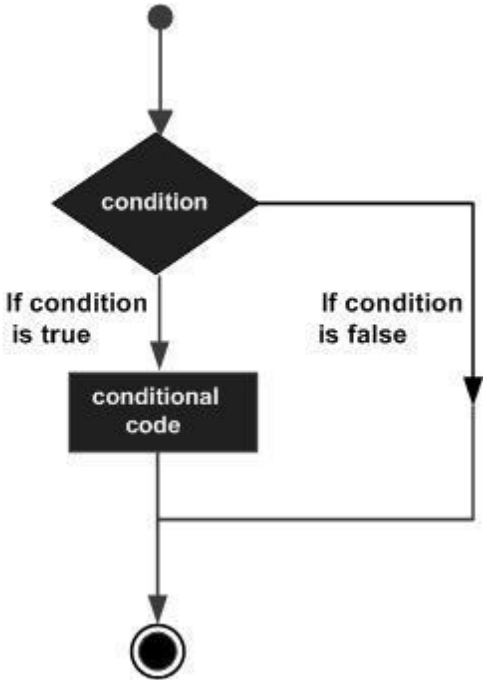
Decision Making in C

Decision making structures require that the programmer specify one or more conditions to be evaluated or tested by the program, along with a statement or statements to be executed if the condition is determined to be true, and optionally, other statements to be executed if the condition is determined to be false.
Following is the general form of a typical decision making structure found in most of the programming languages:



C programming language assumes any non-zero and non-null values as true, and if it is either zero or null, then it is assumed as false value. C programming language provides following types of decision making statements.

if statement

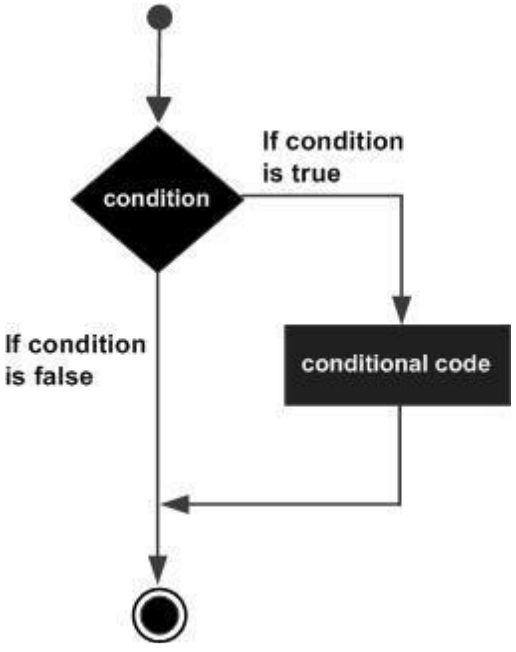
An **if** statement consists of a boolean expression followed by one or more statements.

Syntax

The syntax of an if statement in C programming language is:

```
if(boolean_expression)
{
/* statement(s) will execute if the boolean expression is true */
}
```

If the boolean expression evaluates to true, then the block of code inside the if statement will be executed. If boolean expression evaluates to false, then the first set of code after the end of the if statement (after the closing curly brace) will be executed. C programming language assumes any non-zero and non-null values as true and if it is either zero or null then it is assumed as false value.



Example

```
#include <stdio.h>
int main ()
{
/* local variable definition */
int a = 10;

/* check the boolean condition using if statement */
if( a < 20 )
{
/* if condition is true then print the following */
printf("a is less than 20\n" );
}
printf("value of a is : %d\n", a);
return 0;
}
```

When the above code is compiled and executed, it produces the following result:

a is less than 20;
value of a is: 10

if...else statement

An **if** statement can be followed by an optional **else** statement, which executes when the boolean expression is **false**.

