEF_LONG or INDEF_LLONG</td>
<td>When the type of the element is not supported</td>
</tr>
<tr>
<td></td>
<td>When the index of the elements exceeding the size of the array is specified</td>
</tr>
</tbody>
</table>

EXAMPLE

The following code sets a value to the mdarray_float-class object my_mdarray and gets the value as a long number and as a long long number, and prints them to stdout:

```c
stdstreamio sio;

mdarray_float my_mdarray;
my_mdarray[0] = 123.556;
sio.printf("my_mdarray lvalue... [%ld]\n", my_mdarray.lvalue(0));
my_mdarray.set_rounding(true);
sio.printf("my_mdarray llvalue... [%lld]\n", my_mdarray.llvalue(0));
```

Output:

```
my_mdarray lvalue... [123]
my_mdarray llvalue... [124]
```

12.3.34 default_value(), assign_default()

NAME
default_value(), assign_default() — Acquire and set the initial value upon size expansion

SYNOPSIS

type default_value() const; ................................................................. 1
mdarray_type &assign_default( type value ); ....................................... 2

DESCRIPTION
The member function 1 returns the initial value for size extension.
The member function 2 sets up the initial value for size extension. The value does not apply
to the existing elements. It becomes valid when the array size is extended.

RETURN VALUE
The member function 1 returns the initial value when the size of the array is expanded.
The member function 2 returns a reference to itself.

EXCEPTION
The function 2 throws an exception when it fails to allocate a local buffer.

EXAMPLE
The following code prints the initial value of the mdarray_float-class object my_mdarr for size
extension to stdout:

```c
sio.printf("*** my_mdarr defval... [%f]\n", my_mdarr.default_value());
```

Output:
*** my_mdarr defval... [50.000000]

12.3.35 auto_resize(), set_auto_resize()

NAME
auto_resize(), set_auto_resize() — Acquire and set the resize mode

SYNOPSIS
```c
bool auto_resize() const; ................................................................. 1
mdarray_type &set_auto_resize( bool tf ); ......................................... 2
```

DESCRIPTION
The member function 1 returns the resize mode by boolean type. The member function 2
sets up the resize mode by boolean type.
The Automatic Resize Mode corresponds to true (=1) and the Manual Resize Mode corre-
sponds to false (=0).
See the Operation Mode Support box in Table 26 to find out which member functions support
the operation modes.

RETURN VALUE
The member function 1 returns an operation mode (or true in the Automatic Resize Mode).
The member function 2 returns a reference to itself.

EXAMPLE
The following code creates mdarr0dim in the Automatic Resize Mode and creates mdarr3dim
in the Manual Resize Mode, and prints the resize modes of the arrays to stdout:
12.3.36 rounding(), set_rounding()

NAME
rounding(), set_rounding() — Acquire and set the rounding off possibility

SYNOPSIS

```cpp
bool rounding() const;
mdarray_type &set_rounding(bool tf);
```

DESCRIPTION

The member function 2 sets up the rounding mode. Either the floating-point numbers are truncated or rounded to the whole number in some high-level member functions. The member function 1 returns true in the round mode and false in the truncate mode.

Upon creation of an object, it is set to the truncate mode.

When objects are copied by the operator “=” or the init() member function, the rounding attribution is also copied. For more information about init(), see §12.3.44.

The member functions that support the rounding attribution are: lvalue(), llvalue() (§12.3.33), assign_default() (§12.3.34), assign() (§12.3.45), and all member functions for images.

RETURN VALUE

The member function 1 returns an attribute of the operation on rounding.

The member function 2 returns a reference to itself.

EXAMPLE

The following code creates the mdarray<llong>-class object my_mdarr and sets a real number twice before and after setting the rounding mode. Then the code prints the substituted values to stdout for confirmation:

```cpp
stdstreamio sio;

mdarray_llong my_mdarr;
my_mdarr.assign(1.618, 0);
sio.printf("my_mdarr value[0]... [lld]\n", my_mdarr[0]);

my_mdarr.set_rounding(true);
my_mdarr.assign(1.618, 1);
sio.printf("my_mdarr value[1]... [lld]\n", my_mdarr[1]);
```
Output:
my_imdarr value[0]... [1]
my_imdarr value[1]... [2]

12.3.37 dprint()
NAME
dprint() — Output of the object information to the stderr output (for user’s debug)
SYNOPSIS
void dprint() const;
DESCRIPTION
This member function prints the information of the object itself to stderr.
This is a function for debugging a user program.
EXAMPLE
The following code prints the information on the object my_array to stderr. The address of
the object in [] is system-dependent.

mdarray_int my_array (false, 3,2,1);
my_array (2,0,0) = 100;
my_array (0,1,0) = 200;
my_array.dprint();

Output:
sli::mdarray[0x7fbffff630, sz_type=4, dim=(3,2,1)] = {
  { 0,0,100 },
  { 200,0,0 } }

12.3.38 carray (), array_ptr()
NAME
carray(), array_ptr() — Acquire the specified element’s address
SYNOPSIS
const type *carray () const; ................................. 1
const type *carray ( ssize_t idx0, ssize_t idx1 = MDARRAY_INDEF,
  ssize_t idx2 = MDARRAY_INDEF ) const; .................. 2
type *array_ptr(); ........................................... 3
type *array_ptr( ssize_t idx0, ssize_t idx1 = MDARRAY_INDEF,
  ssize_t idx2 = MDARRAY_INDEF ); .......................... 4
const type *array_ptr() const; .................................. 5
const type *array_ptr( ssize_t idx0, ssize_t idx1 = MDARRAY_INDEF,
  ssize_t idx2 = MDARRAY_INDEF ) const; .................. 6
const type *array_ptr_cs() const; ............................. 7
const type *array_ptr_cs( ssize_t idx0, ssize_t idx1 = MDARRAY_INDEF,
  ssize_t idx2 = MDARRAY_INDEF ) const; ............... 8
DESCRIPTION

These member functions get the address of the element specified by the index in the array of the object itself. Member functions 1, 2, and 5 through 8 get the address for read only.

For the function `array_ptr()`, whether the member functions 3, 4 or 5, 6 are used depends on whether the object has the “const ” attribute. The member function 3 or 4 is used for the object without the “const ” attribute, and the function 5 or 6 is used with the attribute automatically.

Do not specify `MDARRAY_INDEF` for an argument explicitly.

PARAMETER

- `[I] idx0` Subscript for the first dimension being designated as 0
- `[I] idx1` Subscript for the second dimension being designated as 1 (optional)
- `[I] idx2` Subscript for the third dimension being designated as 2 (optional)

((I) : input, (O) : output)

RETURN VALUE

An address of the specified element

EXAMPLE

The following code gets the address of the value at (0, 1) in the object `my_fmdarr` with a two-dimension array and prints the value to stdout:

```cpp
#include <iostream>
#include <sstream>

int main() {
    std::stringstream sio;
    mdarray<float> my_fmdarr(false, 2, 2);
    my_fmdarr(0, 0) = 1000;
    my_fmdarr(1, 0) = 2000;
    my_fmdarr(0, 1) = 3000;
    my_fmdarr(1, 1) = 4000;

    const float *my_carray_ptr = my_fmdarr.carray(0, 1);
    sio.printf("*** my_fmdarr carray[0] ---> [%f] *** \n", my_carray_ptr[0]);

    std::cout << sio.str() << std::endl;
    return 0;
}
```

Output:
*** my_fmdarr carray[0] ---> [3000.000000] ***

12.3.39 get_elements ()

NAME

get_elements () — Copy the array itself to the user’s buffer

SYNOPSIS

```cpp
ssize_t get_elements ( type *dest_buf, size_t elem_size,
    ssize_t idx0 = 0, ssize_t idx1 = MDARRAY_INDEF,
    ssize_t idx2 = MDARRAY_INDEF ) const;
```

DESCRIPTION

This member function copies the contents of the array for the object itself to the user buffer specified by `dest_buf`. The size of the buffer `elem_size` is set by the number of elements. The source is specified by the arguments `idx0`, `idx1`, and `idx2`.

Do not specify `MDARRAY_INDEF` for an argument explicitly.
PARAMETER

<table>
<thead>
<tr>
<th></th>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>[O]</td>
<td>dest_buf</td>
<td>Address of user’s buffer</td>
</tr>
<tr>
<td>[I]</td>
<td>elem_size</td>
<td>The number of elements to be copied</td>
</tr>
<tr>
<td>[I]</td>
<td>idx0</td>
<td>Subscript of this array for its first dimension being designated as 0 (optional)</td>
</tr>
<tr>
<td>[I]</td>
<td>idx1</td>
<td>Subscript of this array for its second dimension being designated as 1 (optional)</td>
</tr>
<tr>
<td>[I]</td>
<td>idx2</td>
<td>Subscript of this array for its third dimension being designated as 2 (optional)</td>
</tr>
</tbody>
</table>


RETURN VALUE

The number of the elements copied when the user buffer length is enough

EXCEPTION

The function throws an exception when it detects memory corruption.

EXAMPLE

The following code copies the contents of the object `my_fmdarr` with a two-dimension array to the user buffer `myfloat` and prints the values of elements in `myfloat` to stdout for confirmation:

```cpp
stdstreamio sio;

float my_data[] = {1000, 2000, 3000, 4000};
mdarray_float my_fmdarr(false, 2, 2, my_data);

float myfloat[4];
my_fmdarr.get_elements (myfloat, sizeof(myfloat)/sizeof(float));
for ( int i = 0 ; i < sizeof(myfloat)/sizeof(float) ; i++ ) {
    sio.printf("myfloat value[%d]... [%f]\n", i, myfloat[i]);
}
```

Output:

```
myfloat_ptr value[0]... [1000.000000]
myfloat_ptr value[1]... [2000.000000]
myfloat_ptr value[2]... [3000.000000]
myfloat_ptr value[3]... [4000.000000]
```

12.3.40 put_elements ()

NAME

`put_elements ()` — Copy the array in the user’s buffer to the array itself

SYNOPSIS

```cpp
ssize_t put_elements ( const type *src_buf, size_t elem_size, ssize_t idx0 = 0,
                        ssize_t idx1 = MDARRAY_INDEF, ssize_t idx2 = MDARRAY_INDEF );
```

DESCRIPTION

This member function copies the contents of the user buffer specified by `src_buf` to the array for the object itself. The size of the buffer `elem_size` is set by the number of elements. The destination is specified by the arguments `idx0`, `idx1`, and `idx2`.

