ARRAYS IN DATASTRUCTURES USING 'C'

Overview

- What is Array?
- Types of Arrays.
- Array operations.
- Merging of arrays.
- Arrays of pointers.
- Arrays and Polynomials.

ARRAY

- An array is a linear data structure. Which is a finite collection of similar data items stored in successive or consecutive memory locations.
- For example an array may contains all integer or character elements, but not both.

- Each array can be accessed by using array index and it is must be positive integer value enclosed in square braces.
- This is starts from the numerical value 0 and ends at 1 less than of the array index value.
- For example an array[n] containing n number of elements are denoted by array[0],array[1],…..array[n-1]. where ‘0’ is called lower bound and the ‘n-1’ is called higher bound of the array.

Types of Arrays

- Array can be categorized into different types. They are
  - One dimensional array
  - Two dimensional array
  - Multi dimensional array

One dimensional array:-

- One dimensional array is also called as linear array. It is also represents 1-D array.
- the one dimensional array stores the data elements in a single row or column.
- The syntax to declare a linear array is as fallows

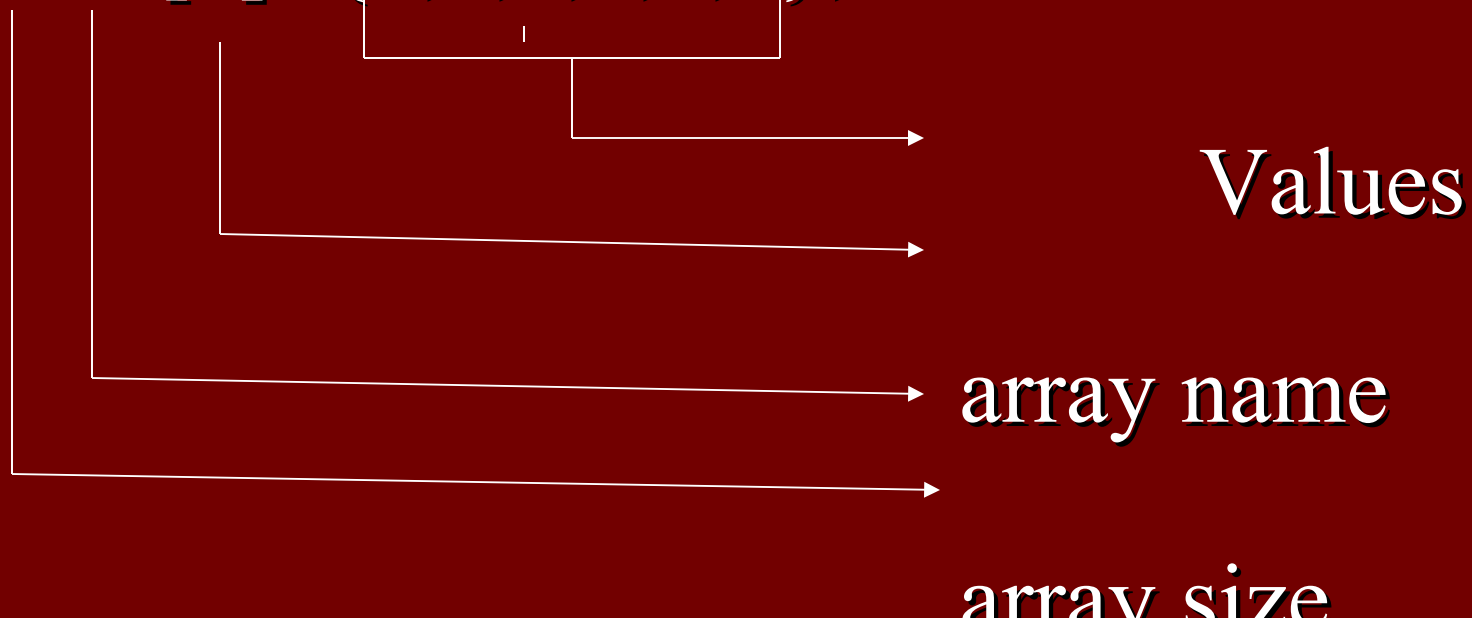
  Syntax: <data type> <array name> [size];

