8

C Characters and Strings



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The chief defect of Henry King Was chewing little bits of string. —Hilaire Belloc

Vigorous writing is concise. A sentence should contain no unnecessary words, a paragraph no unnecessary sentences. —William Strunk, Jr.

I have made this letter longer than usual, because I lack the time to make it short.

-Blaise Pascal

The difference between the almost-right word & the right word is really a large matter—it's the difference between the lightning bug and the lightning.

-Mark Twain

Mum's the word.

-Miguel de Cervantes, Don Quixote de la Mancha



OBJECTIVES

In this chapter you will learn:

- To use the functions of the character-handling library (ctype).
- To use the string-conversion functions of the general utilities library (stdlib).
- To use the string and character input/output functions of the standard input/output library (stdio).
- To use the string-processing functions of the string handling library (string).
- The power of function libraries as a means of achieving software reusability.



8.1 Introduction

- 8.2 Fundamentals of Strings and Characters
- 8.3 Character-Handling Library
- 8.4 String-Conversion Functions
- 8.5 Standard Input/Output Library Functions
- 8.6 String-Manipulation Functions of the String-Handling Library
- 8.7 Comparison Functions of the String-Handling Library
- 8.8 Search Functions of the String-Handling Library
- 8.9 Memory Functions of the String-Handling Library
- 8.10 Other Functions of the String-Handling Library



8.1 Introduction

Introduce some standard library functions

- Easy string and character processing
- Programs can process characters, strings, lines of text, and blocks of memory

These techniques used to make

- Word processors
- Page layout software
- Typesetting programs



8.2 Fundamentals of Strings and Characters

- Characters
 - Building blocks of programs
 - Every program is a sequence of meaningfully grouped characters
 - Character constant
 - An int value represented as a character in single quotes
 - 'z' represents the integer value of z
- Strings
 - Series of characters treated as a single unit
 - Can include letters, digits and special characters (*, /, \$)
 - String literal (string constant) written in double quotes
 - "Hello"
 - Strings are arrays of characters
 - String a pointer to first character
 - Value of string is the address of first character



Portability Tip 8.1

When a variable of type **char** * is initialized with a string literal, some compilers may place the string in a location in memory where the string cannot be modified. If you might need to modify a string literal, it should be stored in a character array to ensure modifiability on all systems.



Not allocating sufficient space in a character array to store the null character that terminates a string is an error.



Printing a "string" that does not contain a terminating null character is an error.



Error-Prevention Tip 8.1

When storing a string of characters in a character array, be sure that the array is large enough to hold the largest string that will be stored. C allows strings of any length to be stored. If a string is longer than the character array in which it is to be stored, characters beyond the end of the array will overwrite data in memory following the array.



8.2 Fundamentals of Strings and Characters

String definitions

Define as a character array or a variable of type char *

char color[] = "blue";

```
char *colorPtr = "blue";
```

- Remember that strings represented as character arrays end with ' $\0'$
 - color has 5 elements
- Inputting strings
 - Use scanf

scanf("%s", word);

- Copies input into word[]
- Do not need & (because a string is a pointer)
- Remember to leave room in the array for ' \0'

Processing a single character as a string. A string is a pointer—probably a respectably large integer. However, a character is a small integer (ASCII values range 0–255). On many systems this causes an error, because low memory addresses are reserved for special purposes such as operating-system interrupt handlers—so "access violations" occur.



Passing a character as an argument to a function when a string is expected is a syntax error.



Passing a string as an argument to a function when a character is expected is a syntax error.



8.3 Character Handling Library

Character handling library

- Includes functions to perform useful tests and manipulations of character data
- Each function receives a character (an i nt) or EOF as an argument

The following slides contain a table of all the functions in <ctype. h>



Prototype

Function description

<pre>int isdigit(int c);</pre>	Returns a true value if c is a digit and 0 (false) otherwise.		
<pre>int isalpha(int c);</pre>	Returns a true value if c is a letter and 0 otherwise.		
<pre>int isalnum(int c);</pre>	Returns a true value if c is a digit or a letter and 0 otherwise.		
<pre>int isxdigit(int c);</pre>	Returns a true value if c is a hexadecimal digit character and 0 otherwise. (See Appendix E, Number Systems, for a detailed explanation of binary numbers, octal numbers, decimal numbers and hexadecimal numbers.)		
<pre>int islower(int c);</pre>	Returns a true value if c is a lowercase letter and 0 otherwise.		
<pre>int isupper(int c);</pre>	Returns a true value if c is an uppercase letter and 0 otherwise.		
<pre>int tolower(int c);</pre>	If c is an uppercase letter, tol ower returns c as a lowercase letter. Otherwise, tol ower returns the argument unchanged.		

Fig. 8.1 | Character-handling library functions. (Part 1 of 2.)



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Prototype

Function description

<pre>int toupper(int c);</pre>	If c is a lowercase letter, toupper returns c as an uppercase letter. Otherwise, toupper returns the argument unchanged.
<pre>int isspace(int c);</pre>	Returns a true value if c is a white-space character—newline (' n '), space (' '), form feed (' f '), carriage return (' r ' horizontal tab (' t ') or vertical tab (' v ')—and 0 otherwise.
<pre>int iscntrl(int c);</pre>	Returns a true value if c is a control character and 0 otherwise.
<pre>int ispunct(int c);</pre>	Returns a true value if c is a printing character other than a space, a digit, or a letter and returns 0 otherwise.
<pre>int isprint(int c);</pre>	Returns a true value if c is a printing character including a space (' ') and returns 0 otherwise.
<pre>int isgraph(int c);</pre>	Returns a true value if c is a printing character other than a space (' ') and returns 0 otherwise.

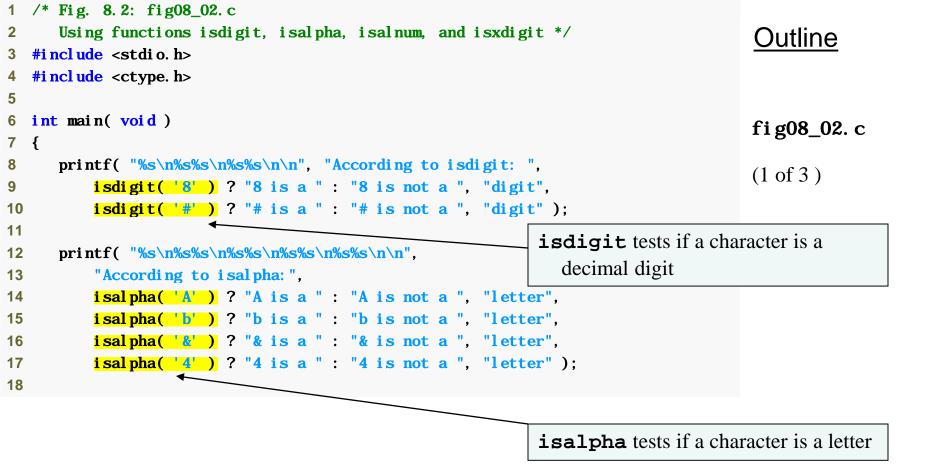
Fig. 8.1 | Character-handling library functions. (Part 2 of 2.)



