Assignment 4

- Your basic shape drawing should be
  - centered on (0, 0)
  - with respect to some size field
- Constructor (and functions) should take parameters
- Use `mousePressed()` function not the global variable
  - call your constructor in there to create objects
- Comment your class fields, function parameters and variables

Review

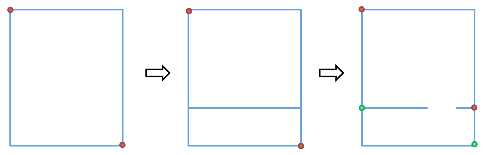
- Recursion
- Call Stack

Coding Examples

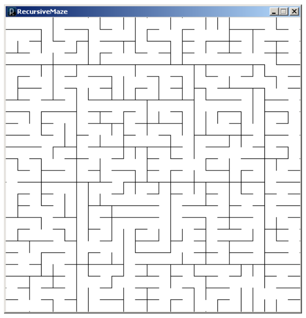
- recursive sum
- recursive findMax

Creating a maze, recursively

1. Start with a rectangular region defined by its upper left and lower right corners
2. Divide the region at a random location through its more narrow dimension
3. Add an opening at a random location
4. Repeat on two rectangular subregions



Inspired by http://weblog.jamisbuck.org/2011/1/12/maze-generation-recursive-division-algorithm



Example

- recursiveMaze with stack

Two-dimensional Arrays

- Visualized as a grid
- `int[][] grays = {{0, 20, 40},`
- `{60, 80, 100},`
- `{120, 140, 160},`
- `{180, 200, 220}};`
- `int[][] grays = new int[4][3];`

	0	1	2
0	0	20	40
1	60	80	100
2	120	140	160
3	180	200	220

Indexing 2D Arrays

- Need two indices, one for the rows and one for the columns.
- `grays[2][1] = 255;`
- `grays[2][3] = 0;`

Lengths of 2D Arrays

- `int[][] grays = new int[80][100];`
- `println(grays.length);`
- `println(grays[0].length);`

Exercise

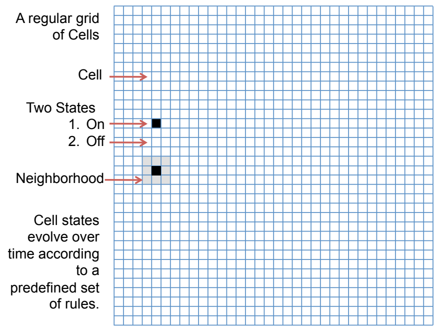
Add the necessary lines of code within `setup()` to fill the `vals` array with random numbers of your choosing. Your implementation must use `for` loops.

```
float[][] vals;
void setup() {
        vals = new float[20][300];

        // Add your code here

}
```

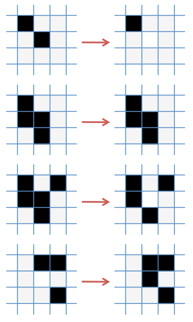
Examples

- graySquares

Cellular Automata


A regular grid of Cells
Cell
Two States
1. On
2. Off
Neighborhood
Cell states evolve over time according to a predefined set of rules.

Sample Set of Rules – Conway's Game of Life

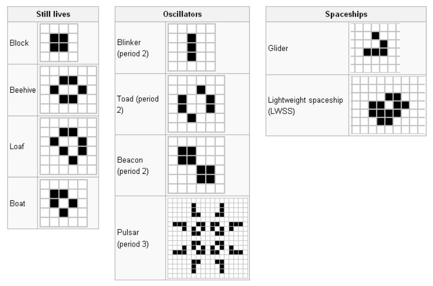


1. Any live cell with fewer than two live neighbors dies, as if caused by under-population.
2. Any live cell with two or three live neighbors lives on to the next generation.
3. Any live cell with more than three live neighbors dies, as if by overcrowding.
4. Any dead cell with exactly three live neighbors becomes a live cell, as if by reproduction.

An example of "Emergence"

http://en.wikipedia.org/wiki/Conway%27s_game_of_life

Interesting Patterns – Conway's Game of Life



http://en.wikipedia.org/wiki/Conway%27s_game_of_life

2D Array of Booleans

```
int N = 5;
boolean[][] cell = new boolean[N][N];
```

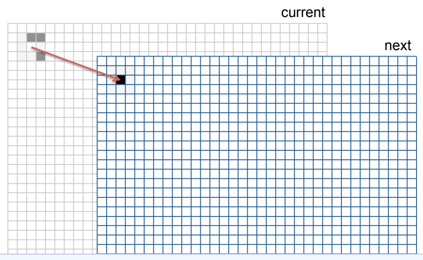
cell

	0	1	2	3	4
0	false	false	false	false	false
1	false	false	false	false	false
2	false	false	false	false	false
3	false	false	false	false	false
4	false	false	false	false	false

```
int N = 5;
boolean[][] cell = new boolean[N][N];

cell[1][2] = true;
```

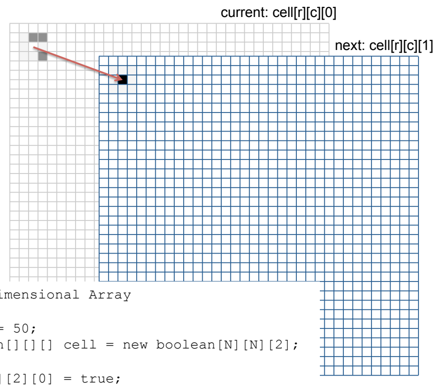
cell

	0	1	2	3	4
0	false	false	false	false	false
1	false	false	**true**	false	false
2	false	false	false	false	false
3	false	false	false	false	false
4	false	false	false	false	false

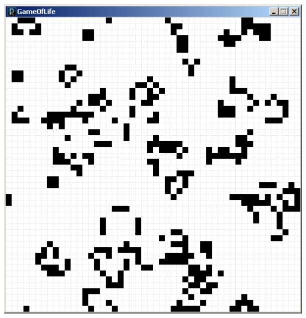


Top-level procedure

1. Draw the current grid
2. Advance game by applying rules to all cells of current and filling next
3. Swap current and next grid



```
// 3-Dimensional Array

int N = 50;
boolean[][][] cell = new boolean[N][N][2];

cell[1][2][0] = true;
```



What are we printing?

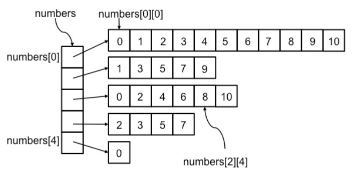
```
float[][] vals;

void setup() {
  vals = new float[20][300];

  for (int i=0; i<20; i++) {
    println(vals[i].length);
  }
}
```

2D Array as an array of arrays

- Each element of a 2D array is a 1D array
- Thus each element of a 2D array has a length
- Declaration can be tiered:
  - `float[][] vals;`
  - `float[20][] vals;`
  - `float[20][300] vals;`
- Each element array does not have to be the same length

Ragged Arrays

```
int[][] numbers = {
{0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10},
{1, 3, 5, 7, 9},
{0, 2, 4, 6, 8, 10},
{2, 3, 5, 7},
{0},
};
```



Example

- ragged

Challenge

- Recall the graySquares example
- Modify to plot black squares whenever both the row and column indices of a cell are even and white otherwise.