Programming in C

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Module 3:
Arrays, Structures And Unions

Arrays, Structures And Unions

- One dimensional array
- Multidimensional array
- Declaration and Initialization of Arrays
- Reading and Displaying arrays
- String and its related functions

Arrays, Structures And Unions

An array is a sequence of data item of homogeneous values (same type).

Arrays are of two types:

1. One dimensional arrays (1D array)
2. Multidimensional arrays (2D, #D, etc.)

1D array

Rows	Mon 0	Tue 1	Wed 2	Thu 3	Fri 4
0	8	12	9	7	10
1	5	7	3	0	4
2	20	15	18	21	14
3	6	5	5	8	11

2D array

Arrays, Structures And Unions

An array is defined as an ordered set of similar data items. All the data items of an array are stored in consecutive memory locations in RAM. The elements of an array are of same data type and each item can be accessed using the same name.

Declaration of an array:- We know that all the variables are declared before the are used in the program. Similarly, an array must be declared before it is used. During declaration, the size of the array has to be specified. The size used during declaration of the array informs the compiler to allocate and reserve the specified memory locations.

Syntax:- data_type array_name[n];

where, n is the number of data items (or) index(or) dimension.

0 to (n-1) is the range of array.

Ex: int a[5];

float x[10];

Arrays, Structures And Unions

Initialization of Arrays:-

The different types of initializing arrays:

1. At Compile time

(i) Initializing all specified memory locations.

(ii) Partial array initialization

(iii) Initialization without size.

(iv) String initialization.

2. At Run Time

Arrays, Structures And Unions

1. Compile Time Initialization

We can initialize the elements of arrays in the same way as the ordinary variables when they are declared. The general form of initialization of arrays is

Type array-name[size]={ list of values};

(i) Initializing all specified memory locations:- Arrays can be initialized at the time of declaration when their initial values are known in advance. Array elements can be initialized with data items of type int, char etc.

Ex:- int a[5]={10,15,1,3,20};

float b[3]={0.2,2.1,4.5};

printf("b[0]=%f\tb[1]=%f\tb[2]=%f",b[0],b[1],b[2]);

During compilation, 5 contiguous memory locations are reserved by the compiler for the variable a and all these locations are initialized as shown in figure.

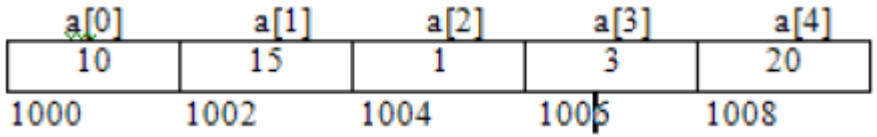


Fig: Initialization of int Arrays

Ex:-

int a[3]={9,2,4,5,6}; //error: no. of initial vales are more than the size of array.

Arrays, Structures And Unions

1. Compile Time Initialization

(ii) Partial array initialization:- Partial array initialization is possible in c language. If the number of values to be initialized is less than the size of the array , then the elements will be initialized to zero automatically.

Ex:-

int a[5]={10,15};

Eventhough compiler allocates 5 memory locations, using this declaration statement; the compiler initializes first two locations with 10 and 15, the next set of memory locations are automatically initialized to 0's by compiler as shown in figure.

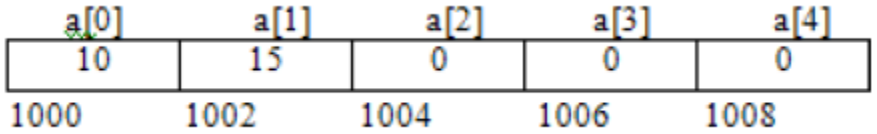


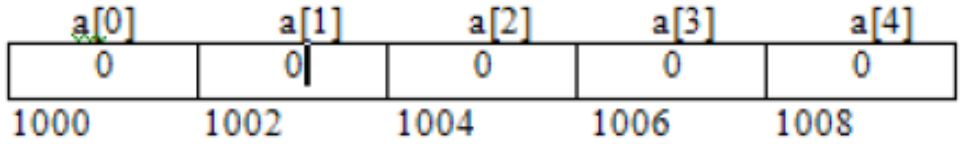
Fig: Partial Array Initialization

Arrays, Structures And Unions

1. Compile Time Initialization

Initialization with all zeros:-
Ex:-

int a[5]={0};



Arrays, Structures And Unions

1. Compile Time Initialization

(iii) Initialization without size:- Consider the declaration along with the initialization.
Ex:-
char b[]={'C','O','M','P','U','T','E','R'};

In this declaration, eventhough we have not specified exact number of elements to be used in array b, the array size will be set of the total number of initial values specified. So, the array size will be set to 8 automatically. the array b is initialized as shown in figure.