- Syntax for the initialization of the linear array is as fallows
- Syntax:

  <data type><array name>[size]={values};

- Example:

```
int arr[6]={2,4,6,7,5,8};
```



Memory representation of the one dimensional array:-

a[0]	a[1]	a[2]	a[3]	a[4]	a[5]
2	4	6	7	5	8
100	102	104	106	108	110

- The memory blocks a[0],a[1],a[2],a[3],a[4] , a[5] with base addresses 1,102,104,106,108, 110 store the values 2,4,6,7,5,8 respectively.

- Here need not to keep the track of the address of the data elements of an array to perform any operation on data element.
- We can track the memory location of any element of the linear array by using the base address of the array.
- To calculate the memory location of an element in an array by using formulae.

  Loc (a[k])=base address +w(k-lower bound)

- Here k specifies the element whose location to find.
- W means word length.
- Ex: We can find the location of the element 5, present at a[3],base address is 100, then

$$loc(a[3])=100+2(3-0)$$
$$=100+6$$
$$=106.$$

Two dimensional array:-

- A two dimensional array is a collection of elements placed in rows and columns.
- The syntax used to declare two dimensional array includes two subscripts, of which one specifies the number of rows and the other specifies the number of columns.
- These two subscripts are used to reference an element in an array.

- Syntax to declare the two dimensional array is as fallows
- Syntax:

  <data type> <array name> [row size] [column size];

- Syntax to initialize the two dimensional array is as fallows
- Syntax:

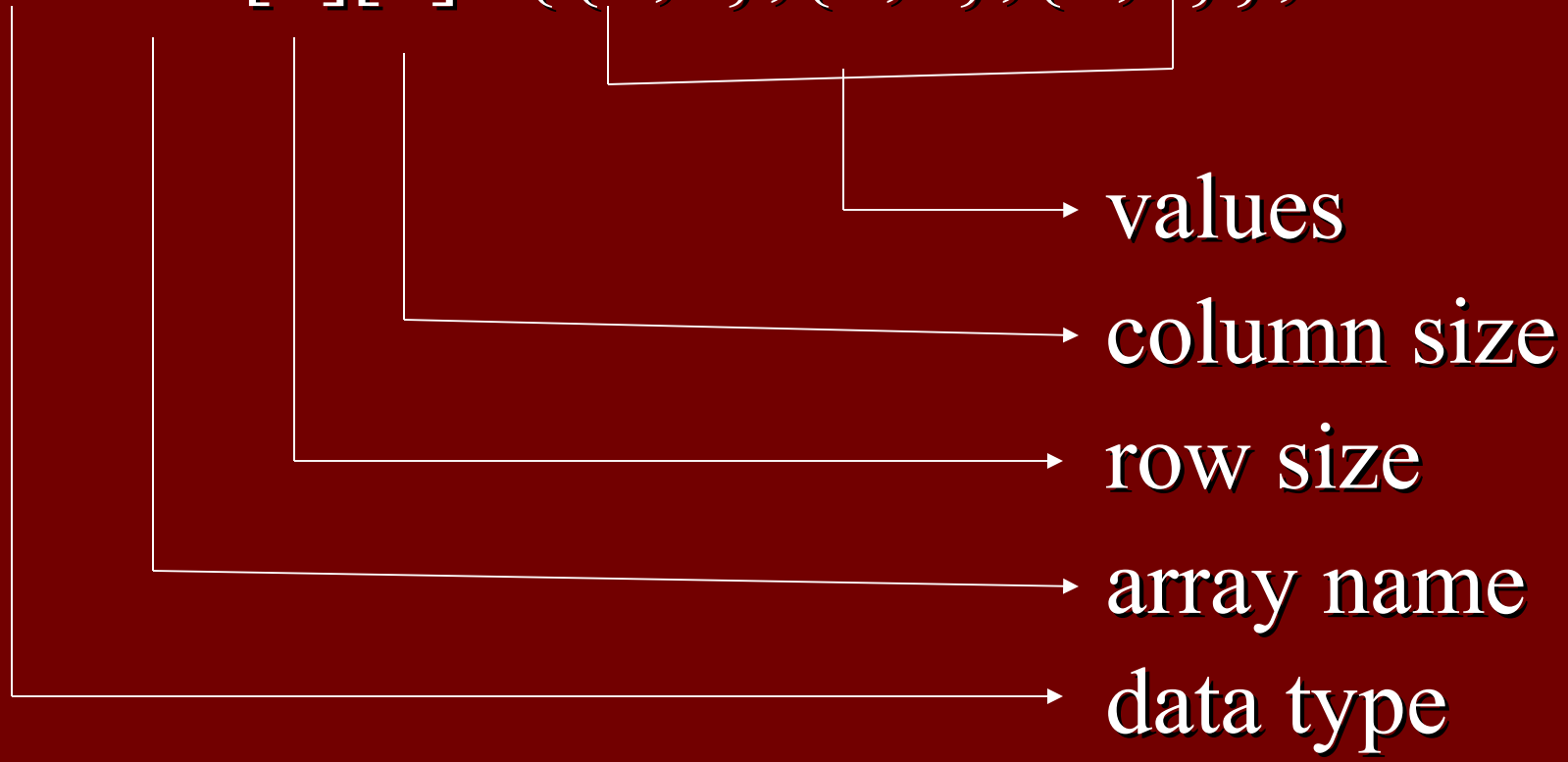
  <data type> <array name> [row size] [column size]={values};

