Chapter 2
Introduction to C Programming

C How to Program, 8/e, GE

2.2 A Simple C Program: Printing a Line of Text

- We begin by considering a simple C program.
- Our first example prints a line of text:

```c
// Fig. 2.1: fig02_01.c
// A first program in C.
#include <stdio.h>

// function main begins program execution
int main( void )
{
    printf( "Welcome to C!\n" );
} // end function main
```

```
Welcome to C!
```

Fig. 2.1 | A first program in C.

2.2 A Simple C Program: Printing a Line of Text (Cont.)

- `// Fig. 2.1: fig02_01.c`
  `// A first program in C`
  - begin with `//`, indicating that these two lines are comments.
  - Comments document programs and improve program readability.
  - Comments do not cause the computer to perform any action when the program is run.

2.2 A Simple C Program: Printing a Line of Text (Cont.)

- Comments are ignored by the C compiler and do not cause any machine-language object code to be generated.
- Comments also help other people read and understand your program.

2.2 A Simple C Program: Printing a Line of Text (Cont.)

- You can also use /*…*/ multi-line comments in which everything from /* on the first line to */ at the end of the line is a comment.
- We prefer // comments because they're shorter and they eliminate the common programming errors that occur with /*…*/ comments, especially when the closing */ is omitted.

#include Preprocessor Directive

- **`#include <stdio.h>`**
  - is a directive to the C preprocessor.

2.2 A Simple C Program: Printing a Line of Text (Cont.)

- Lines beginning with # are processed by the preprocessor before compilation.
- Line 3 tells the preprocessor to include the contents of the standard input/output header (<stdio.h>) in the program.
- This header contains information used by the compiler when compiling calls to standard input/output library functions such as `printf`.

Blank Lines and White Space

- You use blank lines, space characters and tab characters (i.e., “tabs”) to make programs easier to read.
- Together, these characters are known as white space. White-space characters are normally ignored by the compiler.

2.2 A Simple C Program: Printing a Line of Text (Cont.)

The* `main` *Function

- `int main( void )`
  - is a part of every C program.
  - The parentheses after `main` indicate that `main` is a program building block called a function.
- C programs contain one or more functions, one of which *must* be **`main`**.
- Every program in C begins executing at the function **`main`**.
- The keyword **`int`** to the left of `main` indicates that `main` "returns" an integer value.

2.2 A Simple C Program: Printing a Line of Text (Cont.)

- For now, simply include the keyword `int` to the left of `main` in each of your programs.
- Functions also can receive information when they're called upon to execute.
- The **`void`** in parentheses here means that `main` does not receive any information.

Good Programming Practice 2.1

Every function should be preceded by a comment describing the function's purpose.

2.2 A Simple C Program: Printing a Line of Text (Cont.)

- A left brace, **{**, begins the body of every function
- A corresponding right brace ends each function
- This pair of braces and the portion of the program between the braces is called a **block**.

An Output Statement

- `printf( "Welcome to C!\n" );`
  - instructs the computer to perform an action, namely to print on the screen the string of characters marked by the quotation marks.
  - A string is sometimes called a character string, a message or a literal.

2.2 A Simple C Program: Printing a Line of Text (Cont.)

- The entire line, including the `printf` function, its argument within the parentheses and the semicolon (`;`), is called a statement.
- Every statement must end with a semicolon
- When the preceding `printf` statement is executed, it prints the message `Welcome to C!` on the screen.

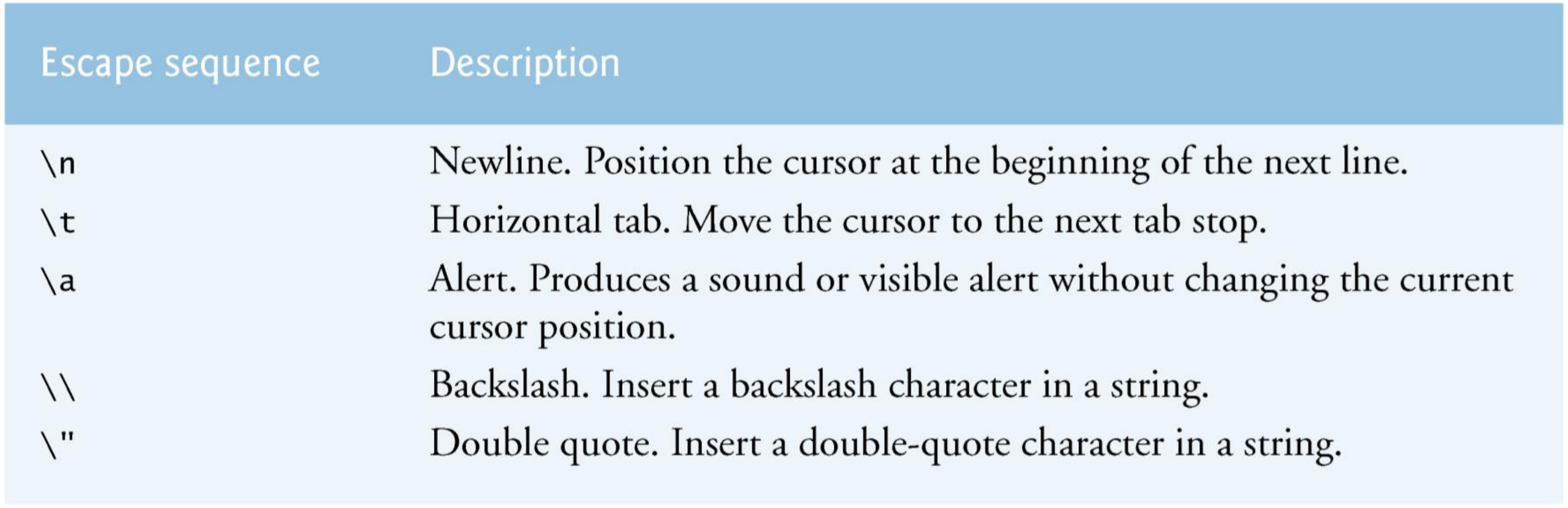
Escape Sequences

- Notice that the characters **`\n`** were not printed on the screen.
- The backslash (\) is called an escape character.
- It indicates that `printf` is supposed to do something out of the ordinary.

2.2 A Simple C Program: Printing a Line of Text (Cont.)

- When encountering a backslash in a string, the compiler looks ahead at the next character and combines it with the backslash to form an escape sequence.
- The escape sequence `\n` means newline.
- When a newline appears in the string output by a `printf`, the newline causes the cursor to position to the beginning of the next line on the screen.

Some common escape sequences are listed in Fig. 2.2.

