

C++ Arrays

C++ provides a data structure, **the array**, which stores a fixed-size sequential collection of elements of the same type. An array is used to store a collection of data, but it is often more useful to think of an array as a collection of variables of the same type.

Instead of declaring individual variables, such as `number0`, `number1`, ..., and `number99`, you declare one array variable such as `numbers` and use `numbers[0]`, `numbers[1]`, and ..., `numbers[99]` to represent individual variables. A specific element in an array is accessed by an index.

All arrays consist of contiguous memory locations. The lowest address corresponds to the first element and the highest address to the last element.

Declaring Arrays

To declare an array in C++, the programmer specifies the type of the elements and the number of elements required by an array as follows –

```
type arrayName [ arraySize ];
```

This is called a single-dimension array. The **arraySize** must be an integer constant greater than zero and **type** can be any valid C++ data type. For example, to declare a 10-element array called `balance` of type `double`, use this statement –

```
double balance[10];
```

Initializing Arrays

You can initialize C++ array elements either one by one or using a single statement as follows –

```
double balance[5] = {1000.0, 2.0, 3.4, 17.0, 50.0};
```

The number of values between braces `{ }` can not be larger than the number of elements that we declare for the array between square brackets `[]`. Following is an example to assign a single element of the array –

If you omit the size of the array, an array just big enough to hold the initialization is created. Therefore, if you write –

```
double balance[] = {1000.0, 2.0, 3.4, 17.0, 50.0};
```

You will create exactly the same array as you did in the previous example.

```
balance[4] = 50.0;
```

The above statement assigns element number 5th in the array a value of 50.0. Array with 4th index will be 5th, i.e., last element because all arrays have 0 as the index of their first element which is also called base index. Following is the pictorial representation of the same array we discussed above –

	0	1	2	3	4
balance	1000.0	2.0	3.4	7.0	50.0

Accessing Array Elements

An element is accessed by indexing the array name. This is done by placing the index of the element within square brackets after the name of the array. For example –

```
double salary = balance[9];
```

The above statement will take 10th element from the array and assign the value to salary variable. Following is an example, which will use all the above-mentioned three concepts viz. declaration, assignment and accessing arrays –

```
#include <iostream>
using namespace std;

#include <iomanip>
using std::setw;

int main () {

    int n[ 10 ]; // n is an array of 10 integers

    // initialize elements of array n to 0
    for ( int i = 0; i < 10; i++ ) {
        n[ i ] = i + 100; // set element at location i to i + 100
    }
    cout << "Element" << setw( 13 ) << "Value" << endl;

    // output each array element's value
    for ( int j = 0; j < 10; j++ ) {
        cout << setw( 7 ) << j << setw( 13 ) << n[ j ] << endl;
    }

    return 0;
}
```

This program makes use of **setw()** function to format the output. When the above code is compiled and executed, it produces the following result –

Element	Value
0	100
1	101
2	102
3	103
4	104
5	105
6	106
7	107
8	108
9	109

Arrays in C++

Arrays are important to C++ and should need lots of more detail. There are following few important concepts, which should be clear to a C++ programmer –

Sr.No	Concept & Description
1	Multi-dimensional arrays C++ supports multidimensional arrays. The simplest form of the multidimensional array is the two-dimensional array.
2	Pointer to an array You can generate a pointer to the first element of an array by simply specifying the array name, without any index.
3	Passing arrays to functions You can pass to the function a pointer to an array by specifying the array's name without an index.
4	Return array from functions C++ allows a function to return an array.

C++ Multi-dimensional Arrays

C++ allows multidimensional arrays. Here is the general form of a multidimensional array declaration –

```
type name[size1][size2]...[sizeN];
```

For example, the following declaration creates a three dimensional 5 . 10 . 4 integer array

```
int threedim[5][10][4];
```

Two-Dimensional Arrays

The simplest form of the multidimensional array is the two-dimensional array. A two-dimensional array is, in essence, a list of one-dimensional arrays. To declare a two-dimensional integer array of size x,y, you would write something as follows –

```
type arrayName [ x ][ y ];
```

Where **type** can be any valid C++ data type and **arrayName** will be a valid C++ identifier.