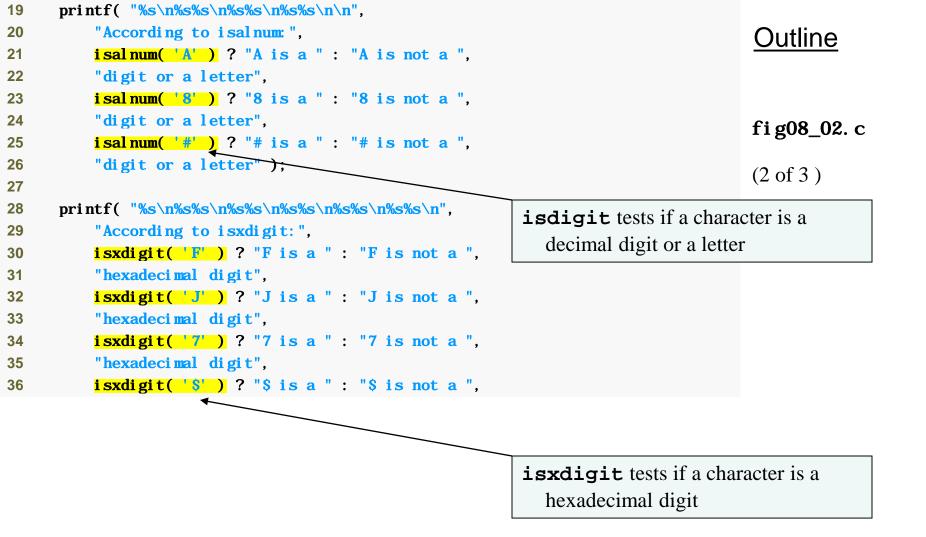
Error-Prevention Tip 8.2

When using functions from the characterhandling library, include the <ctype. h> header.







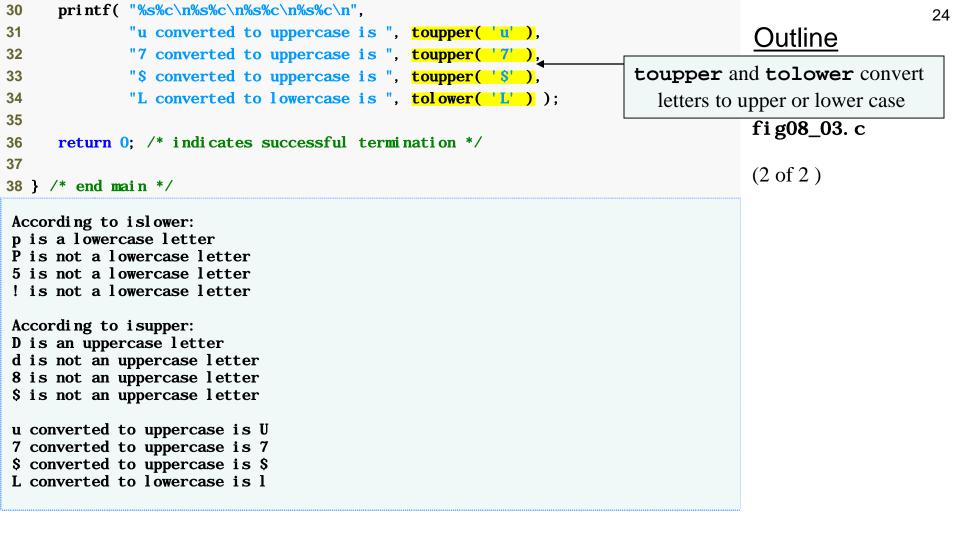




```
"hexadecimal digit",
37
          isxdigit('f') ? "f is a " : "f is not a ",
38
                                                                                       Outline
          "hexadecimal digit" );
39
40
41
     return 0; /* indicates successful termination */
42
                                                                                       fig08_02. c
43 } /* end main */
                                                                                       (3 \text{ of } 3)
According to isdigit:
8 is a digit
# is not a digit
According to isalpha:
A is a letter
b is a letter
& is not a letter
4 is not a letter
According to isal num:
A is a digit or a letter
8 is a digit or a letter
# is not a digit or a letter
According to isxdigit:
F is a hexadecimal digit
J is not a hexadecimal digit
7 is a hexadecimal digit
$ is not a hexadecimal digit
f is a hexadecimal digit
```



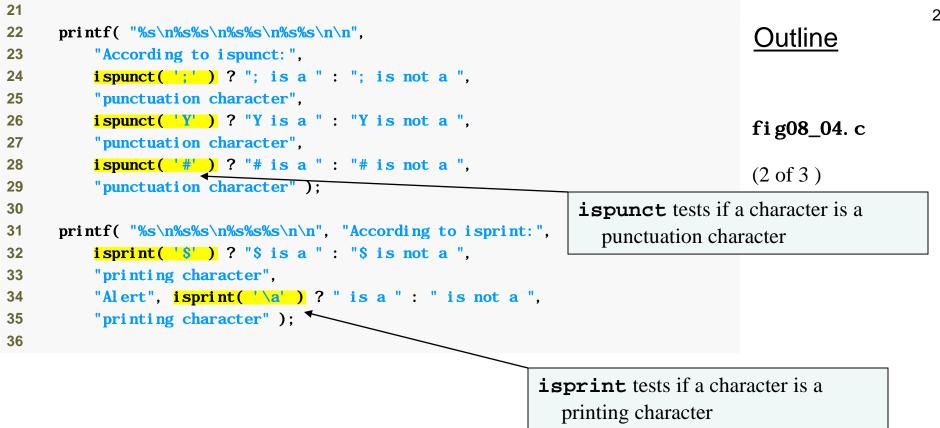
```
/* Fig. 8.3: fig08_03.c
1
      Using functions islower, isupper, tolower, toupper */
2
                                                                                       Outline
  #i ncl ude <stdi o. h>
3
  #include <ctype. h>
4
5
6 int main( void )
                                                                                      fig08_03. c
7 {
8
      printf( "%s\n%s%s\n%s%s\n%s%s\n\n",
                                                                                      (1 \text{ of } 2)
              "According to islower: ",
9
              islower('p') ? "p is a " : "p is not a ",
10
              "lowercase letter".
11
              islower('P') ? "P is a " : "P is not a ",
12
              "lowercase letter".
13
              islower('5') ? "5 is a " : "5 is not a ",
14
              "lowercase letter".
15
              islower('!') ? "! is a " : "! is not a ",
16
              "lowercase letter" ):
17
                                                              islower tests if a character is a
18
      printf( "%s\n%s%s\n%s%s\n%s%s\n\n",
19
                                                                lowercase letter
20
              "According to isupper:",
              isupper( 'D' ) ? "D is an " : "D is not an ",
21
              "uppercase letter",
22
23
              isupper( 'd' ) ? "d is an " : "d is not an ",
              "uppercase letter",
24
              isupper( '8') ? "8 is an " : "8 is not an ",
25
              "uppercase letter".
26
              isupper( '$' )_? "$ is an " : "$ is not an ",
27
              "uppercase letter" );
28
                                                        isupper tests if a character is an
29
                                                           uppercase letter
```





```
1 /* Fig. 8.4: fig08_04.c
    Using functions isspace, iscntrl, ispunct, isprint, isgraph */
2
                                                                                      Outline
  #i ncl ude <stdi o. h>
3
  #include <ctype. h>
4
5
6 int main(void)
                                                                                      fig08_04. c
7 {
8
      printf( "%s\n%s%s%s\n%s%s\n%s%s\n\n",
                                                                                      (1 \text{ of } 3)
          "According to isspace: ",
9
          "Newline", isspace('\n'_) ? " is a " : " is not a ",
10
          "whitespace character", "Horizontal tab",
11
                                                           isspace tests if a character is a
          isspace( | t ) ? " is a " : " is not a ",
12
                                                              whitespace character
          "whitespace character",
13
          isspace('%') ? "% is a " : "% is not a ",
14
          "whitespace character" );
15
16
      printf( "%s\n%s%s\n%s%s\n\n", "According to iscntrl:",
17
18
          "Newline", iscntrl('\n')?" is a ": " is not a ",
          "control character", iscntrl('$') ? "$ is a " :
19
          "$ is not a ", "control character" )
20
                                                         iscntrl tests if a character is a
                                                            control character
```







