Pointer
IT Batch 400
Full Lecture

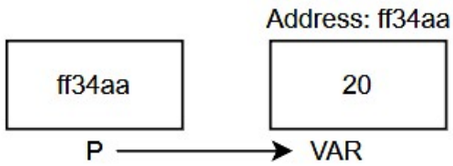
See the following output:

```
#include <stdio.h>
int main()
{
   int *ptr, q;
   q = 50;
   /* address of q is assigned to ptr */
   ptr = &q;
   /* display q's value using ptr variable */
   printf("%d", *ptr);
   return 0;
}
```

Output: 50

***p vs **p vs ***p meaning:**

***p:** *p is a pointer to a variable, as shown below. It is also called single pointer. The single pointer has two purposes: to create an array and to allow a function to change its contents (pass by reference).



****p:** **p is a pointer to a pointer variable, also called double pointer. It is a form of multiple indirection, or a chain of pointers. When we define a pointer to a pointer, the first pointer contains the address of the second pointer, which points to the location that contains the actual value as shown below.

*****p:** ***p is a pointer to a double pointer, rather a pointer to a pointer to a pointer variable, as shown below. It is mostly called triple pointer. It is an even higher level of multiple indirection or pointer chaining. A triple pointer is used to traverse an array of pointers.

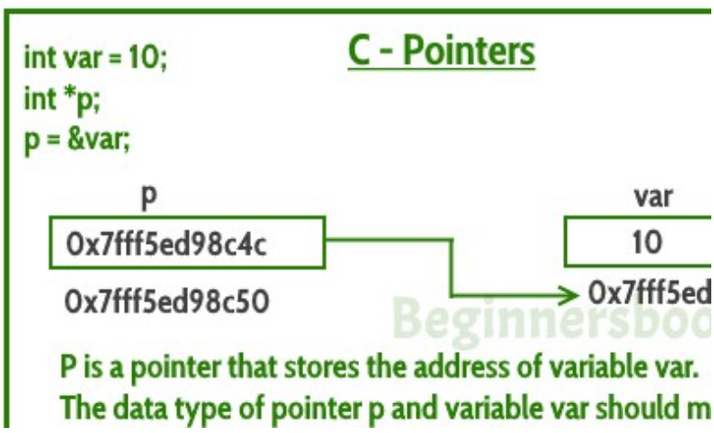
Example of Pointer demonstrating the use of & and *

```
int main()
{
  /* Pointer of integer type, this can hold the
   * address of a integer type variable.
   */
  int *p;

  int var = 10;

  /* Assigning the address of variable var to the pointer
   * p. The p can hold the address of var because var is
   * an integer type variable.
   */
  p= &var;
  printf("Value of variable var is: %d", var);
  printf("\nValue of variable var is: %d", *p);
  printf("\nAddress of variable var is: %p", &var);
  printf("\nAddress of variable var is: %p", p);
  printf("\nAddress of pointer p is: %p", &p);
  return 0;
}
```

Output:
Value of variable var is: 10
Value of variable var is: 10
Address of variable var is: 0x7fff5ed98c4c
Address of variable var is: 0x7fff5ed98c4c
Address of pointer p is: 0x7fff5ed98c50



See the following Example:

```
int main()
{
  int var;
  int *p,**pp,***ppp;
  var =100;
  p=&var;
  pp=&p;
  ppp=&pp;
  printf("value at var= %d\n",var);
  printf("value available at *p= %d\n",*p);
  printf("value available at **p= %d\n",**pp);
  printf("value available at ***p= %d\n",***ppp);
  return 0;
}
```

Output:
value at var= 100
value available at *p= 100
value available at **p= 100
value available at ***p= 100

Understand Pointer how it works:

```
int main () {
int  var = 20;   /* actual variable declaration */
int  *ip;        /* pointer variable declaration */
ip = &var; /* store address of var in pointer variable*/
printf("Address of var variable: %x\n", &var  );
   /* address stored in pointer variable */
printf("Address stored in ip variable: %x\n", ip );
   /* access the value using the pointer */
printf("Value of *ip variable: %d\n", *ip );
return 0;
}
```

Output: Address of var variable: bffd8b3c
Address stored in ip variable: bffd8b3c
Value of *ip variable: 20

Pointer to Pointer

We know, pointer is a variable that contains address of another variable. Now this variable address might be stored in another pointer. Thus, we now have a pointer that contains address of another pointer, known as pointer to pointer.

