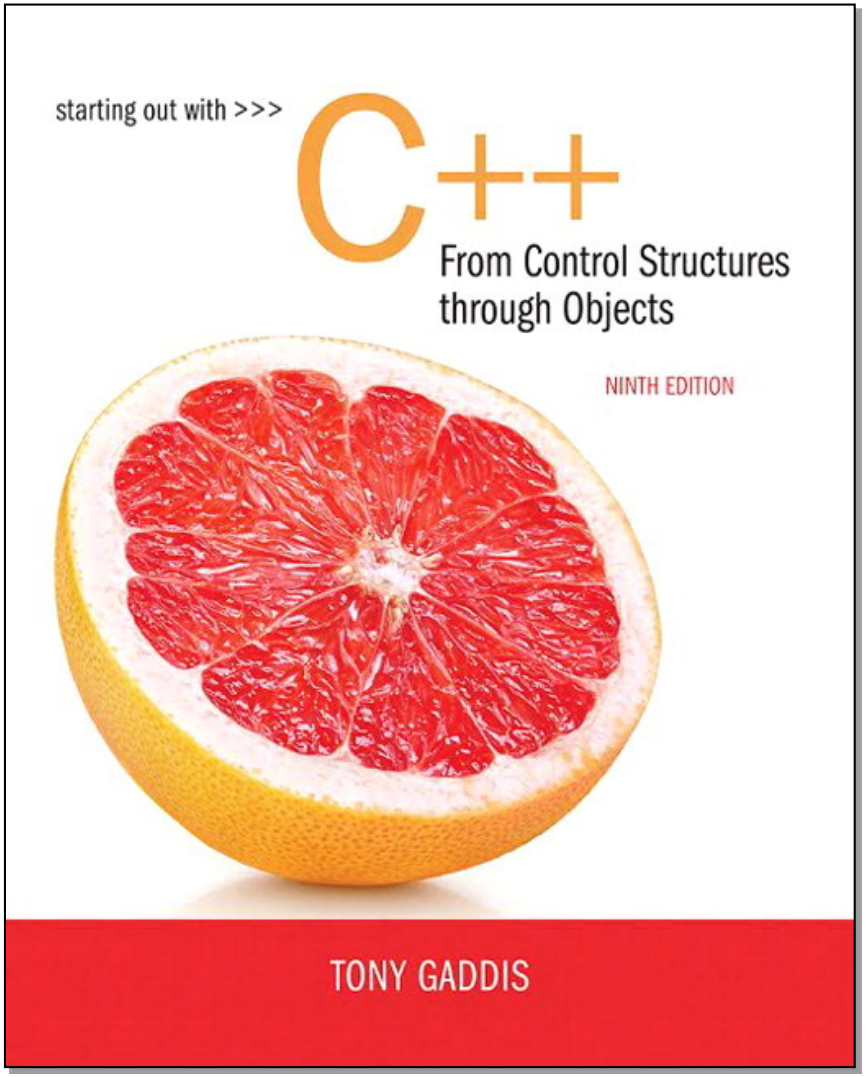
STARTING OUT WITH C++

9th Edition



الفصل الخامس
Chapter 5

الحلقات والملفات
Loops and Files

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مفهوم الزيادة والإنقاص
Increment and Decrement Concept

- تقوم كلا من العبارتين:

```
num = num + 1;
num += 1;
```

- بزيادة المتغير num بمقدار واحد.

كما تقوم كلا من العبارتين:

```
num = num − 1;
num −= 1;
```

بإنقاص المتغير num بمقدار واحد.

- تقدم لغة C++ مجموعة عوامل أحادية بسيطة صممت خصيصا لزيادة المتغيرات أو إنقاصها.

عوامل (مؤثرات) الزيادة والإنقاص
The Increment and Decrement Operators

- عامل الزيادة هو ++ وهو يضيف قيمة واحد إلى متغير ما.
- الكتابة `val++;` تكافئ تماما الكتابة `val = val + 1;`
- يمكن لعامل الزيادة أن يستخدم قبل (prefix) أو بعد (postfix) المتغير:

```
++val;      val++;
```

The Increment and Decrement Operators

- عامل الإنقاص هو -- وهو ينقص قيمة واحد من متغير ما.

- الكتابة `val--;` هي نفسها (تكافئ) `val = val - 1;`

- يمكن لعامل الإنقاص أن يستخدم قبل (prefix) أو بعد (postfix) المتغير:

```
--val;     val--;
```

```
int main()
 {
 int num = 4; // num starts out with 4.
 cout << num << endl;
 cout << ++num << endl;
 cout << num<< endl;
 return 0;
 }
```

Increment and Decrement Operators

Program 5-1

```
1  // This program demonstrates the ++ and -- operators.
2  #include <iostream>
3  using namespace std;
4
5  int main()
6  {
7     int num = 4;   // num starts out with 4.
8
9     // Display the value in num.
10    cout << "The variable num is " << num << endl;
11    cout << "I will now increment num.\n\n";
12
13    // Use postfix ++ to increment num.
14    num++;
15    cout << "Now the variable num is " << num << endl;
16    cout << "I will increment num again.\n\n";
17
18    // Use prefix ++ to increment num.
19    ++num;
20    cout << "Now the variable num is " << num << endl;
21    cout << "I will now decrement num.\n\n";
22
23    // Use postfix -- to decrement num.
24    num--;
25    cout << "Now the variable num is " << num << endl;
26    cout << "I will decrement num again.\n\n";
27
```

Continued…

Increment and Decrement Operators

Program 5-1 *(continued)*

```
28      // Use prefix -- to increment num.
29      --num;
30      cout << "Now the variable num is " << num << endl;
31      return 0;
32  }
```

Program Output

```
The variable num is 4
I will now increment num.

Now the variable num is 5
I will increment num again.

Now the variable num is 6
I will now decrement num.

Now the variable num is 5
I will decrement num again.

Now the variable num is 4
```

بادئة أو لاحقة (قبل مقابل بعد)
Prefix vs. Postfix

- يمكن استخدام المعاملين ++ و -- في عبارات وتعابير معقدة.
- في الصيغة (++val, --val) يتم زيادة العامل أو إنقاصه أولا ومن ثم يرجع قيمة المتغير.
- في الصيغة (val++, val--) يرجع العامل قيمة المتغير ومن ثم تتم زيادة العامل أو إنقاصه.

