Pointers II

Arrays And Pointers

Arrays are themselves pointers

- The name of an array variable in C++, without the use of the [ ] operator, represents the starting address of the array. This address can be stored in a pointer variable

- Since array values are guaranteed to be in contiguous memory, you can access array values using this one pointer

Examples of this is the "pointer arithmetic"

Ex: *int A[3] = { 2, 4, 6 };*

*int *iPtr;*

iPtr =& A; //error , A is actually is the address of the first element in the array

iPtr = A; // it is equivallent to iPtr=&A[0]; //ok

*cout << "value: " << *iPtr << endl; // cout<< A[0];*

cout<< " address of first element in the array "<<iPtr<<endl;

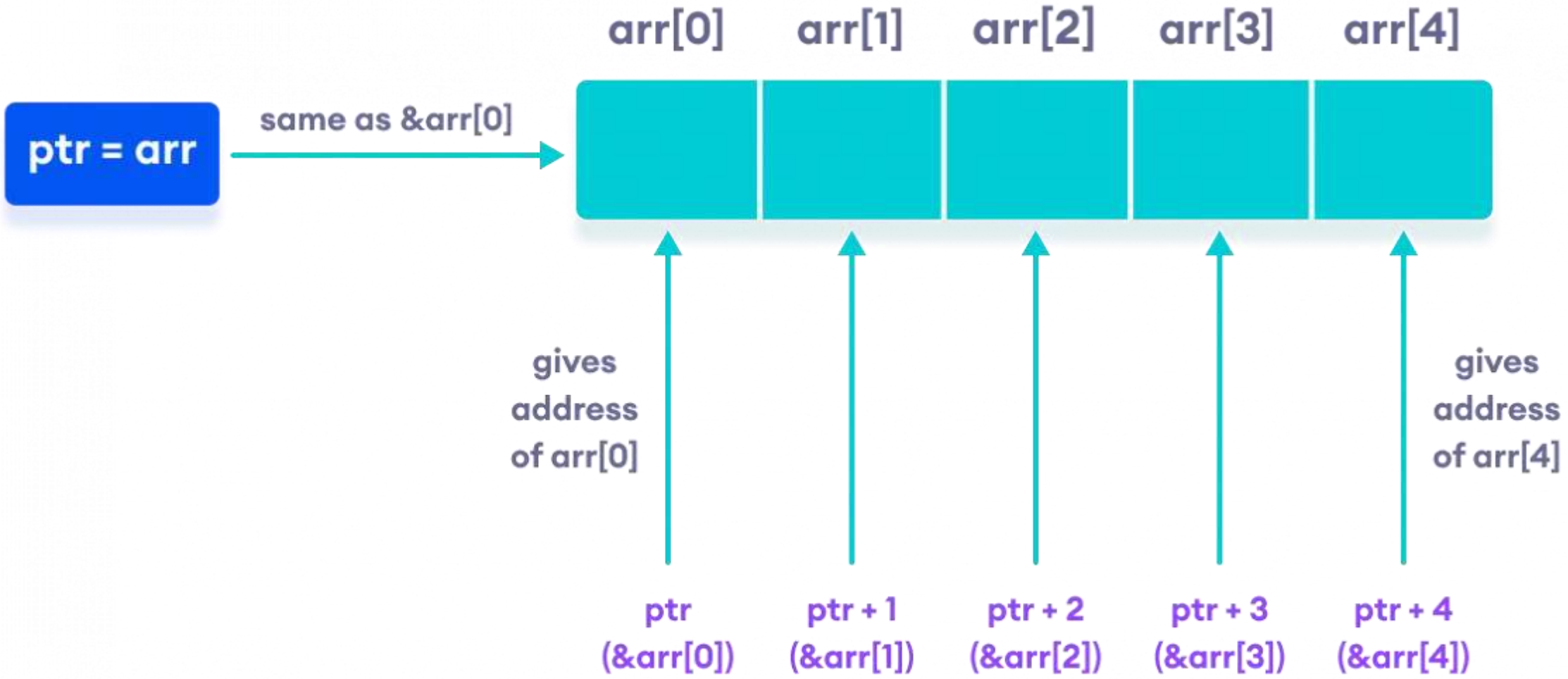
Comments:

- Assigns iPtr to point to the first integer in the iAry array

- The program prints the value stored in the location iPtr that points to the first element in the array A, in this case

Output

Value: 2 address of first element in the array 0x28fed0


arr[0]
arr[1]
arr[2]
arr[3]
arr[4]
ptr = arr
same as &arr[0]
gives address of arr[0]
gives address of arr[4]
ptr (&arr[0])
ptr + 1 (&arr[1])
ptr + 2 (&arr[2])
ptr + 3 (&arr[3])
ptr + 4 (&arr[4])

Arrays and pointers

int *ptr; int arr[5]; ptr = arr;

ptr + 1 is equivalent to &arr[1];

ptr + 2 is equivalent to &arr[2];

ptr + 3 is equivalent to &arr[3];

ptr + 4 is equivalent to &arr[4];

Similarly, we can access the elements using the single pointer. For example,

// use dereference operator

*ptr == arr[0];

*(ptr + 1) is equivalent to arr[1];

*(ptr + 2) is equivalent to arr[2];

*(ptr + 3) is equivalent to arr[3];

*(ptr + 4) is equivalent to arr[4];

Accessing arrays through pointers

We can access arrays using array name or pointer to the array as follows

Example 1:

```
1-  { int b[5]={10,20,30,40,50};
   2- int *pt=b;              // pt is pointer to array b          // *pt=&b    error
   3- cout<<" array through indices   "<<endl;
    4- for(int i=0;i<5;i++)
    5- cout<<b[i]<<"   "; cout<<endl<<endl;
   6-  cout<<" array as pointer   "<<endl;
    7- for(int i=0;i<5;i++)cout<<*(b+i)<<"   ";
     8- cout<<endl<<endl;      cout<<" values of array from pointer   "<<endl;
    9-  for(int i=0;i<5;i++)cout<<*(pt+i)<<"   "; }
```

Example 1 (cont.)

```
10- cout<<endl<<endl;  cout<<" addresses of   of array  "<<endl;

   11-  for(int i=0;i<5;i++)       cout<<pt+i<<"   ";

12- cout<<" addreses of array from array name    "<<endl;

13- for(int i=0;i<5;i++)cout<<(b+i)<<"   "; }
```

We can access the elements of the array using b[i] as in statement 5, or using the name of the array itself (b+i), statement 7 or from its pointer *(pt+i) statement 11. Cout<<Ptr+i, will print the addresses of the array (each element stored in 4 bytes)

Output

```
 array through indices
10   20   30   40   50

 array as pointer
10   20   30   40   50

 values of array from pointer
10   20   30   40   50

 addresses of   of array
0x0018ff3c   0x0018ff40   0x0018ff44   0x0018ff48   0x0018ff4c

 addreses of array from array name
0x0018ff3c   0x0018ff40   0x0018ff44   0x0018ff48   0x0018ff4c
```

Example: assign values to array by its name as pointer

Example 2:

```
1-   {    int i, num[10];
2-  cout<< "  assign values to array "<<endl;
3-   for(i=0;i<6;i++)
4-    { *num=i;            cout<< *num <<"     "; }
5-      //num++   error
6-     cout<<endl<<"  first element after loop =  "<<num[0]<<endl;
7-     cout<< "   last element after loop = "<<num[5]<<endl;    //error, num[5] has no value
8-    cout<<"  correct assign of array values "<<endl<<endl;
9-              *num= 80;    cout<<" first value of array=   "<<num[0]<<endl;
10-            *(num+1)=100;   cout<<" second value of array=   "<<num[1]<<endl;
11-            *(num+9)=55;     cout<<" last value of array=   "<<num[9]<<endl;
12-            cout<<"  assign values to array by its name as pointer  "<<endl;
13-            for(i=0;i<10;i++)
14-            { *(num+i)= 2*i;   cout<< "  value  "<<(*num+i) <<"  pointer  "<<(num+i)<<" actual
values  "<< *(num+i)<<endl;}  }
```

array name is a constant pointer

can change value that address hold
but
cant change the address

Comments

- In statement 4, *num= i; assign the value of i to the first element in the array, so after exit from loop, we find that num[0]= 5
- While array name is pointer itself, we cann't increment it as in pointers, so num++ is an error
- In statements 9, 10 and 11, we assign values to some elements of the array