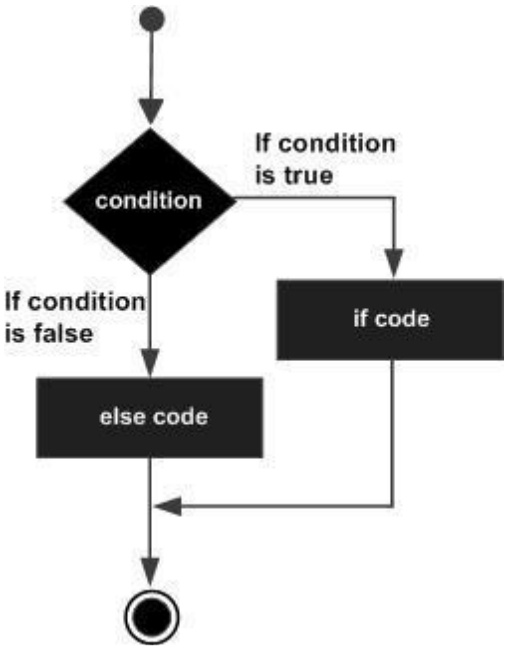
Syntax

The syntax of an **if...else** statement in C programming language is:

```
if(boolean_expression)
{
/* statement(s) will execute if the boolean expression is true */
}
else
{
/* statement(s) will execute if the boolean expression is false */
}
```

If the **boolean** expression evaluates to **true,** then the if block of code will be executed, otherwise **else** block of code will be executed.

C programming language assumes any **non-zero** and **non-null** values as **true** and if it is either **zero** or **null** then it is assumed as **false** value.



Example

```
#include <stdio.h>
int main ()
{
/* local variable definition */
int a = 100;
/* check the boolean condition */
if( a < 20 )
{
/* if condition is true then print the following */
printf("a is less than 20\n" );
}
else
{
/* if condition is false then print the following */
printf("a is not less than 20\n" );
}
printf("value of a is : %d\n", a);
return 0;
}
```

When the above code is compiled and executed, it produces the following result:
a is not less than 20;
value of a is: 100

The if...else if...else Statement

An **if** statement can be followed by an optional **else if...else** statement, which is very useful to test various conditions using single **if...else if** statement.
When using **if , else if , else** statements there are few points to keep in mind:
 An **if** can have zero or one else's and it must come after any **else if's**.

 An **if** can have zero to many **else if's** and they must come before the **else**.

 Once an **else if** succeeds, none of the remaining **else if's** or **else's** will be tested.

Syntax

The syntax of an **if...else if...else** statement in C programming language is:

```
if(boolean_expression 1)
{
/* Executes when the boolean expression 1 is true */
```

```
}
else if( boolean_expression 2)
{
/* Executes when the boolean expression 2 is true */
}
else if( boolean_expression 3)
{
/* Executes when the boolean expression 3 is true */
}
else
{
/* executes when the none of the above condition is true */
}
```

Example

```
#include <stdio.h>
int main ()
{
/* local variable definition */
int a = 100;
/* check the boolean condition */
if( a == 10 )
{
/* if condition is true then print the following */
printf("Value of a is 10\n" );
}
else if( a == 20 )
{
/* if else if condition is true */
printf("Value of a is 20\n" );

}
else if( a == 30 )
{
/* if else if condition is true */
printf("Value of a is 30\n" );
}
else
{
/* if none of the conditions is true */
printf("None of the values is matching\n" );
}
printf("Exact value of a is: %d\n", a );
return 0;
}
```

When the above code is compiled and executed, it produces the following result:

None of the values is matching

Exact value of a is: 100

Nested if statements

It is always legal in C programming to **nest if-else** statements, which means you can use one **if** or **else if** statement inside another **if** or **else if** statement(s).

Syntax

The syntax for a **nested if** statement is as follows:

```
if( boolean_expression 1)
{
/* Executes when the boolean expression 1 is true */
if(boolean_expression 2)
{
/* Executes when the boolean expression 2 is true */
}
}
```

You can nest else **if...else** in the similar way as you have **nested if** statement.

Example

```
#include <stdio.h>
int main ()
{
/* local variable definition */
int a = 100;
int b = 200;
/* check the boolean condition */

if( a == 100 )
{
/* if condition is true then check the following */
if( b == 200 )
{
/* if condition is true then print the following */
printf("Value of a is 100 and b is 200\n" );
}
}
printf("Exact value of a is : %d\n", a );
printf("Exact value of b is : %d\n", b );
return 0;
}
```

When the above code is compiled and executed, it produces the following result:
Value of a is 100 and b is 200
Exact value of a is: 100
Exact value of b is: 200

switch statement

A **switch** statement allows a variable to be tested for equality against a list of values. Each value is called a case, and the variable being switched on is checked for each switch case.