Prefix vs. Postfix - Examples

```
int num, val = 12;
cout << val++; // displays 12,
                // val is now 13;
cout << ++val; // sets val to 14,
                // then displays it
num = --val;   // sets val to 13,
                // stores 13 in num
num = val--;   // stores 13 in num,
                // sets val to 12
```

ملاحظات حول الزيادة والإنقاص
Notes on Increment and Decrement

- يمكن استخدامهما في التعابير:

```
result = num1++ + --num2;
```

- يجب تطبيقهما على شيء له موقع في الذاكرة. لا يمكن كتابة:

```
result = (num1 + num2)++;
```

- يمكن استخدامهما في التعابير العلائقية (النسبية):

```
if (++num > limit)
```

pre- and post-operations will cause different comparisons

5.2

مقدمة إلى الحلقات: حلقة while

Introduction to Loops: The `while` Loop

Introduction to Loops: The `while` Loop

- **الحلقة:** هي عبارة (بنية) تحكم تسبب تكرار تنفيذ عبارة ما أو عبارات.
- الصيغة العامة لحلقة `while` هي:

```
while (expression)
        statement;
```

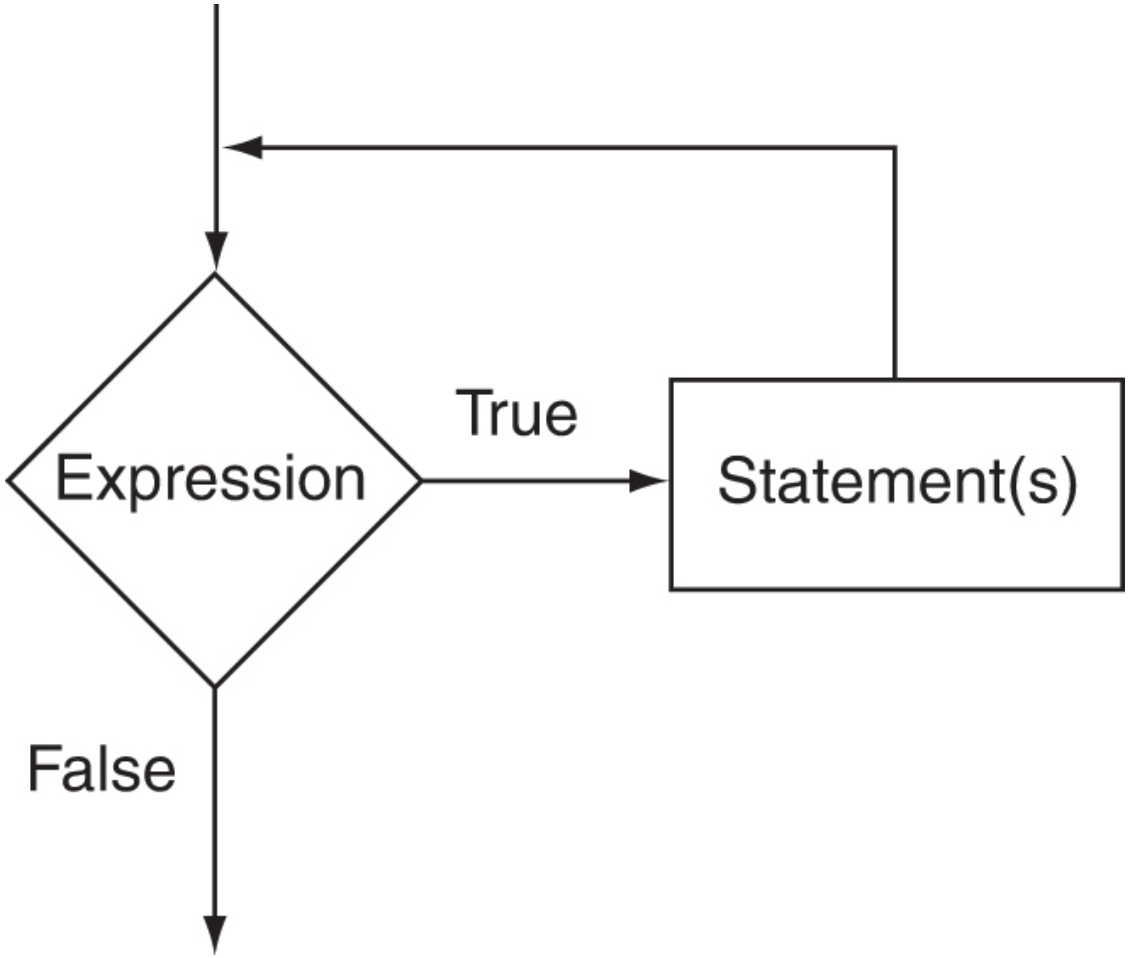
- يمكن لـ *`statement;`* أن تكون مجموعة (كتلة) من التعليمات محاطة بـ `{ }`.

مبدأ عمل حلقة while
The `while` Loop – How It Works

```
while (expression)
      statement;
```

- *`expression`* is evaluated
  - if `true`, then *`statement`* is executed, and *`expression`* is evaluated again
  - if `false`, then the loop is finished and program statements following *`statement`* execute

منطق حلقة while (مخطط While التدفقي)
The Logic of a while Loop



The `while` loop in Program 5-3

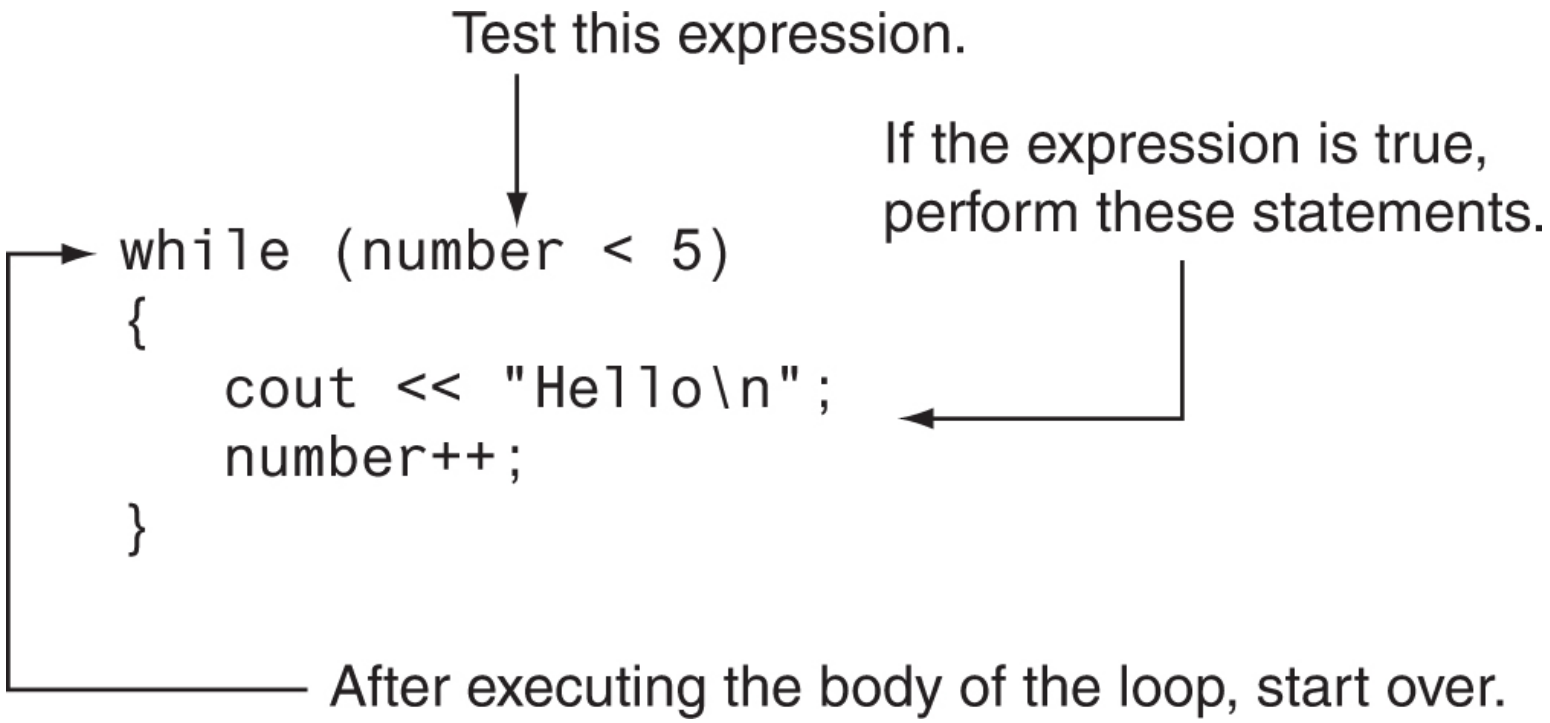
Program 5-3

```
1  // This program demonstrates a simple while loop.
2  #include <iostream>
3  using namespace std;
4
5  int main()
6  {
7     int number = 1;
8
9     while (number <= 5)
10    {
11       cout << "Hello\n";
12       number++;
13    }
14    cout << "That's all!\n";
15    return 0;
16 }
```