37 printf("%s\n%s%s\n%s%s%s\n", "According to isgraph:",			27
38 isgraph('Q') ? "Q is a " : "Q is not a ",		Outline	
39 "printing character other than a space",			٦
40 "Space", isgraph(''')?" is a ": " is not a ",	isgraph tests if a	a character is a	
41 "printing character other than a space");	printing characte	er that is not a space	
42		fig08_04. c	
43 return 0; /* indicates successful termination */		11600_01.0	
44		(3 of 3)	
45 } /* end main */		(3013)	
According to isspace: Newline is a whitespace character Horizontal tab is a whitespace character % is not a whitespace character According to iscntrl: Newline is a control character \$ is not a control character According to ispunct: ; is a punctuation character Y is not a punctuation character # is a punctuation character # is a punctuation character According to isprint: \$ is a printing character According to isprint: \$ is a printing character Alert is not a printing character According to isgraph: Q is a printing character other than a space Space is not a printing character other than a space			



8.4 String-Conversion Functions

Conversion functions

- In <stdl i b. h> (general utilities library)
- Convert strings of digits to integer and floatingpoint values



Function prototypeFunction descriptiondouble atof(const char *nPtr);Converts the string nPtr to double.int atoi(const char *nPtr);Converts the string nPtr to int.long atol(const char *nPtr);Converts the string nPtr to long int.double strtod(const char *nPtr, char **endPtr);Converts the string nPtr to double.long strtol(const char *nPtr, char **endPtr, int base);Converts the string nPtr to long.unsigned long strtoul(const char *nPtr, char **endPtr, int base);Converts the string nPtr to unsi gned long.

Fig. 8.5 | String-conversion functions of the general utilities library.



Error-Prevention Tip 8.3

When using functions from the general utilities library, include the <stdl i b. h> header.



```
/* Fig. 8.6: fig08_06.c
1
      Using atof */
2
                                                                                      Outline
  #include <stdio. h>
3
  #include <stdlib.h>
4
5
6 int main( void )
                                                                                      fig08_06. c
7 {
      double d; /* variable to hold converted string */
8
9
                                                    atof converts a string to a double
10
      d = atof( "99.0" ); ←
11
      printf( "%s%. 3f\n%s%. 3f\n",
12
              "The string \"99.0\" converted to double is ", d,
13
              "The converted value divided by 2 is ",
14
15
              d / 2.0);
16
      return 0; /* indicates successful termination */
17
18
19 } /* end main */
The string "99.0" converted to double is 99.000
The converted value divided by 2 is 49.500
```



```
/* Fig. 8.7: fig08_07.c
1
     Using atoi */
2
                                                                                      Outline
  #include <stdio. h>
3
  #include <stdlib.h>
4
5
6 int main(void)
                                                                                     fig08_07. c
7 {
     int i; /* variable to hold converted string */
8
9
                                                    atoi converts a string to an int
10
     i = atoi ( "2593" ); ←
11
     printf( "%s%d\n%s%d\n",
12
              "The string \"2593\" converted to int is ", i,
13
              "The converted value minus 593 is ", i - 593 );
14
15
     return 0; /* indicates successful termination */
16
17
18 } /* end main */
The string "2593" converted to int is 2593
The converted value minus 593 is 2000
```



```
/* Fig. 8.8: fig08_08.c
1
     Using atol */
2
                                                                                      Outline
  #include <stdio. h>
3
  #include <stdlib.h>
4
5
6 int main( void )
                                                                                      fig08_08. c
  {
7
     long l; /* variable to hold converted string */
8
9
     l = atol ( "1000000" ); ←
                                                    atol converts a string to a long
10
11
     printf( "%s%l d\n%s%l d\n",
12
              "The string \"1000000\" converted to long int is ", l,
13
              "The converted value divided by 2 is ", 1 / 2 );
14
15
16
     return 0; /* indicates successful termination */
17
18 } /* end main */
The string "1000000" converted to long int is 1000000
The converted value divided by 2 is 500000
```



```
/* Fig. 8.9: fig08_09.c
1
      Using strtod */
2
                                                                                      Outline
  #include <stdio. h>
3
  #include <stdlib.h>
4
5
6 int main(void)
                                                                                     fig08_09. c
  {
7
      /* initialize string pointer */
8
     const char *string = "51.2% are admitted"; /* initialize string */
9
10
     double d;
                       /* variable to hold converted sequence */
11
      char *stringPtr; /* create char pointer */
12
13
                                                      strtod converts a piece of a string to a double
     d = strtod( string, &stringPtr ); 
14
15
      printf( "The string \"%s\" is converted to the\n", string );
16
      printf( "double value %. 2f and the string \"\s\\"\n", d, stringPtr );
17
18
     return 0; /* indicates successful termination */
19
20
21 } /* end main */
The string "51.2% are admitted" is converted to the
double value 51.20 and the string "% are admitted"
```



```
/* Fig. 8.10: fig08_10.c
1
      Using strtol */
2
                                                                                       Outline
  #include <stdio. h>
3
  #include <stdlib.h>
4
5
6 int main( void )
                                                                                      fig08_10. c
  {
7
8
      const char *string = "-1234567abc"; /* initialize string pointer */
9
      char *remainderPtr; /* create char pointer */
10
     long x;
                          /* variable to hold converted sequence */
11
12
                                                       strtol converts a piece of a string to a long
     x = strtol ( string, &remainderPtr, 0 );
13
14
      printf( "%s\"%s\"\n%s%ld\n%s\"%s\"\n%s%ld\n",
15
16
              "The original string is ", string,
              "The converted value is ". x.
17
              "The remainder of the original string is ",
18
              remainderPtr.
19
              "The converted value plus 567 is ", x + 567);
20
21
      return 0: /* indicates successful termination */
22
23
24 } /* end main */
The original string is "-1234567abc"
The converted value is -1234567
The remainder of the original string is "abc"
The converted value plus 567 is -1234000
```