  *(num+i)= value, assign value to the element num[i] in the array.
- In statement 14, *(num+i)= i; assign the values i to the elements of the array
- cout<<*num+ i, prints the value of num[0]+value of i.
- To get the actual values of the array, we must use *(num+i) or *(pointer of array + i).

Output

```
 assign values to array
0     1     2     3     4     5
 first element after loop =  5
  last element after loop = 1703748 // any random value,  error
  correct assign of array values

first value of array=   80
second value of array=   100
last value of array=   55
 assign values to array by its name as pointer
 value  0  pointer  0x0019ff04    actual values  0
 value  1  pointer  0x0019ff08    actual values  2
 value  2  pointer  0x0019ff0c    actual values  4
 value  3  pointer  0x0019ff10    actual values  6
 value  4  pointer  0x0019ff14    actual values  8
 value  5  pointer  0x0019ff18    actual values  10assign values to array
```

Arrays and pointers

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int *x [10] -> array of pointers

int (*x)[10] -> pointer to array of 10 elements

Syntax to Declare Pointer to 2D Array

data_type (*array_name**)[column_size];**

For example,

int (*ptr)[4] = arr;

Or int *ptr[row size]

pointer for array = array name != & array name

Here, if array arr[3][4] declares an array with 3 rows (outer arrays) and 4 columns (inner arrays) of integers. If we declare an array as int arr[n][m] then n is the number of rows or we can say number of arrays it stores and m denotes the number of element each array(row) have in integers as int data type is declared.

Syntax to Declare Pointer to 3D Array

data_type (*array_name)[col_size][depth_size];

For example, for array int arr[1][2][3], we can delcare a pointer to it as:

int (*ptr)[2][3] = arr;

Arrays and pointers

int arr[3][4] = { {1, 2, 3, 4}, {5, 6, 7, 8}, {9, 10, 11, 12} };
We know that the name of an array is a constant pointer that points to 0th 1-D array and if it starts at address 5000. Since arr is a 'pointer to an array of 4 integers', according to pointer arithmetic the expression arr + 1 will represent the address 5016 and expression arr + 2 will represent address 5032.

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arr	-	Points to 0th element of arr	-	Points to 0th 1-D array - 5000
arr + 1	-	Points to 1th element of arr	-	Points to 1nd 1-D array - 5016
arr + 2	-	Points to 2th element of arr	-	Points to 2nd 1-D array - 5032

addresse of rows(arays)

for 2D array

* or [] -> addrese
** or [][] -> value

pointer[i]

[i] [j] == *(*(pointer+i)+j)

Ex: 3 Example of 2D array with pointer

If we want to get the address of each element in the 2D array, (* (pointer name+i)+j) as follows:

```
int main()
    { int(*p)[4];
    cout<<" addresses of each row in the Array from its pointer "<<endl;
                for(int i=0;i< 5; i++)
      cout<<(p+i)<<"   ";
                cout<<endl<<endl;

     cout<<" address of each element in the array"<<endl<<endl;
     for(int i=0; i< 5;i++) {for (int j=0; j< 4; j++)
   cout<<(*(p+i)+j)<<"   ";
    cout<<endl; }  return 0;}
```

Output

```
addresses of each row in the Array from its pointer       // (p+i)
0x61fdb0   0x61fdc0   0x61fdd0   0x61fde0   0x61fdf0
// *(p)+I gives the addresses of first row
 address of each element in the array  // from pointer (*(p+i)+j)

0x61fdb0   0x61fdb4   0x61fdb8   0x61fdbc
0x61fdc0   0x61fdc4   0x61fdc8   0x61fdcc
0x61fdd0   0x61fdd4   0x61fdd8   0x61fddc
0x61fde0   0x61fde4   0x61fde8   0x61fdec
0x61fdf0   0x61fdf4   0x61fdf8   0x61fdfc
```

