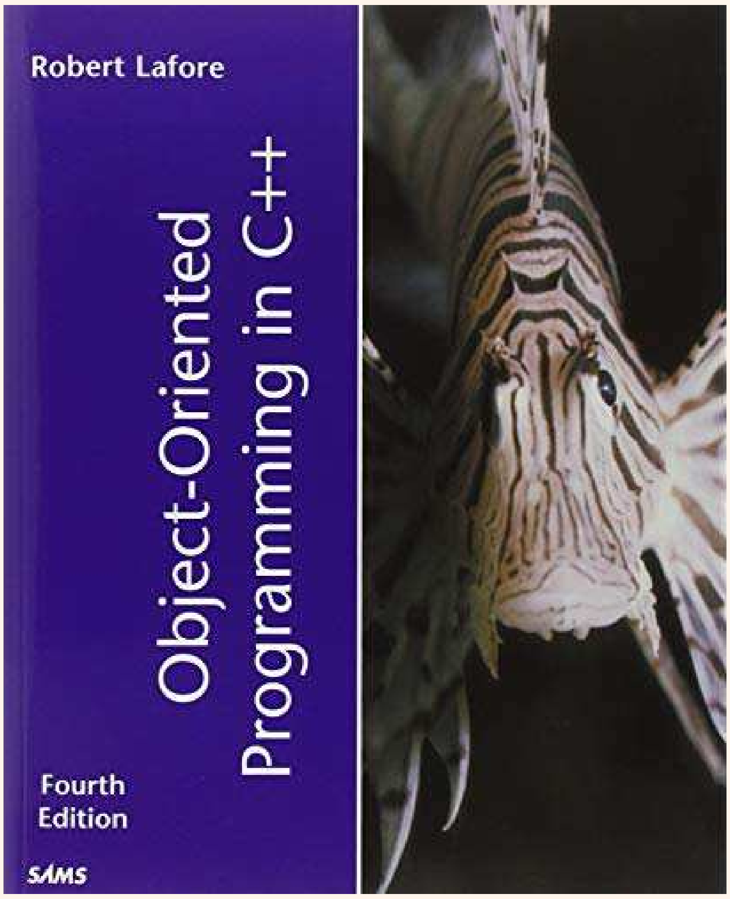


Chapter 3

Loops

&

Decisions

Animated Version

Topics

- Relational Operators
- Loops
- Decisions
- Logical Operators
- Precedence Summary
- Other Control Statements

Relational Operators

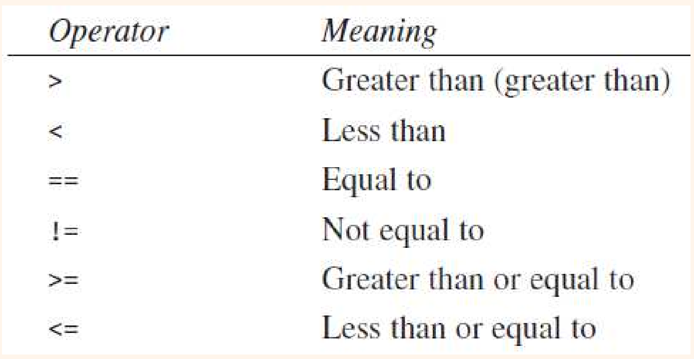
- A relational operator compares two values.
- The comparison involves such relationships as equal to, less than, and greater than.
- The result of the comparison is true or false; for example, either two values are equal (true), or they're not (false).

```cpp
// relat.cpp
// demonstrates relational operators
#include <iostream>
using namespace std;

int main()
   {
   int numb;

   cout << "Enter a number: ";
   cin >> numb;
   cout << "numb<10  is " << (numb < 10)  << endl;
   cout << "numb>10  is " << (numb > 10)  << endl;
   cout << "numb==10 is " << (numb == 10) << endl;
   return 0;
   }
```

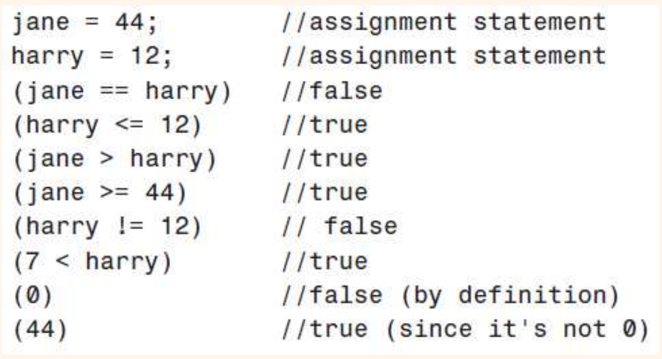
Output:
```
Enter a number: 20
numb<10 is 0
numb>10 is 1
numb==10 is 0
```

Relational Operators (1)

Complete List Of C++ Relational Operators:



Operator	*Meaning*
>	Greater than (greater than)
<	Less than
==	Equal to
!=	Not equal to
>=	Greater than or equal to
<=	Less than or equal to



```
jane = 44;          //assignment statement
harry = 12;         //assignment statement
(jane == harry)     //false
(harry <= 12)       //true
(jane > harry)      //true
(jane >= 44)        //true
(harry != 12)       // false
(7 < harry)         //true
(0)                 //false (by definition)
(44)                //true (since it's not 0)
```

<u>Note that:</u>

- ❑ The equal operator, ==,uses two equal signs. A common mistake is to use a single equal sign—the assignment operator—as a relational operator. This is a nasty bug, since the compiler may not notice anything wrong.
- ❑ C++ generates a 1 to indicate true, it assumes that any value other than 0 (such as –7 or 44) is true; only 0 is false.