- Example:

```
int num[3][2]={4,3,5,6,,8,9};
```

or

```
int num[3][2]={{4,3},{5,6},{8,9}};
```



Representation of the 2-D array:-

Rows	columns	
	0th column	1st column
0th row	a[0][0]	a[0][1]
	a[1][0]	a[1][1]
1st row	a[2][0]	a[2][1]
2nd row		

Memory representation of 2-D array:-

- Memory representation of a 2-D array is different from the linear array.
- in 2-D array possible two types of memory arrangements. They are

  - Row major arrangement

- Row major arrangement:

0th row		1st row		2nd row	
4	3	5	6	8	9
502	504	506	508	510	512

- Column major arrangement:

0th column			1st column		
4	5	8	3	6	9
502	504	506	508	510	512

- We can access any element of the array once we know the base address of the array and number of row and columns present in the array.
- In general for an array a[m][n] the address of element a[i][j] would be,
  - In row major arrangement

    Base address+2(i*n+j)
  - In column major arrangement

    Base adress+2(j*m+i)

- Ex:

  we can find the location of the element 8 then an array a[3][2] , the address of element would be a[2][0] would be

- In row major arrangement

$$loc(a[2][0])=502+2(2*2+0)$$
$$=502+8$$
$$=510$$

- In column major arrangement

$$loc(a[2][0])=502+2(0*3+2)$$
$$=502+4$$
$$=506$$

Multi dimensional arrays:-

- An array haves 2 or more subscripts, that type of array is called multi dimensional array.
- The 3 –D array is called as multidimensional array this can be thought of as an array of two dimensional arrays.
- Each element of a 3-D array is accessed using subscripts, one for each dimension.

- Syntax for the declaration and initialization as fallows Syntax
- <data type><array name>[s1][s2][s3] ={values};

- Ex:

```
int a[2][3][2]={
                  {  {2,1},{3,6},{5,3}  },
                   { {0,9},{2,3},{5,8}  }
                    };
```

Memory representation of 3-D array:-

- In multi dimensional arrays permits only a row major arrangement.