Syntax

The syntax for a **switch** statement in C programming language is as follows:

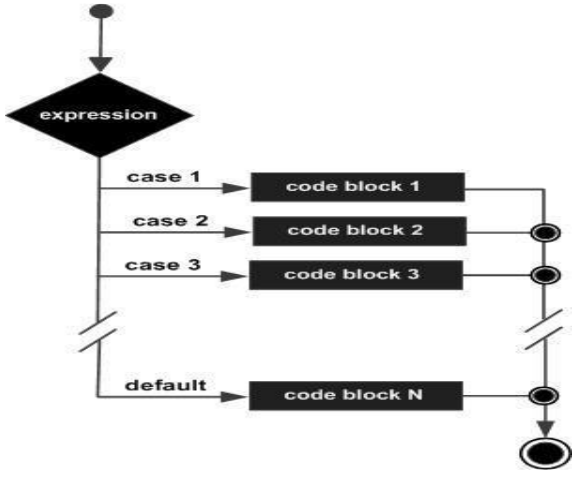
```
switch(expression){
case constant-expression :
statement(s);
break; /* optional */
case constant-expression :
statement(s);
break; /* optional */
/* you can have any number of case statements */
default : /* Optional */
statement(s);
}
```

The following rules apply to a **switch** statement:

- The **expression** used in a **switch** statement must have an integral or enumerated type, or be of a class type in which the class has a single conversion function to an integral or enumerated type.

- You can have any number of case statements within a switch. Each case is followed by the value to be compared to and a colon.
- The **constant-expression** for a case must be the same data type as the variable in the switch, and it must be a constant or a literal.
- When the variable being switched on is equal to a case, the statements following that case will execute until a **break** statement is reached.
- When a **break** statement is reached, the switch terminates, and the flow of control jumps to the next line following the switch statement.
- Not every case needs to contain a **break**. If no **break** appears, the flow of control will *fall through* to subsequent cases until a break is reached.

- A **switch** statement can have an optional **default** case, which must appear at the end of the switch. The default case can be used for performing a task when none of the cases is true. No **break** is needed in the default case.



Example

```
#include <stdio.h>
int main ()
{
/* local variable definition */
char grade = 'B';
switch(grade)
{
case 'A' :
printf("Excellent!\n" );
break;
case 'B' :
case 'C' :
printf("Well done\n" );
break;
case 'D' :
printf("You passed\n" );
break;
case 'F' :
printf("Better try again\n" );
break;
default :
printf("Invalid grade\n" );
}
printf("Your grade is %c\n", grade );
return 0;
}
```

When the above code is compiled and executed, it produces the following result:
Well done
Your grade is B

Nested switch statements

It is possible to have a **switch** as part of the statement sequence of an **outer switch**. Even if the case constants of the inner and outer switch contain common values, no conflicts will arise.

Syntax

The syntax for a **nested switch** statement is as follows:

```
switch(ch1) {
case 'A':
printf("This A is part of outer switch" );
switch(ch2) {
case 'A':
printf("This A is part of inner switch" );
```

```
break;
case 'B': /* case code */
}
break;
case 'B': /* case code */
}
```

Example

```
#include <stdio.h>
int main () {
/* local variable definition */
int a = 100;
int b = 200;
switch(a) {
case 100:
printf("This is part of outer switch\n", a );
switch(b) {
case 200:
printf("This is part of inner switch\n", a );
}
}
printf("Exact value of a is : %d\n", a );
printf("Exact value of b is : %d\n", b );
return 0;
}
```

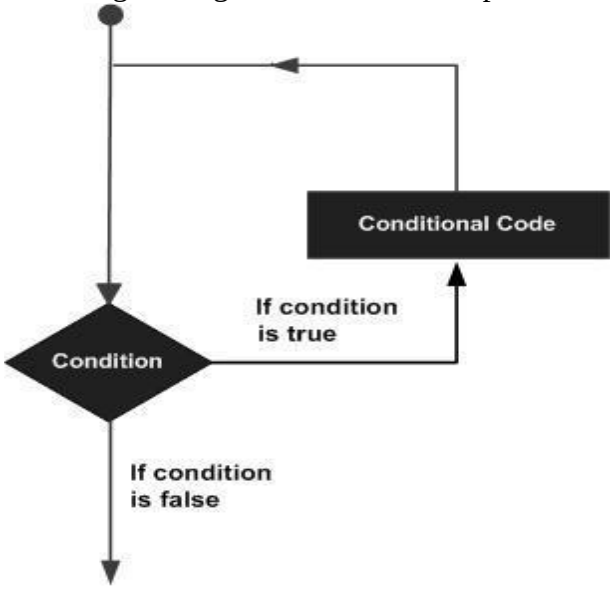
When the above code is compiled and executed, it produces the following result:
This is part of outer switch
This is part of inner switch
Exact value of a is: 100
Exact value of b is: 200

CLoops

There may be a situation, when you need to execute a block of code several number of times. In general, statements are executed sequentially: The **first** statement in a function is executed first, followed by the **second**, and **so on**.