Loops

- Loops cause a section of your program to be repeated a certain number of times. The repetition continues while a condition is true. When the condition becomes false, the loop ends and control passes to the statements following the loop.
- three kinds of loops in C++: the `for` loop, the `while` loop, and the `do` loop.

The For Loop:

- The for loop executes a section of code a fixed number of times.
- Basic Construction: `for(j=0; j<15; j++)`
- Here, The for statement controls the loop. It consists of the keyword for, followed by parentheses that contain three expressions separated by semicolons.
- These three expressions are the initialization expression, the test expression, and the increment expression.

Loops (2)

The Initialization Expression:

The initialization expression is executed only once, when the loop first starts. It gives the loop variable an initial value

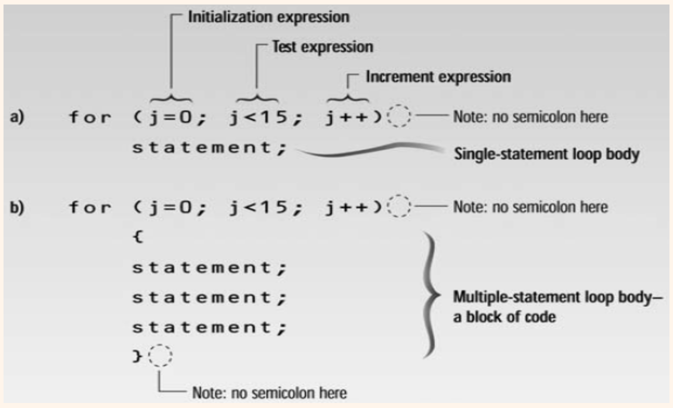
The Test Expression:

The test expression usually involves a relational operator. It is evaluated each time through the loop, just before the body of the loop is executed. It determines whether the loop will be executed again. If the test expression is true, the loop is executed one more time. If it's false, the loop ends, and control passes to the statements following the loop.

The Increment Expression

The increment expression changes the value of the loop variable, often by incrementing it. It is always

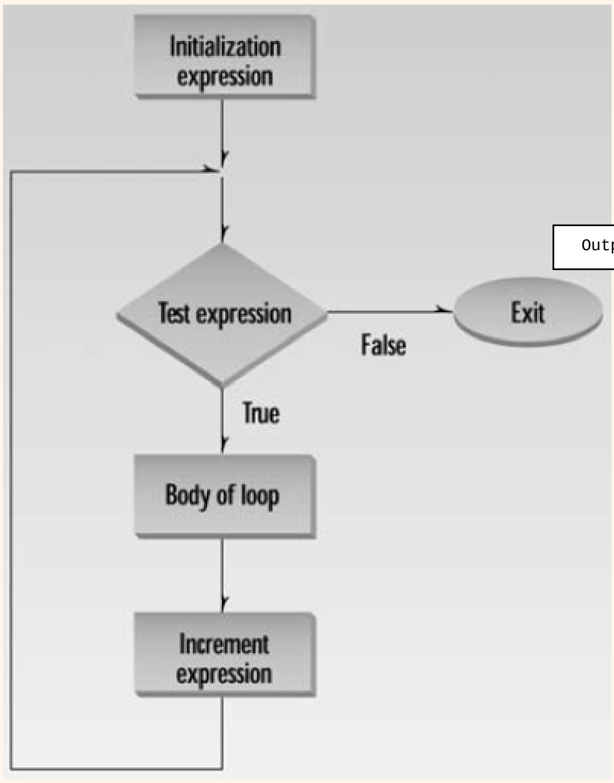
executed at the end of the loop, after the loop body has been executed. Here the increment operator ++ adds 1 to j each time through the loop.



```
for (j=0; j<15; j++)
    statement;
```

```
for (j=0; j<15; j++)
    {
    statement;
    statement;
    statement;
    }
```

Loops (2)



```
// fordemo.cpp
// demonstrates simple FOR loop
#include <iostream>
using namespace std;
int main()
   {
   int j;                           //define a loop
     variable
   for(j=0; j<15; j++)              //loop from 0 to 14,
      cout << j * j << "  ";        //displaying the
     square of j
   cout << endl;
   return 0;    }
```

```
Output: 0   1   4   9   16   25   36  49  64   81   100   121   144   169   196
```

```
// cubelist.cpp
// lists cubes from 1 to 10
#include <iostream>
#include <iomanip>                        //for setw
using namespace std;

int main()
   {
   int numb;                              //define loop variable

   for(numb=1; numb<=10; numb++)          //loop from 1 to 10
      {
      cout << setw(4) << numb;            //display 1st column
      int cube = numb*numb*numb;          //calculate cube
      cout << setw(6) << cube << endl;    //display 2nd column
      }
   return 0;
   }
```

```
Output:
1             1
2             8
3              27
4              64
5              125
6              216
7              343
8              512
9              729
10             1000
```

Loops (3)

```
// factor.cpp
// calculates factorials, demonstrates FOR loop
#include <iostream>
using namespace std;

int main()
   {
   unsigned int numb;
   unsigned long fact=1;           //long for lar

   cout << "Enter a number: ";
   cin >> numb;                    //get number

   for(int j=numb; j>0; j--)       //multiply 1 by
      fact *= j;                   //numb, numb-1, ..., 2, 1
   cout << "Factorial is " << fact << endl;
   return 0;
   }
```

-Variables Defined in for Statements

decrements the loop variable

```
Output:
Enter a number: 10
Factorial is 3628800
```

```
for( j=0, alpha=100; j<50; j++, beta-- )
   {
   // body of loop
   }
```