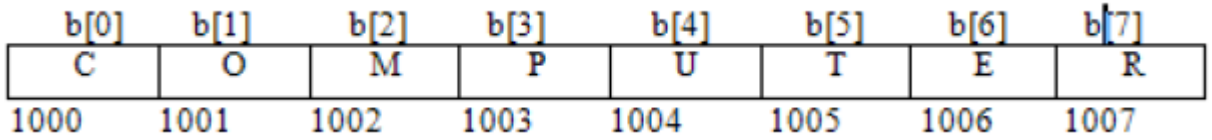


Fig: Initialization without size

Ex:- int ch[]={1,0,3,5} // array size is 4

Arrays, Structures And Unions

1. Compile Time Initialization

(iv) Array initialization with a string: - Consider the declaration with string initialization.
Ex:-
char b[]="COMPUTER";
The array b is initialized as shown in figure.

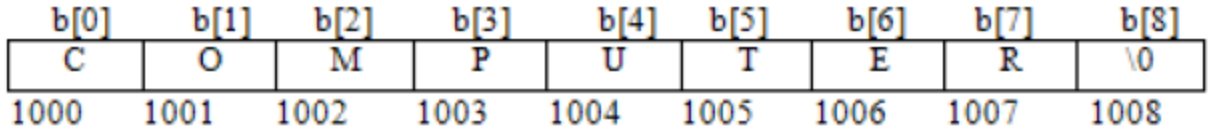


Fig: Array Initialized with a String

Eventhough the string "COMPUTER" contains 8 characters, because it is a string. It always ends with null character. So, the array size is 9 bytes (i.e., string length 1 byte for null character).
Ex:-
char b[9]="COMPUTER";
char b[8]="COMPUTER";

Arrays, Structures And Unions

1. Compile Time Initialization

(iv) Array initialization with a string: - Consider the declaration with string initialization.
Ex:-
char b[]="COMPUTER";
The array b is initialized as shown in figure.

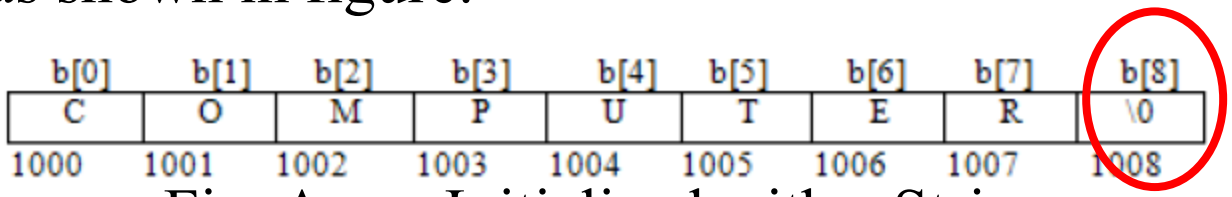


Fig: Array Initialized with a String

Eventhough the string "COMPUTER" contains 8 characters, because it is a string. It always ends with null character. So, the array size is 9 bytes (i.e., string length 1 byte for null character).
Ex:-
char b[9]="COMPUTER"; // correct
char b[8]="COMPUTER"; // wrong

Arrays, Structures And Unions

Task

- Consider an array of integer, float and character with **Compile Time Initialization**
- Display all elements in an array
- Display any particular value/ character from the array

x[0]= x[1]= x[2]= x[3]=

And as

x[0]=

x[1]=…

2. Run Time Initialization

An array can be explicitly initialized at run time. This approach is usually applied for initializing large arrays.

Ex:- scanf can be used to initialize an array.

```
Int x[3];
Scanf("%d%d%d",&x[0],&x[1],&x[2]);
```

The above statements will initialize array elements with the values entered through the key board.

