03: CONTROL STRUCTURES

Programming Technique I
(SCSJ1013)

Boolean and Logical Operator

- In C++ logical data declared as `bool` data type

  e.g.

  ```
  bool variable_name;
  ```

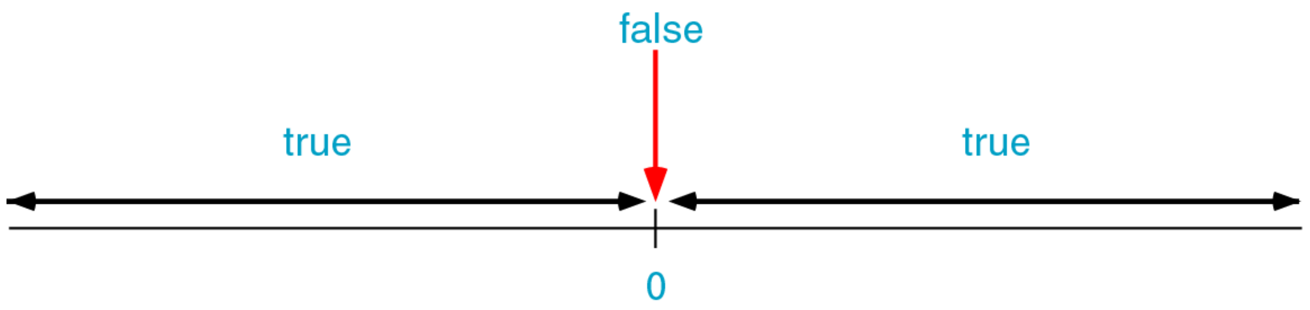
- There are only two values: `true` and `false`
- Type-casting `bool` to `int`:
  - `true => 1`
  - `false => 0`

  Example

```
int number;
number = 2 + true;
cout << number; //output: 3
```

Boolean and Logical Operator

- Type-casting `int` to `bool`:
  - A *Zero value* => `false`
  - A *Non-Zero value* => `true`



Example:

```
bool b = false;        // b initially is false
int number = 0;
b = -10;               // Now, b is true
b = number;            // Here, b is false again
```

Boolean and Logical Operator

What would be printed by this code segment

```
bool b;
int p;
int q = 5;

b = q;
p = b;
cout <<"The value of p is " << p <<endl;
```

```
Output:

The value of p is 1
```

Logical operators truth table

not

x	!x
false	true
true	false

logical

!

x	!x
zero	1
nonzero	0

C Language

and

x	y	x&&y
false	false	false
false	true	false
true	false	false
true	true	true

logical

&&

x	y	x&&y
zero	zero	0
zero	nonzero	0
nonzero	zero	0
nonzero	nonzero	1

C Language

or

x	y	x||y
false	false	false
false	true	true
true	false	true
true	true	true

logical

||

x	y	x||y
zero	zero	0
zero	nonzero	1
nonzero	zero	1
nonzero	nonzero	1

C Language

Operations for logical and/or

false && (anything) → false

true || (anything) → true

Relational operators

Operator	Meaning
<	less than
<=	less than or equal
>	greater than
>=	greater than or equal
==	equal
!=	not equal

Logical expression

Example:

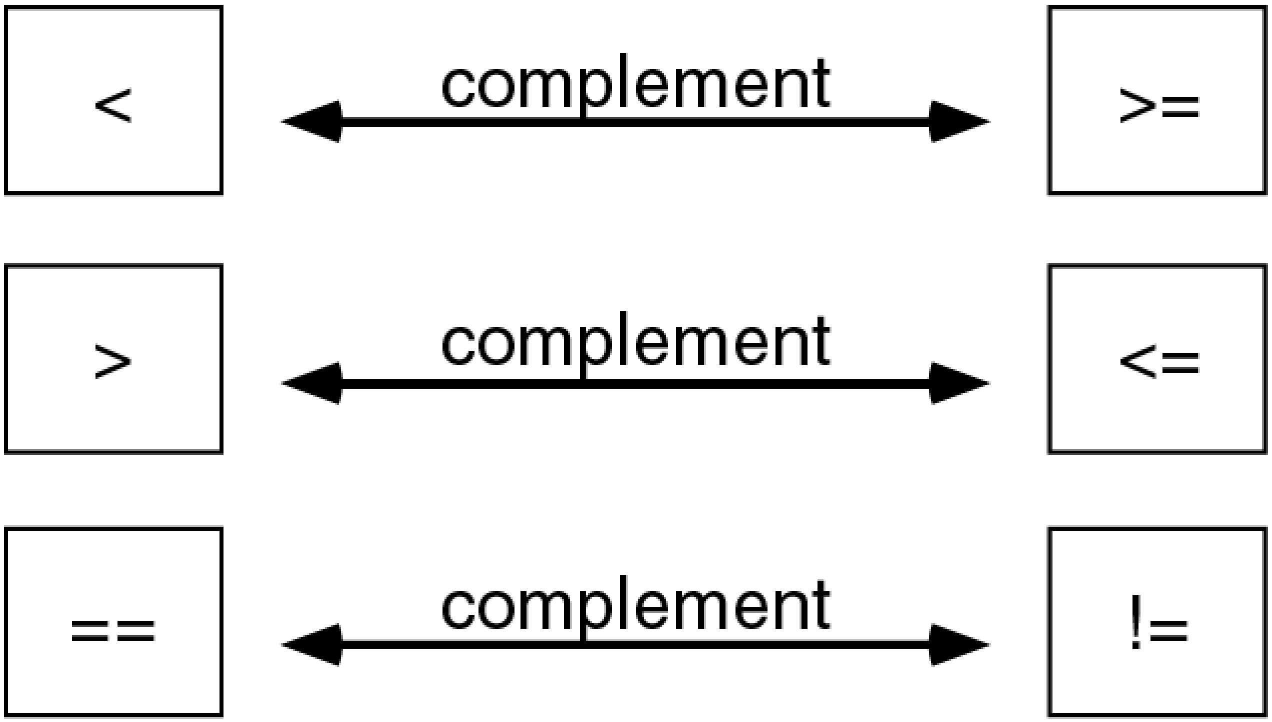
```
int a=10;

cout << a;
cout << (a==1);
cout << (a>1);
cout << (a=5);

a = (a != 5);
out << a;
```

- `cout << a;` — Prints **10**
- `cout << (a==1);` — Prints **0.** Is 10==1 ? => false =>0
- `cout << (a>1);` — Prints **1.** Is 10>1 ? => true => 1
- `cout << (a=5);` — Prints **5.** This is not a logical expression. It is an assignment expression.
- `out << a;` — Prints **0.** Is 5!=5 ? => false =>0

Logical operator complements



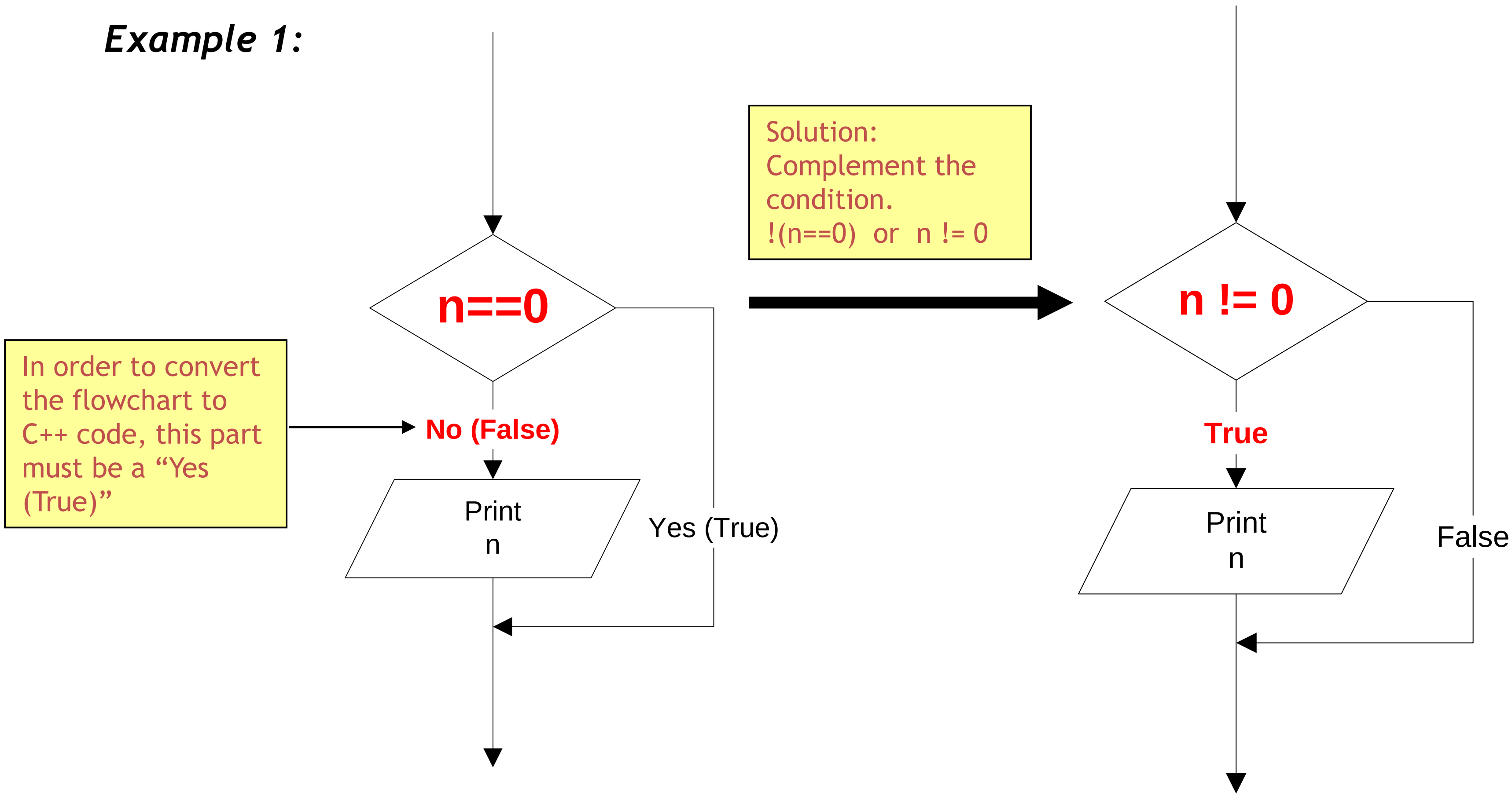
- Another way to complement an expression is just putting a Not operator (!) in front of it.

Example: Complement of n==0 is

`!(n==0)`

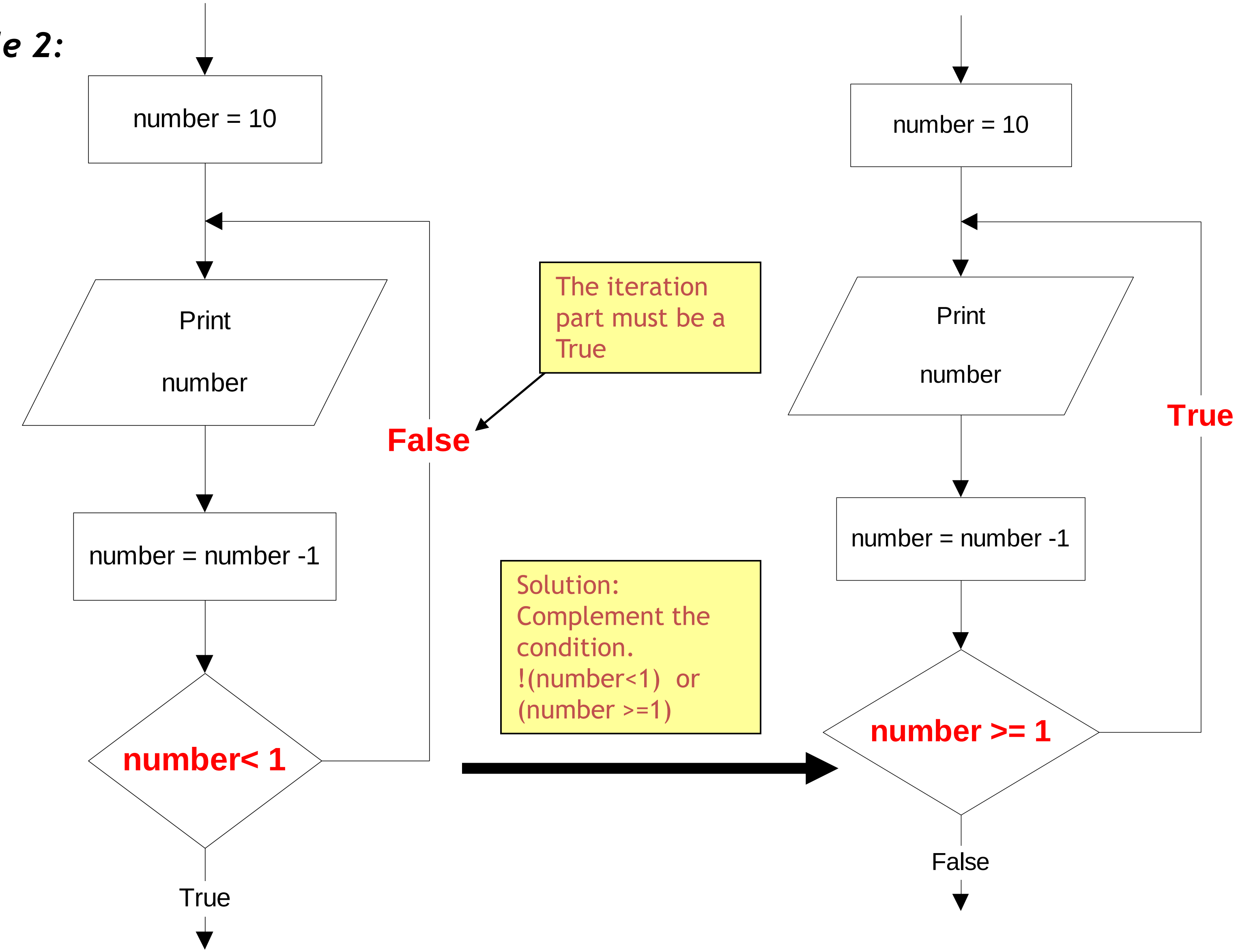
- **When to use complement?**

Example 1:



- **When to use complement?**

Example 2:



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Selection / Branch

- Sometimes your programs need to make logical choices.
- Example:

  IF score is higher than 50

  THEN grade is PASS

  ELSE grade is FAIL

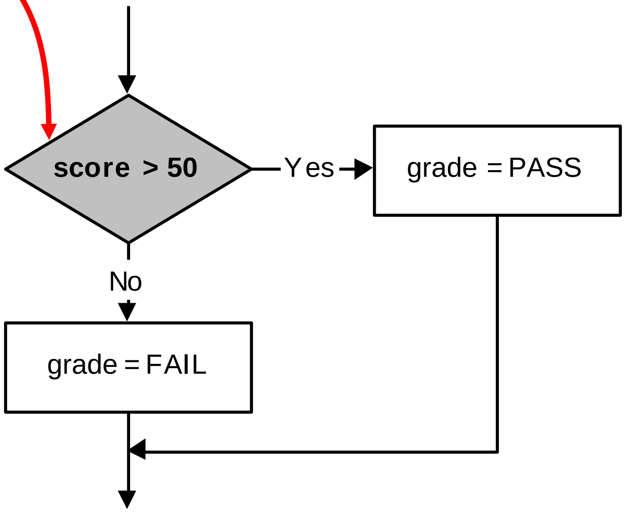
- In C++, this corresponds to **`if`** statement with three parts:

```
if (score > 50)   //part 1
{
     grade  = PASS;   //part 2
}
else
{
     grade = FAIL;   //part 3
}
```

`if` statement

- Part 1 : the **condition** - an expression that evaluates to `true` or `false`.