-Multiple Initialization and Test Expressions

Loops(4)

The While Loop:

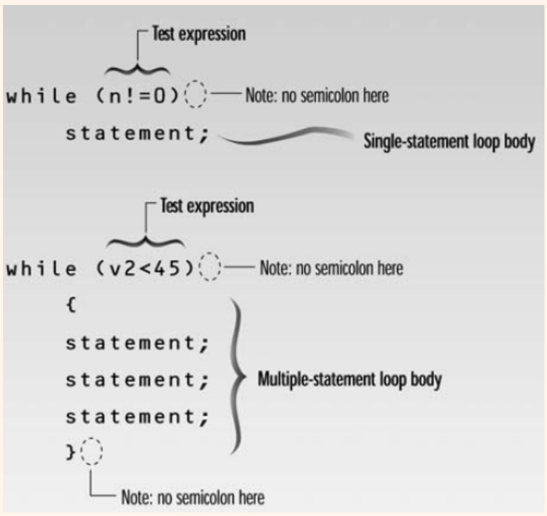
The for loop does something a fixed number of

Times but While loop is used when you don't know how many times you want to do something before you start the loop.

❑The while loop looks like a simplified version of the for loop. It contains a test expression but no initialization or increment expressions.

❑In a while loop, the test expression is evaluated at the beginning of the loop. If the test expression is false when the loop is entered, the loop body won't be executed at all.

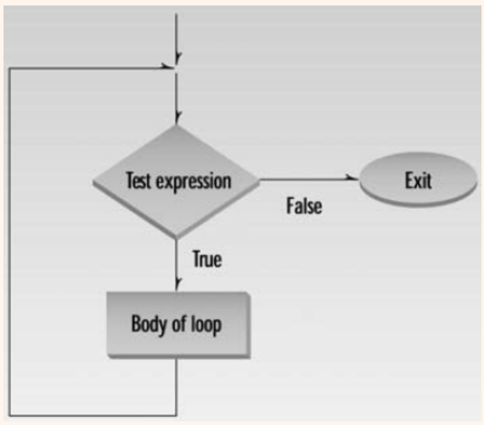
❑Multiple statement is also used in while loop.



```
// endon0.cpp
// demonstrates WHILE loop
#include <iostream>
using namespace std;
int main()
   {
   int n = 99;        // make sure n isn't
     initialized to 0

   while( n != 0 )   // loop until n is 0
      cin >> n;      // read a number into n
   cout << endl;
   return 0;    }
```

```
Output:
1
27
33
144
9
0
```

Loops (5)



```
// while4.cpp
// prints numbers raised to fourth power
#include <iostream>
#include <iomanip>                  //for setw
using namespace std;

int main()
   {
   int pow=1;                       //power initially 1
   int numb=1;                      //numb goes from 1 to ???

   while( pow<10000 )               //loop while power <= 4 digits
      {
      cout << setw(2) << numb;            //display number
      cout << setw(5) << pow << endl;     //display fourth power
      ++numb;                             //get ready for next
     power
      pow = numb*numb*numb*numb;          //calculate fourth power
      }
   cout << endl;
   return 0;
   }
```

```
Output:
1            1
2            16
3             81
4             256
5             625
6             1296
7             2401
8             4096
9             6561
```

```
// fibo.cpp
// demonstrates WHILE loops using fibonacci series
#include <iostream>
using namespace std;

int main()
   {                          //largest unsigned long
   const unsigned long limit = 4294967295;
   unsigned long next=0;      //next-to-last term
   unsigned long last=1;      //last term

   while( next < limit / 2 )  //don't let results get too big
      {
      cout << last << "  ";   //display last term
      long sum = next + last; //add last two terms
      next = last;            //variables move forward
      last = sum;             //   in the series
      }
   cout << endl;
   return 0;
   }
```

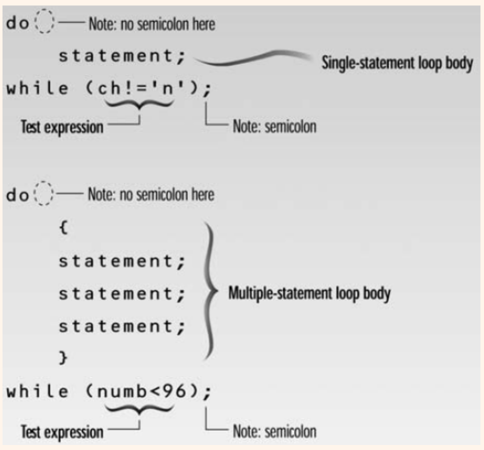
```
Output:
1 1 2 3 5 8 13 21 34 55 89 144 233 377 610 987 1597 2584 4181 6765 10946
17711 28657 46368 75025 121393 196418 317811 514229 832040 1346269 2178309
3524578 5702887 9227465 14930352 24157817 39088169 63245986 102334155
165580141 267914296 433494437 701408733 1134903170 1836311903 2971215073
```

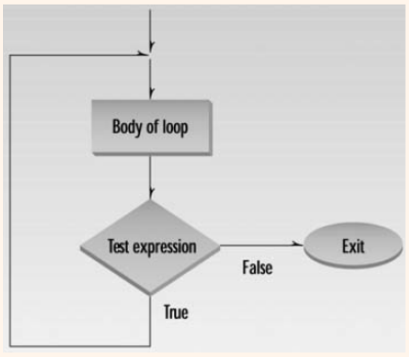
Arithmetic Vs. Relational Operator:

- Arithmetic operators have a higher precedence than relational operators.