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```
/* Fig. 8.11: fig08_11.c
1
                                                                                                           36
      Using strtoul */
2
                                                                                      Outline
  #include <stdio. h>
3
  #include <stdlib.h>
4
5
6 int main( void )
                                                                                      fig08_11. c
  {
7
8
      const char *string = "1234567abc"; /* initialize string pointer */
                         /* variable to hold converted sequence */
      unsigned long x;
9
      char *remainderPtr; /* create char pointer */
10
11
                                                                 strtoul converts a piece of a string to
      x = strtoul ( string, &remainderPtr, 0 );
12
                                                                   an unsigned long
13
      printf( "%s\"%s\"\n%s%lu\n%s\"%s\"\n%s%lu\n",
14
15
              "The original string is ", string,
              "The converted value is ", x,
16
              "The remainder of the original string is ",
17
              remainderPtr.
18
              "The converted value minus 567 is ", x - 567 );
19
20
21
      return 0; /* indicates successful termination */
22
23 } /* end main */
The original string is "1234567abc"
The converted value is 1234567
The remainder of the original string is "abc"
The converted value minus 567 is 1234000
```



8.5 Standard Input/Output Library Functions

- Functions in <stdi o. h>
- Used to manipulate character and string data



Function prototype	Function description	
<pre>int getchar(void);</pre>	Inputs the next character from the standard input and returns it as an integer.	
<pre>char *gets(char *s);</pre>	Inputs characters from the standard input into the array s until a newline or end-of-file character is encountered. A terminating null character is appended to the array. Returns the string inputted into s . Note that an error will occur if s is not large enough to hold the string.	
<pre>int putchar(int c);</pre>	Prints the character stored in c and returns it as an integer.	
<pre>int puts(const char *s);</pre>	Prints the string s followed by a newline character. Returns a non-zero integer if successful, or E0F if an error occurs.	
<pre>int sprintf(char *s, const char *format,);</pre>		
	Equivalent to printf , except the output is stored in the array s instead of printed on the screen. Returns the number of characters written to s , or EOF if an error occurs.	
int sscanf(char *s, const	<pre>char *format,);</pre>	
	Equivalent to \mathbf{scanf} , except the input is read from the array \mathbf{s} rather than from the keyboard. Returns the number of items successfully read by the function, or EOF if an error occurs.	

Fig. 8.12 | Standard input/output library character and string functions.



Error-Prevention Tip 8.4

When using functions from the standard input/output library, include the **<stdi o**. h> header.



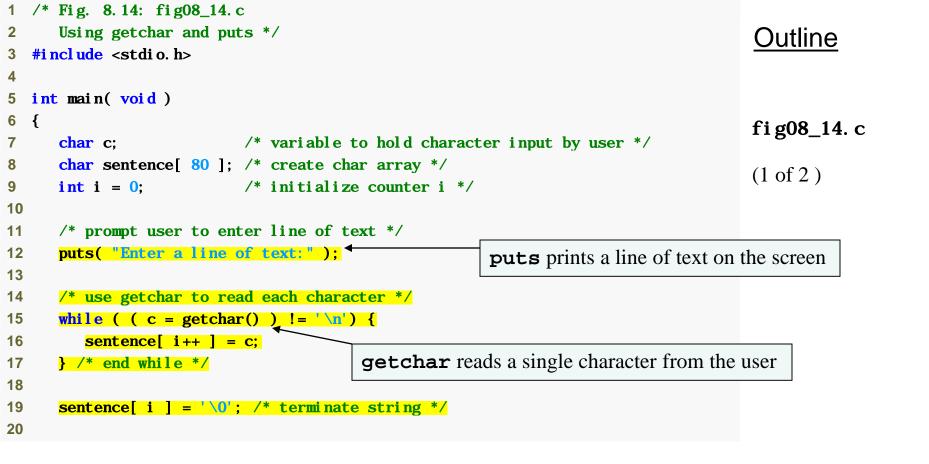
```
1 /* Fig. 8.13: fig08_13.c
      Using gets and putchar */
2
                                                                                       Outline
  #include <stdio. h>
3
4
  void reverse( const char * const sPtr ); /* prototype */
5
6
                                                                                       fig08_13. c
7 int main(void)
8 {
                                                                                       (1 \text{ of } 2)
      char sentence[ 80 ]; /* create char array */
9
10
11
      printf( "Enter a line of text: \n" );
12
      /* use gets to read line of text */
13
      gets( sentence ); 🖛
14
                                             gets reads a line of text from the user
15
16
      printf( "\nThe line printed backward is: \n" );
      reverse( sentence );
17
18
      return 0; /* indicates successful termination */
19
20
21 } /* end main */
```



```
22
23 /* recursively outputs characters in string in reverse order */
                                                                                       Outline
24 void reverse( const char * const sPtr )
25 {
     /* if end of the string */
26
     if ( sPtr[0] == ' \ 0' ) { /* base case */
27
                                                                                       fig08_13. c
         return:
28
     } /* end if */
29
                                                                                       (2 \text{ of } 2)
     else { /* if not end of the string */
30
31
         reverse( &sPtr[ 1 ] ); /* recursion step */
32
         putchar( sPtr[ 0 ] ); /* use putchar to display character */
33
     } /* end else */
34
                                                     putchar prints a single character on the screen
35
36 } /* end function reverse */
Enter a line of text:
Characters and Strings
The line printed backward is:
sgnirtS dna sretcarahC
Enter a line of text:
able was I ere I saw elba
The line printed backward is:
able was I ere I saw elba
```



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<pre>21 /* use puts to display sentence */ 22 puts("\nThe line entered was: ");</pre>	Outline
23 puts(sentence);	
24	
25 return 0; /* indicates successful termination */	
26	fig08_14. c
27 } /* end main */	
Enter a line of text: This is a test.	(2 of 2)
The line entered was: This is a test.	



```
/* Fig. 8.15: fig08_15.c
1
                                                                                                            44
      Using sprintf */
2
                                                                                       Outline
  #include <stdio. h>
3
4
 int main( void )
5
6
  {
                                                                                      fig08_15. c
      char s[ 80 ]; /* create char array */
7
                    /* x value to be input */
      int x:
8
                /* y value to be input */
      double y;
9
10
      printf( "Enter an integer and a double: \n" );
11
      scanf( "%d%l f", &x, &y );
12
13
      sprintf( s, "integer:%6d\ndouble:%8.2f", x, y ); 
                                                                sprintf prints a line of text into an array
14
15
                                                                   like printf prints text on the screen
16
      printf( "%s n%s n",
              "The formatted output stored in array s is: ", s );
17
18
      return 0; /* indicates successful termination */
19
20
21 } /* end main */
Enter an integer and a double:
298 87.375
The formatted output stored in array s is:
integer:
            298
doubl e:
          87.38
```