Programming languages provide various control structures that allow for more complicated execution paths.

A **loop** statement allows us to execute a statement or group of statements multiple times and following is the general form of a loop statement in most of the programming languages.



C programming language provides the following types of loops to handle looping requirements.

while loop in C

A **while** loop statement in C programming language repeatedly executes a target statement as long as a given condition is **true**.

Syntax

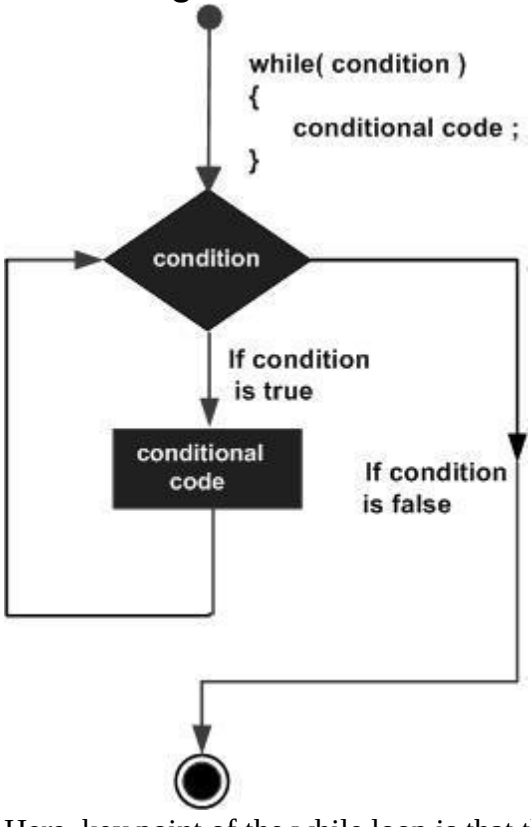
The syntax of a **while** loop in C programming language is:

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

Here, statement(s) may be a single statement or a block of statements. The **condition** may be any expression, and **true** is any **nonzero** value. The loop iterates while the condition is **true**.

When the condition becomes **false**, program control passes to the line immediately following the loop.

Flow Diagram



Here, key point of the while loop is that the loop might not ever run. When the condition is tested and the result is **false**, the loop body will be skipped and the first statement after the while loop will be executed.

Example

```
#include <stdio.h>
int main ()
{
/* local variable definition */
```

```
int a = 10;
/* while loop execution */
while( a < 20 )
{
printf("value of a: %d\n", a);
a++;
}
return 0;
}
```

When the above code is compiled and executed, it produces the following result:

value of a: 10
value of a: 11
value of a: 12
value of a: 13
value of a: 14
value of a: 15
value of a: 16
value of a: 17
value of a: 18
value of a: 19

for loop in C

A **for** loop is a repetition control structure that allows you to efficiently write a loop that needs to execute a specific number of times.

Syntax

The syntax of a **for** loop in C programming language is:

```
for ( init; condition; increment )
{
statement(s);
}
```

