GEOG 178/258
Week 3:

Arrays, Objects and Classes

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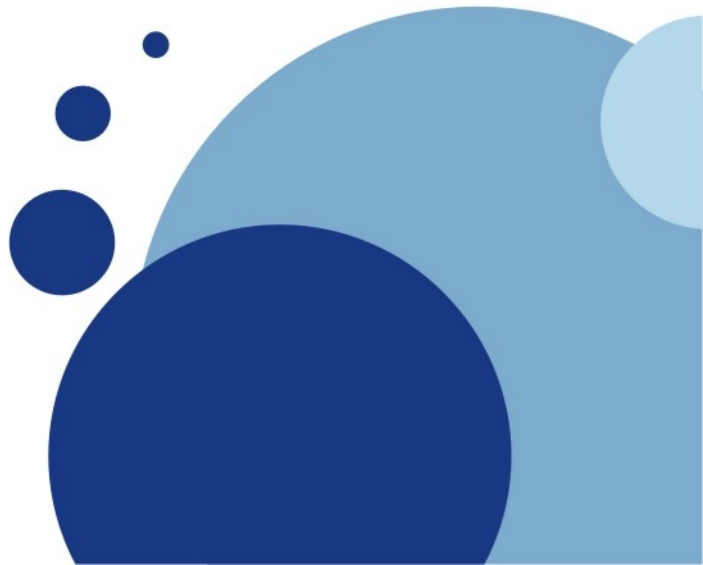

Recap:

- **Workspace:** the top level directory
  - **/Users/mikejohnson/geog178**
- **Project: a single folder** where all related code lives and is compiled from
  - **/Users/mikejohnson/geog178/week3/**
- **Package**: collection of pieces of code that can be shared together
  - **/Users/mikejohnson/geog178/week3/chair_ex**
- **Src:** where the code YOU write (.java files) lives
  - **/Users/mikejohnson/geog178/week3/chair_ex/src/**
- **Bin**: where source code is compiled to
  - **/Users/mikejohnson/geog178/week3/chair_ex/bin**
- **Class**: the *type* of files that you create (for now ☺) – MORE ON THIS TODAY!
  - **/Users/mikejohnson/geog178/week3/chair_ex/src/chair**
- **Public**: This declares public access to a member across a package
- **Void**: This means that a method has no return value
- **Main**: the part of the code that will execute.
  - It is a static method meaning it is part of its class and not part of objects.
  - Its what compiled code looks for to run

1. Arrays

Week 3

Arrays

So far…

- So far we have looked at initializing variables as single values:
  - For example int x = 10
  - creates an integer called x that is equal to 10
- Sometimes we want a collection of data to be stored together.
  - Examples of this might be:
    1. Large data tables or matrices
    2. Lat, Long Pairs
    3. Yearly values (Jan, Feb, March values)
    4. A list of any sort
    5. What can you think of??

What is an Array??

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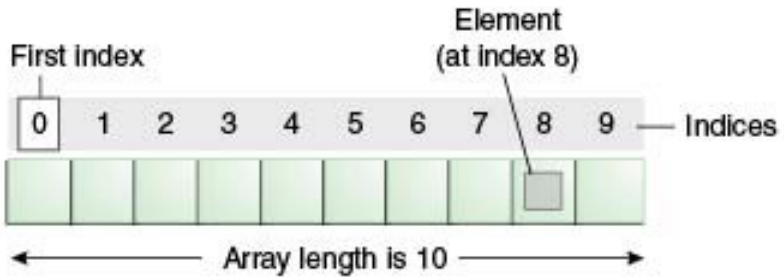
Arrays

- An array acts as a 'container' object to hold a fixed number of values of the same type!

- When an array is initialized the type of data it can contain AS WELL as the length must be established!

- In an array, each item is called an element, and the below diagram highlights how Java interprets an array



An array of 10 elements.

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Arrays

Creating an array…

1. Initializing an array is similar to initializing a variable with one difference:

```
Int[] testArray; // An array of integers is declared
```

2. The length of the array is then specified:

```
testArray = new int[10];
// memory reserved in testArray for 10 integers
// be sure to include the 'new', its significance will be covered soon…
```

3. Elements can then be set using the numerical indexof the array:

```
testArray[0] = 10; // first element set to 10  testArray[1] = 20;
                   // second element set to 20
                   ...
```

4. Remember that Java is a 0 referenced language. This means the first entery of an array is indexed at **0 NOT 1**.

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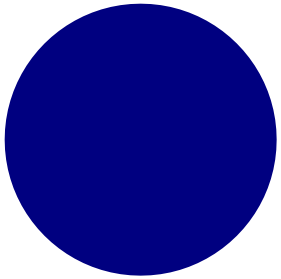
Arrays

Challenge!!

