Multidimensional Arrays

```java
int array[] = new int[3];
int array[][] = new int[2][3];
int array[][][] = new int[4][2][3];
int array[][][][] = new int[2][4][2][3];
```

- What are examples of these?
  - 2-D – Matrices, Spreadsheet, Minesweeper, Battleship, etc.
  - 3-D – Multiple Spreadsheets, (x, y, z) system
  - 4-D – (x, y, z, time) system

Declaring Multidimensional Arrays

- Create the same way as 1-D, but specify...

```java
int array[][] = new int[2][3]; //rows, cols
int array[][][] = new int[4][2][3]; //planes, rows, cols
int array[][][][] = new int[2][4][2][3]; //time, planes, rows, cols
```

- What is the array name by itself?
Initializing 2-D Arrays

- **Declaration:** int array[][] = {{0,0,0},{0,0,0}};
- **Individual elements:**
  - array[0][0]=0; array[0][1]=0; array(0)[2]=0; array(1)[0]=0; array(1)[1]=0; array(1)[2]=0;
- **Loop:**
  ```java
  for(int i=0; i<array.length; i++)
  for(int j=0; j<array[i].length; j++)
  array[i][j]=0;
  ```
- Why do we need multiple brackets?

Static vs. Dynamic 2-D arrays...

Printing 2-D Arrays

- What happens when we print the array that the array name points to?
  System.out.println(array + " "+ Arrays.toString(array));
- Need to use Arrays.deepToString(array);
  System.out.println(Arrays.deepToString(array));
Jagged Arrays

int array[][] = new int[2][];
array[0] = new int[3];
array[1] = new int[2];

• Can we make the columns jagged?

Object Oriented Programming (OOP)

• What type of programming have we seen so far?
  – Procedural decomposition
• What is OOP?
  – Set of Objects (nouns) vs. Actions (verbs)
• What is an object?
  – Entity with state and behavior

Classes vs. Objects

• Class
  – Client – code that creates/uses objects
  – Blueprint for creating objects
• Properties
  – States for object
  – Behavior for object
  – How to construct object, i.e. constructor
• Object: instance of a class
Object vs. Class Examples

- Book Example:
  - Radios
    - States
    - Behaviors
- My Example:
  - Board Games
    - States
    - Behaviors
- What is the object and what is the class?

Point Objects

Point p = new Point(3, 8);
- States
  - (x and y)
- Behaviors
  - (translate(dx, dy), setLocation(x, y), distance(p2))
- Constructor
  - Assign states to value
- How do we get to these properties?

Point Objects...

Point p = new Point(3, 8);
- Constructor
  p = new Point(3, 8);
- States
  p.x=3; p.y=8;
  int sum = p.x + p.y;
- Behaviors
  p.translate(-1, -2);
Array of Point Objects...

Point points[] = new Point[2];

• Constructor
  points[0] = new Point(3, 8);
  points[1] = new Point(10, 20);

• States
  points[0].x = 3; points[0].y = 8;
  int sum = points[0].x + points[1].y;

• Behaviors
  points[0].translate(-1, -2);