0^{th} 2-D array						1^{st} 2-D array					
2	1	3	6	5	3	0	9	2	3	5	8
10	12	14	16	18	20	22	24	26	28	30	32

- For any 3-D array a [x][y][z], the element a[i][j][k] can be accessed as

  Base address+2(i*y*z +j*z+ k)

- Array a can be defined as int a [2][3][2] , element 9 is present at a[1][0][1]
- Hence address of 9 can be obtained as

  =10+2(1*3*2+0*2+1)

  =10+14

  =24

ARRAY OPERATIONS

- There are several operations that can be performed on an array. They are
  - Insertion
  - Deletion
  - Traversal
  - Reversing
  - Sorting
  - Searching

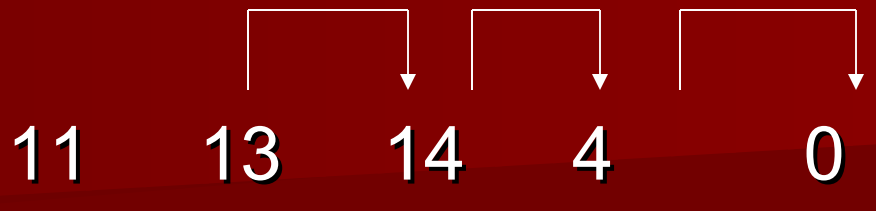
Insertion:

- Insertion is nothing but adding a new element to an array.
- Here through a loop, we have shifted the numbers, from the specified position, one place to the right of their existing position.
- Then we have placed the new number at the vacant place.

- Ex:

```
for (i=4;i>= 2;i++)
    {
        a[i]=a[i-1];
        }
    a[i]=num;
```

- Before insertion :



- After insertion:

11 12 13 14 4

0 1 2 3 4

- Fig: shifting the elements to the right while Insuring an element at 2nd position

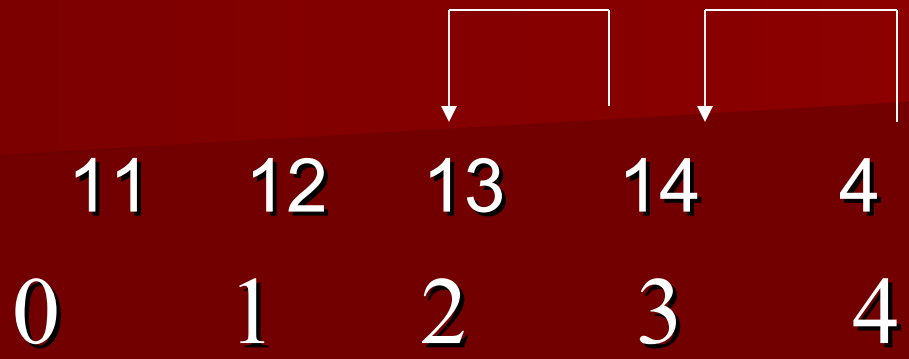
Deletion:

- Deletion is nothing but process of remove an element from the array.
- Here we have shifted the numbers of placed after the position from where the number is to be deleted, one place to the left of their existing positions.
- The place that is vacant after deletion of an element is filled with ‘0’.

- Ex:

```
for (i=3;i<5;i++)
{
    a[i-1]=a[i];
     }
   a[i-1]=0;
```

- Before deletion:



- After deletion:

- Fig: shifting the elements to the left while deleting 3rd element in an array.