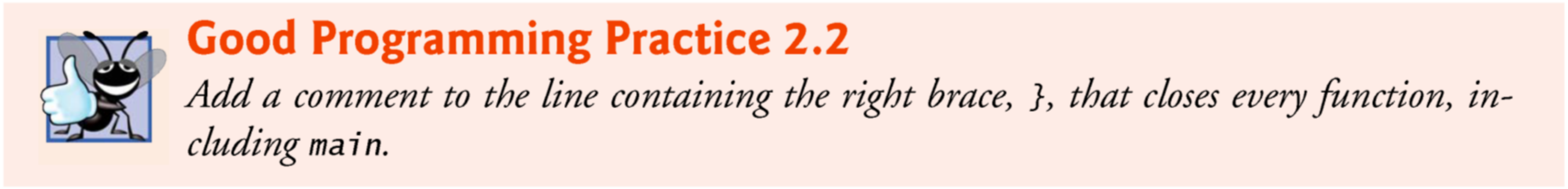


Escape sequence	Description
`\n`	Newline. Position the cursor at the beginning of the next line.
`\t`	Horizontal tab. Move the cursor to the next tab stop.
`\a`	Alert. Produces a sound or visible alert without changing the current cursor position.
`\\`	Backslash. Insert a backslash character in a string.
`\"`	Double quote. Insert a double-quote character in a string.

Fig. 2.2 | Some common escape sequences .

2.2 A Simple C Program: Printing a Line of Text (Cont.)

- Because the compiler recognizes backslash as an escape character, we use a **double backslash (`\\`)** to place a single backslash in a string.
- Printing a double quote also presents a problem because double quotes mark the boundaries of a string—such quotes are not printed.
- By using the escape sequence `\"` in a string to be output by `printf`, we indicate that `printf` should display a double quote.
- The right brace, `}`, indicates that the end of `main` has been reached.



Good Programming Practice 2.2

Add a comment to the line containing the right brace, }, that closes every function, including `main`.

2.2 A Simple C Program: Printing a Line of Text (Cont.)

The Linker and Executables

- Standard library functions like **`printf`** and **`scanf`** are not part of the C programming language.
- For example, the compiler cannot find a spelling error in `printf` or `scanf`.
- When the compiler compiles a `printf` statement, it merely provides space in the object program for a "call" to the library function.
- But the compiler does not know where the library functions are—the linker does.
- When the **linker** runs, it <u>locates the library functions</u> and inserts the proper calls to these library functions in the object program.

2.2 A Simple C Program: Printing a Line of Text (Cont.)

- Now the object program is complete and ready to be executed.
- For this reason, the **linked** program is called an executable.
- If the function name is misspelled, it's the **linker** that will spot the error, because it will not be able to match the name in the C program with the name of any known function in the libraries.

2.2 A Simple C Program: Printing a Line of Text (Cont.)

Using Multiple `printf`s

- The `printf` function can print `Welcome to C!` several different ways.
- For example, the program of Fig. 2.3 produces the same output as the program of Fig. 2.1.
- This works because each `printf` resumes printing where the previous `printf` stopped printing.

```c
// Fig. 2.3: fig02_03.c
// Printing on one line with two printf statements.
#include <stdio.h>

// function main begins program execution
int main( void )
{
   printf( "Welcome " );
   printf( "to C!\n" );
} // end function main
```

```
Welcome to C!
```

Fig. 2.3 | Printing one line with two `printf` statements.

2.2 A Simple C Program: Printing a Line of Text (Cont.)

- One **`printf`** can print *several* lines by using additional newline characters as in Fig. 2.4.
- Each time the **`\n`** (newline) escape sequence is encountered, output continues at the beginning of the next line.

```c
// Fig. 2.4: fig02_04.c
// Printing multiple lines with a single printf.
#include <stdio.h>

// function main begins program execution
int main( void )
{
   printf( "Welcome\nto\nC!\n" );
} // end function main
```

```
Welcome
to
C!
```

Fig. 2.4 | Printing multiple lines with a single `printf`.

2.3 Another Simple C Program: Adding Two Integers

- Program (fig. 2.5) uses the Standard Library function **`scanf`** to obtain two integers typed by a user at the keyboard, computes the sum of these values and prints the result using `printf`.

```c
// Fig. 2.5: fig02_05.c
// Addition program.
#include <stdio.h>

// function main begins program execution
int main( void )
{
   int integer1; // first number to be entered by user
   int integer2; // second number to be entered by user

   printf( "Enter first integer\n" ); // prompt
   scanf( "%d", &integer1 ); // read an integer

   printf( "Enter second integer\n" ); // prompt
   scanf( "%d", &integer2 ); // read an integer

   int sum; // variable in which sum will be stored
   sum = integer1 + integer2; // assign total to sum

   printf( "Sum is %d\n", sum ); // print sum
} // end function main
```

Fig. 2.5 | Addition program. (Part 1 of 2.)

```
Enter first integer
45
Enter second integer
72
Sum is 117
```

Fig. 2.5 | Addition program. (Part 2 of 2.)

2.3 Another Simple C Program: Adding Two Integers (Cont.)

Variables and Variable Definitions

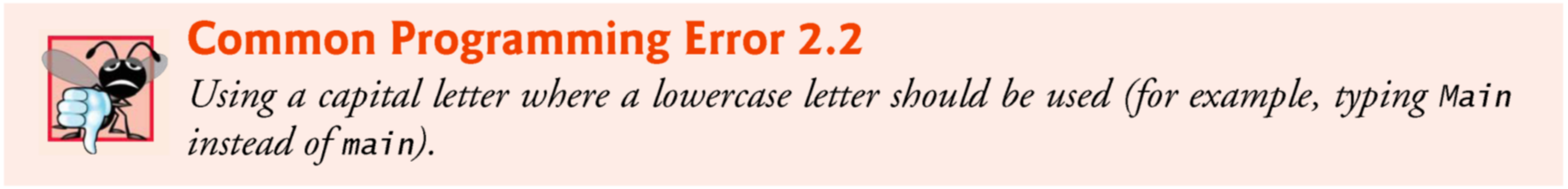
-
  ```
  int integer1; // first number to be entered by user
  int integer2; // second number to be entered by user
  int sum; // variable in which sum will be stored
  ```
  are definitions.
- The names `integer1`, `integer2` and `sum` are the names of variables—locations in memory where values can be stored for use by a program.
- These definitions specify that the variables `integer1`, `integer2` and `sum` are of type **`int`**, which means that they'll hold integer values.
- All variables must be defined <u>with a name</u> and <u>a data type</u> before they can be used in a program.
- The preceding definitions could have been combined into a single definition statement as follows:
  - `int integer1, integer2, sum;`

  but that would have made it difficult to describe the variables with corresponding comments

