CHAPTER 2.2
CONTROL STRUCTURES (ITERATION)

Dr. Shady Yehia Elmashad

Outline

1. C++ Iterative Constructs
2. The for Repetition Structure
3. Examples Using the for Structure
4. The while Repetition Structure
5. Examples Using the while Structure
6. Nested control structures
7. The do/while Repetition Structure
8. The break and continue Statements

1. C++ Iterative Constructs

- There are three constructs:
  - while statement
  - for statement
  - do-while statement

2. The for Repetition Structure

The general format when using **for** loops is

```
for ( initialization;
  LoopContinuationTest; increment )

    statement
```

Example:

```
for( int counter = 1; counter <= 10; counter++ )
   cout << counter << endl;
```

- Prints the integers from one to ten

No semicolon after last statement

2. The for Repetition Structure

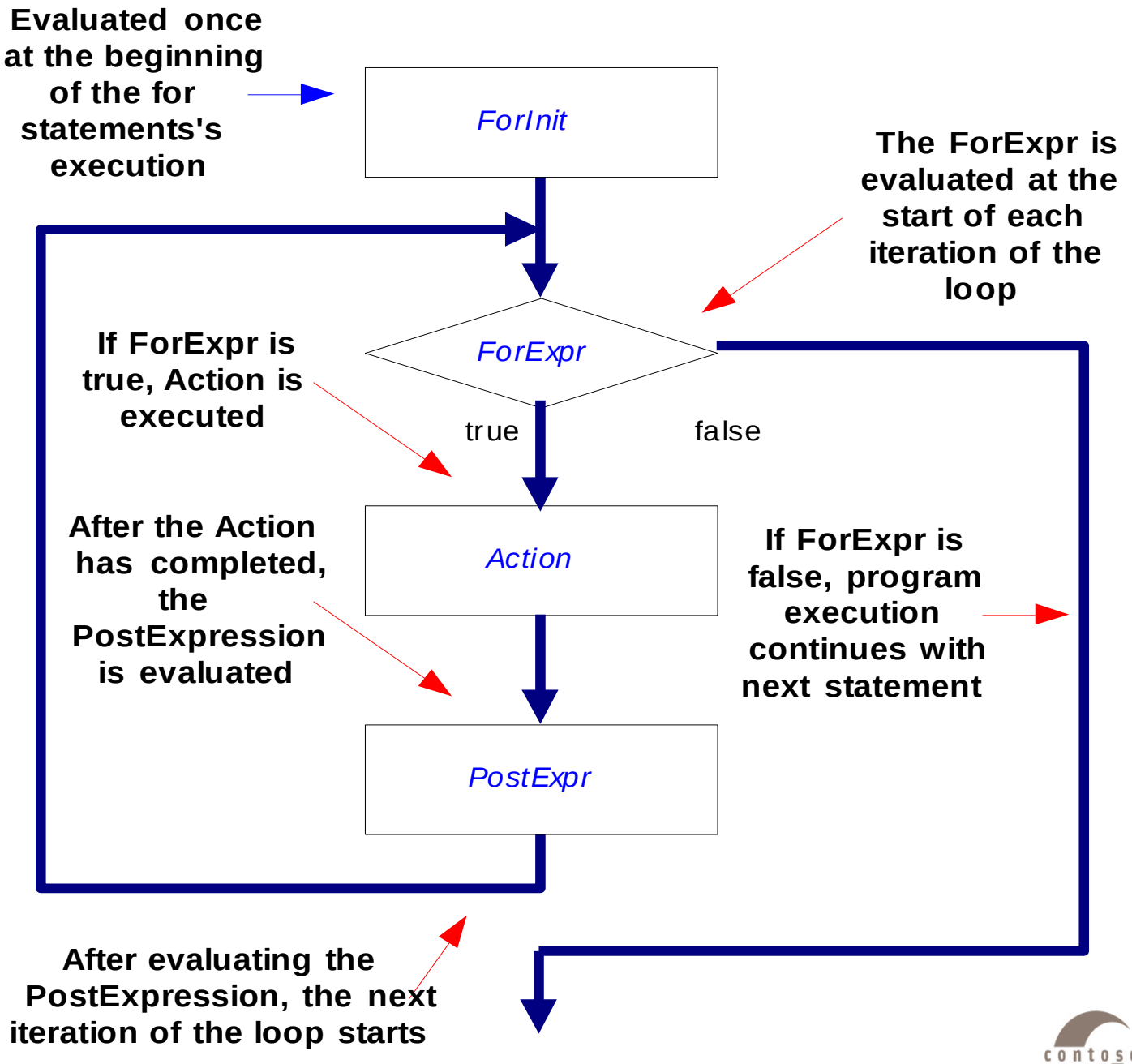
- Syntax

  `for` (*ForInit* ; *ForExpression*; *PostExpression*)

  Action

- Example

```
for (int i = 0; i < 3; ++i) {
  cout << "i is " << i << endl;
}
```


Evaluated once at the beginning of the for statements's execution
ForInit
The ForExpr is evaluated at the start of each iteration of the loop
If ForExpr is true, Action is executed
ForExpr
true
false
After the Action has completed, the PostExpression is evaluated
Action
If ForExpr is false, program execution continues with next statement
PostExpr
After evaluating the PostExpression, the next iteration of the loop starts

