Chapter 5

REPETITION STRUCTURES

Outline

- *Overview*
- *while* loops
- *for* loops
- do-while Loops
- Interactive *while* loops
- Nested loops
- Break and Continue statements

Overview

- C++ provides three different forms of repetition structures:

1. *while* structure
2. *for* structure
3. *do-while* structure

- Each of these structures requires a condition that must be evaluated.
- The condition can be tested at either (1) the beginning or (2) the end of the repeating section of code.
- If the test is at the beginning of the loop, the type of loop is a *pre-test loop*.
- If the test is at the end of the loop, the type of loop is a *post-test loop*.

Fixed count loop and variable condition loop

- In addition to where the condition is tested, repeating sections of code are also classified.
- In a *fixed count loop*, the condition is used to keep track of how many repetitions have occurred. In this kind of loops, a fixed number of repetitions are performed, at which point the repeating section of code is exited.

- In many situations, the exact number of repetitions are not known in advance. In such cases, a *variable condition loop* is used.
- In a *variable condition loop*, the tested condition does not depend on a count being achieved, but rather on a variable that can change interactively with each pass through the loop. When a specified value is encountered, regardless of how many iterations have occurred, repetitions stop.

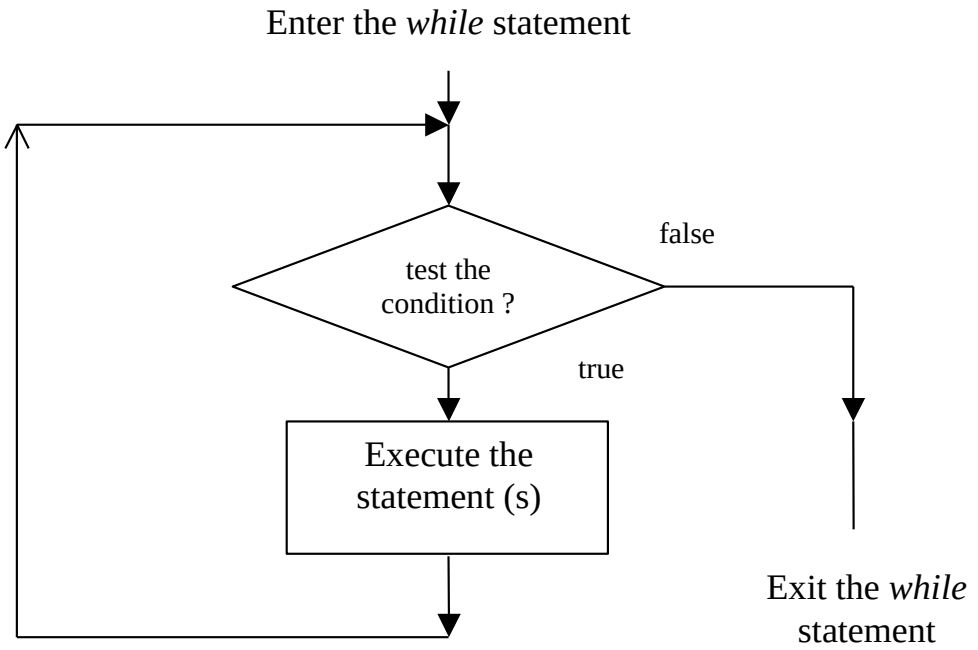
while loops

The *while* statement is used for repeating a statement or series of statements as long as a given conditional expression is evaluated to true.

The syntax for the *while* statement:

while(condition expression)

statement



Example 5.2.1

```
// This program prints out the numbers from 1 to 10
#include <iostream.h>
int main()
{
  int count;
  count = 1;                // initialize count
  while (count <= 10){
    cout << count << "  ";
    count++;                // increment count
  }
  return 0;
}
```

The output of the above program:

```
  1  2  3  4  5  6  7  8  9  10
```

In the above program, the loop incurs a *counter-controlled repetition*. Counter-controlled repetition requires:

1) the name of a control variable (the variable *count*)

2) the initial value of the control variable (*count* is initialized to 1 in this case

3) the condition that tests for the final value of the control variable (i.e., whether looping should continue) ;

4) the *increment* (or *decrement*) by which the control variable is modified each time through the loop.