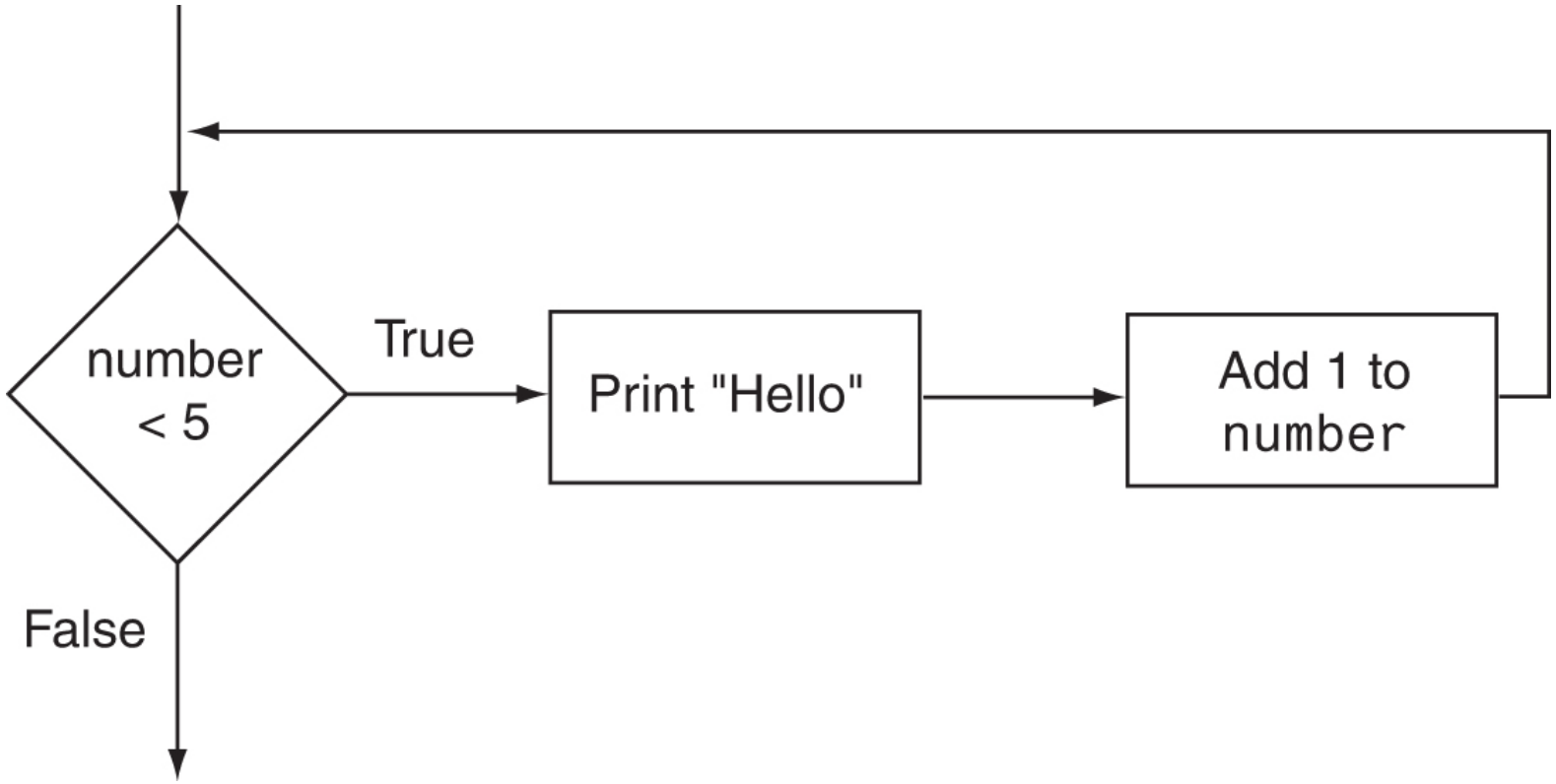
Program Output

```
Hello
Hello
Hello
Hello
Hello
That's all!
```

How the `while` Loop in Program 5-3 Lines 9 through 13 Works



مخطط حلقة While في البرنامج السابق
Flowchart of the `while` Loop in Program 5-3



حلقة while هي حلقة اختبار أولي
The `while` Loop is a Pretest Loop

يتم تقييم (حساب) التعبير *expression* قبل تنفيذ الحلقة. لا يتم تنفيذ العبارة التالية أبدا:

```
int number = 6;
while (number <= 5)
{
   cout << "Hello\n";
   number++;
}
```

مراقبة الحلقات غير المنتهية
Watch Out for Infinite Loops

- يجب أن تحتوي الحلقة على شيفرة تجعل *expression* خاطئا `false`.
- وإلا فليس هناك طريقة لتوقفها والخروج منها.
- تدعى مثل هذه الحلقة بالحلقة غير المنتهية لأنها ستتكرر عدد غير منته من المرات.

مثال عن الحلقة غير المنتهية
Example of an Infinite Loop

```
int number = 1;
while (number <= 5)
{
   cout << "Hello\n";
}
```

5.4

العدادات

Counters

العدادات
Counters

- العداد: هو متغير يزداد أو ينقص في كل مرة تتكرر فيها الحلقة.
- يمكن استخدامه لتنفيذ التحكم بالحلقة (يعرف أيضا بمتغير التحكم بالحلقة)
- يجب تهيئته بقيمة ما قبل دخول الحلقة.

