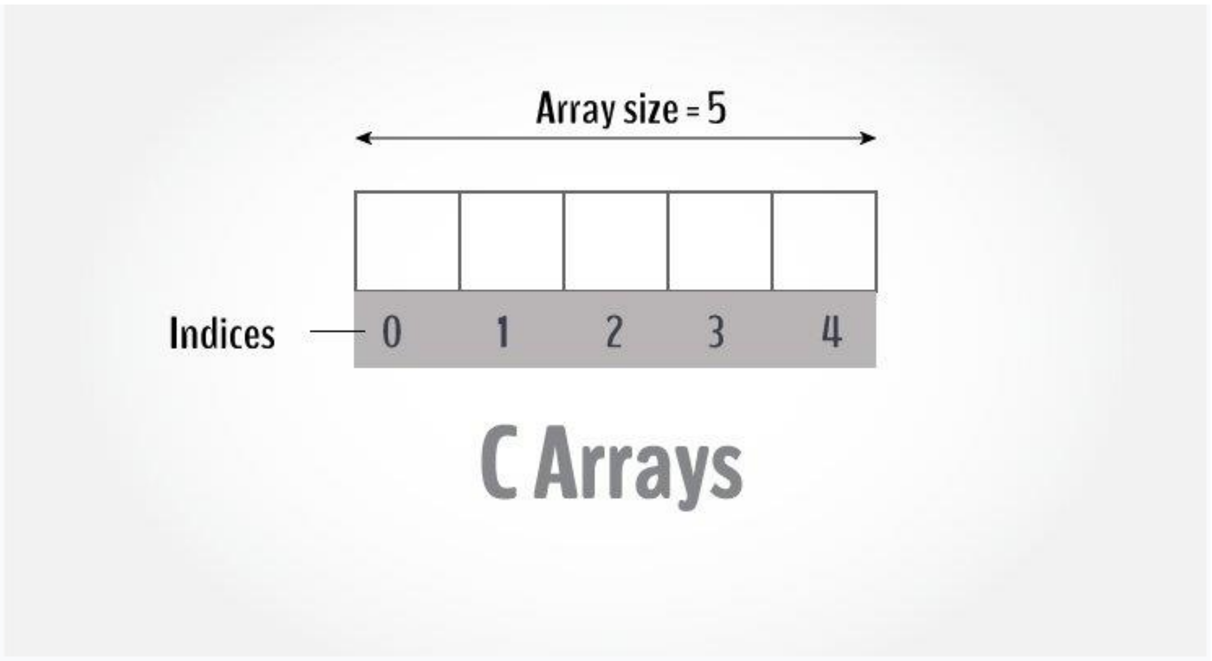
MODULE 5 - Arrays, String, Structure:

ARRAYS:



An array is a variable that can store multiple values. For example, if you want to store 100 integers, you can create an array for it.

```
int data[100];
```

How to declare an array?

```
dataType arrayName[arraySize];
```

For example,

```
float mark[5];
```

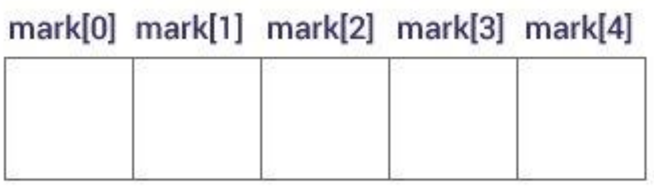
Here, we declared an array, `mark`, of floating-point type. And its size is 5. Meaning, it can hold 5 floating-point values.

It's important to note that the size and type of an array cannot be changed once it is declared.

Access Array Elements

You can access elements of an array by **indices**.

Suppose you declared an array **mark** as above. The first element is **mark[0]**, the second element is **mark[1]** and so on.



Declare an Array

Few keynotes:

- Arrays have 0 as the first index, not 1. In this example, **mark[0]** is the first element.
- If the size of an array is **n**, to access the last element, the **n-1** index is used. In this example, **mark[4]**
- Suppose the starting address of **mark[0]** is **2120d**. Then, the address of the **mark[1]** will be **2124d**. Similarly, the address of **mark[2]** will be **2128d** and so on.
  This is because the size of a **float** is 4 bytes.

How to initialize an array?

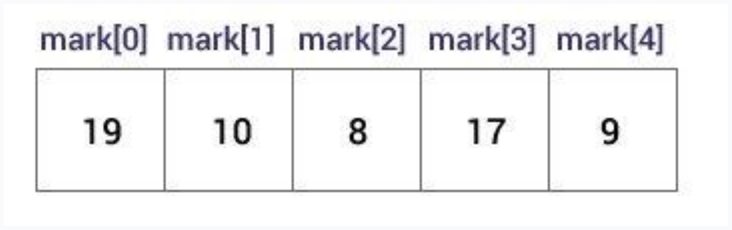
It is possible to initialize an array during declaration. For example,

```
int mark[5] = {19, 10, 8, 17, 9};
```

You can also initialize an array like this.

```
int mark[] = {19, 10, 8, 17, 9};
```

Here, we haven't specified the size. However, the compiler knows its size is 5 as we are initializing it with 5 elements.



