CMSC 131

Object-Oriented Programming I

Two-Dimensional Arrays

Dept of Computer Science
University of Maryland College Park

This material is based on material provided by Ben Bederson, Bonnie Dorr, Fawzi Emad, David Mount, Jan Plane

Overview

- Multidimensional arrays
- Arrays of arrays
- Multidimensional initializers
- Ragged arrays
- Multidimensional Arrays of Objects

News

- Site with Java Examples
  http://www.java2s.com/
- Firesheep
  http://codebutler.com/firesheep

About Arrays

- Zero-size arrays
  - What space do they occupied?
  - Advantages/disadvantages when compare with null
- Visualization of arrays through the debugger
  - Let's see an array through the debugger

Multidimensional Arrays

- We have discussed the notions of:

  Array of primitive types: Consider the declaration:

  char[ ] c = new char[5];

  c: is of type char[ ] , that is, an array of characters.
  c[2] and c[i]: are of type char (a single character)

  Array of class objects:

  String[ ] s = new String[10];

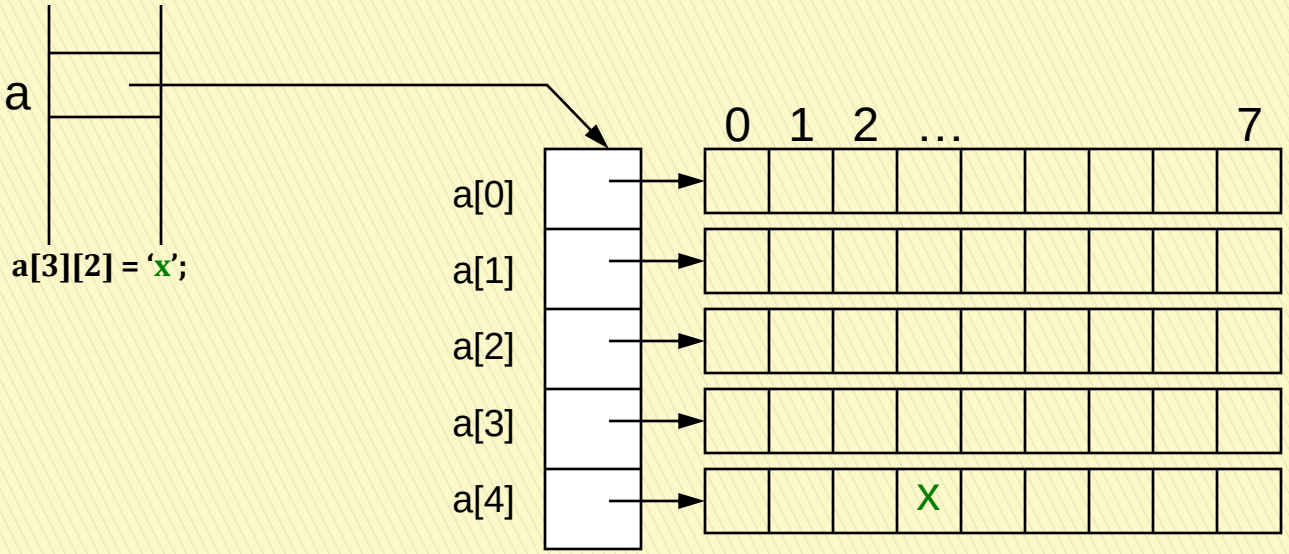
  s: is of type String[ ], that is, an array of strings.
  s[3] and s[j]: are of type String (a single String).

- Can we have an array of arrays? Yes! In Java this is called a **multidimensional array.**

Two-Dimensional Arrays

- Java's stores a 2-dim array as an **array of array references**.

  char[ ] [ ] a = new char[5][8];