```
/* Fig. 8.16: fig08_16.c
1
      Using sscanf */
2
                                                                                       Outline
  #include <stdio. h>
3
4
5 int main( void )
6
  {
                                                                                       fig08_16. c
      char s[] = "31298 87.375"; /* initialize array s */
7
      int x; /* x value to be input */
8
      double y; /* y value to be input */
9
10
      sscanf( s, "%d%l f", &x, &y ); ←
11
                                                       sscanf reads a line of text from an array
12
                                                          like scanf reads text from the user
      printf( "%s \ N%s \ 6d \ N%s \ 8. \ 3f \ ",
13
              "The values stored in character array s are:",
14
              "integer:", x, "double:", y);
15
16
     return 0: /* indicates successful termination */
17
18
19 } /* end main */
The values stored in character array s are:
integer: 31298
double: 87.375
```



8.6 String Manipulation Functions of the String Handling Library

String handling library has functions to

- Manipulate string data
- Search strings
- Tokenize strings
- Determine string length



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<pre>char *strcpy(char *s1,</pre>	<pre>const char *s2)</pre>
	Copies string s2 into array s1. The value of s1 is returned.
<pre>char *strncpy(char *s1,</pre>	<pre>const char *s2, size_t n)</pre>
	Copies at most n characters of string s2 into array s1 . The value of s1 is returned.
<pre>char *strcat(char *s1, const char *s2)</pre>	
	Appends string $s2$ to array $s1$. The first character of $s2$ overwrites the terminating null character of $s1$. The value of $s1$ is returned.
<pre>char *strncat(char *s1,</pre>	<pre>const char *s2, size_t n)</pre>
	Appends at most n characters of string $s2$ to array $s1$. The first character of $s2$ overwrites the terminating null character of $s1$. The value of $s1$ is returned.

Fig. 8.17 | String-manipulation functions of the string-handling library.



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Portability Tip 8.2

Type si ze_t is a system-dependent synonym for either type unsi gned l ong or type unsi gned i nt.



Error-Prevention Tip 8.5

When using functions from the stringhandling library, include the <string. h> header.



Common Programming Error 8.6

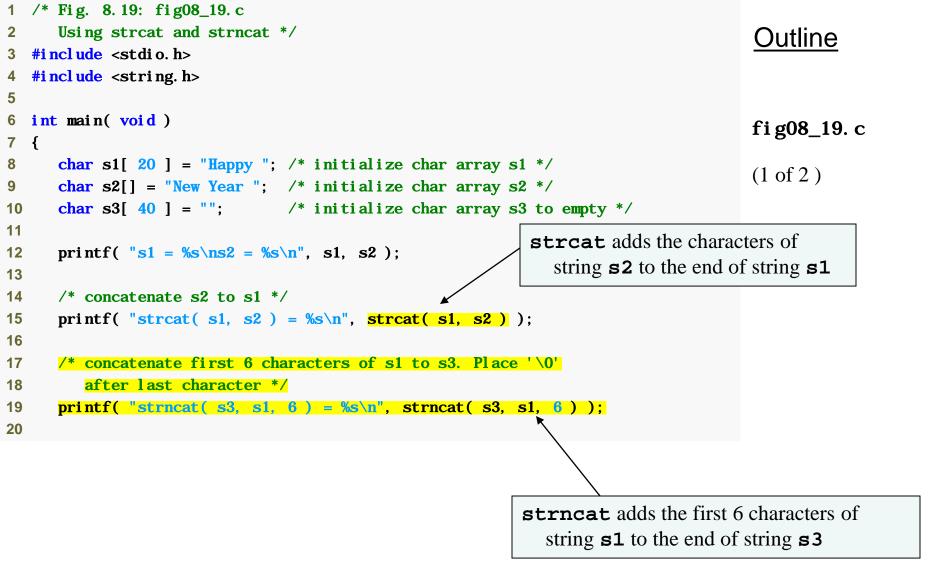
Not appending a terminating null character to the first argument of a **strncpy** when the third argument is less than or equal to the length of the string in the second argument.



```
/* Fig. 8.18: fig08_18.c
1
      Using strcpy and strncpy */
2
                                                                                      Outline
  #include <stdio. h>
3
  #include <string. h>
4
5
6 int main( void )
                                                                                      fig08_18. c
  {
7
      char x[] = "Happy Birthday to You"; /* initialize char array x */
8
      char y[ 25 ]; /* create char array y */
9
     char z[ 15 ]; /* create char array z */
10
11
     /* copy contents of x into y */
12
     printf( "%s%s\n%s%s\n",
13
         "The string in array x is: ", x,
14
                                                                          strcpy copies string x
         "The string in array y is: ", strcpy( y, x ) ); 
15
                                                                             into character array y
16
     /* copy first 14 characters of x into z. Does not copy null
17
18
        character */
                                                                 strncpy copies 14 characters of
      strncpy( z, x, 14 ); 
19
                                                                    string x into character array z
20
     z[ 14 ] = '\0'; /* terminate string in z */ 🔨
21
     printf( "The string in array z is: %s\n", z );
22
23
                                                              Note that strncpy does not
     return 0; /* indicates successful termination */
24
                                                                 automatically append a null character
25
26 } /* end main */
The string in array x is: Happy Birthday to You
The string in array y is: Happy Birthday to You
The string in array z is: Happy Birthday
                                                                                      © 2007 Pearson Education,
```

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```
/* concatenate s1 to s3 */
21
     printf( "strcat( s3, s1 ) = %s\n", strcat( s3, s1 ) );
22
                                                                                    Outline
23
24
     return 0; /* indicates successful termination */
25
26 } /* end main */
                                                                                    fig08_19. c
s1 = Happy
s2 = New Year
                                                                                    (2 of 2)
strcat( s1, s2 ) = Happy New Year
strncat(s3, s1, 6) = Happy
strcat( s3, s1 ) = Happy Happy New Year
```



8.7 Comparison Functions of the String-Handling Library

- Comparing strings
 - Computer compares numeric ASCII codes of characters in string
 - Appendix D has a list of character codes



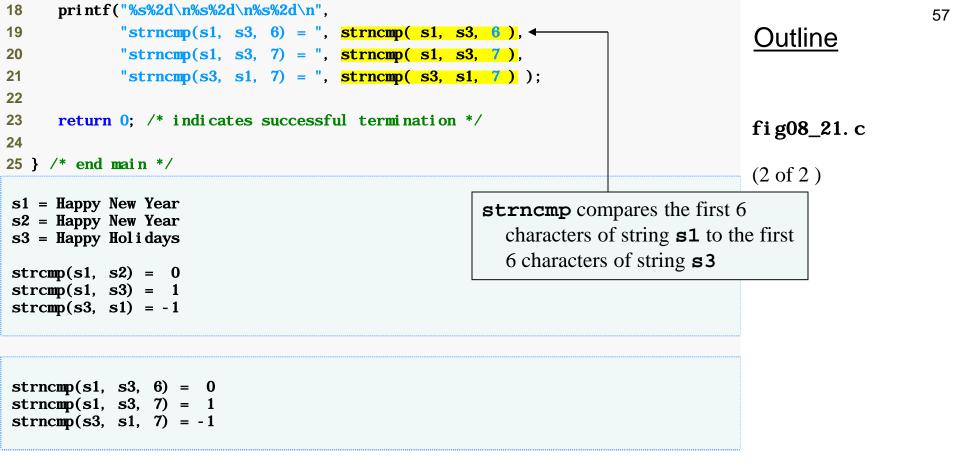
int strcmp(c	onst char	*s1, const	char *s2);
		-	or greater than (the string $s2$. The function returns 0 if $s1$ is equal to, less than or
int strncmp(const cha	r *s1, cons	t char *s2	, size_t n);
		The function re	turns 0 , less th	of the string $s1$ with the string $s2$. an 0 or greater than 0 if $s1$ is han $s2$, respectively.