2.3 Another Simple C Program: Adding Two Integers (Cont.)

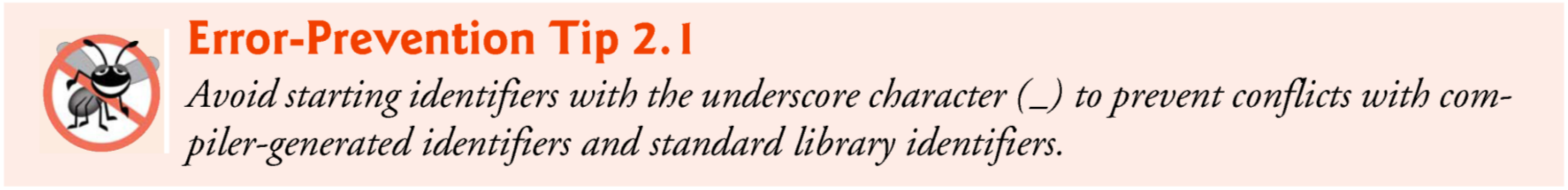
Identifiers and Case Sensitivity

- A variable name in C is any valid identifier.
- An identifier is a series of characters consisting of letters, digits and underscores (_) that does *not* begin with a digit.
- C is case sensitive—uppercase and lowercase letters are different in C, so `a1` and `A1` are different identifiers.



Common Programming Error 2.2

Using a capital letter where a lowercase letter should be used (for example, typing `Main` *instead of* `main`*).*



Error-Prevention Tip 2.1

Avoid starting identifiers with the underscore character (_) to prevent conflicts with compiler-generated identifiers and standard library identifiers.

2.3 Another Simple C Program: Adding Two Integers (Cont.)

Prompting Messages

- `printf( "Enter first integer\n" ); // prompt`
  - displays the literal "`Enter first integer`" and positions the cursor to the beginning of the next line.
  - This message is called a prompt because it tells the user to take a specific action.

The scanf Function and Formatted Inputs

- The next statement
    - `scanf( "%d", &integer1 ); // read an integer`

  uses scanf to obtain a value from the user.
- The **`scanf`** function reads from the standard input, which is usually the keyboard.

2.3 Another Simple C Program: Adding Two Integers (Cont.)

- This **`scanf`** has two arguments, **`"%d"`** and **`&integer1`**.
- The first, the format control string, indicates the type of data that should be input by the user.
- The %d conversion specifier indicates that the data should be an integer (the letter `d` stands for "decimal integer").
- The **`%`** in this context is treated by `scanf` (and **`printf`** as we'll see) as a special character that begins a conversion specifier.
- The second argument of `scanf` begins with an ampersand (&)—called the address operator in C—followed by the variable name.

2.3 Another Simple C Program: Adding Two Integers (Cont.)

- The **&**, when combined with the variable name, tells **scanf** the location (or address) in memory at which the variable `integer1` is stored.
- The computer then stores the value that the user enters for `integer1` at that location.
- The use of ampersand (&) is often confusing
- For now, just remember to precede each variable in every call to `scanf` with an ampersand.

2.3 Another Simple C Program: Adding Two Integers (Cont.)

- When the computer executes the preceding `scanf`, it waits for the user to enter a value for variable `integer1`.
- The user responds by typing an integer, then pressing the *Enter* key to send the number to the computer.
- The computer then assigns this number, or value, to the variable `integer1`.
- Any subsequent references to `integer1` in this program will use this same value.
- Functions **`printf`** and **`scanf`** facilitate interaction between the user and the computer.
- Because this interaction resembles a dialogue, it's often called interactive computing.

- `printf( "Enter second integer\n" ); // prompt`
  - displays the message `Enter second integer` on the screen, then positions the cursor to the beginning of the next line.
- `scanf( "%d", &integer2 ); // read an integer`
  - obtains a value for variable `integer2` from the user.

Assignment Statement

- The assignment statement
  - `sum = integer1 + integer2; // assign total to sum`

  calculates the total of variables `integer1` and `integer2` and assigns the result to variable `sum` using the assignment operator **=**
- The = operator and the **+** operator are called binary operators because each has two operands.
- The **+** operator's two operands are **`integer1`** and **`integer2`**.
- The **=** operator's two operands are **`sum`** and the value of the expression **`integer1 + integer2`**.

Common Programming Error 2.3

A calculation in an assignment statement must be on the right side *of the = operator. It's a compilation error to place a calculation on the* left side *of an assignment operator.*

2.3 Another Simple C Program: Adding Two Integers (Cont.)

Printing with a Format Control String

- `printf( "Sum is %d\n", sum ); // print sum`
  - This **`printf`** has two arguments, **`"Sum is %d\n"`** and **`sum`**.
  - The first argument is the <u>format control string</u>.
  - It contains some literal characters to be displayed, and it contains the conversion specifier **`%d`** indicating that an integer will be printed.
  - The second argument specifies the <u>value to be printed</u>.

Calculations in `printf` Statements

- We could have combined the previous two statements into the statement
    - `printf( "Sum is %d\n", integer1 + integer2 );`
- The right brace, }, at line 21 indicates that the end of function `main` has been reached.

Common Programming Error 2.5

Preceding a variable included in a `printf` statement with an ampersand when, in fact, that variable should not be preceded by an ampersand.

2.4 Memory Concepts

- Variable names such as `integer1`, `integer2` and `sum` actually correspond to locations in the computer's memory.
- Every variable has a name, a type and a value.

When the statement

- `scanf( "%d", &integer1 ); // read an integer`

is executed, the value entered by the user is placed into a memory location to which the name `integer1` has been assigned.

- Suppose the user enters the `45` as the value for `integer1`.
- The computer will place `45` into location `integer1` as shown in Fig. 2.6.

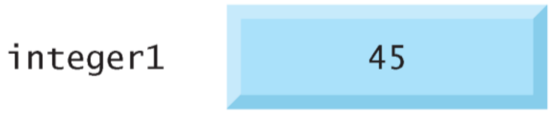


Fig. 2.6 | Memory location showing the name and value of a variable.

2.4 Memory Concepts (Cont.)

- Whenever a value is placed in a memory location, the value replaces the previous value in that location; thus, this process is said to be destructive.
- When the statement
  - `scanf( "%d", &integer2 ); // read an integer`

  executes, suppose the user enters the value 72.
- This value is placed into location `integer2`, and memory appears as in Fig. 2.7.
- These locations are not necessarily adjacent in memory.

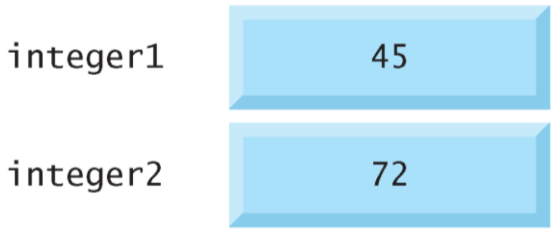


Fig. 2.7 | Memory locations after both variables are input.