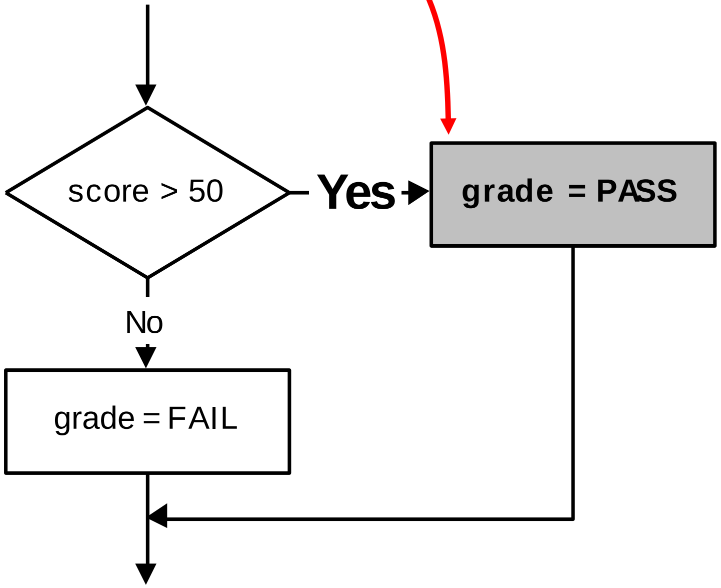
```
if (score > 50)
{
     grade  = PASS;
}
else
{
     grade = FAIL;
}
```



if statement

- Part 2 : the **TRUE-PART** - a block of statements that are executed if the condition evaluates to `true`

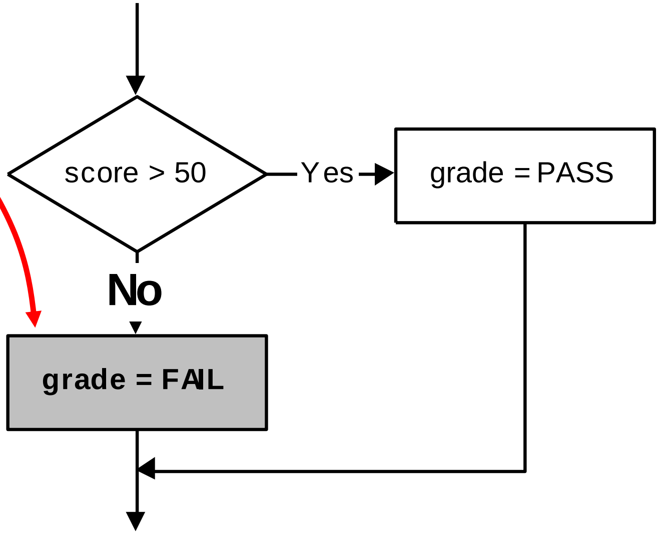
```
if (score > 50)
 {
      grade  = PASS;
 }
else
 {
      grade = FAIL;
 }
```



`if` statement

- Part 3 : the **FALSE-PART** - a block of statements that are executed if the condition evaluates to `false`

```
if (score > 50)
{
    grade = PASS;
}
else
{
    grade  = FAIL;
}
```

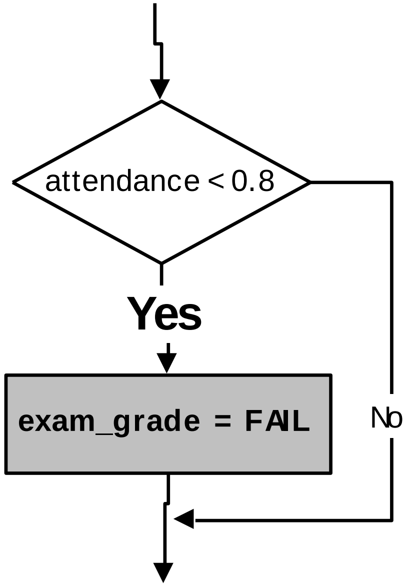


if the condition evaluates to `false`, the TRUE-PART is skipped.

`if` statement

- Sometimes there is no FALSE-PART. The "**`else`**" is omitted

```
if ( attendance < 0.8 )
{
    exam_grade = FAIL;
}
```



`if` statement

- If the TRUE-PART (or FALSE-PART) consists of only one statement, then the curly braces may be omitted.

- *Example: these two statements are equivalent:*

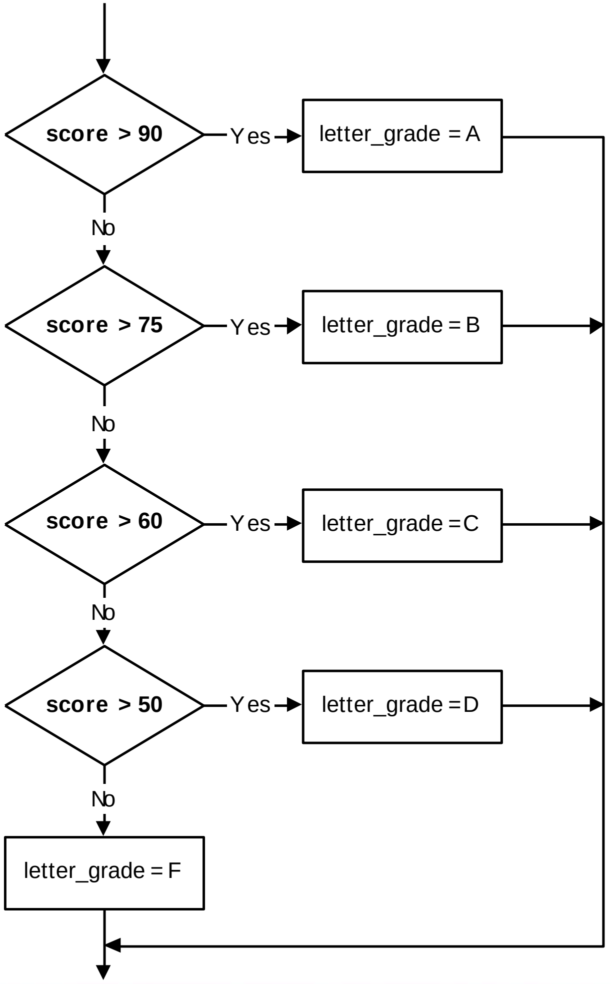
```
if (score > 50)
{
   grade   = PASS;
}
else
{
   grade = FAIL;
}
```

```
if (score > 50)
      grade   = PASS;
else
      grade = FAIL;
```

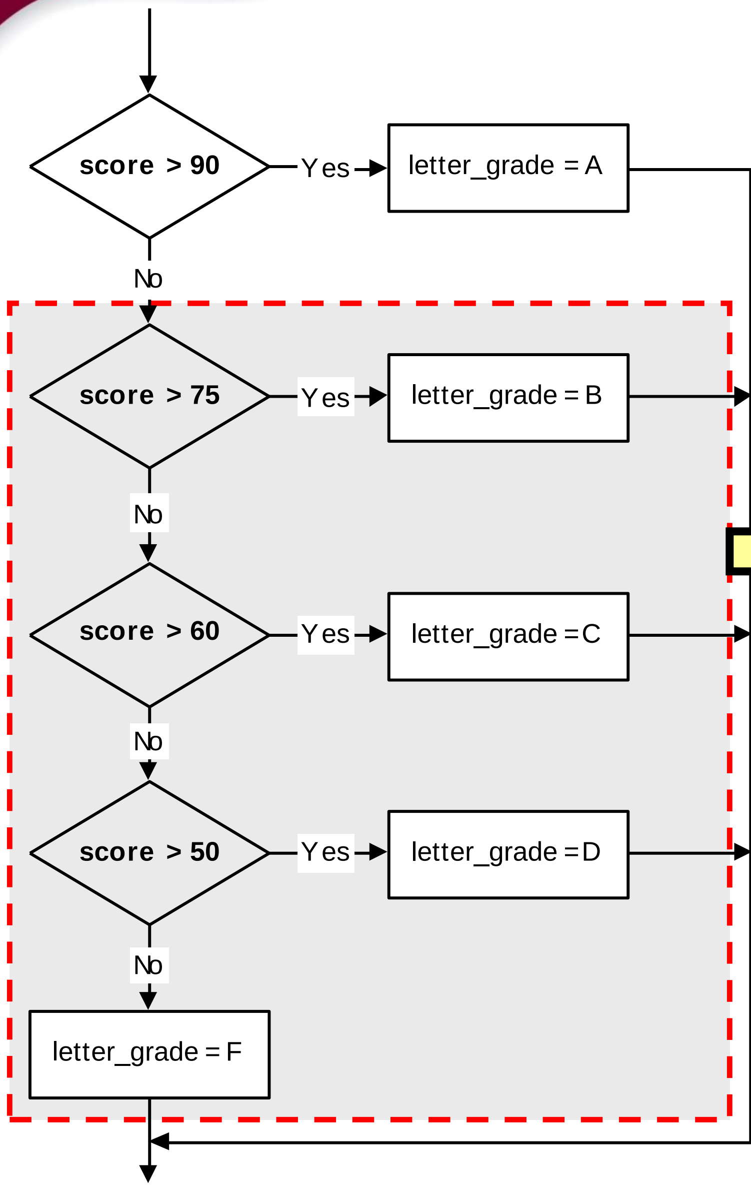
if statement

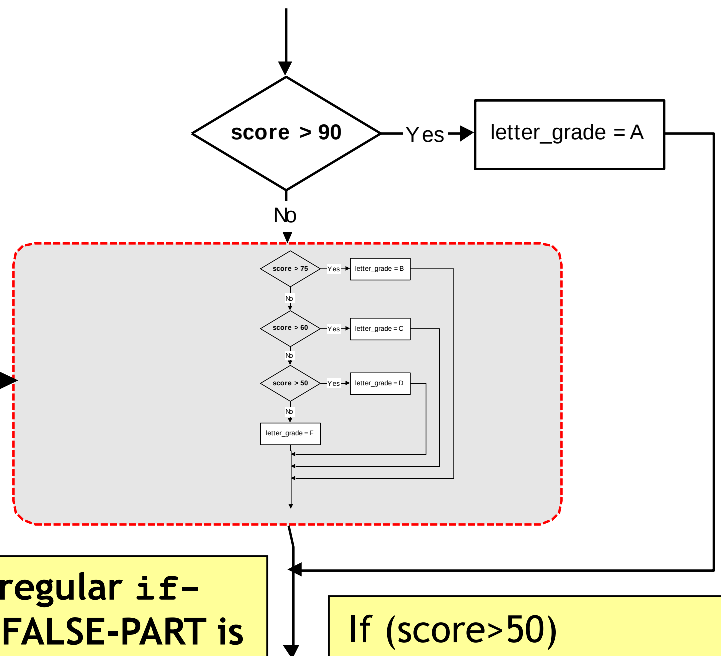
- Sometimes there are more than two parts. In those cases you may use nested **if-else** statements:

```
if (score > 90)
        letter_grade  = 'A';
else if (score > 75)
        letter_grade = 'B';
else if (score > 60)
        letter_grade = 'C';
else if (score > 50)
        letter_grade = 'D';
else
        letter_grade = 'F';
```



Let's look closer





It is actually a regular `if-else` with the FALSE-PART is another `if-else` statement

```
If (score>50)
{
   letter_grade = 'A';
}
else {
   ........
   .......
}
```

`if` statement

- Three forms of **`if`** statements are shown at the next table.
- The *condition must be placed* in parentheses
- Statement may exist either as a single statement or as a collection of statements (also called compound statement)

```
if(condition)
   statement;
```

```
if (condition)
{  statement;
       :
   statement;
}
```

```
if (condition)
{  statement;
       :
   statement;
}
else
{  statement;
       :
   statement;
}
```

- A **compound statement** is one or more statements that are grouped together by enclosing them in brackets , **{ }**.

- **Example:**

```
if (value>0)
  cout << value;        <-- This is a single statement. The semi-colon belongs to "if" not to "cout"

value = value * 2;      <-- a single statement

if (value>10)
{
  value = 10;
  cout << value;
}
```

This is a compound statement which consists two single statements.

Related issues

- The condition must be placed in parentheses

Example:

```
if (0<x) && (x<10)      //syntax error
     cout << x;
```

Correction:

```
if ((0<x) && (x<10))   // place both conditions into
                       //   a parentheses
     cout << x;
```

Related issues

- But be careful when converting mathematical comparisons. Some of them are not straight forward

Example: Print x only if (2<x<9)

```
if (2<x<9)
   cout << x;
```

There is no syntax error, but this leads to a **logic error** due to the misinterpretation.

The condition **always evaluates to true**, whatever the value of x

Let say x=1
(2<x<9)
⇒(2<1<9)
⇒(false<9)
⇒(0<9)
⇒true

Let say x=5
(2<x<9)
⇒(2<5<9)
⇒(true<9)
⇒(1<9)
⇒true

Correction:

```
if ((2<x) && (x<9))
    cout << x;
```

Related issues

- The condition must evaluate to a Boolean value (i.e. either **`true`** or **`false`**)
- There are only two types of expression that result a Boolean value
  - o Comparison expression (e.g. **`a>2`**)
  - o Boolean expression (e.g. **`b && false`**)
- If the result of the condition is not a Boolean, it will be type-casted

The condition evaluates to **`0`**. It then is type-casted to Boolean, becomes **`false`**

Example:

```
int n=0;

if (n)
   cout << "Yes";
else
   cout << "No";
```

Output:

```
No
```

Example:

The condition evaluates to **5.** It then is type-casted to Boolean, becomes **true**

```
int n=0;

if (n + 5)
   cout << "Yes";
else
   cout << "No";
```

Output:

```
Yes
```

Example:

Remember! This is an **assignment expression**, not an equality.

The value of the expression is **0.** It then is type-casted to Boolean, becomes **`false`.** The result is always false.

```
int x=0;

if (x=0)
   cout << "Yes";
else
   cout << "No";
```

Output:

```
No
```

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Example:

Remember! This is an **assignment expression**, not an equality.

The value of the expression is `10.` It then is type-casted to Boolean, becomes `true.` The result is always true.

```
int y=5;

if (y=10)
    cout << "Yes";
else
    cout << "No";
```

Output:

```
Yes
```

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Example:

Remember! This is an **assignment expression**.

The condition always evaluates to **`true`**. The value of **`y`** is changed to **5** due to the side-effect caused by the assignment operator

```
int y=1;

if (y=5)
   cout << y
```

Output:

```
5
```

Related issues

- Be careful when using the Boolean operator NOT (!)

Example:

```
int n=5;

if (!n>9)
   cout << "Yes";
else
   cout << "No";
```

Operator ! has higher precedence then operator >. So, it is executed first.

Expression !n is evaluated as !true where n is type-casted from integer 5 to Boolean true. The result is **false**

The expression is further evaluated as **(false>9)**. The false value is then type-casted to 0, since it will be compared with an integer. The expression then looks like **(0 > 9)** and the final result is **false**

Output:

```
No
```

Example:

```
int n=5;

if (!(n>9))
    cout << "Yes";
else
    cout << "No";
```

```
(!(n>9))
⇒ (!(n>9))
⇒ (!(5>9))
⇒ (!(false))
⇒ (!false)
⇒ true
```

Output:

```
Yes
```

Related issues

- Statements should be indented correctly to avoid misinterpretations

Example:

```
if (x<3)
    cout <<"Yes" << endl;
    cout <<"No" << endl;
```

The second `cout` doesn't belong to `if` statement. It is on its own but was indented incorrectly.

Let say x=1,
Condition => true

Output:

```
Yes
No
```

Let say x=3
Condition => false

Output:

```
No
```

Correction:

```
if (x<3)
    cout <<"Yes" << endl;

cout <<"No" << endl;
```

Example:

```
if (x<y)
   cout << x;
   x = y;
else
   cout << y;
```

Syntax error – misplace else.
There must only be a single statement before `else`. If more than that, use a compound statement.

Correction:

```
if (x<y)
{
   cout << x;
   x = y;
}
else
   cout << y;
```

Example:

Print x only if it is an odd number less than 10, otherwise print “Wrong number”

```
if (x%2==1)
    if (x<10)
        cout <<x;
else
  cout << “Wrong number”;
```

Let say x=7,
Output:

```
7
```

Correct!

Let say x=11,
Output:

```
Wrong Number
```

Correct!

There is no syntax error, but this leads to a **logic error** due to the misinterpretation.

The **else** part actually belongs to the **second if** (`if (x<10)`), not to the first one

But, when x=12,
There is no output. This is incorrect.
It suppose to print “Wrong number”

Correction: use brackets {}

```
if (x%2==1)
{
    if (x<10)
        cout << x;
}
else
   cout << “Wrong number”;
```

Related issues

- Null statements are statements that do nothing

Example:

```
if (x<3) ;
    cout <<"Yes";
```

The semi-colon represents a null statement. Either the condition evaluates to true or false, there is nothing to do.

The `cout` doesn't belong to `if statement`. The statement has already been ended up with semi-colon previously.

The output is always:

```
Yes
```

Example:

Let say x=5,
Output:

```
No
```

Let say x=1,
Output:

```
Yes
No
```

```
if (x<3)
    cout <<"Yes" <<endl;
else;
    cout <<"No" <<endl;
```

The semi-colon represents a null statement.

This **cout** doesn't belong to **else** part.

