15. Multidimensional Arrays

Java

Fall 2009

Instructor: Dr. Masoud Yaghini

Outline

Declaring and Creating of Two-Dimensional Arrays

Declaring and Creating of 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
dataType refVar[][] = new dataType[10][10];
// This style is allowed, but not preferred
```

Declaring and Creating of Two-Dimensional Arrays

- Example:

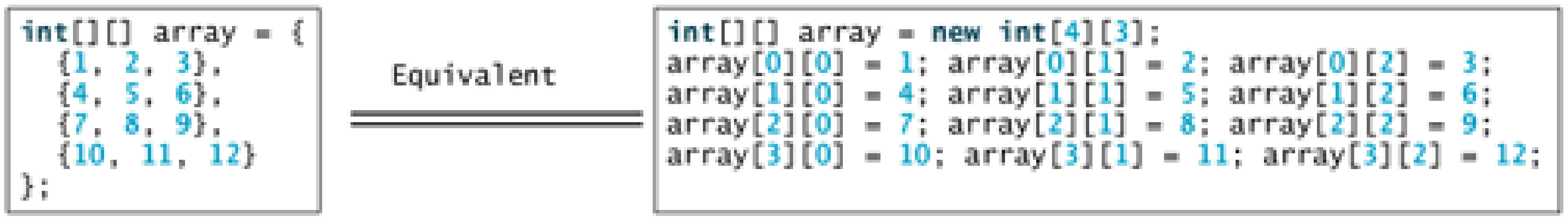
```
int[][] matrix = new int[10][10];
```

- or

```
int matrix[][] = new int[10][10];
matrix[0][0] = 3;
```

Declaring and Creating of Two-Dimensional Arrays

- You can also use an array **initializer** to declare, create, and initialize a two-dimensional array:



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

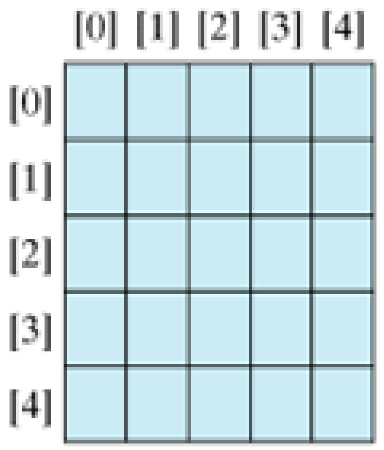
(a)

Equivalent

```
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;
```

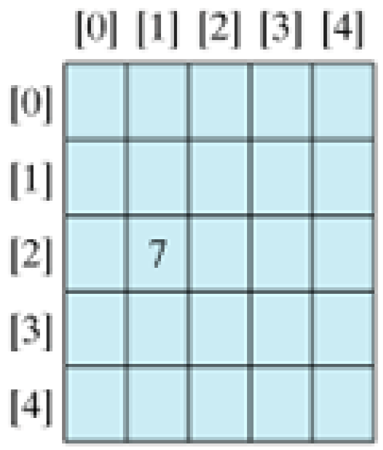
(b)

Declaring and Creating of Two-Dimensional Arrays



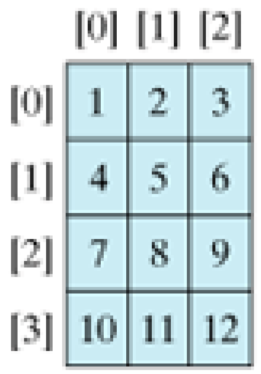
```
matrix = new int[5][5];
```

(a)



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

(b)



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

(c)

Example

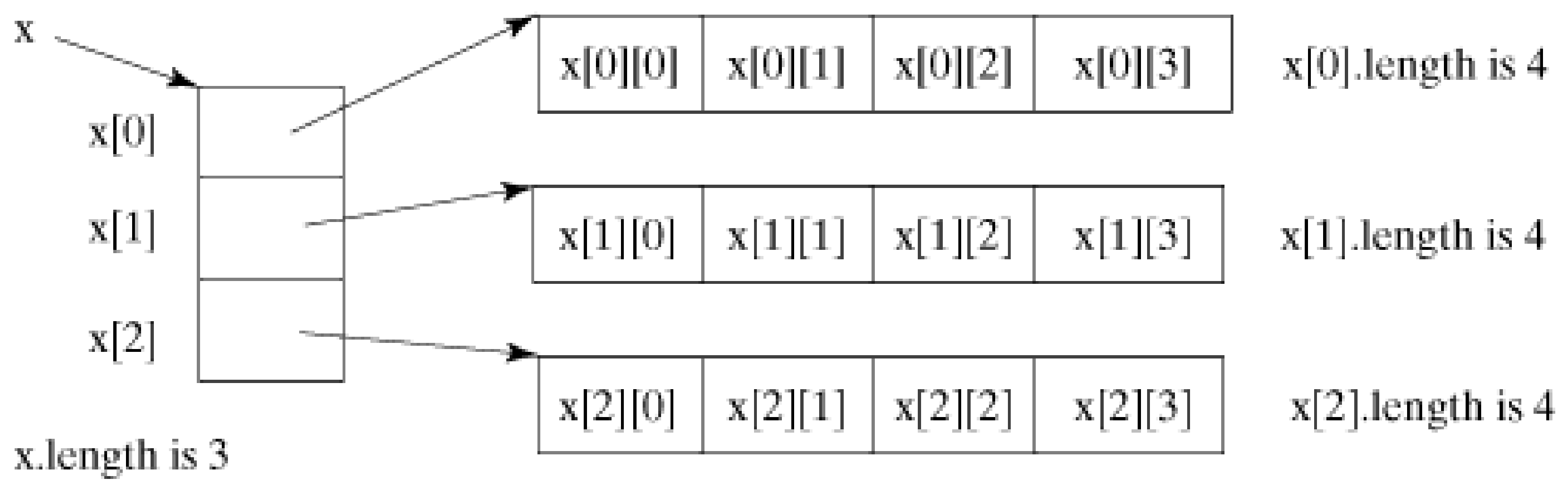
- Example:
  - MultiDimArrayDemo.java
- The output of program:

