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Lecture: (3)

Arrays Part III

Subject: Computer Programming II
Level: First
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Multidimensional Arrays in Java

Multidimensional Arrays can be defined in simple words as array of arrays. Data in multidimensional arrays are stored in tabular form (in row major order).

Syntax:

```
data_type[1st dimension][2nd dimension][...][Nth dimension] array_name = new  
data_type[size1][size2]...[sizeN];
```

Where:

- **data_type**: Type of data to be stored in the array. For example: int, char, etc.
- **dimension**: The dimension of the array created. For example: 1D, 2D, etc.
- **array_name**: Name of the array
- **size1, size2, ..., sizeN**: Sizes of the dimensions respectively.

Examples:

Two dimensional array:

```
int[][] twoD_arr = new int[10][20];
```

Three dimensional array:

```
int[][][] threeD_arr = new int[10][20][30];
```

Size of multidimensional arrays: The total number of elements that can be stored in a multidimensional array can be calculated by multiplying the size of all the dimensions.



For example: The array `int[][] x = new int[10][20]` can store a total of $(10*20) = 200$ elements. Similarly, array `int[][][] x = new int[5][10][20]` can store a total of $(5*10*20) = 1000$ elements.

- Example program demonstrating the use of a four-dimensional (4D) array in Java. This program initializes a 4D array, assigns values to it, and prints those values.

```
public class FourDimensionalArrayExample {
    public static void main(String[] args) {
        // Declare and initialize a 4D array with dimensions 2x3x4x5
        int[][][][] array = new int[2][3][4][5];

        // Assign values to the array
        int value = 1;
        for (int i = 0; i < array.length; i++) {
            for (int j = 0; j < array[i].length; j++) {
                for (int k = 0; k < array[i][j].length; k++) {
                    for (int l = 0; l < array[i][j][k].length; l++) {
                        array[i][j][k][l] = value++;
                    }
                }
            }
        }

        // Print the array
        System.out.println("The 4D array:");
        for (int i = 0; i < array.length; i++) {
            System.out.println("Dimension 1, index " + i + ":");
            for (int j = 0; j < array[i].length; j++) {
                System.out.println(" Dimension 2, index " + j + ":");
                for (int k = 0; k < array[i][j].length; k++) {
                    System.out.print(" Dimension 3, index " + k + ": ");
                    for (int l = 0; l < array[i][j][k].length; l++) {
                        System.out.print(array[i][j][k][l] + " ");
                    }
                    System.out.println();
                }
            }
        }
    }
}
```

- When you run this program, it will output the values assigned to the 4D array in a structured format. The exact output is quite lengthy due to the size of the array, but it will show the values organized by each dimension, such as:

The 4D array:



Dimension 1, index 0:

Dimension 2, index 0:

Dimension 3, index 0: 1 2 3 4 5

Dimension 3, index 1: 6 7 8 9 10

Dimension 3, index 2: 11 12 13 14 15

Dimension 3, index 3: 16 17 18 19 20

Dimension 2, index 1:

Dimension 3, index 0: 21 22 23 24 25

Dimension 3, index 1: 26 27 28 29 30

Dimension 3, index 2: 31 32 33 34 35

Dimension 3, index 3: 36 37 38 39 40

Dimension 2, index 2:

Dimension 3, index 0: 41 42 43 44 45

Dimension 3, index 1: 46 47 48 49 50

Dimension 3, index 2: 51 52 53 54 55

Dimension 3, index 3: 56 57 58 59 60

Dimension 1, index 1:

Dimension 2, index 0:

Dimension 3, index 0: 61 62 63 64 65

Dimension 3, index 1: 66 67 68 69 70

Dimension 3, index 2: 71 72 73 74 75

Dimension 3, index 3: 76 77 78 79 80

Dimension 2, index 1:

Dimension 3, index 0: 81 82 83 84 85

Dimension 3, index 1: 86 87 88 89 90

Dimension 3, index 2: 91 92 93 94 95

Dimension 3, index 3: 96 97 98 99 100

Dimension 2, index 2:

Dimension 3, index 0: 101 102 103 104 105

Dimension 3, index 1: 106 107 108 109 110

Dimension 3, index 2: 111 112 113 114 115

Dimension 3, index 3: 116 117 118 119 120



Two – dimensional Array (2D-Array)

Two – dimensional array is the simplest form of a multidimensional array. A two – dimensional array can be seen as an array of one – dimensional array for easier understanding.

- **Declaration – Syntax:**

```
data_type[][] array_name = new data_type[x][y];  
For example: int[][] arr = new int[10][20];
```

- **Initialization – Syntax:**

```
array_name[row_index][column_index] = value;  
For example: arr[0][0] = 1;
```

Example:

```
import java.io.*;  
  
public class GFG {  
    public static void main(String[] args)  
    {  
  
        int[][] arr = new int[10][20];  
        arr[0][0] = 1;  
  
        System.out.println("arr[0][0] = " + arr[0][0]);  
    }  
}
```



