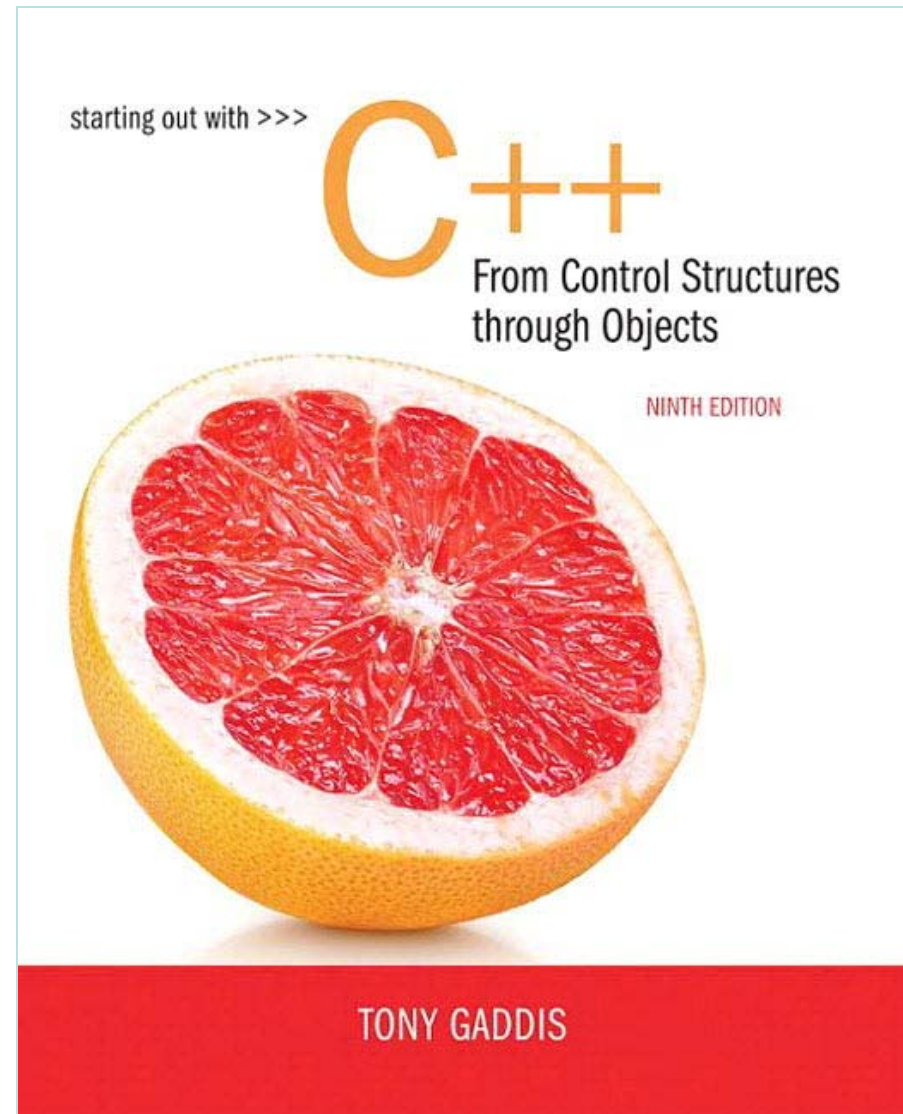


Chapter 10:

Characters, C-Strings, and More About the string Class





10.1

Character Testing

Character Testing

- Requires `cctype` header file

FUNCTION	MEANING
<code>isalpha</code>	true if arg. is a letter, false otherwise
<code>isalnum</code>	true if arg. is a letter or digit, false otherwise
<code>isdigit</code>	true if arg. is a digit 0-9, false otherwise
<code>islower</code>	true if arg. is lowercase letter, false otherwise
<code>isprint</code>	true if arg. is a printable character, false otherwise
<code>ispunct</code>	true if arg. is a punctuation character, false otherwise
<code>isupper</code>	true if arg. is an uppercase letter, false otherwise
<code>isspace</code>	true if arg. is a whitespace character, false otherwise