2. The for Repetition Structure

- **`For`** loops can usually be rewritten as **`while`** loops:

```
initialization;
while ( loopContinuationTest){
   statement
   increment;
}
```

- Initialization and increment as comma-separated lists

```
for (int i = 0, j = 0;  j + i <= 10; j++, i++)
      cout << j + i << endl;
```

3. Examples Using the `for` Structure

Sum the numbers from 0 to 10

```
#include <iostram.h>
void main ( )
{
int sum = 0 ;
    for ( int i = 0; i < = 10; i++ )
   {
     sum = sum + i ;
     }
cout << " Summation = " << sum ;
}
```

Summation =

3. Examples Using the `for` Structure

Sum the even numbers from 0 to 100

```
#include <iostram.h>
void main ( )
{
int sum = 0 ;
    for ( int i = 0; i < = 100; i+=2 )
   {
     sum = sum + i ;
     }
cout << " Summation = " << sum ;
}
```

Summation =

3. Examples Using the `for` Structure

Sum the odd numbers from 0 to 100

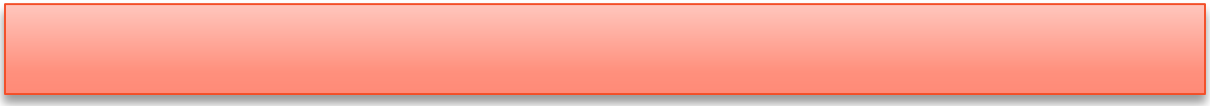
```
#include <iostram.h>
void main ( )
{
int sum = 0 ;
    for ( int i = 1; i < = 100; i+=2 )
   {
     sum = sum + i ;
     }
cout << " Summation = " << sum ;
}
```

Summation =

3. Examples Using the `for` Structure

Printing characters depending on user entry

```
#include <iostram.h>
void main ( )
{
int n ; char  ch;
cout << " Please enter the character: " ;
cin >> ch ;
cout << " Please enter the number of
repetition: " ;
cin >> n ;
      for ( int i = 0; i <  n ; i++ )
      cout <<  ch;
 }
```