A Counter Variable Controls the Loop in Program 5-6

Program 5-6

```
1  // This program displays a list of numbers and
2  // their squares.
3  #include <iostream>
4  using namespace std;
5
6  int main()
7  {
8     const int MIN_NUMBER = 1,   // Starting number to square
9               MAX_NUMBER = 10;  // Maximum number to square
10
11    int num = MIN_NUMBER;       // Counter
12
13    cout << "Number Number Squared\n";
14    cout << "-------------------------\n";
```

Continued…

A Counter Variable Controls the Loop in Program 5-6

```
15     while (num <= MAX_NUMBER)
16     {
17        cout << num << "\t\t" << (num * num) << endl;
18        num++; //Increment the counter.
19     }
20     return 0;
21  }
```

Program Output

```
Number Number Squared
---------------------
1            1
2            4
3            9
4            16
5            25
6            36
7            49
8            64
9            81
10           100
```

5.5

do-while حلقة

The `do-while` Loop

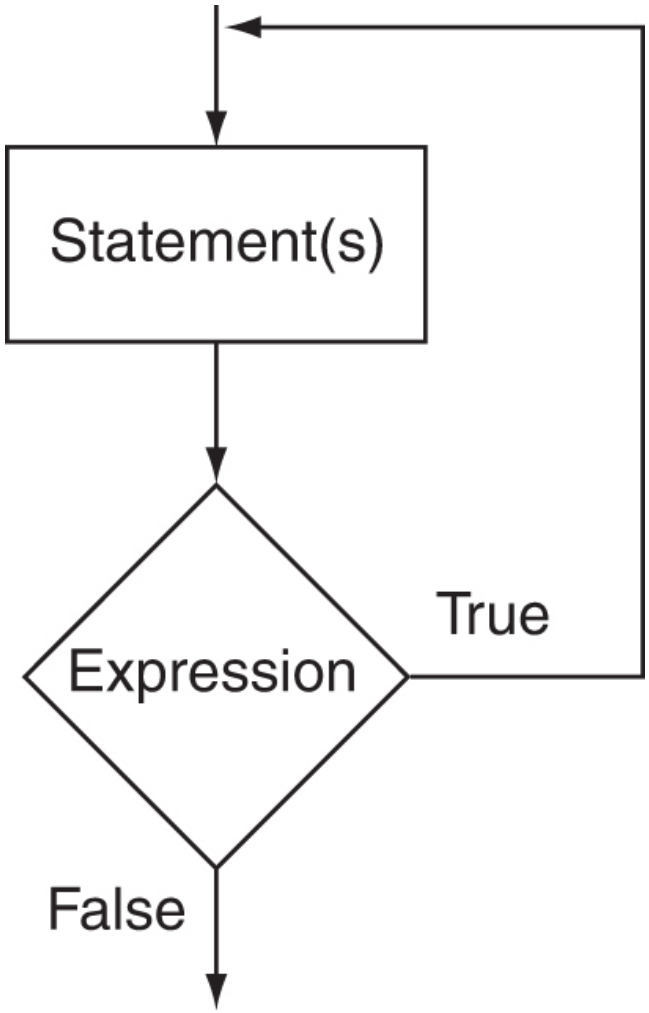
The `do-while` Loop

- تعتبر حلقة `do-while` حلقة اختبار لاحق `post test`
بمعنى أنها تنفذ الحلقة ومن ثم تختبر التعبير.
- صيغتها العامة:

```
do
  statement;  // or block in { }
while (expression);
```

- Note that a semicolon is required after (*expression*)

The Logic of a `do-while` Loop



An Example do-while Loop

```
int x = 1;
do
{
    cout << x << endl;
} while(x < 0);
```

مع أن عبارة الاختبار خاطئة فإن هذه الحلقة ستنفذ مرة واحدة لأن do-while حلقة اختبار لاحقة.

A `do-while` Loop in Program 5-7

Program 5-7

```
1  // This program averages 3 test scores. It repeats as
2  // many times as the user wishes.
3  #include <iostream>
4  using namespace std;
5
6  int main()
7  {
8     int score1, score2, score3; // Three scores
9     double average;             // Average score
10    char again;                 // To hold Y or N input
11
12    do
13    {
14       // Get three scores.
15       cout << "Enter 3 scores and I will average them: ";
16       cin >> score1 >> score2 >> score3;
17
18       // Calculate and display the average.
19       average = (score1 + score2 + score3) / 3.0;
20       cout << "The average is " << average << ".\n";
21
22       // Does the user want to average another set?
23       cout << "Do you want to average another set? (Y/N) ";
24       cin >> again;
25    } while (again == 'Y' || again == 'y');
26    return 0;
27 }
```

Continued…

A `do-while` Loop in Program 5-7

Program Output with Example Input Shown in Bold

```
Enter 3 scores and I will average them: 80 90 70 [Enter]
The average is 80.
Do you want to average another set? (Y/N) y [Enter]
Enter 3 scores and I will average them: 60 75 88 [Enter]
The average is 74.3333.
Do you want to average another set? (Y/N) n [Enter]
```

ملاحظات حول حلقة do-while
do-while Loop Notes

- دائما تنفذ الحلقة لمرة واحدة على الأقل.
- يستمر التنفيذ طالما بقي expression صحيحا true ويتوقف التكرار عندما يصبح التعبير خاطئا false.
- مفيدة في البرامج المقادة بالقوائم menu-driven programs لإرجاع المستخدم إلى القائمة لتنفيذ خيار آخر.

(*see* Program 5-8 *on pages* 245-246)

5.6

for حلقة

The `for` Loop

The `for` Loop

- مفيدة للحلقة المحكومة بعداد ما
- الشكل العام:

```
for(initialization; test; update)
        statement; // or block in { }
```

- ليس هناك فاصلة منقوطة بعد عبارة update أو بعد القوس الأخير)

آليات الحلقة for
for Loop - Mechanics

```
for(initialization; test; update)
        statement; // or block in { }
```

١) تنفذ عملية التهيئة *initialization*

٢) يتم تقييم تعبير الاختبار *test*

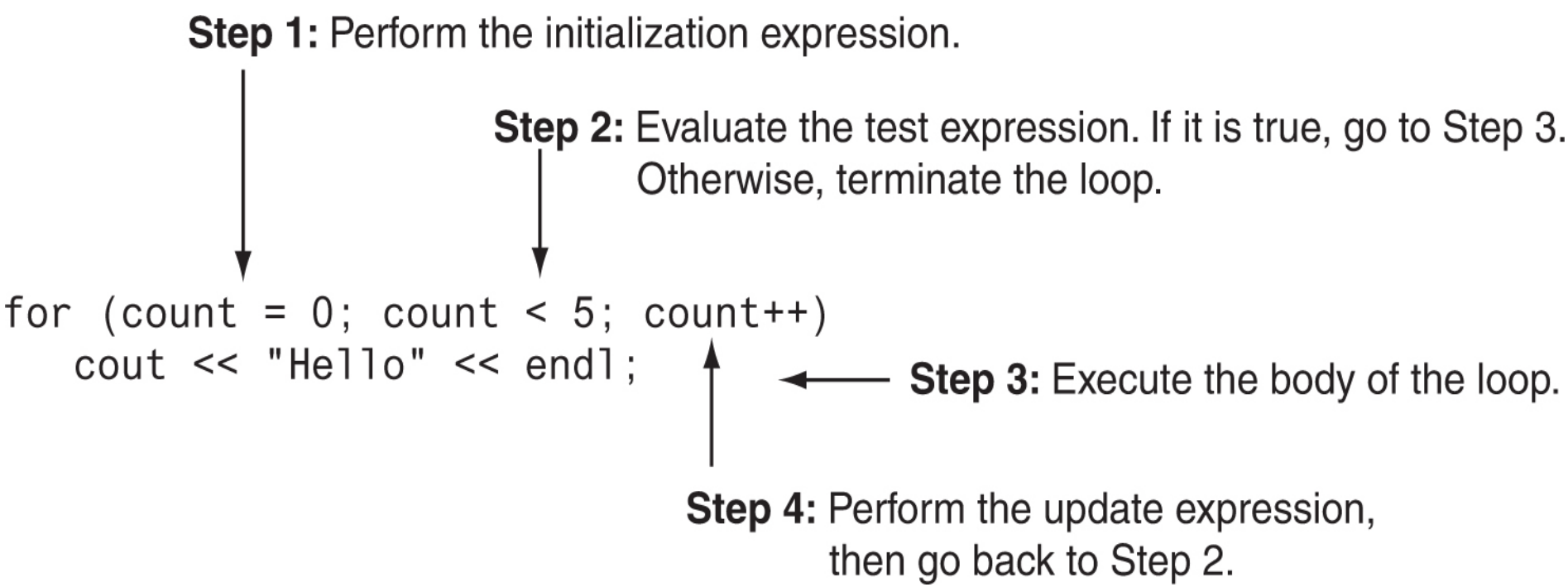
- إذا كان صحيحا true تنفذ العبارة statement
- إذا كان خاطئا false تنهي الحلقة

