Understanding pointers in c

Pointer is a variable just like other variables of c but only difference is unlike the other variable it stores the memory address of any other variables of c. This variable may be type of int, char, array, structure, function or any other pointers. For examples:

(1) Pointer p which is storing memory address of a int type variable:

```
int i=50;

int *p=&i;
```

(2) Pointer p which is storing memory address of an array:

```
int arr[20];

int (*p)[20]=&arr;
```

(3) Pointer p which is storing memory address of a function:

```
char display(void);

char(*p)(void)=&display;
```

(4) Pointer p which is storing memory address of struct type variable:

```
struct abc{

int a;

float b;

}var;

struct abc *p=&var;
```

What is pointer in c programming?

Pointer is a user defined data type which creates special types of variables which can hold the address of primitive data type like **char**, **int**, **float**, **double** or user defined data type like function, pointer etc. or derived data type like array, structure, **union**, **enum**.

Examples:

```
int *ptr;
int (*ptr)();
int (*ptr)[2];
```

In c programming every variable keeps two type of value.

1. Contain of variable or value of variable.
2. Address of variable where it has stored in the memory.

(1) Meaning of following simple pointer declaration and definition:

```
int a=5;
int * ptr;
ptr=&a;
```

Explanation:

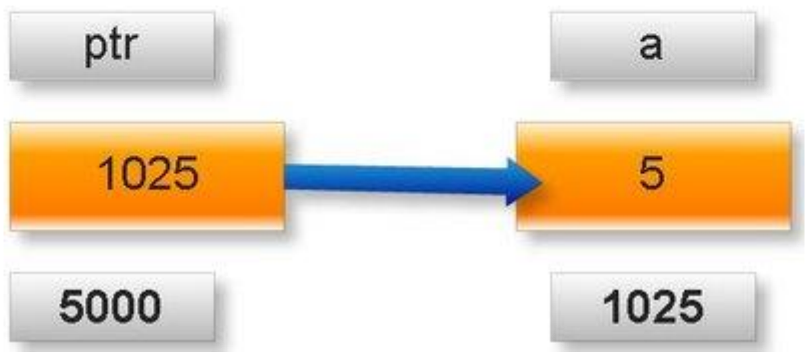
About variable a:

1. Name of variable : a
2. Value of variable which it keeps: 5
3. Address where it has stored in memory : 1025 (assume)

About variable ptr:

4. Name of variable : ptr
5. Value of variable which it keeps: 1025
6. Address where it has stored in memory : 5000 (assume)

Pictorial representation:



Note: A variable where it will be stored in memory is decided by operating system. We cannot guess at which location a particular variable will be stored in memory.

(2) Meaning of following pointer declaration and definition:

```
int a=50;
int *ptr1;
int **ptr2;
ptr1=&a;
ptr2=&pt1;
```

Explanation:
About variable a:

1. Name of variable : a
2. Value of variable which it keeps: 50
3. Address where it has stored in memory : 5000 (assume)

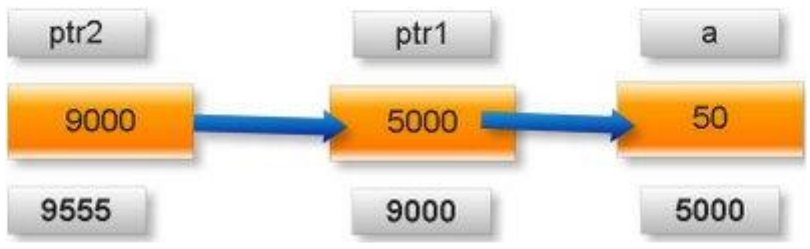
About variable ptr1:

4. Name of variable : ptr1
5. Value of variable which it keeps: 5000
6. Address where it has stored in memory : 9000 (assume)

About variable ptr2:

7. Name of variable : ptr2
8. Value of variable which it keeps: 9000
9. Address where it has stored in memory : 9555 (assume)

Pictorial representation of above pointer declaration and definition:



Note:
* is know as indirection operator which gives content of any variable.
& is know as reference operator which gives address where variable has stored in memory.

Cancellation rule of above two operators:
* and & operators always cancel to each other. i.e.
***&p=p**
But it is not right to write:
&*p=p
Simple example:

What will be output of following c program?

```
void main(){
int x=25;
int *ptr=&x; //statement one
int **temp=&ptr; //statement two
printf("%d %d %d",x,*ptr,**temp);
}
```

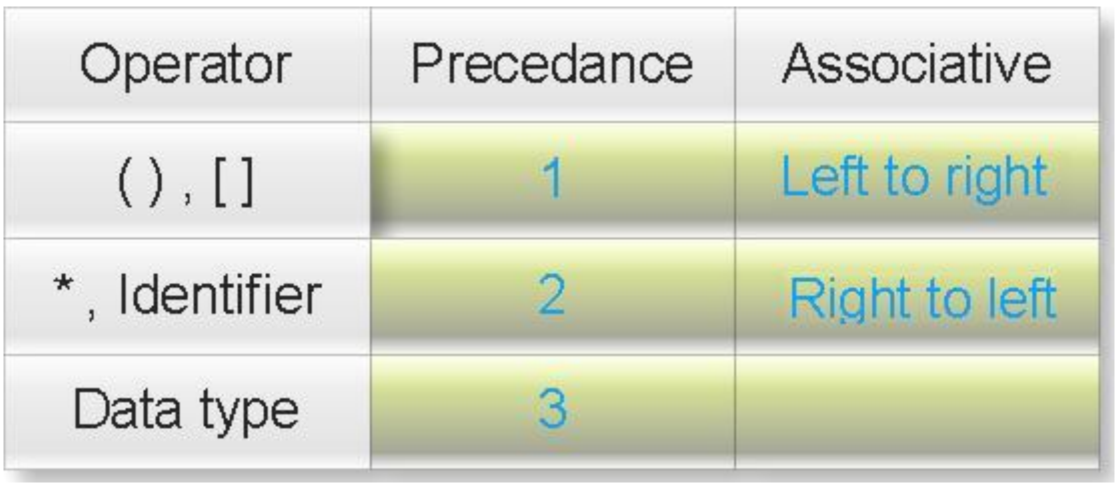
Output: 25 25 25
Explanation:
As we know value of variable x is 25.

*ptr= *(&x) //from statement one
=*&x
=x //using cancellation rule
=25

**temp= **(&ptr)=*(*&ptr)=*ptr=*(&x)=*&x=x=25

How to read complex pointers in C Programming?

Rule 1. Assign the priority to the pointer declaration considering precedence and associative according to following table.



Operator	Precedance	Associative
( ) , [ ]	1	Left to right
* , Identifier	2	Right to left
Data type	3	

Where

(): This operator behaves as bracket operator or function operator.

[]: This operator behaves as array subscription operator.

*****: This operator behaves as pointer operator not as multiplication operator.

Identifier: It is not an operator but it is name of pointer variable. You will always find the first priority will be assigned to the name of pointer.

Data type: It is also not an operator. Data types also includes modifier (like signed int, long double etc.)

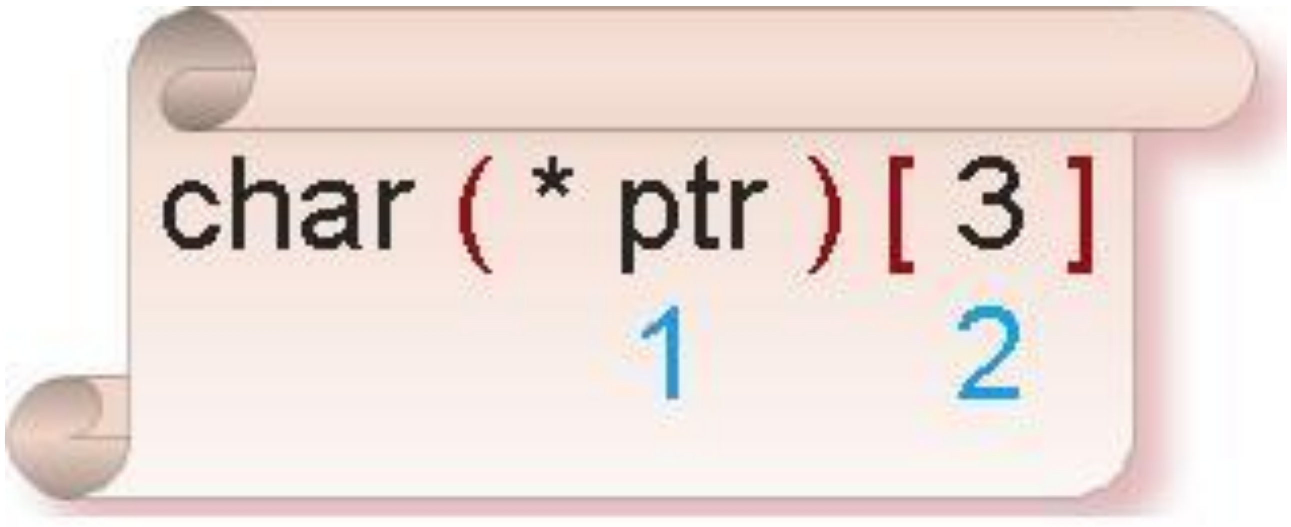
What is meaning of priority of operator? Click me.
What is meaning of associative of operator? Click me.

