

Chapter 9

Formatted Input/Output

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Chapter 9 - Formatted Input/Output

Outline

- 9.1 Introduction
- 9.2 Streams
- 9.3 Formatting Output with `printf`
- 9.4 Printing Integers
- 9.5 Printing Floating-Point Numbers
- 9.6 Printing Strings and Characters
- 9.8 Printing with Field Widths and Precisions
- 9.9 Using Flags in the `printf` Format-Control String
- 9.10 Printing Literals and Escape Sequences
- 9.11 Formatting Input with `scanf`

Objectives

- In this chapter, you will learn:
 - To understand input and output streams.
 - To be able to use all print formatting capabilities.
 - To be able to use all input formatting capabilities.

9.1 Introduction

- In this chapter
 - Presentation of results
 - `scanf` and `printf`
 - Streams (input and output)
 - `gets`, `puts`, `getchar`, `putchar` (in `<stdio.h>`)

9.2 Streams

- Streams
 - Sequences of characters organized into lines
 - Each line consists of zero or more characters and ends with newline character
 - ANSI C must support lines of at least 254 characters
 - Performs all input and output
 - Can often be redirected
 - Standard input – keyboard
 - Standard output – screen
 - Standard error – screen
 - More in Chapter 11

9.3 Formatting Output with `printf`

- `printf`
 - Precise output formatting
 - Conversion specifications: flags, field widths, precisions, etc.
 - Can perform rounding, aligning columns, right/left justification, inserting literal characters, exponential format, hexadecimal format, and fixed width and precision
- Format
 - `printf(format-control-string, other-arguments);`
 - Format control string: describes output format
 - Other-arguments: correspond to each conversion specification in format-control-string
 - Each specification begins with a percent sign(%), ends with conversion specifier

9.4 Printing Integers

Conversion Specifier	Description
d	Display a signed decimal integer.
i	Display a signed decimal integer. (<i>Note:</i> The <code>i</code> and <code>d</code> specifiers are different when used with <code>scanf</code> .)
o	Display an unsigned octal integer.
u	Display an unsigned decimal integer.
x or X	Display an unsigned hexadecimal integer. <code>X</code> causes the digits 0-9 and the letters A-F to be displayed and <code>x</code> causes the digits 0-9 and a-f to be displayed.
h or l (letter l)	Place before any integer conversion specifier to indicate that a short or long integer is displayed respectively. Letters h and l are more precisely called <i>length modifiers</i> .
Fig. 9.1 Integer conversion specifiers.	

9.4 Printing Integers

- Integer
 - Whole number (no decimal point): 25, 0, -9
 - Positive, negative, or zero
 - Only minus sign prints by default (later we shall change this)



Outline

fig09_02.c

```
1 /* Fig 9.2: fig09_02.c */
2 /* Using the integer conversion specifiers */
3 #include <stdio.h>
4
5 int main()
6 {
7     printf( "%d\n", 455 );
8     printf( "%i\n", 455 ); /* i same as d in printf */
9     printf( "%d\n", +455 );
10    printf( "%d\n", -455 );
11    printf( "%hd\n", 32000 );
12    printf( "%ld\n", 2000000000 );
13    printf( "%o\n", 455 );
14    printf( "%u\n", 455 );
15    printf( "%u\n", -455 );
16    printf( "%x\n", 455 );
17    printf( "%X\n", 455 );
18
19    return 0; /* indicates successful termination */
20
21 } /* end main */
```

455
455
455
-455
32000
2000000000
707
455
4294966841
1c7
1C7



Outline

Program Output

9.5 Printing Floating-Point Numbers

- Floating Point Numbers
 - Have a decimal point (33. 5)
 - Exponential notation (computer's version of scientific notation)
 - 150. 3 is $1. 503 \times 10^2$ in scientific
 - 150. 3 is 1. 503E+02 in exponential (E stands for exponent)
 - use e or E
 - f – print floating point with at least one digit to left of decimal
 - g (or G) - prints in f or e with no trailing zeros (1. 2300 becomes 1. 23)
 - Use exponential if exponent less than -4, or greater than or equal to precision (6 digits by default)

9.5 Printing Floating-Point Numbers

Conversion specifier	Description
e or E	Display a floating-point value in exponential notation.
f	Display floating-point values.
g or G	Display a floating-point value in either the floating-point form f or the exponential form e (or E).
L	Place before any floating-point conversion specifier to indicate that a long double floating-point value is displayed.