Simplifying `if` statements

- Simplifying conditions:

Original statement	*Simplified statement*
`if ( a != 0 ) statement;`	`if ( a ) statement;`
`if ( a > 0 ) statement;`	`if ( a ) statement;`
`if ( a < 0 ) statement;`	`if ( a ) statement;`
`if ( a == 0 ) statement;`	`if ( !a ) statement;`

Simplifying `if` statements

- Example 1 : print a number only if it is an odd number

Original statement

```
if ( n%2==1 )
    cout << n;
```

Simplified statement

```
if ( n%2 )
    cout << n;
```

- Example 2: print a number only if it is an even number

Original statement

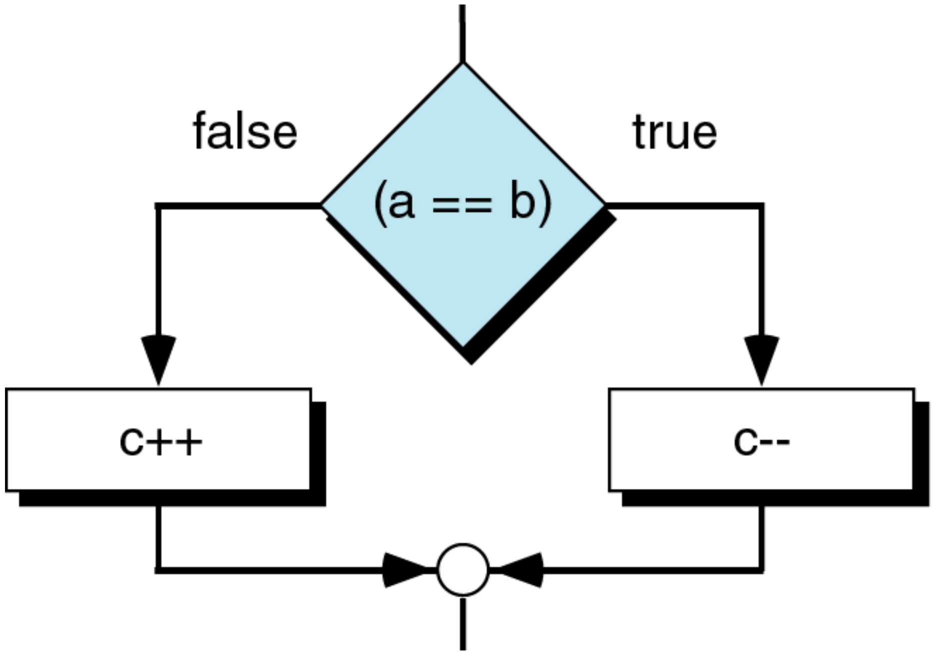
```
if ( n%2==0 )
    cout << n;
```

Simplified statement

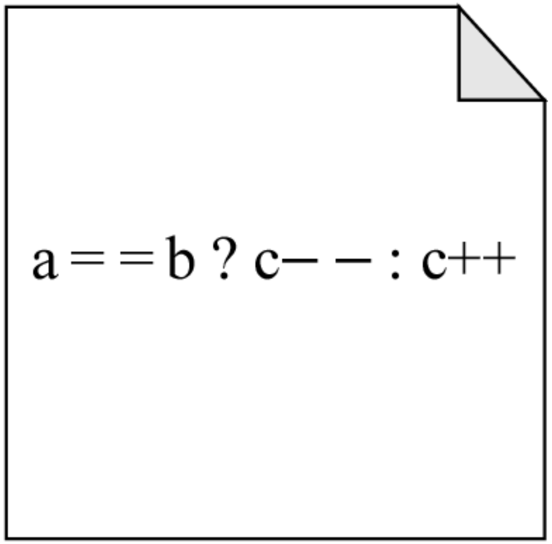
```
if ( !(n%2) )
    cout << n;
```

Simplifying `if` statements

- Conditional Expressions:



(a) Logic Flow



(b) Code

Simplifying `if` statements

- Conditional Expressions:

If the condition is **true**, take the **value1**

If the condition is **false**, take the **value2**

Syntax:

```
condition ? value1 : value2
```

Example:

```
p = (p<5) ? q + 1 : 5;
```

This statement means

```
if (p<5)
      p = q + 1;
 else
      p = 5;
```

switch statement

- If there are many nested if/else statements, you may be able to replace them with a switch statement:

```
if (letter_grade == 'A')
        cout << "Excellent!";
else if (letter_grade == 'B')
        cout << "Very good!";
else if (letter_grade == 'C')
        cout << "Good";
else if (letter_grade == 'D')
        cout << "Adequate";
else
        cout << "Fail";
```

→

```
switch (letter_grade)
{
 case 'A' : cout <<"Excellent!";
            break;

 case 'B' : cout <<"Very good!";
            break;

 case 'C' : cout <<"Good";
            break;

 case 'D' : cout <<"Adequate";
            break;

 default  : cout <<"Fail";
            break;
}
```

switch statement

```
switch (expression)
{
 case value1: statements_1;
               break;

 case value2 : statements_2;
               break;
   ...

 default : statements;
           break;
}
```

How the **switch** statement works?

1. Check the value of expression.
2. Is it equal to value1?
   - If yes, execute the statements_1 and break out of the switch.
   - If no, is it equal to value2? etc.
3. If it is not equal to any values of the above, execute the default statements and then break out of the switch.

switch statement

Example 1:

```
int value = 1;

switch (value)
{
 case 1: cout << "One";
         break;

 case 2: cout << "Two";
         break;

 default : cout << "Neither One nor Two";
          break;
}
```

evaluates to 1

Prints **One**

break out of the switch

it is equal to this case-value (i.e. 1==1). So, execute the statements of 'case 1'.

Output:

One

switch statement

Example 2:

```
int value = 1;

switch (value + 1)
{
  case 1: cout << "One";
          break;

  case 2: cout << "Two";
           break;

  default : cout << "Neither One nor Two";
             break;
}
```

this expression evaluates to **2**

it is not equal to this case-value (i.e. 2!=1). So, skip the statements of 'case 1' and move to the next case.

it is equal to this case-value (i.e. 2==2). So, execute the statements of 'case 2'.

Prints **Two**

break out of the switch

Output:

Two

switch statement

Example 3:

```
int value = 5;

switch (value)
{
 case 1: cout << "One";
         break;

 case 2: cout << "Two";
          break;

 default : cout << "Neither One nor Two";
            break;
}
```

evaluates to 5

The switch expression (i.e. 5) is not equal to both cases (i.e 5!=1 and 5!=2). So, their statements are skipped.

When the 'default case' is reached, its statements are always executed.

break out of the switch

Prints Neither One nor Two

Output:

Neither One nor Two

`switch` statement

What if the ***`break`*** *statement is not written?*

```
int value = 1;

switch (value)
{
 case 1: cout << “One\n”;


 case 2: cout << “Two\n”;
         break;


 default : cout << “Neither One nor Two\n”;
          break;
}
```

evaluates to 1

it is equal to this case-value (i.e. 1==1). So, execute the statements of the ‘case 1’.

Prints **One**

No `break` statement here. So, no break out and move to the next line.

Prints **Two**

break out of the switch

Output:

One
Two

switch statement

- The switch expression must be of integral type (i.e. **int,char,bool**).
- The following examples would be an error

```
void main()
{
 float point=4.0;
 int mark;

 switch (point)
 {
   case 4   : mark = 100;
              break;

   case 3.7 : mark = 80;
              break;

   default  : mark = 0;
              break;
 }

}
```

Error! The switch expression cannot be a **float** value

```
void main()
{
 char name[]="Ali";
 int mark;

 switch (name)
 {
   case "Ali"    : mark=95;
                   break;

   case "Aminah": mark=90;
                   break;

   default      : mark=50;
                  break;
 }
}
```

Error! The switch expression cannot be a **string** value

switch statement

- The case-value must be a constant (literal, memory or defined constant)
- The following example would be an error

```
void main()
{
 #define DEFINE 1
 const int const2=2;
 int var3 = 3;
 int value;

 switch (value)
 { case 0       : cout << "Four";
                  break;
   case DEFINE  : cout << "One";
                  break;
   case const2  : cout << "Two";
                  break;
   case var3    : cout << "Three";
                  break;
 }
}
```

a literal is OK (case 0)

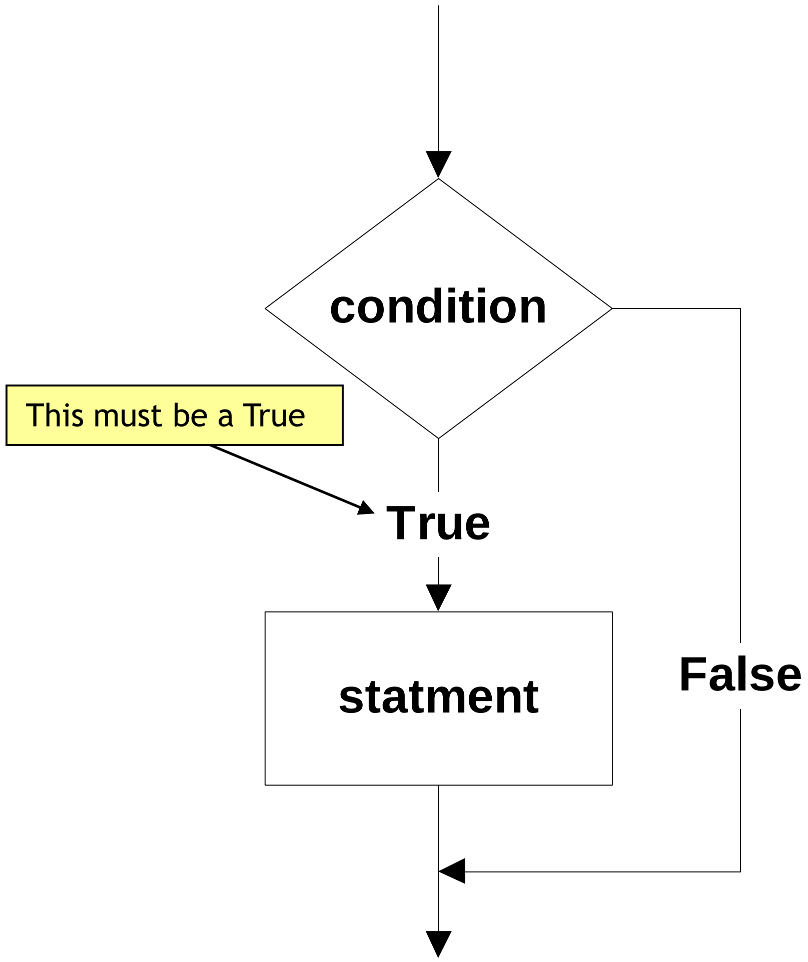
a defined constant is OK (case DEFINE)

a memory constant is OK (case const2)

Error! case-value cannot be a variable (case var3)

Translating flowchart to C++ code

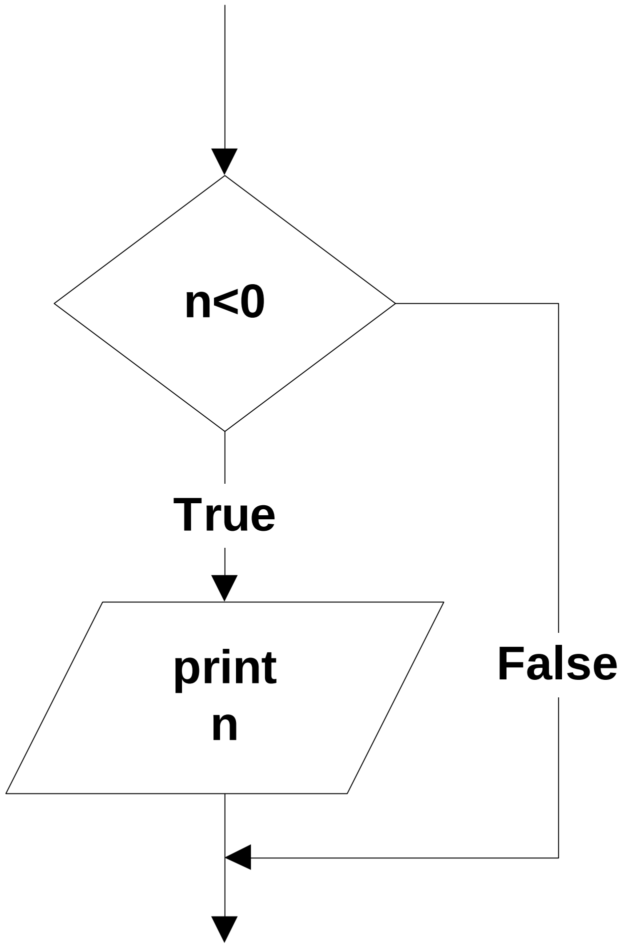
Pattern 1




```
if (condition)
{
 statement;
}
```

Translating flowchart to C++ code

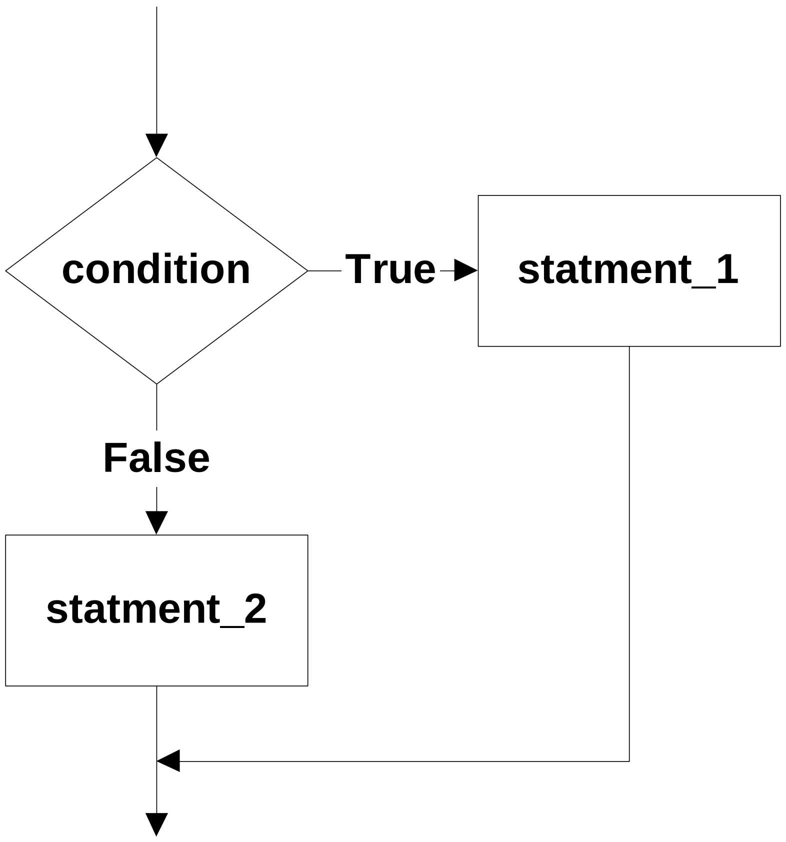
Example 1: *Printing a number only if it is a negative*




```
if (n<0)
{
 cout << n;
}
```

Translating flowchart to C++ code

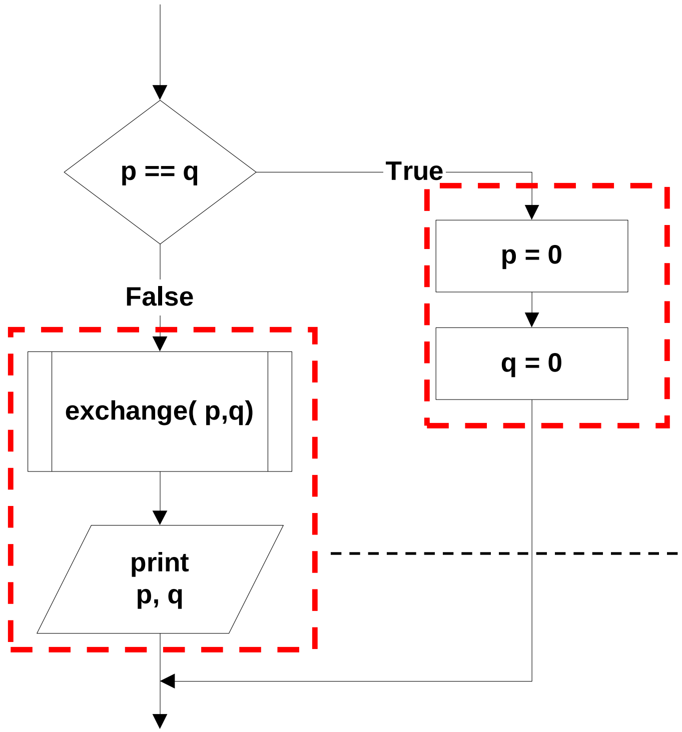
Pattern 2




```
if (condition)
{
 statement_1;
}
else
   {
      statement_2;
   }
```

