12/02/2023

Till now we have studied about 1D arrays. Today we will be studying about the 2D arrays.

2D Arrays

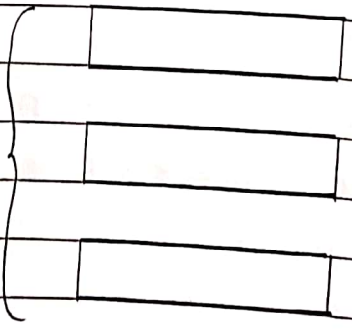
```
int arr[] = {1,2,5,7};
```

arr → | 1 | 2 | 5 | 7 |

This is how 1D arrays are stored in the memory. But the question is what happens in case of 2D arrays. We can relate 2D arrays with Tic-tac-toe game which have 9 cells.

row 0			
row 1			
row 2			
	col 0	col 1	col 2

A grid is formed where there are multiple rows and multiple columns. The above grid can be formed by taking 3, 1D arrays of size 3 each.



But this is a small grid, that's why we created 1D arrays but what if there are 1000 rows & it is not practical to create 1000 1D arrays. Hence 2D arrays make our job simpler.

int arr [1000][1000] ;

- int → data type
- arr → name
- first [1000] → no. of rows
- second [1000] → no. of columns

Also we can mention different no. of rows & different number of columns.

Memory representation of 2D arrays

int arr [2] [2] ; → Total elements = 2×2 = 4

arr →

1	2	3	4

→ 2D array

Matrix was just used to visualize the 2D arrays but in memory, the 1D array representation is used.

	col0	col1
row0	1	2
row1	3	4

} Just way of visualizing 2D arrays

Accessing elements of 2D arrays

In the above 2D array, say we want to access 3. We can access it by arr [1] [0] → 3

arr [0] [0] → 1
arr [0] [1] → 2
arr [1] [1] → 4

arr [ ] [ ] — first [ ] → row index, second [ ] → column index

Formulae for mapping in 1D array representatn

is C * i + j

C → no. of columns

i → row-index

j → column-index

arr[0][1] = 2

Formula = 2 × 0 + 1 = 0 + 1 = 1st index in 1D array.

1	2	3	4
0	1	2	3

2 is present at 1st index in 1D array.

arr[1][1] = 4

Formula = 2 × 1 + 1 = 2 + 1 = 3rd index, 4 is stored in 1D array.

Note → arr[0][1] ≠ arr[1]. It is just a way that in memory 1D array is used but the actual interface is the matrix only so use arr[i][j] to access the elements of 2D array.

Initialization of 2D array

int arr[2][2] = { {1,2}, {3,4} };

(row-0 = {1,2}, row-1 = {3,4})

	col-0	col-1
row-0 →	1	2
row-1 →	3	4

Input and Output in 2D Array

Input → cin >> arr[i][j];
Output → cout << arr[i][j];

We always have to play within 0 to n-1 index where n → rows and colums = n.

Note → arr[i][j]
No of rows = n
No of columns = m

$i \in [0, n-1]$
$j \in [0, m-1]$
} Never go out this range

Accessing elements row-wise

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

for (int i=0; i<3; i++) {
    for (int j=0; j<3; j++) {
        cout << arr[i][j] << " ";
    }
    cout << endl;
}
```

row
column

1	2	3
4	5	6
7	8	9

arr

Output

```
1 2 3
4 5 6
7 8 9
```

Accessing elements column-wise

```
for(int i=0; i<3; i++) {
```

Column

row

```
for (int j=0; j<3; j++) {
        cout << arr[j][i] << " ";
}
cout << endl;
}
```

(swapped in case of column wise)

Output

1	4	7
2	5	8
3	6	9

Similarly we can take row-wise input & column-wise input.

Problem Solving

1) Row sum print

i/p →

1	2	3
4	5	6
7	8	9

o/p → 6
15
24

Go to every row, calculate the sum & then print. We have to simply do row wise traversal.

Code

```
void printRowSum(int arr[][3], int rows
                 int cols) {
```

```
for (int i=0 ; i< rows ; i++) {
        int sum = 0 ;→ After each row, sum = 0
        for (int j=0 ; j< cols ; j++) {
            sum = sum + arr[i][j];
        }
        cout << "Row" << i << "sum is"
        << sum << endl;
}
```

Note → While passing 2D arrays in function, we need to mention the bound of column. It is a rule. Formulae of $c * i + j$ is the reason behind this.

2) Column sum print

i/p → Same array as that of Ques-1

o/p → 12
15
18

We just have to do column-wise traversal & print the sum just like we did in row wise sum print.

In the above code just change
sum = sum + arr[i][j] to
sum = sum + arr[j][i]

3) Linear search in 2D array

i/p → Same array as that of ques-1
element = 3

o/p → True

We can do either row-wise traversal or column-wise traversal & compare each element with the element that is given to us as in i/p. If element is matched return true else return false if not found even after traversing full array.

Code