2.4 Memory Concepts (Cont.)

- Once the program has obtained values for `integer1` and `integer2`, it adds these values and places the total into variable `sum`.
- `sum = integer1 + integer2; // assign total to sum`
  - replaces whatever value was stored in `sum`.
- After `sum` is calculated, memory appears as in Fig. 2.8.
- The values of `integer1` and `integer2` appear exactly as they did before they were used in the calculation.

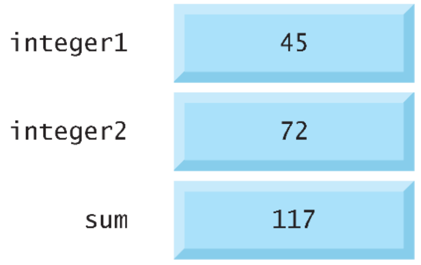
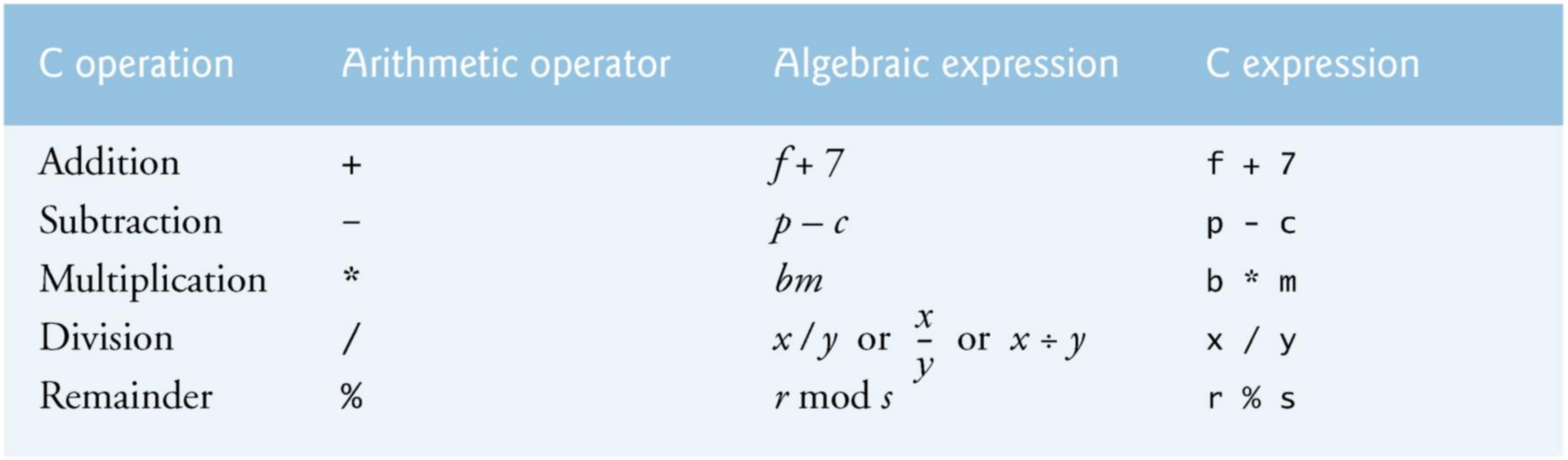


Fig. 2.8 | Memory locations after a calculation.

2.4 Memory Concepts (Cont.)

- They were used, but not destroyed, as the computer performed the calculation.
- Thus, when a value is read from a memory location, the process is said to be nondestructive.
- Most C programs perform calculations using the C arithmetic operators (Fig. 2.9).



C operation	Arithmetic operator	Algebraic expression	C expression
Addition	+	$f + 7$	`f + 7`
Subtraction	–	$p - c$	`p - c`
Multiplication	*	bm	`b * m`
Division	/	x / y or $\frac{x}{y}$ or $x \div y$	`x / y`
Remainder	%	$r \bmod s$	`r % s`

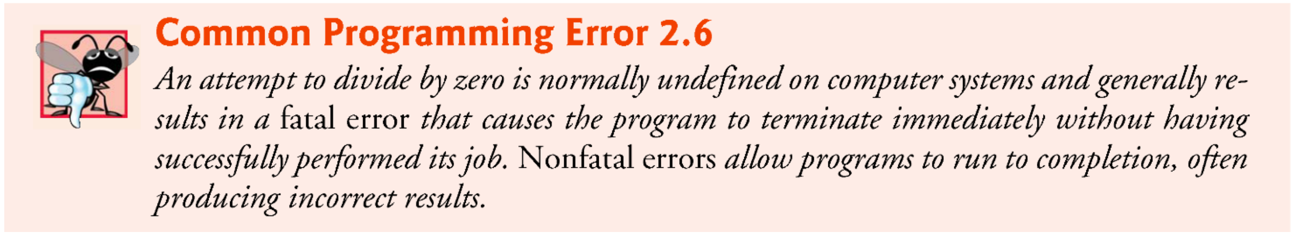
Fig. 2.9 | Arithmetic operators.

2.5 Arithmetic in C

- The asterisk (*) indicates multiplication and the percent sign (%) denotes the remainder operator
- C requires that multiplication be explicitly denoted by using the * operator as in a * b.
- The arithmetic operators are all binary operators.
- For example, the expression 3 + 7 contains the binary operator + and the operands 3 and 7.

Integer Division and the Remainder Operator

- Integer division yields an integer result
- For example, the expression 7 / 4 evaluates to 1
- C provides the remainder operator, %, which yields the remainder after integer division (used only with integer operands)
- The expression **x % y** yields the remainder after x is divided by y
- Thus, 7 % 4 yields 3 and 17 % 5 yields 2



Common Programming Error 2.6

An attempt to divide by zero is normally undefined on computer systems and generally results in a fatal error *that causes the program to terminate immediately without having successfully performed its job.* Nonfatal errors *allow programs to run to completion, often producing incorrect results.*

2.5 Arithmetic in C (Cont.)

Arithmetic Expressions in Straight-Line Form

- Arithmetic expressions in C must be written in straight-line form to facilitate entering programs into the computer.
- Thus, expressions such as “`a` divided by `b`” must be written as **`a/b`** so that all operators and operands appear in a straight line.
- The algebraic notation

$$\frac{a}{b}$$

is generally not acceptable to compilers.

Parentheses for Grouping Subexpressions

- Parentheses are used in C expressions in the same manner as in algebraic expressions.
- For example, to multiply `a` times the quantity `b + c` we write `a * ( b + c )`.

2.5 Arithmetic in C (Cont.)

Rules of Operator Precedence

- C applies the operators in arithmetic expressions in a precise sequence determined by the following rules of operator precedence, which are generally the same as those in algebra:
  - Operators in expressions contained within pairs of parentheses are evaluated first. Parentheses are said to be at the "highest level of precedence."
  - In cases of nested, or embedded, parentheses, such as

```
( ( a + b ) + c )
```

  the operators in the innermost pair of parentheses are applied first.