1. Create an array that takes a pair of lat, long points for UCSB
   - The coordinates for UCSB are:
     - Latitude: 34.41
     - Longitude: -119.84
2. Print: **“The Latitude of UCSB is 34.41.”** using your array…
3. Print an empty line:
4. Print: **“The Longitude of UCSB is - 119.84.”** again, using your array…
5. Optional: Print the location of UCSB as WKT… **“UCSB is located at …”**



Week 3

Arrays

Solution

```
1  package week3;
2
3  public class Arrays {
4      public static void main(String[] args) {
5
6          double[] UCSB = new double[2];
7
8          UCSB[0] = 34.41;
9          UCSB[1] = -119.84;
10
11         System.out.print("The Latitude of UCSB is " + UCSB[0] + "." +
12                          "\n\nThe Longitude of UCSB is "+ UCSB[1] + "." +
13                  "\n\nUCSB is located at POINT (" + UCSB + ")"
14              );
15
16     }
17
18 }
```

Looks good right?!

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Arrays

Solution

```
1  package week3;
2
3  public class Arrays {
4      public static void main(String[] args) {
5
6          double[] UCSB = new double[2];
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14              );
15
16     }
17
18 }
```

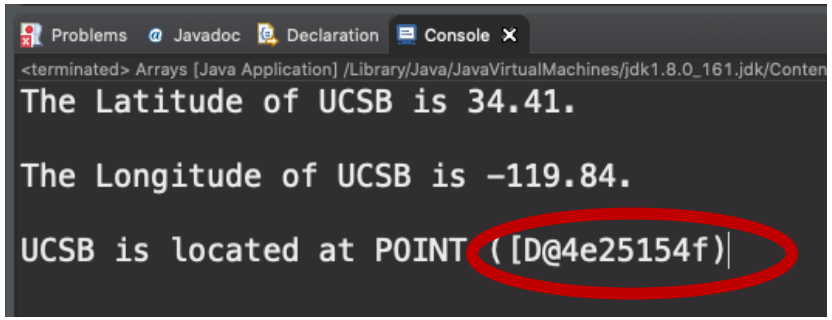

What is that??

Memory Addresses

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Memory Addresses

```
UCSB is located at POINT ([D@4e25154f)
```

That is the class name ([D)
and System.identityHashCode() separated by the '@' character.

The identity the hash code represents is implementation-specific but is often the initial memory address of the object.

Since the object can be moved in memory by the VM (not by the ‘code’) over time, you can't rely on it being anything.

Call by value VS call by reference PARTI

Week 3

Value or Reference?

- Is Java **pass by value** or **pass by reference?** What does that mean?
- This question has its origin on C and C++ where you can pass a function parameter *either* by **value** or by **memory address** (pointer).
- Per Java's specification, everything in Java is **pass by value** whether its primitive value or objects
- Java doesn't support pointers or pointer arithmetic!
- Many programmers confuse *reference* with *pointers.* Reference is a type of handle which helps locate or change an object, but it doesn't allow you to "work-on" the pointer (e.g. you cannot increase or decrease a memory address to locate a different object)
- Java is always **pass-by-value**. Unfortunately, when we pass the value of an object, we are passing the *reference* to it. This is confusing**…. More to come at the end!!**

2. Objects

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Objects

What is Java??... OOP

- Java is an **Object-Oriented** language, or Object-Oriented Program (OOP)
- As such, it has the following characteristics:

1. Organized around '**objects**' rather than 'actions'
2. Organized around '**data**' rather then 'logic'

- OOP's care about the **objects** we want to manipulate rather then the logic that manipulates them.
- Other languages are often viewed viewed as a logical sequence to process input data and produces output data. (Think R or instances of MatLab)

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Objects

What is an OBJECT??

- An OBJECT has **states** and **behaviors**
- **States are conditions** (think long-term/identity)
  - The apple is (red, yellow, green, big, 1/2, whole, …)
  - The door is (wood, metal, glass, heavy, thin, …)
  - The chair is (recliner, rocker, leather, soft, hard, …)
- **Behaviors are 'actions' (think short-term)**
  - **The apple is (hanging, falling, ripe, rotten, wet, …)**
  - **The door is (open, closed, broken, working, …)**
  - **The chair is (reclined, empty, taken, …)**
- **Objects are like the things we interact with everyday, there are millions and millions of objects and trying to code that into a computer language would prove very difficult…**

3. Classes

Week 3

Classes

What is a CLASS??