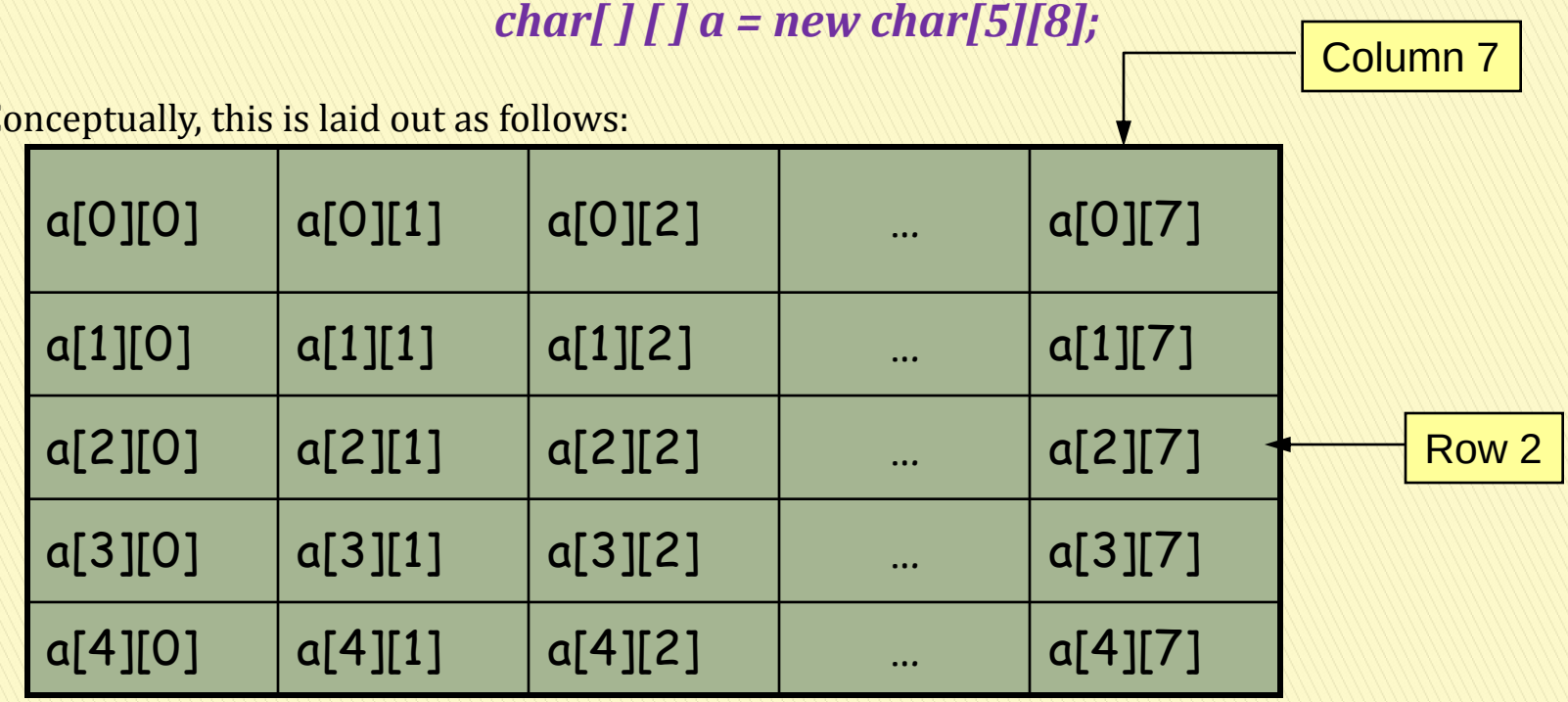
- Java allocates space for the **array of array references**, and then allocates space for the **individual arrays**
- **a:** is of type char[ ][ ], an array of array of characters (whole page)
- **a[4]** : is of type char[ ], an array of characters (a single line)
- **a[4][23]:** is of type char, a single character (character 23 of line 4)

Conceptual Layout

- Let's be more concrete. Consider the following declaration:

char[ ] [ ] a = new char[5][8];

- Conceptually, this is laid out as follows:



- By convention the 1st index is the row, the 2nd is the column.

Multidimensional Array Length

- Consider the declaration:

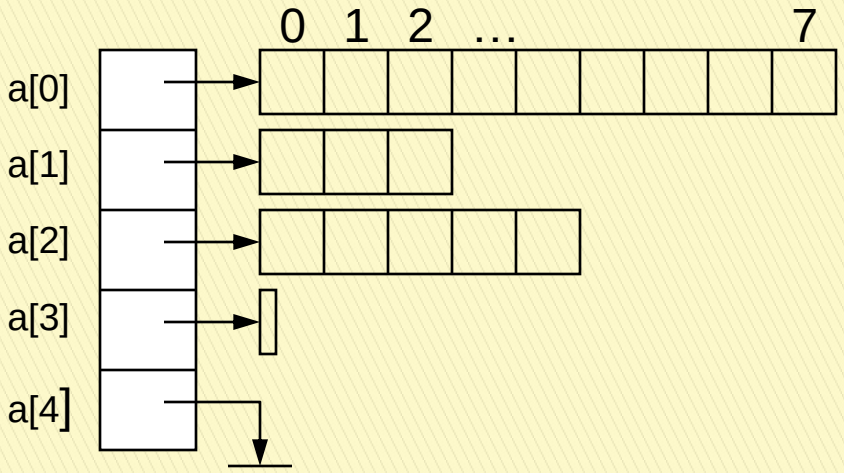
  char[ ] [ ] a = new char[5][8];

- What is the meaning of **a.length**?
  - 5? 8? 40?
  - Undefined?
- **Ans**: 5. This is clear from the illustration on the previous page. Array **a** is an **array of 5 references** to other arrays.
- What is the meaning of **a[2].length**?
- **Ans**: 8, because **a[2]** is an **array of 8 characters**.