```
bool
    findKey (int arr[][3], int r, int c, int k
        for (int i=0; i<r; i++) {
            for (int j=0; j<c; j++) {
                if (arr[i][j] == k) {
                    return true;
                }
            }
        } return false;
}
```

4) Maximum and minimum in 2D array

i/p → same array as that of ques-1

o/p →

Maximum = 9

Minimum = 1

Initialize maxi = INT_MIN & mini = INT_MAX and compare maxi & mini with each element

✓ maxi < arr[i][j] → update maxi

✓ mini > arr[i][j] → update mini

After traversing full array, return the maxi & mini

we can leave only first index empty

it is neccessary to give bound to 2d array ,while declaring in fuxn

Code

```
int maximum (int arr[][3], int r, int c) {
        int maxi = INT_MIN;
        for (int i=0 ; i<r     ; i++) {
            for (int j=0 ; j<c ; j++) {
                if (arr[i][j] > maxi) {
                    maxi = arr[i][j];
                }
            }
        } return maxi ;
}

int minimum (int arr[][3], int r, int c){
        int mini = INT_MAX;
        for (int i=0; i<r; i++) {
            for (int j=0 ; j<c; j++) {
                if (arr[i][j] < mini) {
                    mini = arr[i][j];
                }
            }
        }
    return mini;
}
```

5) Transpose of matrix

i/p → same array as that of ques-1

o/p →

1	4	7
2	5	8
3	6	9

We just have to change the rows into the column. We need to perform the swap on each cell.

swap (arr[i][j], arr[j][i]);

But the inner for loop won't run fully as some elements will be swapped twice & would reach to the original position and hence the matrix would be same.

Code

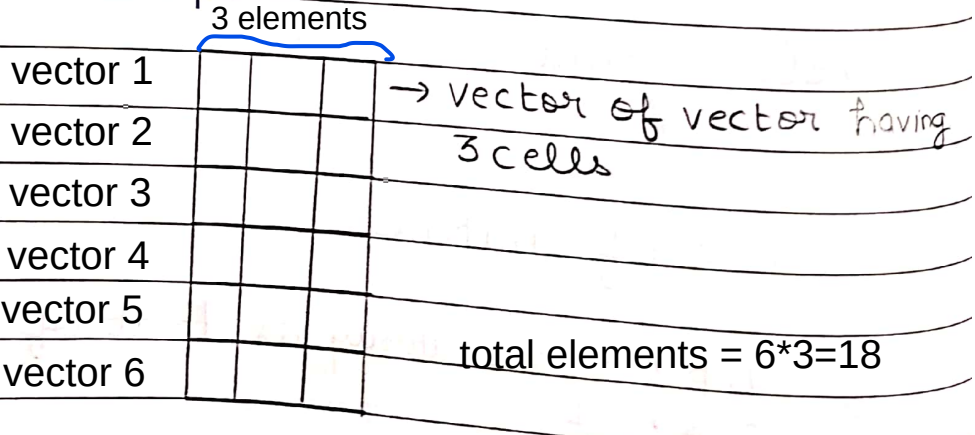
```
void transpose (int arr[][3], int r, int c){

        for (int i=0; i<r; i++){
            for (int j=0; j<i; j++){
                swap (arr[i][j], arr[j][i])
            }
        }
}
```

Better way to use 2D arrays

1D array → vector <int> arr;

2D array → We will be using vector of vector concept



00000
00000
00000

o/p

outer vector
inner vector

```
vector <vector <int>> V;
```

↳ data type ↑ name of vector

Each block will contain vector of integers.

How to mention no. of rows & no. of columns?

```
vector <vector <int>> arr (3, vector<int>(5,0));
```

↳ no. of rows = 3

↳ no. of columns = 5

initalised with 0

Inserting data in the 2D vector / vector of vector.

```
vector <vector <int>> arr;
```

In arr, vectors will be pushed.

```
vector <int> a {1,2,3};
arr.push_back(a);
```

No. of rows in vector of vector

arr.size() will tell the no. of rows in vector of vector

No. of columns in vector of vectors

arr[i].size() where i is row-index will tell the no. of columns in each row.

Note →

```
vector <vector <int>> arr (rows,
                vector <int> (col, 0));
```

Inner vector will be initialized to 0.