- One of the first jobs of an OOP is to identify the objects that
  - need to be modeled,
  - what defines them,
  - and how they relate to each other.

- This is known as **data modeling**
- Once an OBJECT is identified it can be generalized into its core components…

- In Java this generalized form is a CLASS.
  - It describes the relevant **states** and **behaviors**
  - Defines the kind of data it contains and the logical sequences that can **manipulate** it
  - It provides methods for **getting** and **changing** these states and behaviors
  - Each logic sequence in a class is known as a **method.**

The Blueprints within Java

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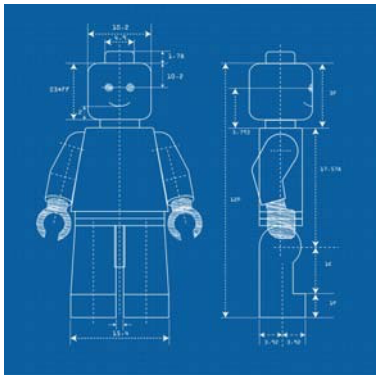
Classes



Ways to think of Classes….

- In Java classes are templates for describing an object….
- It is the generic form of an object and describes what it "means to be that object"
- It is an object with "Open Variables"
- It is a form that needs to be filled out …

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Classes

In Class Chair Example

- Consider a chair…
- If I ask you to think of a chair, each of you knows what I am talking about.
- If I asked you to sit in a chair you won't mistakenly sit on a table.
- If I asked you to build me a chair you would all be able to.
- Given there are so many type of chairs, how do you all know what I am taking about???



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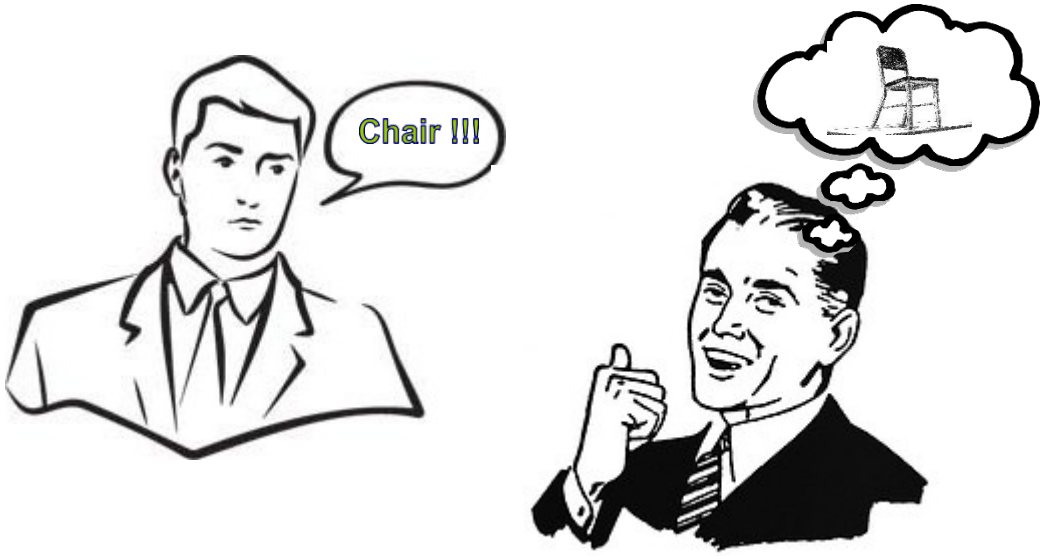
Classes

In Class Chair Example

- If ‘chair’ is to have a definite meaning there must be something common to **ALL** chairs…
- The thing that is common to all chairs is considered “the form of the chair”
- The form of the ‘chair’ allows people to communicate:



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Classes

So…

An object is a specific instance of a more general idea deconstructed into a sum of parts

If you look around the class you see that all your peers are ’people’. None of us are ‘aliens’, ’dogs’ or ‘cats’.

However your brain can also detect characteristics that make each of us unique, and specific 'objects' of the class ‘people’.

For example we all have a gender, hair color, age, race, and occupation, ect that make us unique.

All ’people’ have these things (this is the class people), and each object (individual) has a unique make up of these general qualities.