Ex 4: Another example of 2D array with pointer

```
int arr[3][4] = {  {1, 2, 3, 4},    {5, 6, 7, 8},     {9, 10, 11, 12} };
 int (*ptr)[4];  ptr = arr;
 cout<<" addresses of rows of the array using increments of ptr "<<endl
 << ptr<<"  "< ptr + 1<<"   "<< ptr + 2<<endl<<endl;
cout<<" addresses of first row using increments of *ptr  "<<endl
<<* ptr<<"  "<< *(ptr )+ 1<<"   "<< *(ptr) + 2<<"   "<<*(ptr)+3<<endl<<endl;

cout<<" values of first row from pointer "<<endl;
cout<<** ptr<<"  "<<**(ptr) + 1<<"   "<< **(ptr) + 2<<"   "<<**(ptr)+3<<endl<<endl;

cout<<" another way of rows addresses of array   "<<endl<<endl;
cout<<* ptr<<"  "<< *(ptr + 1)<<"   "<< *(ptr + 2)<<endl<<endl;
```

Example of 2D array with pointer (cont.)

```
cout<<" values of array of first column "<<** ptr<<"  "<<* *(ptr + 1)<<"   "<< **(ptr + 2)<<endl;


cout<< " addresses of second row  "<<*(ptr+1 )<<"      "<<*(ptr + 1)+1<<"   "<< *(ptr + 1) +
2<<endl<<endl;
cout<< " values of second row"<< **(ptr+1) <<"   "<<*(*(ptr + 1)+1)<<"   "<< *(*(ptr + 2) +
1)<<endl<<endl;
cout<<"values of some elements (increment row and column "
<<*(*(ptr+1)+2)<<"   "<<*(*(ptr+2)+1)<<endl<<endl;
cout<<" another way to get values from pointer  "<<endl;
cout<< ptr[0][0]<< "   "<<ptr[1][2]<<"   "<< ptr[2][3]<<endl;
cout<<" some values from array name"<<endl<<endl;
cout<<arr[0][0]<<"    "<<arr[1][2]<<"    "<<arr[2][3];     return 0;}
```

addresses of rows of the array using increments of ptr
0x61fdf0 0x61fe00 0x61fe10

addresses of first row using increments of *ptr
0x61fdf0 0x61fdf4 0x61fdf8 0x61fdfc

values of first row from pointer **ptr
1 2 3 4
another way of rows addresses of array **(ptr+i)**
0x61fdf0 0x61fe00 0x61fe10

values of array of first column 1 5 9 ****(ptr+i)**
addresses of second row 0x61fe00 0x61fe04 0x61fe08 ***(ptr + 1)+i**
values of second row 5 6 10 ****(ptr + 1)+i**

Values of some elements (increment row and column 7 10

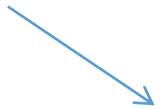
another way to get values from pointer ptr[i][j] 1 7 12
some values from array name arr[i][j] 1 7 12

Array of pointers , another method to declare 2D array

We can create array of pointers as shown:

Example 5

A[3][4]



0	3	6	9
2	5	8	11
4	7	10	13

```
{int A[3][4]; int *p[3];  // p is an array of integer pointers
  for(int i=0; i<3;i++)
{   p[i]=A[i];              //p points to the two dimensional array A
 cout<<"   row no.  "<<i<<"  through pointer p[ "<<i<< "] "<<endl;
  for(int j=0;j<4;j++)
   {     A[i][j]=2*i+ 3*j;                cout<<* (p[i]+j)<<"   ";  } cout<<endl; } }
```

// the above statement is equivalent to cout<<A[i][j]

Output

```
 row no.  0  through pointer p[ 0]
0   3   6   9
   row no.  1  through pointer p[ 1]
2   5   8   11
   row no.  2  through pointer p[ 2]
4   7   10   13
```