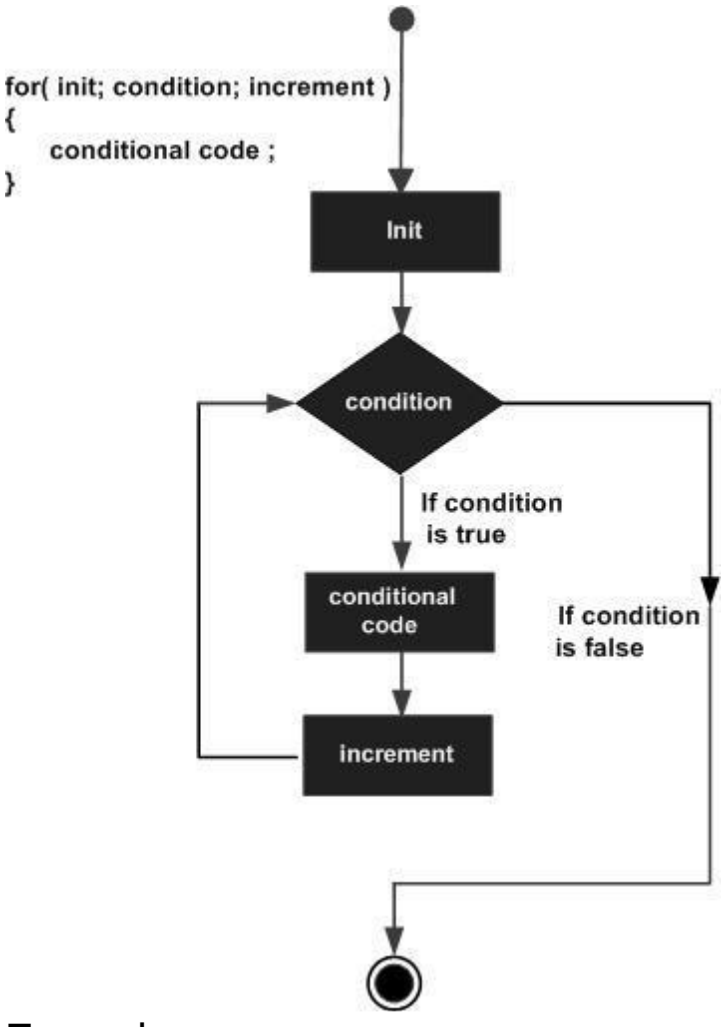
Here is the flow of control in a for loop:

1. The **init** step is executed first, and only once. This step allows you to declare and initialize any loop control variables. You are not required to put a statement here, as long as a semicolon appears.

2. Next, the **condition** is evaluated. If it is true, the body of the loop is executed. If it is false, the body of the loop does not execute and flow of control jumps to the next statement just after the for loop.

3. After the body of the for loop executes, the flow of control jumps back up to the **increment** statement. This statement allows you to update any loop control variables. This statement can be left blank, as long as a semicolon appears after the condition.
4. The condition is now evaluated again. If it is true, the loop executes and the process repeats itself (body of loop, then increment step, and then again condition). After the condition becomes false, the for loop terminates.

Flow Diagram



Example

```
#include <stdio.h>
int main ()
```

```
{
/* for loop execution */
for( int a = 10; a < 20; a = a + 1 )
{
printf("value of a: %d\n", a);
}
return 0;
}
```

When the above code is compiled and executed, it produces the following result:

value of a: 10
value of a: 11
value of a: 12
value of a: 13
value of a: 14
value of a: 15
value of a: 16
value of a: 17
value of a: 18
value of a: 19

do...while loop in C

Unlike for and while loops, which test the loop condition at the top of the loop, the **do...while** loop in C programming language checks its condition at the bottom of the loop.

A **do...while** loop is similar to a while loop, except that a **do...while** loop is guaranteed to execute at least one time.

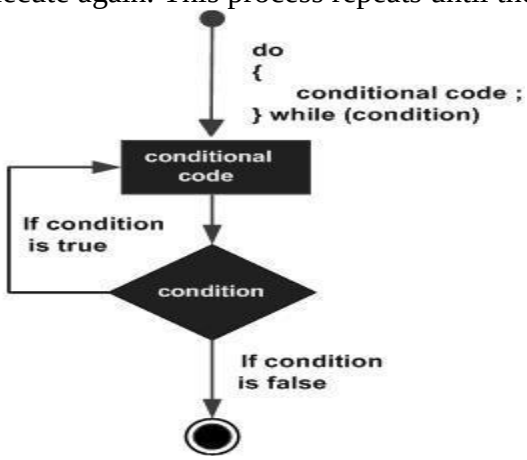
Syntax

The syntax of a **do...while** loop in C programming language is:

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

Notice that the conditional expression appears at the end of the loop, so the statement(s) in the loop execute once before the condition is tested.

If the condition is **true**, the flow of control jumps back up to do, and the statement(s) in the loop execute again. This process repeats until the given condition becomes **false**.



Example

```
#include <stdio.h>
int main ()
{
/* local variable definition */
int a = 10;
/* do loop execution */
do
{
printf("value of a: %d\n", a);
a = a + 1;
}while( a < 20 );
return 0;
}
```

When the above code is compiled and executed, it produces the following result:
value of a: 10
value of a: 11
value of a: 12
value of a: 13
value of a: 14
value of a: 15
value of a: 16
value of a: 17
value of a: 18
value of a: 19

nested loops in C

C programming language allows to use one loop inside another loop. Following section shows few examples to illustrate the concept.