Fig. 9.3 Floating-point conversion specifiers.



Outline

fig09_04.c

```
1  /* Fig 9. 4: fig09_04.c */
2  /* Printing floating-point numbers with
3     floating-point conversion specifiers */
4
5  #include <stdio.h>
6
7  int main()
8  {
9     printf( "%e\n", 1234567.89 );
10    printf( "%e\n", +1234567.89 );
11    printf( "%e\n", -1234567.89 );
12    printf( "%E\n", 1234567.89 );
13    printf( "%f\n", 1234567.89 );
14    printf( "%g\n", 1234567.89 );
15    printf( "%G\n", 1234567.89 );
16
17    return 0; /* indicates successful termination */
18
19 } /* end main */
```

```
1.234568e+006
1.234568e+006
-1.234568e+006
1.234568E+006
1234567.890000
1.23457e+006
1.23457E+006
```

Program Output

9.6 Printing Strings and Characters

- C
 - Prints char argument
 - Cannot be used to print the first character of a string
- S
 - Requires a pointer to char as an argument
 - Prints characters until NULL (' \0') encountered
 - Cannot print a char argument
- Remember
 - Single quotes for character constants (' z')
 - Double quotes for strings " z" (which actually contains two characters, ' z' and ' \0')



Outline

fig09_05.c

```
1  /* Fig 9.5: fig09_05c */
2  /* Printing strings and characters */
3  #include <stdio.h>
4
5  int main()
6  {
7      char character = 'A'; /* initialize char */
8      char string[] = "This is a string"; /* initialize char array */
9      const char *stringPtr = "This is also a string"; /* char pointer */
10
11     printf( "%c\n", character );
12     printf( "%s\n", "This is a string" );
13     printf( "%s\n", string );
14     printf( "%s\n", stringPtr );
15
16     return 0; /* indicates successful termination */
17
18 } /* end main */
```

```
A
This is a string
This is a string
This is also a string
```

9.8 Printing with Field Widths and Precisions

- Field width
 - Size of field in which data is printed
 - If width larger than data, default right justified
 - If field width too small, increases to fit data
 - Minus sign uses one character position in field
 - Integer width inserted between % and conversion specifier
 - %4d – field width of 4

9.8 Printing with Field Widths and Precisions

- Precision
 - Meaning varies depending on data type
 - Integers (default 1)
 - Minimum number of digits to print
 - If data too small, prefixed with zeros
 - Floating point
 - Number of digits to appear after decimal (e and f)
 - For g – maximum number of significant digits
 - Strings
 - Maximum number of characters to be written from string
 - Format
 - Use a dot (.) then precision number after %
%. 4f

9.8 Printing with Field Widths and Precisions

- Field width and precision
 - Can both be specified
 - `%width.precision`
`printf("%10.3f \n", 123.5269);`
OUTPUT: `123.527`
 - Negative field width – left justified
 - Positive field width – right justified
 - Precision must be positive
 - Can use integer expressions to determine field width and precision values



Outline

fig09_08.c

```
1  /* Fig 9.8: fig09_08.c */
2  /* Printing integers right-justified */
3  #include <stdio.h>
4
5  int main()
6  {
7      printf( "%4d\n", 1 );
8      printf( "%4d\n", 12 );
9      printf( "%4d\n", 123 );
10     printf( "%4d\n", 1234 );
11     printf( "%4d\n\n", 12345 );
12
13     printf( "%4d\n", -1 );
14     printf( "%4d\n", -12 );
15     printf( "%4d\n", -123 );
16     printf( "%4d\n", -1234 );
17     printf( "%4d\n", -12345 );
18
19     return 0; /* indicates successful termination */
20
21 } /* end main */
```