From Program 10-1

```
10     cout << "Enter any character: ";
11     cin.get(input);
12     cout << "The character you entered is: " << input << endl;
13     if (isalpha(input))
14         cout << "That's an alphabetic character.\n";
15     if (isdigit(input))
16         cout << "That's a numeric digit.\n";
17     if (islower(input))
18         cout << "The letter you entered is lowercase.\n";
19     if (isupper(input))
20         cout << "The letter you entered is uppercase.\n";
21     if (isspace(input))
22         cout << "That's a whitespace character.\n";
```





10.2

Character Case Conversion

Character Case Conversion

- Require `cctype` header file

- Functions:

`toupper`: if `char` argument is lowercase letter, return uppercase equivalent; otherwise, return input unchanged

```
char ch1 = 'H';
```

```
char ch2 = 'e';
```

```
char ch3 = '!';
```

```
cout << toupper(ch1); // displays 'H'
```

```
cout << toupper(ch2); // displays 'E'
```

```
cout << toupper(ch3); // displays '!'
```

Character Case Conversion

● Functions:

`tolower`: if `char` argument is uppercase letter, return lowercase equivalent; otherwise, return input unchanged

```
char ch1 = 'H';
```

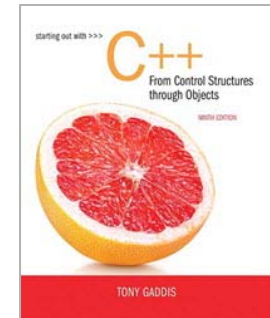
```
char ch2 = 'e';
```

```
char ch3 = '!';
```

```
cout << tolower(ch1); // displays 'h'
```

```
cout << tolower(ch2); // displays 'e'
```

```
cout << tolower(ch3); // displays '!'
```



10.3

C-Strings

C-Strings

- C-string: sequence of characters stored in adjacent memory locations and terminated by `NULL` character
- String literal (string constant): sequence of characters enclosed in double quotes " " :
"Hi there!"

H	i		t	h	e	r	e	!	\0
---	---	--	---	---	---	---	---	---	----

C-Strings

- Array of `chars` can be used to define storage for string:

```
const int SIZE = 20;  
char city[SIZE];
```

- Leave room for `NULL` at end
- Can enter a value using `cin` or `>>`
 - Input is whitespace-terminated
 - No check to see if enough space
- For input containing whitespace, and to control amount of input, use `cin.getline()`

Using C-Strings in Program 10-5

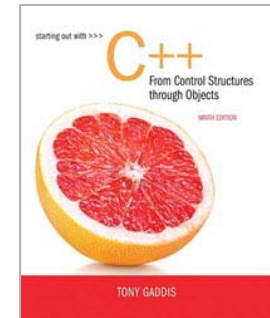
Program 10-5

```
1 // This program displays a string stored in a char array.
2 #include <iostream>
3 using namespace std;
4
5 int main()
6 {
7     const int SIZE = 80; // Array size
8     char line[SIZE];      // To hold a line of input
9     int count = 0;        // Loop counter variable
10
11     // Get a line of input.
12     cout << "Enter a sentence of no more than "
13          << (SIZE - 1) << " characters:\n";
14     cin.getline(line, SIZE);
15
16     // Display the input one character at a time.
17     cout << "The sentence you entered is:\n";
18     while (line[count] != '\0')
19     {
20         cout << line[count];
21         count++;
22     }
23     return 0;
24 }
```

Program Output with Example Input Shown in Bold

Enter a sentence of no more than 79 characters:
C++ is challenging but fun! [Enter]
The sentence you entered is:
C++ is challenging but fun!





