Function

A function is a group of statements that together perform a task. Every C program has at least one function, which is **main()**, and all the most trivial programs can define additional functions.

You can divide up your code into separate functions. How you divide up your code among different functions is up to you, but logically the division is such that each function performs a specific task.

A function **declaration** tells the compiler about a function's name, return type, and parameters. A function **definition** provides the actual body of the function.

The C standard library provides numerous built-in functions that your program can call. For example, **strcat()** to concatenate two strings, **memcpy()** to copy one memory location to another location, and many more functions.

A function can also be referred as a method or a sub-routine or a procedure, etc.

Defining a Function

The general form of a function definition in C programming language is as follows −

```
return_type function_name( parameter list ) {
   body of the function
}
```

A function definition in C programming consists of a *function header* and a *function body*. Here are all the parts of a function −

- **Return Type** − A function may return a value. The **return_type** is the data type of the value the function returns. Some functions perform the desired operations without returning a value. In this case, the return_type is the keyword **void**.
- **Function Name** − This is the actual name of the function. The function name and the parameter list together constitute the function signature.
- **Parameters** − A parameter is like a placeholder. When a function is invoked, you pass a value to the parameter. This value is referred to as actual parameter or argument. The parameter list refers to the type, order, and number of the parameters of a function. Parameters are optional; that is, a function may contain no parameters.
- **Function Body** − The function body contains a collection of statements that define what the function does.

Example

Given below is the source code for a function called **max()**. This function takes two parameters num1 and num2 and returns the maximum value between the two −

```
/* function returning the max between two numbers */
int max(int num1, int num2) {
```

```
   /* local variable declaration */
   int result;

   if (num1 > num2)
      result = num1;
   else
      result = num2;

   return result;
}
```

Function Declarations

A function **declaration** tells the compiler about a function name and how to call the function. The actual body of the function can be defined separately.

A function declaration has the following parts −

return_type function_name(parameter list);

For the above defined function max(), the function declaration is as follows −

int max(int num1, int num2);

Parameter names are not important in function declaration only their type is required, so the following is also a valid declaration −

int max(int, int);

Function declaration is required when you define a function in one source file and you call that function in another file. In such case, you should declare the function at the top of the file calling the function.

Calling a Function

While creating a C function, you give a definition of what the function has to do. To use a function, you will have to call that function to perform the defined task.

When a program calls a function, the program control is transferred to the called function. A called function performs a defined task and when its return statement is executed or when its function-ending closing brace is reached, it returns the program control back to the main program.

To call a function, you simply need to pass the required parameters along with the function name, and if the function returns a value, then you can store the returned value. For example −

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```
#include <stdio.h>

/* function declaration */
int max(int num1, int num2);

int main () {
```

```
   /* local variable definition */
   int a = 100;
   int b = 200;
   int ret;

   /* calling a function to get max value */
   ret = max(a, b);

   printf( "Max value is : %d\n", ret );

   return 0;
}

/* function returning the max between two numbers */
int max(int num1, int num2) {

   /* local variable declaration */
   int result;

   if (num1 > num2)
      result = num1;
   else
      result = num2;

   return result;
}
```

We have kept max() along with main() and compiled the source code. While running the final executable, it would produce the following result −