4. The while Repetition Structure

Logical expression that determines whether the action is to be executed

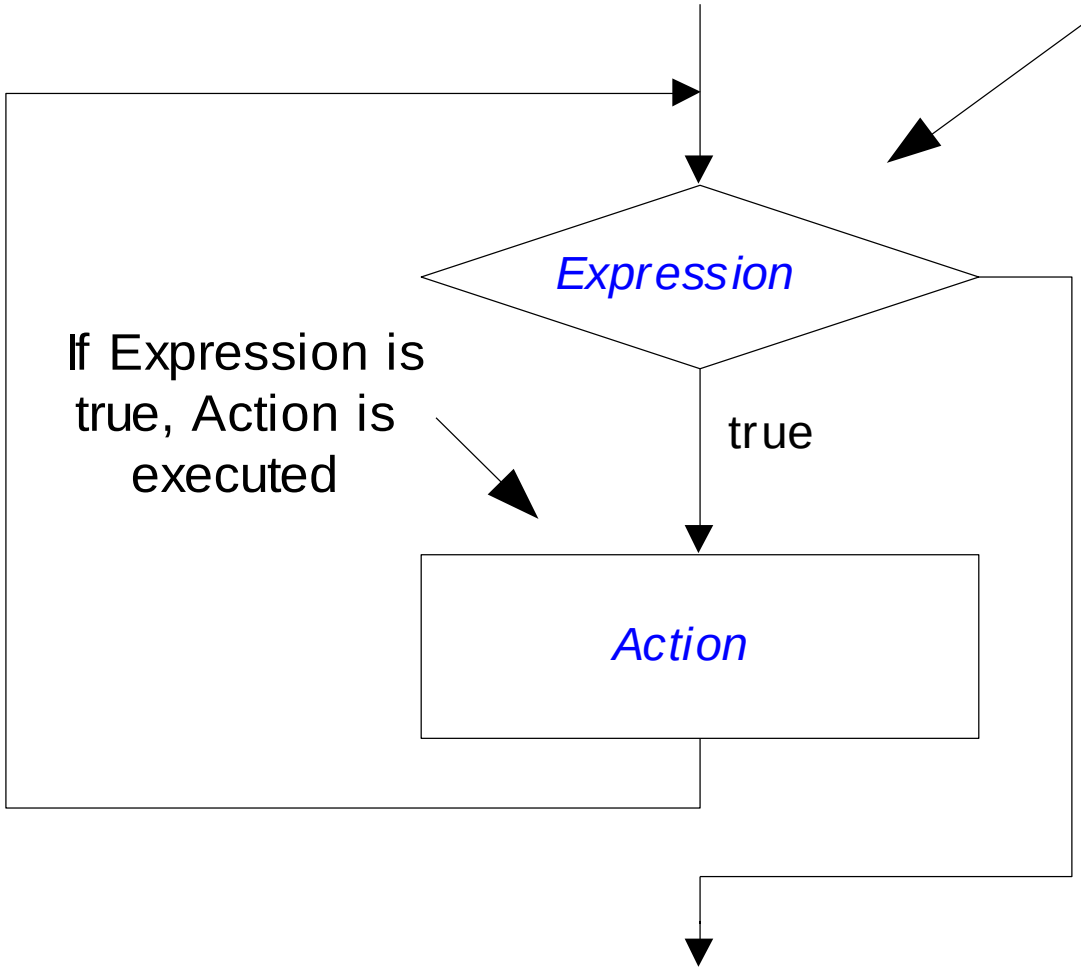
Action to be iteratively performed until logical expression is false

while (*Expression*) *Action*

4. The while Repetition Structure

While Semantics

Expression is evaluated at the start of each iteration of the loop



If Expression is true, Action is executed

If Expression is false, program execution continues with next statement

4. The while Repetition Structure

- Repetition structure
  - Programmer specifies an action to be repeated while some condition remains true
  - Psuedocode