Do not specify `MDARRAY_INDEF` for an argument explicitly.
PARAMETER

- **src_buf** : Address of the user’s buffer
- **elem_size** : Number of elements to be copied
- **idx0** : Subscript of this array for its first dimension being designated as 0 (optional)
- **idx1** : Subscript of this array for its second dimension being designated as 1 (optional)
- **idx2** : Subscript of this array for its third dimension being designated as 2 (optional)

(I : input, [O] : output)

RETURN VALUE

The number of the elements copied when the user buffer length is enough

EXCEPTION

The function throws an exception when it detects memory corruption.

EXAMPLE

The following code copies the contents of the user buffer `my_float` to the object `my_fmdarr` with a two-dimension array and prints the values of elements in `my_fmdarr` to stdout for confirmation:

```c
# include <iostream>
# include <sstream>
# include <assert.h>

# define MDARRAY_INDEF (-1)

using namespace std;

int main() {
    std::streamio sio;

    mdarray_float my_fmdarr(false, 2,2);

    float my_float[] = {1000, 2000, 3000, 4000};
    my_fmdarr.put_elements (my_float, sizeof(my_float)/sizeof(float));

    for ( size_t j = 0 ; j < my_fmdarr.length(1) ; j++ ) {
        for ( size_t i = 0 ; i < my_fmdarr.length(0) ; i++ ) {
            sio.printf("my_fmdarr value(%zu,%zu)... [%f]\n",
                      i, j, my_fmdarr(i, j));
        }
    }

    return 0;
}
```

Output:

```
my_fmdarr value(0,0)... [1000.000000]
my_fmdarr value(1,0)... [2000.000000]
my_fmdarr value(0,1)... [3000.000000]
my_fmdarr value(1,1)... [4000.000000]
```

12.3.41 getdata()

NAME

getdata() — Copy the array itself to the user’s buffer

SYNOPSIS

```c
ssize_t getdata( void *dest_buf, size_t buf_size, ssize_t idx0 = 0,
                 ssize_t idx1 = MDARRAY_INDEF, ssize_t idx2 = MDARRAY_INDEF ) const;
```
DESCRIPTION
This member function copies the contents of the array for the object itself to the user buffer specified by dest_buf. The size of the buffer buf_size is set by the byte unit. The source is specified by the arguments idx0, idx1, and idx2.
Do not specify MDARRAY_INDEF for an argument explicitly.

PARAMETER
- [O] dest_buf: Address of user’s buffer
- [I] buf_size: Size of the buffer in bytes
- [I] idx0: Subscript of this array for its first dimension being designated as 0 (optional)
- [I] idx1: Subscript of this array for its second dimension being designated as 1 (optional)
- [I] idx2: Subscript of this array for its third dimension being designated as 2 (optional)

([I]: input, [O]: output)

RETURN VALUE
A size of the buffer copied when the user buffer size (buf_size) is enough

EXCEPTION
The function throws an exception when memory corruption is detected.

EXAMPLE
The following code copies the contents of the object my_fmdarr with a two-dimension array to the user buffer myfloat and prints the values of elements in myfloat to stdout for confirmation:

```cpp
stdstreamio sio;

mdarray_float my_fmdarr(false, 2, 2);
my_fmdarr(0,0) = 1000;
my_fmdarr(1,0) = 2000;
my_fmdarr(0,1) = 3000;
my_fmdarr(1,1) = 4000;

float myfloat[4];
my_fmdarr.getdata((void *)myfloat, sizeof(myfloat));
for ( int i = 0 ; i < sizeof(myfloat)/sizeof(float) ; i++ ) {
    sio.printf("myfloat value[%d]... [%f]\n", i, myfloat[i]);
}
```

Output:
myfloat value[0]... [1000.000000]
myfloat value[1]... [2000.000000]
myfloat value[2]... [3000.000000]
myfloat value[3]... [4000.000000]

12.3.42 putdata()

NAME
putdata() — Copy the array in the user’s buffer to the array itself
SYNOPSIS

```c
ssize_t putdata( const void *src_buf, size_t buf_size, ssize_t idx0 = 0,
                  ssize_t idx1 = MDARRAY_INDEF, ssize_t idx2 = MDARRAY_INDEF );
```

DESCRIPTION

This member function copies the contents of the user buffer specified by `src_buf` to the array for the object itself. The size of the buffer `buf_size` is set by the byte unit. The destination is specified by the arguments `idx0`, `idx1`, and `idx2`.

Do not specify `MDARRAY_INDEF` for an argument explicitly.

PARAMETER

| [I] | src_buf  | Address of user’s buffer |
| [I] | buf_size | Size of the user’s buffer in bytes |
| [I] | idx0     | Subscript of this array for its first dimension being designated as 0 (optional) |
| [I] | idx1     | Subscript of this array for its second dimension being designated as 1 (optional) |
| [I] | idx2     | Subscript of this array for its third dimension being designated as 2 (optional) |

Return Value

A size of the buffer copied when the user buffer size (buf_size) is enough

EXCEPTION

The function throws an exception when it detects memory corruption.

EXAMPLE

The following code copies the contents of the user buffer `my_float` to the object `my_fmdarr` with a two-dimension array and prints the values of elements in `my_fmdarr` to stdout for confirmation:

```c
stdstreamio sio;

mdarray_float my_fmdarr(false, 2,2);

float my_float[] = {1000, 2000, 3000, 4000};
my_fmdarr.putdata((const void *)my_float, sizeof(my_float));

for ( size_t j = 0 ; j < my_fmdarr.length(1) ; j++ ) {
    for ( size_t i = 0 ; i < my_fmdarr.length(0) ; i++ ) {
        sio.printf("my_fmdarr value(%zu,%zu)... [%f]\n",
                    i, j, my_fmdarr(i, j));
    }
}
```

Output:

```
my_fmdarr value(0,0)... [1000.000000]
my_fmdarr value(1,0)... [2000.000000]
my_fmdarr value(0,1)... [3000.000000]
my_fmdarr value(1,1)... [4000.000000]
```
12.3.43  reverse_endian()

NAME
reverse_endian() — Reverse endian if necessary

SYNOPSIS

mdarray_type &reverse_endian( bool is_little_endian ); ....................... 1
mdarray_type &reverse_endian( bool is_little_endian,
                           size_t begin, size_t length ); ................... 2

DESCRIPTION

This member function is called to save the array of the object itself as a binary data in a file
or load a binary data in a file to the array of the object itself.

To save data in a file, convert the endian of the data to the appropriate form for storing
by this member function. Next, write the content by the stream writing function with the
address obtained from the function such as carray () (§ 12.3.38). Then call this function again
for turning back the endian.

To load data from a file, read the content by the stream reading function with the address
obtained from the functions such as array_ptr() (§ 12.3.38). Then convert the endian to the
appropriate form for the system by this member function.

In both cases shown above, if the data to be stored on a file is big endian, the first argument
is set to false (if little endian, set to true).

For this member function, users do not have to be conscious of the difference in system
architecture. For instance, a user specifies false to the argument is_little_endian and
calls this function so that a data in big endian is saved in a file. If the machine is a big endian
system, the inversion process is not executed in practice. (With a little endian system, the
inversion process is executed.) Next, the user saves binary data in the object in a file in a
straightforward way, and the binary file in the specified byte order is created. And then, the
user calls this member function with the same arguments again in order to turn back the
endian if it was inverted.

This means that to save in a file this member function must be called twice with the same
arguments.

Setting begin and length arguments allows a partial endian conversion of array elements.

PARAMETER
[I]  is_little_endian  True when the ordering of data in a computer’s memory should
be little endian after one conversion
[I]  begin          Starting position of elements to be converted (0-indexed)
[I]  length        Length of elements to be converted

RETURN VALUE
A reference to itself

EXAMPLE

The following code outputs the binary file that contains the data of the object my_mdarr with
a two-dimension array in big endian:

    stdstreamio sio;

    mdarray_int my_mdarr(false, 2,2);
my_mdarr(0,0) = 10;
my_mdarr(1,0) = 20;
my_mdarr(0,1) = 30;
my_mdarr(1,1) = 40;

my_mdarr.reverse_endian(false);
const void *mydata_ptr = my_mdarr.data_ptr();

if ( fio.openf("w", "%s", "binary.dat") < 0 ) {
    // Error Handling
}
if ( fio.write(mydata_ptr, my_mdarr.byte_length()) < 0 ) {
    // Error Handling
}
my_mdarr.reverse_endian(false);

fio.close();

Output:
the contents of binary.dat:
"00 00 00 0A"
"00 00 00 14"
"00 00 00 1E"
"00 00 00 28"

For more information about endian conversion, see §3.6.10

12.3.44 init()

NAME
init() — Initialize the array

SYNOPSIS

mdarray_type &init(); .................................................. 1
mdarray_type &init( bool auto_resize ); .................................. 2
mdarray_type &init( bool auto_resize, 
    const size_t naxisx[], size_t ndim ); ......................... 3
mdarray_type &init( bool auto_resize, size_t naxis0 ); ............... 4
mdarray_type &init( bool auto_resize, size_t naxis0, size_t naxis1 ); ... 5
mdarray_type &init( bool auto_resize, size_t naxis0, size_t naxis1, 
    size_t naxis2 ); .................................................. 6
mdarray_type &init( bool auto_resize, size_t naxis0, 
    const type vals[] ); ........................................ 7
mdarray_type &init( bool auto_resize, size_t naxis0, size_t naxis1, 
    const type vals[] ); ........................................ 8
mdarray_type &init( bool auto_resize, size_t naxis0, size_t naxis1, 
    const type *const vals[] ); .................................. 9
mdarray_type &init( bool auto_resize, size_t naxis0, size_t naxis1, 
    size_t naxis2, const type vals[] ); ......................... 10
mdarray_type &init( bool auto_resize, size_t naxis0, size_t naxis1,
size_t naxis2, const type *const *const vals[] );  .. 11
mdarray_type &init( const mdarray_type &obj ); .......................... 12

DESCRIPTION
This member function initializes the array of the object itself.
The member function 1 initializes the object with the array size 0. The operation mode is
set to the Automatic Resize Mode.
For the member functions 2 to 11, the operation mode is specified to the first argument
auto_resize and the size of the arrays and the address of the arrays for initialization are
specified to the rest of the arguments.
The member function 12 copies all the contents and attributes of obj to the object itself.
For the member functions 1 to 11, arguments are passed to them just like when creating
objects (constructor). See [12.1] for the arguments and operation modes in creating objects.