٣) تنفذ التحديث update ثم تعيد تقييم عبارة الاختبار test

for Loop - Example

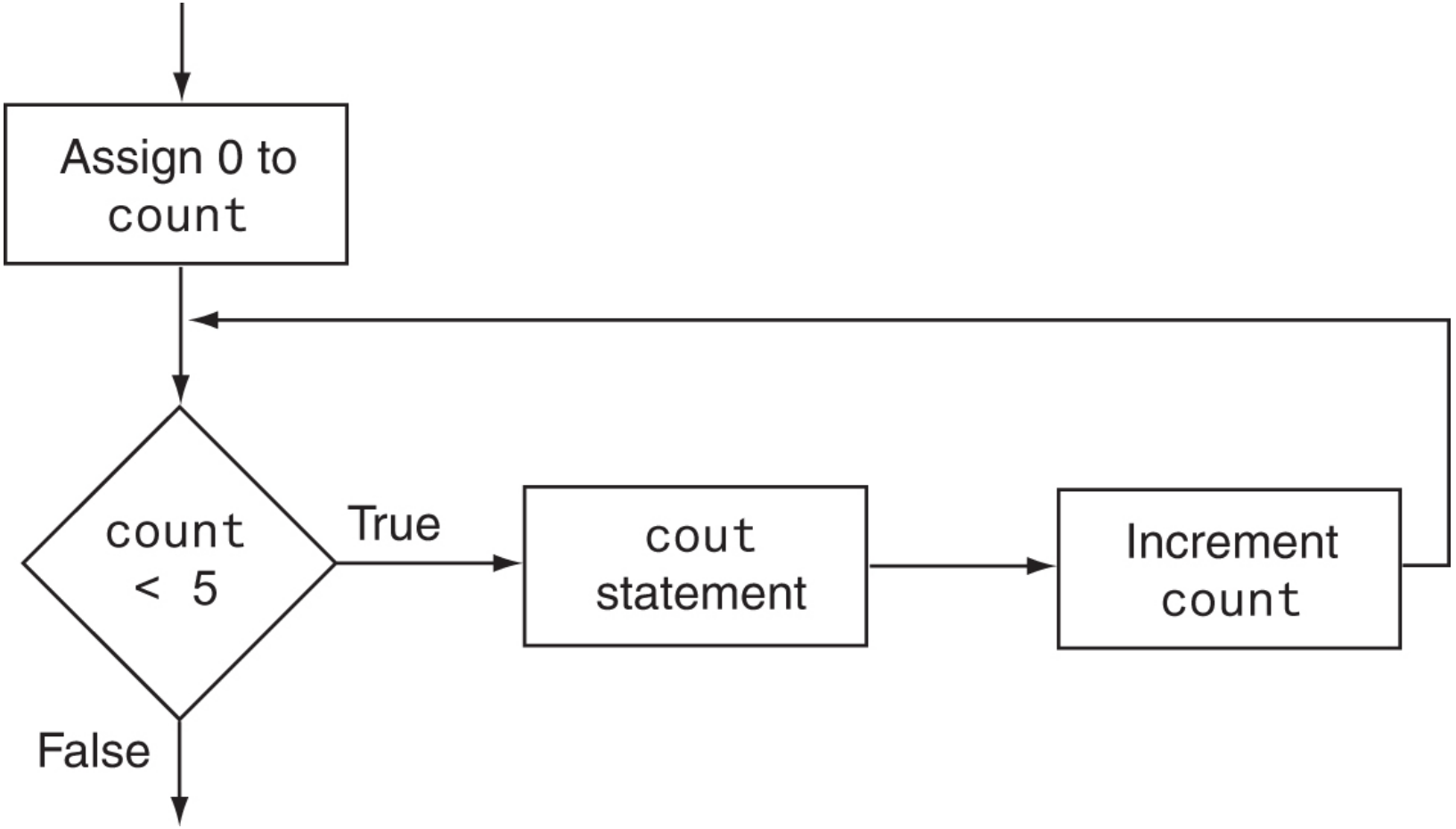
```
int count;

for (count = 1; count <= 5; count++)
   cout << "Hello" << endl;
```

نظرة أقرب إلى المثال السابق
A Closer Look at the Previous Example



المخطط التدفقي للمثال السابق

Flowchart for the Previous Example



A for Loop in Program 5-9

Program 5-9

```
1  // This program displays the numbers 1 through 10 and
2  // their squares.
3  #include <iostream>
4  using namespace std;
5
6  int main()
7  {
8     const int MIN_NUMBER = 1,    // Starting value
9               MAX_NUMBER = 10;   // Ending value
10    int num;
11
12    cout << "Number Number Squared\n";
13    cout << "-------------------------\n";
14
15    for (num = MIN_NUMBER; num <= MAX_NUMBER; num++)
16       cout << num << "\t\t" << (num * num) << endl;
17
18    return 0;
19 }
```