You will understand it better by examples:

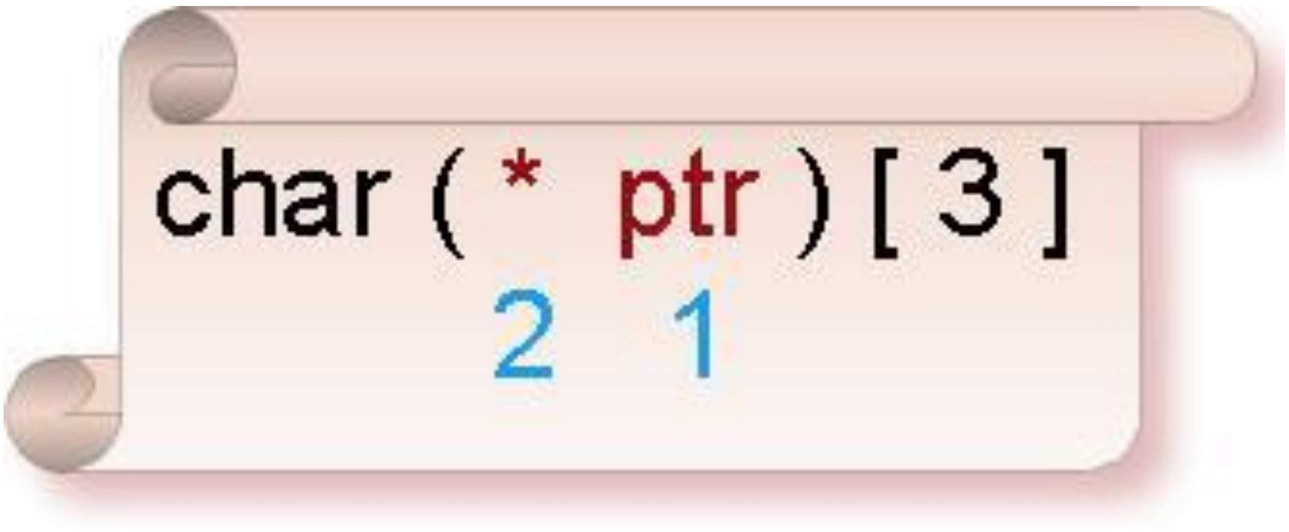
(1) How to read following pointer?
char (* ptr)[3]

Answer:

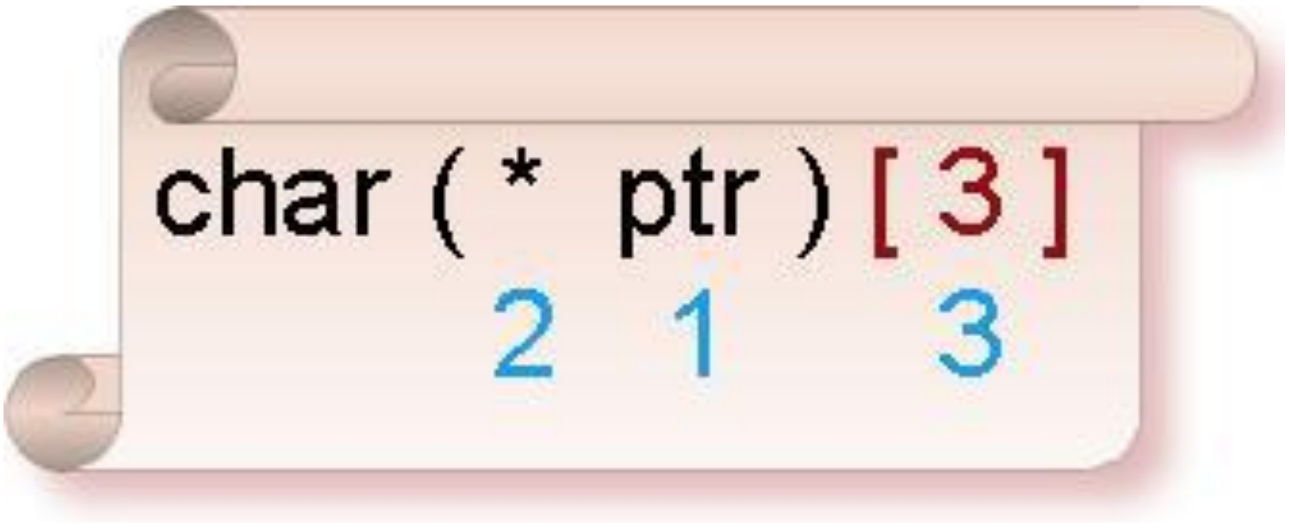
Step 1: () and [] enjoys equal precedence. So rule of associative will decide the priority. Its associative is left to right So first priority goes to ().



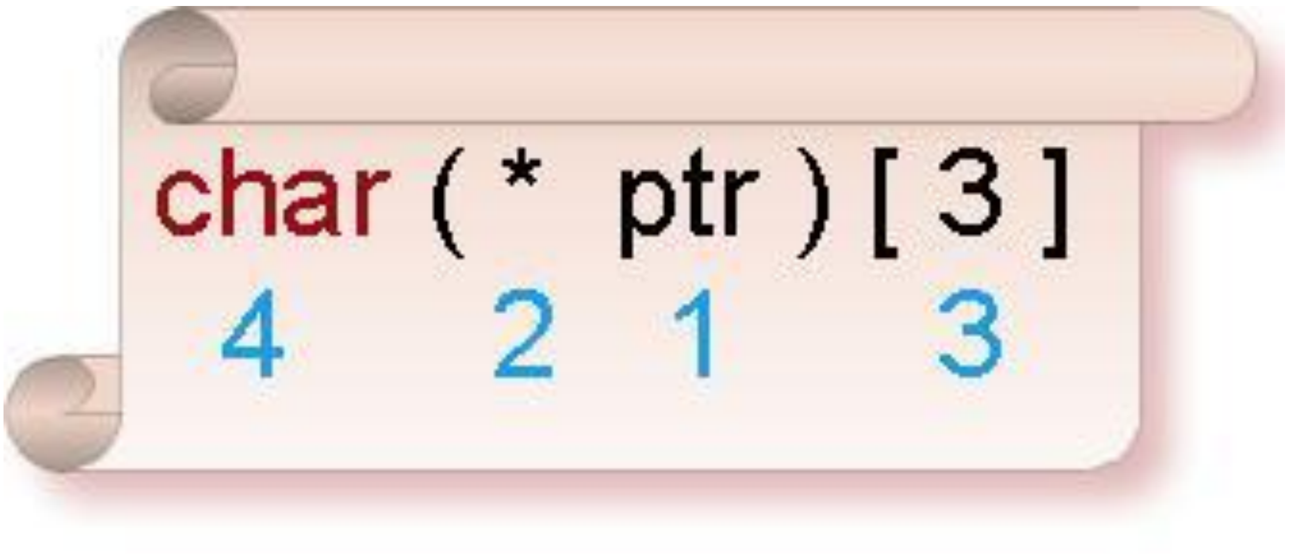
Step 2: Inside the bracket * and ptr enjoy equal precedence. From rule of associative (right to left) first priority goes to ptr and second priority goes to *.



Step3: Assign third priority to [].



Step4: Since data type enjoys least priority so assign fourth priority to char.



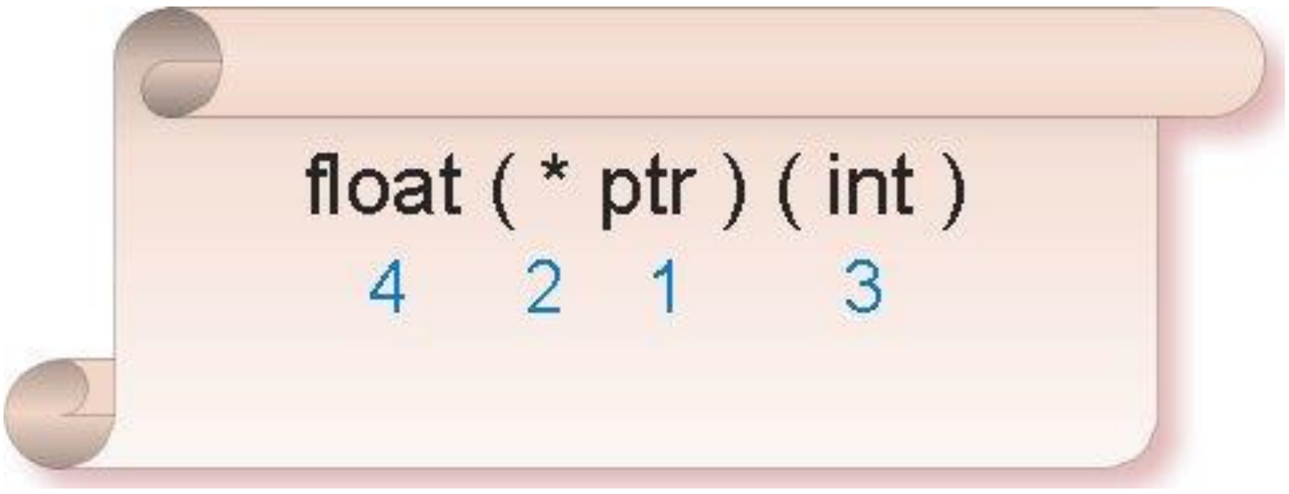
Now read it following manner:

ptr is pointer to such one dimensional array of size three which content char type data.

(2) How to read following pointer?
float (* ptr)(int)

Answer:

Assign the priority considering precedence and associative.



Now read it following manner:

ptr is pointer to such function whose parameter is int type data and return type is float type data.

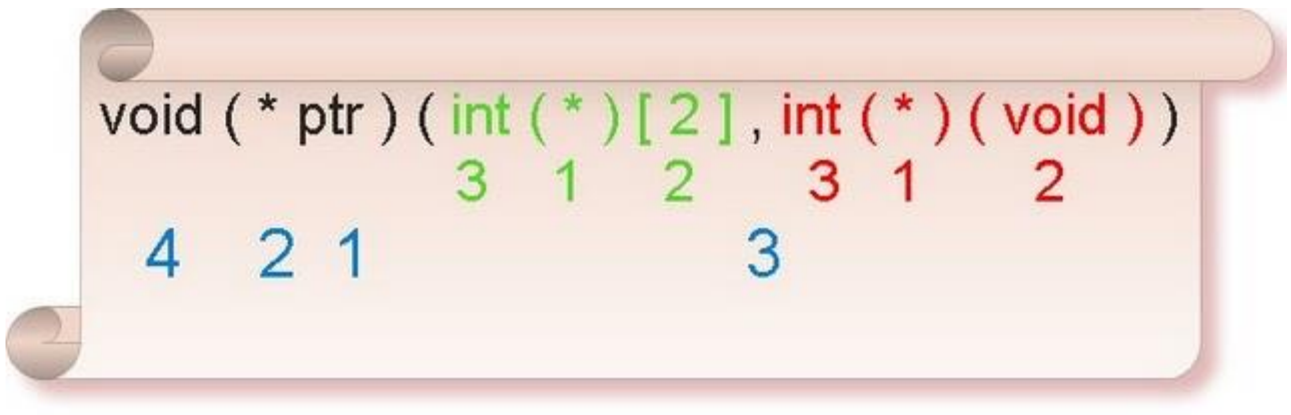
Rule 2: Assign the priority of each function parameter separately and read it also separately.