10.4

Library Functions for Working with C-Strings

Library Functions for Working with C-Strings

- Require the `cstring` header file
- Functions take one or more C-strings as arguments. Can use:
 - C-string name
 - pointer to C-string
 - literal string

Library Functions for Working with C-Strings

Functions:

- **strlen(str):** returns length of C-string str

```
char city[SIZE] = "Missoula";  
cout << strlen(city); // prints 8
```

- **strcat(str1, str2):** appends str2 to the end of str1

```
char location[SIZE] = "Missoula, ";  
char state[3] = "MT";  
strcat(location, state);  
// location now has "Missoula, MT"
```

Library Functions for Working with C-Strings

Functions:

🍊 `strcpy(str1, str2)`: copies `str2` to `str1`

```
const int SIZE = 20;  
char fname[SIZE] = "Maureen", name[SIZE];  
strcpy(name, fname);
```

Note: `strcat` and `strcpy` perform no bounds checking to determine if there is enough space in receiving character array to hold the string it is being assigned.

C-string Inside a C-string

Function:

- `strstr(str1, str2)`: finds the first occurrence of `str2` in `str1`. Returns a pointer to match, or `NULL` if no match.

```
char river[] = "Wabash";  
char word[] = "aba";  
cout << strstr(state, word);  
// displays "abash"
```




10.5

C-String/Numeric Conversion Functions

C-String/Numeric Conversion Functions

- Requires `<cstdlib>` header file

FUNCTION	PARAMETER	ACTION
<code>atoi</code>	C-string	converts C-string to an <code>int</code> value, returns the value
<code>atol</code>	C-string	converts C-string to a <code>long</code> value, returns the value
<code>atof</code>	C-string	converts C-string to a <code>double</code> value, returns the value
<code>itoa</code>	<code>int</code> , C-string, <code>int</code>	converts 1 st <code>int</code> parameter to a C-string, stores it in 2 nd parameter. 3 rd parameter is base of converted value

C-String/Numeric Conversion Functions

```
int iNum;  
long lNum;  
double dNum;  
char intChar[10];  
iNum = atoi("1234"); // puts 1234 in iNum  
lNum = atol("5678"); // puts 5678 in lNum  
dNum = atof("35.7"); // puts 35.7 in dNum  
itoa(iNum, intChar, 8); // puts the string  
// "2322" (base 8 for 123410) in intChar
```

C-String/Numeric Conversion Functions - Notes

- if C-string contains non-digits, results are undefined
 - function may return result up to non-digit
 - function may return 0
- `itoa` does no bounds checking – make sure there is enough space to store the result

string to Number Conversion

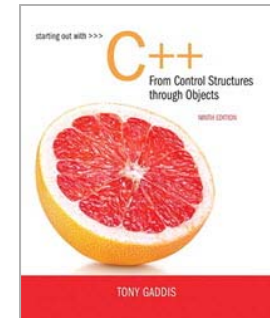
Table 10-5 string to Number Functions

Function	Description
<code>stoi(string str)</code>	Accepts a string argument and returns that argument's value converted to an int.
<code>stol(string str)</code>	Accepts a string argument and returns that argument's value converted to a long.
<code>stoul(string str)</code>	Accepts a string argument and returns that argument's value converted to an unsigned long.
<code>stoll(string str)</code>	Accepts a string argument and returns that argument's value converted to a long long.
<code>stoull(string str)</code>	Accepts a string argument and returns that argument's value converted to an unsigned long long.
<code>stof(string str)</code>	Accepts a string argument and returns that argument's value converted to a float.
<code>stod(string str)</code>	Accepts a string argument and returns that argument's value converted to a double.
<code>stold(string str)</code>	Accepts a string argument and returns that argument's value converted to a long double.

The to_string Function

Table 10-6 Overloaded Versions of the to_string Function

Function	Description
<code>to_string(int value);</code>	Accepts an <code>int</code> argument and returns that argument converted to a <code>string</code> object.
<code>to_string(long value);</code>	Accepts a <code>long</code> argument and returns that argument converted to a <code>string</code> object.
<code>to_string(long long value);</code>	Accepts a <code>long long</code> argument and returns that argument converted to a <code>string</code> object.
<code>to_string(unsigned value);</code>	Accepts an <code>unsigned</code> argument and returns that argument converted to a <code>string</code> object.
<code>to_string(unsigned long value);</code>	Accepts an <code>unsigned long</code> argument and returns that argument converted to a <code>string</code> object.
<code>to_string(unsigned long long value);</code>	Accepts an <code>unsigned long long</code> argument and returns that argument converted to a <code>string</code> object.
<code>to_string(float value);</code>	Accepts a <code>float</code> argument and returns that argument converted to a <code>string</code> object.
<code>to_string(double value);</code>	Accepts a <code>double</code> argument and returns that argument converted to a <code>string</code> object.
<code>to_string(long double value);</code>	Accepts a <code>long double</code> argument and returns that argument converted to a <code>string</code> object.