Loops (7)

- do Loop: the loop body is executed at least once, no matter what the initial state of the test expression then do loop is used.





```
// divdo.cpp
// demonstrates DO loop
#include <iostream>
using namespace std;

int main()
   {
   long dividend, divisor;
   char ch;

   do                                       //start of do loop
      {                                     //do some processing
      cout << "Enter dividend: "; cin >> dividend;
      cout << "Enter divisor: ";  cin >> divisor;
      cout << "Quotient is " << dividend / divisor;
      cout << ", remainder is " << dividend % divisor;

      cout << "\nDo another? (y/n): ";  //do it again?
      cin >> ch;
      }
   while( ch != 'n' );                      //loop condition
   return 0;
   }
```

Output:

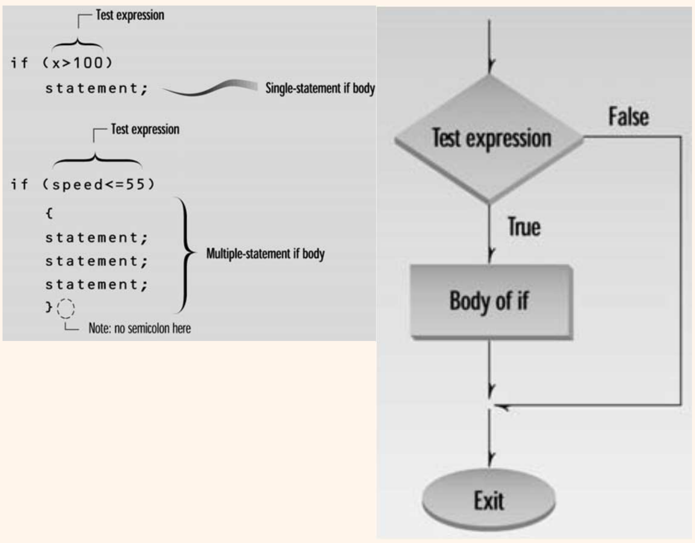
```
Enter dividend: 11
Enter divisor: 3
Quotient is 3, remainder is 2
Do another? (y/n): y
Enter dividend: 222
Enter divisor: 17
Quotient is 13, remainder is 1
Do another? (y/n): n
```

When to Use Which Loop

- The for loop is appropriate when you know in advance how many times the loop will be executed.
- The while and do loops are used when you don’t know in advance when the loop will terminate
  - – the while loop when you may not want to execute the loop body even once, and
  - – the do loop when you’re sure you want to execute the loop body at least once.

Decisions: The `if` Statement (1)

- The if statement is the simplest of the decision statements.
- The if keyword is followed by a test expression in parentheses
- the syntax of if is very much like that of while The difference is that the statements following the if are executed only once if the test expression is true.
- You can nest ifs inside loops, loops inside ifs, ifs inside ifs, and so on.



```
// ifdemo.cpp
// demonstrates IF statement
#include <iostream>
using namespace std;

int main()
   {
   int x;

   cout << "Enter a number: ";
   cin >> x;
   if( x > 100 )
      cout << "That number is greater than 100\n";
   return 0;
   }
```

Output:
```
Enter a number: 2000
That number is greater than 100
```

The `if` Statement (2)

- Multiple Statements in the `if` Body

```
// if2.cpp
// demonstrates IF with multiline body
#include <iostream>
using namespace std;

int main()
   {
   int x;

   cout << "Enter a number: ";
   cin >> x;
   if( x > 100 )
      {
      cout << "The number " << x;
      cout << " is greater than 100\n";
      }
   return 0;
   }
```

Output:
```
Enter a number: 12345
The number 12345 is greater than 100
```

- Nesting `if` s Inside Loops

```
// prime.cpp
// demonstrates IF statement with prime numbers
#include <iostream>
using namespace std;
#include <process.h>              //for exit()

int main()
   {
   unsigned long n, j;

   cout << "Enter a number: ";
   cin >> n;                      //get number to
     test
   for(j=2; j <= n/2; j++)        //divide by every
     integer from
      if(n%j == 0)                //2 on up; if
     remainder is 0,
         {                        //it's divisible
     by j
         cout << "It's not prime; divisible by "
     << j << endl;
         exit(0);                 //exit from the
     program
         }
   cout << "It's prime\n";
   return 0;
   }
```

Output:
```
Enter a number: 13
It’s prime
Enter a number: 22229
It’s prime
Enter a number: 22231
It’s not prime; divisible by 11
```

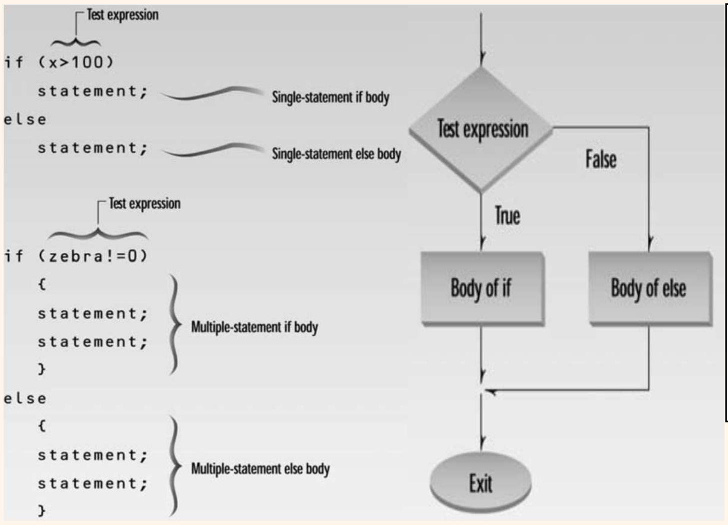
- causes the program to terminate, no matter where it is in the listing.
- argument is returned to the operating system when the program exits.
  - 0: successful termination;
  - other numbers: errors.