Output

arr[0][0] = 1

Example: Implementing 2D array with by default values with 4*4 matrix

```
public class TwoDArray {
    public static void main(String[] args) {
        int rows = 4;
        int columns = 4;

        int[][] array = new int[rows][columns];

        int value = 1;
        for (int i = 0; i < rows; i++) {
            for (int j = 0; j < columns; j++) {
                array[i][j] = value;
                value++;
            }
        }

        System.out.println("The 2D array is: ");
        for (int i = 0; i < rows; i++) {
            for (int j = 0; j < columns; j++) {
                System.out.print(array[i][j] + " ");
            }
            System.out.println();
        }
    }
}
```

Output

The 2D array is:
1 2 3 4
5 6 7 8
9 10 11 12
13 14 15 16



Representation of 2D array in Tabular Format:

A two – dimensional array can be seen as a table with ‘x’ rows and ‘y’ columns where the row number ranges from 0 to (x-1) and column number ranges from 0 to (y-1). A two – dimensional array ‘x’ with 3 rows and 3 columns is shown below:

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

Print 2D array in tabular format:

To output all the elements of a Two-Dimensional array, use nested for loops. For this two for loops are required, One to traverse the rows and another to traverse columns.

Example:

```
import java.io.*;
class GFG {
    public static void main(String[] args)
    {

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

        for (int i = 0; i < 2; i++) {
            for (int j = 0; j < 2; j++) {
                System.out.print(arr[i][j] + " ");
            }
        }
    }
}
```



```
        System.out.println();
    }
}
}
```

Output

```
1 2
3 4
```

Example: Implementation of 2D array with User input

```
import java.util.Scanner;

public class Main {
    public static void main(String[] args)
    {
        Scanner scan = new Scanner(System.in);

        System.out.print("Enter number of rows: ");
        int rows = scan.nextInt();

        System.out.print("Enter number of columns: ");
        int columns = scan.nextInt();

        int[][] multidimensionalArray= new int[rows][columns];

        // Now you can use the array like a regular
        // 2-dimensional array
        for (int i = 0; i < rows; i++) {
            for (int j = 0; j < columns; j++) {
                multidimensionalArray[i][j]= (i + 1) * (j + 1);
            }
        }
        for (int i = 0; i < rows; i++) {
            for (int j = 0; j < columns; j++) {
                System.out.print(multidimensionalArray[i][j]+ " ");
            }

            System.out.println();
        }
        scan.close();
    }
}
```



Output

```
Enter number of rows: 3
Enter number of columns: 3
1 2 3
2 4 6
3 6 9
```

Processing 2D-Arrays java

1. Initializing a 2D Array

You can initialize a 2D array in Java using either a direct assignment or a nested loop.

Direct Assignment:

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

Using Nested Loops:

```
int rows = 3;
int cols = 3;
int[][] matrix = new int[rows][cols];

for (int i = 0; i < rows; i++) {
    for (int j = 0; j < cols; j++) {
        matrix[i][j] = i * cols + j + 1;
    }
}
```

2. Iterating Over a 2D Array

To iterate over the elements of a 2D array, you typically use nested loops.

Using Nested For Loops:

```
for (int i = 0; i < matrix.length; i++) { // Iterate over rows
    for (int j = 0; j < matrix[i].length; j++) { // Iterate over columns
        System.out.print(matrix[i][j] + " ");
    }
    System.out.println();
}
```



3. Performing Operations on a 2D Array

Calculating the Sum of All Elements:

```
int sum = 0;
for (int i = 0; i < matrix.length; i++) {
    for (int j = 0; j < matrix[i].length; j++) {
        sum += matrix[i][j];
    }
}
System.out.println("Sum of all elements: " + sum);
```

Finding the Maximum Element:

```
int max = matrix[0][0];
for (int i = 0; i < matrix.length; i++) {
    for (int j = 0; j < matrix[i].length; j++) {
        if (matrix[i][j] > max) {
            max = matrix[i][j];
        }
    }
}
System.out.println("Maximum element: " + max);
```

Transposing a 2D Array (Converting Rows to Columns):

```
int[][] transpose = new int[cols][rows];
for (int i = 0; i < rows; i++) {
    for (int j = 0; j < cols; j++) {
        transpose[j][i] = matrix[i][j];
    }
}
```

4. Example of a Complete Program

Example: initializes a 2D array, prints it, calculates the sum of its elements, and finds the maximum value:

```
public class ArrayProcessing {
    public static void main(String[] args) {
        // Initialize a 2D array
```



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

// Print the 2D array
System.out.println("Original Matrix:");
for (int i = 0; i < matrix.length; i++) {
    for (int j = 0; j < matrix[i].length; j++) {
        System.out.print(matrix[i][j] + " ");
    }
    System.out.println();
}

// Calculate the sum of all elements
int sum = 0;
for (int i = 0; i < matrix.length; i++) {
    for (int j = 0; j < matrix[i].length; j++) {
        sum += matrix[i][j];
    }
}
System.out.println("Sum of all elements: " + sum);

// Find the maximum element
int max = matrix[0][0];
for (int i = 0; i < matrix.length; i++) {
    for (int j = 0; j < matrix[i].length; j++) {
        if (matrix[i][j] > max) {
            max = matrix[i][j];
        }
    }
}
System.out.println("Maximum element: " + max);
}
```

This code demonstrates how to work with 2D arrays in Java, covering initialization, iteration, and basic operations. Modify and expand upon these examples based on your specific needs.