Translating flowchart to C++ code

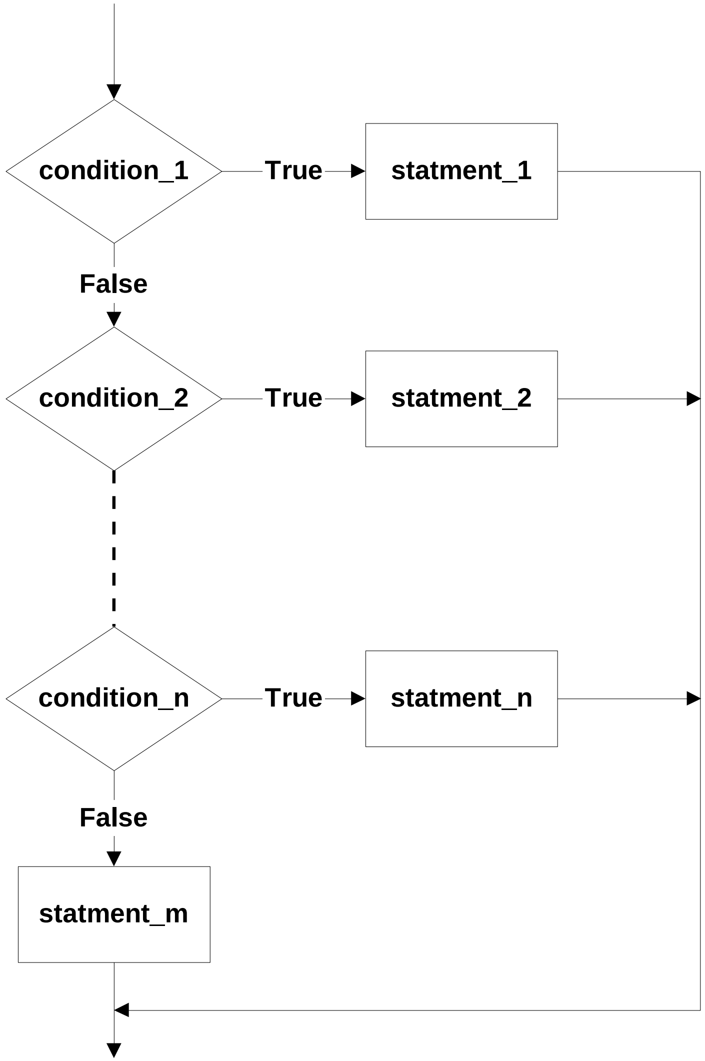
Example 2: *If two numbers (p and q) are equivalent reset them to zero, otherwise exchange or swap their value each other and then print the new values.*




```
if (p==q)
{
  p = 0;
  q = 0;
}
else
{
  exchange(&p,&q);
  cout << p << q;
}
```

Translating flowchart to C++ code

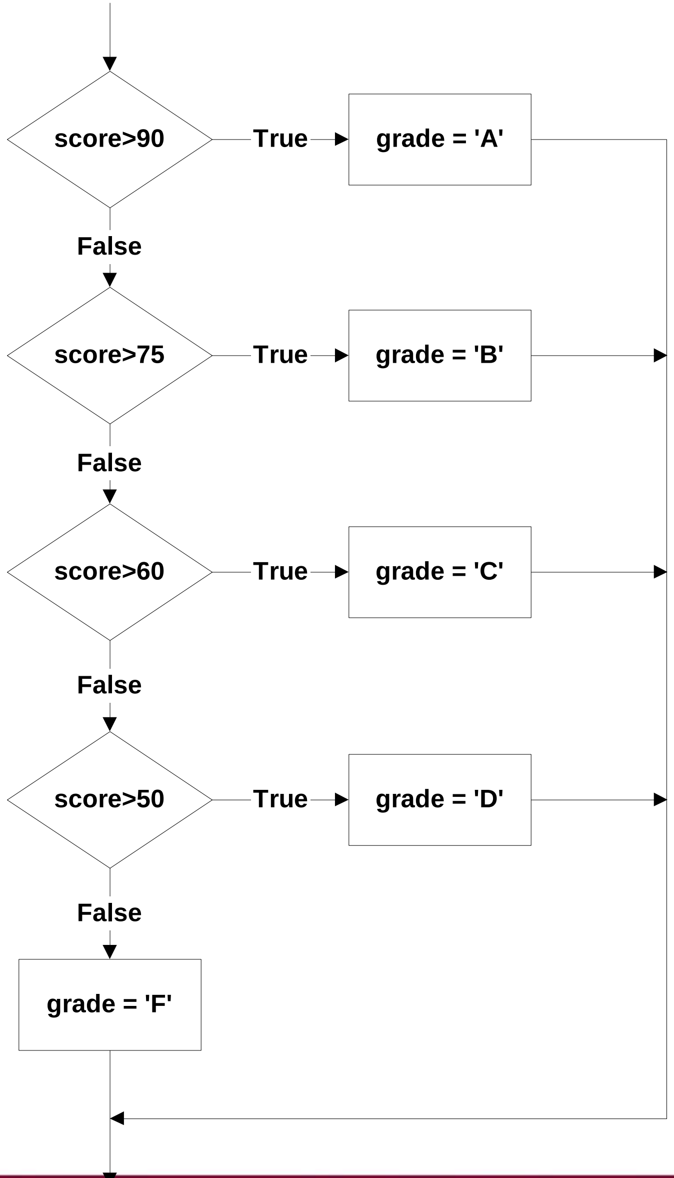
Pattern 3




```
if (condition_1)
{
 statement_1;
}
else if (condition_2)
{
 statement_2;
}
      |
      |
      |
      |
      |
else if (condition_n)
{
 statement_n;
}
else
{
 statement_m;
}
```

Translating flowchart to C++ code

Example 3: *Identifying the grade of a score*



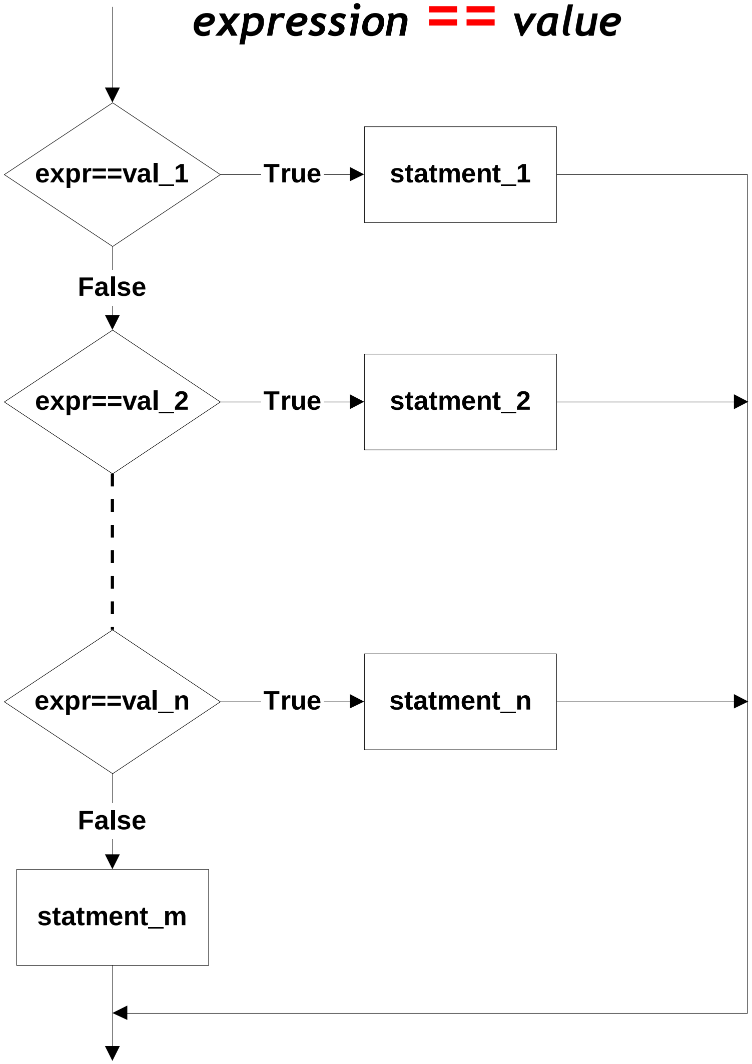

```
if (score > 90)
{
   grade  = 'A';
}
else if (score > 75)
{
   grade = 'B';
}
else if (score > 60)
{
   grade = 'C';
}
else if (score > 50)
{
   grade = 'D';
}
else
{
   grade = 'F';
}
```

Translating flowchart to C++ code

Pattern 4

- *The conditions must be in this form:*

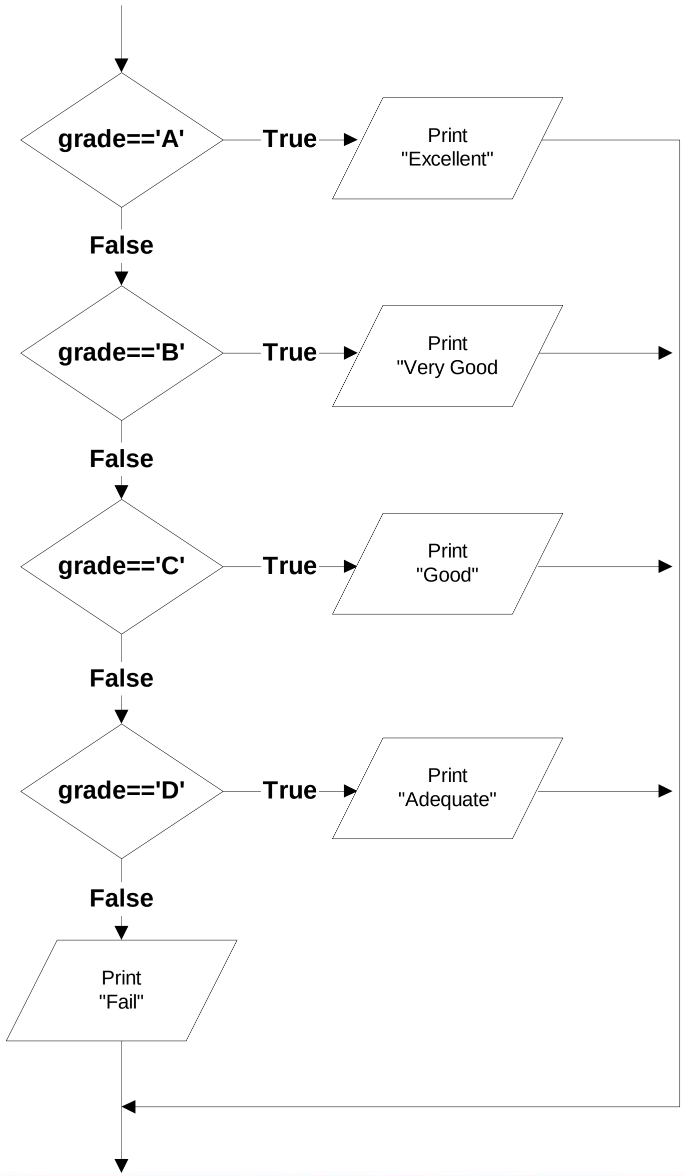
expression **==** *value*




```
switch (expr)
{
  case val_1 :   statement_1;
                 break;

  case val_2 :   statement_2;
                 break;
      |
      |
      |

  case val_n :   statement_n;
                 break;

  default:       statement_m;
                 break;
}
```

Translating flowchart to C++ code

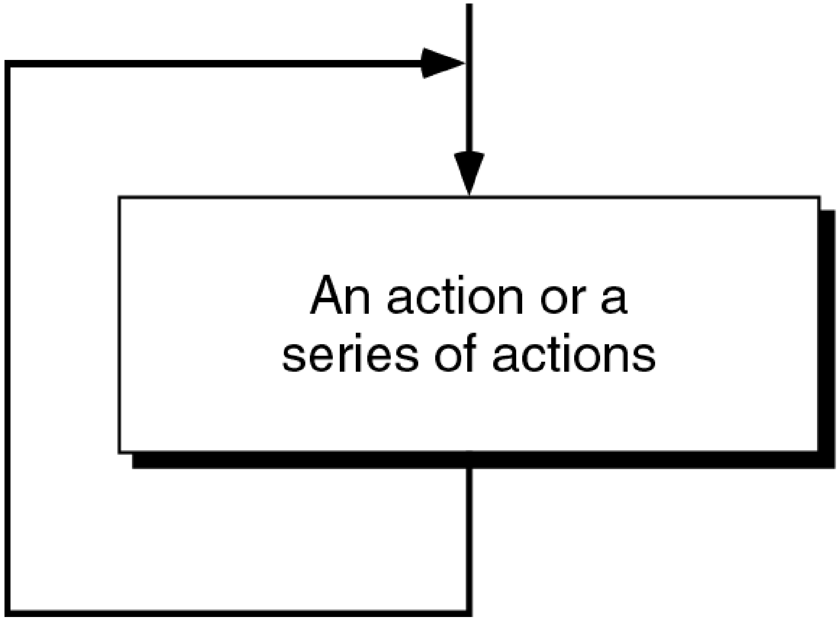
Example 4: *Printing the description of a grade.*




```
switch (grade)
{
  case 'A' : cout << "Excellent!";
             break;

  case 'B' : cout << "Very good!";
             break;

  case 'C' : cout << "Good";
             break;

  case 'D' : cout << "Adequate";
             break;

  default  : cout << "Fail";
             break;
}
```

Loop / Repetition

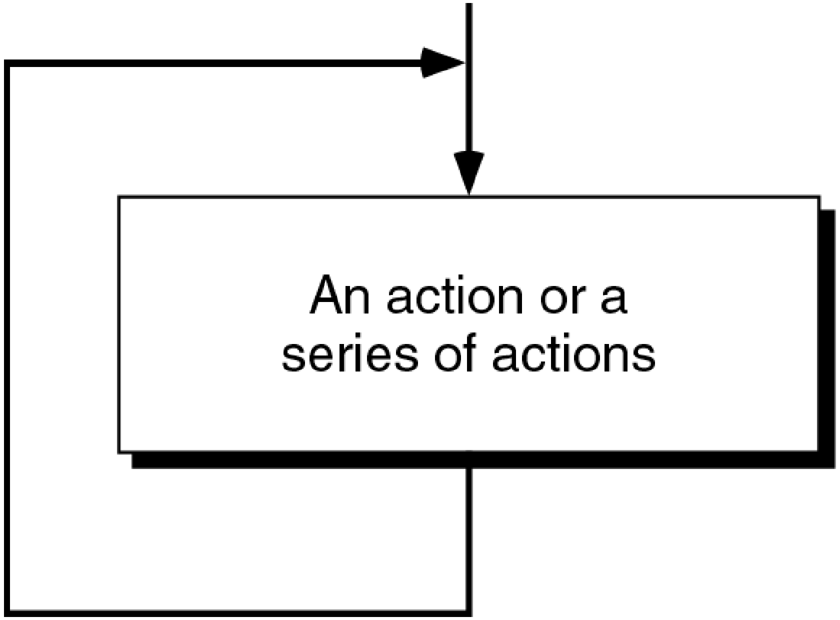
- The main idea of a loop is to repeat an action or a series of actions.



The concept of a loop

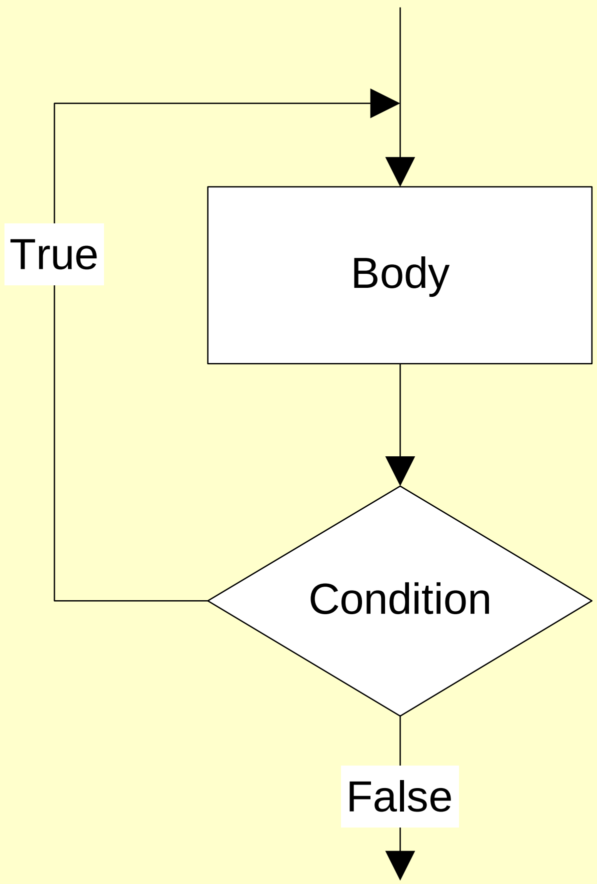
Loops

- But, when to stop looping?
- In the following flowchart, the action is executed over and over again. It never stop – This is called an infinite loop
- Solution – put a condition to tell the loop either continue looping or stop.