Outline

Program Output

1
12
123
1234
12345

-1
-12
-123
-1234
-12345



Outline

fig09_09.c

```
1  /* Fig 9. 9: fig09_09.c */
2  /* Using precision while printing integers,
3     floating-point numbers, and strings */
4  #include <stdio.h>
5
6  int main()
7  {
8     int i = 873;           /* initialize int i */
9     double f = 123.94536; /* initialize double f */
10    char s[] = "Happy Birthday"; /* initialize char array s */
11
12    printf( "Using precision for integers\n" );
13    printf( "\t%.4d\n\t%.9d\n\n", i, i );
14
15    printf( "Using precision for floating-point numbers\n" );
16    printf( "\t%.3f\n\t%.3e\n\t%.3g\n\n", f, f, f );
17
18    printf( "Using precision for strings\n" );
19    printf( "\t%.11s\n", s );
20
21    return 0; /* indicates successful termination */
22
23 } /* end main */
```

Using precision for integers

0873

000000873

Using precision for floating-point numbers

123.945

1.239e+002

124

Using precision for strings

Happy Birth



Outline

Program Output

9.9 Using Flags in the printf Format-Control String

- Flags
 - Supplement formatting capabilities
 - Place flag immediately to the right of percent sign
 - Several flags may be combined

Flag	Description
- (minus sign)	Left-justify the output within the specified field.
+ (plus sign)	Display a plus sign preceding positive values and a minus sign preceding negative values.
<i>space</i>	Print a space before a positive value not printed with the + flag.
#	Prefix 0 to the output value when used with the octal conversion specifier o.
	Prefix 0x or 0X to the output value when used with the hexadecimal conversion specifiers x or X.
	Force a decimal point for a floating-point number printed with e, E, f, g or G that does not contain a fractional part. (Normally the decimal point is only printed if a digit follows it.) For g and G specifiers, trailing zeros are not eliminated.
0 (zero)	Pad a field with leading zeros.

Fig. 9.10 Format control string flags.

```

1  /* Fig 9.11: fig09_11.c */
2  /* Right justifying and left justifying values */
3  #include <stdio.h>
4
5  int main()
6  {
7      printf( "%10s%10d%10c%10f\n\n", "hello", 7, 'a', 1.23 );
8      printf( "%-10s%-10d%-10c%-10f\n", "hello", 7, 'a', 1.23 );
9
10     return 0; /* indicates successful termination */
11
12 } /* end main */

```

```

      hello          7          a  1.230000
hello      7          a          1.230000

```



Outline

fig09_11.c

Program Output

```
1 /* Fig 9.12: fig09_12.c */
2 /* Printing numbers with and without the + flag */
3 #include <stdio.h>
4
5 int main()
6 {
7     printf( "%d\n%d\n", 786, -786 );
8     printf( "%+d\n%+d\n", 786, -786 );
9
10    return 0; /* indicates successful termination */
11
12 } /* end main */
```



Outline

fig09_12.c

```
786
-786
+786
-786
```

Program Output

```
1  /* Fig 9.15: fig09_15.c */
2  /* Printing with the 0( zero ) flag fills in leading zeros */
3  #include <stdio.h>
4
5  int main()
6  {
7      printf( "+09d\n", 452 );
8      printf( "%09d\n", 452 );
9
10     return 0; /* indicates successful termination */
11
12 } /* end main */
```



Outline

fig09_15.c

```
+00000452
000000452
```

Program Output

9.10 Printing Literals and Escape Sequences

- Printing Literals
 - Most characters can be printed
 - Certain "problem" characters, such as the quotation mark "
 - Must be represented by escape sequences
 - Represented by a backslash \ followed by an escape character

9.10 Printing Literals and Escape Sequences

Escape sequence	Description
\'	Output the single quote (') character.
\"	Output the double quote (") character.
\?	Output the question mark (?) character.
\\	Output the backslash (\) character.
\a	Cause an audible (bell) or visual alert.
\b	Move the cursor back one position on the current line.
\f	Move the cursor to the start of the next logical page.
\n	Move the cursor to the beginning of the next line.
\r	Move the cursor to the beginning of the current line.
\t	Move the cursor to the next horizontal tab position.
\v	Move the cursor to the next vertical tab position.
Fig. 9.16 Escape sequences.	