Fig. 8.20 | String-comparison functions of the string-handling library.



```
/* Fig. 8.21: fig08_21.c
1
                                                                                                           56
      Using strcmp and strncmp */
2
                                                                                      Outline
  #i ncl ude <st di o. h>
3
  #include <string. h>
4
5
6 int main(void)
                                                                                      fig08_21. c
7 {
      const char *s1 = "Happy New Year"; /* initialize char pointer */
8
                                                                                      (1 \text{ of } 2)
      const char *s2 = "Happy New Year"; /* initialize char pointer */
9
      const char *s3 = "Happy Holidays"; /* initialize char pointer */
10
11
12
      printf("%s%s\n%s%s\n%s%s\n\n%s%2d\n%s%2d\n%s%2d\n\n",
             "s1 = ", s1, "s2 = ", s2, "s3 = ", s3,
13
                                                                                  strcmp compares
             "strcmp(s1, s2) = ", strcmp(s1, s2), ←
14
                                                                                     string s1 to string s2
             "strcmp(s1, s3) = ", strcmp(s1, s3),
15
16
             "strcmp(s3, s1) = ", strcmp(s3, s1));
17
```







Common Programming Error 8.7

Assuming that strcmp and strncmp return 1 when their arguments are equal is a logic error. Both functions return 0 (strangely, the equivalent of C's false value) for equality. Therefore, when testing two strings for equality, the result of function strcmp or strncmp should be compared with 0 to determine if the strings are equal.



Portability Tip 8.3

The internal numeric codes used to represent characters may be different on different computers.



```
char *strchr( const char *s, int c );
Locates the first occurrence of character c in string s. If c is found, a
pointer to c in s is returned. Otherwise, a NULL pointer is returned.size_t strcspn( const char *s1, const char *s2 );
Determines and returns the length of the initial segment of string s1
consisting of characters not contained in string s2.
size_t strspn( const char *s1, const char *s2 );
Determines and returns the length of the initial segment of string s1
consisting only of characters contained in string s2.
char *strpbrk( const char *s1, const char *s2 );
Locates the first occurrence in string s1 of any character in string
s2. If a character from string s2 is found, a pointer to the character
in string s1 is returned. Otherwise, a NULL pointer is returned.
```

Fig. 8.22 | String-manipulation functions of the string-handling library. (Part 1 of 2.)



```
char *strrchr( const char *s, int c );
Locates the last occurrence of c in string s. If c is found, a pointer to
c in string s is returned. Otherwise, a NULL pointer is returned.
char *strstr( const char *s1, const char *s2 );
Locates the first occurrence in string s1 of string s2. If the string is
found, a pointer to the string in s1 is returned. Otherwise, a NULL
pointer is returned.
char *strtok( char *s1, const char *s2 );
A sequence of calls to strtok breaks string s1 into "tokens"—
logical pieces such as words in a line of text—separated by characters
contained in string s2. The first call contains s1 as the first
argument, and subsequent calls to continue tokenizing the same string
contain NULL as the first argument. A pointer to the current token is
returned by each call. If there are no more tokens when the function
is called, NULL is returned.
```

Fig. 8.22 | String-manipulation functions of the string-handling library. (Part 2 of 2.)



```
1 /* Fig. 8.23: fig08_23.c
      Using strchr */
2
                                                                                      Outline
  #i ncl ude <stdi o. h>
3
 #include <string.h>
4
5
6 int main(void)
                                                                                      fig08_23. c
7 {
      const char *string = "This is a test"; /* initialize char pointer */
8
                                                                                      (1 \text{ of } 2)
      char character1 = 'a'; /* initialize character1 */
9
      char character2 = 'z'; /* initialize character2 */
10
11
      /* if character1 was found in string */
12
                                                                  strchr searches for the first instance
      if ( strchr( string, character1 ) != NULL ) { 🗲
13
                                                                     of character1 in string
         printf( "\'%c\' was found in \"%s\". n",
14
            character1, string );
15
      } /* end if */
16
      else { /* if character1 was not found */
17
         printf( "\'%c\' was not found in \"%s\". \n",
18
            character1, string);
19
      } /* end else */
20
```



```
21
22
      /* if character2 was found in string */
                                                                                        Outline
      if ( strchr( string, character2 ) != NULL ) {
23
         printf( "\'%c\' was found in \"%s\". \n",
24
            character2, string);
25
     } /* end if */
26
                                                                                        fig08_23. c
      else { /* if character2 was not found */
27
28
         printf( "\'%c\' was not found in \"%s\". n",
                                                                                        (2 \text{ of } 2)
            character2, string );
29
     } /* end else */
30
31
     return 0; /* indicates successful termination */
32
33
34 } /* end main */
'a' was found in "This is a test".
'z' was not found in "This is a test".
```



```
/* Fig. 8.24: fig08_24.c
1
      Using strcspn */
2
                                                                                      Outline
  #include <stdio. h>
3
  #include <string. h>
4
5
6 int main( void )
                                                                                      fig08_24. c
  {
7
      /* initialize two char pointers */
8
      const char *string1 = "The value is 3.14159";
9
      const char *string2 = "1234567890";
10
11
12
      printf( "%s%s\n%s%s\n\n%s\n%s%u\n",
13
         "string1 = ", string1, "string2 = ", string2,
         "The length of the initial segment of string1",
14
         "containing no characters from string2 = ",
15
                                                           strcspn returns the length of the initial
        strcspn( string1, string2 ); ____
16
                                                              segment of string1 that does not
17
                                                              contain any characters in string2
     return 0: /* indicates successful termination */
18
19
20 } /* end main */
string1 = The value is 3.14159
string2 = 1234567890
The length of the initial segment of string1
containing no characters from string2 = 13
```



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```
/* Fig. 8.25: fig08_25.c
1
     Using strpbrk */
2
                                                                            Outline
  #include <stdio. h>
3
  #include <string. h>
4
5
6 int main( void )
                                                                            fig08_25. c
7 {
     const char *string1 = "This is a test"; /* initialize char pointer */
8
     9
10
     printf( "%s\"%s\"\n'%c'%s\n\"%s\"\n",
11
        "Of the characters in ", string2,
12
                                                   strpbrk returns a pointer to the
       *strpbrk( string1, string2 ), 
13
                                                     first appearance in string1 of
        " appears earliest in ", string1 );
14
                                                     any character from string2
15
16
     return 0; /* indicates successful termination */
17
18 } /* end main */
Of the characters in "beware"
'a' appears earliest in
"This is a test"
```