Initialize an Array

Here,

```
mark[0] is equal to 19

mark[1] is equal to 10

mark[2] is equal to 8

mark[3] is equal to 17

mark[4] is equal to 9
```

Change Value of Array elements

```
int mark[5] = {19, 10, 8, 17, 9}

// make the value of the third element to -1
mark[2] = -1;

// make the value of the fifth element to 0
mark[4] = 0;
```

Input and Output Array Elements

Here's how you can take input from the user and store it in an array element.

```
// take input and store it in the 3rd element
scanf("%d", &mark[2]);

// take input and store it in the ith element
scanf("%d", &mark[i-1]);
```

Here's how you can print an individual element of an array.

```
// print the first element of the array
printf("%d", mark[0]);

// print the third element of the array
printf("%d", mark[2]);

// print ith element of the array
printf("%d", mark[i-1]);
```

Example 1: Array Input/Output

```
// Program to take 5 values from the user and store them in an array
// Print the elements stored in the array
#include <stdio.h>

int main() {
 int values[5];

 printf("Enter 5 integers: ");

 // taking input and storing it in an array
 for(int i = 0; i < 5; ++i) {
  scanf("%d", &values[i]);
 }

 printf("Displaying integers: ");

 // printing elements of an array
 for(int i = 0; i < 5; ++i) {
   printf("%d\n", values[i]);
 }
 return 0;
}
```

Output

```
Enter 5 integers: 1
-3
34
0
3
Displaying integers: 1
-3
34
0
3
```

Here, we have used a `for` loop to take 5 inputs from the user and store them in an array. Then, using another `for` loop, these elements are displayed on the screen.

Example 2: Calculate Average

```
// Program to find the average of n numbers using arrays
```

```c
#include <stdio.h>
int main() {

  int marks[10], i, n, sum = 0, average;

  printf("Enter number of elements: ");
  scanf("%d", &n);

  for(i=0; i < n; ++i) {
    printf("Enter number%d: ",i+1);
    scanf("%d", &marks[i]);

    // adding integers entered by the user to the sum variable
    sum += marks[i];
  }

  average = sum / n;
  printf("Average = %d", average);

  return 0;
}
```

Output

```
Enter n: 5
Enter number1: 45
Enter number2: 35
Enter number3: 38
Enter number4: 31
Enter number5: 49
Average = 39
```

Here, we have computed the average of `n` numbers entered by the user.

Access elements out of its bound!

Suppose you declared an array of 10 elements. Let's say,

```
int testArray[10];
```

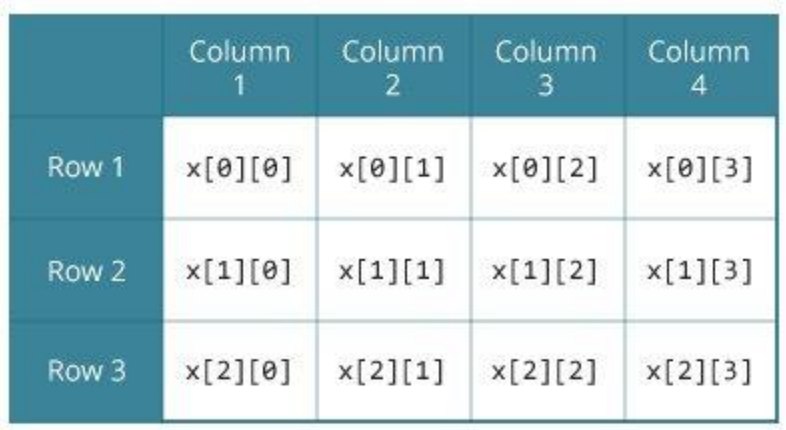
You can access the array elements from `testArray[0]` to `testArray[9]`. Now let's say if you try to access `testArray[12]`. The element is not available. This may cause unexpected output (undefined behavior). Sometimes you might get an error and some other time your program may run correctly. Hence, you should never access elements of an array outside of its bound.

MULTIDIMENSIONAL ARRAYS:

In C programming, you can create an array of arrays. These arrays are known as multidimensional arrays. For example,

```
float x[3][4];
```

Here, x is a two-dimensional (2d) array. The array can hold 12 elements. You can think the array as a table with 3 rows and each row has 4 columns.



	Column 1	Column 2	Column 3	Column 4
Row 1	x[0][0]	x[0][1]	x[0][2]	x[0][3]
Row 2	x[1][0]	x[1][1]	x[1][2]	x[1][3]
Row 3	x[2][0]	x[2][1]	x[2][2]	x[2][3]

Two dimensional Array

Similarly, you can declare a three-dimensional (3d) array. For example,

```
float y[2][4][3];
```

Here, the array y can hold 24 elements.