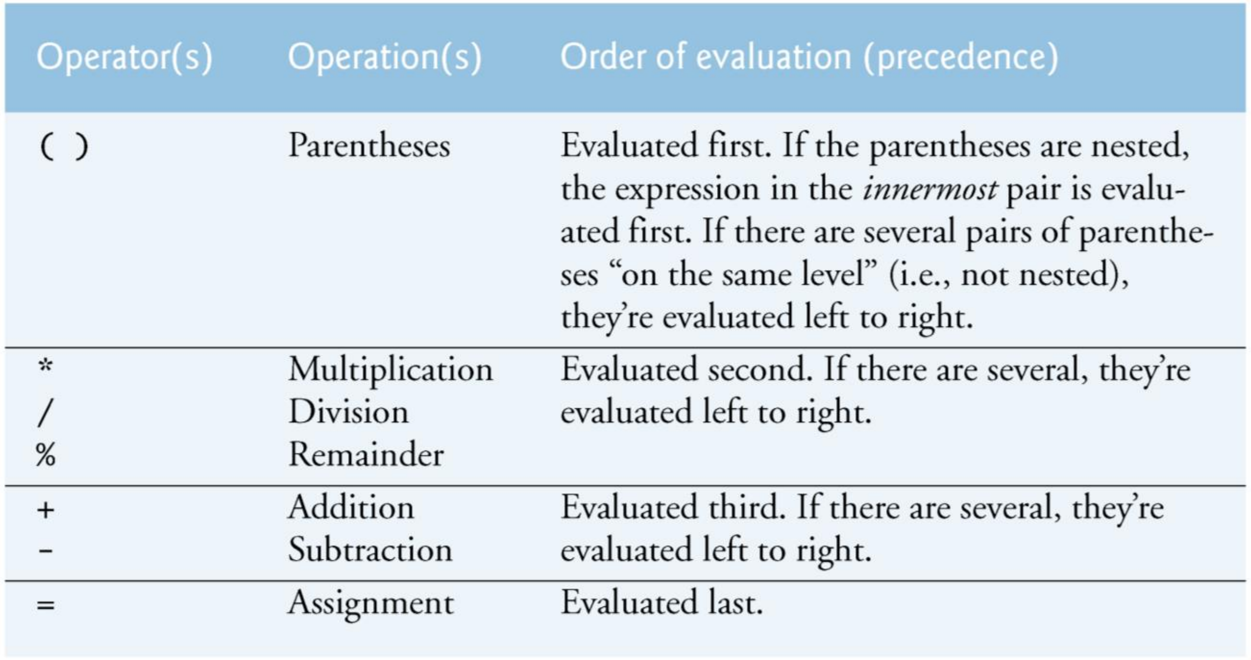
- As in algebra, it's acceptable to place unnecessary parentheses in an expression to make the expression clearer. These are called redundant parentheses.

2.5 Arithmetic in C (Cont.)

- **Multiplication**, **division** and **remainder** operations are applied next.
- If an expression contains several multiplication, division and remainder operations, evaluation proceeds from left to right.
- Multiplication, division and remainder are said to be on the same level of precedence.
- **Addition** and **subtraction** operations are evaluated next.
- If an expression contains several addition and subtraction operations, evaluation proceeds from left to right.
- Addition and subtraction also have the same level of precedence, which is lower than the precedence of the multiplication, division and remainder operations.
- The assignment operator (=) is evaluated last.

2.5 Arithmetic in C (Cont.)

- The rules of **operator precedence** specify the order C uses to evaluate expressions. When we say evaluation proceeds from left to right, we're referring to the associativity of the operators.
- We'll see that some operators associate from right to left.
- Figure 2.10 summarizes these rules of **operator precedence** for the operators we've seen so far.