Decisions: The `if...else` Statement

– The if statement lets you do something if a condition is true. If it isn't true, nothing happens.

– But suppose we want to do one thing if a condition is true, and do something else if it's false. That's where the if...else statement comes in.

– It consists of an if statement, followed by a statement or block of statements, followed by the keyword else, followed by another statement or block of statements.



```
if (x>100)
    statement;
else
    statement;

if (zebra!=0)
    {
    statement;
    statement;
    }
else
    {
    statement;
    statement;
    }
```

```
// ifelse.cpp
// demonstrates IF...ELSE statememt
#include <iostream>
using namespace std;

int main()
   {
   int x;

   cout << "\nEnter a number: ";
   cin >> x;
   if( x > 100 )
      cout << "That number is greater than 100\n";
   else
      cout << "That number is not greater than
     100\n";
   return 0;
   }
```

```
Output:
Enter a number: 300
That number is greater than 100
Enter a number: 3
That number is not greater than
100
```

Style Guide

```
if ( <boolean expression> ) {
      …
} else {
      …
}
```

Style 1

```
if ( <boolean expression> )
{
      …
}
else
{
      …
}
```

Style 2

Decisions: The `if...else` Statement (2)

- The `getche()` Library Function
  - cin and >>: requires the user always press the Enter key
  - getche(): returns each character as soon as it’s typed
  - requires the CONIO.H header file
  - getch(): doesn’t echo the character to the screen

```cpp
// chcount.cpp
// counts characters and words typed in
#include <iostream>
using namespace std;
#include <conio.h>            //for getche()

int main()
   {
   int chcount=0;      //counts non-space characters
   int wdcount=1;      //counts spaces between words
   char ch = 'a';             //ensure it isn't '\r'

   cout << "Enter a phrase: ";
   while( ch != '\r' )        //loop until Enter typed
      {
      ch = getche();          //read one character
      if( ch==' ' )           //if it's a space
      wdcount++;              //count a word
      else                    //otherwise,
      chcount++;              //count a character
      }                       //display results
   cout << "\nWords=" << wdcount << endl
        << "Letters=" << (chcount-1) << endl;
   return 0;
   }
```

```
Output:
For while and do
Words=4
Letters=13
```

- With assignment expressions

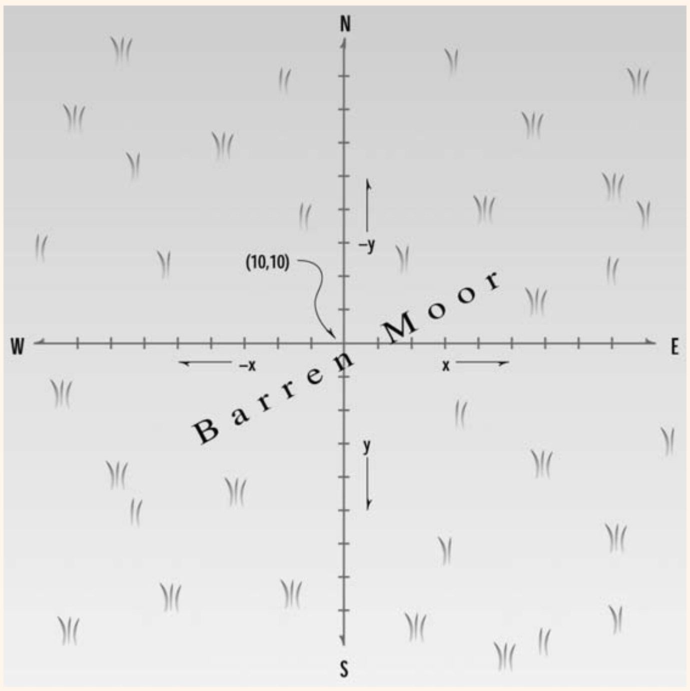
```cpp
// chcnt2.cpp
// counts characters and words typed in
#include <iostream>
using namespace std;
#include <conio.h>            // for getche()

int main()
   {
   int chcount=0;
   int wdcount=1;             // space between two words
   char ch;

   while( (ch=getche()) != '\r' )  // loop until Enter typed
      {
      if( ch==' ' )           // if it's a space
         wdcount++;           // count a word
      else                    // otherwise,
         chcount++;           // count a character
      }                       // display results
   cout << "\nWords=" << wdcount << endl
        << "Letters=" << chcount << endl;
   return 0;
   }
```

```
Output:
Enter a number: 13
It’s prime
Enter a number: 22229
It’s prime
Enter a number: 22231
It’s not prime; divisible by 11
```

Nested `if...else` Statements

```cpp
// adelseif.cpp
// demonstrates ELSE...IF with adventure program
#include <iostream>
using namespace std;
#include <conio.h>              //for getche()

int main()
   {
   char dir='a';
   int x=10, y=10;

   cout << "Type Enter to quit\n";
   while( dir != '\r' )         //until Enter is typed
      {
      cout << "\nYour location is " << x << ", " << y;
      cout << "\nPress direction key (n, s, e, w): ";
      dir = getche();           //get character
      if( dir=='n')             //go north
         y--;
      else if( dir=='s' )       //go south
         y++;
      else if( dir=='e' )       //go east
         x++;
      else if( dir=='w' )       //go west
         x--;
      }  //end while
   return 0;
   }  //end main
```

```
Output:
Your location is 10, 10
Press direction key (n, s, e, w): n
Your location is 10, 9
Press direction key (n, s, e, w): e
Your location is 11, 9
Press direction key (n, s, e, w):
```