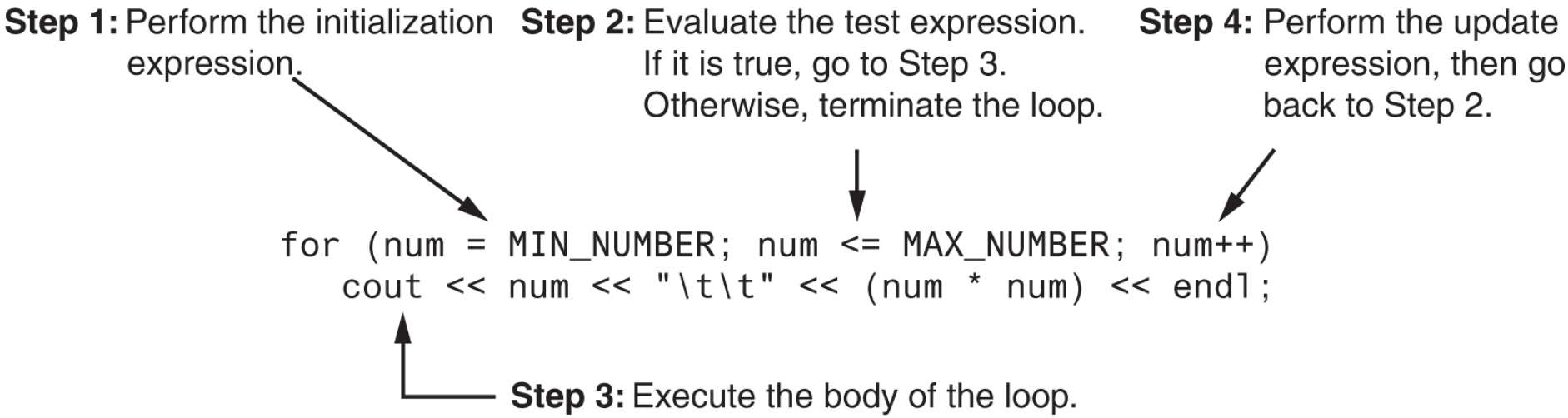
Continued…

A for Loop in Program 5-9

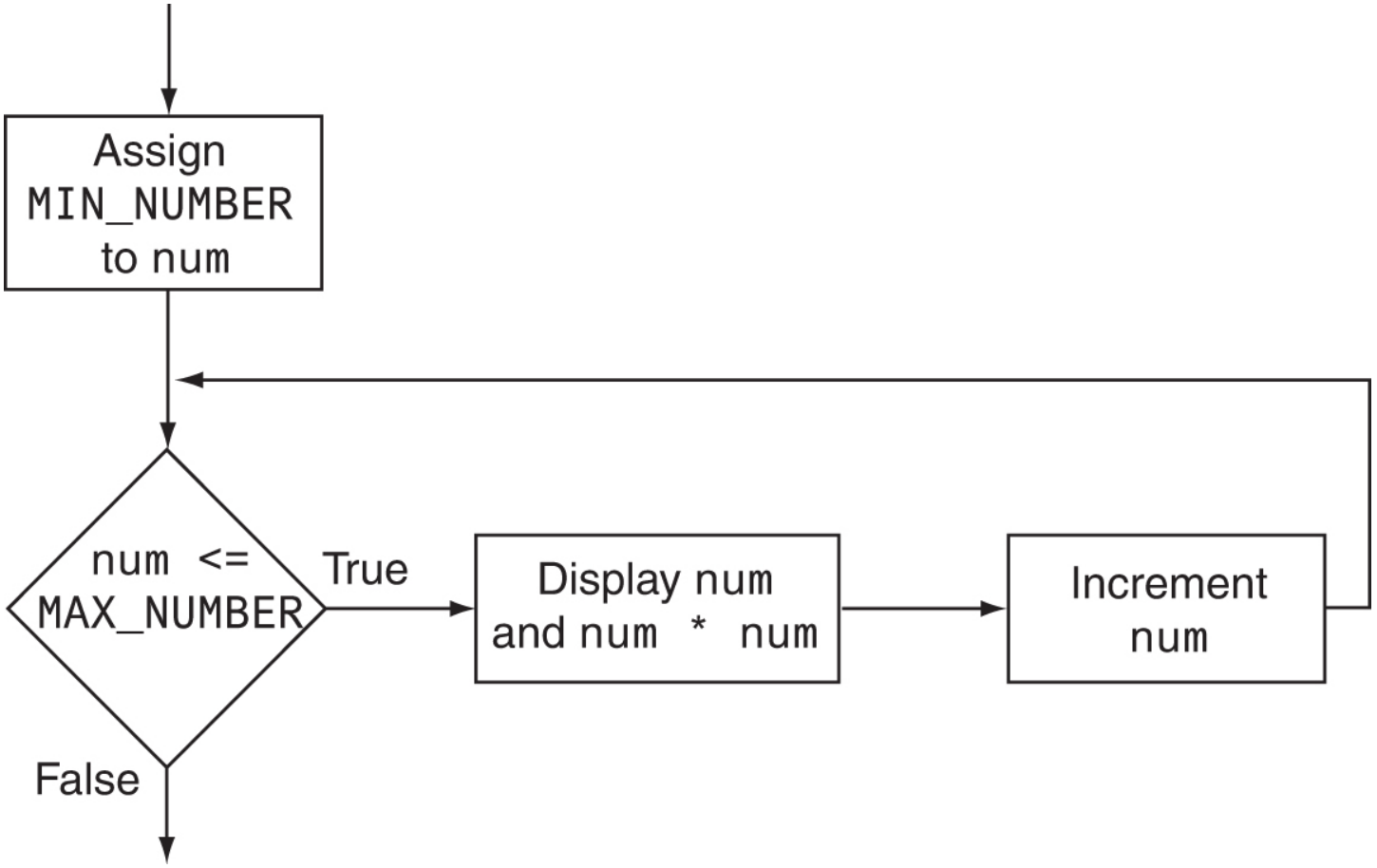
Program Output

```
Number Number Squared
---------------------
1              1
2              4
3              9
4              16
5              25
6              36
7              49
8              64
9              81
10             100
```

A Closer Look at Lines 15 through 16 in Program 5-9



Flowchart for Lines 15 through 16 in Program 5-9



متى نستخدم حلقة for
When to Use the for Loop

- في أي حالة تتطلب بوضوح ما يلي :
- - عملية تهيئة
- شرط خاطئ (مزيف) لإيقاف الحلقة
- تحديث يجب حصوله في نهاية كل تكرار

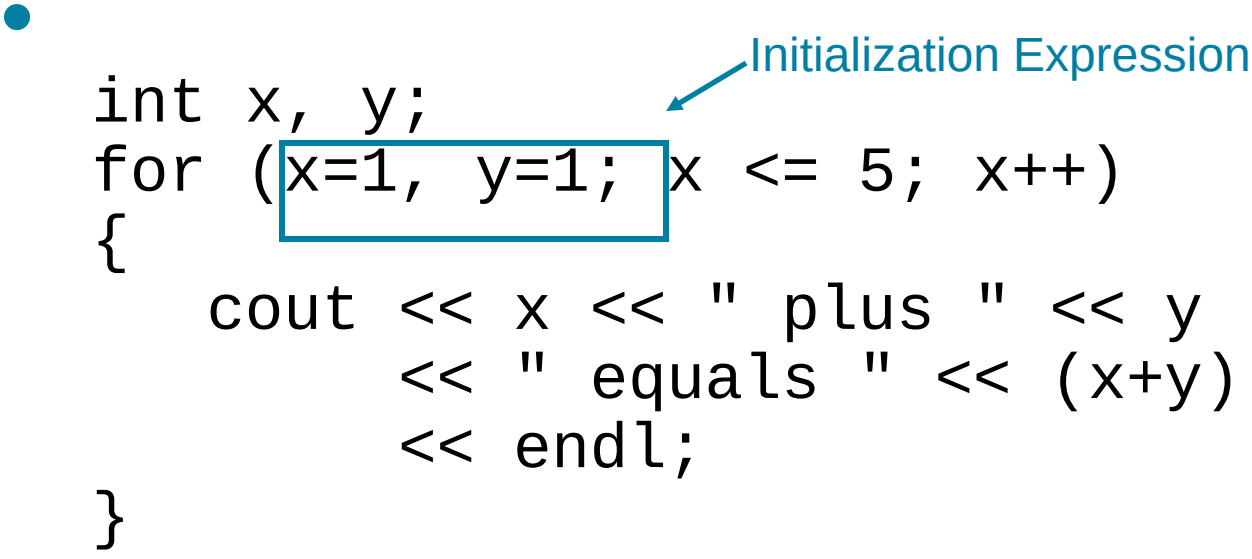
حلقة for هي حلقة اختبار أولي
The for Loop is a Pretest Loop

