

Computer Science Department

Lesson 2 from

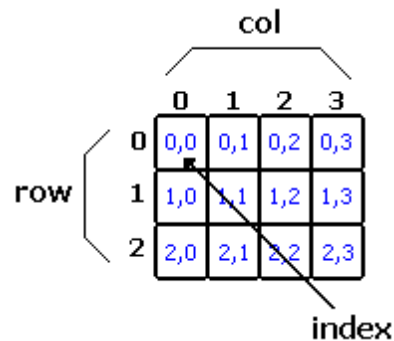
STRUCTURED PROGRAMMING

First Class

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2. Array of Two Dimensions

A two-dimensional array in C++ is the simplest form of a multi-dimensional array. It can be visualized as an array of arrays. The image below depicts a two-dimensional array. In a 2-D array, each element is referred to by two indexes. Elements are stored in these Arrays in the form of matrices. The first index shows a row of the matrix and the second index shows the column of the matrix. The figure below depicts a two-dimensional array.



The general declaration of two-dimensional arrays is:

```
data-type Array-name [ Row-size] [ Col-size];
```

For example,

```
Int a[10][10];
```

```
Int num[3][4];
```

Initializing 2D-array elements.

There are various ways in which a Two-Dimensional array can be initialized.

- **First Method.**

```
int num[3][4] = {0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11};
```

0	1	2	3
4	5	6	7
8	9	10	11

The above numbers array has 3 rows and 4 columns. The elements in the braces from left to right are stored in the table also from left to right. The elements will

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be filled in the array in order, the first 4 elements from the left in the first row, the next 4 elements in the second row, and so on.

- **Second Method.**

```
int num[3][4] = {{0,1,2,3}, {4,5,6,7}, {8,9,10,11}};
```

- **Third Method.**

```
int num[3][4];
int i,j;

for(int i = 0; i < 3; i++)
    {for(int j = 0; j < 4; j++)
        {cin >> num[i][j];
        }
    }
```

Input / print / process array elements.

Herein several C++ codes illustrate how to input, print, and processing of **num** array elements.

Input	Processing	Printing
<pre>cin>>num[0][0]; cin>>num[0][1]; cin>>num[1][0];</pre>	<pre>sum=0; int i,j; for (i=0;i<3;i++){ for (j=0;j<4;j++){ sum=sum+num[i][j]; } }</pre>	<pre>cout << num [0][0]; cout>>num[0][1]; cout>>num[1][0]; cout>>num[2][2]+4;</pre>
<pre>cin>>num[0][2]; cin>>num[2][0]; cin>>num[2][2];</pre>	<pre>int i,j; for (i=0;i<3;i++){ for (j=0;j<4;j++){ num[i][j]=num[i][j]+1; } }</pre>	<pre>int i,j; for (i=0; i<3; i++) { for(j=0;j<4;j++){ cout << num[i][j]; } }</pre>

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<pre>int i,j; for (i=0<3;i++){ for (j=0;j<4;j++){ cin>>num[i][j]; } }</pre>	<pre>num[0][0]=num[2][2]+num[1][1]; num[0][2]=num[1][1]*num[2][1]; num[2][0]=num[1][2]*2; num[2][2]=num[0][1]+num[2][2];</pre>	<pre>if (num [1][2] > 5) { cout << "greater"; }</pre>
----------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------------

Ex 1: Write a C++ program to read 4 numbers, 2 numbers per row, then print them.

```
void main()
{
    int a [ 2 ] [ 2 ];
    int i , j;
    cout<<"Enter array numbers"<<endl;
    for ( i = 0 ; i < 2; i++ ) {
        for ( j = 0 ; j < 2; j++ ) {
            cin >> a [ i ] [ j ];
        }
    }
    cout<<endl;
    cout<<"The elements of array are." <<endl;
    for ( i = 0 ; i < 2; i++ ) {
        for ( j = 0 ; j < 2; j++ ) {
            cout << a [ i ] [ j ]<<" ";
        }
    }
    cout<<endl;
}
```