Example 3:

```
main ()
```

```
{
int i = 3, *p, **q;
p = &i;
q=&p;
printf("\n Address of i = %u", &i);
printf("\n Address of i = %u", p);
printf("\n Address of i = %u", *q);
printf("\n Address of p= %u", &p);
printf("\n Address of p= %u", q);
printf("\n Address of q = %u", &q);
printf("\n value of i= %d", i);
printf("\n value of i= %d", *(&i));
printf("\n value of i= %d", *p);
printf("\n value of i= %d", **q);
}
```

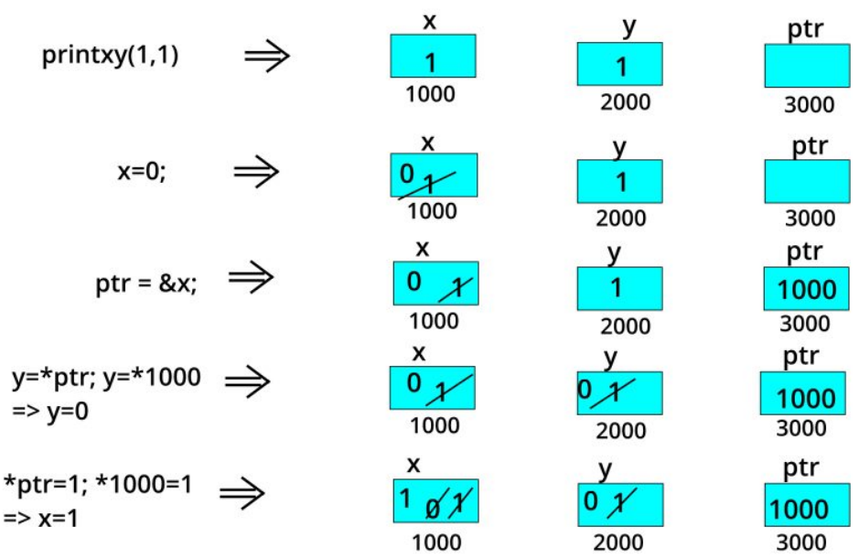
If the memory map is **q=20555 , *p=20122 and i=2000

Then the **output** is:

Address of i = 2000
Address of i = 2000
Address of i = 2000
Address of p= 20122
Address of p = 20122
Address of q = 20555
Value of i = 3
Value of i=3
Value of i=3
Value of i=3

Example 1:

```
void printxy(int x, int y)
{ int *ptr;
 x=0;
ptr=&x;
y=*ptr;
*ptr=1;
printf("%d",%d",x,y);
}
```



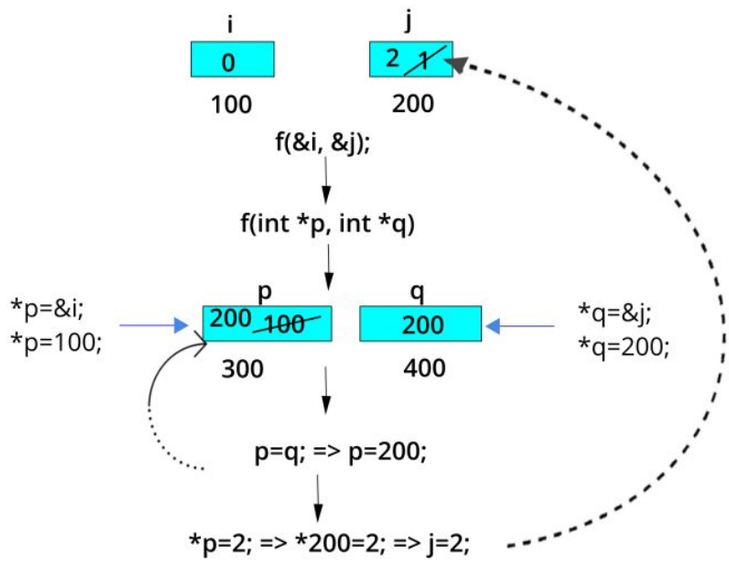
printf(%d, %d",x,y); => Correct answer is: 1, 0