TASK

Consider an array of 4 elements and display using scanf and printf as

x[0]= x[1]= x[2]= x[3]=

And as

x[0]=

x[1]=…

2. Run Time Initialization

OR

```
float Sum[150];
For(i=0;i<100;i=i+1)
{
If(i<50)
Sum[i]=0.0;
Else
Sum[i]=1.0;
}
```

2. Run Time Initialization

OR

```
float Sum[150];
For(i=0;i<100;i=i+1)
{
If(i<50)
Sum[i]=0.0;
Else
Sum[i]=1.0;
}
```

The first 50 elements of the array sum are initialized to 0 while the remaining 50 are initialized to 1.0 at run time.

Arrays, Structures And Unions

2 D arrays

An array consisting of two subscripts is known as two-dimensional array. These are often known as array of the array. In two dimensional arrays the array is divided into rows and columns,. These are well suited to handle the table of data. In 2-D array we can declare an array as :

Declaration:-

Data_type array_name[row_size][column_size] = {{list of first row elements},
{list of second row elements},….
{list of last row elements}};

Ex:- int arr[3][3];

where first index value shows the number of the rows and second index value shows the no. of the columns in the array.

Initialization:-

int arr[3][3] = {{ 1, 2, 3},{4, 5, 6},{7, 8, 9}};

Arrays, Structures And Unions

2 D arrays: Memory storage

These are stored in the memory as given below.

1. Row-Major order Implementation
2. Column-Major order Implementation

In Row-Major Implementation of the arrays, the arrays are stored in the memory in terms of the row design, i.e. first the first row of the array is stored in the memory then second and so on. Suppose we have an array named arr having 3 rows and 3 columns then it can be stored in the memory in the following manner :

arr[0][0]	arr[0][1]	arr[0][2]
arr[1][0]	arr[1][1]	arr[1][2]
arr[2][0]	arr[2][1]	arr[2][2]

2 D arrays: Memory storage: Row-Major Implementation

int arr[3][3];

Thus an array of 3*3 can be declared as follows :

arr[3][3] = { 1, 2, 3,
4, 5, 6,
7, 8, 9 };

and it will be represented in the memory with row major implementation as follows :

1	2	3	4	5	6	7	8	9

2 D arrays: Memory storage: Column-Major Implementation

The arrays are stored in the memory in the term of the column design, i.e. the first column of the array is stored in the memory then the second and so on.

int arr[3][3];
Thus an array of 3*3 can be declared as follows :

arr[3][3] = { 1, 2, 3,
4, 5, 6,
7, 8, 9 };
and it will be represented in the memory with column major implementation as follows :

Arrays, Structures And Unions

2 D arrays: Memory storage: Column-Major Implementation

int arr[3][3];

Thus an array of 3*3 can be declared as follows :

arr[3][3] = { 1, 2, 3,
4, 5, 6,
7, 8, 9 };

and it will be represented in the memory with column major implementation as follows :

1	4	7	2	5	8	3	6	9

2 D arrays:

To initialize values for variable length arrays we can use scanf statement & loop constructs.

```
int arr[5][5];
for (i=0 ; i<3; i++)
for(j=0;j<3;j++)
scanf("%d",&arr[i][j]);
```

Task:
Consider 2-D array, display the 2-D array and also display any particular element or specified by user from it

2 D arrays:

To initialize values for variable length arrays we can use scanf statement & loop constructs.

```
int arr[5][5];
for (i=0 ; i<3; i++)
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scanf("%d",&arr[i][j]);
```

Task:
Consider 2-D array, display the 2-D array and also display any particular element

Multidimensional #D arrays:

Syntax:

Data_type arrat_name[size1][size2][size3]------[sizeN];

```
int arr[3][3][3] =
{ 1, 2, 3,
4, 5, 6,
7, 8, 9,

10, 11, 12,
13, 14, 15,
16, 17, 18,

19, 20, 21,
22, 23, 24,
25, 26, 27 };
```

/* here we have divided array into grid for sake of convenience as in above declaration we have created 3 different grids, each have rows and columns */

If we want to access the element the in 3-D array we can do it as follows :

```
printf("%d",&arr[2][2][2]);
```

Output=?