9.11 Formatting Input with scanf

Conversion specifier	Description
<i>Integers</i>	
d	Read an optionally signed decimal integer. The corresponding argument is a pointer to integer.
i	Read an optionally signed decimal, octal, or hexadecimal integer. The corresponding argument is a pointer to integer.
o	Read an \octal integer. The corresponding argument is a pointer to unsigned integer.
u	Read an unsigned decimal integer. The corresponding argument is a pointer to unsigned integer.
x or X	Read a hexadecimal integer. The corresponding argument is a pointer to unsigned integer.
h or l	Place before any of the integer conversion specifiers to indicate that a short t or l ong integer is to be input.
Fig. 9.17 Conversion specifiers for scanf.	

9.11 Formatting Input with scanf

Conversion specifier	Description
<i>Floating-point numbers</i>	
e, E, f, g or G	Read a floating-point value. The corresponding argument is a pointer to a floating-point variable.
l or L	Place before any of the floating-point conversion specifiers to indicate that a double or long double value is to be input.
<i>Characters and strings</i>	
C	Read a character. The corresponding argument is a pointer to char, no null ('\0') is added.
S	Read a string. The corresponding argument is a pointer to an array of type char that is large enough to hold the string and a terminating null ('\0') character—which is automatically added.
<i>Scan set</i>	
[scan characters	Scan a string for a set of characters that are stored in an array.
<i>Miscellaneous</i>	
P	Read an address of the same form produced when an address is output with %p in a printf statement.
N	Store the number of characters input so far in this scanf. The corresponding argument is a pointer to integer
%	Skip a percent sign (%) in the input.
Fig. 9.17 Conversion specifiers for scanf.	

9.11 Formatting Input with scanf

- scanf
 - Input formatting
 - Capabilities
 - Input all types of data
 - Input specific characters
 - Skip specific characters
- Format
 - `scanf(format-control-string, other-arguments);`
 - Format-control-string
 - Describes formats of inputs
 - Other-arguments
 - Pointers to variables where input will be stored
 - Can include field widths to read a specific number of characters from the stream

9.11 Formatting Input with scanf

- Scan sets
 - Set of characters enclosed in square brackets []
 - Preceded by % sign
 - Scans input stream, looking only for characters in scan set
 - Whenever a match occurs, stores character in specified array
 - Stops scanning once a character not in the scan set is found
 - Inverted scan sets
 - Use a caret ^: [^aei ou]
 - Causes characters **not** in the scan set to be stored
- Skipping characters
 - Include character to skip in format control
 - Or, use * (assignment suppression character)
 - Skips any type of character without storing it



Outline

fig09_18.c

```

1  /* Fig 9.18: fig09_18.c */
2  /* Reading integers */
3  #include <stdio.h>
4
5  int main()
6  {
7      int a; /* define a */
8      int b; /* define b */
9      int c; /* define c */
10     int d; /* define d */
11     int e; /* define e */
12     int f; /* define f */
13     int g; /* define g */
14
15     printf( "Enter seven integers: " );
16     scanf( "%d%i%i%i%o%u%x", &a, &b, &c, &d, &e, &f, &g );
17
18     printf( "The input displayed as decimal integers is:\n" );
19     printf( "%d %d %d %d %d %d %d\n", a, b, c, d, e, f, g );
20
21     return 0; /* indicates successful termination */
22
23 } /* end main */

```

Program Output

```

Enter seven integers: -70 -70 070 0x70 70 70 70
The input displayed as decimal integers is:
-70 -70 56 112 56 70 112

```



Outline

fig09_19.c

```
1 /* Fig 9.19: fig09_19.c */
2 /* Reading floating-point numbers */
3 #include <stdio.h>
4
5 /* function main begins program execution */
6 int main()
7 {
8     double a; /* define a */
9     double b; /* define b */
10    double c; /* define c */
11
12    printf( "Enter three floating-point numbers: \n" );
13    scanf( "%le%lf%lg", &a, &b, &c );
14
15    printf( "Here are the numbers entered in plain " );
16    printf( "floating-point notation: \n" );
17    printf( "%f\n%f\n%f\n", a, b, c );
18
19    return 0; /* indicates successful termination */
20
21 } /* end main */
```