```
Mr. Smith
Ms. Jones
```

Obtaining the Lengths of Two-Dimensional Arrays

- A two-dimensional array is actually an array in which each element is a one-dimensional array.

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

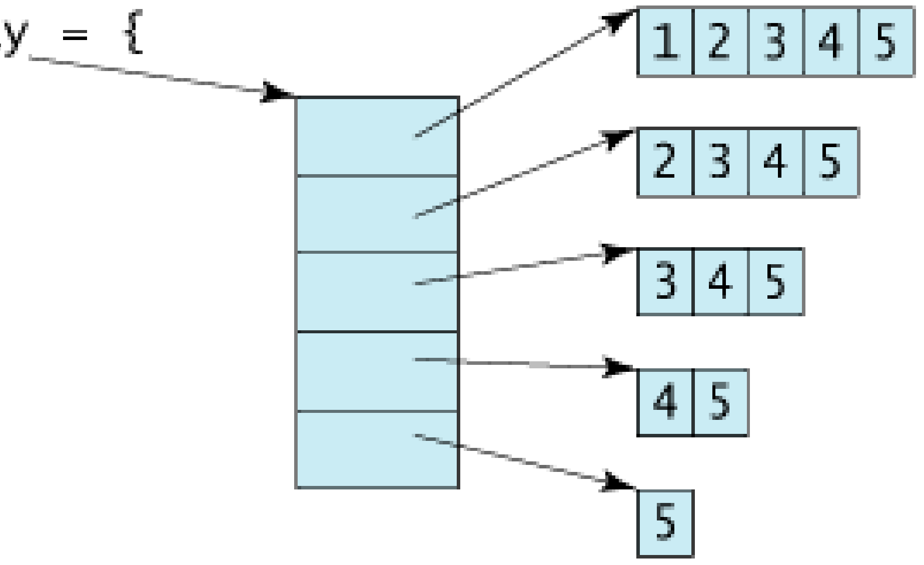


Ragged Arrays

Ragged Arrays

- Each row in a two-dimensional array is itself an array. So, the rows can have different lengths. Such an array is known as *a* **ragged array**. For example:

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



- triangleArray.length is 5, triangleArray[0].length is 5
  triangleArray[1].length is 4, triangleArray[2].length is 3
  triangleArray[3].length is 2, and triangleArray[4].length is 1

Ragged Arrays

- you can create a ragged array using the syntax that follows:

```
int[][] triangleArray = new int[5][];
triangleArray[0] = new int[5];
triangleArray[1] = new int[4];
triangleArray[2] = new int[3];
triangleArray[3] = new int[2];
triangleArray[4] = new int[1];
```

Simple Processing on Two-Dimensional Arrays

Processing Two-Dimensional Arrays

- Suppose an array matrix is declared as follows:

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

- **Initializing 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);
  }
}
```