Example2:

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

```
void f(int *p, int*q)
 {
p=q;
*p=2;
}

int i=0, j=1;
 int main()
{
f(&i, &j);
 printf("%d%d\n",i,j);
 return 0;
 }
```



printf("%d %d\n",i,j); => Correct answer is: 0 2

NULL Pointers

It is always a good practice to assign a NULL value to a pointer variable in case you do not have an exact address to be assigned. This is done at the time of variable declaration. A pointer that is assigned NULL is called a **null** pointer.

The NULL pointer is a constant with a value of zero defined in several standard libraries. Consider the following program −

```
 int main ()
 {
 int *ptr = NULL;
 printf ("The value of ptr is : %x\n", ptr);
 return 0;
 }
```

Output: The value of ptr is 0

See the following example

```
int main()
{
 int val[3] = { 5, 10, 20 };
 int *ptr;
 ptr = val ; //assigning all array value to ptr
 printf("Elements of the array are: ");
 printf("%d %d %d ", ptr[0], ptr[1], ptr[2]);
 ++*ptr; // increment the first value of ptr
 printf(" %d %d %d ", ptr[0], ptr[1], ptr[2]);
 printf("  %d",*(++ptr)); // inctrement the index
 return 0;
```

}

Output: 5 10 20 6 10 20 10

Here 'val' array is assign to ptr. Then ptr point to the array. Print 5 10 20 . Now, ++*ptr means increment the value of ptr *ptr is the first value of array which is 5 ,So,++*ptr=++5=6. So, next output is 6 10 20. And the final line ++ptr means increment the index. Now ptr goes to index 1 which is 10. Print 10.

In most of the operating systems, programs are not permitted to access memory at address 0 because that memory is reserved by the operating system. However, the memory address 0 has special significance; it signals that the pointer is not intended to point to an accessible memory location. But by convention, if a pointer contains the null (zero) value, it is assumed to point to nothing.

- ✓ if(ptr) /* succeeds if p is not null */
- ✓ if(!ptr) /* succeeds if p is null */

✍ **What is the correct output of the following C program?** *[Com 6 bank AP-2021]*

int array[] = {6,7,8,9,0,1,2,3,4,5,6};
**p=array+5;*
printf("%d\n", p[1]);

a) 1 b) 2 c) 3 d) Compile Error

** it is clear that &x[0] is equivalent to x. And, x[0] is equivalent to *x.
Similarly,

- &x[1] is equivalent to x+1 and x[1] is equivalent to *(x+1).
- &x[2] is equivalent to x+2 and x[2] is equivalent to *(x+2).

Replacing the **printf("%d", *p);** statement of above example, with below mentioned statements. Lets see what will be the result.