A two-dimensional array can be think as a table, which will have x number of rows and y number of columns. A 2-dimensional array **a**, which contains three rows and four columns can be shown as below –

	Column 0	Column 1	Column 2	Column 3
Row 0	a[0][0]	a[0][1]	a[0][2]	a[0][3]
Row 1	a[1][0]	a[1][1]	a[1][2]	a[1][3]
Row 2	a[2][0]	a[2][1]	a[2][2]	a[2][3]

Thus, every element in array **a** is identified by an element name of the form **a[i][j]**, where **a** is the name of the array, and **i** and **j** are the subscripts that uniquely identify each element in **a**.

Initializing Two-Dimensional Arrays

Multidimensioned arrays may be initialized by specifying bracketed values for each row. Following is an array with 3 rows and each row have 4 columns.

```
int a[3][4] = {
    {0, 1, 2, 3} , /* initializers for row indexed by 0 */
    {4, 5, 6, 7} , /* initializers for row indexed by 1 */
    {8, 9, 10, 11} /* initializers for row indexed by 2 */
};
```

The nested braces, which indicate the intended row, are optional. The following initialization is equivalent to previous example –

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

Accessing Two-Dimensional Array Elements

An element in 2-dimensional array is accessed by using the subscripts, i.e., row index and column index of the array. For example –

```
int val = a[2][3];
```

The above statement will take 4th element from the 3rd row of the array. You can verify it in the above digram.

```
#include <iostream>
using namespace std;

int main () {
    // an array with 5 rows and 2 columns.
    int a[5][2] = { {0,0}, {1,2}, {2,4}, {3,6},{4,8}};

    // output each array element's value
    for ( int i = 0; i < 5; i++ )
        for ( int j = 0; j < 2; j++ ) {

            cout << "a[" << i << "][" << j << "]: ";
            cout << a[i][j]<< endl;
        }

    return 0;
}
```

When the above code is compiled and executed, it produces the following result –

```
a[0][0]: 0
a[0][1]: 0
a[1][0]: 1
a[1][1]: 2
a[2][0]: 2
a[2][1]: 4
a[3][0]: 3
a[3][1]: 6
a[4][0]: 4
a[4][1]: 8
```

As explained above, you can have arrays with any number of dimensions, although it is likely that most of the arrays you create will be of one or two dimensions.

C++ Pointer to an Array

It is most likely that you would not understand this chapter until you go through the chapter related C++ Pointers.

So assuming you have bit understanding on pointers in C++, let us start: An array name is a constant pointer to the first element of the array. Therefore, in the declaration –

```
double balance[50];
```

balance is a pointer to `&balance[0]`, which is the address of the first element of the array `balance`. Thus, the following program fragment assigns **p** the address of the first element of **balance** –

```
double *p;  
double balance[10];  
p = balance;
```

It is legal to use array names as constant pointers, and vice versa. Therefore, `*(balance + 4)` is a legitimate way of accessing the data at `balance[4]`.

Once you store the address of first element in `p`, you can access array elements using `*p`, `*(p+1)`, `*(p+2)` and so on. Below is the example to show all the concepts discussed above –

```
#include <iostream>  
using namespace std;  
  
int main () {  
    // an array with 5 elements.  
    double balance[5] = {1000.0, 2.0, 3.4, 17.0, 50.0};  
    double *p;  
  
    p = balance;  
  
    // output each array element's value  
    cout << "Array values using pointer " << endl;  
  
    for ( int i = 0; i < 5; i++ ) {  
        cout << "*(p + " << i << " ) : ";  
        cout << *(p + i) << endl;  
    }  
    cout << "Array values using balance as address " << endl;  
  
    for ( int i = 0; i < 5; i++ ) {  
        cout << "*(balance + " << i << " ) : ";  
        cout << *(balance + i) << endl;  
    }  
  
    return 0;  
}
```

C++ Programming

When the above code is compiled and executed, it produces the following result –

```
Array values using pointer
*(p + 0) : 1000
*(p + 1) : 2
*(p + 2) : 3.4
*(p + 3) : 17
*(p + 4) : 50
Array values using balance as address
*(balance + 0) : 1000
*(balance + 1) : 2
*(balance + 2) : 3.4
*(balance + 3) : 17
*(balance + 4) : 50
```

In the above example, `p` is a pointer to double which means it can store address of a variable of double type. Once we have address in `p`, then `*p` will give us value available at the address stored in `p`, as we have shown in the above example.