PARAMETER
[I] auto_resize True if you want to use the function in the Automatic Resize Mode
[I] ndim Number of dimensions of the array
[I] naxisx[] Number of elements along each dimension
[I] naxis0 Number of elements along the first dimension (dimension 0)
[I] naxis1 Number of elements along the second dimension (dimension 1)
[I] naxis2 Number of elements along the third dimension (dimension 2)
[I] vals the address of an input array or a pointer array
[I] obj A reference to an input object

RETURN VALUE
A reference to itself

EXCEPTION
The function throws an exception when it fails to allocate a local buffer, or it detects memory
corruption.

EXAMPLE
The following code initializes the object my_mdarr with the 2×3 array and prints the length
of the dimensions to stdout:

```
stdstreamio sio;

mdarray_int my_mdarr;
my_mdarr.init(false, 2,3);
sio.printf("*** my_mdarr 0 dim length ===> [%zu] *** \n", my_mdarr.length(0));
sio.printf("*** my_mdarr 1st dim length ===> [%zu] *** \n", my_mdarr.length(1));
```

Output:

*** my_mdarr 0 dim length ===> [2] ***
*** my_mdarr 1st dim length ===> [3] ***
12.3.45 assign()

NAME
assign() — Substitute a value for an element

SYNOPSIS
mdarray_type &assign( double value, ssize_t idx0,
    ssize_t idx1 = MDARRAY_INDEF, ssize_t idx2 = MDARRAY_INDEF );

DESCRIPTION
This member function assigns a value to the element specified by \( \text{idx}_n \) in the array of the object itself. When a floating-point number is assigned to an element with the data type integer, it is truncated by default. To round it, call set_rounding() in advance. For more information about set_rounding(), see §12.3.36.

In the Automatic Resize Mode, the size of the arrays are resized according to the specified element index automatically.

In the Manual Resize Mode, assigning a value to an element beyond the array size does not cause any error. The operation is ignored. In order to assign a value to an element beyond the array size, the array size has to be extended by the member function resize() in advance. For more information about resize(), see §12.3.53.

Do not specify MDARRAY_INDEF for an argument explicitly.

PARAMETER

- [I] value A real scalar in double precision
- [I] idx0 Subscript for the first dimension being designated as 0
- [I] idx1 Subscript for the second dimension being designated as 1 (optional)
- [I] idx2 Subscript for the third dimension being designated as 2 (optional)


RETURN VALUE
A reference to itself

EXCEPTION
The function throws an exception when it fails to allocate a local buffer in the Automatic Resize Mode.

EXAMPLE
The following code sets the value to the element specified by index 1 in the mdarray_float-class object my_mdarr and prints the values of elements to stdout:

```c
stdstreamio sio;

mdarray_float my_mdarr;
my_mdarr.assign(200.0, 1);
for ( size_t i = 0 ; i < my_mdarr.length() ; i++ ) {
    sio.printf("my_mdarr lvalue[%zu]... [%ld]\n", i, my_mdarr.lvalue(i));
}
```

Output:
my_mdarr lvalue[0]... [0]
my_mdarr lvalue[1]... [200]```
12.3.46 put()

NAME
put() — Set a value to an arbitrary element’s point

SYNOPSIS

```
mdarray_type &put( type value, ssize_t idx, size_t len );                1
mdarray_type &put( type value,
                        size_t dim_index, ssize_t idx, size_t len );    2
```

DESCRIPTION
This member function puts \( \text{len} \) straight value(s) to the element index \( \text{idx} \) of the array in the object itself. The element index and the dimension index start from 0.

Any values can be set to \( \text{idx} \) and \( \text{len} \). In the Automatic Resize Mode, if the length of the array in the object is lower than the specified argument, the array is resized automatically. The additional part in which the value is not set is filled with the default value. In the Automatic Resize Mode, the writing operation is not executed for the elements beyond the array size.

The member function 1 writes \( \text{len} \) value(s) to elements from \( \text{idx} \) in the array sequentially.

The member function 2 writes \( \text{len} \) value(s) to elements from \( \text{idx} \) in the dimension index \( \text{dim\_index} \) of the arrays in the object sequentially. When \( \text{dim\_index} \) is 1 or over, values are written to all elements in the lower dimensions.

PARAMETER

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>[I]</td>
<td>value</td>
</tr>
<tr>
<td>[I]</td>
<td>idx</td>
</tr>
<tr>
<td>[I]</td>
<td>len</td>
</tr>
<tr>
<td>[I]</td>
<td>dim_index</td>
</tr>
</tbody>
</table>

RETURN VALUE
A reference to itself

EXCEPTION
The function throws an exception when it fails to allocate a local buffer in the Automatic Resize Mode.

EXAMPLE
The following code puts two values to the array elements starting with index 1 in the object \( \text{my\_smdarr} \) with a one-dimension array and prints the values of elements to stdout:

```
mdarray\_short my\_smdarr(false, 3);
my\_smdarr.put(12, 1,2);
for ( size\_t i = 0 ; i < my\_smdarr.length() ; i++ ) {
    sio.printf("my\_smdarr value[\%zu]... [\%hd]\n", i, my\_smdarr[i]);
}
```

Output:
```
my\_smdarr value[0]... [0]
my\_smdarr value[1]... [12]
my\_smdarr value[2]... [12]
```
12.3.47 swap()

NAME

swap() — Replace values between elements

SYNOPSIS

\[
\begin{align*}
\text{mdarray-type} & \text{ } \& \text{ } \text{swap( ssize_t idx_src, size_t len, ssize_t idx_dst );} \\
\text{mdarray-type} & \text{ } \& \text{ } \text{swap( size_t dim_index,} \\
& \text{ssize_t idx_src, size_t len, ssize_t idx_dst );}
\end{align*}
\]

DESCRIPTION

This member function swaps values in the array of the object itself.

The member function 1 swaps \( len \) elements from the index \( idx\_src \) for \( len \) elements from the index \( idx\_dst \). If \( idx\_dst + len \) exceeds the size of the array, the process is executed for up to the size of the array.

The member function 2 swaps \( len \) elements from the index \( idx\_src \) in the dimension with the index \( dim\_index \) for \( len \) elements from the index \( idx\_dst \). If \( idx\_dst + len \) exceeds the size of the array, the process is executed for up to the size of the array.

When the area for swapping is overlapped, only the non-overlapped area in the source area is swapped.

PARAMETER

\[
\begin{align*}
[I] & \text{ } \text{idx\_src} & \text{Subscript specifying the first element of one of the two subarrays to be swapped with each other} \\
[I] & \text{ } \text{len} & \text{Number of elements in the subarray} \\
[I] & \text{ } \text{idx\_dst} & \text{Subscript specifying the first element of the other subarray} \\
[I] & \text{ } \text{dim\_index} & \text{The integer number that specifies one of the dimensions of the array} \\
& & (I: \text{input}, O: \text{output})
\end{align*}
\]

RETURN VALUE

A reference to itself

EXAMPLE

The following code swaps one element specified by index 0 in the second dimension (dimension index: 1) for the element with the index 1 in the mdarray_uchar-class object \texttt{my\_cmdarr} and prints the values of elements to stdout:

\[
\begin{align*}
\text{stdinstreamio } & \text{sio;} \\
\text{unsigned } & \text{char my\_char[]} = \{51, 52, 101, 102\}; \\
\text{mdarray\_uchar } & \text{my\_cmdarr(false, 2,2, my\_char);} \\
\text{my\_cmdarr} & \text{.swap( 1, 0, 1, 1 );} \\
\text{for } & \text{( size\_t } j = 0 ; j < \text{my\_cmdarr.length}(1) ; j++ ) \{ \\
& \text{for } ( \text{ size\_t } i = 0 ; i < \text{my\_cmdarr.length}(0) ; i++ ) \{ \\
& \text{sio.printf("my\_cmdarr value(\%zu,\%zu)... [\%hhu]\n",} \\
& \text{ i, j, my\_cmdarr(i, j));} \\
& \text{ }
& \}
\}
\end{align*}
\]

Output:

my\_cmdarr value(0,0)... [101]
my_cmdarr value(1,0)...
my_cmdarr value(0,1)...
my_cmdarr value(1,1)...

12.3.48  move()

NAME
move() — Copy values between elements

SYNOPSIS
mdarray_type &move( ssize_t idx_src, size_t len, ssize_t idx_dst, bool clr ); .......................... 1
mdarray_type &move( size_t dim_index, ssize_t idx_src, size_t len, ssize_t idx_dst, bool clr ); .......................... 2

DESCRIPTION
This member function moves values in the array of the object itself.
When false is passed to the argument clr, the values of the source remain. For true, the
values of the source do not remain and they are filled with the default values. If the value
exceeding the existing array size is specified to the argument idx_dst, the size is not changed.
This operation is different from that of the member function cpy(). (See \[12.3.49\])
For the member function 1, the moving operation is always applied to the elements in the
first dimension (dimension index: 0). For the member function 2, the moving operation is
applied to the elements in the dimension with the index dim_index.