Ragged Arrays

- When you allocate an array of arrays, do all the arrays have to be of the **same size**?
- **No**. When the arrays have different sizes, it is called a **ragged array**. You can specify their sizes individually.

```
char[ ][ ] a = new char[5][ ];
a[0] = new char[8];
a[1] = new char[3];
a[2] = new char[5];
a[3] = new char[0];
a[4] = null;
```

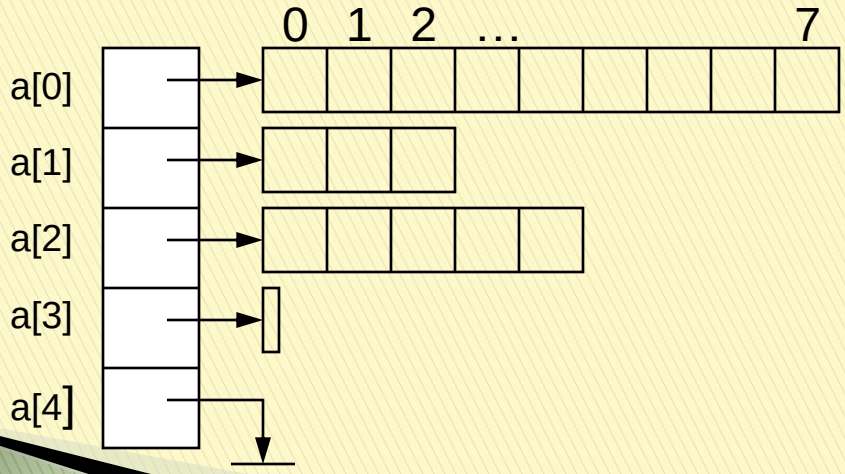


Two-Dimensional Arrays and Loops

- Nested loops go hand in hand with two-dimensional arrays
- The following is the standard nested loop to go row by row in a two-dimensional array

```
for (int row = 0; row < a.length; row++)
    for (int col = 0; col < a[r].length; col++)
        a[row][col] = ' ';
```

When all rows have the same length we could use a[0].length



Multidimensional Initializers

- **1-dim Initializer**: recall

```
int[ ] quizScoresOne = { 90, 82, 75, 66 };
```

- **2-dimensional Initializer**:

```
int[ ][ ] quizScoresTwo = { { 90, 82, 75, 66 },
                            { 85 },
                            { 45, 77, 99 } };
```

Note: The size of the array is determined by the initializer.

This allocates and initializes a **ragged array** with 3 rows.

- **Example (Initializers.java):** Print the array.

```
for ( int row = 0; row < quizScores.length; row++ ) {
    System.out.print( "Scores for student " + row+ ":");
    for ( int col = 0; col < quizScores[row].length; col++ )
        System.out.print( " " + quizScores[row][col] );
    System.out.println( );
}
```

Output:

```
Scores for student 0: 90 82 75 66
Scores for student 1: 85
Scores for student 2: 45 77 99
```

Multidimensional Arrays of Objects

- We have discussed the notion of two-dimensional arrays of primitives:

```
char[ ] [ ] page = new char[50][100];
```

- Can we have multidimensional arrays of objects? **Yes!**
- Multidimensional arrays of objects behave exactly as multidimensional arrays of primitives except for one main difference: When you define the array:

```
ObjectType[][] var = new ObjectType[MAXROW][MAXCOL]
```

  you are actually creating a two-dimensional array of references to objects; those objects don't exist yet!
- **Example:** TwoDimArrayObjects.java
- **Example:** PassingArrays.java
  - Notice that we can pass arrays as one-dimensional arrays
  - Notice we can pass a row of a two-dimensional array
- Let's see a two-dimensional array through the debugger

Miscellaneous

- In our examples, we have processed the two-dimensional array row by row but we could also process it column by column
- Notice that we can have sharing of objects by several array entries and sharing of rows
- Two-dimensional arrays examples online

  http://www.java2s.com/Tutorial/Java/0140__Collections/0060__Multidimensional-Arrays.htm