10.6

Writing Your Own C-String Handling Functions

Writing Your Own C-String Handling Functions

- Designing C-String Handling Functions
 - can pass arrays or pointers to `char` arrays
 - Can perform bounds checking to ensure enough space for results
 - Can anticipate unexpected user input

From Program 10-12

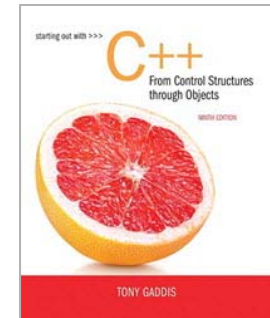
```
31 void stringCopy(char string1[], char string2[])
32 {
33     int index = 0;    // Loop counter
34
35     // Step through string1, copying each element to
36     // string2. Stop when the null character is encountered.
37     while (string1[index] != '\0')
38     {
39         string2[index] = string1[index];
40         index++;
41     }
42
43     // Place a null character in string2.
44     string2[index] = '\0';
45 }
```



From Program 10-13

```
29 void nameSlice(char userName[])
30 {
31     int count = 0; // Loop counter
32
33     // Locate the first space, or the null terminator if there
34     // are no spaces.
35     while (userName[count] != ' ' && userName[count] != '\0')
36         count++;
37
38     // If a space was found, replace it with a null terminator.
39     if (userName[count] == ' ')
40         userName[count] = '\0';
41 }
```





10.7

More About the C++ string Class

The C++ `string` Class

- Special data type supports working with strings
- `#include <string>`
- Can define `string` variables in programs:
`string firstName, lastName;`
- Can receive values with assignment operator:
`firstName = "George";`
`lastName = "Washington";`
- Can be displayed via `cout`
`cout << firstName << " " << lastName;`

Using the `string` class in Program 10-15

Program 10-15

```
1  // This program demonstrates the string class.
2  #include <iostream>
3  #include <string>    // Required for the string class.
4  using namespace std;
5
6  int main()
7  {
8      string movieTitle;
9
10     movieTitle = "Wheels of Fury";
11     cout << "My favorite movie is " << movieTitle << endl;
12     return 0;
13 }
```

Program Output

My favorite movie is Wheels of Fury



Input into a `string` Object

- Use `cin >>` to read an item into a string:

```
string firstName;  
cout << "Enter your first name: ";  
cin >> firstName;
```

Using `cin` and `string` objects in program 10-16

Program 10-16

```
1  // This program demonstrates how cin can read a string into
2  // a string class object.
3  #include <iostream>
4  #include <string>
5  using namespace std;
6
7  int main()
8  {
9      string name;
10
11      cout << "What is your name? ";
12      cin >> name;
13      cout << "Good morning " << name << endl;
14      return 0;
15  }
```

Program Output with Example Input Shown in Bold

What is your name? **Peggy** [Enter]
Good morning Peggy

Input into a `string` Object

- Use `getline` function to put a line of input, possibly including spaces, into a `string`:

```
string address;  
cout << "Enter your address: ";  
getline(cin, address);
```


string Comparison

- Can use relational operators directly to compare string objects:

```
string str1 = "George",  
        str2 = "Georgia";  
if (str1 < str2)  
    cout << str1 << " is less than "  
        << str2;
```

- Comparison is performed similar to `strcmp` function.
Result is `true` or `false`