- تختبر حلقة for تعبير اختبارها قبل كل تكرار لذلك تعتبر حلقة اختبار أولي.
- لن تتكرر الحلقة التالية أبدا:

```
for (count = 11; count <= 10; count++)
   cout << "Hello" << endl;
```

تعديلات الحلقة for
for Loop - Modifications

- يمكن أن نضع عدة جمل في تعبير التهيئة *initialization*. تفصل الجمل بالفاصلة:

- 

for Loop - Modifications

- يمكن أيضا وضع عدة جمل في تعبير الاختبار *test*. تفصل كل جملة بالفاصلة:


```
int x, y;
for (x=1, y=1; x <= 5, y<=4; x++, y++)
{
   cout << x << " plus " << y
        << " equals " << (x+y)
        << endl;
}
```

for Loop - Modifications

- يمكننا إغفال تعبير التهيئة إذا قمنا به سابقا (قبل for):

```
int sum = 0, num = 1;
for (; num <= 10; num++)
    sum += num;
```

for Loop - Modifications

- يمكننا التصريح عن المتغيرات في عبارة التهيئة *initialization:*

```
int sum = 0;
for (int num = 0; num <= 10; num++)
     sum += num;
```

مجال المتغير num هو الحلقة for فقط.

5.7

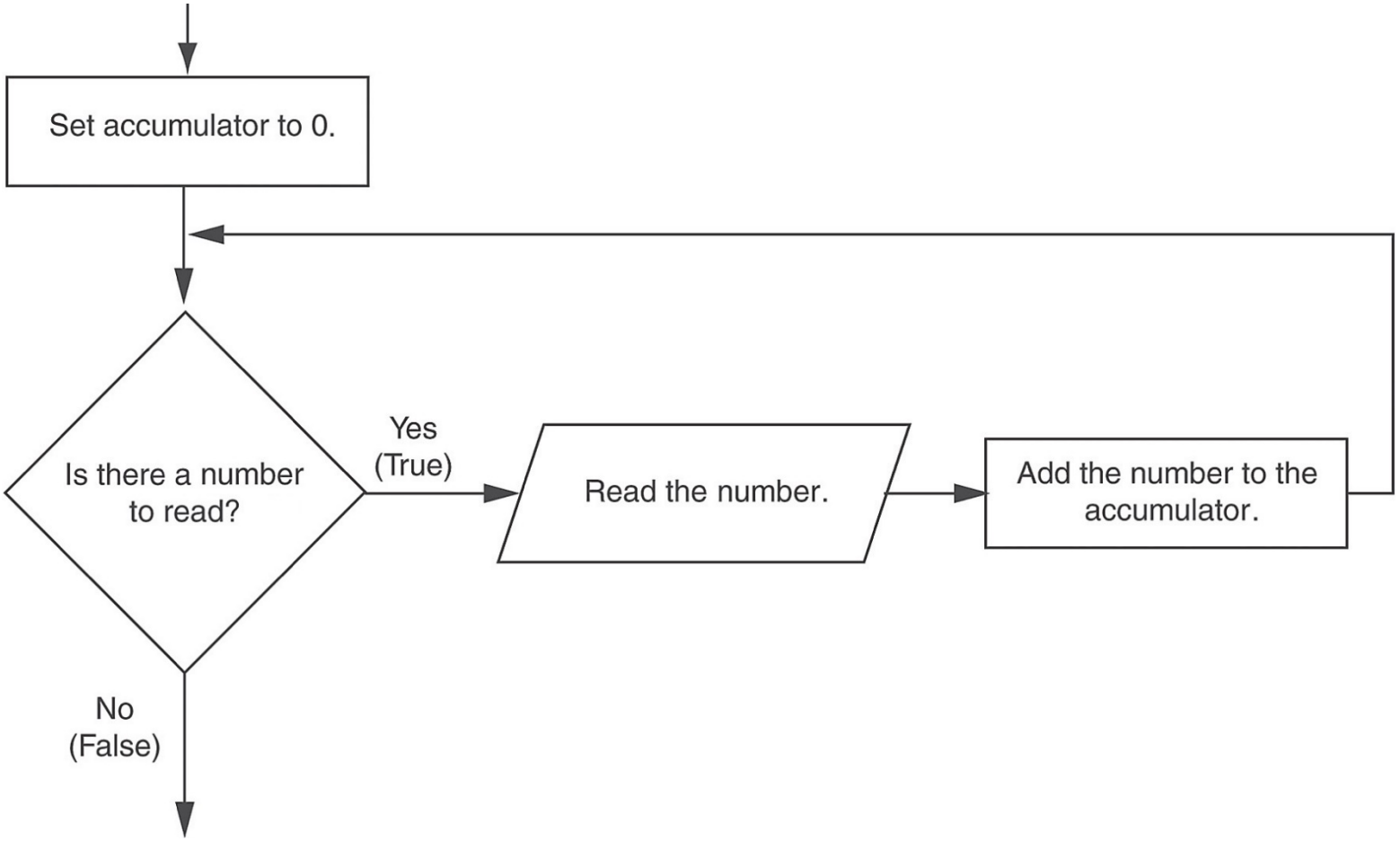
Keeping a Running Total

Keeping a Running Total

- running total: accumulated sum of numbers from each repetition of loop
- accumulator: variable that holds running total

```
int sum=0, num=1; // sum is the
while (num <= 10) // accumulator
{  sum += num;
   num++;
}
cout << "Sum of numbers 1 – 10 is"
     << sum << endl;
```

Logic for Keeping a Running Total



A Running Total in Program 5-12

Program 5-12

```
1  // This program takes daily sales amounts over a period of time
2  // and calculates their total.
3  #include <iostream>
4  #include <iomanip>
5  using namespace std;
6
7  int main()
8  {
9       int days;            // Number of days
10      double total = 0.0; // Accumulator, initialized with 0
11
12      // Get the number of days.
13      cout << "For how many days do you have sales amounts? ";
```

Continued…

A Running Total in Program 5-12

```
14      cin >> days;
15
16      // Get the sales for each day and accumulate a total.
17      for (int count = 1; count <= days; count++)
18      {
19          double sales;
20          cout << "Enter the sales for day " << count << ": ";
21          cin >> sales;
22          total += sales;  // Accumulate the running total.
23      }
24
25      // Display the total sales.
26      cout << fixed << showpoint << setprecision(2);
27      cout << "The total sales are $" << total << endl;
28      return 0;
29  }
```

Program Output with Example Input Shown in Bold

```
For how many days do you have sales amounts? 5 Enter
Enter the sales for day 1: 489.32 Enter
Enter the sales for day 2: 421.65 Enter
Enter the sales for day 3: 497.89 Enter
Enter the sales for day 4: 532.37 Enter
Enter the sales for day 5: 506.92 Enter
The total sales are $2448.15
```