Loops

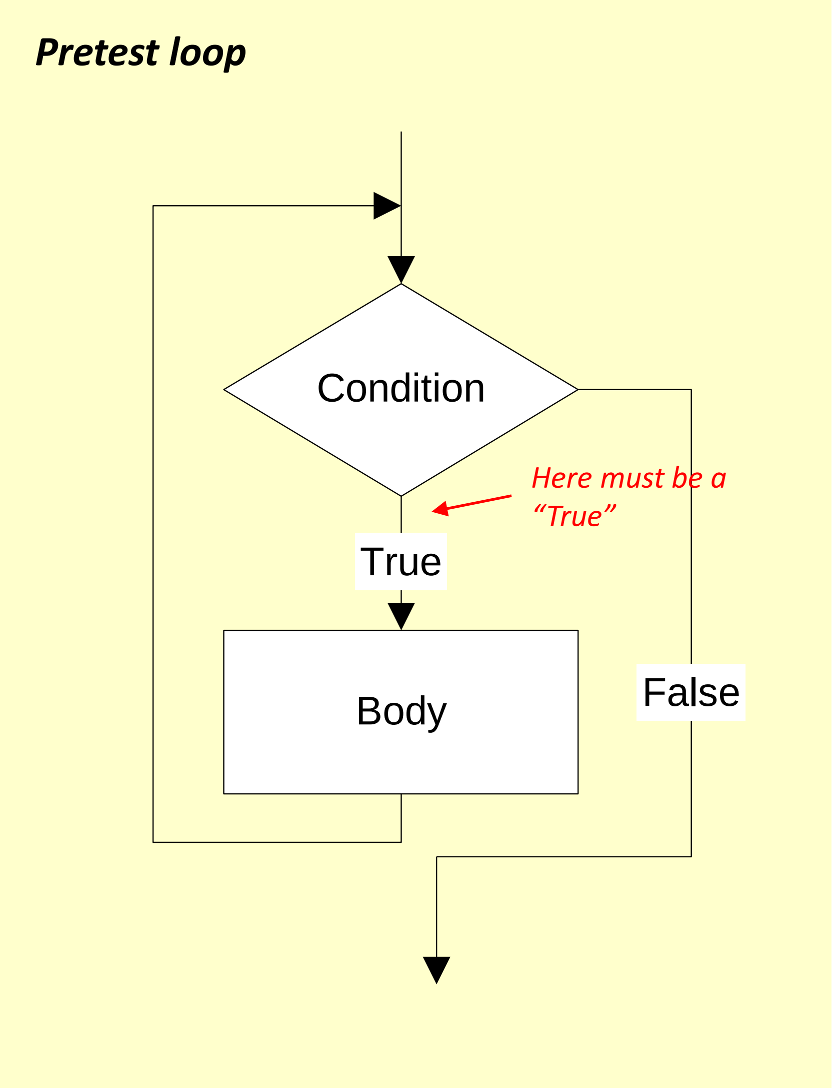
- A loop has two parts – body and condition
- Body – a statement or a block of statements that will be repeated.
- Condition – is used to control the iteration – either to continue or stop iterating.



Types of loop

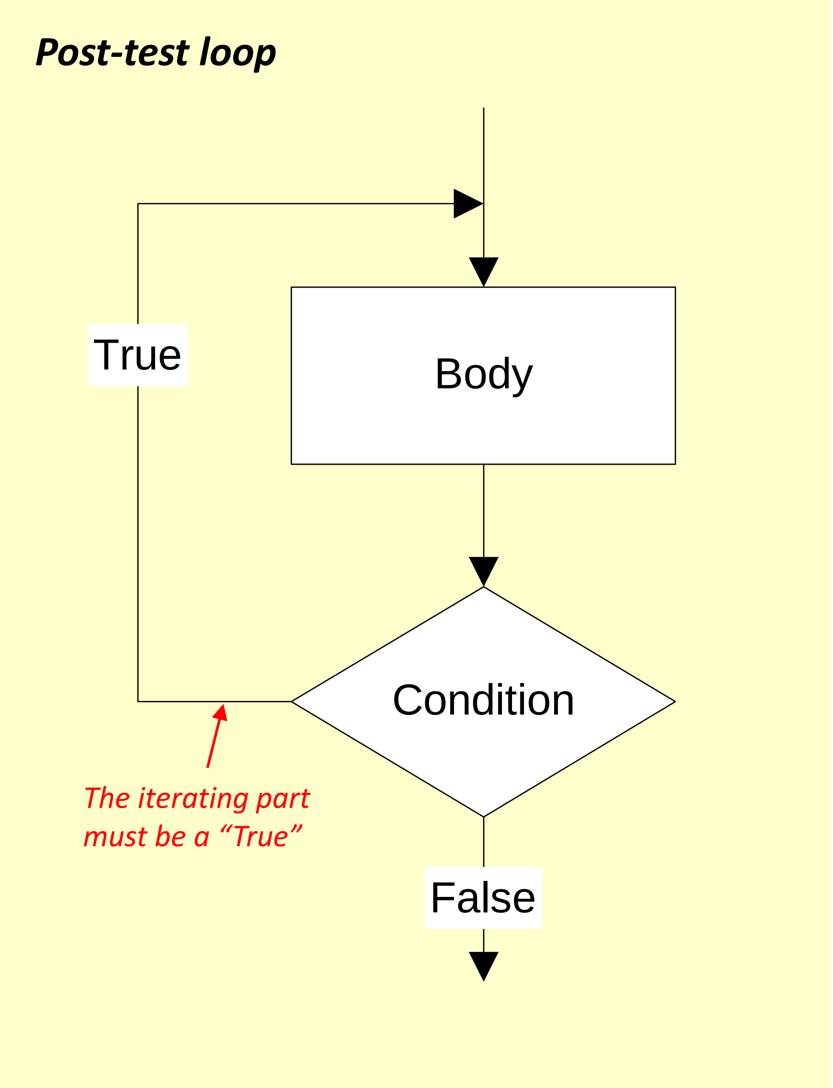
- Two forms of loop – pretest loop and post-test loop.

- Pretest loop
  - the condition is tested first, before we start executing the body.
  - The body is executed if the condition is true.
  - After executing the body, the loop repeats



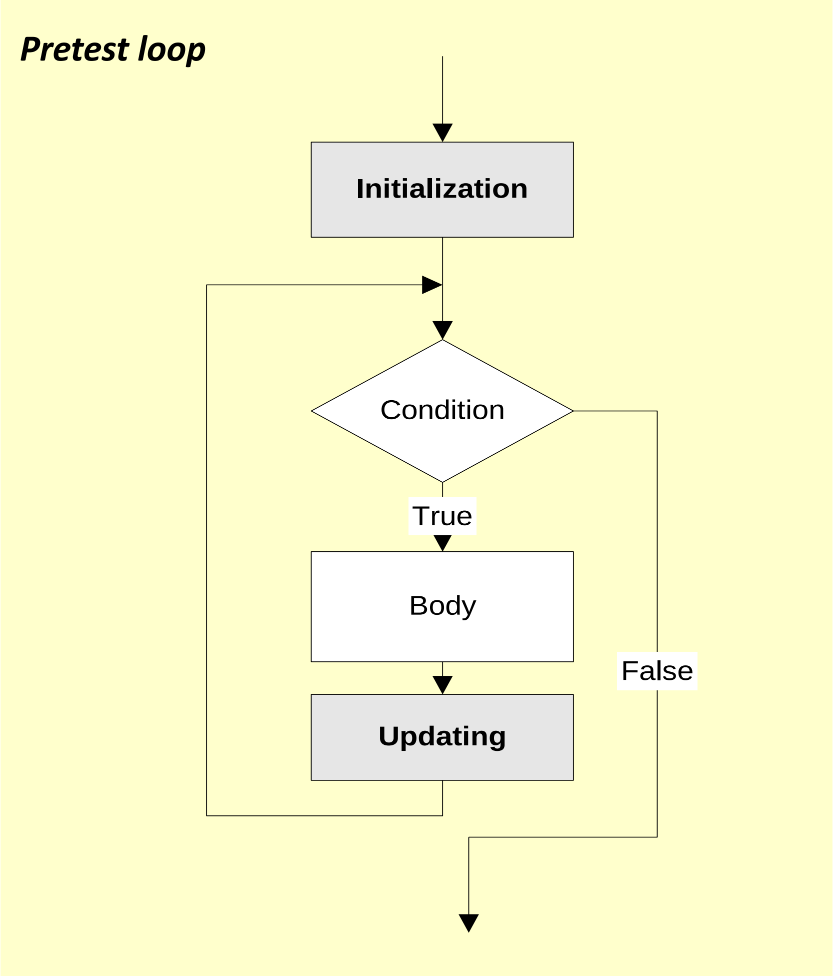
Types of loop

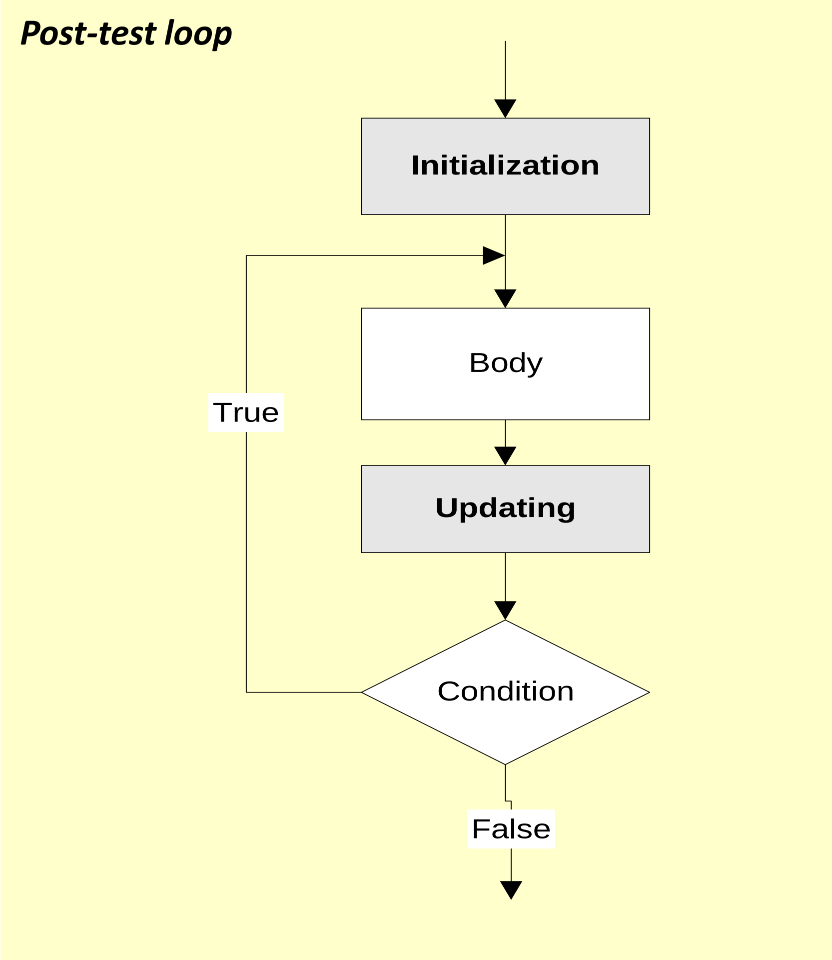
- Post-test loop
  - the condition is tested later, after executing the body.
  - If the condition is true, the loop repeats, otherwise it terminates.
  - The body is always executed at least once.



Parts of a loop

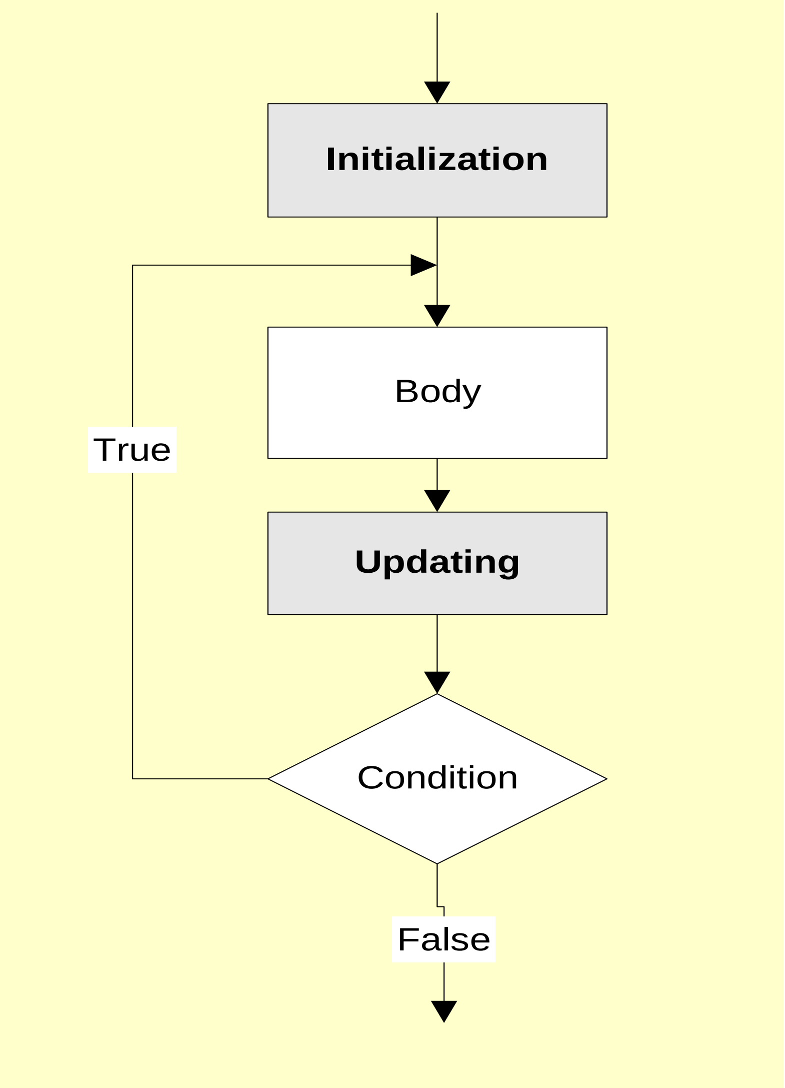
- Beside the body and condition, a loop may have two other parts – Initialization and Updating