printf("%d", a[i]); ⟶ **prints the array, by incrementing index**

printf("%d", i[a]); ⟶ **this will also print elements of array**

printf("%d", a+i); ⟶ **This will print address of all the array elements**

printf("%d", *(a+i)); ⟶ **Will print value of array element.**

printf("%d", *a);⟶ **will print value of a[0] only**

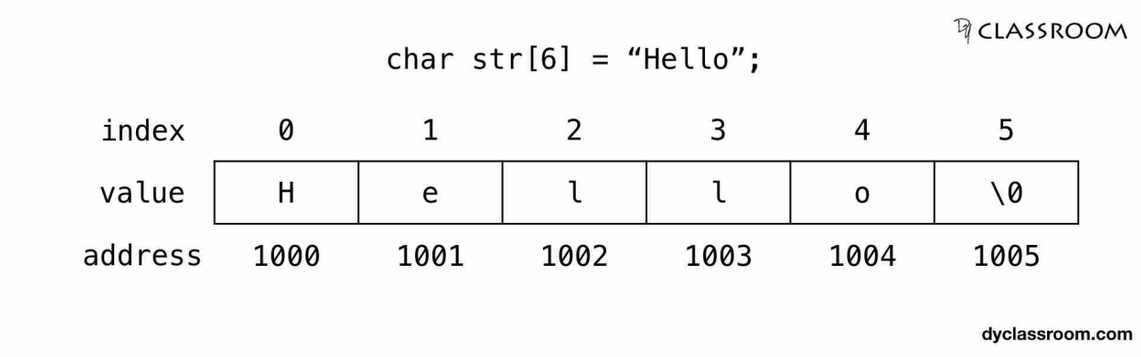
a++;⟶ **Compile time error, we cannot change base address of the array.**

Pointer To String

We know that a string is a sequence of characters which we save in an array. And in C programming language the \0 null character marks the end of a string.

Creating a string

In the following example we are creating a string str using char character array of size 6.

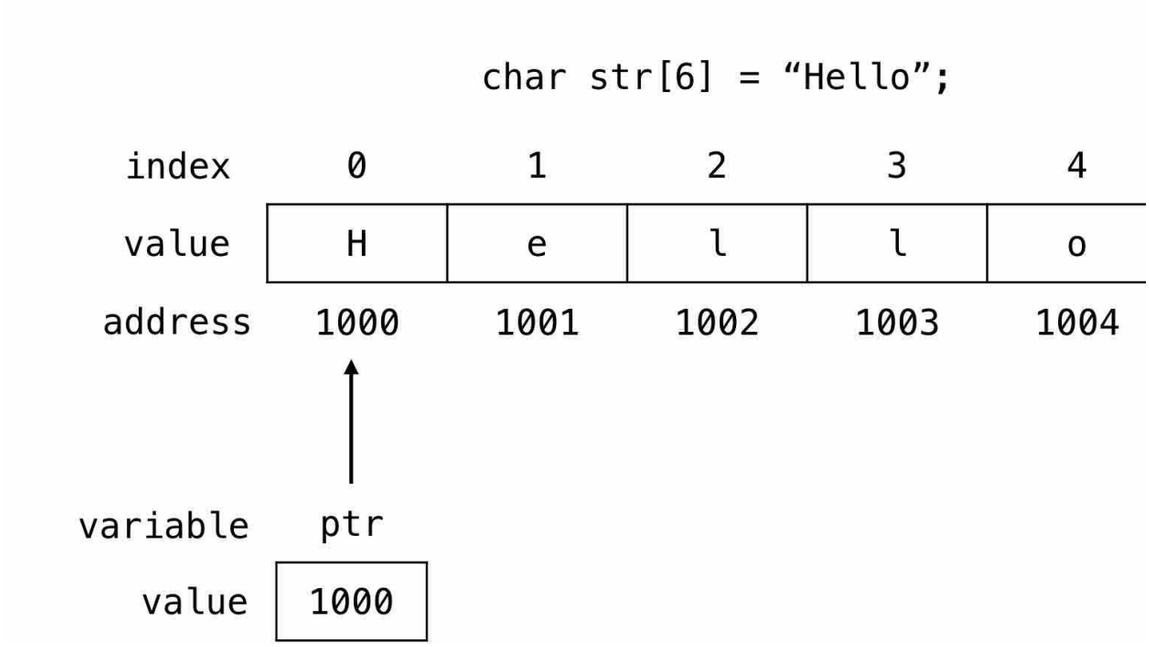


Creating a pointer for the string

The variable name of the string `str` holds the address of the first element of the array i.e., it points at the starting memory address.