Processing Two-Dimensional Arrays

- **Printing arrays:**

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

Processing Two-Dimensional Arrays

- **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);
}
```

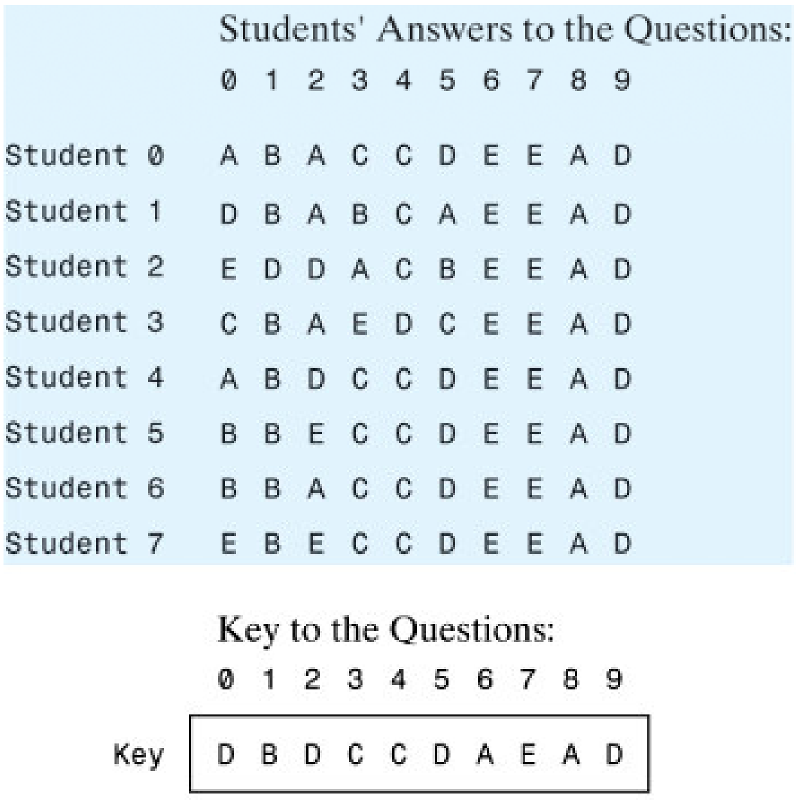
Processing Two-Dimensional Arrays

- **Which row as the largest sum?**

```
int maxRow = 0;
int indexOfMaxRow = 0; // Get sum of the first row in maxRow
for (int column = 0; column < matrix[0].length; column++) {
   maxRow += matrix[0][column];
}
for (int row = 1; row < matrix.length; row++) {
   int totalOfThisRow = 0;
   for (int column = 0; column < matrix[row].length; column++) {
        totalOfThisRow += matrix[row][column];
        if (totalOfThisRow >  maxRow) {
              maxRow = totalOfThisRow; indexOfMaxRow = row;
        }
   }
}
System.out.println("Row " + indexOfMaxRow + " has the maximum
   sum" + " of " + maxRow);
```

Example: Grading a Multiple-Choice Test

- Suppose there are eight students and ten questions, and the answers are stored in a two-dimensional array.
- Each row records a student's answers to the questions.
- Objective: write a program that grades multiple-choice test.



Students' Answers to the Questions:

	0	1	2	3	4	5	6	7	8	9
Student 0	A	B	A	C	C	D	E	E	A	D
Student 1	D	B	A	B	C	A	E	E	A	D
Student 2	E	D	D	A	C	B	E	E	A	D
Student 3	C	B	A	E	D	C	E	E	A	D
Student 4	A	B	D	C	C	D	E	E	A	D
Student 5	B	B	E	C	C	D	E	E	A	D
Student 6	B	B	A	C	C	D	E	E	A	D
Student 7	E	B	E	C	C	D	E	E	A	D

Key to the Questions:

	0	1	2	3	4	5	6	7	8	9
Key	D	B	D	C	C	D	A	E	A	D

Example: Grading a Multiple-Choice Test

- Grading a Multiple-Choice Test
  - GradeExam.java
- The output:

```
Student 0's correct count is 7
Student 1's correct count is 6
Student 2's correct count is 5
Student 3's correct count is 4
Student 4's correct count is 8
Student 5's correct count is 7
Student 6's correct count is 7
Student 7's correct count is 7
```

Three-Dimensional Arrays

An Example of Three-Dimensional Arrays

- Suppose the scores are stored in a three-dimensional array named scores.
- The first index in scores refers to a student, the second refers to an exam, and the third refers to a part of the exam.
- Suppose there are seven students, five exams, and each exam has two parts: a multiple-choice part and a programming part.
- The program calculates the total score for the students in a class.

An Example of Three-Dimensional Arrays

- TotalScore.java

- The output:

```
Student 0's score is 160.0
Student 1's score is 163.0
Student 2's score is 147.4
Student 3's score is 174.4
Student 4's score is 201.4
Student 5's score is 181.4
Student 6's score is 165.9
```

References

References

- Y. Daniel Liang, **Introduction to Java Programming**, Sixth Edition, Pearson Education, 2007. (Chapter 6)
- S. Zakhour and et. al., **The Java Tutorial: A Short Course on the Basics**, 4th Edition, Prentice Hall, 2006. (Chapter 3)

The End