Multidimensional #D arrays:

Syntax:

Data_type arrat_name[size1][size2][size3]------[sizeN];

```
int arr[3][3][3] =
{ 1, 2, 3,
4, 5, 6,
7, 8, 9,

10, 11, 12,
13, 14, 15,
16, 17, 18,

19, 20, 21,
22, 23, 24,
25, 26, 27 };
```

/* here we have divided array into grid for sake of convenience as in above declaration we have created 3 different grids, each have rows and columns */

If we want to access the element the in 3-D array we can do it as follows :

```
printf("%d",a[2][2][2]);
```

Output=?

27

Array indexing start with zero

Arrays, Structures And Unions

Task

Addition of 2-D array (2 * 2)
Display both the array
Display added array

Task: Addition of 2-D array (2 * 2)

```
#include<stdio.h>
void main()
{
int i,j;
int a[2][2]={1,2,3,4};
int b[2][2]={1,2,3,4};
int c[2][2];

for(i=0;i<2;i++)
{
for(j=0;j<2;j++)
{
printf("%2d",a[i][j]);
}
printf("\n\n");
}
```

```
for(i=0;i<2;i++)
{
for(j=0;j<2;j++)
{
printf("%2d",b[i][j]);
}
printf("\n\n");
}


printf("\n The addition of given two matrices is\n");
for(i=0;i<2;i++)
{
for(j=0;j<2;j++)
{
c[i][j]=a[i][j]+b[i][j];
}
}
```

```
for(i=0;i<2;i++)
{
for(j=0;j<2;j++)
{
printf("%2d",c[i][j]);
}
printf("\n\n");
}
getch();
}
```

Arrays, Structures And Unions

Character Arrays and Strings: Introduction, Declaring and Initializing String Variables, Reading Character and Writing Character, Reading and Writing Strings, String Handling Functions

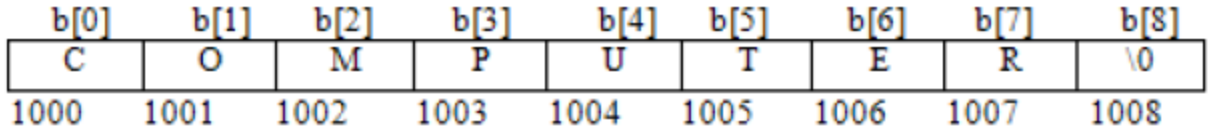
Character Arrays and Strings: Introduction, Declaring and Initializing String Variables, Reading Character and Writing Character, Reading and Writing Strings

Array declaration and initialization with a character/string: - Consider the declaration with string initialization.

Ex:-

```
char b[]="COMPUTER";
```

The array b is initialized as shown in figure.



Eventhough the string "COMPUTER" contains 8 characters, because it is a string. It always ends with null character. So, the array size is 9 bytes (i.e., string length 1 byte for null character).

Ex:-

```
char b[9]="COMPUTER";
char b[8]="COMPUTER";
```

Character Arrays and Strings: Introduction, Declaring and Initializing String Variables, Reading Character and Writing Character, Reading and Writing Strings

Array declaration and initialization with a character/string: - Consider the declaration with string initialization.

Ex:-

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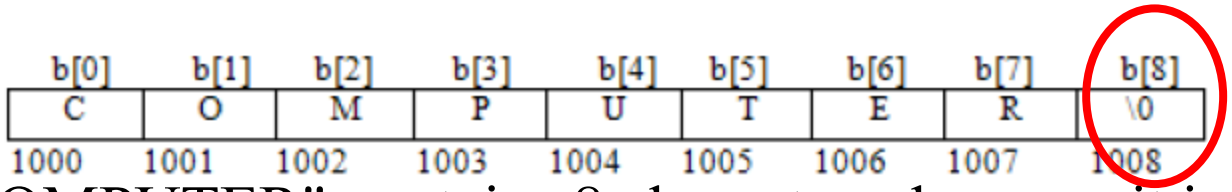

Eventhough the string "COMPUTER" contains 8 characters, because it is a string. It always ends with null character. So, the array size is 9 bytes (i.e., string length 1 byte for null character).

Ex:-

```
char b[9]="COMPUTER"; // correct
char b[8]="COMPUTER"; // wrong
```

Arrays, Structures And Unions

Character Arrays and Strings: Introduction, Declaring and Initializing String Variables, Reading Character and Writing Character, Reading and Writing Strings

Task

- Consider an array of integer, float and **character** with **Compile Time Initialization**
- Display all elements in an array
- Display any particular value/ character from the array

x[0]= x[1]= x[2]= x[3]= And as

x[0]=

x[1]=…

```
#include <stdio.h>
int main ()
{
  char greeting[6] = {'H', 'e', 'l', 'l', 'o', '\0'};
  printf("Greeting message: %s\n", greeting );
  return 0;
}
```

Output?