Enter three floating-point numbers:

2.5 3.5 4.5

Here are the numbers entered in plain floating-point notation:

2.500000

3.500000

4.500000

Program Output



Outline

fig09_20.c

```
1 /* Fig 9.20: fig09_20.c */
2 /* Reading characters and strings */
3 #include <stdio.h>
4
5 int main()
6 {
7     char x;      /* define x */
8     char y[ 9 ]; /* define array y */
9
10    printf( "Enter a string: " );
11    scanf( "%c%s", &x, y );
12
13    printf( "The input was: \n" );
14    printf( "the character \"%c\" ", x );
15    printf( "and the string \"%s\"\n", y );
16
17    return 0; /* indicates successful termination */
18
19 } /* end main */
```

```
Enter a string: Sunday
The input was:
the character "S" and the string "unday"
```

Program Output



Outline

fig09_21.c

```
1  /* Fig 9.21: fig09_21.c */
2  /* Using a scan set */
3  #include <stdio.h>
4
5  /* function main begins program execution */
6  int main()
7  {
8      char z[ 9 ]; /* define array z */
9
10     printf( "Enter string: " );
11     scanf( "[%aelou]", z ); /* search for set of characters */
12
13     printf( "The input was \"%s\"\n", z );
14
15     return 0; /* indicates successful termination */
16
17 } /* end main */
```

```
Enter string: ooeeooahah
The input was "ooeeooa"
```

Program Output



Outline

fig09_22.c

```
1  /* Fig 9. 22: fig09_22.c */
2  /* Using an inverted scan set */
3  #include <stdio.h>
4
5  int main()
6  {
7      char z[ 9 ] = { '\0' }; /* initialize array z */
8
9      printf( "Enter a string: " );
10     scanf( "%[^aeiou]", z ); /* inverted scan set */
11
12     printf( "The input was \"%s\"\n", z );
13
14     return 0; /* indicates successful termination */
15
16 } /* end main */
```

```
Enter a string: String
The input was "Str"
```

Program Output



Outline

fig09_23.c

```
1  /* Fig 9. 23: fig09_23.c */
2  /* inputting data with a field width */
3  #include <stdio.h>
4
5  int main()
6  {
7      int x; /* define x */
8      int y; /* define y */
9
10     printf( "Enter a six digit integer: " );
11     scanf( "%2d%d", &x, &y );
12
13     printf( "The integers input were %d and %d\n", x, y );
14
15     return 0; /* indicates successful termination */
16
17 } /* end main */
```

```
Enter a six digit integer: 123456
The integers input were 12 and 3456
```

Program Output



Outline

fig09_24.c

```
1  /* Fig 9. 24: fig09_24.c */
2  /* Reading and discarding characters from the input stream */
3  #include <stdio.h>
4
5  int main()
6  {
7      int month1; /* define month1 */
8      int day1;   /* define day1 */
9      int year1;  /* define year1 */
10     int month2; /* define month2 */
11     int day2;   /* define day2 */
12     int year2;  /* define year2 */
13
14     printf( "Enter a date in the form mm-dd-yyyy: " );
15     scanf( "%d%c%d%c%d", &month1, &day1, &year1 );
16
17     printf( "month = %d  day = %d  year = %d\n\n", month1, day1, year1 );
18
19     printf( "Enter a date in the form mm/dd/yyyy: " );
20     scanf( "%d%c%d%c%d", &month2, &day2, &year2 );
21
22     printf( "month = %d  day = %d  year = %d\n", month2, day2, year2 );
23
24     return 0; /* indicates successful termination */
25
26 } /* end main */
```

```
Enter a date in the form mm-dd-yyyy: 11-18-2003
month = 11  day = 18  year = 2003
```

```
Enter a date in the form mm/dd/yyyy: 11/18/2003
month = 11  day = 18  year = 2003
```



Outline

Program Output