Understand it through following example.

(3) How to read following pointer?
void (*ptr)(int (*)[2],int (*) void))

Answer:

Assign the priority considering rule of precedence and associative.

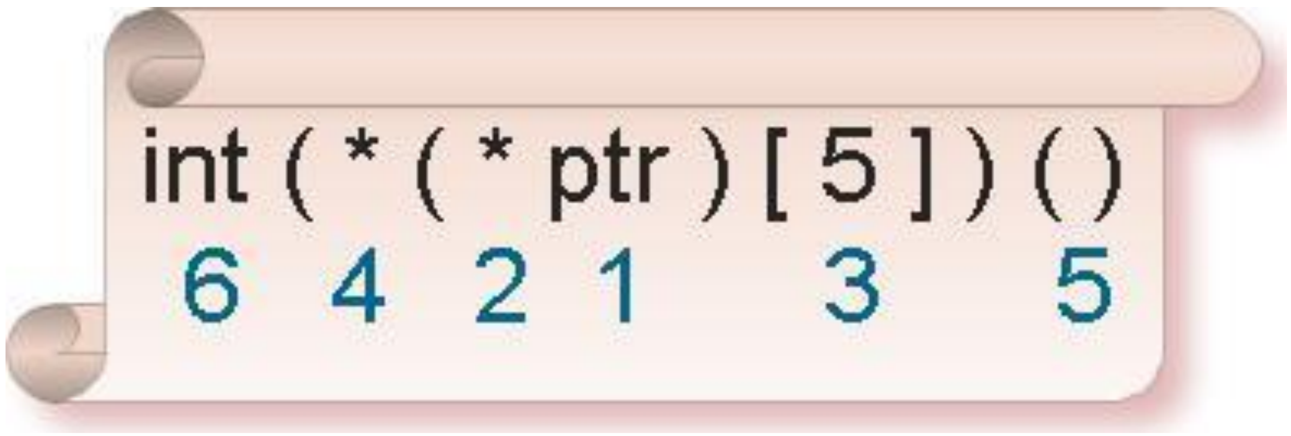


Now read it following manner:

ptr is pointer to such function which first parameter is pointer to one dimensional array of size two which content int type data and second parameter is pointer to such function which parameter is void and return type is int data type and return type is void.

(4) How to read following pointer?
int (* (* ptr) [5]) ( )
Answer:

Assign the priority considering rule of precedence and associative.

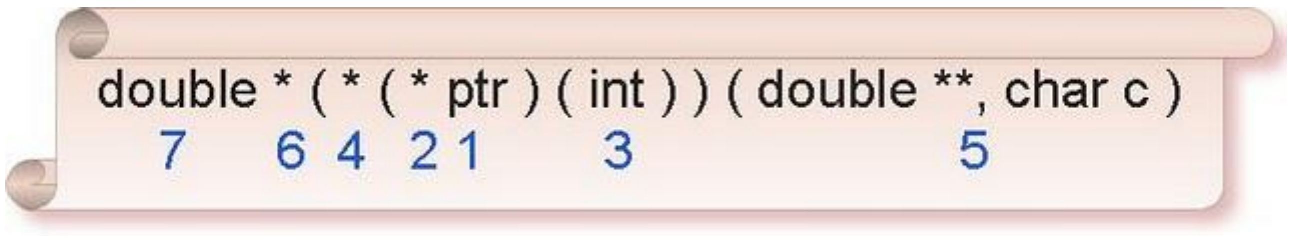


Now read it following manner:

ptr is **pointer** to such **array** of size five which content are **pointer** to such **function** which parameter is void and return type is **int** type data.

(5) How to read following pointer?
double*(*(*ptr)(int))(double **,char c)

Answer:



```
double * ( * ( * ptr ) ( int ) ) ( double **, char c )
    7    6   4  2 1       3                 5
```

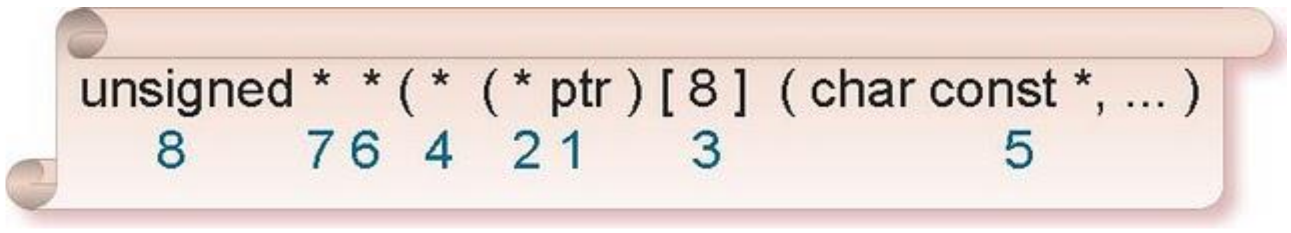
Assign the priority considering rule of precedence and associative.

Now read it following manner:

ptr is **pointer** to **function** which parameter is int type data and return type is **pointer** to **function** which first parameter is pointer to pointer of double data type and second parameter is char type data type and return type is **pointer** to **double** data type.

(6) How to read following pointer?
unsigned int**(*(*ptr)[8](char const *, ...)
Answer:

Assign the priority considering rule of precedence and associative.



```
unsigned *  * ( *  ( * ptr ) [ 8 ]  ( char const *, ... )
     8      7  6  4    2 1      3                5
```

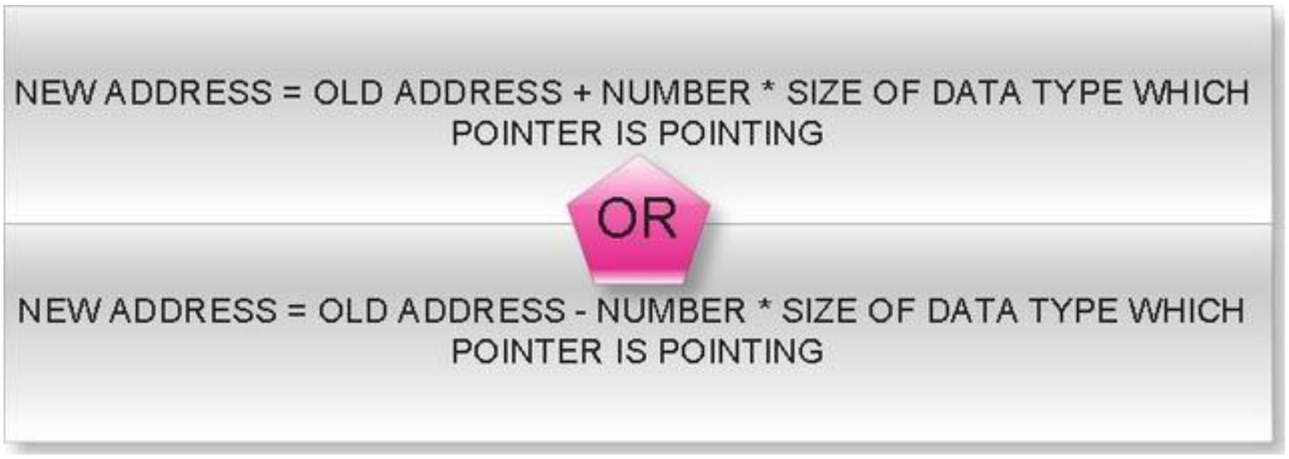
Now read it following manner:

ptr is **pointer** to **array** of size eight and content of array is **pointer** to **function** which first parameter is pointer to character constant and second parameter is variable number of arguments and return type is **pointer** to **pointer** of **unsigned** int data type.

Arithmetic operation with pointer in c programming

Rule 1:

Address + Number= Address
Address - Number= Address
Address++ = Address
Address-- = Address
++Address = Address
--Address = Address
If we will add or subtract a number from an address result will also be an address.
New address will be:



NEW ADDRESS = OLD ADDRESS + NUMBER * SIZE OF DATA TYPE WHICH POINTER IS POINTING

OR

NEW ADDRESS = OLD ADDRESS - NUMBER * SIZE OF DATA TYPE WHICH POINTER IS POINTING

(1)What will be output of following c program?

```
void main(){
        int *ptr=( int *)1000;
        ptr=ptr+1;
        printf(" %u",ptr);

}
```

Output: 1002

(2)What will be output of following c program?

```
void main(){
        double *p=(double *)1000;
        p=p+3;
        printf(" %u",p);

}
```

Output: 1024

(3)What will be output of following c program?

```
void main(){
	float array[5]={1.1f,2.2f,3.3f};
	float(*ptr)[5];
	ptr=&array;
	printf("%u",ptr);
	ptr=ptr+1;
	printf(" %u",ptr);

}
```

Output: 1000 1020

(4)What will be output of following c program?

```
typedef struct abc{
	int far*a;
	double b;
	unsigned char c;
}ABC;
void main(){
	ABC *ptr=(ABC *)1000;
	ptr=ptr+2;
	printf(" %u",ptr);

}
```

Output: 1026

(5)What will be output of following c program?

```
typedef union abc{
	char near*a;
	long double d;
	unsigned int i;
}ABC;
void main(){
	ABC *ptr=(ABC *)1000;
	ptr=ptr-4;
	printf(" %u",ptr);

}
```

Output: 960

(6)What will be output of following c program?