Arrays and pointers

We know, the pointer expression *(arr + i) is equivalent to the subscript expression arr[i]. So *(arr + i) which is same as arr[i] gives us the base address of ith 1-D array.
To access an individual element of our 2-D array, we should be able to access any jth element of ith 1-D array. we can get the addresses of subsequent elements in the ith 1-D array by adding integer values to *(arr + i). For example *(arr + i) + 1 will represent the address of 1st element of 1stelement of ith 1-D array and *(arr+i)+2 will represent the address of 2nd element of ith 1-D array.
Similarly *(arr + i) + j will represent the address of jth element of ith 1-D array. On dereferencing this expression we can get the jth element of the ith 1-D array.

Thus the pointer expression *(*(*(arr + i) + j) + k) is equivalent to the subscript

expression arr[i][j][k].

Ex: 6 Example of pointer to 3D array

```
// C program to print the elements of 3-D
// array using pointer notation
int arr[2][3][3] = { 5, 10, 22,  6, 11, 44,  7, 12, 55,  20, 30, 66, 21, 31, 77,  22, 32, 88 };
  int i, j, k;
  for (i = 0; i < 2; i++)
  {    cout<<" first dimension  "<<endl;
       for (j = 0; j < 3; j++)
    {          for (k = 0; k < 3; k++)
       cout<< *(*(*(arr + i) + j) +k) <<"   ";
       cout<<" second dimension  "<<endl;
      cout<<endl;     }  }  return 0;}
```

Output

Elements of the 3D array through pointer

first dimension

5 10 22 second dimension

6 11 44 second dimension

7 12 55 second dimension

first dimension

20 30 66 second dimension

21 31 77 second dimension

22 32 88 second dimension

Strings and pointers

Example 7:

```
//  strings with pointers
    1-    int  main() {int i;
    2-                  char *c, st[20]="C++ exam";
    3-                  c=st;   // c is a pointer to string st
    4-                   // c=&st    Error
    5-                 cout << *st<<endl;       // prints character st[0]
    6-                    cout<<*(st+2)<<endl;     // prints character st[2]
    7-                  cout<<" string st = "<<st<<endl<<endl;      print while string
    8-                  cout<<"  string through pointer c  ="<<c<<endl<<endl;
    9-                      for(i=0; i<7;i++)
    10-         { cout <<" character "<<st[i] <<" pointer "<<(c+i)<<"  character from
          pointer "<<*(c+i)<<" string "<<(st+i)<<endl;     }
             return 0;}
```

Comments

- In statement 3, the pointer c points to the string st.
- cout<<*st ; prints the first character in the string st, while cout<<*(st+2) prints the character st[2].
- We can print the string using the pointer c of the string as in statement 8
- We can print the characters of the string using cout<<st[i]; or cout<<*(c+i)* as in statement 10

quiz 2025

- When we use cout<< (c+i) or cout<<*st+i, the string will be printed starting from character no. i.*

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Solution

C
+
string st = C++ exam

string through pointer c =C++ exam

character C pointer C++ exam
character + pointer ++ exam
character + pointer + exam
character pointer exam
character e pointer exam
character x pointer xam
character a pointer am

character from pointer C string C++ exam
character from pointer + string ++ exam
character from pointer + string + exam
character from pointer string exam
character from pointer e string exam
character from pointer x string xam
character from pointer a string am

If we want to see the address of the string as array of characters, we should cast the pointer to another pointer type, such as **int *.** Thus, **c** displays as the string “C++ exam", but **(int *)c** displays as the address where the string is located.

