W 2. The following program fragments illustrate the logical operators. Show the output produced by each, assuming that `i`, `j`, and `k` are `int` variables.

(a)
```
i = 10; j = 5;
printf("%d", !i < j);
```
(b)
```
i = 2; j = 1;
printf("%d", !!i + !j);
```
(c)
```
i = 5; j = 0; k = -5;
printf("%d", i && j || k);
```
(d)
```
i = 1; j = 2; k = 3;
printf("%d", i < j || k);
```

*3. The following program fragments illustrate the short-circuit behavior of logical expressions. Show the output produced by each, assuming that `i`, `j`, and `k` are `int` variables.

(a)
```
i = 3; j = 4; k = 5;
printf("%d ", i < j || ++j < k);
printf("%d %d %d", i, j, k);
```
(b)
```
i = 7; j = 8; k = 9;
printf("%d ", i - 7 && j++ < k);
printf("%d %d %d", i, j, k);
```
(c)
```
i = 7; j = 8; k = 9;
printf("%d ", (i = j) || (j = k));
printf("%d %d %d", i, j, k);
```
(d)
```
i = 1; j = 1; k = 1;
printf("%d ", ++i || ++j && ++k);
printf("%d %d %d", i, j, k);
```

W *4. Write a single expression whose value is either –1, 0, or +1, depending on whether `i` is less than, equal to, or greater than `j`, respectively.

Section 5.2

*5. Is the following `if` statement legal?

```
if (n >= 1 <= 10)
  printf("n is between 1 and 10\n");
```

If so, what does it do when `n` is equal to 0?

W *6. Is the following `if` statement legal?

```
if (n == 1-10)
  printf("n is between 1 and 10\n");
```

If so, what does it do when `n` is equal to 5?

7. What does the following statement print if `i` has the value 17? What does it print if `i` has the value –17?

```
printf("%d\n", i >= 0 ? i : -i);
```

8. The following `if` statement is unnecessarily complicated. Simplify it as much as possible. (*Hint:* The entire statement can be replaced by a single assignment.)

```
if (age >= 13)
  if (age <= 19)
    teenager = true;
  else
    teenager = false;
else if (age < 13)
  teenager = false;
```

9. Are the following `if` statements equivalent? If not, why not?

```
if (score >= 90)
  printf("A");
else if (score >= 80)
  printf("B");
else if (score >= 70)
  printf("C");
else if (score >= 60)
  printf("D");
else
  printf("F");
```

```
if (score < 60)
  printf("F");
else if (score < 70)
  printf("D");
else if (score < 80)
  printf("C");
else if (score < 90)
  printf("B");
else
  printf("A");
```

Section 5.3

W*10. What output does the following program fragment produce? (Assume that `i` is an integer variable.)

```
i = 1;
switch (i % 3) {
  case 0: printf("zero");
  case 1: printf("one");
  case 2: printf("two");
}
```

11. The following table shows telephone area codes in the state of Georgia along with the largest city in each area:

Area code	*Major city*
229	Albany
404	Atlanta
470	Atlanta
478	Macon
678	Atlanta
706	Columbus
762	Columbus
770	Atlanta
912	Savannah

Write a `switch` statement whose controlling expression is the variable `area_code`. If the value of `area_code` is in the table, the `switch` statement will print the corresponding city name. Otherwise, the `switch` statement will display the message `"Area code not recognized"`. Use the techniques discussed in Section 5.3 to make the `switch` statement as simple as possible.

Programming Projects

1. Write a program that calculates how many digits a number contains:

```
Enter a number: 374
The number 374 has 3 digits
```

You may assume that the number has no more than four digits. *Hint:* Use `if` statements to test the number. For example, if the number is between 0 and 9, it has one digit. If the number is between 10 and 99, it has two digits.