2-DIMENSIONAL ARRAYS

CS302 – Introduction to Programming
University of Wisconsin - Madison
Lecture 14

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Two-Dimensional Arrays

- We talked about how we can store multiple values of a single type in an array, where each value is stored at a unique index of the array
- We have stored Strings, doubles, and ints
- Can we store arrays in an array? Yes!

2-Dimensional Arrays

- An array that stores arrays is called a **2-Dimensional Array**
- In mathematics this is called a **Matrix**:

$$\begin{bmatrix} 1 & 5 & 10 & 5 \\ 6 & 4 & 12 & 4 \\ 10 & 5 & 12 & 11 \\ 5 & 11 & 23 & 9 \end{bmatrix}$$

Initializing an empty 2D Array

The following code creates an empty 4 x 3 array. That is, it has 4 arrays where each array holds 3 doubles

```
double[][] matrix = new double[4][3];
```

Number of elements per array (the number of columns)

Number of array elements (the number of rows)

Creates:

```
{
  {0.0, 0.0, 0.0},
  {0.0, 0.0, 0.0},
  {0.0, 0.0, 0.0},
  {0.0, 0.0, 0.0}
}
```

Initializing a 2D Array with values

```
int[][] matrix = {
            { 16,   3,  2,  13 },
            {  5, 10, 11,   8 },
            {  9,   6,   7, 12 },
            {  4, 15,  14,  1 }
};
```

Each element of the array, is itself an array

Each element of each sub-array is an int

Accessing Elements

- Given the following array:

```
int[][] matrix = {
                    { 16,   3,  2,  13 },
                    {   5, 10, 11,   8 },
                    {   9,   6,   7, 12 },
                    {   4, 15,  14,  1 }
                 };
```

- We can access the element at the *i*th row and *j*th column as follows:

```
int someVariable = matrix[0][2];  // "someVariable" will equal 2
```

Accessing Elements

- We can also access entire array elements
- Given the following array:

```
int[][] matrix = {
                    { 16,  3,  2,  13 },
                    {  5, 10, 11,   8 },
                    {  9,  6,  7, 12 },
                    {  4, 15,  14,  1 }
                  };
```

- We can access the ith array as follows (this gives us the entire i^{th} row of the matrix):

```
int[] someArray = matrix[1];   // Will grab {5, 10, 11, 8}
```

Programming Exercise

- Given the following array:

```
int[][] matrix = {
        { 16,   3,  2,  13 },
        {  5, 10, 11,   8 },
        {  9,   6,  7, 12 },
        {  4, 15,  14,  1 }
};
```

- Get the 2nd column of the matrix and store it as an array

Programming Exercise – Matrix Multiplication

- Given two matrices, A and B, where the number of rows of A is equal to the number of columns of B, write a program that produces the result of multiplying A and B.

- Example:

More Dimensions

- We can actually make an array as many dimensions as want!

- The following code creates an empty 7 x 4 x 3 array:

  int[][][] multiDimensions = new int[7][4][3];

- You can think of this as an array that stores 7 2D arrays, where each 2D array stores 4 regular arrays, where each regular arrays stores 3 ints.

Cool CS Link of the Day

- A look at Google's self-driving car
- http://www.youtube.com/watch?v=cdgQpa1pUUE