5.8

القيم الحارسة

Sentinels

Sentinels

- sentinel: value in a list of values that indicates end of data
- Special value that cannot be confused with a valid value, *e.g.*, `-999` for a test score
- Used to terminate input when user may not know how many values will be entered

A Sentinel in Program 5-13

Program 5-13

```
1  // This program calculates the total number of points a
2  // soccer team has earned over a series of games. The user
3  // enters a series of point values, then -1 when finished.
4  #include <iostream>
5  using namespace std;
6
7  int main()
8  {
9     int game = 1,    // Game counter
10        points,     // To hold a number of points
11        total = 0;  // Accumulator
12
13    cout << "Enter the number of points your team has earned\n";
14    cout << "so far in the season, then enter -1 when finished.\n\n";
15    cout << "Enter the points for game " << game << ": ";
16    cin >> points;
17
18    while (points != -1)
19    {
20       total += points;
21       game++;
22       cout << "Enter the points for game " << game << ": ";
23       cin >> points;
24    }
25    cout << "\nThe total points are " << total << endl;
26    return 0;
27 }
```

Continued…

A Sentinel in Program 5-13

Program Output with Example Input Shown in Bold

```
Enter the number of points your team has earned
so far in the season, then enter -1 when finished.

Enter the points for game 1: 7 [Enter]
Enter the points for game 2: 9 [Enter]
Enter the points for game 3: 4 [Enter]
Enter the points for game 4: 6 [Enter]
Enter the points for game 5: 8 [Enter]
Enter the points for game 6: -1 [Enter]

The total points are 34
```

5.9

Deciding Which Loop to Use

Deciding Which Loop to Use

- The `while` loop is a conditional pretest loop
  - Iterates as long as a certain condition exits
  - Validating input
  - Reading lists of data terminated by a sentinel
- The `do-while` loop is a conditional posttest loop
  - Always iterates at least once
  - Repeating a menu
- The `for` loop is a pretest loop
  - Built-in expressions for initializing, testing, and updating
  - Situations where the exact number of iterations is known

5.10

Nested Loops

Nested Loops

- A nested loop is a loop inside the body of another loop
- Inner (inside), outer (outside) loops:

```
for (row=1; row<=3; row++) //outer
  for (col=1; col<=3; col++)//inner
    cout << row * col << endl;
```

Nested for Loop in Program 5-14

```
26    // Determine each student's average score.
27    for (int student = 1; student <= numStudents; student++)
28    {
29       total = 0;       // Initialize the accumulator.
30       for (int test = 1; test <= numTests; test++)
31       {
32          double score;
33          cout << "Enter score " << test << " for ";
34          cout << "student " << student << ": ";
35          cin >> score;
36          total += score;
37       }
38       average = total / numTests;
39       cout << "The average score for student " << student;
40       cout << " is " << average << ".\n\n";
41    }
```

Inner Loop

Outer Loop

Nested Loops - Notes

- Inner loop goes through all repetitions for each repetition of outer loop
- Inner loop repetitions complete sooner than outer loop
- Total number of repetitions for inner loop is product of number of repetitions of the two loops.

5.11

Using Files for Data Storage

Using Files for Data Storage

- Can use files instead of keyboard, monitor screen for program input, output
- Allows data to be retained between program runs
- Steps:
  - *Open* the file
  - *Use* the file (read from, write to, or both)
  - *Close* the file

Files: What is Needed

- Use `fstream` header file for file access
- File stream types:
  - `ifstream` for input from a file
  - `ofstream` for output to a file
  - `fstream` for input from or output to a file
- Define file stream objects:

```
ifstream infile;
ofstream outfile;
```

Opening Files

- Create a link between file name (outside the program) and file stream object (inside the program)
- Use the open member function:

```
infile.open("inventory.dat");
outfile.open("report.txt");
```

- Filename may include drive, path info.
- Output file will be created if necessary; existing file will be erased first
- Input file must exist for open to work

Testing for File Open Errors

- Can test a file stream object to detect if an open operation failed:

```
infile.open("test.txt");
if (!infile)
{
    cout << "File open failure!";
}
```

- Can also use the `fail` member function

Using Files

- Can use output file object and << to send data to a file:

```
outfile << "Inventory report";
```

- Can use input file object and >> to copy data from file to variables:

```
infile >> partNum;
infile >> qtyInStock >> qtyOnOrder;
```

Using Loops to Process Files

- The stream extraction operator >> returns `true` when a value was successfully read, `false` otherwise

- Can be tested in a `while` loop to continue execution as long as values are read from the file:

```
while (inputFile >> number) ...
```

Closing Files

- Use the `close` member function:

```
infile.close();
outfile.close();
```

- Don’t wait for operating system to close files at program end:
  - may be limit on number of open files
  - may be buffered output data waiting to send to file

Letting the User Specify a Filename

- In many cases, you will want the user to specify the name of a file for the program to open.
- In C++ 11, you can pass a `string` object as an argument to a file stream object's `open` member function.

Letting the User Specify a Filename in Program 5-24

Program 5-24

```
1  // This program lets the user enter a filename.
2  #include <iostream>
3  #include <string>
4  #include <fstream>
5  using namespace std;
6
7  int main()
8  {
9      ifstream inputFile;
10     string filename;
11     int number;
12
13     // Get the filename from the user.
14     cout << "Enter the filename: ";
15     cin >> filename;
16
17     // Open the file.
18     inputFile.open(filename);
19
20     // If the file successfully opened, process it.
21     if (inputFile)
```

Continued…

Letting the User Specify a Filename in Program 5-24

```
22      {
23          // Read the numbers from the file and
24          // display them.
25          while (inputFile >> number)
26          {
27              cout << number << endl;
28          }
29
30          // Close the file.
31          inputFile.close();
32      }
33      else
34      {
35          // Display an error message.
36          cout << "Error opening the file.\n";
37      }
38      return 0;
39  }
```

Program Output with Example Input Shown in Bold

```
Enter the filename: ListOfNumbers.txt [Enter]
100
200
300
400
500
600
700
```

Using the `c_str` Member Function in Older Versions of C++

- Prior to C++ 11, the `open` member function requires that you pass the name of the file as a null-terminated string, which is also known as a *C-string*.
- *String literals are stored* in memory as null-terminated C-strings, but *string objects* are **not**.

Using the `c_str` Member Function in Older Versions of C++

- `string` objects have a member function named `c_str`
  - It returns the contents of the object formatted as a null-terminated C-string.
  - Here is the general format of how you call the `c_str` function:

```
stringObject.c_str()
```

    - Line 18 in Program 5-24 could be rewritten in the following manner:

```
inputFile.open(filename.c_str());
```

5.12

Breaking and Continuing a Loop

Breaking Out of a Loop

- Can use `break` to terminate execution of a loop
- Use sparingly if at all – makes code harder to understand and debug
- When used in an inner loop, terminates that loop only and goes back to outer loop

The `continue` Statement

- Can use `continue` to go to end of loop and prepare for next repetition
  - `while`, `do-while` loops: go to test, repeat loop if test passes
  - `for` loop: perform update step, then test, then repeat loop if test passes
- Use sparingly – like `break`, can make program logic hard to follow

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