Program 10-18

```
1 // This program uses relational operators to alphabetically
2 // sort two strings entered by the user.
3 #include <iostream>
4 #include <string>
5 using namespace std;
6
7 int main ()
8 {
9     string name1, name2;
10
11     // Get a name.
12     cout << "Enter a name (last name first): ";
13     getline(cin, name1);
14
15     // Get another name.
16     cout << "Enter another name: ";
17     getline(cin, name2);
18
19     // Display them in alphabetical order.
20     cout << "Here are the names sorted alphabetically:\n";
21     if (name1 < name2)
22         cout << name1 << endl << name2 << endl;
23     else if (name1 > name2)
24         cout << name2 << endl << name1 << endl;
25     else
26         cout << "You entered the same name twice!\n";
27     return 0;
28 }
```

Program Output with Example Input Shown in Bold

Enter a name (last name first): **Smith, Richard**

Enter another name: **Jones, John**

Here are the names sorted alphabetically:

Jones, John

Smith, Richard



Other Definitions of C++ strings

Definition	Meaning
<code>string name;</code>	defines an empty string object
<code>string myname("Chris");</code>	defines a string and initializes it
<code>string yourname(myname);</code>	defines a string and initializes it
<code>string aname(myname, 3);</code>	defines a string and initializes it with first 3 characters of <code>myname</code>
<code>string verb(myname, 3, 2);</code>	defines a string and initializes it with 2 characters from <code>myname</code> starting at position 3
<code>string noname('A', 5);</code>	defines string and initializes it to 5 'A's

string Operators

OPERATOR	MEANING
>>	extracts characters from stream up to whitespace, insert into string
<<	inserts string into stream
=	assigns string on right to string object on left
+=	appends string on right to end of contents on left
+	concatenates two strings
[]	references character in string using array notation
>, >=, <, <=, ==, !=	relational operators for string comparison. Return <code>true</code> or <code>false</code>

string Operators

```
string word1, phrase;  
string word2 = " Dog";  
cin >> word1; // user enters "Hot Tamale"  
               // word1 has "Hot"  
phrase = word1 + word2; // phrase has  
                       // "Hot Dog"  
phrase += " on a bun";  
for (int i = 0; i < 16; i++)  
    cout << phrase[i]; // displays  
                       // "Hot Dog on a bun"
```

Program 10-20

```
1 // This program demonstrates the C++ string class.
2 #include <iostream>
3 #include <string>
4 using namespace std;
5
6 int main ()
7 {
8     // Define three string objects.
9     string str1, str2, str3;
10
11     // Assign values to all three.
12     str1 = "ABC";
13     str2 = "DEF";
14     str3 = str1 + str2;
15
16     // Display all three.
17     cout << str1 << endl;
18     cout << str2 << endl;
19     cout << str3 << endl;
20
21     // Concatenate a string onto str3 and display it.
22     str3 += "GHI";
23     cout << str3 << endl;
24     return 0;
25 }
```

Program Output

```
ABC
DEF
ABCDEF
ABCDEFGHI
```



string Member Functions

- Are behind many overloaded operators
- Categories:
 - assignment: `assign`, `copy`, `data`
 - modification: `append`, `clear`, `erase`, `insert`, `replace`, `swap`
 - space management: `capacity`, `empty`, `length`, `resize`, `size`
 - substrings: `find`, `front`, `back`, `at`, `substr`
 - comparison: `compare`
- See Table 10-8 for a list of functions.

string Member Functions

```
string word1, word2, phrase;  
cin >> word1;           // word1 is "Hot"  
word2.assign(" Dog");  
phrase.append(word1);  
phrase.append(word2);    // phrase has "Hot Dog"  
phrase.append(" with mustard relish", 13);  
                        // phrase has "Hot Dog with mustard"  
phrase.insert(8, "on a bun ");  
cout << phrase << endl; // displays  
                        // "Hot Dog on a bun with mustard"
```


string Member Functions in Program 10-21

Program 10-21

```
1  // This program demonstrates a string
2  // object's length member function.
3  #include <iostream>
4  #include <string>
5  using namespace std;
6
7  int main ()
8  {
9      string town;
10
11     cout << "Where do you live? ";
12     cin >> town;
13     cout << "Your town's name has " << town.length() ;
14     cout << " characters\n";
15     return 0;
16 }
```

Program Output with Example Input Shown in Bold

Where do you live? **Jacksonville** [Enter]
Your town's name has 12 characters