Q: Is it legal for a function f1 to call a function f2, which then calls f1?

A: Yes. This is just an indirect form of recursion in which one call of f1 leads to another. (But make sure that either f1 or f2 eventually terminates!)

Exercises

Section 9.1

1. The following function, which computes the area of a triangle, contains two errors. Locate the errors and show how to fix them. (*Hint:* There are no errors in the formula.)

```
double triangle_area(double base, height)
double product;
{
  product = base * height;
  return product / 2;
}
```

Ⓦ 2. Write a function check(x, y, n) that returns 1 if both x and y fall between 0 and n – 1, inclusive. The function should return 0 otherwise. Assume that x, y, and n are all of type int.

3. Write a function gcd(m, n) that calculates the greatest common divisor of the integers m and n. (Programming Project 2 in Chapter 6 describes Euclid's algorithm for computing the GCD.)

Ⓦ 4. Write a function day_of_year(month, day, year) that returns the day of the year (an integer between 1 and 366) specified by the three arguments.

5. Write a function num_digits(n) that returns the number of digits in n (a positive integer). *Hint:* To determine the number of digits in a number *n*, divide it by 10 repeatedly. When *n* reaches 0, the number of divisions indicates how many digits *n* originally had.

Ⓦ 6. Write a function digit(n, k) that returns the kth digit (from the right) in n (a positive integer). For example, digit(829, 1) returns 9, digit(829, 2) returns 2, and digit(829, 3) returns 8. If k is greater than the number of digits in n, have the function return 0.

7. Suppose that the function f has the following definition:

```
int f(int a, int b) { … }
```

Which of the following statements are legal? (Assume that i has type int and x has type double.)

```
(a) i = f(83, 12);
(b) x = f(83, 12);
(c) i = f(3.15, 9.28);
(d) x = f(3.15, 9.28);
(e) f(83, 12);
```

Section 9.2

Ⓦ 8. Which of the following would be valid prototypes for a function that returns nothing and has one double parameter?

```
(a) void f(double x);
```

(b) `void f(double);`
(c) `void f(x);`
(d) `f(double x);`

Section 9.3

*9. What will be the output of the following program?

```
#include <stdio.h>

void swap(int a, int b);

int main(void)
{
  int i = 1, j = 2;

  swap(i, j);
  printf("i = %d, j = %d\n", i, j);
  return 0;
}

void swap(int a, int b)
{
  int temp = a;
  a = b;
  b = temp;
}
```

Ⓦ 10. Write functions that return the following values. (Assume that a and n are parameters, where a is an array of int values and n is the length of the array.)

(a) The largest element in a.
(b) The average of all elements in a.
(c) The number of positive elements in a.

11. Write the following function:

```
float compute_GPA(char grades[], int n);
```

The grades array will contain letter grades (A, B, C, D, or F, either upper-case or lower-case); n is the length of the array. The function should return the average of the grades (assume that A = 4, B = 3, C = 2, D = 1, and F = 0).

12. Write the following function:

```
double inner_product(double a[], double b[], int n);
```

The function should return a[0] * b[0] + a[1] * b[1] + ... + a[n-1] * b[n-1].

13. Write the following function, which evaluates a chess position:

```
int evaluate_position(char board[8][8]);
```

board represents a configuration of pieces on a chessboard, where the letters K, Q, R, B, N, P represent White pieces, and the letters k, q, r, b, n, and p represent Black pieces. evaluate_position should sum the values of the White pieces (Q = 9, R = 5, B = 3, N = 3, P = 1). It should also sum the values of the Black pieces (done in a similar way). The function will return the difference between the two numbers. This value will be positive if White has an advantage in material and negative if Black has an advantage.

Section 9.4

14. The following function is supposed to return true if any element of the array a has the value 0 and false if all elements are nonzero. Sadly, it contains an error. Find the error and show how to fix it:

```
bool has_zero(int a[], int n)
{
  int i;

  for (i = 0; i < n; i++)
    if (a[i] == 0)
      return true;
    else
      return false;
}
```

Ⓦ 15. The following (rather confusing) function finds the median of three numbers. Rewrite the function so that it has just one `return` statement.

```
double median(double x, double y, double z)
{
  if (x <= y)
    if (y <= z) return y;
    else if (x <= z) return z;
    else return x;
  if (z <= y) return y;
  if (x <= z) return x;
  return z;
}
```

Section 9.6

16. Condense the `fact` function in the same way we condensed `power`.

Ⓦ 17. Rewrite the `fact` function so that it's no longer recursive.

18. Write a recursive version of the `gcd` function (see Exercise 3). Here's the strategy to use for computing `gcd(m, n)`: If `n` is 0, return `m`. Otherwise, call `gcd` recursively, passing `n` as the first argument and `m % n` as the second.

Ⓦ*19. Consider the following "mystery" function:

```
void pb(int n)
{
  if (n != 0) {
    pb(n / 2);
    putchar('0' + n % 2);
  }
}
```

Trace the execution of the function by hand. Then write a program that calls the function, passing it a number entered by the user. What does the function do?

Programming Projects

1. Write a program that asks the user to enter a series of integers (which it stores in an array), then sorts the integers by calling the function `selection_sort`. When given an array with *n* elements, `selection_sort` must do the following:

1. Search the array to find the largest element, then move it to the last position in the array.

2. Call itself recursively to sort the first *n* – 1 elements of the array.