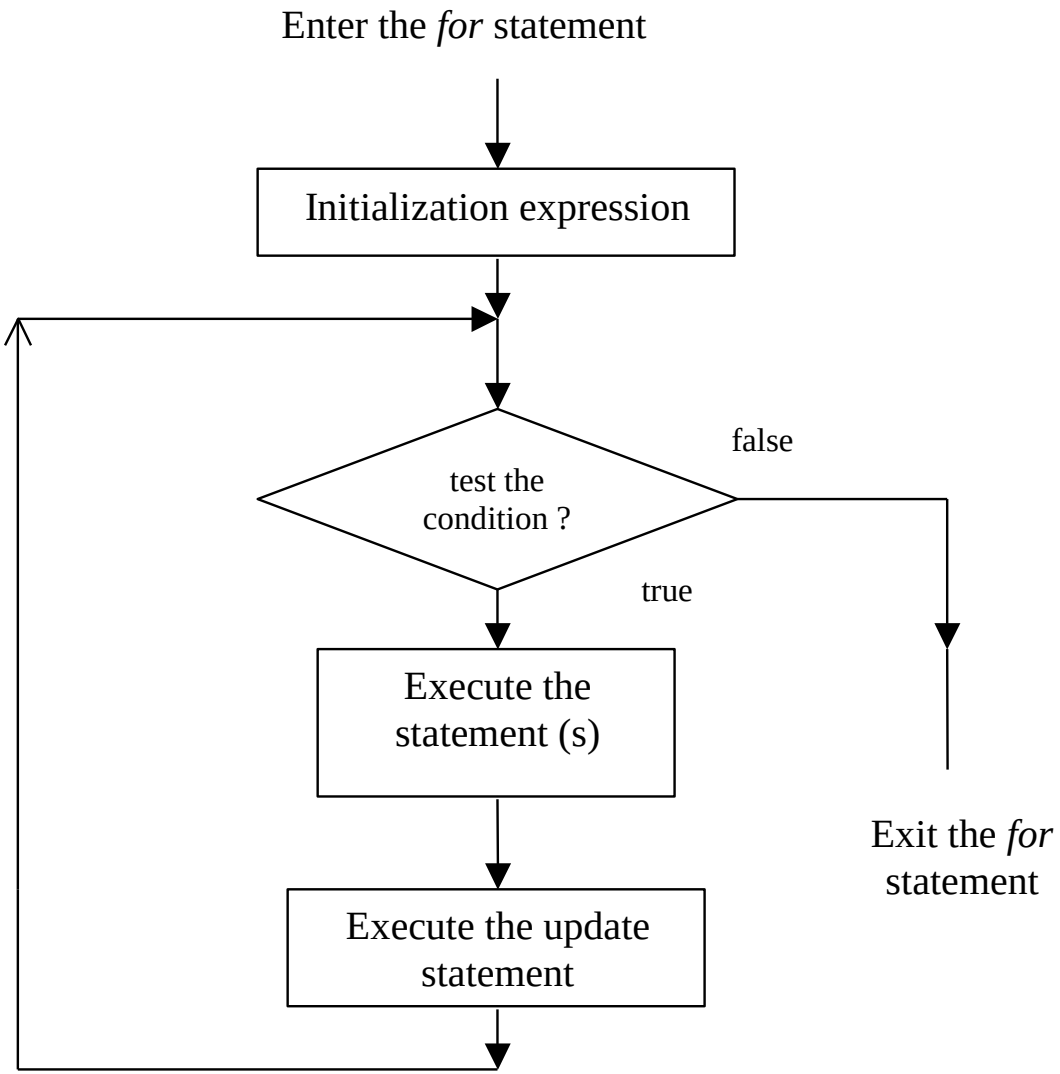
for LOOPS

- The *for* statement is used for repeating a statement or series of statements as long as a given conditional expression evaluates to true.