```
/* Fig. 8.26: fig08_26.c
1
      Using strrchr */
2
                                                                                      Outline
  #include <stdio. h>
3
  #include <string. h>
4
5
6 int main( void )
                                                                                      fig08_26. c
  {
7
     /* initialize char pointer */
8
      const char *string1 = "A zoo has many animals including zebras";
9
10
     int c = 'z'; /* character to search for */
11
12
     printf( "%s\n%s' %c' %s\"%s\"\n",
13
              "The remainder of string1 beginning with the",
14
              "last occurrence of character ", c,
15
              " is: ", strrchr( string1, c ) ); 
16
                                                                strrchr returns the remainder of
17
                                                                   string1 following the last
     return 0: /* indicates successful termination */
18
                                                                   occurrence of the character c
19
20 } /* end main */
The remainder of string1 beginning with the
last occurrence of character 'z' is: "zebras"
```

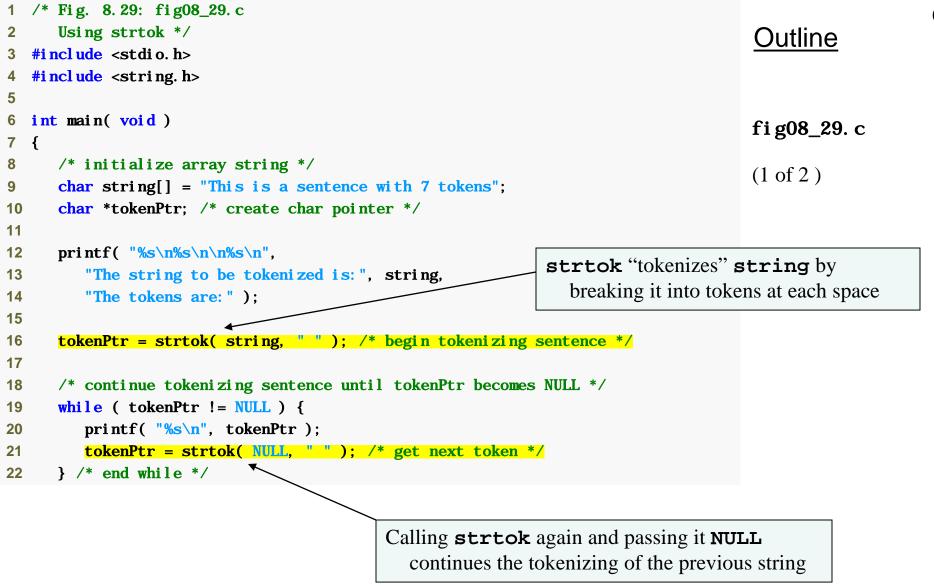


```
/* Fig. 8.27: fig08_27.c
1
                                                                                                           67
      Using strspn */
2
                                                                                      Outline
  #include <stdio. h>
3
  #include <string. h>
4
5
6 int main( void )
                                                                                      fig08_27. c
  {
7
      /* initialize two char pointers */
8
      const char *string1 = "The value is 3.14159";
9
      const char *string2 = "aehi lsTuv";
10
11
12
      printf( "%s%s\n%s%s\n\n%s\n%s%u\n",
13
         "string1 = ", string1, "string2 = ", string2,
         "The length of the initial segment of string1",
14
         "containing only characters from string2 = ",
15
                                                                  strspn returns the length of the initial
        strspn( string1, string2 ) ); 
16
                                                                     segment of string1 that contains
17
18
     return 0; /* indicates successful termination */
                                                                    only characters from string2
19
20 } /* end main */
string1 = The value is 3.14159
string2 = aehi lsTuv
The length of the initial segment of string1
containing only characters from string2 = 13
```



```
/* Fig. 8.28: fig08_28.c
1
     Using strstr */
2
                                                                                  Outline
  #include <stdio. h>
3
  #include <string. h>
4
5
6 int main( void )
                                                                                  fig08_28. c
  {
7
     const char *string1 = "abcdefabcdef"; /* string to search */
8
     const char *string2 = "def"; /* string to search for */
9
10
     printf( "%s%s\n%s%s\n\n%s\n%s%s\n",
11
        "string1 = ", string1, "string2 = ", string2,
12
        "The remainder of string1 beginning with the",
13
        "first occurrence of string2 is: ",
14
                                                   strstr returns the remainder of string1
        15
                                                      following the last occurrence of string2
16
     return 0; /* indicates successful termination */
17
18
19 } /* end main */
string1 = abcdefabcdef
string2 = def
The remainder of string1 beginning with the
first occurrence of string2 is: defabcdef
```







```
23
24
      return 0; /* indicates successful termination */
                                                                                            Outline
25
26 } /* end main */
The string to be tokenized is:
This is a sentence with 7 tokens
                                                                                            fig08_29. c
The tokens are:
                                                                                            (2 \mbox{ of } 2 \mbox{ })
Thi s
is
а
sentence
with
7
tokens
```



8.9 Memory Functions of the String-Handling Library

- Memory Functions
 - In <stdl i b. h>
 - Manipulate, compare, and search blocks of memory
 - Can manipulate any block of data
- Pointer parameters are voi d *
 - Any pointer can be assigned to voi d *, and vice versa
 - voi d * cannot be dereferenced
 - Each function receives a size argument specifying the number of bytes (characters) to process



<pre>void *memcpy(void *s1,</pre>	<pre>const void *s2, size_t n);</pre>	
	Copies n characters from the object pointed to by $s2$ into the object pointed to by $s1$. A pointer to the resulting object is returned.	
void *memmove(void *s1	,	
	Copies n characters from the object pointed to by $s2$ into the object pointed to by $s1$. The copy is performed as if the characters were first copied from the object pointed to by $s2$ into a temporary array and then from the temporary array into the object pointed to by $s1$. A pointer to the resulting object is returned.	
<pre>int memcmp(const void *s1, const void *s2, size_t n);</pre>		
	Compares the first n characters of the objects pointed to by $s1$ and $s2$. The function returns 0 , less than 0 or greater than 0 if $s1$ is equal to, less than or greater than $s2$.	
<pre>void *memchr(const void *s, int c, size_t n);</pre>		
	Locates the first occurrence of c (converted to unsi gned char) in the first n characters of the object pointed to by s . If c is found, a pointer to c in the object is returned. Otherwise, NULL is returned.	
<pre>void *memset(void *s, int c, size_t n);</pre>		
	Copies c (converted to unsi gned char) into the first n characters of the object pointed to by s . A pointer to the result is returned.	

Fig. 8.30 | Memory functions of the string-handling library.



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Common Programming Error 8.8

String-manipulation functions other than **memmove** that copy characters have undefined results when copying takes place between parts of the same string.