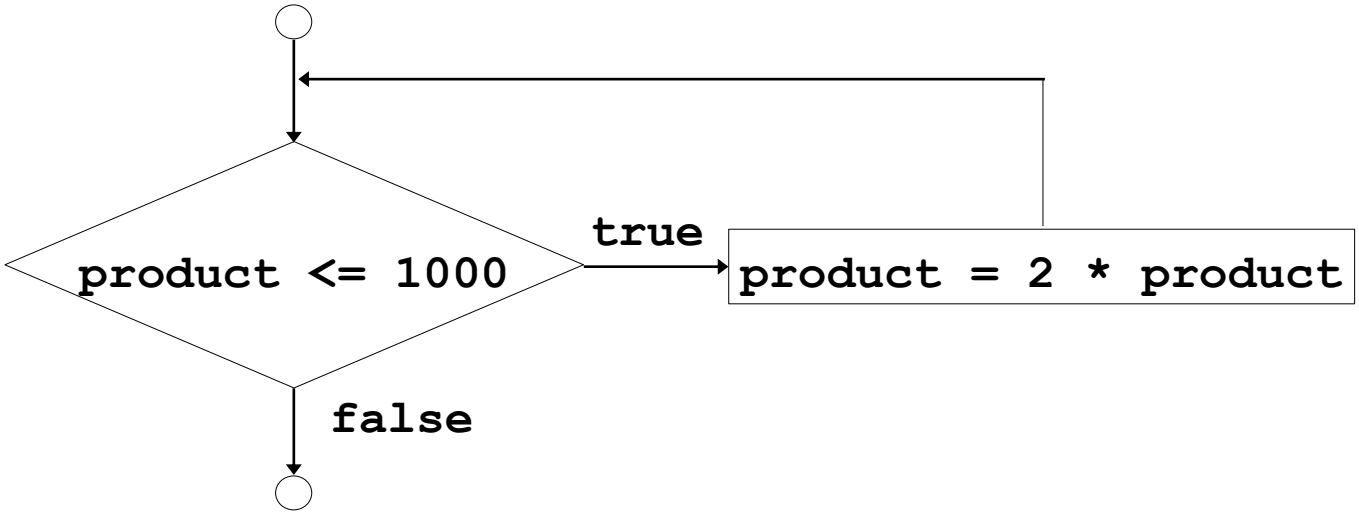
    while there are more items on my shopping list

    Purchase next item and cross it off my list
  - **`while`** loop repeated until condition becomes false.
- Example

```
int product = 2;
while ( product <= 1000 )
   product = 2 * product;
```

4. The while Repetition Structure

- Flowchart of **`while`** loop



5. Examples Using the `while` Structure

Printing characters depending on user entry

```
#include <iostram.h>
void main ( )
{
int n, i = 0 ; char  ch;
cout << " Please enter the character: " ;
cin >> ch ;
cout << " Please enter the number of
repetition: " ;
cin >> n ;
      while ( i <  n )    {
      cout <<  ch ;
      i ++ ;
      }
}
```

5. Examples Using the `while` Structure

The summation of the numbers squared from 0 to 10

```
#include <iostram.h>
void main ( )
{
int sq_sum = 0, x = 0, y ;
     while ( x < =  10 )    {
      y = x * x ;
      sq_sum = sq_sum + y ;
      x ++ ;
      }
cout << “The summation of the
numbers squared from 0 to 10 “ <<
sq_sum ;
}
```

5. Examples Using the `while` Structure

Factorial of a number

```
#include <iostram.h>
void main ( )
{
int n, fact = 1 ;
cout << " Please enter a number " << endl ;
cin >> n ;
      while ( n  > 0 )    {
      fact = fact * n ;
      n -- ;
      }
cout << " The factorial of your number is "
<< fact ;
}
```

6. Nested Control Structures

Accept 10 numbers from the user & print the max. one

```
#include <iostram.h>
void main ( )
{
int num, largest = 0 ;
   for ( int i = 0; i < 10; i ++ )  {
   cout << " Enter a number: " ;
   cin >> num ;
                  if ( num > largest) {
                  largest = num ;
                  }
    }
cout << " The largest number is " << largest
<< endl ;
}
```

6. Nested Control Structures

Multiplication Table of 5

```
#include <iostram.h>
void main ( )
{
cout << " \ t  1   \ t  2   \ t  3   \ t  4   \ t  5 "
; << endl ;
      for ( int i = 1 ; i < = 5 ; i ++ )   {
      cout << i ;
      cout << " \ t " ;
            for ( int j = 1 ; j < = 5 ; j ++ )   {
            cout << i * j << " \ t " << " | " ;
            }
      cout << endl;
      }
}
```