Example to print addresses of string as array of characters through pointers

```
char *c, st[20]="C++ exam";
        c = st;   // c is a pointer to string st
    cout<<c<<“   “<<“ address “<<(int *) c<<endl<<endl;
   for(int i=0;i<6;i++)
   cout << (c+i)<<“    address  "<<(int *)(c+i)<<endl;
```

Output

C++ exam address 0x0019ff24

C++ exam address 0x0019ff24
++ exam address 0x0019ff25
+ exam address 0x0019ff26
 exam address 0x0019ff27
exam address 0x0019ff28
xam address 0x0019ff29 //each character has one byte

Pointers and strings that declared by data type string

Example 8:

```
{   // pointers and class string
        {string st, *sptr;  st="mohammed";   // pointer to string
that has been declared as string data type
  sptr=&st;
 // sptr=st;   //  error
cout<<"string   "<<st<<endl<<"address of string st
        "<<sptr<<endl;
        for(int i=0;i<8; i++)cout<<"char. no.  "<<i<<"  is  "<<st[i]
        <<endl;        sptr++; cout<<"address after incrementing
pointer of string "<<sptr;   return 0;}
```

although string is 1d array but its treated as varible so it needs &

((arr+i)+j) cant be used with array of array of string so use [][]

```
string arr [2]= {"omar","ahmed"};

cout<< *(arr+1)<<endl;    -> ahmed

cout<<*arr[0] <<endl;      -> o
```

Output

string mohammed
address of string st 0x61fde0
char. no. 0 is m
char. no. 1 is o
char. no. 2 is h
char. no. 3 is a
char. no. 4 is m
char. no. 5 is m
char. no. 6 is e
char. no. 7 is d
address after incrementing pointer of string 0x61fe00

Example 9

```
1- main( ) {   string s2=" new string";      string  *ss;
 2-  cout<<"   address of string s2   "<<&s2<<endl;
  cout<<“ string s2 =  “<<s2<<endl;
 3-   // ss=s2;   error
 4-    ss=&s2; cout<<"  address after ss is pointing to string s2  "<<ss<<endl;
 5-    for(int i=0; i<7;i++) cout<< s2[i]<<endl;    }
```

- In statement 1, pointer ss points to string
- In statement 2, cout<<&s2, prints the address of the string s2
- To point to the string, we use ss=&s2 as in statement 4, so statement 3 is wrong
- In statement 5 cout<<s2[i]; prints the characters of string s2

Output of example 9

address of string s2 0x28fed0
string s2 = new string
address after ss is pointing to string s2 0x28fed0
n
e
w

s
t
R

Array of pointers (cont.)

Example 10 : array of pointers to strings

```
 int main()
{       const char *s[4]={"logic","design","c++","computer"};
 for(int i=0;i<4;i++)
    cout<<"  value   "<<  s[i]<<" address  "<<(int *)s[i]<<endl;

 string p[4]={" test_1"," test_2"," test_3"," test_4"} ;
            string *ps=p;   // pointer to array of strings
            cout<<endl<<" print strings as data type string from its array of pointers
"<<endl;
            for(int i=0;i<4;i++)
            cout<<"address      "<<(ps+i)<<"  value      "<<ps[i]<<endl;   } // it is
equivalent to cout<<p[i]
```

*s[0] *s[1] *s[2] *s[3]

cout char pointrer == cout content

casting to print address

Output

```
value   logic          address  0x405001  // logic takes 5 bytes
value   design         address  0x405007  // design takes 6 bytes and so on
value   c++            address  0x40500e
value   computer       address  0x405012
```

print strings as data type string from its array of pointers

```
address     0x7ffc7d9f40f0  value      test_1
address     0x7ffc7d9f4110  value      test_2
address     0x7ffc7d9f4130  value      test_3
address     0x7ffc7d9f4150  value      test_4 // each string needs 20 bytes
```

Addresses of each character in the two strings “logic”, “design”

```
const char *s[4]={"logic","design","c++","computer"};
 for(int i=0;i<2;i++)
   for(int j=0;j<strlen(s[i]);j++)
 cout<<"  address  "<<(int *)(s[i]+j)<<"  value   "<<  s[i]+j<<endl;
```

a[0] a[1] a[2] a[3]

s[i]+n => string start from nth char

*s[i]+n => nth char

Output

address 0x405001 value logic
address 0x405002 value ogic
address 0x405003 value gic
address 0x405004 value ic
address 0x405005 value c
address 0x405007 value design
address 0x405008 value esign
address 0x405009 value sign
address 0x40500a value ign
address 0x40500b value gn
address 0x40500c value n