PARAMETER
[I]  idx_src    Subscript specifying the first element of an input subarray in this object
[I]   len       Number of elements in the input subarray
[I]  idx_dst    Subscript specifying the first element of another subarray to which the
               input subarray is written
[I]   clr       True if the contents of the input subarray may be lost
[I]  dim_index  The integer number that specifies one of the dimensions of the array

RETURN VALUE
A reference to itself

EXAMPLE
The following code copies values inside the array of the mdarray_uchar-class object my_cmdarr
and prints the values of elements to stdout for confirmation. The values of the source are
cleared.

    stdstreamio sio;

    mdarray_uchar my_cmdarr(false, 3);
    my_cmdarr[0] = 99;
    my_cmdarr[1] = 98;
    my_cmdarr[2] = 97;
    my_cmdarr.move( 2, 1, 0, true );
    for ( size_t i = 0 ; i < my_cmdarr.length() ; i++ ) {
        sio.printf("my_cmdarr value[%zu]... [%hhu]n",}
12.3.49  cpy()

NAME
cpy() — Copy values between elements (with automatic expansion)

SYNOPSIS

mdarray_type &cpy( ssize_t idx_src, size_t len, ssize_t idx_dst,
                   bool clr ); ......................................................... 1
mdarray_type &cpy( size_t dim_index, ssize_t idx_src, size_t len, ssize_t idx_dst, 
                   bool clr ); ......................................................... 2

DESCRIPTION
This member function copies values inside the array of the object itself.

When false is passed to the argument clr, the values of the source remain. For true, the 
values of the source do not remain and they are filled with the default values. If idx_dst + 
len exceeds the existing array size, the size is extended automatically.

For the member function 1, the copying operation is always applied to the elements in the 
first dimension (dimension index: 0). For the member function 2, the copying operation is 
applied to the elements in the dimension with the index dim_index.

PARAMETER
[I] idx_src          Subscript specifying the first element of an input subarray
[I] len              Number of elements in the input subarray
[I] idx_dst          Subscript specifying the first element of another subarray to which the 
                     input subarray is written
[I] clr              True if the contents of the input subarray may be lost
[I] dim_index        The integer number that specifies one of the dimensions of the array

RETURN VALUE
A reference to itself

EXCEPTION
The function throws an exception when it fails to allocate a local buffer.

EXAMPLE
The following code copies values inside the array of the mdarray_llong-class object my_lmdarr 
and prints the values of elements to stdout for confirmation. The values of the source remain:

```c
stdstreamio sio;

mdarray_llong my_lmdarr;
my_lmdarr[0] = -2147483646;
my_lmdarr[1] = 2147483647;
```
my_lmdarr.cpy(1, 1, 2, false);
for ( size_t i = 0 ; i < my_lmdarr.length(0) ; i++ ) {
  sio.printf("my_lmdarr value[%zu]... [%lld]\n", i, my_lmdarr[i]);
}

Output:
my_lmdarr value[0]... [-2147483646]
my_lmdarr value[1]... [2147483647]
my_lmdarr value[2]... [2147483647]

12.3.50 insert()

NAME
insert() — Insert an element

SYNOPSIS
mdarray_type &insert( ssize_t idx, size_t len ); ................................. 1
mdarray_type &insert( size_t dim_index, ssize_t idx, size_t len ); ....... 2

DESCRIPTION
This member function inserts len values to the index idx in the array of the object itself.
The values are default values.
For the member function 1, the insertion is always applied to the elements in the first dimension (dimension index: 0). For the member function 2, the insertion is applied to the elements in the dimension with the index dim_index.

PARAMETER
[I] idx         Array subscript specifying an element before which new entries should be inserted
[I] len         Number of elements to be inserted
[I] dim_index   The integer number that specifies one of the dimensions of the array

RETURN VALUE
A reference to itself

EXCEPTION
The function throws an exception when it fails to allocate a local buffer.

EXAMPLE
The following code inserts two default values (0) ahead of the first element of the object my_mdarr for he mdarray_long-class and prints the result to stdout for confirmation:

```c
stdstreamio sio;

mdarray_long my_mdarr(false, 2);
my_mdarr[0] = -2147483646;
my_mdarr[1] = 2147483647;
my_mdarr.insert( 1, 2 );
for ( size_t i = 0 ; i < my_mdarr.length(0) ; i++ ) {
  sio.printf("my_mdarr value[%zu]... [%ld]\n", i, my_mdarr[i]);
}
```
12.3.51  crop()

NAME  
crop() — Extract an element

SYNOPSIS  
mdarray_type &crop( ssize_t idx, size_t len ); ........................... 1
mdarray_type &crop( size_t dim_index, ssize_t idx, size_t len ); ........ 2

DESCRIPTION  
This member function extracts len values from the index idx in the array of the object itself.

For the member function 1, the extraction is always applied to the elements in the first dimension (dimension index: 0). For the member function 2, the extraction is applied to the elements in the dimension with the index dim_index.

PARAMETER  
[I] idx  Array subscript specifying the first element to be extracted
[I] len  Number of elements to be extracted
[I] dim_index  The integer number that specifies one of the dimensions of the array

RETURN VALUE  
A reference to itself

EXCEPTION  
The function throws an exception when it fails to allocate a local buffer.

EXAMPLE  
The following code extracts the one-dimension elements specified by index 1 in the first dimension (dimension index: 0) from the mdarray_uchar-class object my_cmdarr and prints the values of elements to stdout for confirmation:

```c++
streamio sio;

mdarray_uchar my_cmdarr(false, 2, 3);
my_cmdarr(0,0) = 124;
my_cmdarr(1,0) = 125;
my_cmdarr(0,1) = 126;
my_cmdarr(1,1) = 127;
my_cmdarr.crop( 0, 1, 1 );
for ( size_t j = 0 ; j < my_cmdarr.length(1) ; j++ ) {
  for ( size_t i = 0 ; i < my_cmdarr.length(0) ; i++ ) {
    sio.printf("my_cmdarr value(%zu, %zu)... [%hhu]\n",
            i, j, my_cmdarr(i, j));
  }
}
```
12.3.52 erase()

NAME
erase() — Erase an element

SYNOPSIS
mdarray_type &erase( ssize_t idx, size_t len ); ........................... 1
mdarray_type &erase( size_t dim_index, ssize_t idx, size_t len ); ....... 2

DESCRIPTION
This member function erases the specified elements from the array of the object itself. The
length of the array is reduced by len.

For the member function 1, the erasing operation is always applied to the elements in the
first dimension (dimension index: 0). For the member function 2, the erasing operation is
applied to the elements in the dimension with the index dim_index.

PARAMETER
[I] idx Array subscript specifying the first element to be removed
[I] len Number of elements to be removed
[I] dim_index The integer number that specifies one of the dimensions of the array

RETURN VALUE
A reference to itself

EXCEPTION
The function throws an exception when it fails to allocate a local buffer.

EXAMPLE
The following code erases the element specified by index 1 in the object my_mdarr with a
one-dimension array and prints the values of elements to stdout:

    stdstreamio sio;

    mdarray_llong my_mdarr(false, 3);
    my_mdarr[0] = 0;
    my_mdarr[1] = 2147483646;
    my_mdarr[2] = 2147483647;

    my_mdarr.erase( 1, 1 );
    for ( size_t i = 0 ; i < my_mdarr.length() ; i++ ) {
        sio.printf("my_mdarr value[%zu]... [%lld]\n", i, my_mdarr[i]);
    }

Output:
my_mdarr value[0]... [0]
my_mdarr value[1]... [2147483647]
12.3.53  resize()

NAME
    resize() — Change the length of the array

SYNOPSIS
    mdarray_type &resize( size_t len ); .................................................. 1
    mdarray_type &resize( size_t dim_index, size_t len ); ........................... 2
    mdarray_type &resize( const mdarray &src ); ........................................ 3

DESCRIPTION
    This member function resizes the length of the array in the object itself.
    For extension, new values of the elements are filled with the default values. For reduction,
    elements after the index \texttt{len} are removed.
    For the member function 1, the resizing operation is always applied to the elements in the
    first dimension (dimension index: 0). For the member function 2, the resizing operation is
    applied to the elements in the dimension with the index \texttt{dim_index}. For the member function
    3, the number of dimensions and the length of the array are conformed to that of the object
    \texttt{src}.

PARAMETER
    \begin{itemize}
    \item \texttt{[I]} \texttt{len} Number of elements after being resized
    \item \texttt{[I]} \texttt{dim_index} The integer number that specifies one of the dimensions of the array
    \end{itemize}
    ([I]: input, [O]: output)

RETURN VALUE
    A reference to itself

EXCEPTION
    The function throws an exception when it fails to allocate a local buffer.

EXAMPLE
    The following code resizes the length of the array for the second dimension (dimension index:
    1) in the object \texttt{my\textunderscore cmdarr} with a two-dimension array to 3 and prints the result to stdout
    for confirmation:

    \begin{verbatim}
    stdstreamio sio;

    mdarray\textunderscore uchar my\textunderscore cmdarr\textunderscore uchar(false, 2, 2);
    my\textunderscore cmdarr(0,0) = 70;
    my\textunderscore cmdarr(1,0) = 71;
    my\textunderscore cmdarr(0,1) = 36;
    my\textunderscore cmdarr(1,1) = 37;

    my\textunderscore cmdarr.resize( 1, 3 );
    for ( size_t j = 0 ; j < my\textunderscore cmdarr.length(1) ; j++ ) {
        for ( size_t i = 0 ; i < my\textunderscore cmdarr.length(0) ; i++ ) {
            sio.printf("my\textunderscore cmdarr value(\%zu, \%zu)... [\%hhu]\n",
                      i, j, my\textunderscore cmdarr(i, j));
        }
    }
    \end{verbatim}
12.3.54 resizeby()

NAME
resizeby() — Change the length of the array relatively

SYNOPSIS

```c
mdarray_type &resizeby( ssize_t len ); ............................................... 1
mdarray_type &resizeby( size_t dim_index, ssize_t len ); ...................... 2
```

DESCRIPTION

This member function resizes the length of the array in the object itself by `len`.

For reduction, a negative value is passed to the argument `len`. The size of the resized array
is the original size plus `len`.

For the member function 1, the resizing operation is always applied to the elements in the
first dimension (dimension index: 0). For the member function 2, the resizing operation is
applied to the elements in the dimension with the index `dim_index`.