```
/* Fig. 8.31: fig08_31.c
1
     Using memcpy */
2
                                                                                      Outline
  #include <stdio. h>
3
  #include <string. h>
4
5
6 int main(void)
                                                                                     fig08_31. c
7 {
     char s1[ 17 ];
                                       /* create char array s1 */
8
     char s2[] = "Copy this string"; /* initialize char array s2 */
9
10
                                                           memcpy copies the first 17 characters
     memcpy( s1, s2, 17 ); ←
11
     printf( "%s\n%s\"%s\"\n",
                                                              from object s2 into object s1
12
              "After s2 is copied into s1 with memcpy,",
13
              "s1 contains ", s1);
14
15
16
     return 0; /* indicates successful termination */
17
18 } /* end main */
After s2 is copied into s1 with memcpy,
s1 contains "Copy this string"
```



```
/* Fig. 8.32: fig08_32.c
1
     Using memmove */
2
                                                                                     Outline
  #include <stdio. h>
3
  #include <string.h>
4
5
6 int main( void )
                                                                                     fig08_32. c
7
  {
     char x[] = "Home Sweet Home"; /* initialize char array x */
8
9
     printf( "%s%s\n", "The string in array x before memmove is: ", x );
10
     printf( "%s%s\n", "The string in array x after memmove is: ",
11
                                                                     memmove copies the first 10
             memmove( x, &x[5], 10)); ←
12
                                                                        characters from x[5] into object
13
     return 0; /* indicates successful termination */
14
                                                                        x by means of a temporary array
15
16 } /* end main */
The string in array x before memmove is: Home Sweet Home
The string in array x after memmove is: Sweet Home Home
```

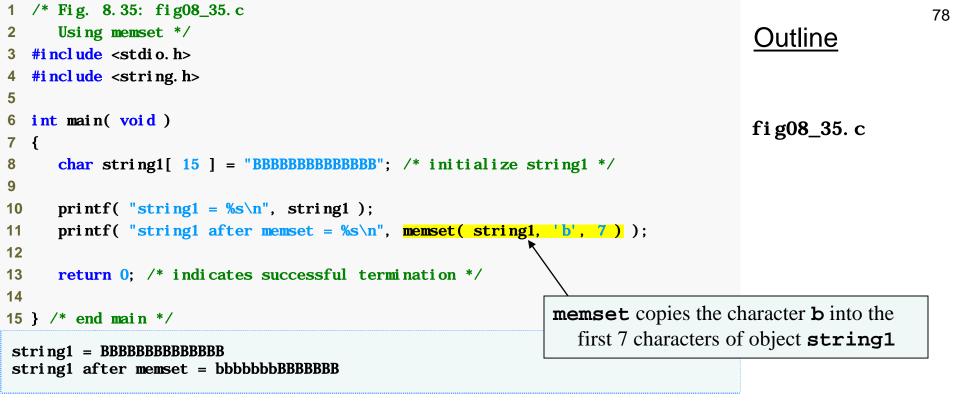


```
1 /* Fig. 8.33: fig08_33.c
                                                                                                         76
     Using memcmp */
2
                                                                                     Outline
  #include <stdio. h>
3
  #include <string. h>
4
5
6 int main( void )
                                                                                    fig08_33. c
7 {
      char s1[] = "ABCDEFG"; /* initialize char array s1 */
8
      char s2[] = "ABCDXYZ"; /* initialize char array s2 */
9
10
     printf( "%s%s\n%s%s\n\n%s%2d\n%s%2d\n%s%2d\n",
11
             "s1 = ", s1, "s2 = ", s2,
12
                                                                      memcmp compares the first 4
              "memcmp(s1, s2, 4) = ", memcmp(s1, s2, 4), \checkmark
13
                                                                         characters of objects s1 and s2
              "memcmp(s1, s2, 7) = ", memcmp(s1, s2, 7),
14
              "memcmp(s2, s1, 7) = ", memcmp(s2, s1, 7));
15
16
     return 0: /* indicate successful termination */
17
18
19 } /* end main */
s1 = ABCDEFG
s2 = ABCDXYZ
memcmp(s1, s2, 4) = 0
memcmp(s1, s2, 7) = -1
memcmp(s2, s1, 7) = 1
```



```
/* Fig. 8.34: fig08_34.c
1
                                                                                                           77
      Using memchr */
2
                                                                                      Outline
  #include <stdio. h>
3
  #include <string. h>
4
5
6 int main( void )
                                                                                      fig08_34. c
7 {
      const char *s = "This is a string"; /* initialize char pointer */
8
9
      printf( "%s\'%c\'%s\"%s\"\n",
10
              "The remainder of s after character ", 'r',
11
                                                                      memchr locates the first occurrence
              " is found is ", memchr(s, 'r', 16));←
12
                                                                         of the character r inside the first
13
      return 0; /* indicates successful termination */
14
                                                                         16 characters of object s
15
16 } /* end main */
The remainder of s after character 'r' is found is "ring"
```





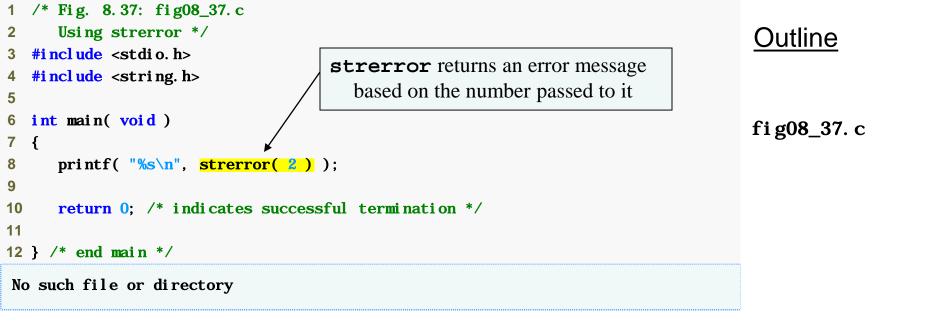


```
char *strerror( int errornum );
```

	Maps errornum into a full text string in a locale-specific manner (e.g. the message may appear in different languages based on its location). A pointer to the string is returned.	
<pre>size_t strlen(const char *s);</pre>		
	Determines the length of string s . The number of characters preceding the terminating null character is returned.	

Fig. 8.36 | Other functions of the string-handling library.







Portability Tip 8.4

The message generated by **strerror** is system dependent.



```
/* Fig. 8.38: fig08_38.c
1
     Using strlen */
2
                                                                                     Outline
  #include <stdio. h>
3
  #include <string. h>
4
5
6 int main( void )
                                                                                    fig08_38. c
  {
7
     /* initialize 3 char pointers */
8
     const char *string1 = "abcdefghijklmnopqrstuvwxyz";
9
     const char *string2 = "four";
10
     const char *string3 = "Boston";
11
12
13
     printf("%s\"%s\lu\n%s\"%s\lu\n%s\"%s\lu\n",
        "The length of ", string1, " is ",
14
                                                         strlen returns the length of string1
        (unsigned long) strlen(string1),
15
        "The length of ", string2, " is ",
16
        (unsigned long) strlen( string2 ),
17
        "The length of ", string3, " is ",
18
        ( unsigned long ) strlen( string3 ) );
19
20
21
     return 0; /* indicates successful termination */
22
23 } /* end main */
The length of "abcdefghijklmnopqrstuvwxyz" is 26
The length of "four" is 4
The length of "Boston" is 6
```



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