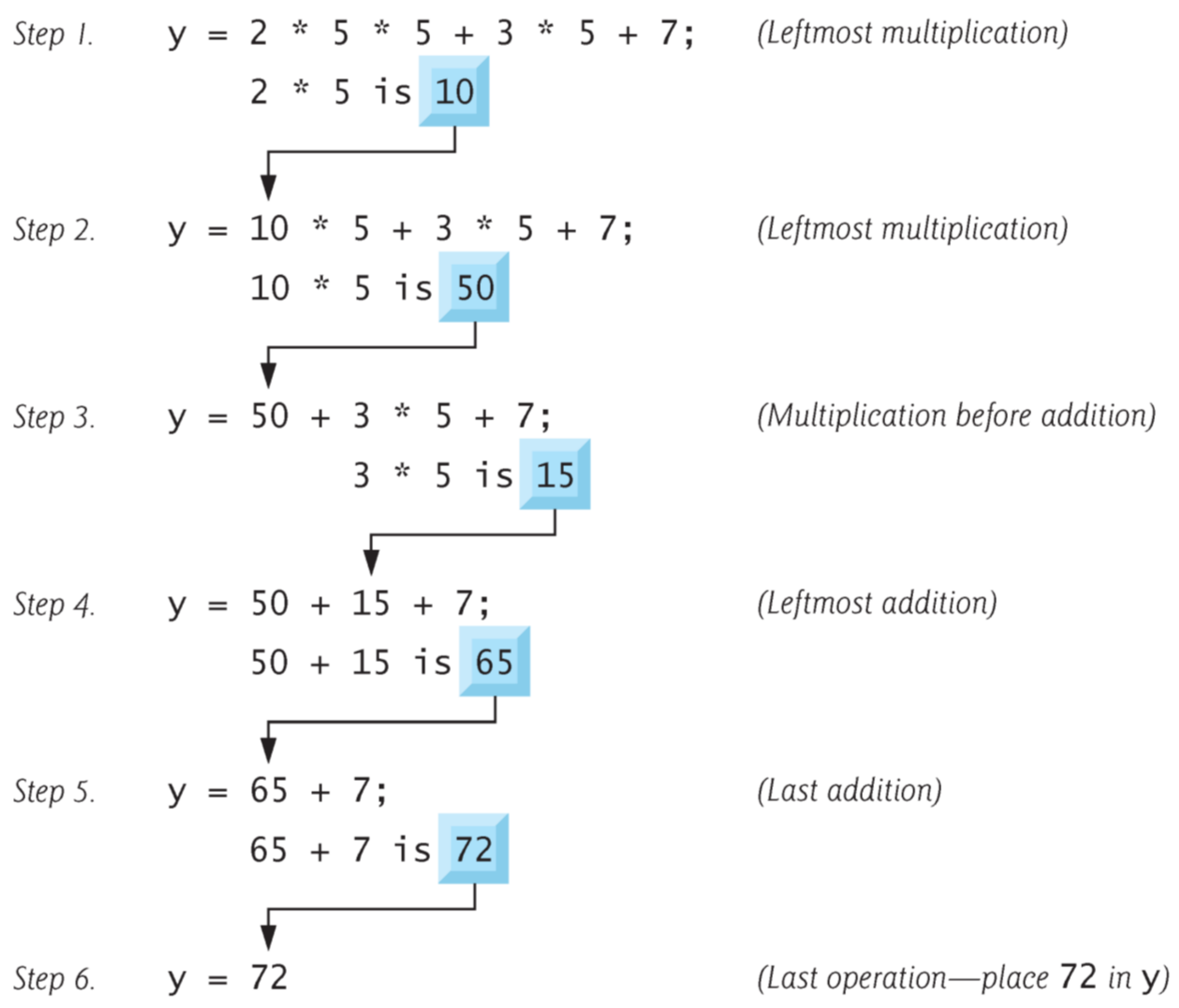


Operator(s)	Operation(s)	Order of evaluation (precedence)
( )	Parentheses	Evaluated first. If the parentheses are nested, the expression in the *innermost* pair is evaluated first. If there are several pairs of parentheses "on the same level" (i.e., not nested), they're evaluated left to right.
* / %	Multiplication Division Remainder	Evaluated second. If there are several, they're evaluated left to right.
+ -	Addition Subtraction	Evaluated third. If there are several, they're evaluated left to right.
=	Assignment	Evaluated last.

Fig. 2.10 | Precedence of arithmetic operators.

2.5 Arithmetic in C (Cont.)

- Figure 2.11 illustrates the order in which the operators are applied.



Step 1. y = 2 * 5 * 5 + 3 * 5 + 7; (Leftmost multiplication)
2 * 5 is 10
Step 2. y = 10 * 5 + 3 * 5 + 7; (Leftmost multiplication)
10 * 5 is 50
Step 3. y = 50 + 3 * 5 + 7; (Multiplication before addition)
3 * 5 is 15
Step 4. y = 50 + 15 + 7; (Leftmost addition)
50 + 15 is 65
Step 5. y = 65 + 7; (Last addition)
65 + 7 is 72
Step 6. y = 72 (Last operation—place 72 in y)

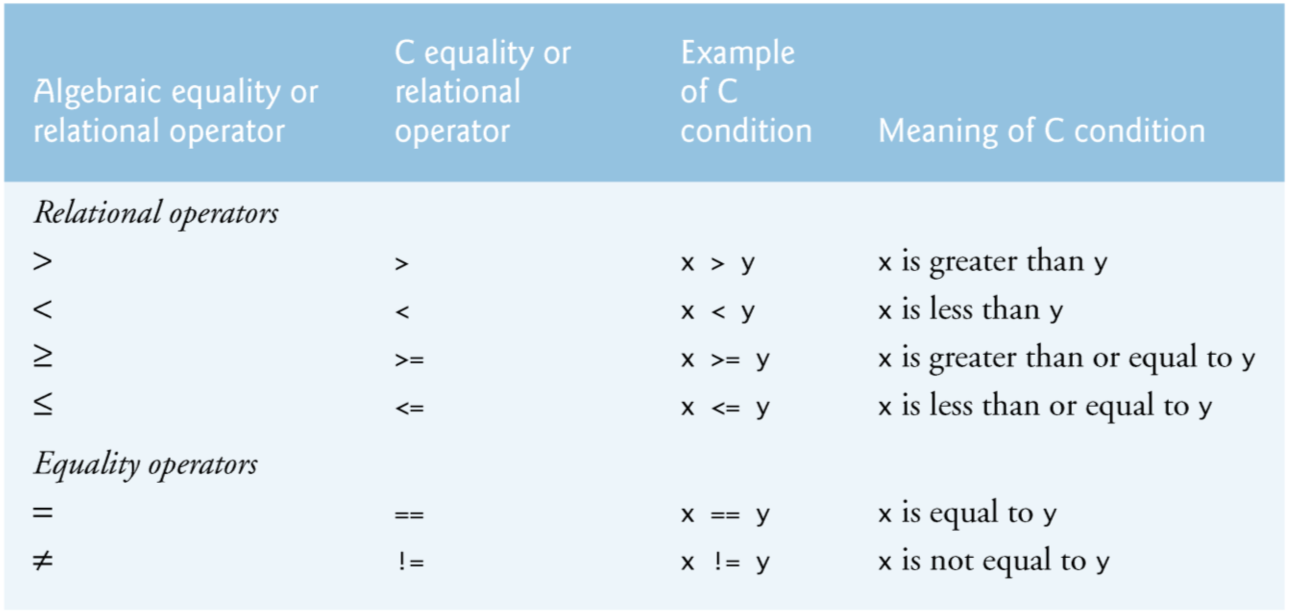
Fig. 2.11 | Order in which a second-degree polynomial is evaluated.

2.6 Decision Making: Equality and Relational Operators

- Executable C statements either perform actions (such as calculations or input or output of data) or make decisions.
- We might make a decision in a program, for example, to determine whether a person's grade on an exam is greater than or equal to 60 and whether the program should print the message "Congratulations! You passed."
- This section introduces a simple version of C's if statement that allows a program to make a decision based on the truth or falsity of a statement of fact called a condition.

2.6 Decision Making: Equality and Relational Operators

- If the condition is true the statement in the body of the **`if`** statement is executed.
- If the condition is false the body statement is not executed.
- Whether the body statement is executed or not, after the **`if`** statement completes, execution proceeds with the next statement after the **`if`** statement.
- Conditions in **`if`** statements are formed by using the equality operators and relational operators summarized in Fig. 2.12.

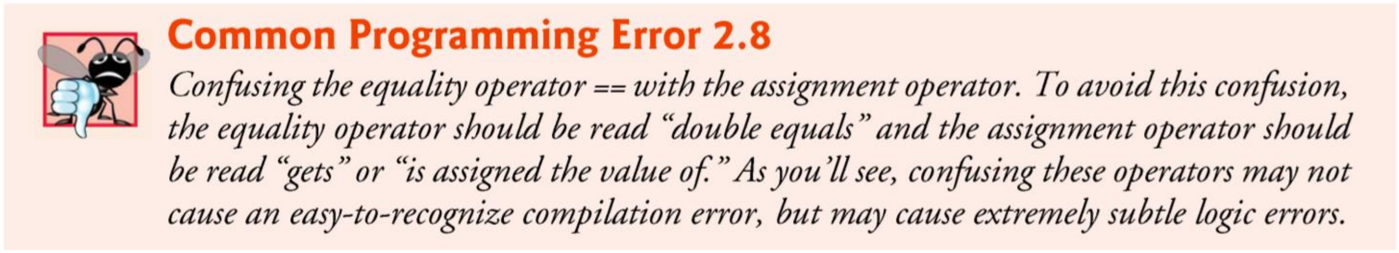


Algebraic equality or relational operator	C equality or relational operator	Example of C condition	Meaning of C condition
Relational operators			
>	`>`	`x > y`	x is greater than y
<	`<`	`x < y`	x is less than y
≥	`>=`	`x >= y`	x is greater than or equal to y
≤	`<=`	`x <= y`	x is less than or equal to y
Equality operators			
=	`==`	`x == y`	x is equal to y
≠	`!=`	`x != y`	x is not equal to y

Fig. 2.12 | Equality and relational operators.