Output

```
Enter array numbers
1
2
3
4
The elements of array are:
1 2
3 4
```

Ex 2: Write a C++ program, to read 2*2 2D-array, then find the summation of the array elements, and finally print these elements.

```
int main()
{
    int a [ 2 ] [ 2 ];
```

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```
int i , j, sum = 0;
for ( i = 0 ; i < 2; i++ ){
    for ( j = 0 ; j < 2; j++ ){
        cin >> a [ i ] [ j ];
    }
}
for ( i = 0 ; i < 2; i++ ){
    for ( j = 0 ; j < 2; j++ ){
        sum =sum+ a [ i ] [ j ];
    }
}
cout << "The summation is:" << sum << endl;
for ( i = 0 ; i < 2; i++ ){
    for ( j = 0 ; j < 2; j++ ){
        cout << a [ i ] [ j ]<<" ";
    }
    cout << endl;
}
}
```

Output

```
1
2
3
4
The summation is:10
1 2
3 4
```

Ex 3: Write a C++ program, to read 2*2 2D-array, then find the summation of each row.

```
int main()
{int a [ 2 ] [ 2 ];
int i , j, sum = 0;
for ( i = 0 ; i < 2; i++ ){
    for ( j = 0 ; j < 2; j++ ){
        cin >> a [ i ] [ j ];
    }
}
for ( i = 0 ; i < 2; i++ ){
    sum = 0;
```

Output

```
10
20
30
40
Summation of row 0 is: 30
Summation of row 1 is: 70
10 20
30 40
```

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```
for (j = 0 ; j < 2; j++) {
    sum += a [ i ] [ j ];
}
cout << "Summation of row " << i << " is: " << sum << endl;
}
for ( i = 0 ; i < 2; i++) {
    for ( j = 0 ; j < 2; j++) {
        cout << a [ i ] [ j ] << " ";
    }
    cout << endl;
}
}
```

Ex 4: Write a C++ program, to read 3*3 2D-array, then replace each value equal to 5 with 0.

```
void main()
{
    int a [ 3 ] [ 3 ];
    int i , j, sum = 0;
    for ( i = 0 ; i < 3; i++) {
        for ( j = 0 ; j < 3; j++) {
            cin >> a [ i ] [ j ];
        }
    }
    cout << "The array before changing" << endl;
    for ( i = 0 ; i < 3; i++) {
        for ( j = 0 ; j < 3; j++) {
            cout << a [ i ] [ j ] << " ";
        }
        cout << endl;
    }
    for ( i = 0 ; i < 3; i++) {
        for ( j = 0 ; j < 3; j++) {
            if (a [ i ] [ j ] == 5)
            {
                a[i][j]=0;
            }
        }
    }
}
```

Output

```
1
5
2
5
3
5
6
7
5
The array before changing
1 5 2
5 3 5
6 7 5
The array after changing
1 0 2
0 3 0
6 7 0
```

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```
    }  
    cout<<"The array after changing"<<endl;  
    for ( i = 0 ; i < 3; i++){  
        for ( j = 0 ; j < 3; j++){  
            cout << a [ i ] [ j ]<<" ";  
        }  
        cout<<endl;  
    }  
}
```

Ex 5: Write a C++ program, to add two 3*3 arrays.