C++ Passing Arrays to Functions

C++ does not allow to pass an entire array as an argument to a function. However, You can pass a pointer to an array by specifying the array's name without an index.

If you want to pass a single-dimension array as an argument in a function, you would have to declare function formal parameter in one of following three ways and all three declaration methods produce similar results because each tells the compiler that an integer pointer is going to be received.

Way-1

Formal parameters as a pointer as follows –

```
void myFunction(int *param) {  
    .  
    .  
    .  
}
```

Way-2

Formal parameters as a sized array as follows –

```
void myFunction(int param[10]) {  
    .  
    .  
    .  
}
```

Way-3

Formal parameters as an unsized array as follows –

```
void myFunction(int param[]) {  
    .  
    .  
    .  
}
```

Now, consider the following function, which will take an array as an argument along with another argument and based on the passed arguments, it will return average of the numbers passed through the array as follows –

```
double getAverage(int arr[], int size) {  
    int i, sum = 0;  
    double avg;  
    for (i = 0; i < size; ++i) {  
        sum += arr[i];  
    }  
    avg = double(sum) / size;  
    return avg;  
}
```


C++ Programming

Now, let us call the above function as follows –

```
#include <iostream>
using namespace std;

// function declaration:
double getAverage(int arr[], int size);

int main () {
    // an int array with 5 elements.
    int balance[5] = {1000, 2, 3, 17, 50};
    double avg;

    // pass pointer to the array as an argument.
    avg = getAverage( balance, 5 ) ;

    // output the returned value
    cout << "Average value is: " << avg << endl;

    return 0;
}
```

When the above code is compiled together and executed, it produces the following result

–

```
Average value is: 214.4
```

As you can see, the length of the array doesn't matter as far as the function is concerned because C++ performs no bounds checking for the formal parameters.

Passing multidimensional array to function

In this example we are passing a multidimensional array to the function square which displays the square of each element.

```
#include <iostream>
#include <cmath>
using namespace std;
/* This method prints the square of each
 * of the elements of multidimensional array
 */
void square(int arr[2][3]){
    int temp;
    for(int i=0; i<2; i++){
        for(int j=0; j<3; j++){
            temp = arr[i][j];
            cout<<pow(temp, 2)<<endl;
        }
    }
}
```

C++ Programming

```
int main(){
    int arr[2][3] = {
        {1, 2, 3},
        {4, 5, 6}
    };
    square(arr);
    return 0;
}
```

```
1
4
9
16
25
36
```

Return Array from Functions in C++

C++ does not allow to return an entire array as an argument to a function. However, you can return a pointer to an array by specifying the array's name without an index.

If you want to return a single-dimension array from a function, you would have to declare a function returning a pointer as in the following example –

```
int * myFunction() {  
    .  
    .  
    .  
}
```

Second point to remember is that C++ does not advocate to return the address of a local variable to outside of the function so you would have to define the local variable as **static** variable.

Now, consider the following function, which will enter 5 numbers and return them using an array and call this function as follows –

```
#include <iostream>  
using namespace std;  
  
// function to enter 5 numbers  
int * print(){  
    static int a[5]={1,2,3,4,5};  
  
    return a;  
}  
  
// main function to call above defined function.  
int main()  
{  
    // a pointer to an int.  
    int * k;  
  
    k = print();  
  
    for(int j=0; j<5; j++)  
        cout<< *(k+j)<<"\t";  
  
    return 0;  
}
```

When the above code is compiled together and executed, it produces result something as follows –

```
1      2      3      4      5
```