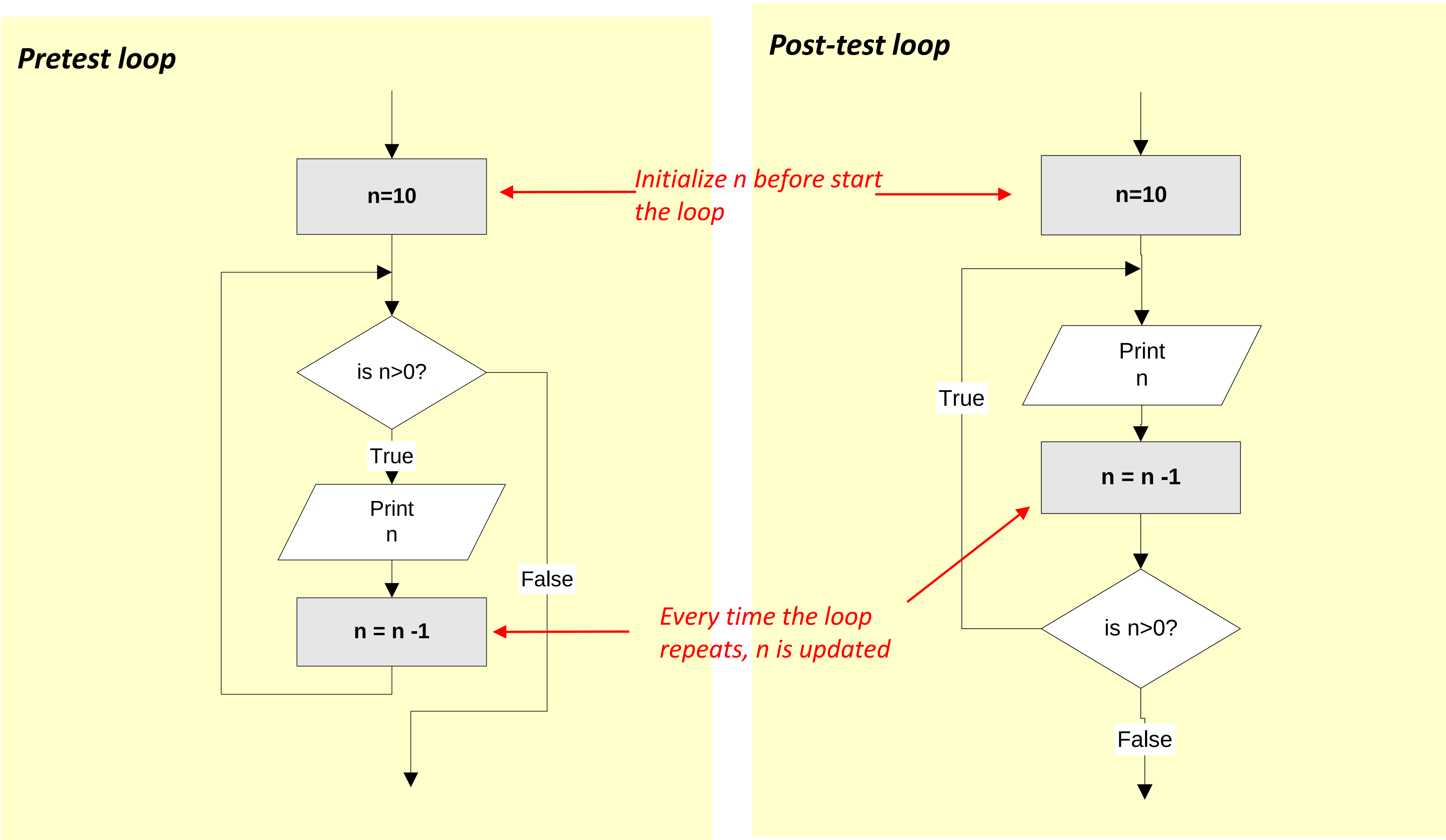
Parts of a loop

- Initialization
  - is used to prepare a loop before it can start –usually, here we initialize the condition
  - The initialization must be written outside of the loop – before the first execution of the body.
- Updating
  - is used to update the condition
  - If the condition is not updated, it always true => the loop always repeats - an infinite loop
  - The updating part is written inside the loop – it is actually a part of the body.



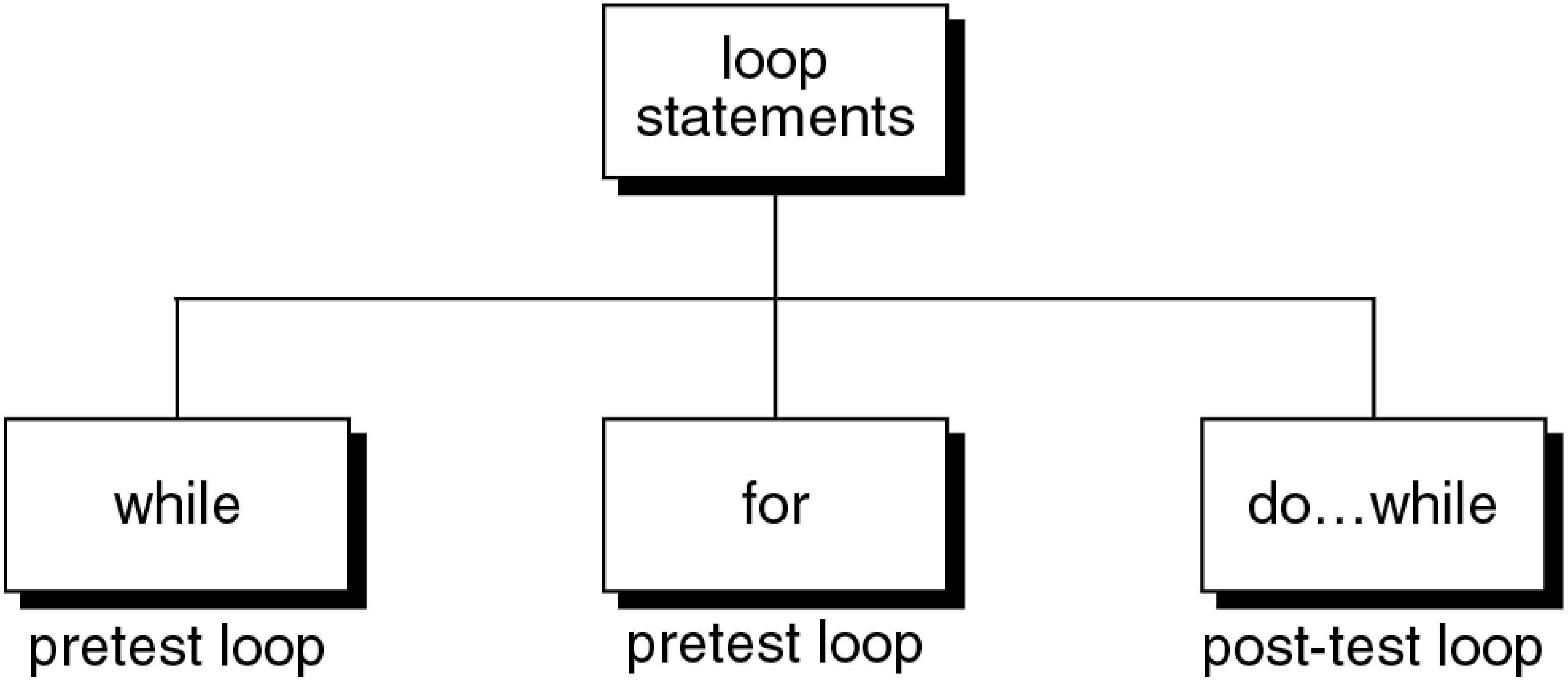
Parts of a loop

Example: *These flowcharts print numbers 10 down to 1*



Loop statements

- C++ provides three loop statements:

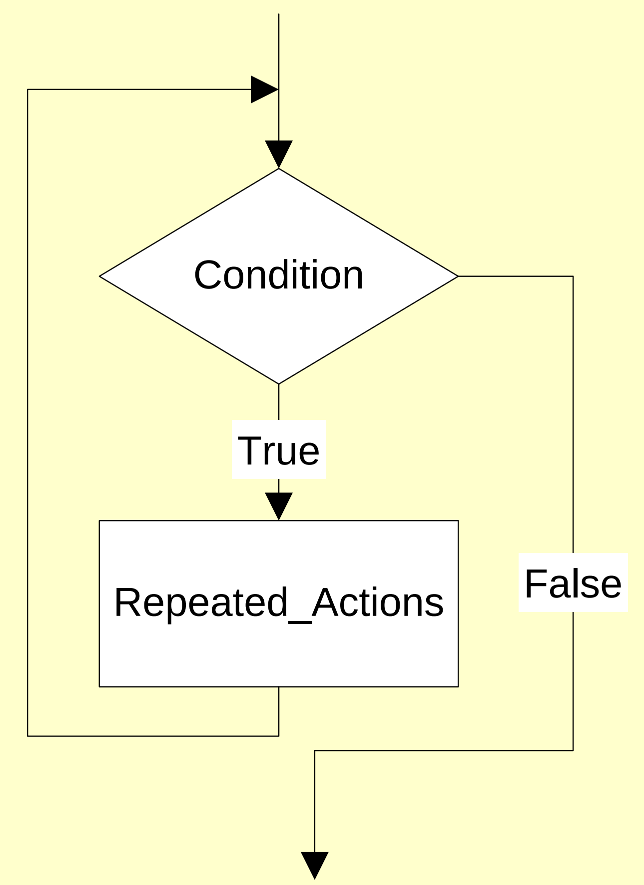


C++ loop constructs

`while` statement

```
while (Condition)
{
  Repeated_Actions;
}
```

while flowchart



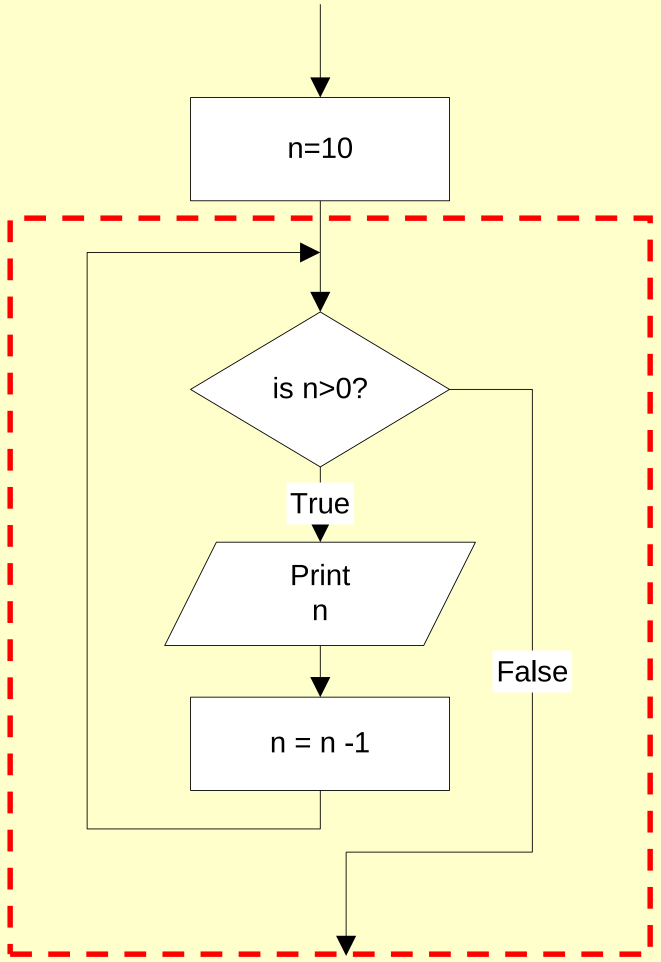
`while` statement

Example: *This* `while` *statement prints numbers 10 down to 1*

Note that, the first line (`n=10`) is actually not a part of the loop statement.

```
n=10;
while (n>0)
{
  cout << n <<" ";
  n=n-1;
}
```

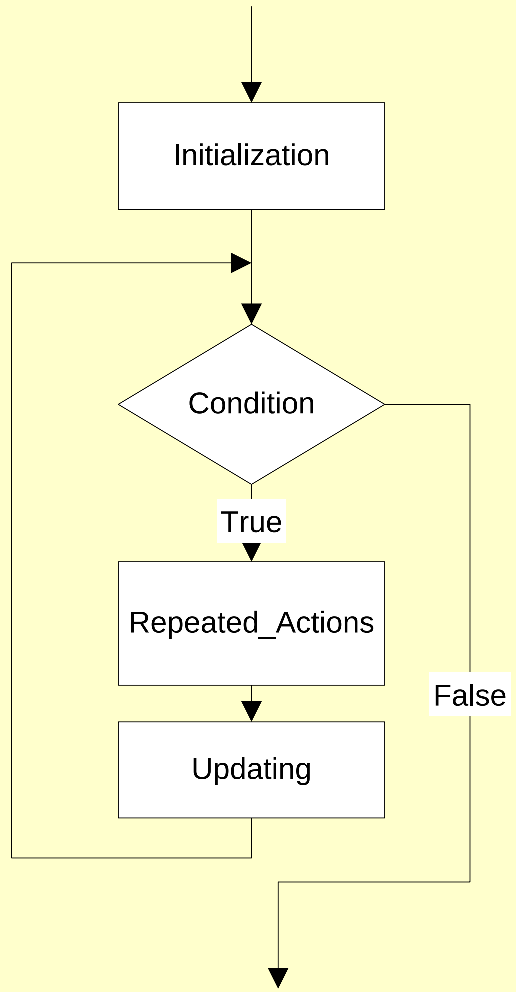
```
Output:

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



for statement

```
for (Initialization; Condition; Updating)
{
  Repeated_Actions;
}
```

for flowchart

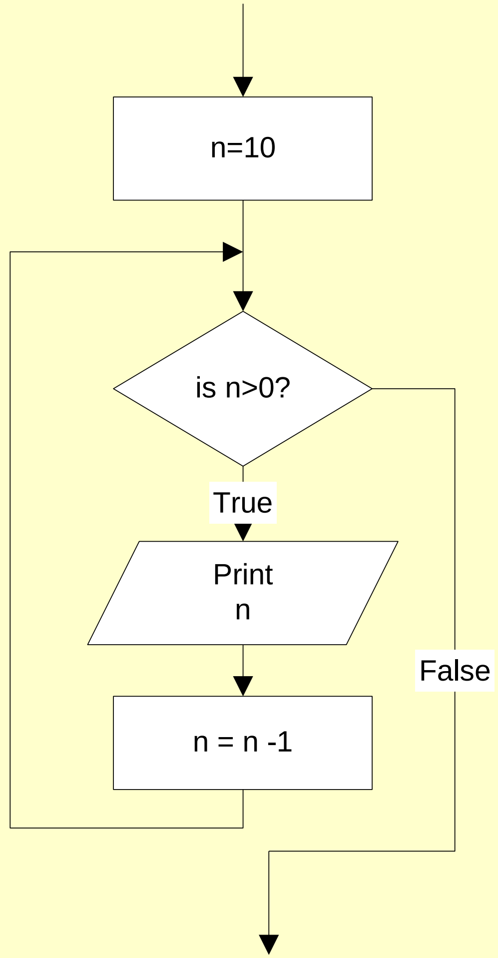


`for` statement

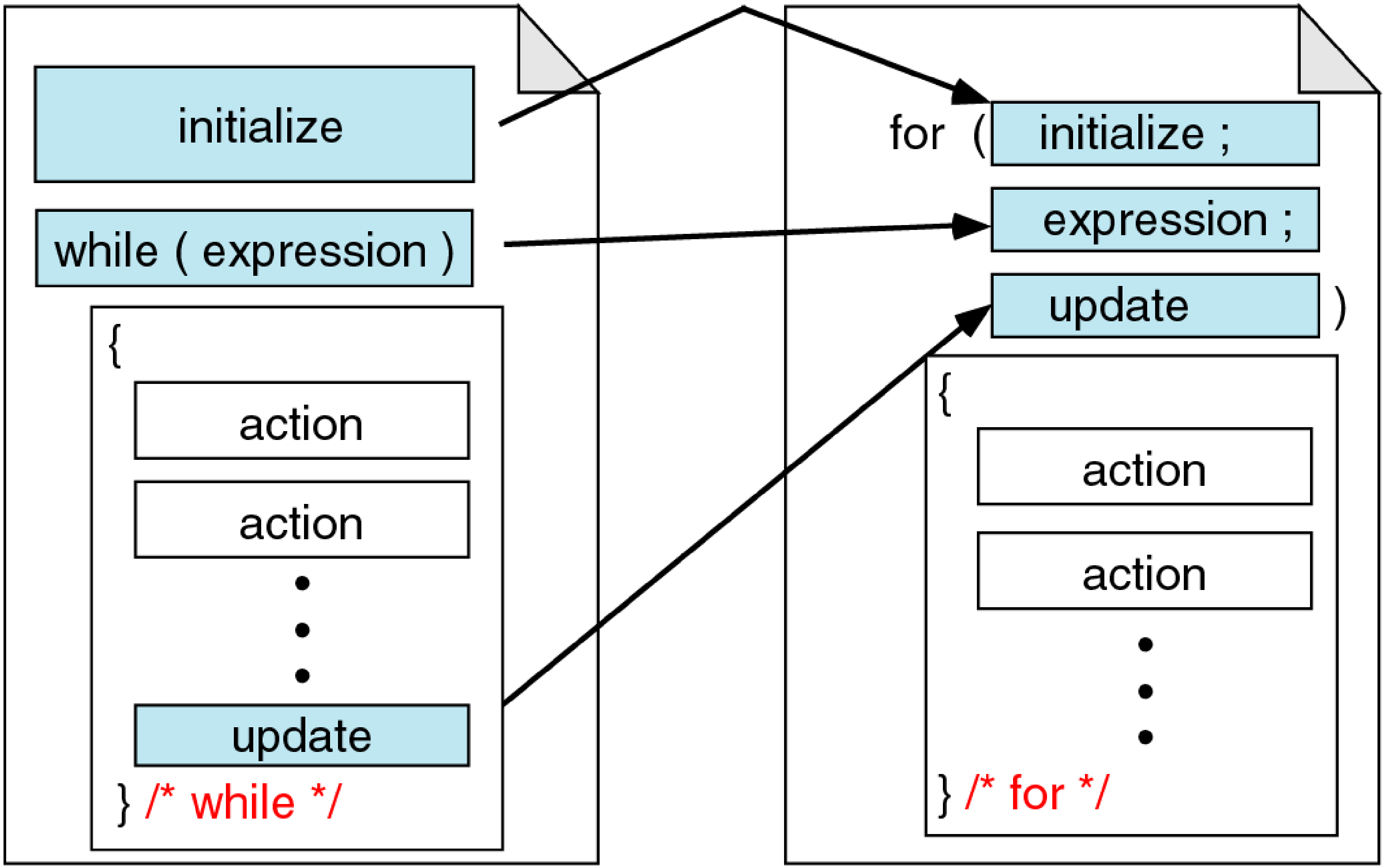
Example: *This* `for` *statement prints numbers 10 down to 1*