```
void main()  
{  
    int a [ 3 ] [ 3 ],b [ 3 ] [ 3 ],c [ 3 ] [ 3 ];  
    int i , j, sum = 0;  
    cout<<"Elements of first array"<<endl;  
    for ( i = 0 ; i < 3; i++ )  
        {for ( j = 0 ; j < 3; j++ )  
            {cin >> a [ i ] [ j ];  
            }  
        }  
    cout<<"Elements of second array"<<endl;  
    for ( i = 0 ; i < 3; i++ )  
        {for ( j = 0 ; j < 3; j++ )  
            { cin >> b [ i ] [ j ];  
            }  
        }  
    for ( i = 0 ; i < 3; i++ )  
        {for ( j = 0 ; j < 3; j++ )  
            { c[i][j]=a[i][j]+b[i][j];  
            }  
        }  
    cout<<"the results of adding"<<endl;  
    for ( i = 0 ; i < 3; i++){  
        for ( j = 0 ; j < 3; j++){  
            cout << c [ i ] [ j ]<<" ";  
        }  
        cout<<endl;  
    }  
}
```

Output

```
Elements of first array  
1  
1  
1  
1  
1  
1  
1  
1  
1  
1  
Elements of second array  
1  
1  
1  
1  
1  
1  
1  
1  
1  
1  
the results of adding  
2 2 2  
2 2 2  
2 2 2
```

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Ex 6: Write a C++ program to convert 2D-array into 1D-array.

```
void main()
{
    int a [ 3 ] [ 3 ], one_dim [ 9 ], i, j, c=0;
    cout<<" Enter the element of array "<<endl;
    for ( i = 0 ; i < 3; i++ ) {
        for ( j = 0 ; j < 3; j++ ) {
            cin >> a [ i ] [ j ];
        }
    }
    cout<<"Elements of array"<<endl;
    for ( i = 0 ; i < 3; i++ ) {
        for ( j = 0 ; j < 3; j++ ) {
            cout << a [ i ] [ j ]<<" ";
        }
        cout<<endl;
    }
    for ( i = 0 ; i < 3; i++ ) {
        for ( j = 0 ; j < 3; j++ ) {
            one_dim[c]= a [ i ] [ j ];
            c=c+1;
        }
    }
    cout<<"The result..." <<endl;
    for ( i = 0 ; i < 9; i++ ) {
        cout<<one_dim[i]<<" ";
    }
}
```

Output

```
Enter the element of array
12
34
44
56
67
89
90
78
56
Elements of array
12 34 44
56 67 89
90 78 56
The result...
12 34 44 56 67 89 90 78 56
```

Ex 7: Write C++ program, to print the square root of an array.

```
void main()
{
    float a [ 3 ] [ 3 ];    int i,j;
    cout<<"Enter the element of array"<<endl;
    for ( i = 0 ; i < 3; i++ ) {
        for ( j = 0 ; j < 3; j++ ) {
            cin >> a [ i ] [ j ];
        }
    }
    cout<<"Elements of array"<<endl;
    for ( i = 0 ; i < 3; i++ ) {
        for ( j = 0 ; j < 3; j++ ) {
            cout << a [ i ] [ j ]<<" ";
        }
        cout<<endl;
    }
    cout<<"The array after changing..." <<endl;
}
```

Output

```
Enter the element of array
4
9
16
25
36
49
64
81
100
Elements of array
4 9 16
25 36 49
64 81 100
The array after changing...
2 3 4
5 6 7
8 9 10
```


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```

for ( i = 0 ; i < 3; i++ ){
    for ( j = 0 ; j < 3; j++ ){
        cout << sqrt((a[i][j]))<<" ";
    }
    cout<<endl;
}
}

