



**TASK**

# **Introduction to Java Programming II - Data Structures**

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# Introduction

## Welcome to the Data Structures Task!

This task introduces you to a fundamental data structure in Java, the array. An array is used to store a fixed-size collection of elements of the same type. This task focuses on both single-dimensional and multidimensional arrays and explains how arrays are declared, created, initialised and processed.



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## What Are Arrays?

The array is a data structure, provided by Java, which stores a fixed number of elements of the same type. An array is used to store a collection of data. However, it is more useful to think of an array as a collection of variables of the same type.

## Declaring Arrays

To use an array in a program, a variable to reference the array must be declared, and the array's element type must be specified. The array can have any element type. All elements that are in the array will have the same data type. To declare a variable, use the following syntax:

```
elementType[] arrayVariable;
```

The following example declares a variable numArray that references an array that stores elements of the type double.

```
double[] numArray;
```

## Creating Arrays

After declaring an array variable you can create an array using the new operator. The syntax is as follows:

```
elementType[] arrayVariable = new elementType[arraySize];
```

The following example declares an array variable called numArray, creates an array of 5 double elements and assigns the reference to the array to numArray.

```
double[] numArray = new double[5];
```

The array size must be given when space for an array is allocated. The size cannot be changed after an array is created. To obtain the size of an array, use arrayVariable.length.

Numeric data types are assigned the default value 0, char types are assigned the value `\u0000` and boolean types are assigned the value `false` when an array is created.

## Array Indices

To access array elements, use an index. Array indices range from 0 to `arrayVariable.length - 1`. For example, the array created above (`numArray`), holds five elements with indices from 0 to 4. You can represent each element in the array using the following syntax:

```
arrayVariable[index];
```

For example, `numArray[1]` represents the second element in the array `numArray`.

## Initialising an Array

To assign values to the elements we will use the syntax:

```
arrayVariable[index] = value;
```

The example below initialises the array referenced by the variable `numArray`:

```
numArray[0] = 23.6;  
numArray[1] = 45.12;  
numArray[2] = 8.4;  
numArray[3] = 77.7;  
numArray[4] = 1.34;
```

You can use shorthand notation in Java, known as the array initialiser, which combines the declaration, creation and initialization of an array in one statement. The syntax for an array initialiser is as follows:

```
elementType[] arrayVariable = {value1, value2, ..., valueN};
```

For example, the following array initialiser statement is equivalent to the example above in which each element was assigned a value individually:

```
double[] numArray = {23.6, 45.12, 8.4, 7.77, 1.34};
```

## Processing Arrays

The easiest way to process the elements of an array is by using a for loop. A for loop is the natural choice when processing arrays because all of the elements in an array have the same data type and are processed in the same way. Since the size of the array is known, it makes sense to use a for loop rather than another repetition structure. Suppose you have created the following array:

```
double[] myArray = new double[10];
```

You can use a for loop to initialise the array with values entered by a user as follows:

```
java.util.Scanner input = new java.util.Scanner(System.in);
System.out.print("Please enter " + myArray.length + " values");
for (int i = 0; i < myArray.length; i++)
    myArray[i] = input.nextDouble();
```

You can also display an array by printing each element in the array by using the following for loop:

```
for (int i = 0; i < myArray.length; i++)
    System.out.print(myArray[i] + " ");
```

As you can see, it would be quite difficult to process each of the array's elements individually, especially if the array is large. For loops are a lifesaver when it comes to performing repetitive operations on elements in an array.

## Two-Dimensional Arrays

In the previous sections, we discussed simple single-dimensional arrays. However, arrays are not limited to one dimension. You can use a two-dimensional array to store data in a table or matrix.

## Declaring and Creating Two-Dimensional Arrays

The syntax for creating a two-dimensional array is as follows:

```
elementType[][] arrayVariable;
```

The following example demonstrates how to declare and create a two-dimensional array of 5-by-5 int values.

```
int[][] table;  
table = new int[5][5];
```

Each number between the square brackets represents the number of rows and columns in a table. The first index represents the rows and the second index represents the columns. Each index begins with a 0, as with a one-dimensional array.

## Assigning Values to Elements in a Two-Dimensional Array

Like a single-dimensional array, use the array indices to access elements in a two-dimensional array. However, unlike a one-dimensional array, a two-dimensional array contains two sets of indices.

The example below shows how to assign the number 4 to the element in the second row and first column:

```
table[1][0] = 4;
```

The array initialiser can also be used to declare, create and initialise a two-dimensional array.

The following example creates an array and initialises it with values.

```
int[][] array = { {1, 2, 3}, {4, 5, 6}, {7, 8, 9}, {10, 11, 12} };
```

This is equivalent to the following:

```
int[][] array = new int[4][3];
```

```
array[0][0] = 1;    array[0][1] = 2;    array[0][2] = 3;
array[1][0] = 4;    array[1][1] = 5;    array[1][2] = 6;
array[2][0] = 7;    array[2][1] = 8;    array[2][2] = 9;
array[3][0] = 10;   array[3][1] = 11;   array[3][2] = 12;
```



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## Ragged Arrays

*In a two-dimensional array, each row is itself an array. Therefore, the rows can have different lengths. Arrays with rows of varying lengths, are known as ragged arrays.*

*Here is an example of a ragged array:*

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

*If you know the sizes of a ragged array, but do not know the values of the elements you can still create one by using the following syntax:*

```
int[][] triArray = new int[4][];
triArray[0] = new int[4];
triArray[1] = new int[3];
triArray[2] = new int[2];
triArray[3] = new int[1];
```

*Note that when using `new int [4] []` to create a new array, the first index (number of rows) must always be specified.*

## Compulsory Task 1

Follow these steps:

- Create a new file called grades.java
- Create an array called 'myTestResults' that stores a list of results out of 100 that you have scored for 5 fictitious tests that you have written in a fictitious class.
- Write the code that will calculate the average grade based on the results in my 'myTestResults'. For example, the average grade based on the values in the example above would be:

$$\text{Average} = (40 + 60 + 80 + 80 + 85)/5;$$

- Based on the average grade, decide which letter symbol should be assigned. Use the table below:

Average percentage	Letter symbol
80 - 100	A
70 - 79	B
60 - 69	C
50 - 59	D
49 or less	F

## Compulsory Task 2

Follow these steps:

- Create a new file called identicalArrays.java
- Write a program that determines whether two arrays are identical.
- Ask the user to enter a number of integer values and store them in an array
- Then ask the user to enter a second set of integer values and store them in a different array.



- Now determine whether the two arrays are identical.
- If they are identical print out, "The two arrays are identical"
- If they are not identical print out, "The two arrays are not identical"

## Compulsory Task 3

Follow these steps:

- Create a new file called sumElements.java
- Write a program that returns the sum of all elements in a specified column of a two-dimensional array.
- Firstly ask the user to enter a 3-by-4 array. The user should enter the array as follows:  
2.6 5.1 6 8  
5.4 4.4 7 1  
9.5 7.9 2 3
- The program should then calculate the sum of each column in the array.



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