So, we can create a character pointer `ptr` and store the address of the string `str` variable in it. This way, ptr will point at the string str.

```
char *ptr = str;
```



Array of strings

We can create a two dimensional array and save multiple strings in it.

For example, in the given code we are storing 4 cities name in a string array `city`.

```
char city[4][12] = {
  "Chennai",
  "Kolkata",
  "Mumbai",
  "New Delhi"
};
```

```
char city[4][12] = {
  "Chennai",
  "Kolkata",
  "Mumbai",
  "New Delhi"
};
```

	0	1	2	3	4	5	6	7	8	9
0	C	h	e	n	n	a	i	\0		
1	K	o	l	k	a	t	a	\0		
2	M	u	m	b	a	i	\0			
3	N	e	w		D	e	l	h	i	\0

Example of String and array of character:

```
int main(void) {
char name[] = "Harry Potter";
printf("%s", name);   // Output: Harry Potter
printf("%s", name+1); // Output: arry Potter
printf("%c", *name); // Output: H
printf("%c", *(name+7));   // Output: o
char *namePtr;
namePtr = name;
printf("%c", *namePtr);     // Output: H
printf("%c", *(namePtr+1));   // Output: a
printf("%c", *(namePtr+7));   // Output: o
```

Practices Problem: 1

char c[]="GATE2011";
char *p=c;
printf("%s",p+p[3]-p[1]);
Ans:
// p[3] is 'E' and p[1] is 'A'.
// p[3] - p[1] = ASCII value of 'E' - ASCII value of 'A' = 4
// So the expression p + p[3] - p[1] becomes p + 4 which is
// base address of string "2011"
Or let the address of p is 2000 so, 2000+E-A=2000+4=2004= p[4]=2

Previous year question:

1. **Which of the following is correct to initial array in C?** *[Com. 6 bank-Ap-2021]*
   a) int array = (1,2,3,4,5) b) int array() = {1,2,3,4,5}
   c) int array() = (1,2,3,4,5) d) int array[5]={1,2,3,4,5} Ans:**d**
2. **What is the access methodology in arrays?** *[Com. 6 bank-Ap-2021]*
   a) Sequential b) Random c) Relational d) Stochastic Ans:**b**
3. **What is the output of the following program:** *[Competition commision(P)-2019]*

```
int main ()
{
char *a[2] = { "hello", "hi" };
printf ("%s", *(a + 1));
return 0;
}
```

Output: hi

4. What is the output of following code:*[Competition commision(P)-2019]*

```
int main ()
{
char s[32] = "niksat";
char t[32] = "";
strrev (s);  //taskin
strcpy (t, s);
strcat (t, " so so ");
puts (t);
printf ("%d\n", strcmp ("taskvar", t));
return 0;
}
```

Output: taskin so so

13

Exercise

```
# include <stdio.h>
void fun(int *ptr)
{
        *ptr = 30;
}

int main()
{
int y = 20;
fun(&y);
printf("%d", y);

return 0;
}
```

Answer: (B)

Explanation: The function fun() expects a pointer ptr to an integer (or an address of an integer). It modifies the value at the address ptr. The dereference operator * is used to access the value at an address. In the statement '*ptr = 30', value at address ptr is changed to 30. The address operator & is used to get the address of a variable of any data type. In the function call statement 'fun(&y)', address of y is passed so that y can be modified using its address.

```
#include <stdio.h>

int main()
{
        int *ptr;
        int x;

        ptr = &x;
        *ptr = 0;

        printf(" x = %d\n", x);
        printf(" *ptr = %d\n", *ptr);

        *ptr += 5;
        printf(" x = %d\n", x);
```

```
        printf(" *ptr = %d\n", *ptr);

        (*ptr)++;
        printf(" x = %d\n", x);
        printf(" *ptr = %d\n", *ptr);

        return 0;
}
```