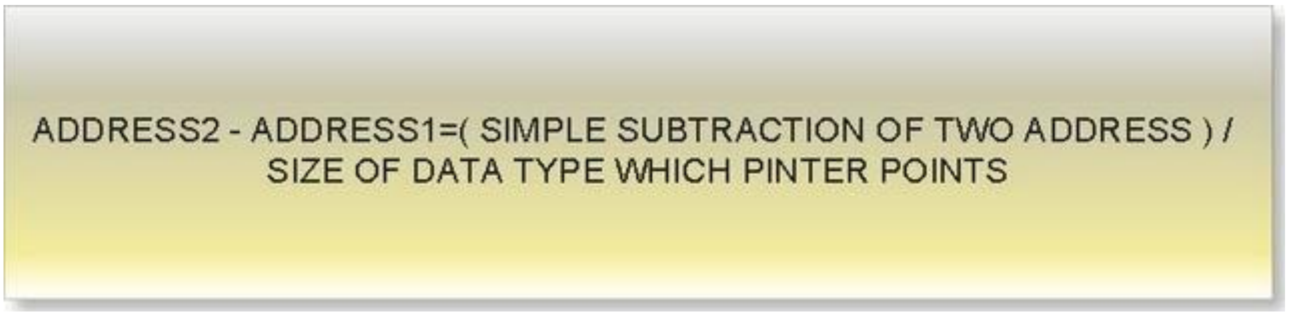
```
float * display(int,int);
int max=5;
void main(){
            float *(*ptr)(int,int);
            ptr=display;
            (*ptr)(2,2);
            printf("%u",ptr);
            ptr=ptr+1;
            printf(" %u",ptr);

}
float * display(int x,int y){
            float f;
            f=x+y+max;
            return &f;
}
```

Output: Compiler error

Rule 2:

Address - Address=Number

If you will subtract two pointers result will be a number but number will not simple mathematical subtraction of two addresses but it follow following rule:
If two pointers are of same type then:



ADDRESS2 - ADDRESS1=(SIMPLE SUBTRACTION OF TWO ADDRESS) / SIZE OF DATA TYPE WHICH PINTER POINTS

Consider following example:

```
void main(){
        int *p=(int *)1000;
        int *temp;
        temp=p;
        p=p+2;
        printf("%u %u\n",temp,p);
        printf("difference= %d",p-temp);

}
```

Output: 1000 1004
Difference= 2
Explanation:
Here two pointer p and temp are of same type and both are pointing to **int** data type varaible.
p-temp = (1004-1000)/**sizeof**(**int**)
=4/2
=2

(1)What will be output of following c program?

```
void main(){
        float *p=(float *)1000;
        float *q=(float *)2000;
        printf("Difference= %d",q-p);

}
```

Output: Difference= 250
Explanation:
q-p=(2000-1000)/sizeof(float)
=1000/4
=250

(2)What will be output of following c program?

```
struct abc{
        signed char c;
        short int i;
        long double l;
};
void main(){
        struct abc *p,*q;
        p=(struct abc *)1000;
        q=(struct abc *)2000;
        printf("Difference= %d",q-p);

}
```

Output: Difference= 76
Explanation:
q-p=(2000-1000)/sizeof(struct abc)
=1000/(1+2+10)
=1000/13
=76

(3)What will be output of following c program?

```
typedef union xxx{
        char far * c;
        const volatile i;
        long int l;
}XXX;
void main(){
        XXX *p,*q;
        p=(XXX *)1000;
        q=(XXX *)2000;
        printf("Difference= %d",q-p);

}
```

Output: Difference= 250
Explanation:
q-p=(2000-100)/max(4,2,4)
=1000/4
=250

(4)What will be output of following c program?

```
void main(){
        const volatile array[4]={0};
        const volatile(*p)[4]=&array;
        const volatile(*q)[4]=&array;
        q++;
        q++;
        printf("%u %u\n",p,q);
        printf("Difference= %d",q-p);

}
```

Output: 1000 1016 (assume)
Difference= 2
Explanation:
q-p=(1016-1000)/**sizeof**(**const volatile**)
= 16/ (2*4)
=2

Rule 3:

Address + Address=Illegal
Address * Address=Illegal
Address / Address=Illegal
Address % Address=Illegal

(q)What will be output of following c program?

```
void main( )
{
        int i=5;
        int *p=&i;
        int *q=(int *)2;
        printf("%d",p+q);
}
```

Output: Compiler error

Rule 4: We can use relation operator and condition operator between two pointers.

a. If two pointers are near pointer it will compare only its offset address.

(q)What will be output of following c program?

```
void main( )
{
        int near*p=(int near*)0x0A0005555;
        int near*q=(int near*)0x0A2115555;
        if(p==q)
                printf("Equql");
        else
        printf("Not equal");
}
```

Output: Equal

b. If two pointers are far pointer it will compare both offset and segment address.

(q)What will be output of following c program?

```
void main(){
        int far*p=(int far*)0x0A0005555;
        int far*q=(int far*)0x0A2115555;
        if(p==q)
        printf("Equal");
        else
        printf("Not equal");

}
```

Output: Not equal

c. If two pointers are huge pointer it will first normalize into the 20 bit actual physical address and compare to its physical address.

(q)What will be output of following c program?

```
void main(){
        int huge*p=(int huge*)0x0A0005555;
        int huge*q=(int huge*)0x0A2113445;
        if(p==q)
        printf("Equql");
        else
        printf("Not equal");

}
```

Output: Equal

Rule 5: We can perform bitwise operation between two pointers like

Address & Address=Illegal
Address | Address=Illegal
Address ^ Address=Illegal
~Address=Illegal

(q)What will be output of following c program?

```
void main(){
        int i=5,j=10;
        int *p=&i;
        int *q=&j;
        printf("%d",p|q);
}
```

Output: Compiler error

Rule 6: We can find size of a pointer using sizeof operator.

(q)What will be output of following c program?

```
void main(){
        int near*far*huge* p;
        printf("%d",sizeof(p));
        printf(" %d",sizeof(*p));
        printf(" %d",sizeof(**p));

}
```

Output: 4 4 2

Complex pointers in c programming

(1) Pointer to function

(2) Pointer to array

  a. Pointer to array of integer

  a. Pointer to array of function

  b. Pointer to array of string

  c. Pointer to array of character

  d. Pointer to array of structure

  e. Pointer to array of union

  f. Pointer to array of array

  g. Pointer to two dimensional array

  h. Pointer to three dimensional array

  i.

  j. Pointer to array of pointer to string

(3) Pointer to structure

(4) Pointer to union

(5) Multilevel pointers

Pointer to array of function in c

Note: array of function means array which content is address of function.

(q) What will be output if you will execute following code?

```
#include"conio.h"

int display();

int(*array[3])();

int(*(*ptr)[3])();

void main(){

            array[0]=display();

            array[1]=getch();

            ptr=&array;

            printf("%d",(**ptr)());

            (*(*ptr+1))();

}

int display(){

            int x=5;

            return x++;

}
```

Output: 5

Explanation:

In this example:

array []: It is array of pointer to such function which parameter is void and return type is int data type.

ptr: It is pointer to array which contents are pointer to such function which parameter is void and return type is int type data.

(ptr)()** = (** (&array)) () //ptr=&array

= (*array) () // from rule *&p=p

=array [0] () //from rule *(p+i)=p[i]

=display () //array[0]=display

(*(*ptr+1))() =(*(*&array+1))() //ptr=&array

=*(array+1) () // from rule *&p=p

=array [1] () //from rule *(p+i)=p[i]

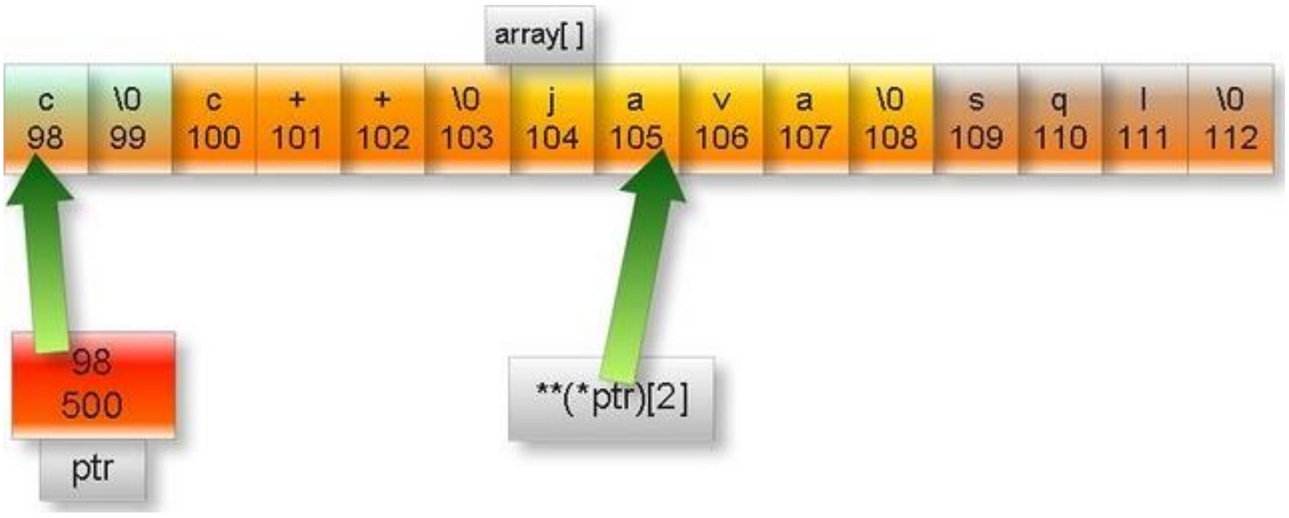
=getch () //array[1]=getch

Pointer to array of string in c programming

(q) What will be output if you will execute following code?

```
void main(){
        char *array[4]={"c","c++","java","sql"};
        char *(*ptr)[4]=&array;
        printf("%s ",++(*ptr)[2]);
}
```

Output: ava
Explanation:
In this example
ptr: It is pointer to array of string of size 4.
array[4]: It is an array and its content are string.
Pictorial representation:



Note: In the above figure upper part of box represent content and lower part represent memory address. We have assumed arbitrary address.

