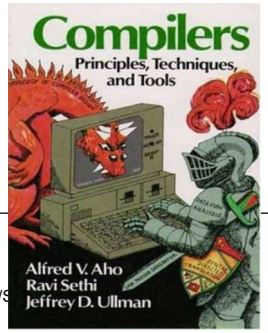
Topic 26
Two Dimensional Arrays

"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/S
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

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;
```


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

// mat.length is the number of rows
// mat[0].length is the number of columns
//     in row 0.
```

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 ...

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.

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

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

Simulation

- http://www.cuug.ab.ca/dewara/life/life.html

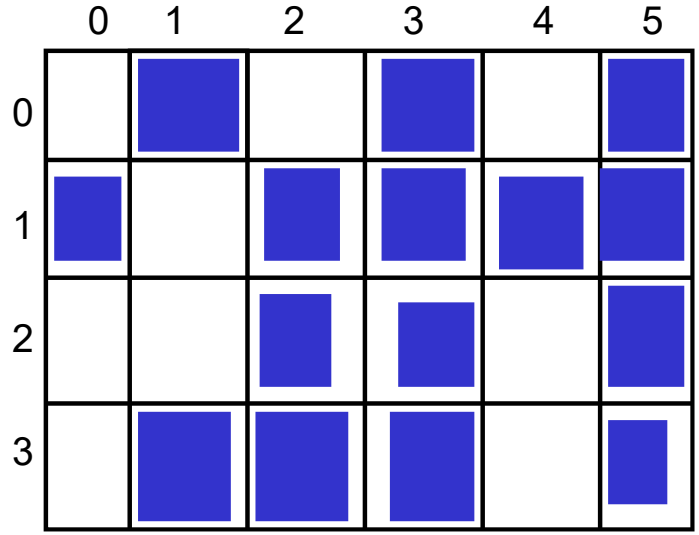
- Select pattern from menu
- Select region in large area with mouse by pressing the control key and left click at the same time
- Select the paste button

Generation 0

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

* indicates occupied, . indicates empty

Or

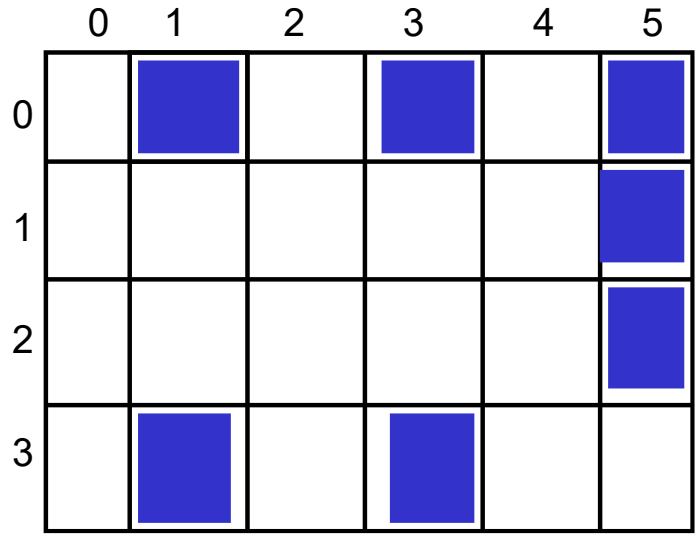


Generation 1

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

* indicates occupied, . indicates empty

Or , Generation 1



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

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

Clicker 3

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

A. No
B. Yes