Traversal:

- Traversal is nothing but display the elements in the array.
- Ex:

```
for (i=0;i<5;i++)
{
    Printf (“%d\t”, a[i]);
}
```

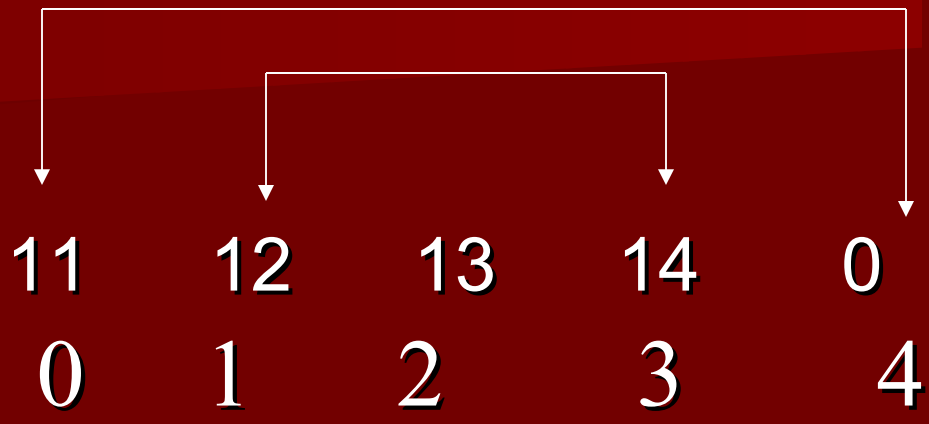
11 12 14 4 0

Reversing:

- This is the process of reversing the elements in the array by swapping the elements.
- Here swapping should be done only half times of the array size.
- Ex:

```
 for (i=0;i<5/2;i++)
      {
      int temp=a[i];
      a[i]=a[5-1-1];
       a[5-1-i]=temp;
         }
```

- Before swapping:



- After swapping:

0 14 13 12 11

0 1 2 3 4

Fig: swapping of elements while reversing an array.

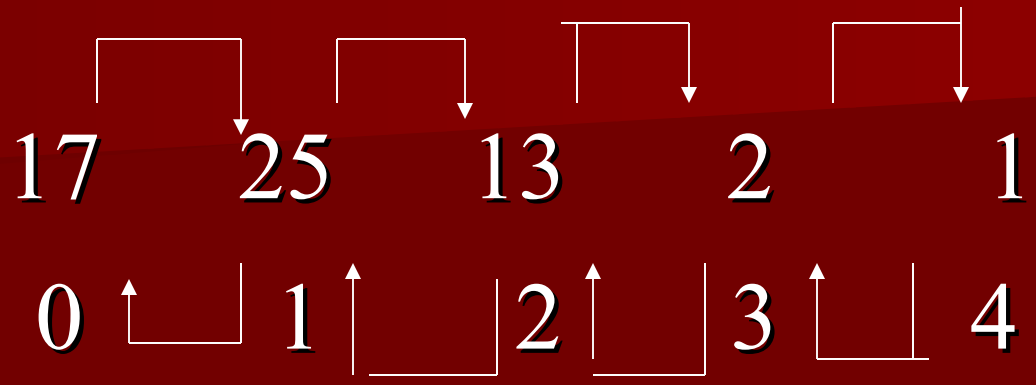
Sorting:

- Sorting means arranging a set of data in some order like ascending or descending order.

- Ex:

```
for (i=0;i<5;i++)
{
 for (j=i+1;j<5;j++)
 {
   if (a[i]>a[j])
    {
      temp=a[i];
      a[i]=a[j];
      a[j]=temp;
        } } }
```

- Before sorting:



- After sorting:

1 2 13 17 25
0 1 2 3 4

Searching:

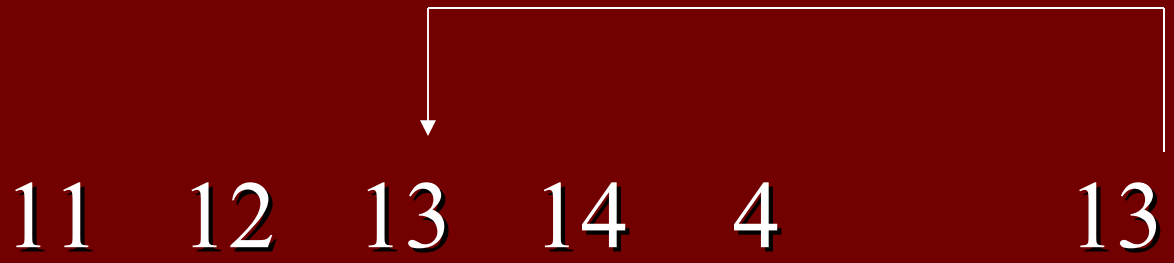
- Searching is the process of finding the location of an element with a given element in a list..
- Here searching is starts from 0^{th} element and continue the process until the given specified number is found or end of list is reached.

- Ex:

```
 for (i=0;i<5;i++)
 {
   if (a[i]==num)
   {
     Printf("\n element %d is present at %dth position",num,i+1);
       return;
}}if (i==5)
Printf ("the element %d is not present in the array ",num);
```


11 12 13 14 4 13


11 12 13 14 4 13


11 12 13 14 4 13

Merging of arrays

- Merging means combining two sorted list into one sorted list.
- Merging of arrays involves two steps:

  They are

  - ❖ sorting the arrays that are to be merged.
  - ❖ Adding the sorted elements of both the arrays a to a new array in sorted order.

- Ex:
- Before merging:

1st array			2nd array		
1	3	13	2	8	11

- After merging:

1	2	3	8	11	13

Arrays of pointers

- A pointer variable always contains an address.
- An array of pointer would be nothing but a collection of addresses.
- The address present in an array of pointer can be address of isolated variables or even the address of other variables.

- An array of pointers widely used for stoning several strings in the array.
- The rules that apply to an ordinary array also apply to an array of pointer as well.
- The elements of an array of pointer are stored in the memory just like the elements of any other kind of array.
- Memory representation of the array of integers and an array of pointers respectively.

- Fig1:Memory representation of an array of integers and integer variables I and j.

a[0]	a[1]	a[2]	a[3]	i	j
3	4	5	6	1	9
100	102	104	106	200	312

- Fig2:Memory representation of an array of pointers.

b[0]	b[1]	b[2]	b[3]	b[4]	b[5]
100	102	104	106	200	312
8112	8114	8116	8118	8120	8122

Arrays and polynomials

- Polynomials like $5x^4+2\ x^3+7x^2+10x-8$ can be maintained using an array.
- To achieve each element of the array should have two values coefficient and exponent.

- While maintaining the polynomial it is assumes that the exponent of each successive term is less than that of the previous term.
- Once we build an array to represent polynomial we can use such an array to perform common polynomial operations like addition and multiplication.

***Addition of two polynomials*:**

- Here if the exponents of the 2 terms beinf compared are equal then their coefficients are added and the result is stored in 3rd polynomial.
- If the exponents of the 2 terms are not equal then the term with the bigger exponent is added to the 3 rd polynomial.

- If the term with an exponent is present in only 1 of the 2 polynomials then that term is added as it is to the 3rd polynomial.
- Ex:
- 1st polynomial is $2x^6+3x^5+5x^2$
- 2nd polynomial is $1x^6+5x^2+1x+2$
- Resultant polynomial is

$$3x^6+3x^5+10x^2+1x+2$$

Multiplication of 2 polynomials:

- Here each term of the coefficient of the 2nd polynomial is multiplied with each term of the coefficient of the 1st polynomial.
- Each term exponent of the 2nd polynomial is added to the each tem of the 1st polynomial.
- Adding the all terms and this equations placed to the resultant polynomial.

- Ex:
- 1st polynomial is

$$1x^4+2x^3+2x^2+2x$$

- 2nd polynomial is

$$2x^3+3x^2+4x$$

- Resultant polynomial is

$$2x^7+7x^6+14x^5+18x^4+14x^3+8x^2$$

THE END