++(*ptr)[2]
=++(*&array)[2] //ptr=&array
=++array[2]
=++"java"
="ava" //Since ptr is character pointer so it
// will increment only one byte
Note: %s is used to print stream of characters up to null (\0) character.

Pointer to structure in c programming

(q) What will be output if you will execute following code?

```
struct address{
            char *name;
            char street[10];
            int pin;
            }cus={"A.Kumar","H-2",456003},*p=&cus;
void main()
{
            printf("%s %s",p->name,(*p).street);
}
```

Output: A.Kumar H-2

Explanation:

p is pointer to structure address.

-> and (*). Both are same thing. These operators are used to access data member of structure by using structure's pointer.

Pointer to union in c programming

(q) What will be output if you will execute following code?

```
union address{
        char *name;
        char street[10];
        int pin;
};
void main(){
        union address emp,*p;
        emp.name="ja\0pan";
        p=&emp;
        printf("%s %s",p->name,(*p).name);
}
```

Output: ja ja
Explanation:
p is pointer to union address.
-> and (*). Both are same thing. These operators are used to access data member of union by using union's pointer.
%s is used to print the string up to null character i.e. '\0'

Multilevel pointers in c programming

(1) What will be output if you will execute following code?

```
void main(){
            int s=2,*r=&s,**q=&r,***p=&q;
            printf("%d",p[0][0][0]);
}
```

Output: 2
Explanation:
As we know p[i] =*(p+i)
So,
P[0][0][0]=*(p[0][0]+0)=**p[0]=***p
Another rule is: *&i=i
So,
p= (&q) =**q=** (&r) =*r=*(&s) =s=2

(2) What will be output if you will execute following code?

```
#define int int*
void main(){
int *p,q;
            p=(int *)5;
            q=10;
            printf("%d",q+p);
}
```

Output: 25
Explanation: If you will see intermediate file you will find following code:

```
void main(){
            int **p,q;
            p=(int **)5;
            q=10;
            printf("%d",q+p);
}
```

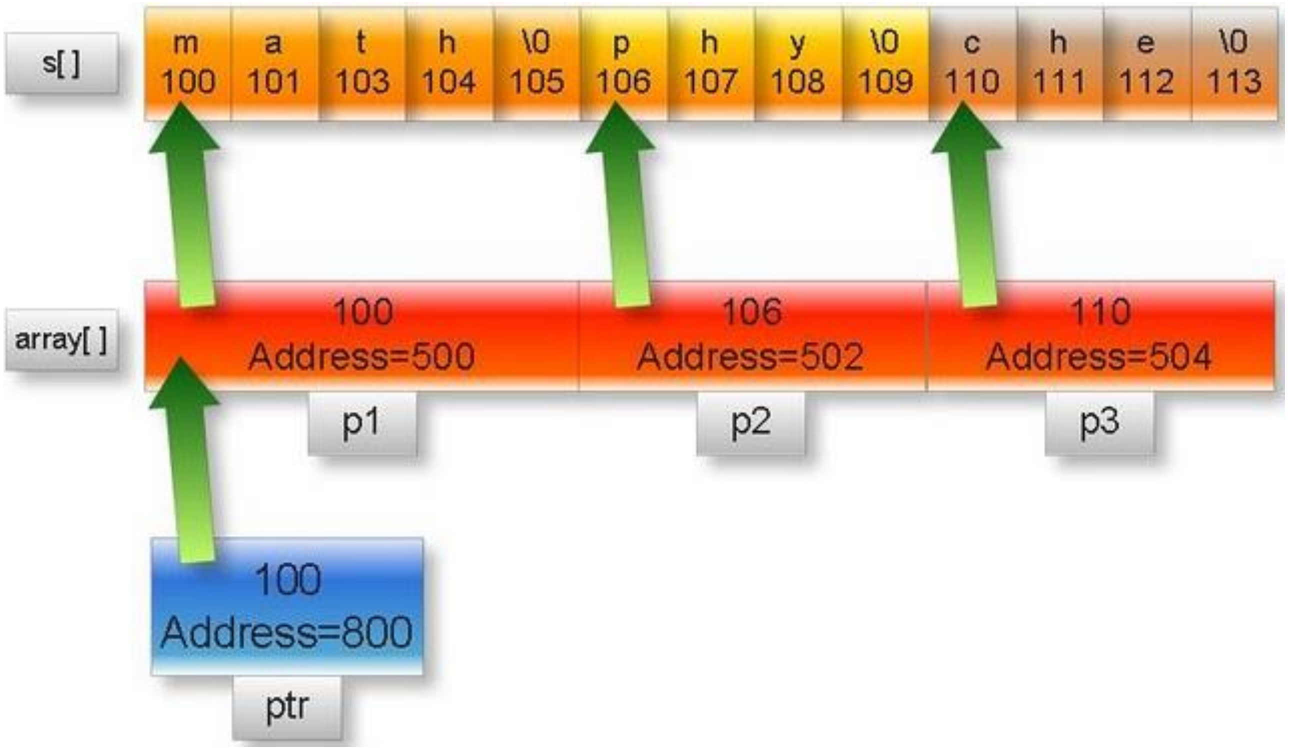
Here q pointer and p is a number.
In c
Address + number = Address
So,
New address = old address + number * Size of data type to which pointer is pointing.
= 5 + 10 * sizeof (*int)
= 5+10*2 = 25.
Note. We are assuming default pointer is near. Actually it depends upon memory model.

Pointer to array of pointer to string in c programming

(q) What will be output if you will execute following code?

```
void main(){
        static char *s[3]={"math","phy","che"};
        typedef char *( *ppp)[3];
        static ppp p1=&s,p2=&s,p3=&s;
        char * (*(*array[3]))[3]={&p1,&p2,&p3};
        char * (*(*(*ptr)[3]))[3]=&array;
        p2+=1;
        p3+=2;
        printf("%s",(***ptr[0])[2]);

}
```

Output: che
Explanation:
Here
ptr: is pointer to array of pointer to string.
P1, p2, p3: are pointers to array of string.
array[3]: is array which contain pointer to array of string.
Pictorial representation:



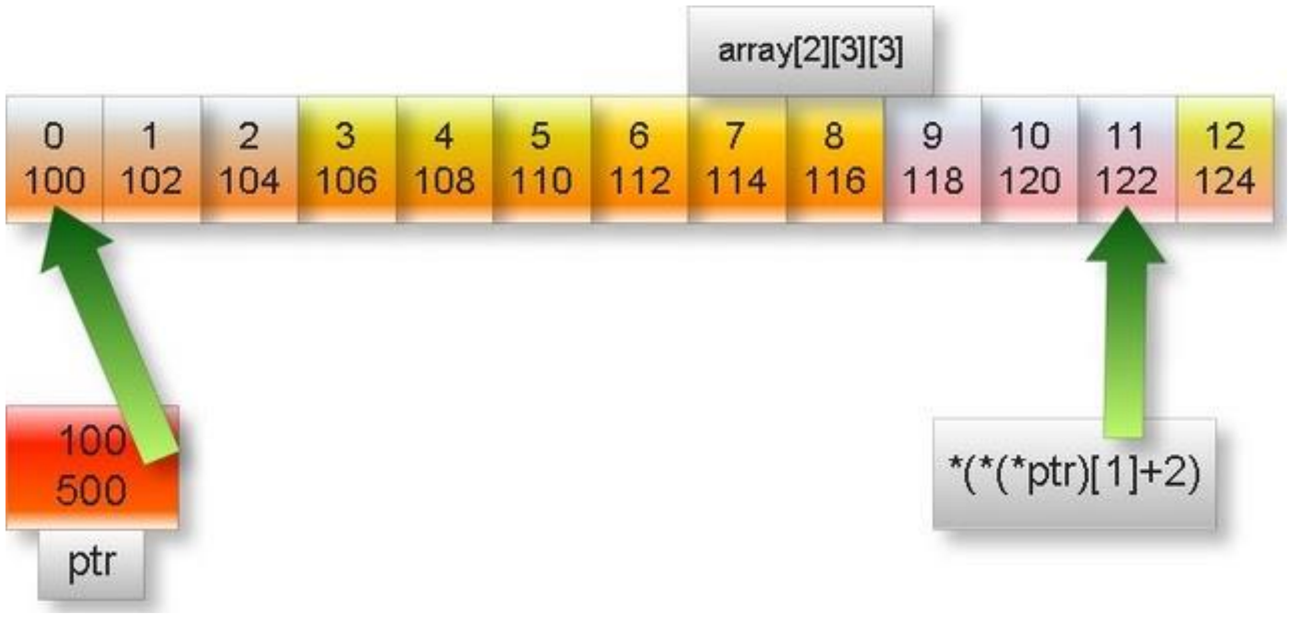
Note: In the above figure upper part of box represent content and lower part represent memory address. We have assumed arbitrary address.

As we know p[i]=*(p+i)
(*ptr[0])[2]**=(*(***ptr+0))[2]=(***ptr)[2]
=(***(&array))[2] //ptr=&array
=(**array)[2] //From rule *&p=p
=(**(&p1))[2] //array=&p1
=(*p1)[2]
=(*&s)[2] //p1=&s
=s[2]="che"

Pointer to three dimensional array in c programming

```
void main(){
const array[2][3][3]={0,1,2,3,4,5,6,7,8,9,10,11,12};
        int const (*ptr)[2][3][3]=&array;
        printf("%d ",*(*(*ptr)[1]+2));
}
```

Output: 11
Explanation:
In this example:
array [2][3][3]:It is three dimensional array and its content are constant integers.
ptr: It is pointer to such three dimensional array whose content are constant integer.
Pictorial representation:



Note: In the above figure upper part of box represent content and lower part represent memory address. We have assumed arbitrary address.