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Classes

So…

Class/ the "Form of a Person":

person ("gender", "age", "hair color", "occupation", "eye color")

Object/ Individauls:

person mike = new person (male, 27, brown, grad student, green)

Mike is a **person** who is a male, grad student with brown hair and green eyes…

person jane = new person(female, 24, black, teacher, brown)

Jane is a **person** who is a female teacher with black hair and brown eyes…

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Classes

Why are CLASSES important?

- Classes make it possible to define subclasses of data objects that share some or all class characteristics. This feature is known as **inheritance**.
- The concept of data classes allow programmer's to **create new data types that are not pre-defined in the language**.
- Class definitions are reusable by both the program it was created for and other OOP's. This allows them to be distributed more easily across networks.
- Classes define only the data it is concerned with. Thus when an instance of that class (an OBJECT) is run, the code will not accidently access other program data. This avoids unintended data corruptions AND enhances system security.

LIVE EXAMPLE

3. Practice

Example:

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Practice Problem

In this example we will do the following:

1. **Create a class called point**
2. **Construct the general form of point**
3. **Create a method in the point class**
4. **Create two points using the point class**
5. **Call on the point method to perform an operation**

Example:

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Practice Problem

1. Open a new project and create a class called ‘Point’
2. Do NOT elected to create a ‘main’ string.

Week 3

Practice Problem

1. Creating a point class

```
1
2  public class Point {
3
4      // Attributes
5
6      // Constructors
7
8      // Getters
9
10     // Setters
11
12     // Methods
13
14
15 }
```

Line 2: Creates a new public class called 'Point'
Line 4: Sets aside space to define the **attributes** of a point
Line 6: Sets aside space to define the **constructors** of a point
Line 8: Sets aside space to define the **getters** of a point
Line 10: Sets aside space to define the **setters** of a point
Line 12: Sets aside space to define the **methods** of a point
Line 15: Closes the point class

2. Defining the attributes

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Practice Problem

```
4   // Attributes
5
6   double x, y;
7
```

Line 6: Declares that all points are comprised of values X and Y (doubles)

3. Defining the constructor

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Practice Problem

```
4       // Attributes
5
6       double x, y;
7
8       // Constructors
9       public Point(double x, double y) {
10          this.x = x;
11          this.y = y;
12      }
13
```

Line 9: Defines a new public method called **Point** that takes an input x and y value (doubles) and assigns them to an internal X,Y to that point.

4. Defining the “getters”

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Practice Problem

Getters allow you (and the program) to access elements of a class

```
14      // Getters
15
16      public double getX() {
17          return x;
18      }
19
20      public double getY() {
21          return y;
22      }
23
```

Line 16: Defines a new **public** method, that can be applied to any object of class **point**, that returns a **double**, called getX(). When run, getX() returns the ‘x’ value associated with the object it is called on.

Line 20: Does the same for y.

5. Defining the “setters”

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Practice Problem

Setters allow you (or the program) to modify the attributes of an object

```
24      // Setters
25
26      public void setX(double x) {
27          this.x = x;
28      }
29
30      public void setY(double y) {
31          this.y = y;
32      }
```

Line 26: Creates a **public** method, that has **no return value** called **setX().** SetX() requires an input **double ‘x’** and sets that values within the point constructor to the new x value, **‘this.x’**.

Line 30: Does the same for y

Week 3

Practice Problem

6. Add an method to the point class

* Return a point as a WKT string

```
34      // Methods
35
36      public String toWKT() {
37          return "POINT (" + x + " " + y + ")";
38      }
```

Line 36: Creates a **public** method called **toWKT()** that **returns a String**. This method uses the ‘x’ and ‘y’ values of the Point object it is called on to populate the returned string.

Week 3

Practice Problem

7. Add another method

* Calculate the area between two points

```
34      // Methods
35
36      public String toWKT() {
37          return "POINT (" + x + " " + y + ")";
38      }
39
40      public double area(double x, double y) {
41          return Math.abs(this.x - x) * Math.abs(this.y - y);
42      }
```

Line 40: Creates a **public** method called **area()** that **returns a double**. This method requires a user supplied x and y (doubles) and computes the area between them and the **x (this.x)** and **y (this.y)** values of the Point object it is called on.

Week 3

Practice Problem

8. Duplicate Methods for Robust Classes

* Calculate distance between two points

```
34      // Methods
35
36      public String toWKT() {
37          return "POINT (" + x + " " + y + ")";
38      }
39
40      public double area(double x, double y) {
41          return Math.abs(this.x - x) * Math.abs(this.y - y);
42      }
43
44      public double area(Point p) {
45          return Math.abs(this.x - p.x) * Math.abs(this.y - p.y);
46      }
```

Line 44: Creates a **public** method called **area()** that **returns a double**. This method requires a user supplied Point and computes the area between it **(p.x, p.y)** and the **x (this.x)** and **y (this.y)** values of the Point object it is called on.