```

- **Some rules for accessing the elements of array.**

<table border="1" style="border-collapse: collapse; text-align: center;"> <tr><td style="background-color: #000080; color: white;">0,0</td><td>0,1</td><td>0,2</td></tr> <tr><td>1,0</td><td style="background-color: #000080; color: white;">1,1</td><td>1,2</td></tr> <tr><td>2,0</td><td>2,1</td><td style="background-color: #000080; color: white;">2,2</td></tr> </table> <p>$i = j$</p> <p>a</p>	0,0	0,1	0,2	1,0	1,1	1,2	2,0	2,1	2,2	<table border="1" style="border-collapse: collapse; text-align: center;"> <tr><td>0,0</td><td>0,1</td><td style="background-color: #000080; color: white;">0,2</td></tr> <tr><td>1,0</td><td style="background-color: #000080; color: white;">1,1</td><td>1,2</td></tr> <tr><td style="background-color: #000080; color: white;">2,0</td><td>2,1</td><td>2,2</td></tr> </table> <p>$i + j = n - 1$</p> <p>b</p>	0,0	0,1	0,2	1,0	1,1	1,2	2,0	2,1	2,2	<table border="1" style="border-collapse: collapse; text-align: center;"> <tr><td>0,0</td><td>0,1</td><td>0,2</td></tr> <tr><td style="background-color: #000080; color: white;">1,0</td><td>1,1</td><td>1,2</td></tr> <tr><td style="background-color: #000080; color: white;">2,0</td><td style="background-color: #000080; color: white;">2,1</td><td>2,2</td></tr> </table> <p>$i > j$</p> <p>c</p>	0,0	0,1	0,2	1,0	1,1	1,2	2,0	2,1	2,2	<table border="1" style="border-collapse: collapse; text-align: center;"> <tr><td>0,0</td><td style="background-color: #000080; color: white;">0,1</td><td>0,2</td></tr> <tr><td>1,0</td><td>1,1</td><td style="background-color: #000080; color: white;">1,2</td></tr> <tr><td>2,0</td><td>2,1</td><td>2,2</td></tr> </table> <p>$i < j$</p> <p>d</p>	0,0	0,1	0,2	1,0	1,1	1,2	2,0	2,1	2,2
0,0	0,1	0,2																																					
1,0	1,1	1,2																																					
2,0	2,1	2,2																																					
0,0	0,1	0,2																																					
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2,0	2,1	2,2																																					
0,0	0,1	0,2																																					
1,0	1,1	1,2																																					
2,0	2,1	2,2																																					

- a: Accessing the elements of the main diagonal in an array.
 b: Accessing the elements of the secondary diagonal in an array.
 c: Accessing the elements of the lower triangle of the main diagonal.
 d: Accessing the elements of the upper triangle of the main diagonal.

Ex 8: Write a C++ program to replace each element in the main diameter with 0.

```

void main()
{
    int a [ 3 ] [ 3 ],i,j;
    cout<<"Enter the elements of array"<<endl;
    for ( i = 0 ; i < 3; i++ ){
        for ( j = 0 ; j < 3; j++ ){
            cin >> a [ i ] [ j ];
        }
    }
    cout<<"Elements of array"<<endl;
    for ( i = 0 ; i < 3; i++ ){
        for ( j = 0 ; j < 3; j++ ){
            cout << a [ i ] [ j ]<<" ";
        }
    }
    cout<<endl;
}
}

```

Output

```

Enter the elements of array
1
2
3
4
5
6
7
8
9
Elements of array
1 2 3
4 5 6
7 8 9
The array after changing...
0 2 3
4 0 6
7 8 0

```

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```
for ( i = 0 ; i < 3; i++ ){
    for ( j = 0 ; j < 3; j++ ){
        if (i==j)
        {
            a[i][j]=0;
        }
    }
}
cout<<"The array after changing..." <<endl;
for ( i = 0 ; i < 3; i++ ){
    for ( j = 0 ; j < 3; j++ ){
        cout << a [ i ] [ j ]<<" ";
    }
    cout<<endl;
}}
```

Ex 9. Write a C++ program, to read 3*3 2D-array, then find the summation of the main diagonal and its secondary diagonal of the array elements, and finally print these elements.