```
Max value is : 200
```

Function Arguments

If a function is to use arguments, it must declare variables that accept the values of the arguments. These variables are called the **formal parameters** of the function.

Formal parameters behave like other local variables inside the function and are created upon entry into the function and destroyed upon exit.

While calling a function, there are two ways in which arguments can be passed to a function −

Sr.No.	Call Type & Description
1	Call by value

	This method copies the actual value of an argument into the formal parameter of the function. In this case, changes made to the parameter inside the function have no effect on the argument.
2	Call by reference This method copies the address of an argument into the formal parameter. Inside the function, the address is used to access the actual argument used in the call. This means that changes made to the parameter affect the argument.

By default, C uses **call by value** to pass arguments. In general, it means the code within a function cannot alter the arguments used to call the function.

What is a Switch Statement?

A switch statement tests the value of a variable and compares it with multiple cases. Once the case match is found, a block of statements associated with that case is executed.

Each case in a block of a switch has a different name/number which is referred to as an identifier. The value provided by the user is compared with all the cases inside the switch block until the match is found.

If a case match is found, then the default statement is executed, and the control goes out of the switch block.

Syntax

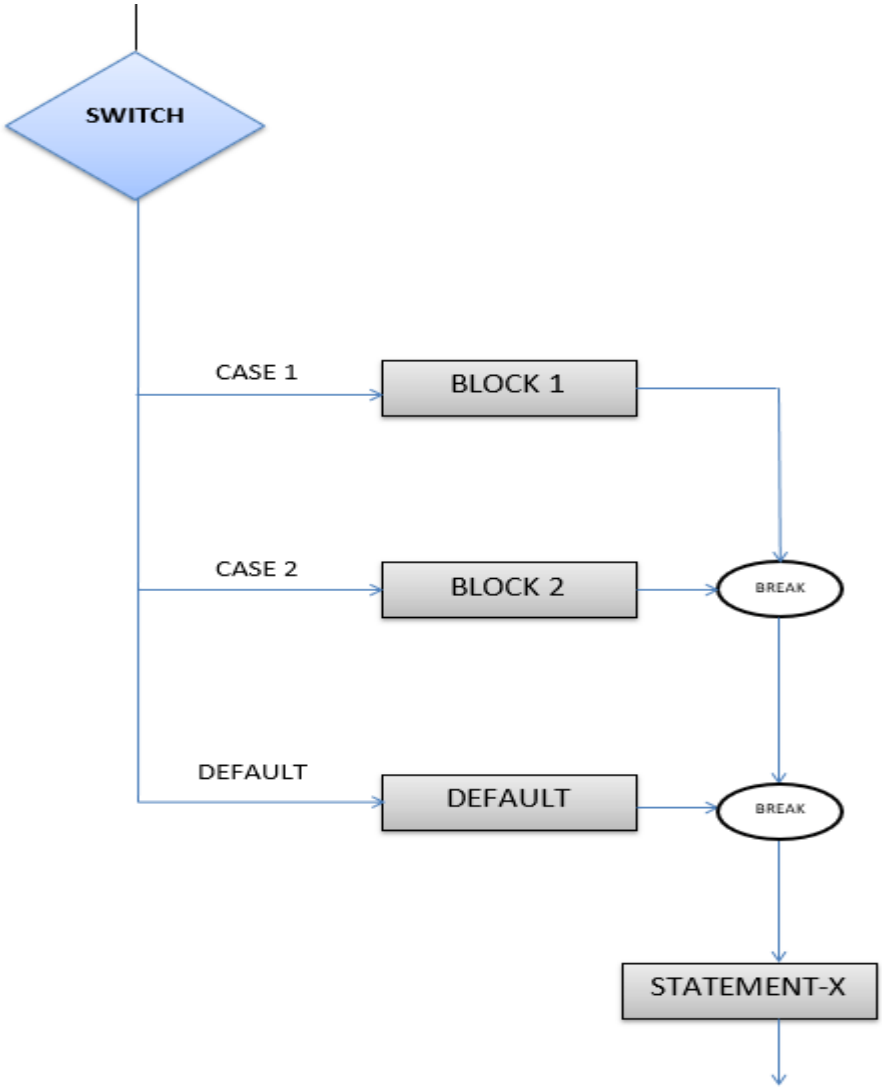
A general syntax of how switch-case is implemented in a 'C' program is as follows:

```
switch( expression )
{
        case value-1:
                        Block-1;
                        Break;
        case value-2:
                        Block-2;
                        Break;
        case value-n:
                        Block-n;
                        Break;
        default:
                        Block-1;
                        Break;
}
Statement-x;
```

- The expression can be integer expression or a character expression.
- Value-1, 2, n are case labels which are used to identify each case individually.
- Case labels always end with a colon (:). Each of these cases is associated with a block.
- A block is nothing but multiple statements which are grouped for a case.
- Whenever the switch is executed, the value of test-expression is compared with all the cases which we have defined inside the switch.
- The break keyword in each case indicates the end of a particular case.
- The default case is an optional one. Whenever the value of test-expression is not matched with any of the cases inside the switch, then the default will be executed. Otherwise, it is not necessary to write default in the switch.
- Once the switch is executed the control will go to the statement-x, and the execution of a program will continue.

Flow Chart Diagram of Switch Case

Following diagram illustrates how a case is selected in switch case:



How Switch Works

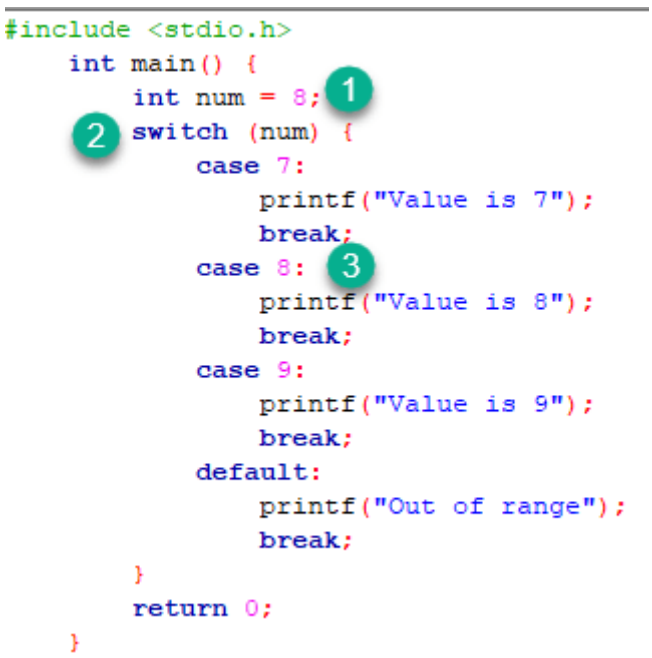
Example

Following program illustrates the use of switch:

```
#include <stdio.h>
   int main() {
      int num = 8;
      switch (num) {
         case 7:
            printf("Value is 7");
            break;
         case 8:
            printf("Value is 8");
            break;
         case 9:
            printf("Value is 9");
            break;
         default:
            printf("Out of range");
            break;
      }
      return 0;
   }
```

Output:

```
Value is 8
```



1. In the given program we have initialized a variable num with value 8.
2. A switch construct is used to compare the value stored in variable num and execute the block of statements associated with the matched case.

3. In this program, since the value stored in variable num is eight, a switch will execute the case whose case-label is 8. After executing the case, the control will fall out of the switch and program will be terminated with the successful result by printing the value on the output screen.

Try changing the value of variable num and notice the change in the output.

For example, we consider the following program which defaults:

```
#include <stdio.h>
int main() {
int language = 10;
  switch (language) {
  case 1:
    printf("C#\n");
    break;
  case 2:
    printf("C\n");
    break;
  case 3:
    printf("C++\n");
    break;
  default:
    printf("Other programming language\n");}}
```

Output:

```
Other programming language
```

When working with switch case in C, you group multiple cases with unique labels. You need to introduce a break statement in each case to branch at the end of a switch statement.

The optional default case runs when no other matches are made.

We consider the following switch statement:

```
#include <stdio.h>
int main() {
int number=5;
switch (number) {
  case 1:
  case 2:
  case 3:
    printf("One, Two, or Three.\n");
    break;
  case 4:
  case 5:
  case 6:
```

```
   printf("Four, Five, or Six.\n");
   break;
 default:
   printf("Greater than Six.\n");}}
```

Output:

```
Four, Five, or Six.
```

Nested Switch

In C, we can have an inner switch embedded in an outer switch. Also, the case constants of the inner and outer switch may have common values and without any conflicts.

We considere the following program which the user to type his own ID, if the ID is valid it will ask him to enter his password, if the password is correct the program will print the name of the user, otherwise ,the program will print Incorrect Password and if the ID does not exist , the program will print Incorrect ID

```
#include <stdio.h>
int main() {
        int ID = 500;
        int password = 000;
        printf("Plese Enter Your ID:\n ");
        scanf("%d", & ID);
        switch (ID) {
           case 500:
              printf("Enter your password:\n ");
              scanf("%d", & password);
              switch (password) {
                 case 000:
                    printf("Welcome Dear Programmer\n");
                    break;
                 default:
                    printf("incorrect password");
                    break;
              }
              break;
           default:
              printf("incorrect ID");
              break;
        }
}
```

OUTPUT:

```
Plese Enter Your ID:
```

```
500
Enter your password:
000
Welcome Dear Programmer
```

```c
#include <stdio.h>
int main() {
    int ID, password;
    printf("Plese Enter Your ID:\n ");
    scanf("%d", & ID);
    switch (ID) {
        case 500:
            printf("Enter your password:\n ");
            scanf("%d", & password);
            switch (password) {
                case 000:
                    printf("Welcome Dear Programmer\n");
                    break;
                default:
                    printf("incorrect password");
                    break;
            }
            break;
        default:
            printf("incorrect ID");
            break;
    }
}
```

1. In the given program we have initialized two variables: ID and password
2. An outer switch construct is used to compare the value entered in variable ID. It execute the block of statements associated with the matched case(when ID==500).
3. If the block statement is executed with the matched case, an inner switch is used to compare the values entered in the variable password and execute the statements linked with the matched case(when password==000).
4. Otherwise, the switch case will trigger the default case and print the appropriate text regarding the program outline.

Why do we need a Switch case?

There is one potential problem with the if-else statement which is the complexity of the program increases whenever the number of alternative path increases. If you use multiple if-else constructs in the program, a program might become difficult to read and comprehend. Sometimes it may even confuse the developer who himself wrote the program.

The solution to this problem is the switch statement.

Rules for switch statement:

- An expression must always execute to a result.
- Case labels must be constants and unique.

- Case labels must end with a colon (:).
- A break keyword must be present in each case.
- There can be only one default label.
- We can nest multiple switch statements.

Summary

- A switch is a decision making construct in 'C.'
- A switch is used in a program where multiple decisions are involved.
- A switch must contain an executable test-expression.
- Each case must include a break keyword.
- Case label must be constants and unique.
- The default is optional.
- Multiple switch statements can be nested within one another.

Structure

Arrays allow to define type of variables that can hold several data items of the same kind. Similarly **structure** is another user defined data type available in C that allows to combine data items of different kinds.

Structures are used to represent a record. Suppose you want to keep track of your books in a library. You might want to track the following attributes about each book −

- Title
- Author
- Subject
- Book ID

Defining a Structure

To define a structure, you must use the **struct** statement. The struct statement defines a new data type, with more than one member. The format of the struct statement is as follows −

```
struct [structure tag] {

   member definition;
   member definition;
   ...
   member definition;
} [one or more structure variables];
```

The **structure tag** is optional and each member definition is a normal variable definition, such as int i; or float f; or any other valid variable definition. At the end of the structure's definition,

before the final semicolon, you can specify one or more structure variables but it is optional. Here is the way you would declare the Book structure −

```
struct Books {
  char  title[50];
  char  author[50];
  char  subject[100];
  int   book_id;
} book;
```

Accessing Structure Members

To access any member of a structure, we use the **member access operator (.)**. The member access operator is coded as a period between the structure variable name and the structure member that we wish to access. You would use the keyword **struct** to define variables of structure type. The following example shows how to use a structure in a program −

Live Demo

```
#include <stdio.h>
#include <string.h>

struct Books {
  char  title[50];
  char  author[50];
  char  subject[100];
  int   book_id;
};

int main( ) {

  struct Books Book1;        /* Declare Book1 of type Book */
  struct Books Book2;        /* Declare Book2 of type Book */

  /* book 1 specification */
  strcpy( Book1.title, "C Programming");
  strcpy( Book1.author, "Nuha Ali");
  strcpy( Book1.subject, "C Programming Tutorial");
  Book1.book_id = 6495407;

  /* book 2 specification */
  strcpy( Book2.title, "Telecom Billing");
  strcpy( Book2.author, "Zara Ali");
  strcpy( Book2.subject, "Telecom Billing Tutorial");
  Book2.book_id = 6495700;

  /* print Book1 info */
  printf( "Book 1 title : %s\n", Book1.title);
  printf( "Book 1 author : %s\n", Book1.author);
  printf( "Book 1 subject : %s\n", Book1.subject);
  printf( "Book 1 book_id : %d\n", Book1.book_id);
```