Matching else

Are A and B different?

```
if (x < y)                          A
   if (x < z)
       cout<<"Hello";
else
    cout<<"Good bye";
```

```
if (x < y)                          B
   if (x < z)
     cout<<"Hello";
   else
     cout<<"Good bye";
```

Both A and B means...

```
if (x < y) {
   if (x < z) {
      cout<<"Hello";
   } else {
      cout<<"Good bye";
   }
}
```

The else...if Construction

- The nested if...else statements in the program look clumsy and can be hard—for humans—to interpret, especially if they are nested more deeply than shown.
- `else...if`: another approach to writing the same statements.

```
// adelseif.cpp
// demonstrates ELSE...IF with adventure program
#include <iostream>
using namespace std;
#include <conio.h>              //for getche()

int main()
   {
   char dir='a';
   int x=10, y=10;

   cout << "Type Enter to quit\n";
   while( dir != '\r' )         //until Enter is typed
      {
      cout << "\nYour location is " << x << ", " << y;
      cout << "\nPress direction key (n, s, e, w): ";
      dir = getche();           //get character
      if( dir=='n')             //go north
         y--;
      else if( dir=='s' )       //go south
         y++;
      else if( dir=='e' )       //go east
         x++;
      else if( dir=='w' )       //go west
         x--;
      }  //end while
   return 0;
   }  //end main
```

clearer and easier to follow than the if...else approach.

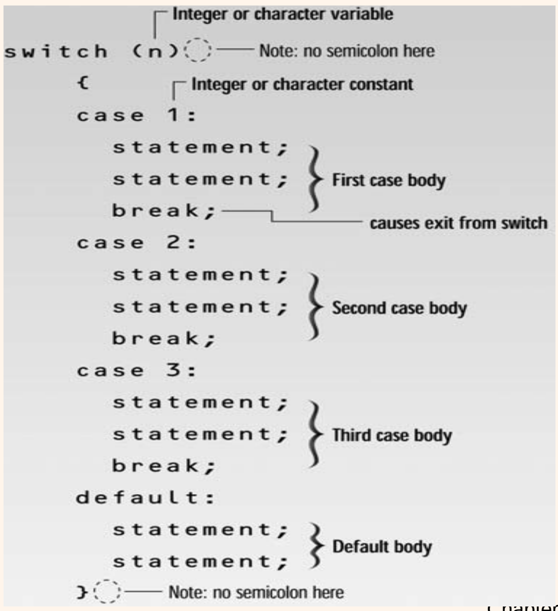
```
Output:
Your location is 10, 10
Press direction key (n, s, e, w): n
Your location is 10, 9
Press direction key (n, s, e, w): e
Your location is 11, 9
Press direction key (n, s, e, w):
```

The switch Statement

- If you have a large decision tree, and all the decisions depend on the value of the same variable -> consider switch statement
- `else…if`: another approach to writing the same statements.
  - Before entering the switch, the program should assign a value to the switch variable.
  - This value will usually match a constant in one of the case statements.
  - the statements immediately following the keyword case will be executed, until a break is reached

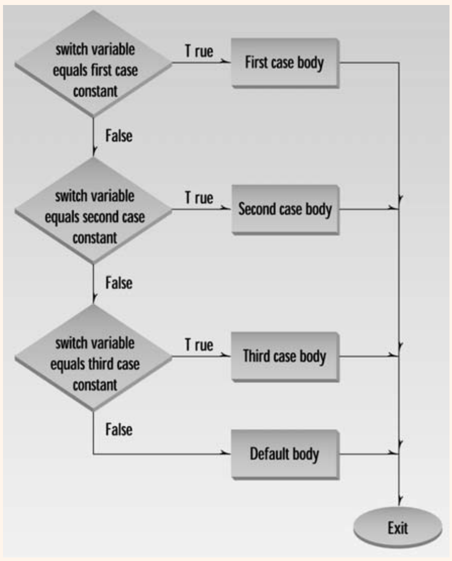
```
// platters.cpp
// demonstrates SWITCH statement
#include <iostream>
using namespace std;

int main()
   {
   int speed;                     //turntable speed

   cout << "\nEnter 33, 45, or 78: ";
   cin >> speed;                  //user enters speed
   switch(speed)               //selection based on speed
      {
      case 33:                       //user entered 33
         cout << "LP album\n";
         break;
      case 45:                       //user entered 45
         cout << "Single selection\n";
         break;
      case 78:                       //user entered 78
         cout << "Obsolete format\n";
         break;
      }
   return 0;
   }
```

```
Output:
Enter 33, 45, or 78: 45
Single selection
```



The switch Statement (2)

- The `break` Statement


switch variable equals first case constant
True
First case body
False
switch variable equals second case constant
True
Second case body
False
switch variable equals third case constant
True
Third case body
False
Default body
Exit

- causes the entire switch statement to exit.
- without it, control passes down (or "falls through") to the statements for the next case

- The `default` Keyword

```
// adswitch.cpp
// demonstrates SWITCH with adventure program
#include <iostream>
using namespace std;
#include <conio.h>                          //for getche()

int main()
   {
   char dir='a';
   int x=10, y=10;

   while( dir != '\r' )
      {
      cout << "\nYour location is " << x << ", " << y;
      cout << "\nEnter direction (n, s, e, w): ";
      dir = getche();                        //get character
      switch(dir)                             //switch on it
         {
         case 'n':  y--; break;               //go north
         case 's':  y++; break;               //go south
         case 'e':  x++; break;               //go east
         case 'w':  x--; break;               //go west
         case '\r': cout << "Exiting\n"; break; //Enter key
         default:   cout << "Try again\n";     //unknown char
         }  //end switch
      }  //end while
   return 0;
   }  //end main
```