Example of new and delete with arrays

Example 11

```
int main()
 {int *p;          p= new int[10];
     cout<<"  pointers and values of the array   assigned by new   " <<endl;
                          for(int i=0;i<4;i++){ *(p+i)=2*i;
  cout<<"  element  "<<i<<"   pointer  "<<(p+i)<< "  value  "<< *(p+i)<<endl;   }
  delete []p;
  for(int i=0;i<4;i++)
    cout<<*(p+i)<<endl;
                int x[ ]= {10,20,30,40,50};
    p=x;
     cout<<endl<<endl;
  cout<<" pointers of array x and   values of array x " <<endl;
   for(int i=0;i<5;i++)  cout<<" pointer "<<(p+i)<<"  value " <<*(x+i) <<endl;
    delete p;
  cout<<"  value of array x after delete pointer p "<<endl;
   for(int i=0;i<5;i++)
       cout<<"  values of array  "<<*(x+i) <<"    "<<endl; cout<<endl;
cout<<"  pointer after delete  ";cout<<p;}
```

Output

```
 pointers and values of the array   assigned by new
 element  0   pointer  0xda1910  value  0
 element  1   pointer  0xda1914  value  2
 element  2   pointer  0xda1918  value  4
 element  3   pointer  0xda191c  value  6
14292880  // error addresses
0
14287184
0
```

cant delete dynamic allocated pointer pointing to a varible or array

```
 pointers of array x and   values of array x
 pointer 0x61fdf0  value 10
 pointer 0x61fdf4  value 20
 pointer 0x61fdf8  value 30
 pointer 0x61fdfc  value 40
 pointer 0x61fe00  value 50
```

Deleting pointer to static array and then trying to print it will give run time error

Pointers to Structure Objects

We can use pointers to point to an object of structure. When dealing with pointer objects, its a standard to use **arrow operator -> instead of '.' operator**

Exampel 12 :

```
#include<stdio.h>
struct st { int a; char ch;};

int main{    st  obj;                  // object of structure st
             st *stobj = &obj;   // stobi is a pointer to object obj
   stobj->a = 5;    stobj->ch = '#';  // operator -> used with member of object
                  // stobi ->a is equivalent to obi.a
    cout<< stobj->a<<" ,"<< stobj->ch;    return 0; }
```

OUTPUT 5 , #

- In the above code, we have declared a pointer stobj of type 'struct st'. Now since the pointer type is a structure, so the address it points to has to be of a 'struct st' type variable(which in this case is 'obj').
- Structure elements are accessed using pointer variable 'stobj' with -> operator.
- We can also use 'obj' to access the structure elements.

Structure elements can be accessed using ‘obj’ as follows

```
Struct st{ int a;  char ch;};
main ( )
{  st  obj;
 obj.a = 10;     obj.ch = ‘&';
cout<< obj .a<<" ,"<< stobj. ch;
return 0; }
```

Comments

- obj is an object of structure st
- We use members of the object obj using dot (.) operator, while in pointers we use -> operator

Output

10 &

Ex: 13 Another example of pointers and structures

pointers of type coordinate

```
struct Coordinate {      int x;     int y;};
float getDistance(struct Coordinate *X, struct Coordinate *Y) {
    int x_diff = X->x - Y->x;
    int y_diff = X->y - Y->y;
        float distance = sqrt((x_diff * x_diff) + (y_diff * y_diff));     return distance; }
int main() {
    struct Coordinate a,b;
        a.x = 5, a.y = 6;
    b.x = 4, b.y = 7;
        float distance = getDistance(&a, &b);
  cout<<"Distance between points <<endl<<"( " a.x<<" , "<< a.y<<") "<<" ("<< b.x<<" , "<<
b.y<<") "endl;
<<" distance ="<< distance;      return 0;  }
```

optional

address of members

Output

Distance between points

(5,6) (4,7)

Distance= 1.414

Example of structures and pointers

Write a program that uses the structure student which contains the student number, name, his scores in m subjects and the average score. Then the program creates n objects of the structure student.