***(*(*ptr) [1] +2)**
=*(*(*&array) [1] +2)
=*(*array [1] +2)
=*(array [1] [0] +2)
=array [1] [0] [2]
I.e. array element at the 1*(3*3) +0(3) + 2=11th position starting from zero which is 11.

Pointer to two dimensional array in c programming

(q) What will be output if you will execute following code?

```
void main(){
        long array[][3]={7l,14l,21l,28l,35l,42l};
        long int (*ptr)[2][3]=&array;
        printf("%li ",-0[1[0[ptr]]]);

}
```

Output: -28

Explanation:

-0[1[0[ptr]]]

=-1[0[ptr]][0] //From rule array[i]=i[array]

=-0[ptr][1][0]

=-ptr [0] [1] [0]

=-*ptr [0] [1] //From rule array[i]=*(array+i)

=-*(&array) [0] [1]

=-(&array) [0] [1][0]

=-(*&array)[1][0] //From rule *&p=p

=-array[1][0]

array[1][0] means 1*(3)+ 0 = 3rd element of array starting from zero i.e. 28

sorting of array using pointer in c

```
void main()
{
int  i,j,temp1,temp2;
int arr[8]={5,3,0,2,12,1,33,2};
int *ptr;
for(i=0;i<7;i++)

{
 for(j=0;j<7-i;j++)

{
  if(*(arr+j)>*(arr+j+1))
  {
    ptr=arr+j;
    temp1=*ptr++;
    temp2=*ptr;
    *ptr--=temp1;
    *ptr=temp2;
  }
}
}
clrscr();
for(i=0;i<8;i++)

  printf(" %d",arr[i]);
getch();
}
```

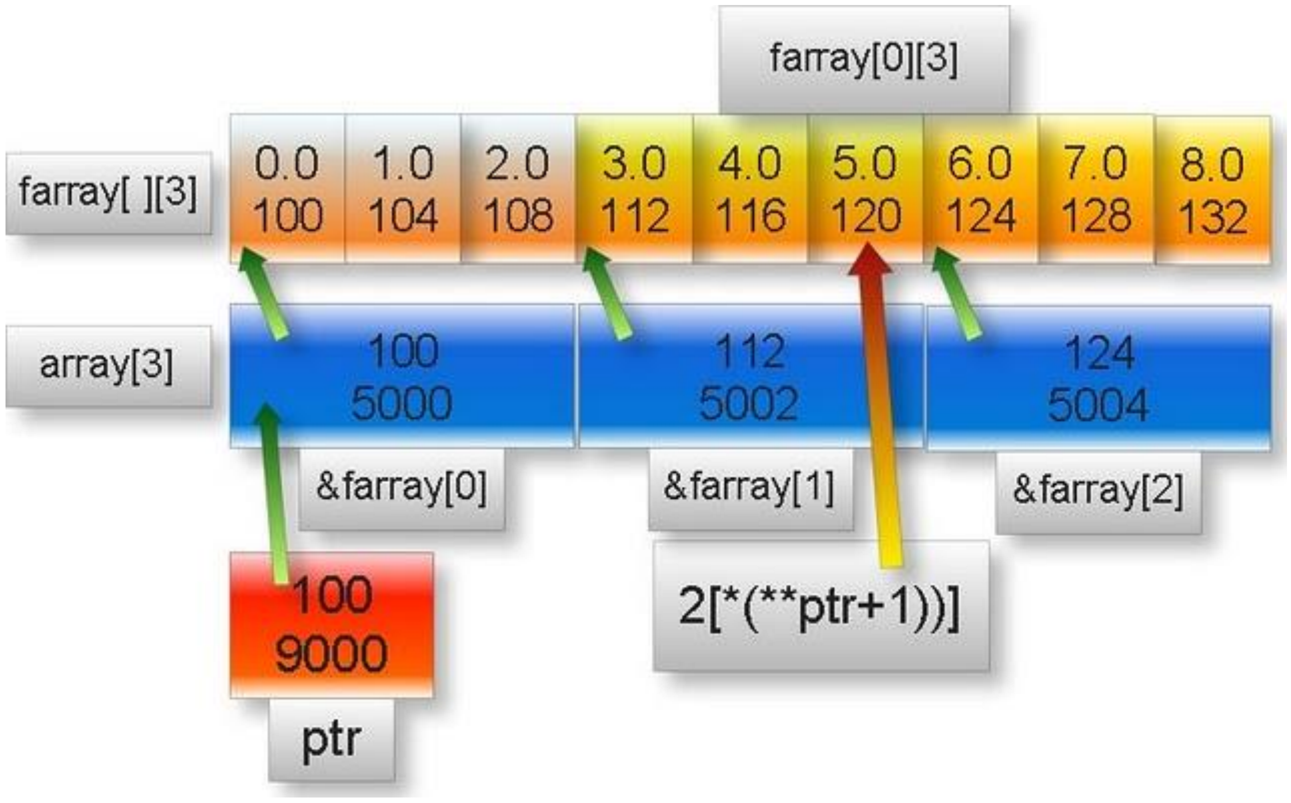
Output: 0 1 2 2 3 5 12 33

Pointer to array of array

(q) What will be output if you will execute following code?

```
void main(){
static float farray[][3]={0.0f,1.0f,2.0f,3.0f,4.0f,5.0f,6.0f,7.0f,8.0f};
float (*array[3])[3]={&farray[0],&farray[1],&farray[2]};
        float (*(*ptr)[])[3]=&array;
        printf("%f ",2[(*(**ptr+1))]);

}
```

Output: 5.000000
Explanation:
In this example:
farray [][3]: It is two dimension array and its content are float constants.
array [3]:It is one dimension array and its content are address of such one dimension array which content are float constant.
ptr: It is pointer to one dimension array which content are address of such one dimension array which content are float constant.
Pictorial representation:



Note: In the above figure upper part of box represent content and lower part represent memory address. We have assumed arbitrary address.

2[(*(ptr+1))]**
= (*(**ptr+1)) [2]
= (*(**&array+1)) [2]
= (*(*array+1)) [2]
= (*(array [0] +1)) [2]
= (*(&farray [0] +1)) [2]
=&farray [0] [1] [2]
=*&farray [1] [2]
=farray [1] [2]
It is 1*(3) +2=5th element of farray starting from zero which is 5.0f

Pointer to array of union in c programming

(q) What will be output if you will execute following code?

```
union emp{
          char *name;
          int id;
};
void main(){
          static union emp e1={"A"},e2={"B"},e3={"C"};
          union emp(*array[])={&e1,&e2,&e3};
          union emp(*(*ptr)[3])=&array;
          printf("%s ",(*(*ptr+2))->name);

}
```

Output: C
Explanation:
In this example:
e1, e2, e3: They are variables of union emp.
array []:It is one dimensional array of size thee and its content are address of union emp.
ptr: It is pointer to array of union.

```
(*(*ptr+2))->name
=(*(*&array+2))->name //ptr=&array
=(*(array+2))->name //from rule *&p=p
=array[2]->name //from rule *(p+i)=p[i]
=(&e3)->name //array[2]=&e3
=*(&e3).name //from rule ->= (*).
=e3.name //from rule *&p=p
=”C”
```

Pointer to array of structure in c programming

(q) What will be output if you will execute following code?

```
struct emp{
         char *name;
         int id;
};
void main(){
         static struct emp e1={"A",1},e2={"B",2},e3={"C",3};
         struct emp(*array[])={&e1,&e2,&e3};
         struct emp(*(*ptr)[3])=&array;
         printf("%s %d",(**(*ptr+1)).name,(*(*ptr+1))->id);

}
```

Output: B 2

Explanation:

((*ptr+1)).name**

```
=(**(*&array+1)).name //ptr=&array
=(**(array+1)).name //from rule *&p =p
=(*array[1]).name //from rule *(p+i)=p[i]
=(*&e2).name //array[1]=&e2
=e2.name="B" //from rule *&p =p
```

(*(*ptr+1))->id

```
=(**(*ptr+1)).id //from rule -> = (*).
=e2.id=2
```

Pointer to array of character in c

(q) What will be output if you will execute following code?

```
char display(char (*)[]);
void main(){
        char c;
        char character[]={65,66,67,68};
        char (*ptr)[]=&character;
        c=display(ptr);
        printf("%c",c);

}
char display(char (*s)[]){
        **s+=2;
        return **s;

}
```

Output: C

Explanation: Here function display is passing pointer to array of characters and returning char data type.

****s+=2**

=>**s=**s+2

=>**ptr=**ptr+2 //s=ptr

=>**&character= **&character+2 //ptr=&character

=>*character=*character+2 //from rule *&p =p

=>character[0]=character[0]+2 //from rule *(p+i)=p[i]

=>character [0] =67

**s=character [0] =67

Note: ASCII value of 'C' is 67

Pointer to array of integer in c

(2) Pointer to array

(1) What will be output if you will execute following code?

```
void main(){
        static int i,j,k;
        int *(*ptr)[];
        int *array[3]={&i,&j,&k};
        ptr=&array;
        j=i+++k+10;
        ++(**ptr);
        printf("%d",***ptr);

}
```

Output: 10

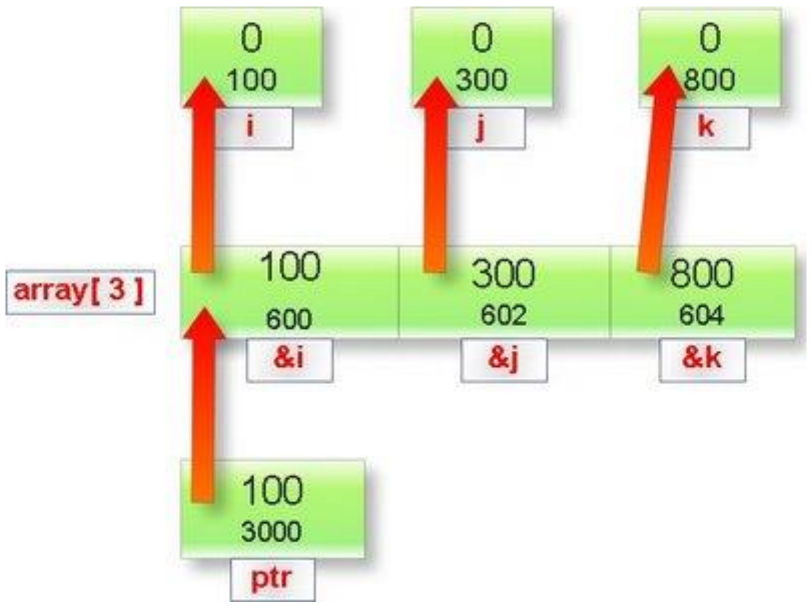
Explanation:

In this example:

array []: It is array of size three and its content are address of integer.

ptr: It is pointer to array which content are address of integer.