- One of the main differences between *while* statement and *for* statement is that in addition to a condition, you can also include code in the *for* statement
  - to initialize a counter variable and
  - changes its value with each iteration

- The syntax of the *for* statement:

for (initialization expression; condition; update expression)
statement


Enter the *for* statement
Initialization expression
test the condition ?
false
true
Execute the statement (s)
Execute the update statement
Exit the *for* statement

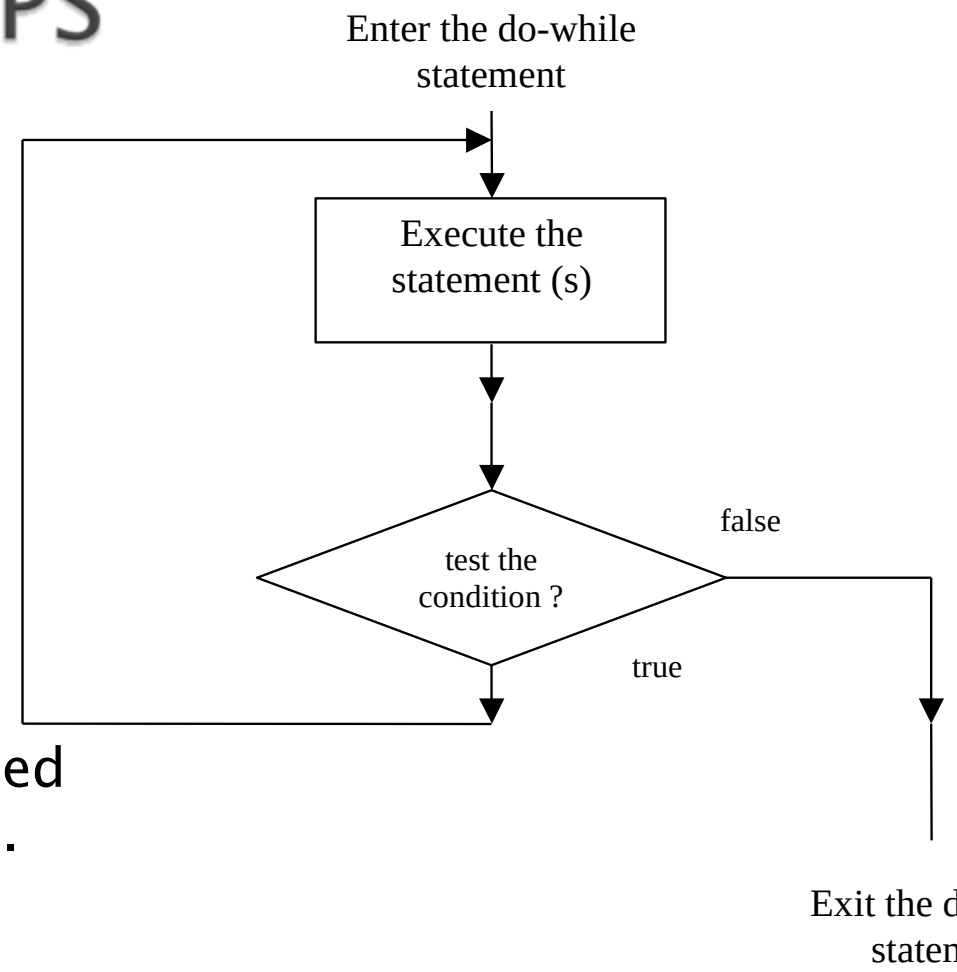
Example 5.4.1

```
// This program prints the even number from 2 to
   20
#include <iostream.h>
int main()
{
  int count;
  for (count = 2; count <= 20; count = count + 2)
    cout << count << "  ";
  return 0;
}
```

The output of the above program:

```
 2  4  6  8  10 12  14  16  18  20
```

do-while LOOPS



- *do..while* statement is used to create *post-test* loops.
- The syntax:

```
do {
        statements
} while (conditional expression);
```

Example

```
// This program prints the odd number from 1 to 19
#include <iostream.h>
int main()
{
  int count = 1;
  do {
       cout << count << "  ";
       count += 2;
   } while (count < 20);
  return 0;
}
```

The output of the above program:

```
  1  3  5  7  9  11  13  15  17  19
```

Exercise

INTERACTIVE LOOP

- Combining interactive data entry with a loop statement produces very adaptable and powerful programs.