- take an action if the value of the loop variable doesn't match any of the case constants
- No break is necessary after default

`switch` Versus `if...else`

- if statement:
  - » you can use a series of expressions that involve unrelated variables and are as complex as you like

```
if( SteamPressure*Factor > 56 )
   // statements
else if( VoltageIn + VoltageOut < 23000)
   // statements
else if( day==Thursday )
   // statements
else
   // statements
```

- switch statement:
  - » all the branches are selected by the same variable;
  - » the only thing distinguishing one branch from another is the value of this variable.
  - » The case constant must be an integer or character constant
  - » You cannot say:

```
case a<3:
   // do something
   break;
```

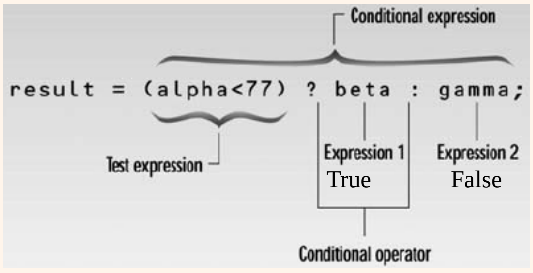
  - » very clean—easy to write and to understand

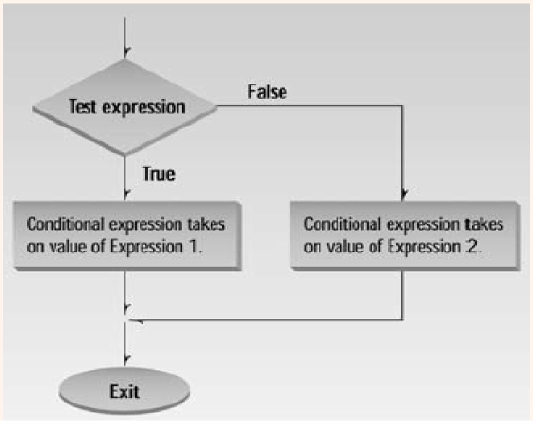
Conditional Operator

- consists of two symbols, which operate on three operands

```
if( alpha < beta )
   min = alpha;
else
   min = beta;
```

```
min = (alpha<beta) ? alpha : beta;
```



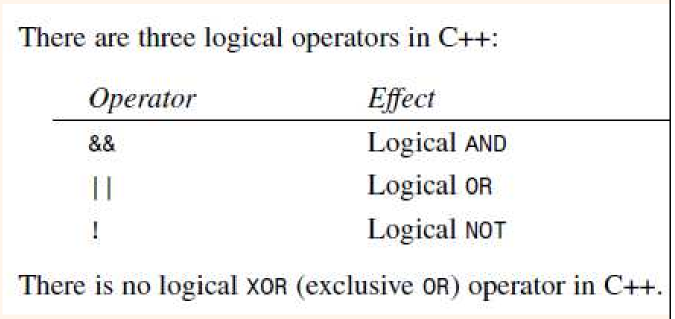

Test expression
False
True
Conditional expression takes on value of Expression 1.
Conditional expression takes on value of Expression 2.
Exit

```
// condi.cpp
// prints 'x' every 8 columns
// demonstrates conditional operator
#include <iostream>
using namespace std;

int main()
   {
   for(int j=0; j<80; j++)           //for every column,
      {                              //ch is 'x' if
     column is
      char ch = (j%8) ? ' ' : 'x';   //multiple of 8,
     and
      cout << ch;                    //' ' (space)
     otherwise
      }
   return 0;
   }
```

```
Output:
x       x       x       x       x       x       x       x       x
```

Logical Operators

- allow you to logically combine Boolean variables
- Logical AND Operator:


There are three logical operators in C++:

Operator	*Effect*
&&	Logical AND
||	Logical OR
!	Logical NOT

There is no logical XOR (exclusive OR) operator in C++.

```
// advenand.cpp
// demonstrates AND logical operator
#include <iostream>
using namespace std;
#include <process.h>              //for exit()
#include <conio.h>                //for getche()

int main()
   {
   char dir='a';
   int x=10, y=10;

   while( dir != '\r' )
      {
      cout << "\nYour location is " << x << ", " << y;
      cout << "\nEnter direction (n, s, e, w): ";
      dir = getche();             //get direction
      switch(dir)
         {
         case 'n': y--; break;    //update coordinates
         case 's': y++; break;
         case 'e': x++; break;
         case 'w': x--; break;
         }
      if( x==7 && y==11 )         //if x is 7 and y is 11
         {
         cout << "\nYou found the treasure!\n";
         exit(0);                 //exit from program
         }
      }  //end switch
   return 0;
   }  //end main
```

```
Output:
Your location is 7, 10
Enter direction (n, s, e, w): s
You found the treasure!
```