Week 3

Practice Problem

9. Create Points using the point Class:

```
2  public class Test {
3
4      public static void main(String[] args) {
5          // TODO Auto-generated method stub
6
7          Point point1 = new Point(1,3);
8
9          System.out.println("Point 1 is: " + point1.toWKT());
10         System.out.println("Point 1 is: " + point1.x + ", " + point1.y);
11         System.out.println("Point 1 is: " + point1.getX() + ", " + point1.getY());
12
13
14     }
15 }
```

Line 7: Creates a new point object in the same way as a principle type in the main() method:

Type(*point*) name(P1) = new value (x,y)

The addition is that the value needed is a set of integers as defined by the class and the addition of the 'new' statement. By doing this Java is creating a new object and attaching the reference to that object within the variable.

Line 9: Prints a description of point1 using the toWKT() method

Line 10: Prints a description of point1 using direct access

Line 11: Prints a description of point1 using our getters

Week 3

Practice Problem

Test our code, apply our methods:

```java
public class Test {

    public static void main(String[] args) {
        // TODO Auto-generated method stub

        Point point1 = new Point(1,3);

        System.out.println("The X value of point 1 is: " + point1.getX());
        System.out.println("The Y value of point 1 is: " + point1.getY());
        System.out.println(" ");

        point1.setX(5);
        point1.setY(10);

        System.out.println("The new X value of point 1 is: " + point1.getX());
        System.out.println("The new Y value of point 1 is: " + point1.getY());
        System.out.println(point1.toWKT());
        System.out.println(" ");

        Point point2 = new Point(1, 3);

        System.out.println(point2.toWKT());

        System.out.println(point1.area(1,3));
        System.out.println(point1.area(point2));


    }
}
```

Problems @ Javadoc Declaration Console

<terminated> Test [Java Application] /Library/Java/JavaVirtualMachir

```
The X value of point 1 is: 1.0
The Y value of point 1 is: 3.0

The new X value of point 1 is: 5.0
The new Y value of point 1 is: 10.0
POINT (5.0 10.0)

POINT (1.0 3.0)
28.0
28.0
```

Call by value VS call by reference PART II

Week 3

Arrays

```
1.    chair myChair = new chair(“Leather");
2.      arg(myChair); // Do this function

3.    public void arg(chair someChair) {
4.          someChair.setType(“wood”);
5.          someChair = new chair(”plastic");
6.          someChair.setType(”fabric");
7.     }
```

Line 1: Create a Chair object at memory address 1

Line 2: Run method arg using myChair (1) as input

Line 3: Create a methods ‘arg’ that takes an input of type chair

Line 4: the input ‘myChair’ is followed to the address of the input (1)

the chair (1) is changed from “leather” to “wood”

Line 5: A new plastic chair is created and stored at memory (2), the parameter name ‘someChair’ to the Chair (2)

Line 6: someChair is followed to the chair object at memory (2), that specific chair is changed to type fabric.

Line 7: Return.

What would myChair.getType() return????

Call by value VS call by reference PART II

Week 3

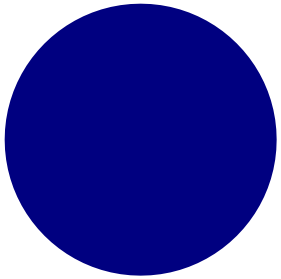
Arrays

ANSWER: **“Wood”**

Remember that myChair is a pointer not a chair.

myChair is still located at memory (1) and still pointing to the ‘original’ chair.

Here we *followed* an address and changed what's at the end of it. We DID NOT change the variable.



Call by value VS call by reference PART II

Week 3

Arrays

- In languages that support **pass-by-reference** (C++, Ada, Pascal), you can change the variable that was passed.
- If Java had **pass-by-reference** semantics, the **arg** method would have changed where myChair was pointing when it assigned someChair on line 5.
- Then myChair would be located at memory(2)

HW 2 Hints

Week 3

HW #2

1. Define a Point class (look at these notes)

2. Define a BoundingBox class
   > Think of the attributes, constructors, getters, setters needed

3. Add a distance method to the Point class
   > Make this robust (take and XY, and a PT)!

4. Add an isInside method to BoundingBox
   > Make this robust!

5. Test your code !!
   > Be sure to think of unique instances that might break your code and test to make sure they don't