The program uses the functions:

Fun_input( ) to read data for certain student

Average( ) to get average score of certain student.

The main function access the above two functions through pointers to the structure,read data of n students and get their average score.

Functions and pointers

We can pass pointers to the function or return a pointer from functions as the following examples:

Example 14

```
float value(float *p1,float *p2)
  {  return *p1**p2;     }
main( )
{   float k1,k2;  float *p1=&k1;  float *p2=&k2;
    k1=10;   k2=20;
     cout<<" output of function  =  "<<value(p1,p2);}
```

Here we send two pointers p1 and p2 to the function

output:

Output of function = 200

Example 15

```
void cub_1(int &n) // call by reference function
  {n= n*n*n;}

 void cub_2(int *n) // function argument is an integer pointer
 { *n=(*n)*(*n)*(*n);  }

 main()
 {  int num=5; // call by reference
   cub_1(num);  cout<<" value of num after cub_1(  ) "<<num<<endl;
   // send pointer to the function
int k=10;   cub_2(&k);cout<<" value of k after cub_2(  ) "<<k<<endl;
```

In function cub_1, it was call by reference, so value of num will be changed after calling it.
In function cub_2, we send pointer to the function, so the value stored in this location will also be changed

Output

value of num after cub_1( ) 125
value of k after cub_2( ) 1000

// function has pointer type (bad pointers)

Example 16

```
// function returns pointer
int * fun(  )
   {int *x;  int y=10; x=&y;    return x;     }
// function needs a pointer as its argument
            int  fun_2(int *x  )       {   *x=30;  return *x;    }
   int main()
    {int *pp= new int;
    *pp=5;  cout<<" value at address pp= "<<*pp<<"    stored at address =   "<<pp<<endl;
// fun(  ) returns the address of a local variable
      pp=fun(); cout<<"  new  address from fun( ) =  "<<pp<<endl<<endl;
// send pointer to fun_2( )
    *pp=80;     *pp=fun_2(pp);
cout<<"  pointer pp will not be changed, address after calling fun_2( )= "<<pp<<endl;
cout<<   "   returned value will be changed "<<*pp<<endl;     }
```

Output

value at address pp= 5 stored at address = 0xeb1910
new address from fun( ) = 0x61fdd4

pointer pp will not be changed, address after calling fun_2( )= 0x61fdd4
returned value will be changed 0
//output of *pp=0 because pp was a pointer to returned address from fun( )
Let's the code will be

int y, *p1; p1=&y; *p1= fun_2(p1);

The output:

pointer p1 after calling fun_2( )= 0x7ffc30ae183c
returned value will be 30

Example 17

```
int * fun(  )
{int y, *p;    y=100;  p=&y;
    return p;     }

int * fun_2( int n)
{  static int  x[10]; // if not use static, warning: address of local variable 'x' returned
  cout<<“array in the function fun_2”<<endl;
   for(int i=0; i<n;i++)
{     x[i]=2*i;      cout<<"  array  "<<x[i]<<endl;}
    return x;     }

main( )
{   int *p;  p=fun( );
    cout<<" pointer  "<<p<<"  value  "<<*p<<endl;
    int n; cin>>n;
      p=fun_2(n);
   cout<< "  array after calling function fun_2  "<<endl;
  for(int i=0; i<n;i++)
 cout<<"  array value "<<*(p+i)<<endl;}
```

static -> save value stored in function even if function terminated

The output if n= 6

supposed give garbage value bec its not static

pointer 0x28feb0 value 100
array in the function fun_2
array 0
array 2
array 4
array 6
array 8
array 10

array after calling function fun_2
array value 0
array value 2
array value 4
array value 6
array value 8
array value 10

Return a pointer from function

C++ allows a function to return a pointer to local variable, static variable and dynamically allocated memory as well.
The following example shows that we can return a pointer from function
In the first function fun( ), a pointer of an integer is returned from the function, while the second function fun_2( ) returns a pointer to an array