PARAMETER

- `[I] len` Number of elements to be increased or decreased
- `[I] dim_index` The integer number that specifies one of the dimensions of the array
  ([I]: input, [O]: output)

RETURN VALUE

A reference to itself

EXCEPTION

The function throws an exception when it fails to allocate a local buffer.

EXAMPLE

The following code resizes the length of the array in the object `my_cmdarr` with a one-
dimension array and prints the values to stdout for confirmation:

```c
stdstreamio sio;

mdarray_uchar my_cmdarr(false, 3);

my_cmdarr.resizeby(-2);
for ( size_t i = 0 ; i < my_cmdarr.length(0) ; i++ ) {
    sio.printf("my_cmdarr value[%d]... [%hhu]\n", i, my_cmdarr[i]);
}
```

Output:

```
my_cmdarr value[0]... [0]
```
12.3.55  

**increase_dim()**

**NAME**

`increase_dim()` — Expand the number of dimensions

**SYNOPSIS**

```cpp
mdarray_type &increase_dim();
```

**DESCRIPTION**

This member function increments the dimension of the array in the object itself.

**RETURN VALUE**

A reference to itself

**EXCEPTION**

The function throws an exception when it fails to allocate a local buffer.

**EXAMPLE**

The following code increments the dimension of the array in the object `my_mdarr` with a three-dimension array and prints the number of dimensions to stdout:

```cpp
stdstreamio sio;

mdarray_uchar my_mdarr(false, 1, 2, 3);
my_mdarr.increase_dim();
sio.printf("my_mdarr dim... [%zu]\n", my_mdarr.dim_length());
```

Output:

```text
my_mdarr dim... [4]
```

---

12.3.56  

**decrease_dim()**

**NAME**

`decrease_dim()` — Reduce the number of dimensions

**SYNOPSIS**

```cpp
mdarray_type &decrease_dim();
```

**DESCRIPTION**

This member function decrements the dimension of the array in the object itself.

**RETURN VALUE**

A reference to itself

**EXCEPTION**

The function throws an exception when it fails to allocate a local buffer, or it detects memory corruption.

**EXAMPLE**

The following code decrements the dimension of the array in the object `my_mdarr` with a three-dimension array and prints the number of dimensions to stdout:

```cpp
stdstreamio sio;

mdarray_uchar my_mdarr(false, 1, 2, 3);
my_mdarr.decrease_dim();
sio.printf("my_mdarr dim... [%zu]\n", my_mdarr.dim_length());
```
12.3.57 swap()

NAME

swap() — Replace the object by another one

SYNOPSIS

\texttt{mdarray\_type \&swap(\ marray\_type \&sobj );}

DESCRIPTION

This member function swaps the specified object \texttt{sobj} for the object itself. All attributes such as the size of arrays are exchanged.

PARAMETER

\texttt{[I/O] sobj} The object that belongs to the same class as this instance

\texttt{([I] : input, [O] : output)}

RETURN VALUE

A reference to itself

EXAMPLE

The following code swaps the object \texttt{my\_fmdarr} with a one-dimension array for the object \texttt{swap\_mdarr} and prints the values of elements in the \texttt{my\_fmdarr} to stdout:

```
stdstreamio sio;

mdarray\_float my\_fmdarr(false, 2);
my\_fmdarr[0] = 1000;
my\_fmdarr[1] = 2000;

mdarray\_float swap\_mdarr(false, 2);
swap\_mdarr[0] = 100;
swap\_mdarr[1] = 200;
my\_fmdarr.swap(swap\_mdarr);
for ( size\_t i = 0 ; i < my\_fmdarr\_length(0) ; i++ ) {
    sio.printf("my\_fmdarr value[\%zu]... [\%g]\n", i, my\_fmdarr\_dvalue(i));
}
```

Output:

\texttt{my\_fmdarr value[0]... [100]}
\texttt{my\_fmdarr value[1]... [200]}
12.3.58 convert()

NAME
convert() — Convert the value of the full array element

SYNOPSIS
mdarray_type &convert( void (*func)(const type [], type [], size_t, bool, void *), void *user_ptr );

DESCRIPTION
This member function converts the all values of the object itself via the user-defined function func.
The first argument of the user-defined function is the address of the original elements in the array; the second is the address of the elements that should be written by user’s programs; the third is length of elements that should be converted in user-defined function, and the fifth is user_ptr. The fourth argument of the user-defined function should be ignored in user’s programs.

PARAMETER
[I] func Address of user-defined function
[I] user_ptr The pointer that is given to the above function as its last argument

RETURN VALUE
A reference to itself

12.3.59 ceil()

NAME
ceil() — Raise decimals to the next whole number in a double type value

SYNOPSIS
mdarray_type &ceil();

DESCRIPTION
This member function rounds up all elements (floating-point number) of the array in the object itself to the nearest integer.

RETURN VALUE
A reference to itself

EXAMPLE
The following code sets the values with decimal places to the object my_fmdarr with a one-dimension array and rounds them up, and prints the values of elements to stdout for confirmation:

```cpp
stdstreamio sio;

mdarray_float my_fmdarr;

my_fmdarr[0] = 1000.1;
my_fmdarr[1] = 2000.6;
my_fmdarr.ceil();
```
for ( size_t i = 0 ; i < my_fmdarr.length() ; i++ ) {
    sio.printf("my_fmdarr value[%zu]... [%f]\n", i, my_fmdarr[i]);
}

Output:
my_fmdarr value[0]... [1001.000000]
my_fmdarr value[1]... [2001.000000]

12.3.60  floor()

NAME
floor() — Devalue decimals in a double type value

SYNOPSIS
mdarray_type &floor();

DESCRIPTION
This member function rounds down all elements (floating-point number) of the array in the
object itself to the nearest integer.

RETURN VALUE
A reference to itself

EXAMPLE
The following code sets the values with decimal places to the object my_fmdarr with a one-
dimension array and rounds them down, and prints the values of elements to stdout for
confirmation:

```c
stdstreamio sio;

mdarray_float my_fmdarr;

my_fmdarr[0] = 1000.1;
my_fmdarr[1] = 2000.9;
my_fmdarr.floor();

for ( size_t i = 0 ; i < my_fmdarr.length() ; i++ ) {
    sio.printf("my_fmdarr value[%zu]... [%f]\n", i, my_fmdarr[i]);
}
```

Output:
my_fmdarr value[0]... [1000.000000]
my_fmdarr value[1]... [2000.000000]

12.3.61  round()

NAME
round() — Round off decimals in a double type value

SYNOPSIS
mdarray_type &round();
DESCRIPTION
This member function rounds all elements (floating-point number) of the array in the object itself to the nearest integer.

RETURN VALUE
A reference to itself

EXAMPLE
The following code sets the values with decimal places to the object `mdarrf` with a one-dimension array and rounds them to the nearest integer, and prints the values of elements to stdout for confirmation:

```c
stdstreamio sio;

mdarray_float my_fmdarr;
my_fmdarr[0] = 1000.5;
my_fmdarr[1] = -1000.5;
my_fmdarr.round();

for ( size_t i = 0 ; i < my_fmdarr.length(0) ; i++ ) {
    sio.printf("my_fmdarr value[%zu]... [%f]\n", i, my_fmdarr[i]);
}
```

Output:
```
my_fmdarr value[0]... [1001.000000]
my_fmdarr value[1]... [-1001.000000]
```

12.3.62 trunc()

NAME
trunc() — Omit decimals in a double type value

SYNOPSIS
```
mdarray_type &trunc();
```

DESCRIPTION
This member function rounds down all elements (floating-point number) of the array in the object itself to the integer which is closer to 0 than the element.

RETURN VALUE
A reference to itself

EXAMPLE
The following code sets the values with decimal places to the object `my_fmdarr` with a one-dimension array and rounds them down to the integers which are closer to 0 than the elements, and prints the values of elements to stdout for confirmation:

```c
stdstreamio sio;

mdarray_float my_fmdarr;
my_fmdarr[0] = 1.7;
my_fmdarr[1] = -1.7;
```
my_fmdarr.trunc();

for ( size_t i = 0 ; i < my_fmdarr.length() ; i++ ) {
    sio.printf("my_fmdarr value[%zu]... [%f]\n", i, my_fmdarr[i]);
}

Output:
my_fmdarr value[0]... [1.000000]
my_fmdarr value[1]... [-1.000000]

### 12.3.63 abs()

**NAME**

abs() — Absolute value of all elements

**SYNOPSIS**

```cpp
mdarray_type &abs();
```

**DESCRIPTION**

This member function returns the absolute values of all elements of the array in the object itself.

**RETURN VALUE**

A reference to itself

**EXAMPLE**

The following code sets negative values to the elements of the object `my_fmdarr` with a one-dimension array and prints the absolute values of elements to stdout:

```cpp
sstreamio sio;

mdarray_float my_fmdarr;

my_fmdarr[0] = -1000.1;
my_fmdarr[1] = -2000.6;
my_fmdarr.abs();

for ( size_t i = 0 ; i < my_fmdarr.length(0) ; i++ ) {
    sio.printf("my_fmdarr value[%zu]... [%5.1f]\n", i, my_fmdarr[i]);
}
```

Output:

```shell
my_fmdarr value[0]... [1000.1]
my_fmdarr value[1]... [2000.6]
```

### 12.3.64 compare()

**NAME**

compare() — Compare array objects

**SYNOPSIS**

```cpp
bool compare(const mdarray &obj) const;
```
DESCRIPTION
This member function compares the array of the object itself with that of the specified object obj.

The argument is the mdarray class. This means that the object with the different type of the array from the object itself can be passed to it. Even when the data types are not identical, this member function returns true (=1) if the length and values of the array are identical. If not, it returns false (=0).