Example 5.3.1

```
#include <iostream.h>
int main(){
   int total,        // sum of grades
       gradeCounter, // number of grades entered
       grade,        // one grade
       average;      // average of grades
    total = 0;
   gradeCounter = 1;                    // prepare to loop
    while ( gradeCounter <= 10 ) {       // loop 10 times
      cout << "Enter grade: ";           // prompt for input
      cin >> grade;                     // input grade
      total = total + grade;            // add grade to total
      gradeCounter = gradeCounter + 1;  // increment counter
   }
```

```
  // termination phase
    average = total / 10;           // integer division
    cout << "Class average is " << average << endl;
    return 0;
}
```

The output of the above program:

```
 Enter grade: 98
Enter grade: 76
Enter grade: 71
Enter grade: 87
Enter grade: 83
Enter grade: 90
Enter grade: 57
Enter grade: 79
Enter grade: 82
Enter grade: 94
Class average is  81
```

Example of interactive *do while* loop

```
do {
    cout<< "\nEnter an identification number:";
    cin >> idNum;
} while (idNum < 1000 | | idNum> 1999);
```

- Here, a request for a new id-number is repeated until a valid number is entered.

- A refined version of the above program:

```
do {
    cout<< "\nEnter an identification number:";
    cin >> idNum;
    if (idNum < 1000 || idNum > 1999)
    {
        cout << "An invalid number was just
  entered\n";
        cout << "Please reenter an ID number
  /n";
    }
    else break;
} while (true);
```

NESTED LOOPS

- In many situations, it is convenient to use a loop contained within another loop. Such loops are called *nested loops*.

- Example 5.4.1

```
#include <iostream.h>
int main()
{
  const int MAXI = 5;
  const int MAXJ = 4;
  int i, j;
  for(i = 1; i <= MAXI; i++)     // start of outer loop
  {
     cout << "\ni is now " << i << endl;
     for(j = 1; j <= MAXJ; j++)   // start of inner loop
          cout << "  j = " << j;      // end of inner loop
  }                              // end of outer loop
```

```
  cout << endl;
  return 0;
}
```

The output of the above program:

```
i is now  1
  j = 1  j = 2  j = 3  j = 4
i is now  2
  j = 1  j = 2  j = 3  j = 4
i is now  3
  j = 1  j = 2  j = 3  j = 4
i is now  4
  j = 1  j = 2  j = 3  j = 4
i is now  5
  j = 1  j = 2  j = 3  j = 4
```

Sentinels

- In programming, data values used to indicate either the start or end of a data series are called *sentinels*.
- The sentinels must be selected so as not to conflict with legitimate data values.

Example 5.3.2

```
#include <iostream.h>
const int HIGHGRADE = 100;   // sentinel value
int main()
{
  float grade, total;
  grade = 0;
  total = 0;
  cout << "\nTo stop entering grades, type in any number"
       << " greater than 100.\n\n";
```

```
cout << "Enter a grade: ";
  cin  >> grade;
  while (grade <= HIGHGRADE)
  {
    total = total + grade;
    cout << "Enter a grade: ";
    cin  >> grade;
  }
  cout << "\nThe total of the grades is " << total << endl;
 return 0;
}
```

- In the above program, the *sentinel* is the value 100 for the entered grade.

break statement

- The *break* statement causes an exit from the innermost enclosing loop.

Example:

```
while( count <= 10)
{
    cout << "Enter a number: ";    cin >> num;
    if (num > 76){
        cout << "you lose!\n";
        break;
    }
    else
       cout << "Keep on trucking!\n";
    count++;
}
//break jumps to here
```

continue Statements

- The *continue* statement halts a looping statement and restarts the loop with a new iteration.

```
while( count < 30)
{
    cout << "Enter a grade: ";
    cin >> grade;
    if (grade < 0 || grade > 100)
       continue;
    total = total + grade;
    count++;
}
```

- In the above program, invalid grades are simply ignored and only valid grades are added to the total.

The null statement

- All statements must be terminated by a semicolon. A semicolon with nothing preceding it is also a valid statement, called the *null statement*. Thus, the statement

  ;

  is a null statement.

- Example:

```
if (a > 0)
        b = 7;
else ;
```

- The null statement is a do-nothing statement.

Exercise