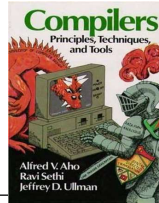


Topic 26

Two Dimensional Arrays

"Computer Science is a science of abstraction
-creating the right model for a problem and
devising the appropriate mechanizable
techniques to solve it."

-Alfred Aho and Jeffery Ullman



Based on slides for Building Java Programs by Reges/Stepp, found at
<http://faculty.washington.edu/stepp/book/>

2D Arrays in Java

- Arrays with multiple dimensions may be declared and used
- ```
int[][] mat = new int[3][4];
```
- the number of pairs of square brackets indicates the dimension of the array.
  - by convention, in a 2D array the first number indicates the row and the second the column

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## Two Dimensional Arrays

|     | 0 | 1 | 2 | 3 | column |
|-----|---|---|---|---|--------|
| 0   | 0 | 0 | 0 | 0 |        |
| 1   | 0 | 0 | 0 | 0 |        |
| 2   | 0 | 0 | 0 | 0 |        |
| row |   |   |   |   |        |

This is our abstract picture of the 2D array and treating it this way is acceptable.

(actual implementation is different)

```
mat[2][1] = 12;
```

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## What is What?

```
int[][] mat = new int[10][12];

// mat is a reference to the whole 2d array

// mat[0] or mat[r] are references to a single row

// mat[0][1] or mat[r][c] are references to
// single elements

// no way to refer to a single column
```

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## 2D Array Problems

- Write a method to find the max value in a 2d array of ints
- Write a method that finds the sum of values in each column of a 2d array of doubles
- Write a method to print out the elements of a 2d array of ints in row order.
  - row 0, then row 1, then row 2 ...
- Write a method to print out the elements of a 2d array of ints in column order
  - column 0, then column 1, then column 2 ...

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## Clicker 1

- What is output by the following code?

```
String[][] strTable = new String[5][8];
System.out.print(strTable.length + " ");
System.out.print(strTable[0].length + " ");
System.out.print(strTable[2][3].length());
```

- A. 40 0 0
- B. 8 5 0
- C. 5 8 0
- D. 5 8 then a runtime error occurs
- E. No output due to a syntax error.

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## Use of Two Dimensional Arrays

- 2D arrays are often used when I need a table of data or want to represent things that have 2 dimensions.
- For instance an area of a simulation

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## Example of using a 2D array

- Conway's Game of Life
  - a cellular automaton designed by John Conway, a mathematician
  - not really a game
  - a simulation
  - takes place on a 2d grid
  - each element of the grid is occupied or empty

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## Simulation

- ▶ <http://www.cuug.ab.ca/dewara/life/life.html>
- ▶ Select pattern from menu
- ▶ Select region in large area with mouse by pressing the control key and left click at the same time
- ▶ Select the paste button

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## Generation 0

|   | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| 0 | . | * | . | * | . | * |
| 1 | * | . | * | * | * | * |
| 2 | . | . | * | * | . | * |
| 3 | . | * | * | * | . | * |

\* indicates occupied, . indicates empty

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Or

|   | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| 0 |   |   |   |   |   |   |
| 1 |   |   |   |   |   |   |
| 2 |   |   |   |   |   |   |
| 3 |   |   |   |   |   |   |

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## Generation 1

|   | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| 0 | . | * | . | * | . | * |
| 1 | . | . | . | . | . | * |
| 2 | . | . | . | . | . | * |
| 3 | . | * | . | * | . | . |

\* indicates occupied, . indicates empty

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## Or , Generation 1

|   | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| 0 |   |   |   |   |   |   |
| 1 |   |   |   |   |   |   |
| 2 |   |   |   |   |   |   |
| 3 |   |   |   |   |   |   |

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## Rules of the Game

- ▶ If a cell is occupied in this generation.
  - it survives if it has 2 or 3 neighbors in this generation
  - it dies if it has 0 or 1 neighbors in this generation
  - it dies if it has 4 or more neighbors in this generation
- ▶ If a cell is unoccupied in this generation.
  - there is a birth if it has exactly 3 neighboring cells that are occupied in this generation
- ▶ Neighboring cells are up, down, left, right, and diagonal. In general a cell has 8 neighboring cells

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## Clicker 2

- ▶ Implement a program to run the simulation
- ▶ What data type do you want to use for the elements of the 2d array?

- A. String
- B. char
- C. int
- D. boolean
- E. double

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## Clicker 3

- ▶ Do you want to use a buffer zone on the edges?

- A.No
- B.Yes

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