

CHAPTER 2.2

CONTROL STRUCTURES (ITERATION)

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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

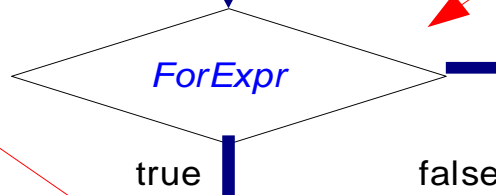
```
for (int i = 0; i < 3; ++i) {  
    cout << "i is " << i << endl;  
}
```

Evaluated once
at the beginning
of the for
statements's
execution

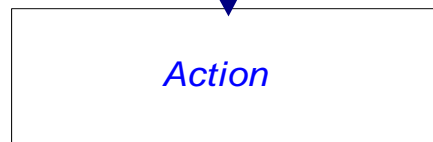


The ForExpr is
evaluated at the
start of each
iteration of the
loop

If ForExpr is
true, Action is
executed



After the Action
has completed,
the
PostExpression
is evaluated



If ForExpr is
false, program
execution
continues with
next statement



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 <iostream.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 <iostream.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 <iostream.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 <iostream.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

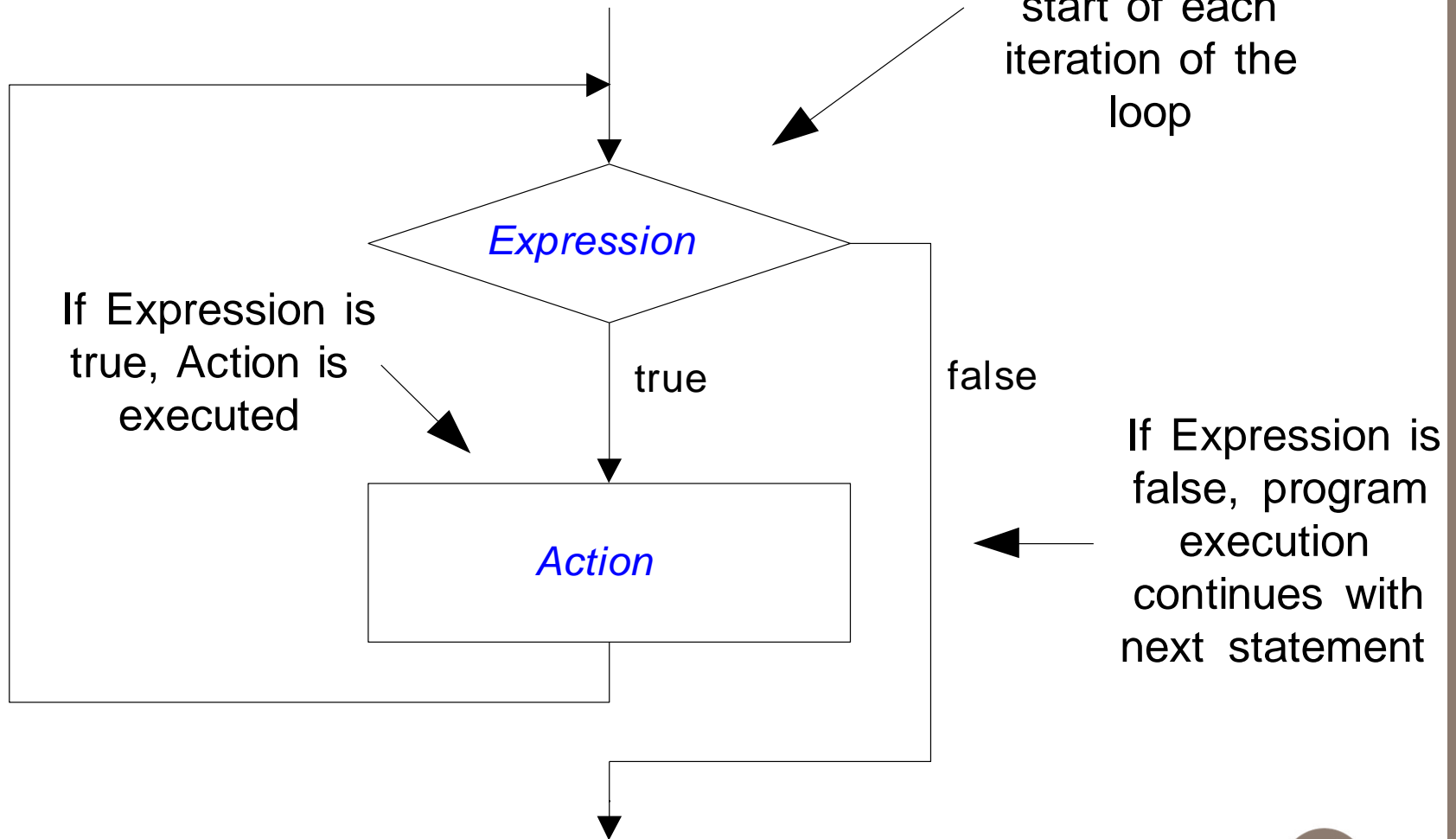
Action to be iteratively performed until logical expression is false