```
for (n=10; n>0; n=n-1)
{
  cout << n <<" ";
}
```

```
Output:

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



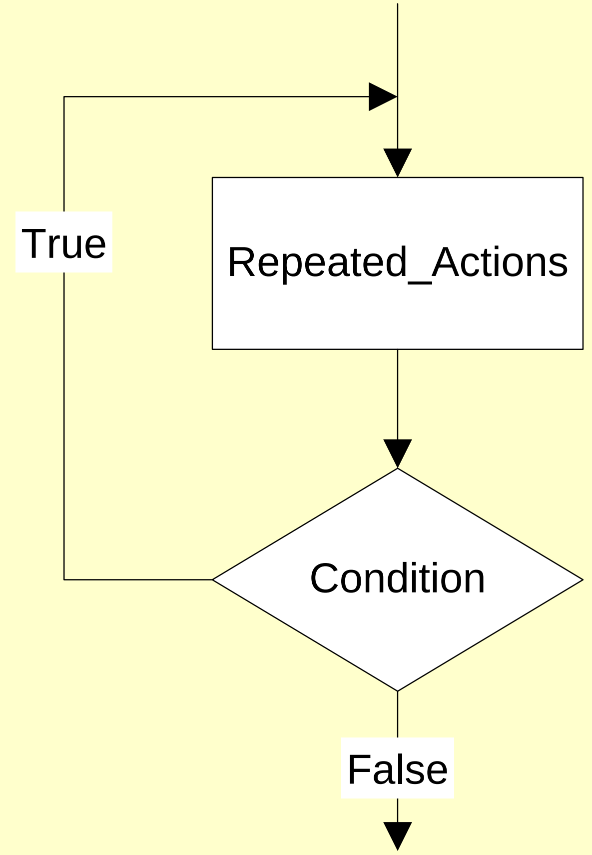
`for` vs. `while` statements



Comparing `for` and `while` loops

do…while statement

```
do
{
  Repeated_Actions;
} while (Condition);
```



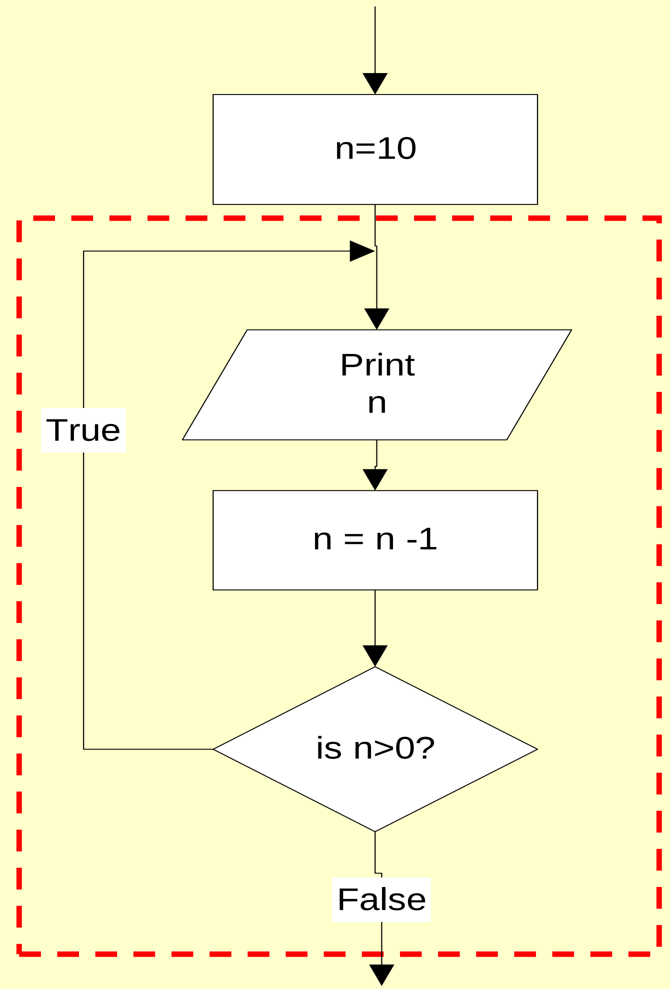
do…while statement

Example: *This* `do…while` *statement prints numbers 10 down to 1*

Note that, the first line (`n=10`) is actually not a part of the loop statement.

```
n=10;
do
{
  cout << n << " ";
  n=n-1;
} while (n>0);
```

```
Output:

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



Loop statements

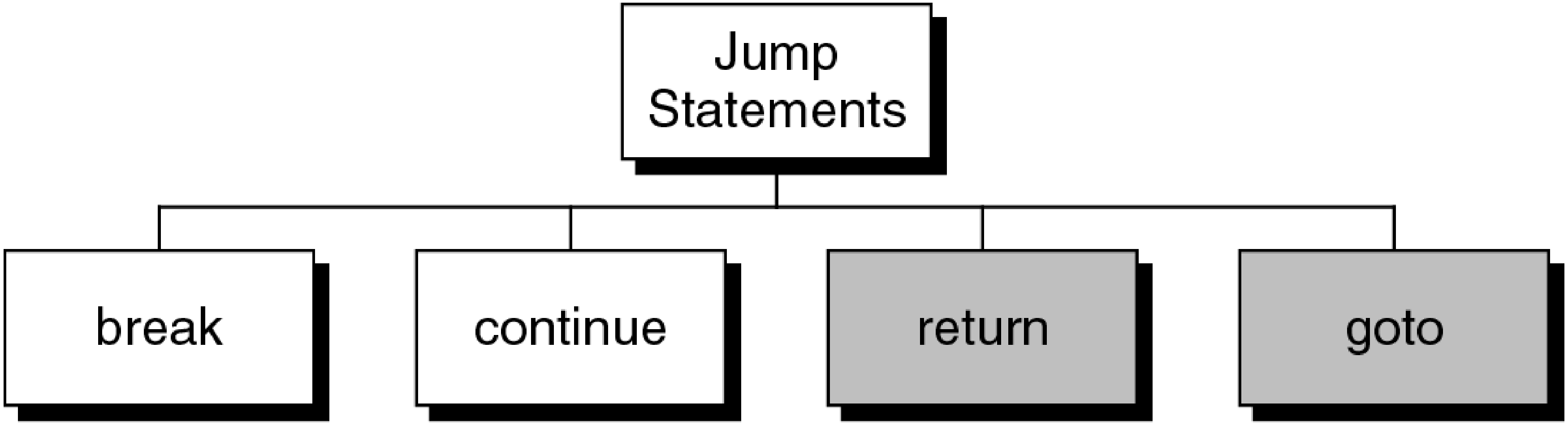
- If the body part has only one statement, then the bracket symbols, { } may be omitted.
- Example: These two `for` statements are equivalent.

```
for (n=10; n>0; n=n-1)
{
 cout << n;
}
```

```
for (n=10; n>0; n=n-1)
   cout << n;
```

Jump statements

- You have learn that, the repetition of a loop is controlled by the loop condition.
- C++ provides another way to control the loop, by using jump statements.
- There are four jump statements:



Breaking Out of a Loop

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

break statement

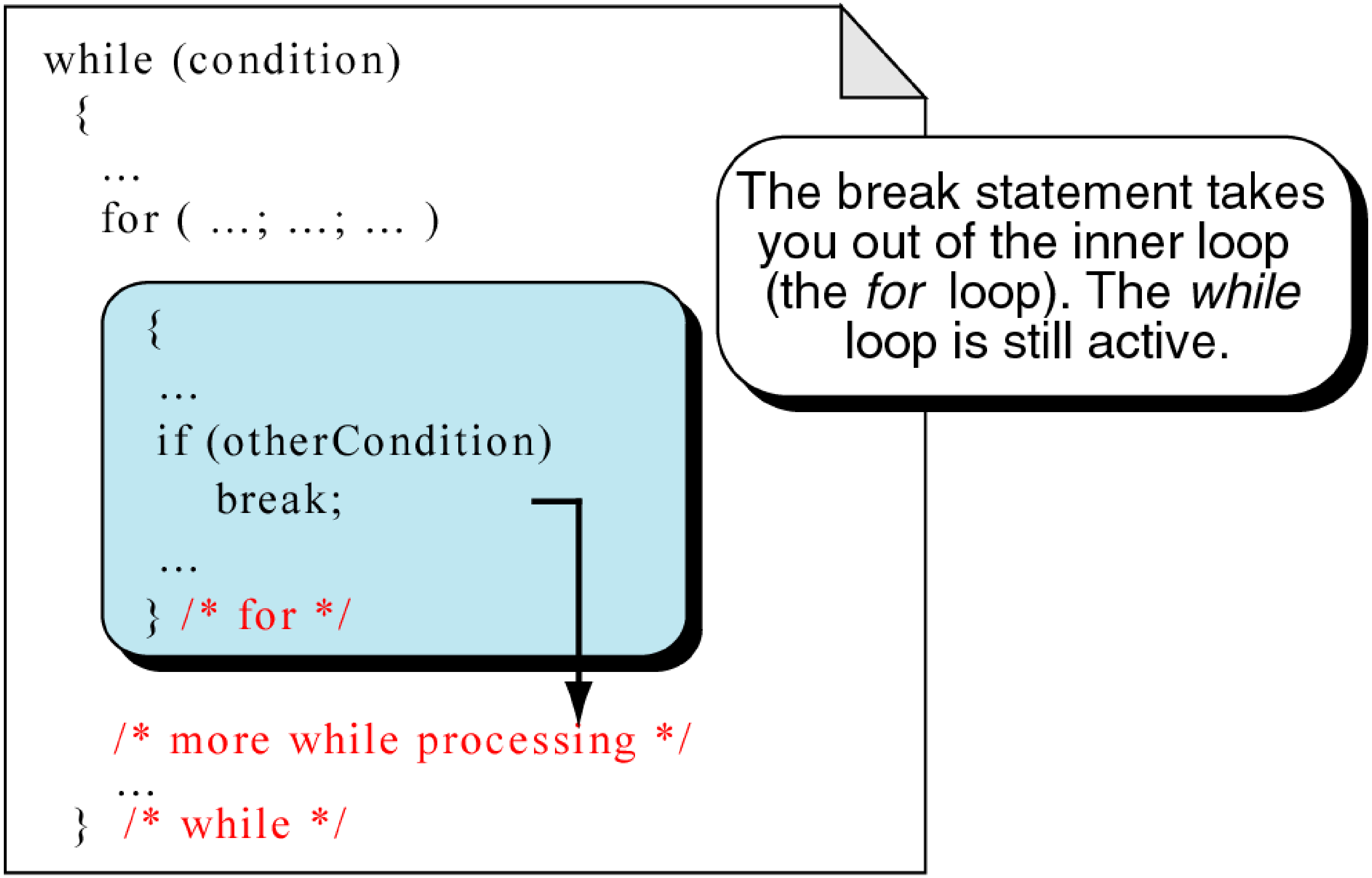
- It causes a loop to terminate

Example:

```
for (n=10; n>0; n=n-1)
{
 if (n<8) break;
 cout << n << " ";
}
```

```
Output:

10 9 8
```

break statement



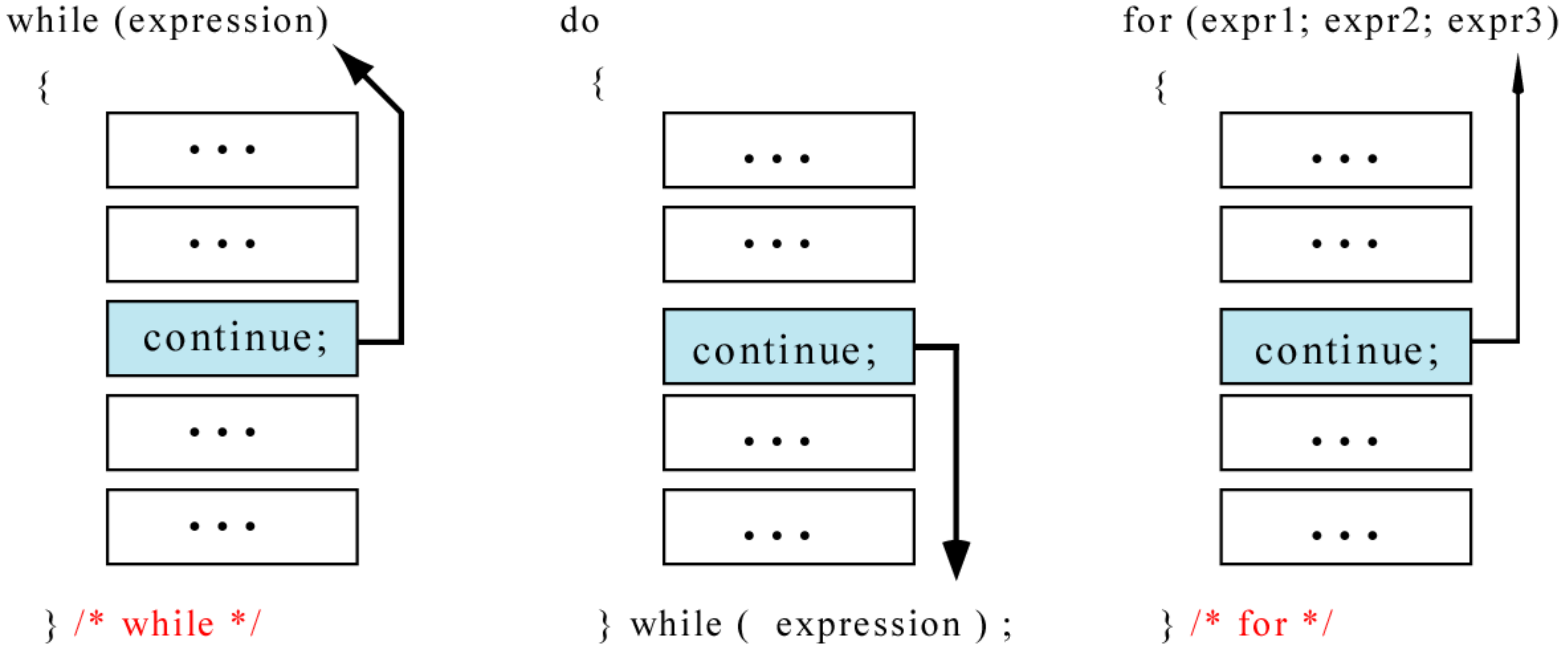
break **an inner loop**

The `continue` Statement

- Can use **`continue`** to go to end of loop and prepare for next repetition
  - **`while`** and **`do-while`** loops go to test and repeat the loop if test condition is true
  - **`for`** loop goes to update step, then tests, and repeats loop if test condition is true
- Use sparingly – like **`break`**, can make program logic hard to follow

`continue` statement

- In `while` and `do…while` loops, the `continue` statement transfers the control to the loop condition.
- In `for` loop, the `continue` statement transfers the control to the updating part.



The *continue* statement

continue statement

Example:

```
for (n=10; n>0; n=n-1)
{
 if (n%2==1) continue;
 cout << n <<" ";
}
```

```
Output:

10 8 6 4 2
```

`continue` statement

Example:

```
n = 10;
while (n>0)
{
 cout << n << " ";
 if (n%2==1) continue;
 n = n -1;
}
```

```
Output:

10 9 9 9 9 9 ..........
```

The loop then prints number 9 over and over again. It never stops.

`return` statement

- You will learn this statement in Chapter 4 – Function.
- It causes a function to terminate.

Example:

```
void print_numbers()
{ int n=10;
  int i;

  while (n>0)
  {
     for (i=n;i>0; i--)
     {
       if (i%2==1) continue;

       if (i%4==0) break;

       if (n==6) return;

       cout <<i <<" ";
     }
     cout << endl;
     n=n-1;
  }
}
```

*The **continue** statement transfers control to the updating part (i--)*

*The **break** statement terminates the **for** loop.*

*The **return** statement terminates the **function*** and returns to the caller.

Output:

```
10


6
```

`return` statement

- When to use `return`?
- *Example:* the following functions are equivalent

```
float calc_point(char grade)
{
 float result;

 if (grade=='A') result = 4.0;
 else if (grade=='B') result = 3.0;
 else if (grade=='C') result = 2.5;
 else if (grade=='D') result = 2.0;
 else result = 0.0;

 return result;
}
```

```
float calc_point(char grade)
{
 if (grade=='A') return 4.0;
 if (grade=='B') return 3.0;
 if (grade=='C') return 2.5;
 if (grade=='D') return 2.0;
 return 0.0;
}
```

The *else* part of each *if* statement may be omitted. It has never been reached.

return statement

```
float calc_point3(char grade)
{
 float result;

 switch (grade)
 {
   case 'A': result = 4.0;
             break;

   case 'B': result = 3.0;
             break;

   case 'C': result = 2.5;
             break;

   case 'D': result = 2.0;
             break;

   default:  result =0.0;
 }

 return result;
}
```

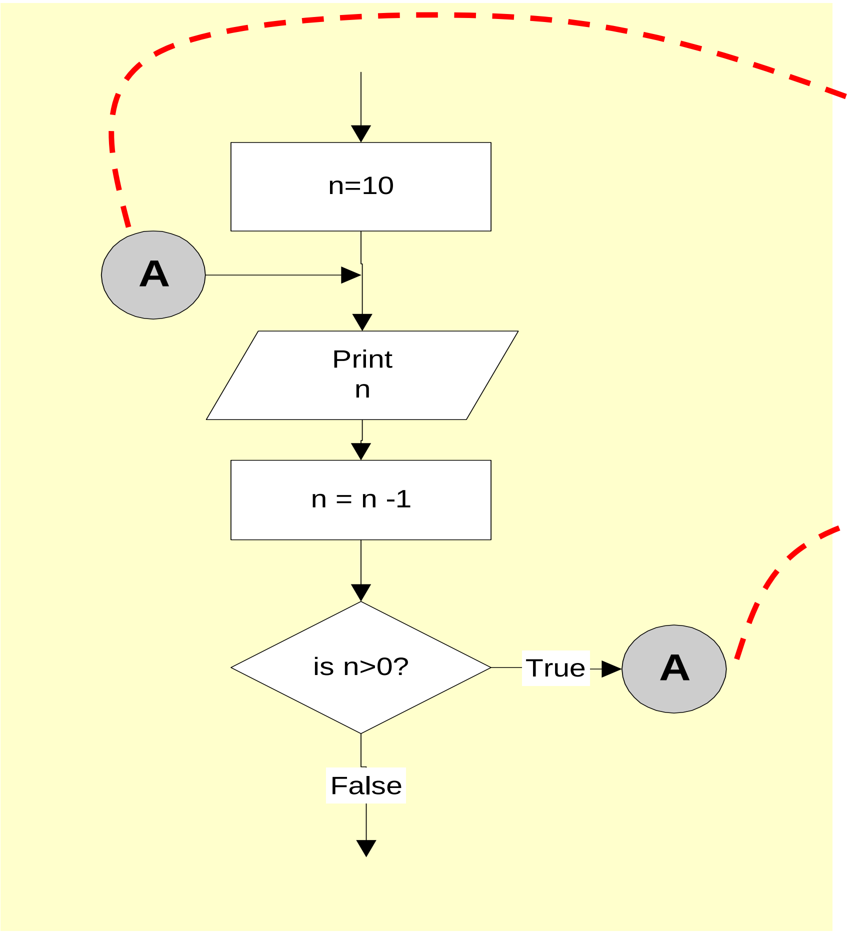
```
float calc_point4(char grade)
{
 switch (grade)
 {
   case 'A': return 4.0;

   case 'B': return 3.0;

   case 'C': return 2.5;

   case 'D': return 2.0;
 }
 return 0.0;
}
```

The *break* statement of each *case* may be omitted. It has never been reached.

goto statement

- It is used to translate connector symbols – jump to another part inside a program.
- But, it is not recommended to use - it may cause unstructured programs.

Example:

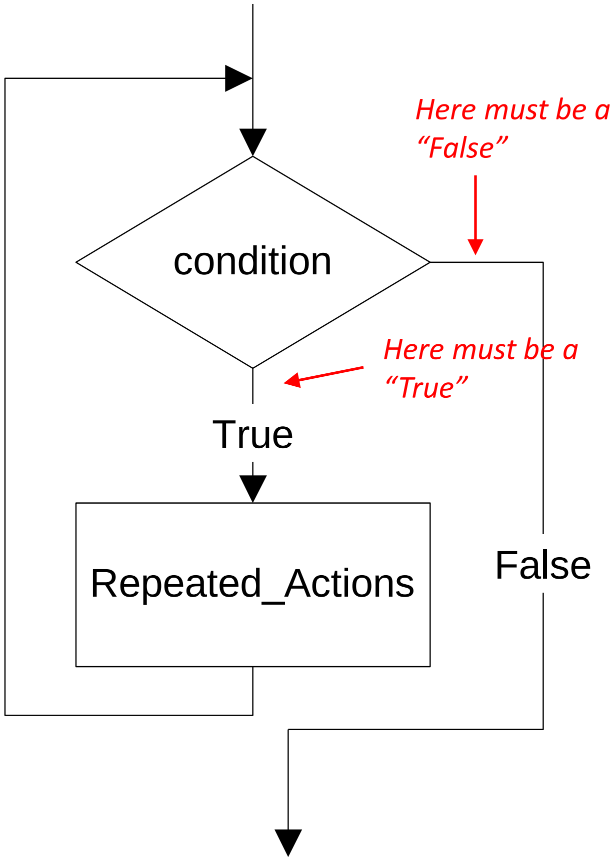



```
n=10;

A:
   cout <<n <<" ";
   n = n -1;

   if (n>0) goto A;
```

```
Output:

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

Translating flowchart to C++ code

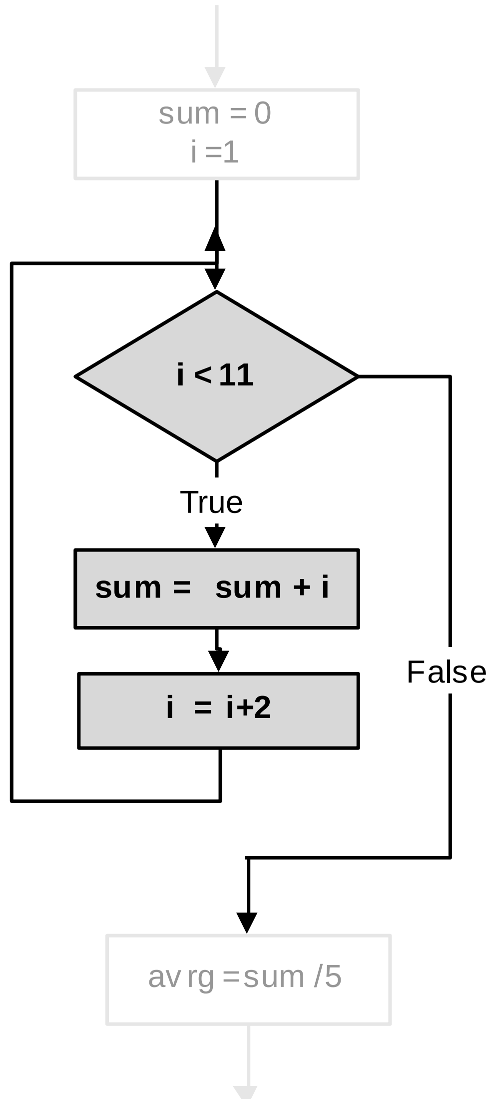
Pattern 1




```
while (condition)
{
 Repeated_Actions;
}
```

Translating flowchart to C++ code

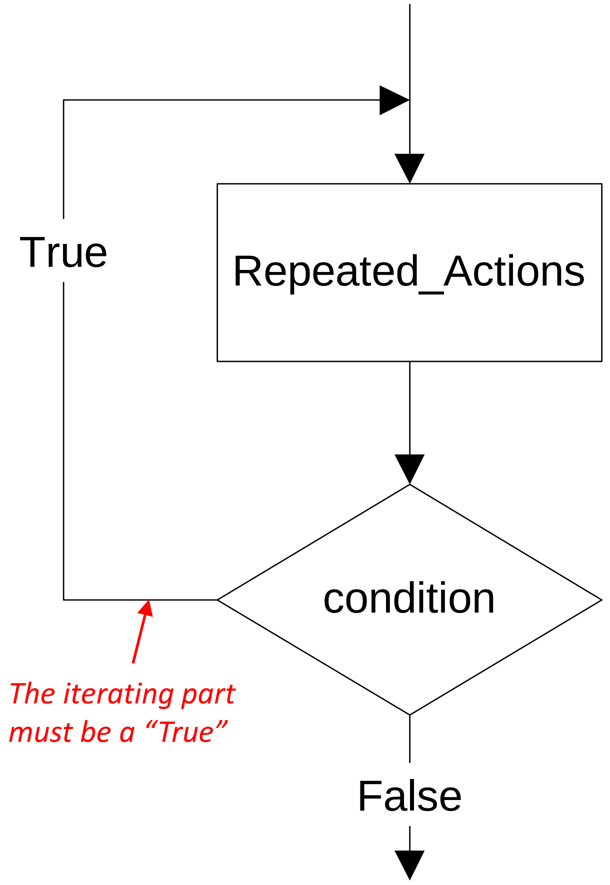
Example: *Calculate the average of odd numbers 1 to 9*




```
sum = 0;
i=1;
while (i<11)
{
 sum = sum + i;
 i = i + 2;
}
avrg = sum/5.0;
```

Translating flowchart to C++ code

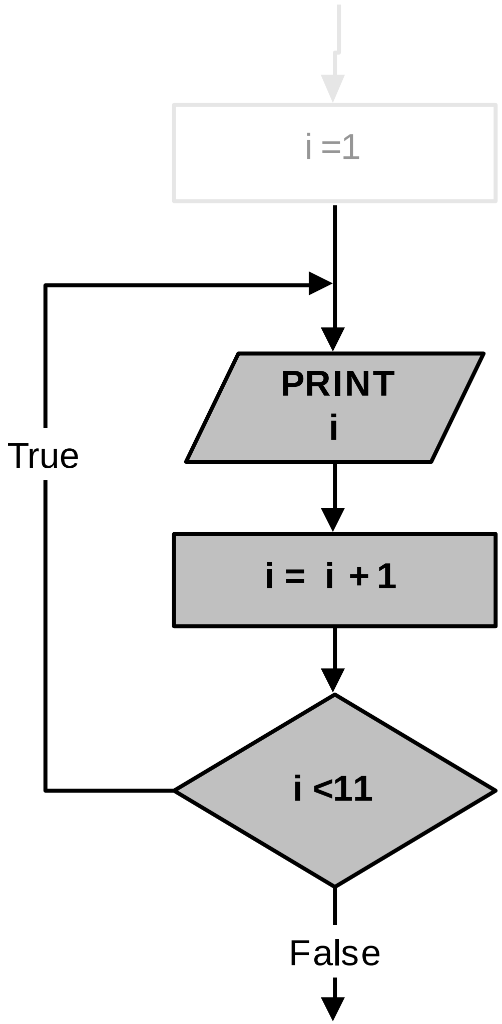
Pattern 2




```
do
{
 Repeated_Actions;
} while(condition);
```

Translating flowchart to C++ code

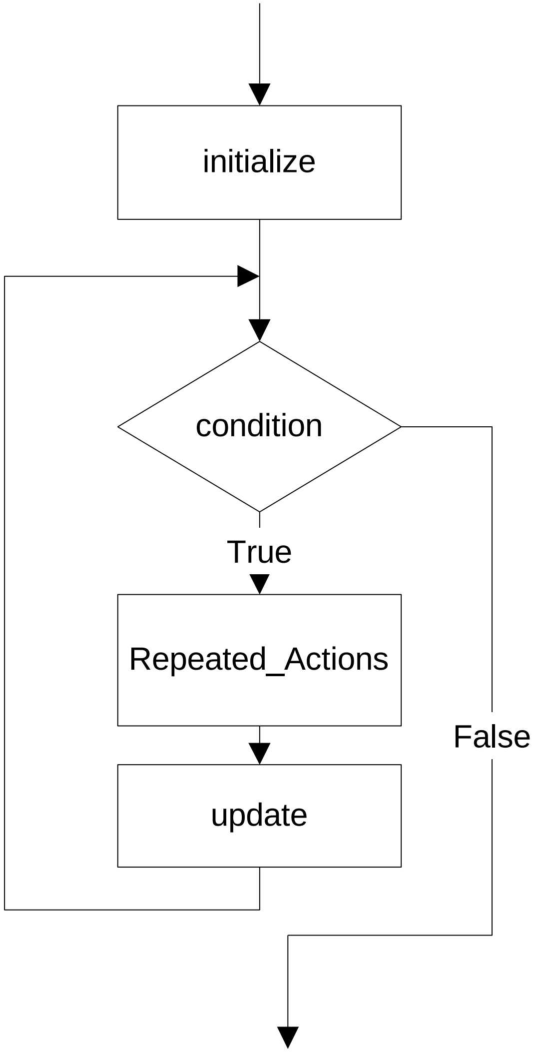
Example: *Prints numbers 1 to 10*




```
i=1;
do
{
 cout <<i <<endl;
 i = i + 1;
} while (i<11);
```

Translating flowchart to C++ code

Pattern 3



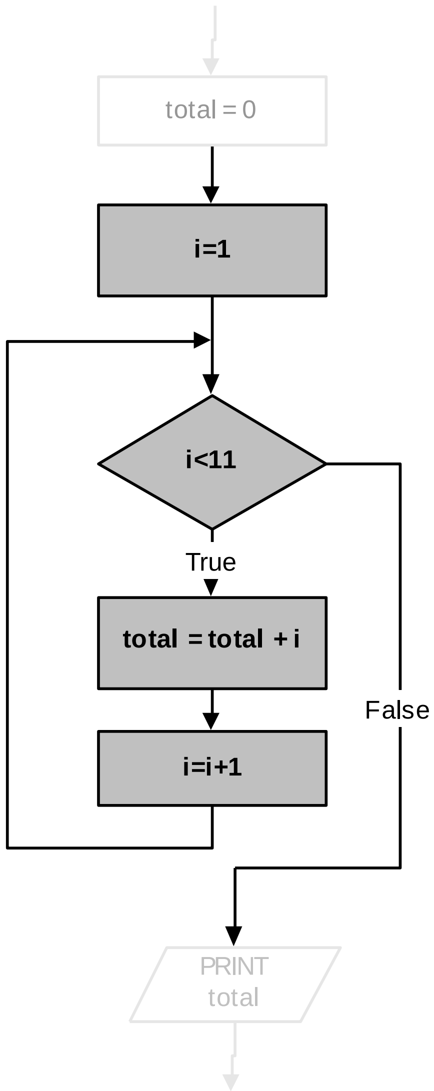

```
for (initialize; condition; update)
{
 Repeated_Actions;
}
```

or

```
initialize;
while (condition)
{
 Repeated_Actions;
 update;
}
```

Translating flowchart to C++ code

Example: *Print the total of numbers 1 to 10*




```
total = 0;
for (i=1; i<11; i++)
{
 total = total + i;
}
cout <<total;
```

or

```
total = 0;
i=1;
while (i<11)
{
 total = total + i;
 i++;
}
cout <<total;
```

Deciding Which Loop to Use

- `while`: pretest loop (loop body may not be executed at all)
- `do-while`: post test loop (loop body will always be executed at least once)
- `for`: pretest loop (loop body may not be executed at all); has initialization and update code; is useful with counters or if precise number of repetitions is known

Nested Loops

- A nested loop is a loop inside the body of another loop
- Example:

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

Notes on Nested Loops

- Inner loop goes through all its 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. In previous example, inner loop repeats 9 times

In-Class Exercise

- How many times the outer loop is executed? How many times the inner loop is executed? What is the output?

```
#include <iostream>
using namespace std;
int main()
{    int x, y;
     for(x=1;x<=8;x+=2)
        for(y=x;y<=10;y+=3)
          cout<<"\nx = " <<x << "  y = "<<y;
     system("PAUSE");
     return 0;}
```