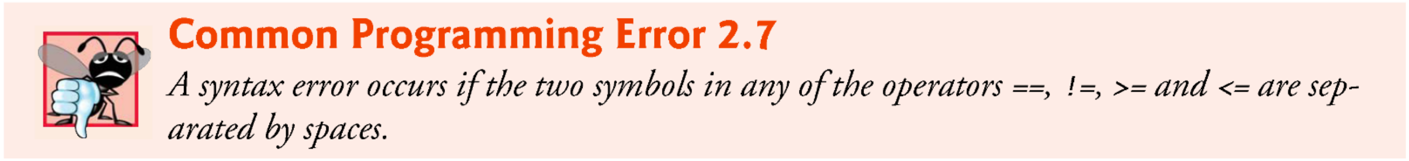
2.6 Decision Making: Equality and Relational Operators

- The **relational operators** all have the same level of precedence and they associate left to right.
- The **equality operators** have a lower level of precedence than the relational operators and they also associate left to right.
- In C, a condition may actually be *any expression that generates a* ***zero (false)*** *or* ***nonzero (true)*** *value*.



Common Programming Error 2.8

Confusing the equality operator == with the assignment operator. To avoid this confusion, the equality operator should be read "double equals" and the assignment operator should be read "gets" or "is assigned the value of." As you'll see, confusing these operators may not cause an easy-to-recognize compilation error, but may cause extremely subtle logic errors.



Common Programming Error 2.7

A syntax error occurs if the two symbols in any of the operators ==, != , >= and <= are separated by spaces.

2.6 Decision Making: Equality and Relational Operators

- Figure 2.13 uses six `if` statements to compare two numbers entered by the user.
- If the condition in any of these `if` statements is true, the `printf` statement associated with that `if` executes.

```c
// Fig. 2.13: fig02_13.c
// Using if statements, relational
// operators, and equality operators.
#include <stdio.h>

// function main begins program execution
int main( void )
{
   printf( "Enter two integers, and I will tell you\n" );
   printf( "the relationships they satisfy: " );

   int num1; // first number to be read from user
   int num2; // second number to be read from user

   scanf( "%d %d", &num1, &num2 ); // read two integers

   if ( num1 == num2 ) {
      printf( "%d is equal to %d\n", num1, num2 );
   } // end if

```

Fig. 2.13 | Using `if` statements, relational operators, and equality operators. (Part 1 of 3.)

```c
    if ( num1 != num2 ) {
       printf( "%d is not equal to %d\n", num1, num2 );
    } // end if

    if ( num1 < num2 ) {
       printf( "%d is less than %d\n", num1, num2 );
    } // end if

    if ( num1 > num2 ) {
       printf( "%d is greater than %d\n", num1, num2 );
    } // end if

    if ( num1 <= num2 ) {
       printf( "%d is less than or equal to %d\n", num1, num2 );
    } // end if

    if ( num1 >= num2 ) {
       printf( "%d is greater than or equal to %d\n", num1, num2 );
    } // end if
 } // end function main
```

Fig. 2.13 | Using if statements, relational

```
Enter two integers, and I will tell you
the relationships they satisfy: 3 7
3 is not equal to 7
3 is less than 7
3 is less than or equal to 7
```

```
Enter two integers, and I will tell you
the relationships they satisfy: 22 12
22 is not equal to 12
22 is greater than 12
22 is greater than or equal to 12
```

```
Enter two integers, and I will tell you
the relationships they satisfy: 7 7
7 is equal to 7
7 is less than or equal to 7
7 is greater than or equal to 7
```

Fig. 2.13 | Using if statements, relational operators, and equality operators. (Part 3 of 3.)

2.6 Decision Making: Equality and Relational Operators

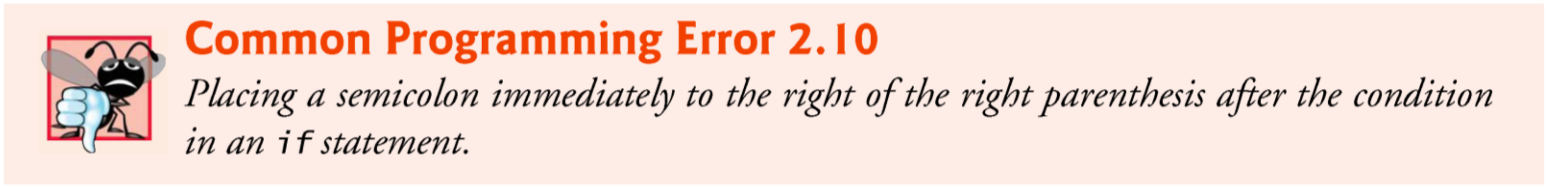
Comparing Numbers

- The if statement

```
if ( num1 == num2 ) {
    printf( "%d is equal to %d\n", num1, num2 );
}
```

  compares the values of variables `num1` and `num2` to test for equality.
- If the conditions are `true` in one or more of the `if` statements, the corresponding body statement displays an appropriate line of text.

- A left brace, **{**, begins the body of each **`if`** statement
- A corresponding right brace, **}**, ends each **`if`** statement's body
- Any number of statements can be placed in the body of an `if` statement.