while (*Expression*) *Action*

4. The while Repetition Structure

While Semantics

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



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*

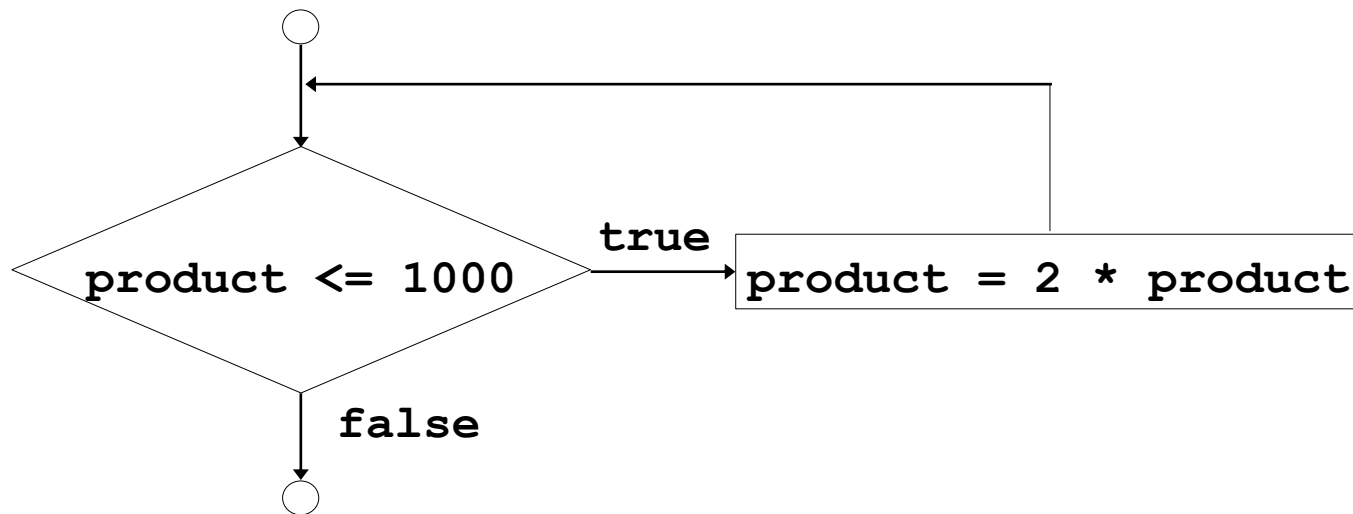
- **while** loop repeated until condition becomes false.

- 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 <iostream.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 <iostream.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 <iostream.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. 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:

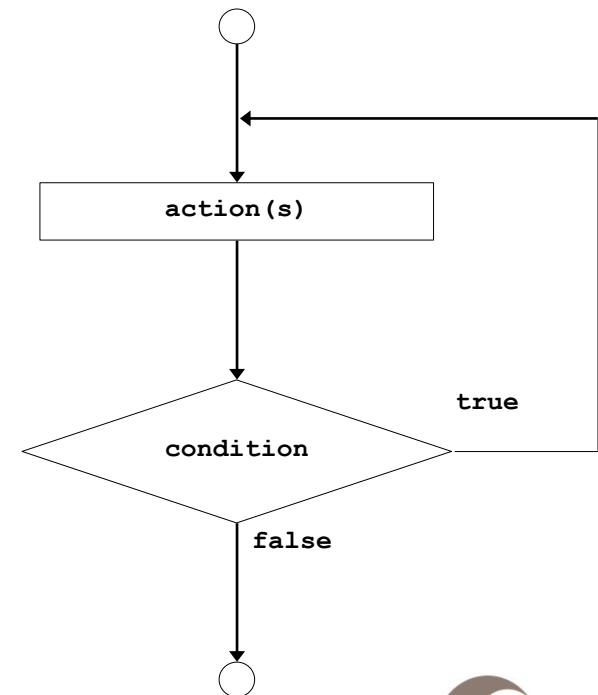
```
do {  
    statement(s)  
} while ( condition );
```

- 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.



7. 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

7. 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

7. 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";
}
```

7. 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";
}
```

7. 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.

8. Nested Control Structures

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

```
#include <iostream.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 ;
}
```

8. Nested Control Structures

Multiplication Table of 5

```
#include <iostream.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 ;
    }
}
```

8. Nested Control Structures

Multiplication Table of n

```
#include <iostream.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 ;
    }
}
```

8. Nested Control Structures

* * * * *

* * * * *

* * * * *

* * * * *

* * * * *

```
for (int i=1; i<=5; i++){  
    for (int j=1; j<=5; j++){  
  
        cout<<"*";  
    }  
    cout<<endl;  
}
```

8. Nested Control Structures

1 1 1 1 1

2 2 2 2 2

3 3 3 3 3

4 4 4 4 4

5 5 5 5 5

```
for (int i=1; i<=5; i++){  
    for (int j=1; j<=5; j++){  
  
        cout<<i;  
    }  
    cout<<endl;  
}
```

8. Nested Control Structures

1 2 3 4 5

1 2 3 4 5

1 2 3 4 5

1 2 3 4 5

1 2 3 4 5

```
for (int i=1; i<=5; i++){  
    for (int j=1; j<=5; j++){  
  
        cout<<j;  
    }  
    cout<<endl;  
}
```

8. Nested Control Structures

```
*  
* *  
* * *  
* * * *  
* * * * *
```

```
for (int i=1; i<=5; i++){  
    for (int j=1; j<=i; j++){  
  
        cout<<"*";  
    }  
    cout<<endl;  
}
```

8. Nested Control Structures

```
1
1 2
1 2 3
1 2 3 4
1 2 3 4 5
```

```
for (int i=1; i<=5; i++){
    for (int j=1; j<=i; j++){

        cout<<j;
    }
    cout<<endl;
}
```


8. Nested Control Structures

```
1
2 2
3 3 3
4 4 4 4
5 5 5 5 5
```

```
for (int i=1; i<=5; i++){
    for (int j=1; j<=i; j++){

        cout<<i;
        }
    cout<<endl;
}
```