Syntax

The syntax for a nested for loop statement in C is as follows:

```
for ( init; condition; increment )
{
for ( init; condition; increment )
{
statement(s);
}
statement(s);
}
```

The syntax for a **nested** while loop statement in C programming language is as follows:

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

The syntax for a **nested do...while** loop statement in C programming language is as follows:

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

A final note on loop nesting is that you can put any type of loop inside of any other type of loop. For example, a **for loop** can be inside a while loop or vice versa.

Example

The following program uses a nested for loop to find the prime numbers from 2 to 100:

```
#include <stdio.h>
int main ()
{
/* local variable definition */
int i, j;
for(i=2; i<100; i++) {
for(j=2; j <= (i/j); j++)
if(!(i%j)) break; // if factor found, not prime
if(j > (i/j)) printf("%d is prime\n", i);
}
return 0;
}
```

When the above code is compiled and executed, it produces the following result:

2 is prime
3 is prime
5 is prime
7 is prime
11 is prime
13 is prime
17 is prime
19 is prime
23 is prime
29 is prime
31 is prime
37 is prime
41 is prime
43 is prime
47 is prime
53 is prime
59 is prime
61 is prime
67 is prime
71 is prime
73 is prime
79 is prime
83 is prime

89 is prime
97 is prime

break statement in C

The **break** statement in C programming language has the following two usages:
1. When the **break** statement is encountered inside a loop, the loop is immediately terminated and program control resumes at the next statement following the loop.

2. It can be used to terminate a case in the **switch** statement (covered in the next chapter).

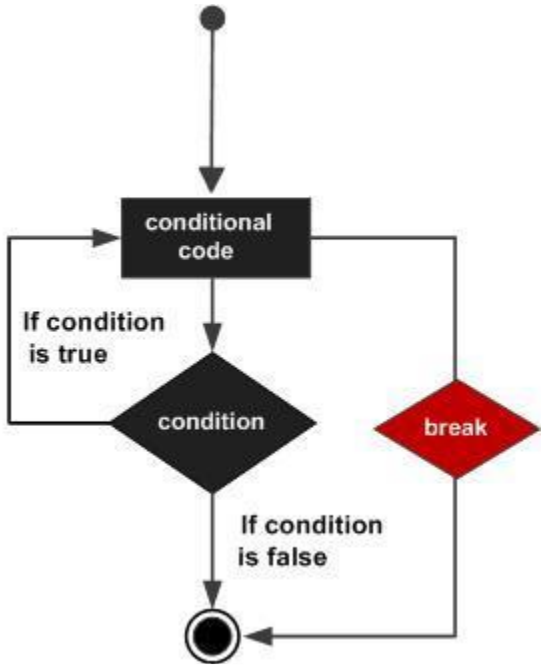
If you are using **nested loops** (i.e., one loop inside another loop), the **break** statement will stop the execution of the innermost loop and start executing the next line of code after the block.

Syntax

The syntax for a **break** statement in C is as follows:

```
break;
```

Flow Diagram



Example

```
#include <stdio.h>
int main ()
{
/* local variable definition */
int a = 10;
```

```
/* while loop execution */
while( a < 20 )
{
printf("value of a: %d\n", a);
a++;
if( a > 15)
{
/* terminate the loop using break statement */
break;
}
}
return 0;
}
```

When the above code is compiled and executed, it produces the following result:

value of a: 10
value of a: 11
value of a: 12
value of a: 13
value of a: 14
value of a: 15

continue statement in C

The **continue** statement in C programming language works somewhat like the break statement. Instead of forcing termination, however, continue forces the next iteration of the loop to take place, skipping any code in between.

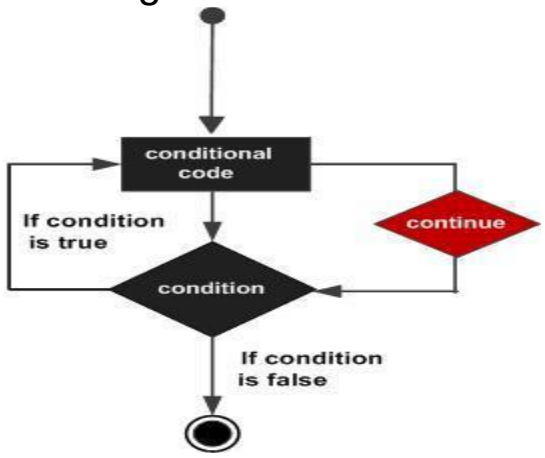
For the **for loop**, **continue** statement causes the conditional test and increment portions of the loop to execute. For the **while** and **do...while** loops, **continue** statement causes the program control passes to the conditional tests.