```
void main()
{
    int a [ 3 ] [ 3 ];
    int i, j, s_d=0, s_s=0;
    cout<<"Enter the element of array"<<endl;
    for ( i = 0 ; i < 3; i++ ){
        for ( j = 0 ; j < 3; j++ ){
            cin >> a [ i ] [ j ];
        }
    }
    cout<<"Elements of array"<<endl;
    for ( i = 0 ; i < 3; i++ ){
        for ( j = 0 ; j < 3; j++ ){
            cout << a[i][j]<<" ";
        }
        cout<<endl;
    }
    for ( i = 0 ; i < 3; i++ ){
```

Output

```
Enter the element of array
12
34
55
6
7
8
1
2
3
Elements of array
12 34 55
6 7 8
1 2 3
The result of main diagonal:22
The result of secondary diagonal:63
```

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```
for ( j = 0 ; j < 3; j++ ){
    if(i==j)
    {
        s_d=s_d+a[i][j];
    }
    if((i+j)==3-1)
    {
        s_s=s_s+a[i][j];
    }
}
}
cout<<"The result of main diagonal:"<<s_d<<endl;
cout<<"The result of secondary diagonal:"<<s_s;
```

Ex 10: Write a C++ program, to read 3*3 2D-array, then find the summation of the elements of the upper triangle of main diagonal.

```
void main()
{
    int a [ 3 ] [ 3 ];
    int i, j, sum=0;
    cout<<"Enter the elements of an array"<<endl;
    for ( i = 0 ; i < 3; i++ ){
        for ( j = 0 ; j < 3; j++ ){
            cin >> a [ i ] [ j ];
        }
    }
    cout<<"Elements of an array"<<endl;
    for ( i = 0 ; i < 3; i++ ){
        for ( j = 0 ; j < 3; j++ ){
            cout << a [ i ] [ j ]<<" ";
        }
        cout<<endl;
    }
    cout<<" The sum of upper triangle is:";
    for ( i = 0 ; i < 3; i++ ){
```

Output

```
Enter the elements of an array
1
2
3
4
5
6
7
8
9
Elements of an array
1 2 3
4 5 6
7 8 9
The sum of upper triangle is:11
```

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```
for ( j = 0 ; j < 3; j++ ){
    if (i<j)
    {
        sum=sum+a[i][j];
    }
}
}
cout<<sum;
}
```

Homework.

1. Examine the following:

```
int values [3] [3] = { {1, 9, 3}, {9, 0, 1}, {7, 6, 4} };
```

What is in values [2][1]?

2. What is the output of the following C++ program?

```
void main()
{ int a [2] [2] = { {1, 2} , {3, 4} };
  int i , j, sum = 0;
  for ( i = 0 ; i < 2; i++ ){
      for ( j = 0 ; j < 2; j++ ){
          sum =sum+ a [ i ] [ j ];
      }
  }
  sum=sum-2+1;
  cout << sum << endl;
}
```

3. Write a C++ program to read 2*2 2D-array. Then, find the summation of each column.
4. Write a C++ program to read 3*3 2D-array. Then, increase each negative number by 1 and decrease each positive number by 1. Later, print the element of an array.

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5. Write a C++ program to read 3*3 2D-array. Then, increase each odd number by 15 and decrease each even number with 3. Later, print the element of an array.
6. Write a C++ program to read 3*3 2D-array. Then, sum odd and even numbers of an array.
7. Write a C++ program to read 3*3 2D-array. Then, count odd and even numbers of an array.
8. Write a C++ program to read 3*3 2D-array. Then, sum the even and odd numbers in the main diameter (diagonal).
9. Write a C++ program to read 3*3 2D-array. Then, count the even and odd numbers in the main diameter (diagonal).
10. Write a C++ program to read 3*3 2D-array. Then, count the positive and negative numbers in the main diameter (diagonal).
11. Write a C++ program to read 3*3 2D-array. Then, count the 5 number(s) in the array.
12. Write a C++ program to read 3*3 2D-array. Then, sum the 5 number(s) in an array.
13. Write a C++ program to read 3*3 2D-array. Then, count the 5 number(s) in the main diameter (diagonal) of array.
14. Write a C++ program to read 3*3 2D-array. Then, sum the positive number(s) in the main diameter (diagonal) of array.
15. Write a C++ program, to read 3*3 2D-array, then find the summation of the elements of the lower triangle of the main diameter (diagonal) in an array.