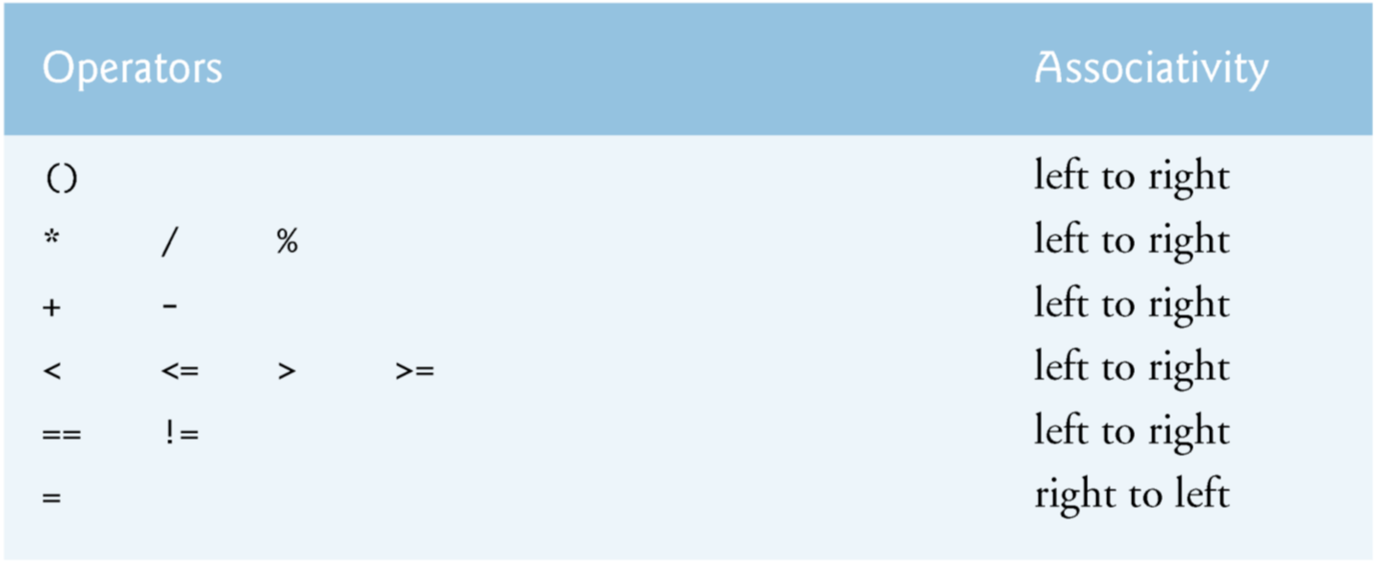


Common Programming Error 2.10

Placing a semicolon immediately to the right of the right parenthesis after the condition in an `if` statement.

2.6 Decision Making: Equality and Relational Operators

- Figure 2.14 lists from highest to lowest the precedence of the operators introduced in this chapter.
- Operators are shown top to bottom in decreasing order of precedence.
- All these operators, with the exception of the assignment operator =, associate from left to right.
- The assignment operator (=) associates from right to left.

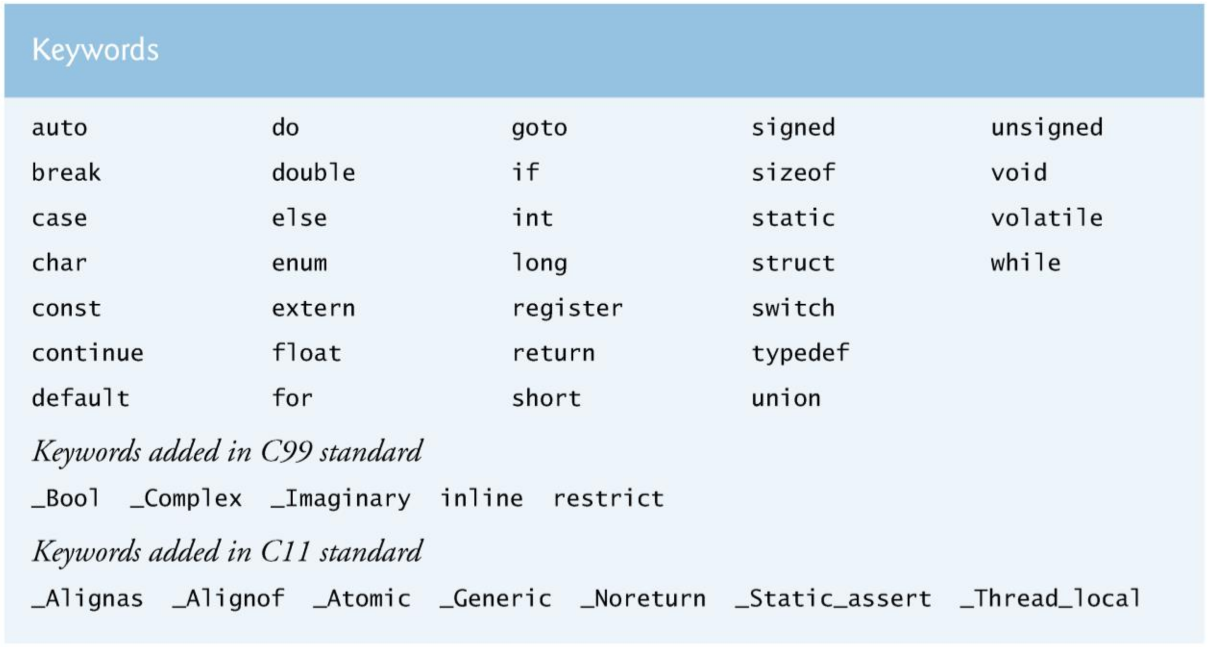


Operators				Associativity
`()`				left to right
`*`	`/`	`%`		left to right
`+`	`-`			left to right
`<`	`<=`	`>`	`>=`	left to right
`==`	`!=`			left to right
`=`				right to left

Fig. 2.14 | Precedence and associativity of the operators discussed so far.

2.6 Decision Making: Equality and Relational Operators

- Some of the words we've used in the C programs in this chapter—in particular `int` and `if`—are keywords or reserved words of the language.
- Figure 2.15 contains the C keywords.
- These words have special meaning to the C compiler, so you must be careful <u>not to use these as identifiers such as variable names</u>.



Keywords

`auto`	`do`	`goto`	`signed`	`unsigned`
`break`	`double`	`if`	`sizeof`	`void`
`case`	`else`	`int`	`static`	`volatile`
`char`	`enum`	`long`	`struct`	`while`
`const`	`extern`	`register`	`switch`	
`continue`	`float`	`return`	`typedef`	
`default`	`for`	`short`	`union`	

Keywords added in C99 standard

`_Bool` `_Complex` `_Imaginary` `inline` `restrict`

Keywords added in C11 standard

`_Alignas` `_Alignof` `_Atomic` `_Generic` `_Noreturn` `_Static_assert` `_Thread_local`

Fig. 2.15 | C's keywords.

2.7 Secure C Programming

- CERT C Secure Coding Standard (Guidelines to avoid attacks)

1. Avoid Single-Argument `printf`s
   - If you need to display a string that <u>terminates with a newline</u>, use the **`puts`** function, which displays its string argument followed by a newline character
   - For example
     - `printf( "Welcome to C!\n" );`
   - should be written as:
     - `puts( "Welcome to C!" );`
   - We did not include `\n` in the preceding string because puts adds it automatically.

2. If you need to display a string without a terminating newline character, use printf <u>with two arguments</u>.
   - For example
     - `printf( "Welcome " );`
   - should be written as:
     - `printf( "%s", "Welcome " );`

- These changes are responsible coding practices that eliminate certain security C vulnerabilities as we get deeper into C