```
   /* print Book2 info */
   printf( "Book 2 title : %s\n", Book2.title);
   printf( "Book 2 author : %s\n", Book2.author);
   printf( "Book 2 subject : %s\n", Book2.subject);
   printf( "Book 2 book_id : %d\n", Book2.book_id);

   return 0;
}
```

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

```
Book 1 title : C Programming
Book 1 author : Nuha Ali
Book 1 subject : C Programming Tutorial
Book 1 book_id : 6495407
Book 2 title : Telecom Billing
Book 2 author : Zara Ali
Book 2 subject : Telecom Billing Tutorial
Book 2 book_id : 6495700
```

Structures as Function Arguments

You can pass a structure as a function argument in the same way as you pass any other variable or pointer.

Live Demo

```
#include <stdio.h>
#include <string.h>

struct Books {
   char  title[50];
   char  author[50];
   char  subject[100];
   int   book_id;
};

/* function declaration */
void printBook( struct Books book );

int main( ) {

   struct Books Book1;        /* Declare Book1 of type Book */
   struct Books Book2;        /* Declare Book2 of type Book */

   /* book 1 specification */
   strcpy( Book1.title, "C Programming");
   strcpy( Book1.author, "Nuha Ali");
   strcpy( Book1.subject, "C Programming Tutorial");
   Book1.book_id = 6495407;
```

```
   /* book 2 specification */
   strcpy( Book2.title, "Telecom Billing");
   strcpy( Book2.author, "Zara Ali");
   strcpy( Book2.subject, "Telecom Billing Tutorial");
   Book2.book_id = 6495700;

   /* print Book1 info */
   printBook( Book1 );

   /* Print Book2 info */
   printBook( Book2 );

   return 0;
}

void printBook( struct Books book ) {

   printf( "Book title : %s\n", book.title);
   printf( "Book author : %s\n", book.author);
   printf( "Book subject : %s\n", book.subject);
   printf( "Book book_id : %d\n", book.book_id);
}
```

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

```
Book title : C Programming
Book author : Nuha Ali
Book subject : C Programming Tutorial
Book book_id : 6495407
Book title : Telecom Billing
Book author : Zara Ali
Book subject : Telecom Billing Tutorial
Book book_id : 6495700
```

Pointers to Structures

You can define pointers to structures in the same way as you define pointer to any other variable −

```
struct Books *struct_pointer;
```

Now, you can store the address of a structure variable in the above defined pointer variable. To find the address of a structure variable, place the '&'; operator before the structure's name as follows −

```
struct_pointer = &Book1;
```

To access the members of a structure using a pointer to that structure, you must use the → operator as follows −

```
struct_pointer->title;
```

Let us re-write the above example using structure pointer.

Live Demo

```c
#include <stdio.h>
#include <string.h>

struct Books {
   char  title[50];
   char  author[50];
   char  subject[100];
   int   book_id;
};

/* function declaration */
void printBook( struct Books *book );
int main( ) {

   struct Books Book1;        /* Declare Book1 of type Book */
   struct Books Book2;        /* Declare Book2 of type Book */

   /* book 1 specification */
   strcpy( Book1.title, "C Programming");
   strcpy( Book1.author, "Nuha Ali");
   strcpy( Book1.subject, "C Programming Tutorial");
   Book1.book_id = 6495407;

   /* book 2 specification */
   strcpy( Book2.title, "Telecom Billing");
   strcpy( Book2.author, "Zara Ali");
   strcpy( Book2.subject, "Telecom Billing Tutorial");
   Book2.book_id = 6495700;

   /* print Book1 info by passing address of Book1 */
   printBook( &Book1 );

   /* print Book2 info by passing address of Book2 */
   printBook( &Book2 );

   return 0;
}

void printBook( struct Books *book ) {

   printf( "Book title : %s\n", book->title);
   printf( "Book author : %s\n", book->author);
   printf( "Book subject : %s\n", book->subject);
   printf( "Book book_id : %d\n", book->book_id);
}
```

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

Book title : C Programming

Book author : Nuha Ali
Book subject : C Programming Tutorial
Book book_id : 6495407
Book title : Telecom Billing
Book author : Zara Ali
Book subject : Telecom Billing Tutorial
Book book_id : 6495700

Bit Fields

Bit Fields allow the packing of data in a structure. This is especially useful when memory or data storage is at a premium. Typical examples include −

- Packing several objects into a machine word. e.g. 1 bit flags can be compacted.
- Reading external file formats -- non-standard file formats could be read in, e.g., 9-bit integers.

C allows us to do this in a structure definition by putting :bit length after the variable. For example −