Pictorial representation above declaration:



Note: In the above figure upper part of box represent content and lower part represent memory address. We have assumed arbitrary address.

j=i+++k+10

=i++ + k+10
=0 +0 +10=10

*****ptr** = *** (&array) //ptr=&array
= **array //From rule *&p=p
//From rule array [0] =*(array+0) and ++ (**ptr)

=*array [1]
=*&j
=j
=10

(2) What will be output if you will execute following code?

```
void main(){
        int i,j,k;
        int *(*ptr)[];
        int *array[3]={&i,&j,&k};
        ptr=&array;
        j=i+++k+10;
        ++(**ptr);
        printf("%d",***ptr);

}
```

Output: Compiler error
Explanation: Address of auto variable cannot be member of an array.

Generic pointer in c programming

5. Generic pointer:

void pointer in c is known as generic pointer. Literal meaning of generic pointer is a pointer which can point type of data.

Example:

```
void *ptr;
```
Here ptr is generic pointer.

Important points about generic pointer in c?

1. We cannot dereference generic pointer.

```
#include "malloc.h"
void main(){
          void *ptr;
          printf("%d",*ptr);

}
```

Output: Compiler error

2. We can find the size of generic pointer using sizeof operator.

```
#include "string.h"
void main(){
          void *ptr;
          printf("%d",sizeof(ptr));

}
```

Output: 2
Explanation: Size of any type of near pointer in c is two byte.

3. Generic pointer can hold any type of pointers like char pointer, struct pointer, array of pointer etc without any typecasting.

Example:
```
void main(){
          char c='A';
          int i=4;
          void *p;
```

```
        char *q=&c;
        int *r=&i;
        p=q;
        printf("%c",*(char *)p);
        p=r;
        printf("%d",*(int *)p);

}
Output: A4
```

4. Any type of pointer can hold generic pointer without any typecasting.

5. Generic pointers are used when we want to return such pointer which is applicable to all types of pointers. For example return type of malloc function is generic pointer because it can dynamically allocate the memory space to stores integer, float, structure etc. hence we type cast its return type to appropriate pointer type.

Examples:

1.

```
char *c;
c=(char *)malloc(sizeof(char));
```

2.

```
double *d;
d=(double *)malloc(sizeof(double));
```

3.

```
Struct student{
        char *name;
        int roll;
};
Struct student *stu;
Stu=(struct student *)malloc(sizeof(struct student));
```

NULL pointer in c programming

4. NULL pointer:

Literal meaning of NULL pointer is a pointer which is pointing to nothing. NULL pointer points the base address of segment.

Examples of NULL pointer:

1. **int** *ptr=(**char** *)0;

2. **float** *ptr=(**float** *)0;

3. **char** *ptr=(**char** *)0;

4. **double** *ptr=(**double** *)0;

5. **char** *ptr='\0';

6. **int** *ptr=NULL;

(q) What is meaning of NULL?

Answer:

NULL is macro constant which has been defined in the heard file stdio.h, alloc.h, mem.h, stddef.h and stdlib.h as

```
#define NULL 0
```

Examples:

(1)What will be output of following c program?

```
#include "stdio.h"

void main(){

        if(!NULL)

                printf("I know preprocessor");

        else

                printf("I don't know preprocessor");

}
```

Output: I know preprocessor

Explanation:

!NULL = !0 = 1

In if condition any non zero number mean true.

(2)What will be output of following c program?

```
#include "stdio.h"

void main(){

            int i;

            static int count;

            for(i=NULL;i<=5;){

                        count++;

                        i+=2;

            }

            printf("%d",count);

}
```

Output: 3

(3)What will be output of following c program?

```
#include "stdio.h"

void main(){

#ifndef NULL

#define NULL 5

#endif

            printf("%d",NULL+sizeof(NULL));

}
```

Output: 2

Explanation:

NULL+sizeof(NULL)

=0+sizeoof(0)

=0+2 //size of int data type is two byte.

We cannot copy any thing in the NULL pointer.

Example:

(q)What will be output of following c program?

```
#include "string.h"

void main(){

        char *str=NULL;

        strcpy(str,"understanding pointer in c");

        printf("%s",str);

}
```

Output: (null)

Wild pointer in c programming language

2. Wild pointer:

A pointer in c which has not been initialized is known as wild pointer.
Example:

(q)What will be output of following c program?

```
void main(){
        int *ptr;
        printf("%u\n",ptr);
        printf("%d",*ptr);

}
```

Output: Any address
Garbage value

Here ptr is wild pointer because it has not been initialized.
There is difference between the NULL pointer and wild pointer. Null pointer points the base address of segment while wild pointer doesn’t point any specific memory location.

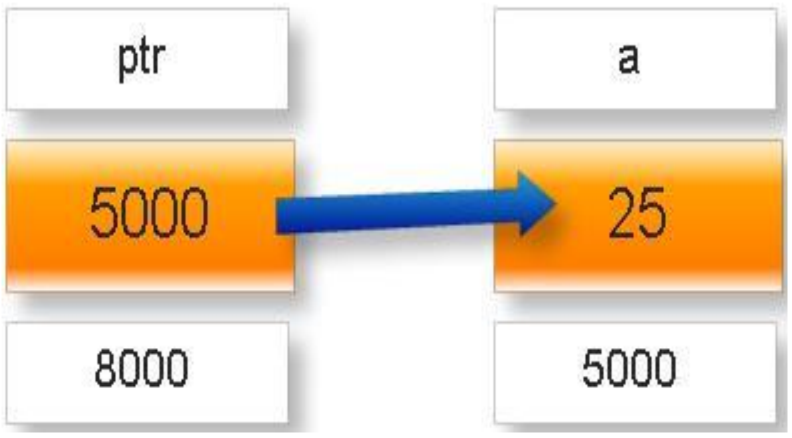
Dangling pointer problem in c programming

Different types of pointers:

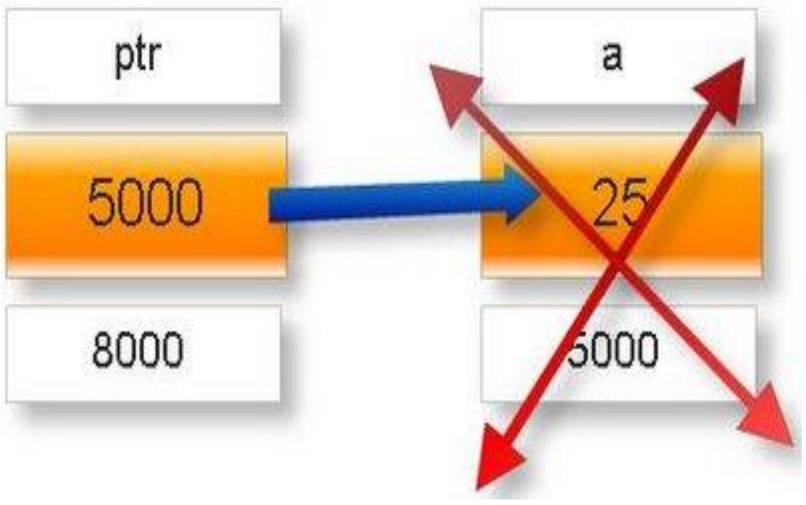
1. Dangling pointer:

If any pointer is pointing the memory address of any variable but after some variable has deleted from that memory location while pointer is still pointing such memory location. Such pointer is known as dangling pointer and this problem is known as dangling pointer problem.

Initially:



Later:



For example:

(q)What will be output of following c program?

```
int *call();

void main(){

            int *ptr;

            ptr=call();

            clrscr();

            printf("%d",*ptr);

}

int * call(){

            int x=25;

            ++x;

return &x;

}
```

Output: Garbage value

Explanation: variable x is local variable. Its scope and lifetime is within the function call hence after returning address of x variable x became dead and pointer is still pointing ptr is still pointing to that location.

Solution of this problem: Make the variable x is as static variable.

In other word we can say a pointer whose pointing object has been deleted is called dangling pointer.

Near pointer in C programming

In TURBO C there are three types of pointers. TURBO C works under DOS operating system which is based on 8085 microprocessor.

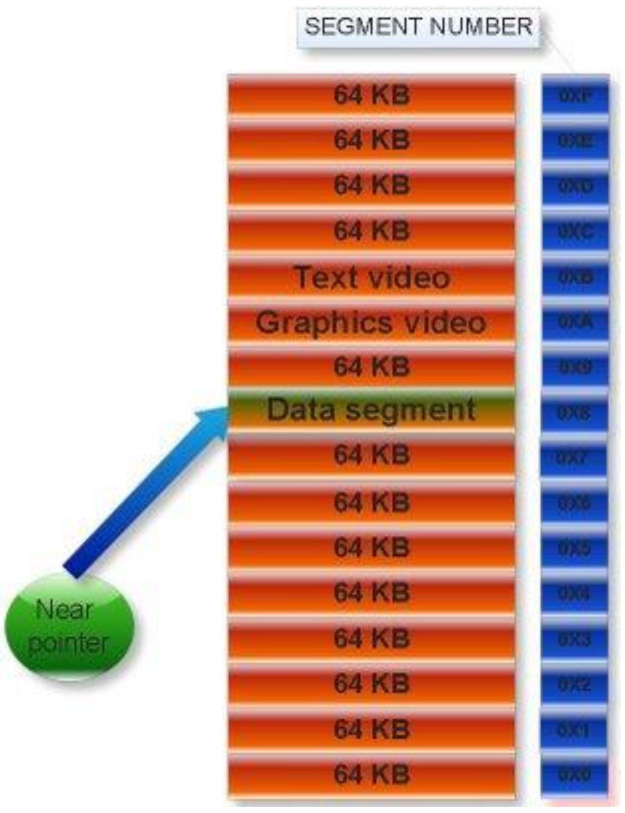
1. Near pointer

2. Far pointer

3. Huge pointer

Near pointer:

The pointer which can points only 64KB data segment or segment number 8 is known as near pointer.