Initializing a multidimensional array

Here is how you can initialize two-dimensional and three-dimensional arrays:

Initialization of a 2d array

```
// Different ways to initialize two-dimensional array

int c[2][3] = {{1, 3, 0}, {-1, 5, 9}};

int c[][3] = {{1, 3, 0}, {-1, 5, 9}};

int c[2][3] = {1, 3, 0, -1, 5, 9};
```

Initialization of a 3d array

You can initialize a three-dimensional array in a similar way to a two-dimensional array. Here's an example,

```
int test[2][3][4] = {
    {{3, 4, 2, 3}, {0, -3, 9, 11}, {23, 12, 23, 2}},
    {{13, 4, 56, 3}, {5, 9, 3, 5}, {3, 1, 4, 9}}};
```

Array initialization:

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

9	8	7
6	5	4

int a[2] [3]={ (9,8,7),(6,5,4) };

int a[ ] [3]={ (9,8,7),(6,5,4) };

int a[2] [3]={ 0 };

0	0	0
0	0	0

int a[2] [3]={ (9,8),(6,5) };

9	8	0
6	5	0

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

9	8	6
5	0	0

Example 1: Two-dimensional array to store and print values

```
// C program to store temperature of two cities of a week and display it.
#include <stdio.h>
const int CITY = 2;
const int WEEK = 7;
int main()
{
  int temperature[CITY][WEEK];

  // Using nested loop to store values in a 2d array
  for (int i = 0; i < CITY; ++i)
  {
    for (int j = 0; j < WEEK; ++j)
    {
      printf("City %d, Day %d: ", i + 1, j + 1);
      scanf("%d", &temperature[i][j]);
    }
  }
  printf("\nDisplaying values: \n\n");

  // Using nested loop to display vlues of a 2d array
  for (int i = 0; i < CITY; ++i)
  {
    for (int j = 0; j < WEEK; ++j)
    {
      printf("City %d, Day %d = %d\n", i + 1, j + 1, temperature[i][j]);
    }
  }
  return 0;
}
```

Output

```
City 1, Day 1: 33
City 1, Day 2: 34
City 1, Day 3: 35
City 1, Day 4: 33
City 1, Day 5: 32
City 1, Day 6: 31
City 1, Day 7: 30
City 2, Day 1: 23
City 2, Day 2: 22
City 2, Day 3: 21
City 2, Day 4: 24
City 2, Day 5: 22
City 2, Day 6: 25
City 2, Day 7: 26

Displaying values:

City 1, Day 1 = 33
City 1, Day 2 = 34
City 1, Day 3 = 35
City 1, Day 4 = 33
City 1, Day 5 = 32
City 1, Day 6 = 31
City 1, Day 7 = 30
City 2, Day 1 = 23
City 2, Day 2 = 22
City 2, Day 3 = 21
City 2, Day 4 = 24
City 2, Day 5 = 22
City 2, Day 6 = 25
City 2, Day 7 = 26
```

Example 2: Sum of two matrices

```
// C program to find the sum of two matrices of order 2*2

#include <stdio.h>
```

```c
int main()
{
  float a[2][2], b[2][2], result[2][2];

  // Taking input using nested for loop
  printf("Enter elements of 1st matrix\n");
  for (int i = 0; i < 2; ++i)
    for (int j = 0; j < 2; ++j)
    {
      printf("Enter a%d%d: ", i + 1, j + 1);
      scanf("%f", &a[i][j]);
    }

  // Taking input using nested for loop
  printf("Enter elements of 2nd matrix\n");
  for (int i = 0; i < 2; ++i)
    for (int j = 0; j < 2; ++j)
    {
      printf("Enter b%d%d: ", i + 1, j + 1);
      scanf("%f", &b[i][j]);
    }

  // adding corresponding elements of two arrays
  for (int i = 0; i < 2; ++i)
    for (int j = 0; j < 2; ++j)
    {
      result[i][j] = a[i][j] + b[i][j];
    }

  // Displaying the sum
  printf("\nSum Of Matrix:");

  for (int i = 0; i < 2; ++i)
    for (int j = 0; j < 2; ++j)
    {
      printf("%.1f\t", result[i][j]);

      if (j == 1)
        printf("\n");
    }
  return 0;
}
```

Output

```
Enter elements of 1st matrix
Enter a11: 2;
Enter a12: 0.5;
Enter a21: -1.1;
Enter a22: 2;
Enter elements of 2nd matrix
Enter b11: 0.2;
Enter b12: 0;
Enter b21: 0.23;
Enter b22: 23;

Sum Of Matrix:
2.2     0.5
-0.9    25.0
```