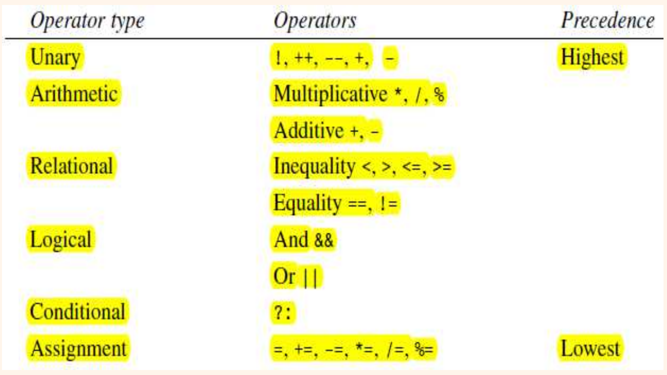
Logical Operators

- Logical OR Operator:

```
// advenor.cpp
// demonstrates OR logical operator
#include <iostream>
using namespace std;
#include <process.h>              //for exit()
#include <conio.h>                //for getche()

int main()
   {
   char dir='a';
   int x=10, y=10;

   while( dir != '\r' )           //quit on Enter key
      {
      cout << "\n\nYour location is " << x << ", " << y;

      if( x<5 || x>15 )           //if x west of 5 OR east of
     15
         cout << "\nBeware: dragons lurk here";

      cout << "\nEnter direction (n, s, e, w): ";
      dir = getche();             //get direction
      switch(dir)
         {
         case 'n': y--; break;    //update coordinates
         case 's': y++; break;
         case 'e': x++; break;
         case 'w': x--; break;
         }  //end switch
      }  //end while
   return 0;
   }  //end main()
```

- The NOT Operator
  - a unary operator—that is, it takes only one operand.
  - If something is true, ! makes it false; if it is false, ! makes it true.

- Precedence Summary

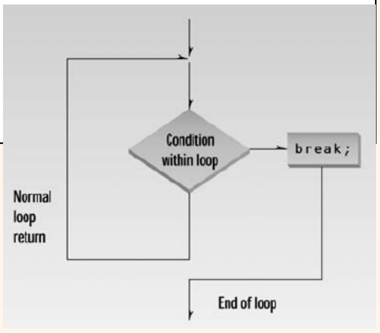


Operator type	*Operators*	*Precedence*
Unary	!, ++, --, +, -	Highest
Arithmetic	Multiplicative *, /, %	
	Additive +, -	
Relational	Inequality <, >, <=, >=	
	Equality ==, !=	
Logical	And &&	
	Or ||	
Conditional	?:	
Assignment	=, +=, -=, *=, /=, %=	Lowest

Other Control Statements

- The `break` Statement

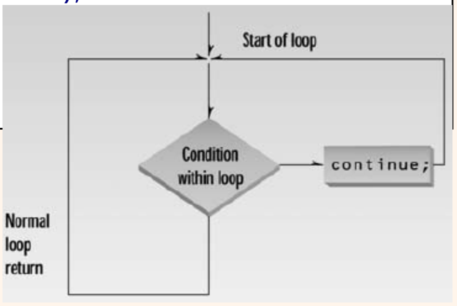
```
// showprim.cpp
// displays prime number distribution
#include <iostream>
using namespace std;
#include <conio.h>               //for getche()

int main()
   {
   const unsigned char WHITE = 219;  //solid color
     (primes)
   const unsigned char GRAY  = 176;  //gray (non primes)
   unsigned char ch;
                              //for each screen position
   for(int count=0; count<80*25-1; count++)
      {
      ch = WHITE;                //assume it's prime
      for(int j=2; j<count; j++) //divide by every
     integer from
         if(count%j == 0)  //2 on up; if remainder is 0,
            {
            ch = GRAY;           //it's not prime
            break;               //break out of inner
     loop
            }
      cout << ch;
      }
   getche();
   return 0;
   }
```



- The `continue` Statement

```
// divdo2.cpp
// demonstrates CONTINUE statement
#include <iostream>
using namespace std;

int main()
   {
   long dividend, divisor;
   char ch;

   do {
      cout << "Enter dividend: "; cin >> dividend;
      cout << "Enter divisor: ";  cin >> divisor;
      if( divisor == 0 )             //if attempt to
         {                           //divide by 0,
         cout << "Illegal divisor\n";  //display message
         continue;                   //go to top of
     loop
         }
      cout << "Quotient is " << dividend / divisor;
      cout << ", remainder is " << dividend % divisor;

      cout << "\nDo another? (y/n): ";
      cin >> ch;
      } while( ch != 'n' );
   return 0;
   }
```

Output:
```
Enter dividend: 10
Enter divisor: 0
Illegal divisor
Enter dividend:
```



Summary (1)

- Relational operators compare two values to see whether they're equal, whether one is larger than the other, and so on.
  – The result is a logical or Boolean (type bool) value, which is true or false.
  – False is indicated by 0, and true by 1 or any other non-zero number.
- There are three kinds of loops in C++.
  – The for loop is most often used when you know in advance how many times you want to execute the loop.
  – The while loop and do loops are used when the condition causing the loop to terminate arises within the loop, with the while loop not necessarily executing at all, and the do loop always executing at least once.
- A loop body can be a single statement or a block of multiple statements delimited by braces. A variable defined within a block is visible only within that block.

Summary (2)

- There are four kinds of decision-making statements.
  - The if statement does something if a test expression is true.
  - The if...else statement does one thing if the test expression is true, and another thing if it isn't. The else if construction is a way of rewriting a ladder of nested if...else statements to make it more readable.
  - The switch statement branches to multiple sections of code, depending on the value of a single variable.
  - The conditional operator simplifies returning one value if a test expression is true, and another if it's false.
- Logiical operators:
  - The logical AND and OR operators combine two Boolean expressions to yield another one, and the logical NOT operator changes a Boolean value from true to false, or from false to true.
- The break statement sends control to the end of the innermost loop or switch in which it occurs.
- The continue statement sends control to the top of the loop in which it occurs.