PARAMETER
[I] obj The object that belongs to a class derived from “mdarray”

RETURN VALUE
true : If the sizes and values of the elements on the arrays are identical
false : If the sizes and one of the values of the elements on the arrays are not identical

EXAMPLE
The following code compares the object my_fmdarr with a two-dimension array with the object my_i64mdarr with a two-dimension array and prints the result to stdout:

```c
sstreamio sio;

mdarray_float my_fmdarr(false, 2,2);
my_fmdarr(0,0) = 1000;

mdarray_int64 my_i64mdarr(false, 2,2);
my_i64mdarr(0,0) = 1000;

sio.printf("*** my_fmdarr compare [%d] *** \n",
(int)my_fmdarr.compare(my_i64mdarr));
```

Output:
*** my_fmdarr compare [1] ***

12.3.65 copy()

NAME
copy() — Copy an array into another object

SYNOPSIS
```c
ssize_t copy( mdarray_type *dest ) const;
```

DESCRIPTION
This member function copies all the contents of the object itself to the specified object dest.

All attributes such as the length and values of the source array are copied to the destination array. This member function does not affect the array of the object itself (source).

PARAMETER
O dest The object to which this array is written

RETURN VALUE
The number of copied elements (column × row × layer)
EXCEPTION
The function throws an exception when it fails to allocate a local buffer, or it detects memory corruption.

EXAMPLE
The following code copies the object `my_cmdarr` with a two-dimension array to the object `my_fmdarr` and prints the values of elements to stdout for confirmation:

```c
#include <sli/mdarray.h>

int main() {
    stdstreamio sio;

    mdarray_float my_fmdarr;
    float my_values[] = {99, 101, 98, 102};
    mdarray_float my_cmdarr(false, 2, 2, my_values);

    ssize_t copy_size = my_cmdarr.copy(&my_fmdarr);

    for ( size_t j = 0 ; j < my_fmdarr.length(1) ; j++ ) {
        for ( size_t i = 0 ; i < my_fmdarr.length(0) ; i++ ) {
            sio.printf("my_fmdarr value(%zu,%zu)... [%f]\n",
                i, j, my_fmdarr(i, j));
        }
    }

    return 0;
}
```

Output:
```
my_fmdarr value(0,0)... [98]
my_fmdarr value(0,0)... [99]
my_fmdarr value(1,0)... [101]
my_fmdarr value(1,0)... [102]
```

12.3.66 copy()

NAME
copy() — Copy a part of an array into another object (for image data)

SYNOPSIS
```c
ssize_t copy( mdarray_type *dest,
    ssize_t col_idx, size_t col_len=MDARRAY_ALL,
    ssize_t row_idx=0, size_t row_len=MDARRAY_ALL,
    ssize_t layer_idx=0, size_t layer_len=MDARRAY_ALL ) const;
```

DESCRIPTION
This member function is for image data and copies a part of the contents of the object itself to the specified object `dest`.

This member function does not affect the array of the object itself (source).

Image data is copied by `copy()` as shown below:
The shaded area in the figure is specified by the second or later arguments, and it is copied to the `dest`.

Do not specify `MDARRAY_ALL` for an argument explicitly.

**PARAMETER**

| [O] dest | An instance of the class “mdarray_type” to which a subarray of this object should be written |
| [I] col_idx | Subscript specifying the first column of the subarray |
| [I] col_len | Number of columns in the subarray |
| [I] row_idx | Subscript specifying the first row of the subarray |
| [I] row_len | Number of rows in the subarray |
| [I] layer_idx | Subscript specifying the first layer of the subarray |
| [I] layer_len | Number of layers in the subarray |

(I : input, O : output)

**RETURN VALUE**

The number of copied elements (column \( \times \) row \( \times \) layer)

**EXCEPTION**

The function throws an exception when it fails to allocate a buffer, or it detects memory corruption.

**EXAMPLE**

The following code copies the object `my_cmdarr` with a two-dimension array to the object `my_fmdarr` and prints the values of elements to stdout for confirmation:

```cpp
stdstreamio sio;

double my_vals[] = {98, 99, 101, 102};
mdarray_double my_cmdarr(false, 2, 2, my_vals);

double my_d[] = {-501, 501, -502, 502};
mdarray_double my_dmdarr(false, 2, 2, my_d);

ssize_t ret_size = my_cmdarr.copy( &my_dmdarr, 1, 1, 1, 1 );
for ( size_t j = 0 ; j < my_dmdarr.length(1) ; j++ ) {
  for ( size_t i = 0 ; i < my_dmdarr.length(0) ; i++ ) {
    sio.printf("my_dmdarr value(%zu,%zu)... [%g]\n",
      i, j, my_dmdarr(i, j));
  }
}
```

Output:

```
my_dmdarr value(0,0)... [102]
```

See §3.6.7 for an example of copy and paste.
12.3.67 cut()

NAME
cut() — Cut all values in an array and copy them into another object

SYNOPSIS
mdarray_type &cut( mdarray_type *dest );

DESCRIPTION
This member function cuts all contents of the array of the object itself and copies it to the
specified object dest.
Since all contents of the array of the object itself are cut, the length of the array (source) is
set to 0.

PARAMETER

[O] dest The object to which this array is written

RETURN VALUE
A reference to itself

EXCEPTION
The function throws an exception when it fails to allocate a buffer, or it detects memory
corruption.

EXAMPLE
The following code cuts the object my_cmdarr with a two-dimension array and copies it
to the object my_mdarr, and prints the length of the array of the my_cmdarr to stdout for
confirmation:

```c
stdstreamio sio;

mdarray_uchar my_mdarr;

unsigned char my_char[] = {51, 101, 52, 102};
mdarray_uchar my_cmdarr(false, 2, 2, my_char);
my_cmdarr.cut(&my_mdarr);
sio.printf("my_cmdarr length()... [%zu]\n", my_cmdarr.length());
```

Output:
my_cmdarr length()... [0]

12.3.68 cut()

NAME
cut() — Cut a part of values in an array and copy them into another object (for image data)

SYNOPSIS
mdarray_type &cut( mdarray_type *dest,
                   ssize_t col_idx, size_t col_len=MDARRAY_ALL,
```
DESCRIPTION
This member function is for image data and cuts a part of the contents of the object itself, and copies it to the specified object `dest`.

The length of the array of the object itself (source) is not changed and the values of the area specified by the second or later arguments are filled with default values.

Do not specify `MDARRAY_ALL` for an argument explicitly.

PARAMETER

| [O] dest | An instance of the class "mdarray_type" to which a subarray of this object should be written |
| [I] col_idx | Subscript specifying the first column of the subarray |
| [I] col_len | Number of columns in the subarray |
| [I] row_idx | Subscript specifying the first row of the subarray |
| [I] row_len | Number of rows in the subarray |
| [I] layer_idx | Subscript specifying the first layer of the subarray |
| [I] layer_len | Number of layers in the subarray |

RETURN VALUE
A reference to itself

EXCEPTION
The function throws an exception when it fails to allocate a local buffer, or it detects memory corruption.

EXAMPLE
The following code cuts the zeroth column of the object `my_cmdarr` with a two-dimension array and copies it to the object `my_mdarr` and prints the values of elements to stdout for confirmation:

```c
stdstreamio sio;

mdarray_uchar my_mdarr;

unsigned char my_char[] = {51, 101, 52, 102};
mdarray_uchar my_cmdarr(false, 2,2, my_char);

my_cmdarr.cut( &my_mdarr, 0, 1 );
for ( size_t j = 0 ; j < my_cmdarr.length(1) ; j++ ) {
    for ( size_t i = 0 ; i < my_cmdarr.length(0) ; i++ ) {
        sio.printf("my_cmdarr value(%zu,%zu)... [%hhu]\n",
                i, j, my_cmdarr(i, j));
    }
}
```

Output:
```
my_cmdarr value(0,0)... [0]
my_cmdarr value(1,0)... [101]
my_cmdarr value(0,1)... [0]
my_cmdarr value(1,1)... [102]
```
12.3.69 clean()

NAME

clean() — Padding of existing values in an array by default ones (for image data)

SYNOPSIS

mdarray_type &clean( ssize_t col_index = 0, size_t col_size = MDARRAY_ALL,
                     ssize_t row_index = 0, size_t row_size = MDARRAY_ALL,
                     ssize_t layer_index = 0, size_t layer_size = MDARRAY_ALL );

DESCRIPTION

This member function fills the array elements of the object itself with default values. The
arguments are optional. When no argument is specified, the cleaning operation is applied to
all elements. The length of the array is not changed by clean().

This member function is for image data.

Do not specify MDARRAY_ALL for an argument explicitly.

PARAMETER

[I] col_index  Subscript specifying the first column of a subarray in this object
[I] col_size   Number of columns of the subarray
[I] row_index  Subscript specifying the first row of the subarray
[I] row_size   Number of rows of the subarray
[I] layer_index Subscript specifying the first layer of the subarray
[I] layer_size Number of layers of the subarray


RETURN VALUE

A reference to itself

EXAMPLE

The following code sets values to the elements of the object my_smdarr with a two-dimension
array and cleans an element, and prints the values of elements to stdout for confirmation:

```c
stdstreamio sio;

mdarray_short my_smdarr(false, 2,2);
my_smdarr(0,0) = 1;
my_smdarr(1,0) = 3;
my_smdarr(0,1) = 2;
my_smdarr(1,1) = 4;

my_smdarr.clean(1,1,1,1);
for ( size_t j = 0 ; j < my_smdarr.length(1) ; j++ ) {
    for ( size_t i = 0 ; i < my_smdarr.length(0) ; i++ ) {
        sio.printf("my_smdarr value(%zu,%zu)... [%hd]\n",
                    i, j, my_smdarr(i, j));
    }
}
```

Output:

my_smdarr value(0,0)... [1]
12.3.70 fill()

NAME

fill() — Rewrite element values (for image data)

SYNOPSIS

mdarray_type &fill( double value,
                  ssize_t col_index = 0, size_t col_size = MDARRAY_ALL,
                  ssize_t row_index = 0, size_t row_size = MDARRAY_ALL,
                  ssize_t layer_index = 0, size_t layer_size = MDARRAY_ALL ); ......... 1
mdarray_type &fill( double value,
                  void (*func)(double [],double,size_t,
                              ssize_t,ssize_t,ssize_t,mdarray_type *,void *),
                  void *user_ptr,
                  ssize_t col_index = 0, size_t col_size = MDARRAY_ALL,
                  ssize_t row_index = 0, size_t row_size = MDARRAY_ALL,
                  ssize_t layer_index = 0, size_t layer_size = MDARRAY_ALL ); ......... 2

DESCRIPTION

This member function rewrites the specified array elements of the object itself as the argument value (Function 1). This member function rewrites the specified array elements of the object itself via the user-defined function func (Function 2).

The arguments of the user-defined function are, from the left, the values of double type stored in temporary buffer converted from that in the object itself, the value specified by value, length of elements in temporary buffer that should be modified by user’s programs, the index of a column, the index of a row, the index of a layer, the address of the object itself, and the user pointer user_ptr, respectively. User’s programs should modify elements in temporary buffer. To find out how to specify a user-defined function, see EXAMPLE in §123.73.

This member function is for image data.

Do not specify MDARRAY_ALL for an argument explicitly.

PARAMETER

[I] value A real scalar to be written to a subarray of this object
[I] user_ptr The pointer that is given to user-defined function as its last argument
[I] col_index Subscript specifying the first column of the subarray
[I] col_size Number of columns of the subarray
[I] row_index Subscript specifying the first row of the subarray
[I] row_size Number of rows of the subarray
[I] layer_index Subscript specifying the first layer of the subarray
[I] layer_size Number of layers of the subarray
[I] func The pointer to user-defined function that defines an operation to be performed on each element of this array


RETURN VALUE

A reference to itself
EXAMPLE
The following code fills all elements of the object my_smdarr with a two-dimension array with 100 and prints the values of elements to stdout for confirmation:

```cpp
stdstreamio sio;

mdarray_short my_smdarr(false, 2, 2);
my_smdarr.fill(100);

for ( size_t j = 0; j < my_smdarr.length(1); j++ ) {
    for ( size_t i = 0; i < my_smdarr.length(0); i++ ) {
        sio.printf("my_smdarr value(%zu,%zu).. [%hd]\n",
                i, j, my_smdarr(i, j));
    }
}
```

Output:
- my_smdarr value(0,0).. [100]
- my_smdarr value(1,0).. [100]
- my_smdarr value(0,1).. [100]
- my_smdarr value(1,1).. [100]

12.3.71 add()

NAME
add() — Add element values (for image data)

SYNOPSIS
```cpp
mdarray_type &add( double value,
        ssize_t col_index = 0, size_t col_size = MDARRAY_ALL,
        ssize_t row_index = 0, size_t row_size = MDARRAY_ALL,
        ssize_t layer_index = 0, size_t layer_size = MDARRAY_ALL );
```

DESCRIPTION
This member function adds the value of the argument value to array elements of the object itself specified by arguments. This member function is for image data.

The value 137 is added to a part of image data by add() as shown below:

The shaded area in the figure is specified by the second or later arguments, and value is added to the area.

Do not specify MDARRAY_ALL for an argument explicitly.
PARAMETER

[I] value A real scalar to be added to a subarray of this object
[I] col_index Subscript specifying the first column of the subarray
[I] col_size Number of columns of the subarray
[I] row_index Subscript specifying the first row of the subarray
[I] row_size Number of rows of the subarray
[I] layer_index Subscript specifying the first layer of the subarray
[I] layer_size Number of layers of the subarray


RETURN VALUE
A reference to itself

EXAMPLE
The following code adds 10 to the value in the second column and second row of the object my_smdarr with a two-dimension array and prints the values of elements to stdout for confirmation:

```cpp
stdstreamio sio;

short my_short[ ] = {1, 2, 3, 4};
mdarray_short my_smdarr(false, 2,2, my_short);

my_smdarr.add(10.0, 1,1,1,1);

for ( size_t j = 0 ; j < my_smdarr.length(1) ; j++ ) {
    for ( size_t i = 0 ; i < my_smdarr.length(0) ; i++ ){
        sio.printf("my_smdarr value(%zu,%zu)... [%hd]\n", i, j, my_smdarr(i, j));
    }
}
```

Output:

my_smdarr value(0,0)... [1]
my_smdarr value(1,0)... [2]
my_smdarr value(0,1)... [3]
my_smdarr value(1,1)... [14]

12.3.72 multiply()

NAME
multiply() — Multiply element values (for image data)

SYNOPSIS

```cpp
mdarray_type &multiply( double value,
            ssize_t col_index = 0, size_t col_size = MDARRAY_ALL,
            ssize_t row_index = 0, size_t row_size = MDARRAY_ALL,
            ssize_t layer_index = 0, size_t layer_size = MDARRAY_ALL );
```

DESCRIPTION
This member function multiplies the specified array elements of the object itself by the value of the argument value. This member function is for image data.
Do not specify \texttt{MDARRAY\_ALL} for an argument explicitly.

\textbf{PARAMETER}
\begin{itemize}
\item \texttt{value} A real scalar to be multiplied to a subarray of this object
\item \texttt{col\_index} Subscript specifying the first column of the subarray
\item \texttt{col\_size} Number of columns of the subarray
\item \texttt{row\_index} Subscript specifying the first row of the subarray
\item \texttt{row\_size} Number of rows of the subarray
\item \texttt{layer\_index} Subscript specifying the first layer of the subarray
\item \texttt{layer\_size} Number of layers of the subarray
\end{itemize}
\(([I] : \text{input}, [O] : \text{output})\)

\textbf{RETURN VALUE}
A reference to itself

\textbf{EXAMPLE}
The following code multiplies all elements of the object \texttt{my\_fmdarr} with a two-dimension array by 50 and prints the values of elements to stdout for confirmation:

\begin{verbatim}
streamio sio;

float my_float[] = {1, 3, 2, 4};
mdarray\_float my\_fmdarr(false, 2,2, my\_float);

my\_fmdarr.multiply(50);
for ( size\_t j = 0 ; j < my\_fmdarr.length(1) ; j++ ) {
  for ( size\_t i = 0 ; i < my\_fmdarr.length(0) ; i++ ) {
    sio.printf("my\_fmdarr value(%zu,%zu)... [%f]\n",
                i, j, my\_fmdarr(i, j));
  }
}
\end{verbatim}

\textbf{Output:}
\begin{verbatim}
my\_fmdarr value(0,0)... [50.000000]
my\_fmdarr value(1,0)... [150.000000]
my\_fmdarr value(0,1)... [100.000000]
my\_fmdarr value(1,1)... [200.000000]
\end{verbatim}

\section{paste()}

\textbf{NAME}
paste() — Paste up an array object (for image data)

\textbf{SYNOPSIS}
\begin{verbatim}
mdarray\_type &paste( const mdarray &src,  
               ssize\_t dest\_col = 0, ssize\_t dest\_row = 0, ssize\_t dest\_layer = 0 );  1
mdarray\_type &paste( const mdarray &src, 
               void (*func)(double [],double [],size\_t, 
                            ssize\_t,ssize\_t,ssize\_t,mdarray\_type *,void *),
               void *user\_ptr, 
               ssize\_t dest\_col = 0, ssize\_t dest\_row = 0, ssize\_t dest\_layer = 0 );  2
\end{verbatim}
DESCRIPTION

This member function pastes the element values specified by src into the specified region of the array in the object itself (Function 1). This member function pastes the element values converted via the user-defined function into the specified region of the array in the object itself (Function 2).

The first argument is the mdarray class. This means that the object with the different type of the array from the object itself can be passed to it.

For the member function 2, the behavior of pasting is customizable by a user-defined function. The arguments of the user-defined function func are, from the left, the values of double type stored in temporary buffer converted from that in the object itself, the values of double type stored in temporary buffer converted from that in object src, length of elements in temporary buffer that should be modified by user’s programs, the index of a column, the index of a row, the index of a layer, the address of the object itself, and the user pointer user_ptr, respectively. User’s programs should modify elements in temporary buffer pointed by first argument. This member function is for image data.

PARAMETER

[I] src An instance of the class “mdarray” containing an input array
[I] func A pointer to user-defined function for computing a new scalar to be pasted
[I] user_ptr The pointer that is given to the user-defined function “func” as its last argument
[I] dest_col Subscript specifying the first column of a subarray of this object on which the input array is pasted
[I] dest_row Subscript specifying the first row of the subarray
[I] dest_layer Subscript specifying the first layer of the subarray

RETURN VALUE

A reference to itself

EXAMPLE

The following code pastes the object mypaste_mdarr with a two-dimension array into the object my_fmdarr with a two-dimension array. In pasting, the values of the objects are summed up and 500 is added to the values via the user-defined function. The values of elements are printed to stdout for confirmation:

```cpp
void my_func(double self[], double src[], size_t len, ssize_t x,
             ssize_t y, ssize_t z, mdarray_float *myptr, void *p)
{
    size_t i;
    for ( i=0 ; i < len ; i++ ) self[i] += src[i] + 500;
}

/* main */
streamio sio;

float my_float[] = {100, 0, 200, 0};
mdarray_float my_fmdarr(false, 2,2, my_float);

float mypaste_float[] = {1000, 3000, 2000, 4000};
```
mdarray_float mypaste_mdarr(false, 2, 2, mypaste_float);

my_fmdarr.paste(mypaste_mdarr, &my_func, NULL);
for ( size_t j = 0 ; j < my_fmdarr.length(1) ; j++ ) {
    for ( size_t i = 0 ; i < my_fmdarr.length(0) ; i++ ) {
        sio.printf("my_fmdarr value[%zu][%zu]... [%f]\n", i, j,
                  my_fmdarr(i, j));
    }
}

Output:
my_fmdarr value(0,0)... [1600.000000]
my_fmdarr value(1,0)... [2500.000000]
my_fmdarr value(0,1)... [3700.000000]
my_fmdarr value(1,1)... [4500.000000]
See §3.6.7 for an example of copy and paste.

12.3.74 add()

NAME
add() — Add an array object (for image data)

SYNOPSIS
mdarray_type &add( const mdarray &src_img, ssize_t dest_col = 0, ssize_t dest_row = 0, ssize_t dest_layer = 0);

DESCRIPTION
This member function adds array elements of the object src_img to those of the object itself. A start position for addition can be specified separately for columns, rows, and layers. This member function is for image data.

The first argument is the mdarray class. This means that the object with the different type of the array from the object itself can be passed to it.

Image data is added to the elements of the object itself by add() as shown below:

![Diagram of add() operation]

The shaded area in the figure is specified by the second or later arguments, and src_img is added to the area.

PARAMETER
[I] src_img An instance of the class “mdarray” to be added to a subarray of this object
[I] dest_col Subscript specifying the first column of the subarray
[I] dest_row Subscript specifying the first row of the subarray
[I] dest_layer Subscript specifying the first layer of the subarray
RETURN VALUE
A reference to itself

EXAMPLE
The following code adds the object `add_smdarr` with a two-dimension array to the object `my_smdarr` with a two-dimension array and prints the values of elements to stdout for confirmation:

```c
stdstreamio sio;

short my_short[] = {1, 2, 3, 4};
mdarray_short my_smdarr(false, 2,2, my_short);

short myadd_short[] = {9, 8, 7, 6};
mdarray_short myadd_smdarr(false, 2,2, myadd_short);

my_smdarr.add(myadd_smdarr);
for ( size_t j = 0 ; j < my_smdarr.length(1) ; j++ ) {
    for ( size_t i = 0 ; i < my_smdarr.length(0) ; i++ ) {
        sio.printf("my_smdarr value(%zu,%zu)... [\%hd]\n", i, j, my_smdarr(i, j));
    }
}
```

Output:

```
my_smdarr value(0,0)... [10]
my_smdarr value(1,0)... [10]
my_smdarr value(0,1)... [10]
my_smdarr value(1,1)... [10]
```

12.3.75 subtract()

NAME
subtract() — Subtract an array object (for image data)

SYNOPSIS
```c
mdarray_type &subtract( const mdarray &src_img, ssize_t dest_col = 0,
                        ssize_t dest_row = 0, ssize_t dest_layer = 0 );
```

DESCRIPTION
This member function subtracts array elements of the object `src_img` from those of the object itself. A start position for subtraction can be specified separately for columns, rows, and layers. This member function is for image data.

The first argument is the mdarray class. This means that the object with the different type of the array from the object itself can be passed to it.

PARAMETER
src_img  An instance of the class “mdarray” to be subtracted from a subarray of this object
dest_col  Subscript specifying the first column of the subarray
dest_row  Subscript specifying the first row of the subarray
dest_layer  Subscript specifying the first layer of the subarray

RETURN VALUE
A reference to itself

EXAMPLE
The following code subtracts the object mysubtract_mdarr with a two-dimension array from the object myfmdarr with a two-dimension array and prints the values of elements to stdout for confirmation:

```cpp
stdstreamio sio;

float my_float[] = {1000, 2000, 3000, 4000};
mdarray_float my_fmdarr(false, 2,2, my_float);

float mysubt_float[] = {100, 200, 300, 400};
mdarray_float mysubtract_mdarr(false, 2,2, mysubt_float);

my_fmdarr.subtract(mysubtract_mdarr);
for ( size_t j = 0 ; j < my_fmdarr.length(1) ; j++ ) {
    for ( size_t i = 0 ; i < my_fmdarr.length(0) ; i++ ) {
        sio.printf("my_fmdarr value(%zu,%zu)... [%f]\n", i, j, my_fmdarr(i, j));
    }
}
```

Output:
my_fmdarr value(0,0)... [900.000000]
my_fmdarr value(1,0)... [1800.000000]
my_fmdarr value(0,1)... [2700.000000]
my_fmdarr value(1,1)... [3600.000000]

12.3.76 multiply()

NAME
multiply() — Multiply an array object (for image data)

SYNOPSIS
```cpp
mdarray_type &multiply( const mdarray &src_img, ssize_t dest_col = 0,
                        ssize_t dest_row = 0, ssize_t dest_layer = 0 );
```

DESCRIPTION
This member function multiplies array elements of the object itself by those of the object src_img. A start position for multiplication can be specified separately for columns, rows, and layers. This member function is for image data.

The first argument is the mdarray class. This means that the object with the different type of the array from the object itself can be passed to it.
PARAMETER

- **src_img**  
  An instance of the class “mdarray” by which a subarray of this object is multiplied

- **dest_col**  
  Subscript specifying the first column of the subarray

- **dest_row**  
  Subscript specifying the first row of the subarray

- **dest_layer**  
  Subscript specifying the first layer of the subarray


RETURN VALUE

A reference to itself

EXAMPLE

The following code multiplies the object `my_fmdarr` with a two-dimension array by the object `mymulti_fmdarr` with a two-dimension array and prints the values of elements to stdout for confirmation:

```c++
stdstreamio sio;

float my_float[] = {1, 2, 3, 4};
mdarray_float my_fmdarr(false, 2,2, my_float);

float mymulti_float[] = {10, 20, 30, 40};
mdarray_float mymulti_fmdarr(false, 2,2, mymulti_float);

my_fmdarr.multiply(mymulti_fmdarr);
for ( size_t j = 0 ; j < my_fmdarr.length(1) ; j++ ) {
    for ( size_t i = 0 ; i < my_fmdarr.length(0) ; i++ ) {
        sio.printf("my_fmdarr value(%zu,%zu)... [%f]\n",
                i, j, my_fmdarr(i, j));
    }
}
```

Output:

```
my_fmdarr value(0,0)... [10.000000]
my_fmdarr value(1,0)... [40.000000]
my_fmdarr value(0,1)... [90.000000]
my_fmdarr value(1,1)... [160.000000]
```

12.3.77 divide()

NAME

divide() — Divide an array object (for image data)

SYNOPSIS

```c++
mdarray_type &divide( const mdarray &src_img, ssize_t dest_col = 0,
                      ssize_t dest_row = 0, ssize_t dest_layer = 0 );
```

DESCRIPTION

This member function divides array elements of the object itself by those of the object `src_img`. A start position for division can be specified separately for columns, rows, and layers. This member function is for image data.

The first argument is the mdarray class. This means that the object with the different type of the array from the object itself can be passed to it.
PARAMETER

[I] src_img An instance of the class “mdarray” by which a subarray of this object is divided

[I] dest_col Subscript for the first column of the subarray

[I] dest_row Subscript for the first row of the subarray

[I] dest_layer Subscript for the first layer of the subarray


RETURN VALUE

A reference to itself

EXAMPLE

The following code divides the object my_fmdarr with a two-dimension array by the object mydiv_mdarrf with a two-dimension array and prints the values of elements to stdout for confirmation:

```c
stdioio sio;

float my_float[] = {1000, 2000, 3000, 4000};
mdarray_float my_fmdarr(false, 2,2, my_float);

float mydiv_float[] = {2, 4, 6, 8};
mdarray_float mydiv_mdarrf(false, 2,2, mydiv_float);

my_fmdarr.divide(mydiv_mdarrf);
for ( size_t j = 0 ; j < my_fmdarr.length(1) ; j++ ) {
    for ( size_t i = 0 ; i < my_fmdarr.length(0) ; i++ ) {
        sio.printf("my_fmdarr value(%zu,%zu)... [%f]\n",
            i, j, my_fmdarr(i, j));
    }
}
```

Output:

my_fmdarr value(0,0)... [500.000000]
my_fmdarr value(1,0)... [500.000000]
my_fmdarr value(0,1)... [500.000000]
my_fmdarr value(1,1)... [500.000000]
Changes in APIs from the version 1.0 series

Member functions name changes

- `tstring::substr() → tstring::crop()`
  The `substr()` member function replaces a string of its own with other parts of a string of its own. Its name was changed to `crop()` because it has different behavior to the `substr()` function that is as generally used. It operates in the same manner as `substr()` formerly did.
  The `copy()` member function is used the same as the `substr()` function is generally. `copy()` enables parts of its own string to be copied to external objects.

- `tstring::strltrim() → tstring::ltrim()`
  `tstring::strrtrim() → tstring::rtrim()`
  `tstring::strtrim() → tstring::trim()`
  The name of these member functions were changed because `strrtrim()` was too long and difficult to read.
  `tstring::strtrim()` can still be used but use of `tstring::trim()` is advisable in the future.

Member functions with argument changes

- `tstring::strtol(), tstring::strtoll(), tstring::strtoul(), tstring::strtoull()`
  Changes were made to ensure that the argument “`size_t *endpos`” always comes at the end. The argument “`int base`” is replaced with the argument “`size_t *endpos`”.
  Compiling codes without having changed them will result in an error being reported.

- `tarray_tstring::split(),
  asarray_tstring::split_keys(),
  asarray_tstring::split_values()`
  Only the argument of “`bool rm_escape`” has been added to the last. Specifying this new argument allows whether or not to delete escape characters in strings after a division to be specified. For example, if the argument is `true` the original string “`program\ files`” becomes “`program files`” after the division. However, with any parts parenthesized by quotations the escape characters are not deleted, irrespective of `rm_escape`.
  To ensure the same operation as in the version 1.0 series set `true` to `rm_escape`.
  Compiling codes without having changed them will result in an error being reported.

  The argument `delims` can use expressions like “`[A-Z]`”. For more details on the expressions refer to `tstring::trim()` (§9.5.26).

Member functions which use of other APIs should be considered, depending on the situation

- `tstring::regmatch( const char *pat ),
  tstring::regmatch( size_t pos, const char *pat )`
  `tarray_tstring::regassign()` is more useful when you need to retrieve back reference information and further process the information.
  `tarray_tstring::regassign()` attempts matching on the string provided by an argument, and stores any parts that match a regular expression and substrings that are back-referenced by those parts as a string array.
Member functions that have been enhanced by overloads

- The const version was added to the [] operators and at() member function for each class.
- `tstring::find()`, `tstring::strpbrk()`, `tstring::regmatch()` etc can be provided with a pointer argument to acquire the next search position.

Primary member functions that have been added

- `strreplace()`, `chomp()`, `trim()`, `tolower()`, `toupper()`, `regreplace()` etc were added to the tarray_tstring class and asarray_tstring class, and all the elements of an array to be changed at once.
- Search APIs such as `find()`, `find_elem()`, `regmatch()` were added to the tarray_tstring class.

The asarray_tstring also makes these search APIs available for use through the values() member function and keys() member function.