That is near pointer cannot access beyond the data segment like graphics video memory, text video memory etc. Size of near pointer is two byte. With help keyword near, we can make any pointer as near pointer.

Examples:

(1)

```
void main(){
        int x=25;
        int near* ptr;
        ptr=&x;
        printf(“%d”,sizeof ptr);
}
```

Output: 2

(2)

```
void main(){
        int near* near * ptr;
        printf(“%d”,sizeof(ptr),sizeof(*ptr));
}
```

Output: 2 2

Explanation: Size of any type of near pointer is two byte.

Near pointer only hold 16 bit offset address. Offset address varies from 0000 to FFFF (in hexadecimal).

Note: In printf statement to print the offset address in hexadecimal, %p is used.

Example:

```
void main(){
        int i=10;
        int *ptr=&i;
        printf("%p",ptr);
}
```

Output: Offset address in hexadecimal number format.

%p is also used to print any number in hexadecimal number format.

Example:

```
void main(){
        int a=12;
        printf("%p",a);
}
```

Output: 000C

Explanation: Hexadecimal value of 12 is C.

Consider the following two c program and analyze its output:

(1)

```
void main(){
        int near * ptr=( int *)0XFFFF;
        ptr++;
        ptr++;
        printf(“%p”,ptr);
}
```

Output: 0003

(2)

```
void main(){
        int i;
        char near *ptr=(char *)0xFFFA;
        for(i=0;i<=10;i++){
                printf("%p \n",ptr);
                ptr++;
        }
}
```

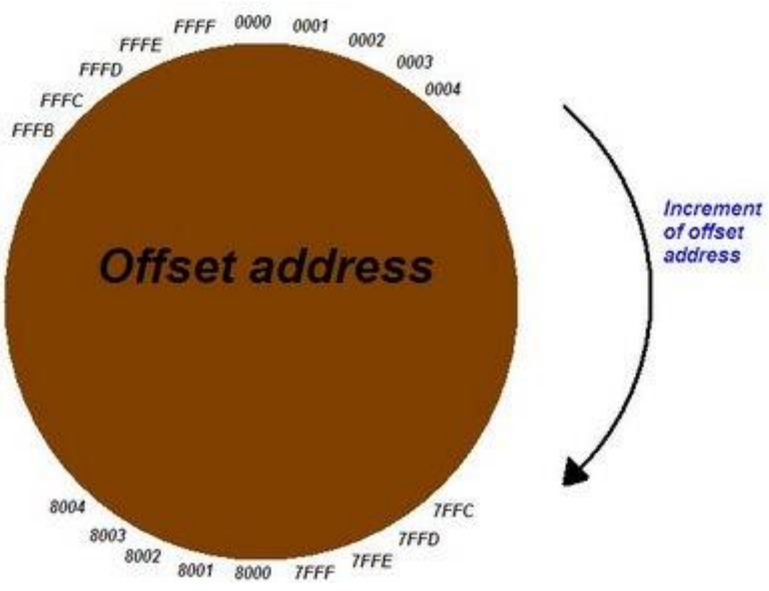
Output:

```
FFFA

FFFB
FFFC
FFFD
FFFE
FFFF
0000

0001

0002

0003

0004
```

Explanation: When we increment or decrement the offset address from maximum and minimum value respectively then it repeats the same value in cyclic order. This property is known as cyclic nature of offset address.

Cyclic property of offset address.

If you increment the near pointer variable then move clockwise direction. If you decrement the near pointer then move anti clockwise direction.



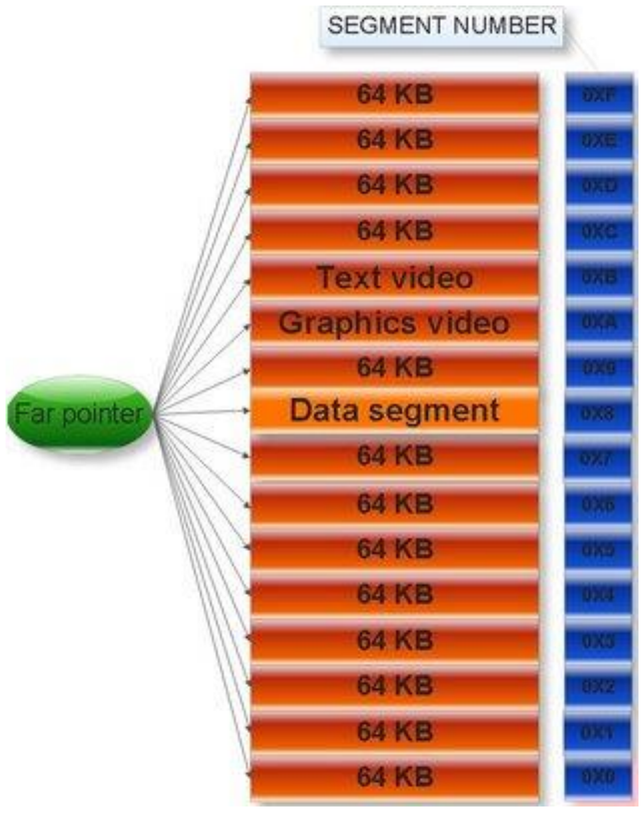
What is default type of pointer in C?

Answer: It depends upon memory model.

What is memory model in C?

Far pointer in c programming

The pointer which can point or access whole the residence memory of RAM i.e. which can access all 16 segments is known as far pointer.



Far pointer:

Size of far pointer is 4 byte or 32 bit.

Examples:

(1) What will be output of following c program?

```
void main(){

    int x=10;

    int far *ptr;

    ptr=&x;
```

```
        printf("%d",sizeof ptr);

}
```

Output: 4

(2)What will be output of following c program?

```
void main(){

        int far *near*ptr;

        printf("%d %d",sizeof(ptr) ,sizeof(*ptr));

}
```

Output: 4 2

Explanation: ptr is far pointer while *ptr is near pointer.

(3)What will be output of following c program?

```
void main(){

        int far *p,far *q;

        printf("%d %d",sizeof(p) ,sizeof(q));

}
```

Output: 4 4

First 16 bit stores: Segment number

Next 16 bit stores: Offset address

What is segment number and offset address?

Example:

```
void main(){

        int x=100;

        int far *ptr;

        ptr=&x;
```

```
    printf("%Fp",ptr);
}
```

Output: 8FD8:FFF4

Here 8FD8 is segment address and FFF4 is offset address in hexadecimal number format.

Note: %Fp is used for print offset and segment address of pointer in printf function in hexadecimal number format.

In the header file dos.h there are three macro functions to get the offset address and segment address from far pointer and vice versa.

1. **FP_OFF():** To get offset address from far address.
2. **FP_SEG():** To get segment address from far address.
3. **MK_FP():** To make far address from segment and offset address.

Examples:

(1)What will be output of following c program?

```
#include "dos.h"
void main(){
    int i=25;
    int far*ptr=&i;
    printf("%X %X",FP_SEG(ptr),FP_OFF(ptr));
}
```

Output: Any segment and offset address in hexadecimal number format respectively.

(2)What will be output of following c program?

```
#include "dos.h"
void main(){
    int i=25;
    int far*ptr=&i;
```

```
        unsigned int s,o;

        s=FP_SEG(ptr);

        o=FP_OFF(ptr);

        printf("%Fp",MK_FP(s,o));

}
```

Output: 8FD9:FFF4 (Assume)

Note: We cannot guess what will be offset address, segment address and far address of any far pointer .These address are decided by operating system.

Limitation of far pointer:

We cannot change or modify the segment address of given far address by applying any arithmetic operation on it. That is by using arithmetic operator we cannot jump from one segment to other segment. If you will increment the far address beyond the maximum value of its offset address instead of incrementing segment address it will repeat its offset address in cyclic order.

Example:

(q)What will be output of following c program?

```
void main(){

        int i;

        char far *ptr=(char *)0xB800FFFA;

        for(i=0;i<=10;i++){

                printf("%Fp \n",ptr);

                ptr++;

        }

}
```

Output:

```
B800:FFFA

B800:FFFB
```

```
B800:FFFC

B800:FFFD

B800:FFFE

B800:FFFF

B800:0000

B800:0001

B800:0002

B800:0003

B800:0004
```

This property of far pointer is called cyclic nature of far pointer within same segment.

Important points about far pointer:

1. Far pointer compares both offset address and segment address with relational operators.

Examples:

(1)What will be output of following c program?

```c
void main(){

        int far *p=(int *)0X70230000;

        int far *q=(int *)0XB0210000;

        if(p==q)

                printf("Both pointers are equal");

        else

                printf("Both pointers are not equal");

}
```

Output: Both pointers are not equal

(2)What will be output of following c program?

```
void main(){

	int far *p=(int *)0X70230000;

	int far *q=(int *)0XB0210000;

	int near *x,near*y;

	x=(int near *)p;

	y=(int near *)q;

	if(x==y)

		printf("Both pointer are equal");

	else

		printf("Both pointer are not equal");

}
```

Output: Both pointers are equal

2. Far pointer doesn’t normalize.

What is normalization of pointer?