Multidimensional Arrays

CSE 114, Computer Science 1

Stony Brook University

http://www.cs.stonybrook.edu/~cse114

Multidimensional Arrays

- How do we represent matrices or tables?
- A two-dimensional array to represent a matrix or a table
  - Example: the following table that describes the distances between the cities can be represented using a two-dimensional array.

Distance Table (in miles)

	Chicago	Boston	New York	Atlanta	Miami	Dallas	Houston
Chicago	0	983	787	714	1375	967	1087
Boston	983	0	214	1102	1763	1723	1842
New York	787	214	0	888	1549	1548	1627
Atlanta	714	1102	888	0	661	781	810
Miami	1375	1763	1549	661	0	1426	1187
Dallas	967	1723	1548	781	1426	0	239
Houston	1087	1842	1627	810	1187	239	0

Declare/Create Two-dimensional Arrays

```
// Declare array ref var
dataType[][] refVar;
// Create array and assign its reference to variable
refVar = new dataType[10][10];
// Combine declaration and creation in one statement
dataType[][] refVar = new dataType[10][10];

// Alternative syntax - Not preferred!
dataType refVar[][] = new dataType[10][10];
```

Declaring Variables of Two-dimensional Arrays and Creating Two-dimensional Arrays

```
int[][] matrix = new int[10][10];
```

or

```
int matrix[][] = new int[10][10];
```

- **Indexed variables:**

```
matrix[0][0] = 3;
```

- **Length:**

```
for (int i = 0; i < matrix.length; i++)
  for (int j = 0; j < matrix[i].length; j++)
    matrix[i][j] = (int)(Math.random() * 1000);
```

Two-dimensional Array Lengths

	0	1	2	3	4
0					
1					
2					
3					
4					

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

matrix.length? 5

matrix[0].length? 5

	0	1	2	3	4
0					
1					
2		7			
3					
4					

```
matrix[2][1] = 7;
```

	0	1	2
0	1	2	3
1	4	5	6
2	7	8	9
3	10	11	12

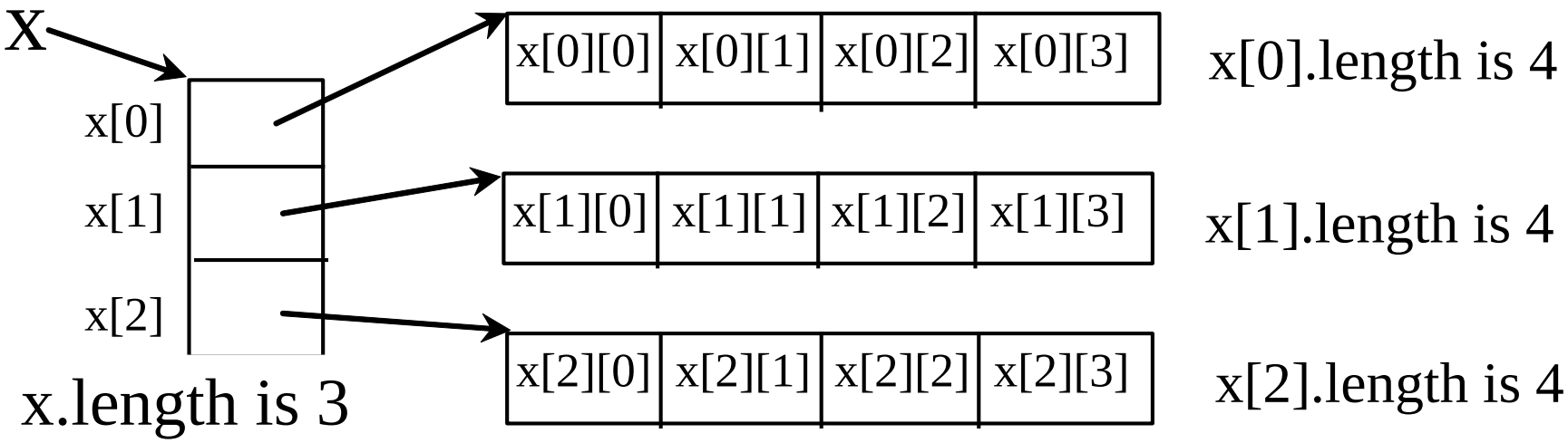
```
int[][] array = {
   {1, 2, 3},
   {4, 5, 6},
   {7, 8, 9},
   {10, 11, 12}
};
```

array.length? 4

array[0].length? 3

Lengths of Two-dimensional Arrays

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



Declaring, Creating, and Initializing Using Shorthand Notations

You can also use an array initializer to declare, create and initialize a two-dimensional array. For example,

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

Same as

```
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;
```

Lengths of Two-dimensional Arrays

```
int[][] array = {      ← array.length
  {1, 2, 3},           ← array[0].length
  {4, 5, 6},           ← array[1].length
  {7, 8, 9},           ← array[2].length
  {10, 11, 12}         ← array[3].length
};
```

`array[4].length`

ArrayIndexOutOfBoundsException

Ragged Arrays

- A ragged array is an array where rows can have different lengths:

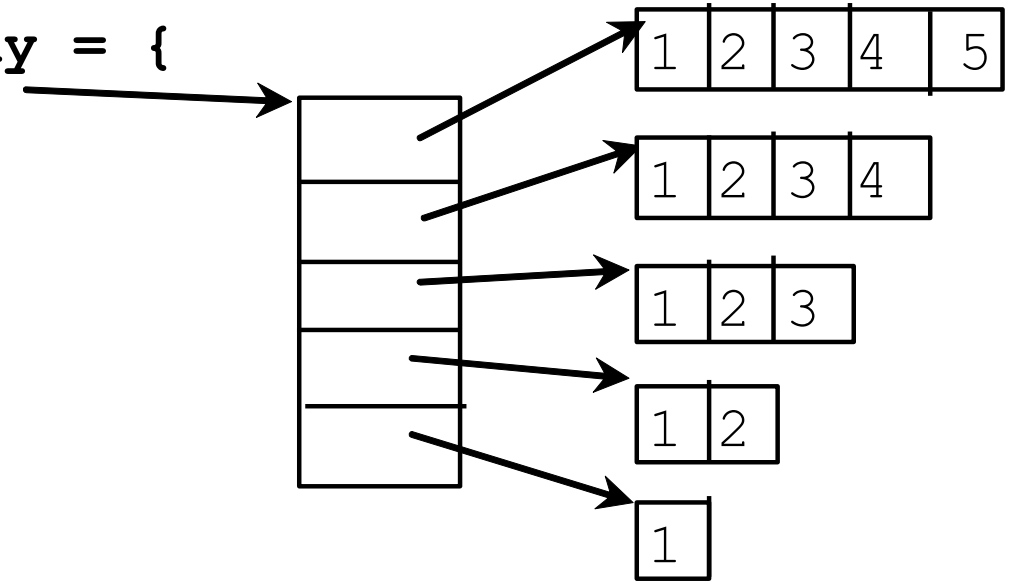
```
int[][] matrix = {
   {1, 2, 3, 4, 5},
   {2, 3, 4, 5},
   {3, 4, 5},
   {4, 5},
   {5}
};
```

```
matrix.length is 5
matrix[0].length is 5
matrix[1].length is 4
matrix[2].length is 3
matrix[3].length is 2
matrix[4].length is 1
```

Ragged Arrays

Storing a ragged array:

```
int[][] triangleArray = {
   {1, 2, 3, 4, 5},
   {1, 2, 3, 4},
   {1, 2, 3},
   {1, 2},
   {1}
};
```



Initializing 2D arrays with input values

```
int matrix[][] = new int[10][10];
java.util.Scanner input =
   new Scanner(System.in);
System.out.println("Enter " +
   matrix.length +" rows and "
   +  matrix[0].length + " columns: ");
for (int row = 0; row < matrix.length;
         row++) {
  for (int column = 0;
         column < matrix[row].length;
         column++) {
    matrix[row][column] = input.nextInt();
  }
}
```

Initializing 2D arrays with random values

```
for(int row = 0;
    row < matrix.length;
    row++) {
  for(int column = 0;
    column < matrix[row].length;
    column++){
      matrix[row][column] =
       (int)(Math.random()*100);
  }
}
```

Printing 2D arrays

```
for(int row=0; row<matrix.length; row++){
   for(int column = 0;
     column<matrix[row].length;
     column++){
      System.out.print(matrix[row][column]
          + " ");
   }
   // new line after each row
   System.out.println();
}
```

Printing 2D arrays with for-each

```
for(int[] row:matrix) {
   for(int elem:row){
         System.out.print(elem + " ");
   }
   // new line after each row
   System.out.println();
}
```

Summing all elements

```
int total = 0;
for(int row = 0; row<matrix.length;
    row++){
   for(int column = 0;
    column < matrix[row].length;
    column++){
        total += matrix[row][column];
   }
}
```

Summing all elements with for-each

```
int total = 0;
for(int[] row:matrix){
   for(int elem:row){
         total += elem;
   }
}
```

Summing elements by column

```
for(int column = 0;
    column < matrix[0].length;
   column++){
  int total = 0;
  for(int row=0; row<matrix.length;
      row++)
     total += matrix[row][column];
  System.out.println(
   "Sum for column " + column
   + " is " + total);
}
```

2D Random shuffling

```
for (int i = 0; i < matrix.length; i++) {
    for (int j = 0; j < matrix[i].length; j++) {
        int i1 = (int)(Math.random() * matrix.length);
        int j1 = (int)(Math.random() * matrix[i1].length);
        // Swap matrix[i][j] with matrix[i1][j1]
        int temp = matrix[i][j];
        matrix[i][j] = matrix[i1][j1];
        matrix[i1][j1] = temp;
    }
}
```

N-dimensional Arrays

- Not just only 2-dimensional arrays!!!
- N-dimensional data structures example:

- grades on multiple dimensions (30 students, 5 courses, 25 lab grades):

```
int[][][] scores = new int[10][5][25];
```