Character Arrays and Strings: Introduction, Declaring and Initializing String Variables, Reading Character and Writing Character, Reading and Writing Strings

Task

- Consider an array of integer, float and **character** with **Compile Time Initialization**
- Display all elements in an array
- Display any particular value/ character from the array

x[0]= x[1]= x[2]= x[3]= And as

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x[1]=…

```
#include <stdio.h>
int main ()
{
  char greeting[6] = {'H', 'e', 'l', 'l', 'o', '\0'};
  printf("Greeting message: %s\n", greeting );
  return 0;
}
```

Output?

Greeting Message:Hello

Character Arrays and Strings: Introduction, Declaring and Initializing String Variables, Reading Character and Writing Character, Reading and Writing Strings

```
#include <stdio.h>
#include <string.h>
int main()
{
   /* String Declaration*/
   char nickname[20];
   printf("Enter your Nick name:");

   /* I am reading the input string and storing it in nickname
    * Array name alone works as a base address of array so
    * we can use nickname instead of &nickname here
    */
   scanf("%s", nickname);

   /*Displaying String*/
   printf("%s",nickname);

   return 0;
}
```

```
#include <stdio.h>
#include <string.h>
int main()
{
   /* String Declaration*/
   char nickname[20];

   /* Console display using puts */
   puts("Enter your Nick name:");

   /*Input using gets*/
   gets(nickname);

   puts(nickname);

   return 0;
}
```

String Handling Functions

Sr.No.	Function & Purpose
1	**strcpy(s1, s2);** Copies string s2 into string s1.
2	**strcat(s1, s2);** Concatenates string s2 onto the end of string s1.
3	**strlen(s1);** Returns the length of string s1.
4	**strcmp(s1, s2);** Returns 0 if s1 and s2 are the same; less than 0 if s1<s2; greater than 0 if s1>s2.
5	**strchr(s1, ch);** Returns a pointer to the first occurrence of character ch in string s1.
6	**strstr(s1, s2);** Returns a pointer to the first occurrence of string s2 in string s1.

String Handling Functions

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

  char str1[12] = "Hello";
  char str2[12] = "World";
  char str3[12];
  int  len ;

  /* copy str1 into str3 */
  strcpy(str3, str1);
  printf("strcpy( str3, str1) :  %s\n", str3 );

  /* concatenates str1 and str2 */
  strcat( str1, str2);
  printf("strcat( str1, str2):   %s\n", str1 );

  /* total lenghth of str1 after concatenation */
  len = strlen(str1);
  printf("strlen(str1) :  %d\n", len );

  return 0;
}
```

Output?

String Handling Functions

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

  char str1[12] = "Hello";
  char str2[12] = "World";
  char str3[12];
  int  len ;

  /* copy str1 into str3 */
  strcpy(str3, str1);
  printf("strcpy( str3, str1) :  %s\n", str3 );

  /* concatenates str1 and str2 */
  strcat( str1, str2);
  printf("strcat( str1, str2):   %s\n", str1 );

  /* total lenghth of str1 after concatenation */
  len = strlen(str1);
  printf("strlen(str1) :  %d\n", len );

  return 0;
}
```

Output?

```
strcpy( str3, str1) :  Hello
strcat( str1, str2):   HelloWorld
strlen(str1) :  10
```

strlen vs sizeof

```
#include <stdio.h>
#include <string.h>
int main()
{
    char str1[20] = "BeginnersBook";
    printf("Length of string str1: %d", strlen(str1));
    printf(“Size of string str1: %d", sizeof(str1));
    return 0;
}
```

Output?

strlen vs sizeof

```
#include <stdio.h>
#include <string.h>
int main()
{
    char str1[20] = "BeginnersBook";
    printf("Length of string str1: %d", strlen(str1));
    printf("Size of string str1: %d", sizeof(str1));
    return 0;
}
```

Output?

strlen(str1) returned value 13.
sizeof(str1) would return value 20 as the array size is 20 (see the first statement in main function).