6. Nested Control Structures

Multiplication Table of n

```
#include <iostram.h>
void main ( )  {
cout << " Please enter a number: " ;
cin >> n ;
      for ( int i = 1 ; i < = n ; i ++ )    {
       cout << i ;
       cout << " \ t " ;
       }
cout << endl ;
            for ( int j = 1 ; j < = n ; j ++ )    {
            cout << i ;
            cout << " \ t " ;
                  for ( int k = 1 ; k < = n ; k ++ )    {
                  cout << j * k << " \ t " << " | " ;
                  }
            cout << endl;
      }
}
```

7. The do/while Repetition Structure

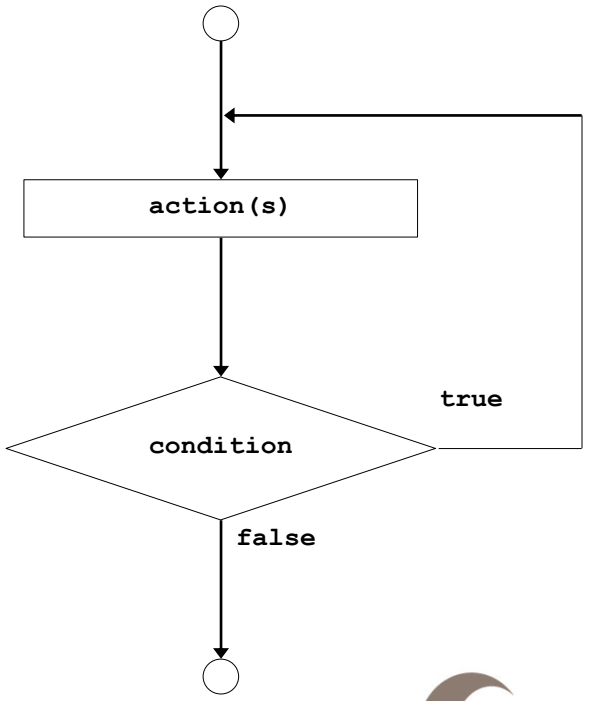
- The **do/while** repetition structure is similar to the **while** structure,
  - Condition for repetition tested after the body of the loop is executed
- Syntax:

```
do {
   statement(s)
} while ( condition );
```

- Example (letting counter = 1):

```
do {
  cout << counter << " ";
} while (++counter <= 10);
```

  - This prints the integers from **1** to **10**
- All actions are performed at least once.



8. The break and continue Statements

- **`Break`**
  - Causes immediate exit from a **`while`**, **`for`**, **`do/while`** or **`switch`** structure
  - Program execution continues with the first statement after the structure
  - Common uses of the **`break`** statement:
    - Escape early from a loop
    - Skip the remainder of a **`switch`** structure

8. The break and continue Statements

- **`Continue`**
  - Skips the remaining statements in the body of a **`while`**, **`for`** or **`do/while`** structure and proceeds with the next iteration of the loop
  - In **`while`** and **`do/while`**, the loop-continuation test is evaluated immediately after the **`continue`** statement is executed
  - In the **`for`** structure, the increment expression is executed, then the loop-continuation test is evaluated

8. The break and continue Statements

```
#include <iostream.h>
Void main()
{
   int sum = 0, num;

    // Allow the user to enter up to 10 numbers
   for (int count=0; count < 10; ++count) {
      cout << "Enter a number to add, or 0 to exit: ";
      cin >> num;

      // exit loop if user enters 0
      if (num == 0)
         break;

      // otherwise add number to our sum
      sum += num;
   }
    cout << "The sum of all the numbers you entered is " << sum << "\n";
}
```

8. The break and continue Statements

```
#include <iostream.h>
 void main ( )
{
   while (true)              // infinite loop
   {
      cout << "Enter 0 to exit or anything else to continue: ";
      int num;
      cin >> num;

      // exit loop if user enters 0
      if (num == 0)
         break;
   }

   cout << "We're out!\n";
}
```

8. The break and continue Statements

```
#include <iostream.h>
 void main ( )
{
        for (int count=0; count  < =20; ++count) {
    // if the number is divisible by 4, skip this iteration
    if ((count % 4) == 0)
       continue;

    // If the number is not divisible by 4, keep going
    cout << count << endl;
}
}
```

- This program prints all of the numbers from 0 to 20 that aren't divisible by 4.