Syntax

The syntax for a **continue** statement in C is as follows:

```
continue;
```

Flow Diagram



Example

```
#include <stdio.h>
int main ()
{
/* local variable definition */
int a = 10;
/* do loop execution */
do
{
if( a == 15)
{
/* skip the iteration */
a = a + 1;
continue;
}
printf("value of a: %d\n", a);
a++;
}while( a < 20 );
return 0;
}
```

When the above code is compiled and executed, it produces the following result:
value of a: 10
value of a: 11
value of a: 12
value of a: 13
value of a: 14
value of a: 16
value of a: 17
value of a: 18
value of a: 19

goto statement in C

A **goto** statement in C programming language provides an unconditional jump from the **goto** to a labeled statement in the same function.

NOTE: Use of **goto** statement is highly discouraged in any programming language because it makes difficult to trace the control flow of a program, making the program hard to understand and hard to modify. Any program that uses a **goto** can be rewritten so that it doesn't need the **goto**.

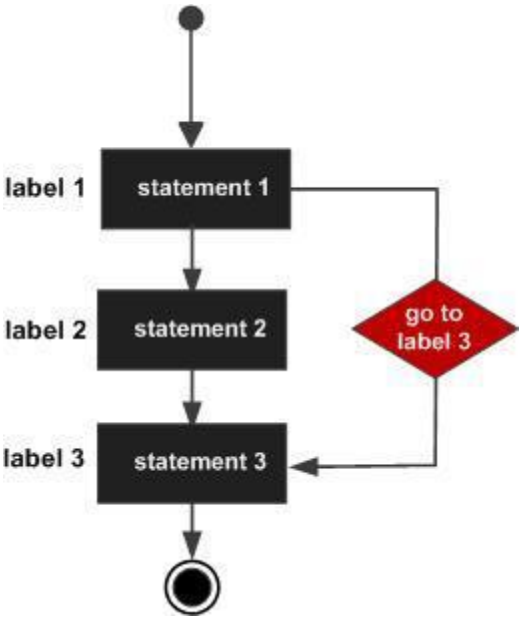
Syntax

The syntax for a **goto** statement in C is as follows:

```
goto label;
..
.
label: statement;
```

Here **label** can be any plain text except C keyword and it can be set anywhere in the C program above or below to **goto** statement.

Flow Diagram



Example

```
#include <stdio.h>
int main ()
{
/* local variable definition */
int a = 10;
/* do loop execution */
LOOP:do
{
if( a == 15)
{
/* skip the iteration */
a = a + 1;
goto LOOP;
}
printf("value of a: %d\n", a);
a++;
}while( a < 20 );
return 0;
}
```

When the above code is compiled and executed, it produces the following result:

value of a: 10
value of a: 11
value of a: 12
value of a: 13
value of a: 14
value of a: 16
value of a: 17
value of a: 18
value of a: 19

The Infinite Loop

A loop becomes **infinite** loop if a condition never becomes **false**. The **for loop** is traditionally used for this purpose. Since **none** of the three expressions that form the **for loop** are required, you can make an endless loop by leaving the conditional expression empty.

```
#include <stdio.h>
int main ()
{
for( ; ; )
{
printf("This loop will run forever.\n");
}
return 0;
}
```

When the conditional expression is absent, it is assumed to be true. You may have an initialization and increment expression, but C programmers more commonly use the **for(;;)** construct to signify an infinite loop.

NOTE: You can terminate an infinite loop by pressing **Ctrl + C** keys.

Exercise:

1. Write a program in C to check whether a year is leap year or not.
2. Write a program in C to find the odd and even numbers from 0 to N.
3. Write a program in C find the factorial of a number n.(Hint : 5!=5*4*3*2*1=120).
4. Write a program to find the sum of digits of a four-digit number input by the user if the number input is less than 4 digits than program should terminate or break.
5. Write a program in C to input having more than one digits and find the number of digits in the number inputted. (Hint:input 10….output: number of digits =2, input:547…..output: number of digits=3).if number inputted have only one digit than program should show break.

Note: Submit the solution of the above exercise latest by 14th April on navedmohd786@gmail.com