String function – strcmp, strncmp

If string1 < string2 OR string1 is a substring of string2 then it would result in a negative value. If string1 > string2 then it would return positive value.
If **string1 == string2** then you would get **0(zero)** when you use this function for compare strings.

String function – strcmp, strncmp

```
#include <stdio.h>
#include <string.h>
int main()
{
    char s1[20] = "BeginnersBook";
    char s2[20] = "BeginnersBook.COM";
    if (strcmp(s1, s2) ==0)
    {
      printf("string 1 and string 2 are equal");
    }else
     {
       printf("string 1 and 2 are different");
     }
    return 0;
}
```

```
#include <stdio.h>
#include <string.h>
int main()
{
    char s1[20] = "BeginnersBook";
    char s2[20] = "BeginnersBook.COM";
    /* below it is comparing first 8 characters of s1 and s2*/
    if (strncmp(s1, s2, 8) ==0)
    {
       printf("string 1 and string 2 are equal");
    }else
    {
       printf("string 1 and 2 are different");
    }
    return 0;
}
```

String function – strcmp, strncmp

```
#include <stdio.h>
#include <string.h>
int main()
{
    char s1[20] = "BeginnersBook";
    char s2[20] = "BeginnersBook.COM";
    if (strcmp(s1, s2) ==0)
    {
      printf("string 1 and string 2 are equal");
    }else
     {
       printf("string 1 and 2 are different");
     }
    return 0;
}
```

string 1 and 2 are different

```
#include <stdio.h>
#include <string.h>
int main()
{
    char s1[20] = "BeginnersBook";
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    /* below it is comparing first 8 characters of s1 and s2*/
    if (strncmp(s1, s2, 8) ==0)
    {
       printf("string 1 and string 2 are equal");
    }else
    {
       printf("string 1 and 2 are different");
    }
    return 0;
}
```

string 1 and 2 are equal

String function – strchr & strstr

```
#include <stdio.h>
#include <string.h>
int main () {
   char str[] = "This is just a String";
   char ch = 's';
   char *p;
   p = strchr(str, ch);
   printf("String starting from %c is: %s", ch, p);
   return 0;
}
```

```
#include <stdio.h>
#include <string.h>
int main () {
   char str[20] = "Hello, how are you?";
   char searchString[10] = "you";
   char *result;

   /* This function returns the pointer of the first occurrence
    * of the given string (i.e. searchString)     */

   result = strstr(str, searchString);
   printf("The substring starting from the given string: %s", result);
   return 0;
}
```

String Handling Functions

String function – strchr & strstr

```
#include <stdio.h>
#include <string.h>
int main () {
   char str[] = "This is just a String";
   char ch = 's';
   char *p;
   p = strchr(str, ch);
   printf("String starting from %c is: %s", ch, p);
   return 0;
}
```

String starting from s is: s is just a String

```
#include <stdio.h>
#include <string.h>
int main () {
   char str[20] = "Hello, how are you?";
   char searchString[10] = "you";
   char *result;

   /* This function returns the pointer of the first occurrence
    * of the given string (i.e. searchString)     */

   result = strstr(str, searchString);
   printf("The substring starting from the given string: %s", result);
   return 0;
}
```

The substring starting from the given string: you ?

String function – strchr & strstr

```
int main () {
   char haystack[20] = "TutorialsPoint";
   char needle[10] = "Point";
   char *ret;

   ret = strstr(haystack, needle);

   printf("The substring is: %s\n", ret);

   return(0);
}
```

```
int main () {
   char haystack[20] = "TutorialsPoint";
   char needle[10] = “Tutorials";
   char *ret;

   ret = strstr(haystack, needle);

   printf("The substring is: %s\n", ret);

   return(0);
}
```

String function – strchr & strstr

```
int main () {
   char haystack[20] = "TutorialsPoint";
   char needle[10] = "Point";
   char *ret;

   ret = strstr(haystack, needle);

   printf("The substring is: %s\n", ret);

   return(0);
}
```

The substring is: Point

```
int main () {
   char haystack[20] = "TutorialsPoint";
   char needle[10] = “Tutorials";
   char *ret;

   ret = strstr(haystack, needle);

   printf("The substring is: %s\n", ret);

   return(0);
}
```

The substring is: TutorialsPoint