```
struct packed_struct {
   unsigned int f1:1;
   unsigned int f2:1;
   unsigned int f3:1;
   unsigned int f4:1;
   unsigned int type:4;
   unsigned int my_int:9;
} pack;
```

Here, the packed_struct contains 6 members: Four 1 bit flags f1..f3, a 4-bit type and a 9-bit my_int.

C automatically packs the above bit fields as compactly as possible, provided that the maximum length of the field is less than or equal to the integer word length of the computer. If this is not the case, then some compilers may allow memory overlap for the fields while others would store the next field in the next word.

Union

A **union** is a special data type available in C that allows to store different data types in the same memory location. You can define a union with many members, but only one member can contain a value at any given time. Unions provide an efficient way of using the same memory location for multiple-purpose.

Defining a Union

To define a union, you must use the **union** statement in the same way as you did while defining a structure. The union statement defines a new data type with more than one member for your program. The format of the union statement is as follows −

```
union [union tag] {
   member definition;
   member definition;
   ...
   member definition;
} [one or more union variables];
```

The **union tag** is optional and each member definition is a normal variable definition, such as int i; or float f; or any other valid variable definition. At the end of the union's definition, before the final semicolon, you can specify one or more union variables but it is optional. Here is the way you would define a union type named Data having three members i, f, and str −

```
union Data {
   int i;
   float f;
   char str[20];
} data;
```

Now, a variable of **Data** type can store an integer, a floating-point number, or a string of characters. It means a single variable, i.e., same memory location, can be used to store multiple types of data. You can use any built-in or user defined data types inside a union based on your requirement.

The memory occupied by a union will be large enough to hold the largest member of the union. For example, in the above example, Data type will occupy 20 bytes of memory space because this is the maximum space which can be occupied by a character string. The following example displays the total memory size occupied by the above union −

Live Demo

```
#include <stdio.h>
#include <string.h>

union Data {
   int i;
   float f;
   char str[20];
};

int main( ) {

   union Data data;

   printf( "Memory size occupied by data : %d\n", sizeof(data));

   return 0;
}
```

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

```
Memory size occupied by data : 20
```

Accessing Union Members

To access any member of a union, we use the **member access operator (.)**. The member access operator is coded as a period between the union variable name and the union member that we wish to access. You would use the keyword **union** to define variables of union type. The following example shows how to use unions in a program −

Live Demo

```
#include <stdio.h>
#include <string.h>

union Data {
   int i;
   float f;
   char str[20];
};

int main( ) {

   union Data data;

   data.i = 10;
   data.f = 220.5;
   strcpy( data.str, "C Programming");

   printf( "data.i : %d\n", data.i);
   printf( "data.f : %f\n", data.f);
   printf( "data.str : %s\n", data.str);

   return 0;
}
```

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

```
data.i : 1917853763
data.f : 4122360580327794860452759994368.000000
data.str : C Programming
```

Here, we can see that the values of **i** and **f** members of union got corrupted because the final value assigned to the variable has occupied the memory location and this is the reason that the value of **str** member is getting printed very well.

Now let's look into the same example once again where we will use one variable at a time which is the main purpose of having unions −

Live Demo

```
#include <stdio.h>
#include <string.h>

union Data {
   int i;
   float f;
   char str[20];
};
```

```
int main( ) {

   union Data data;

   data.i = 10;
   printf( "data.i : %d\n", data.i);

   data.f = 220.5;
   printf( "data.f : %f\n", data.f);

   strcpy( data.str, "C Programming");
   printf( "data.str : %s\n", data.str);

   return 0;
}
```

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

```
data.i : 10
data.f : 220.500000
data.str : C Programming
```

Here, all the members are getting printed very well because one member is being used at a time.