Inheritance

Task 4 Tips: Tip #1

Do not test undefined behavior

- If there is any behavior that is not explicitly defined in the HW doc -> **Do not write a test case for that behavior**
    - Many students are testing the bayesianAverage method with invalid ratings or negative numbers of additional ratings
        - The behavior of the method on these inputs is not defined in the HW doc
        - What should bayesianAverageRating(3, -2) return? I don't know. If you are guessing what it should return, you can't write a test case for it
- If a method is not defined in the HW doc, you cannot test it since that method won't exist in the correct solution (eg. you can't test playlist.getComparator() since it will crash when testing the correct solution)
- It's subtle, but undefined behavior is different from edge cases which are defined

Task 4 Tips: Tip #2

To test a class, you need to create an object of that type

- Refer to the TestClasses1 code as an example
  - To test the Song class, we first create a new object of type Song and call methods through that object
- This will apply to both your Comparators as well
  - Create a new object of the the you are testing, then call compare through the object
  - Note: If a class does not have a constructor, it automatically has the "default constructor" which takes no parameters and an empty body

Task 4 Tips: Tip #3

~~**Have fun!**~~ **Try not to get too frustrated..**

- Task 4 will be much more time consuming that three previous tasks
- Tasks 5 and 6 will be less time consuming than task 4
  - There is less code to write for each of these tasks than for task 4
  - You will already have the tests written when you start these tasks which will make the code easier to debug

- **If you can survive task 4 -> You can survive CSE116!**

Override

Inheritance

- Recall that we used inheritance to add all of the state and behavior of one class to another class
- HealthPotion extends (or, inherits from) GameItem
  - HealthPotion objects have all the instance variables (State) of both HealthPotion and GameItem
- GameItem is the super class of HealthPotion

```
public class GameItem {
    private double xLoc;
    private double yLoc;
    public GameItem(double xLoc, double yLoc) {
        this.xLoc = xLoc;
        this.yLoc = yLoc;
    }
}
```

```
public class HealthPotion extends GameItem {
    private int increase;
    public HealthPotion(double xLoc, double yLoc, int increase) {
        super(xLoc, yLoc);
        this.increase = increase;
    }
}
```

Inheritance

- HealthPotion objects have all the methods (Behavior) of both HealthPotion and GameItem

```
public class GameItem {
    private double xLoc;
    private double yLoc;
    public GameItem(double xLoc, double yLoc) {
        this.xLoc = xLoc;
        this.yLoc = yLoc;
    }
    public void use() {
        System.out.println("Item Used");
    }
}
```

- We add a use method to the HameItem class
  - All HealthPotion objects now have a use method

```
public class HealthPotion extends GameItem {
    private int increase;
    public HealthPotion(double xLoc, double yLoc, int increase) {
        super(xLoc, yLoc);
        this.increase = increase;
    }
}
```

Inheritance

- What if we want to extend a class, but don't want 100% of the inherited state and behavior?

- We want a class to inherit the location code from GameItem, but want the use method to something else
  - Override!

```
public class GameItem {
    private double xLoc;
    private double yLoc;
    public GameItem(double xLoc, double yLoc) {
        this.xLoc = xLoc;
        this.yLoc = yLoc;
    }
    public void use() {
        System.out.println("Item Used");
    }
}
```

```
public class HealthPotion extends GameItem {
    private int increase;
    public HealthPotion(double xLoc, double yLoc, int increase) {
        super(xLoc, yLoc);
        this.increase = increase;
    }
}
```

Override

- Weapon will also inherit the state and behavior from GameItem
- We will **Override** the use method with a new definition specific to the Weapon class
  - The inherited method is **replaced** by this new definition

```java
public class GameItem {
    private double xLoc;
    private double yLoc;
    public GameItem(double xLoc, double yLoc) {
        this.xLoc = xLoc;
        this.yLoc = yLoc;
    }
    public void use() {
        System.out.println("Item Used");
    }
}
```

```java
public class Weapon extends GameItem {
    private int damage;
    public Weapon(double xloc, double yLoc, int damage) {
        super(xloc, yLoc);
        this.damage = damage;
    }
    @Override
    public void use() {
        System.out.println("Damage dealt: " + this.damage);
    }
}
```

```java
public class HealthPotion extends GameItem {
    private int increase;
    public HealthPotion(double xLoc, double yLoc, int increase) {
        super(xLoc, yLoc);
        this.increase = increase;
    }
}
```

Override

- To Override a method definition
  - Use the @Override annotation before the method
  - The annotation makes your intentions clear and tells the compiler that this method will replace an inherited method

```java
public class GameItem {
    private double xLoc;
    private double yLoc;
    public GameItem(double xLoc, double yLoc) {
        this.xLoc = xLoc;
        this.yLoc = yLoc;
    }
    public void use() {
        System.out.println("Item Used");
    }
}
```

```java
public class Weapon extends GameItem {
    private int damage;
    public Weapon(double xloc, double yLoc, int damage) {
        super(xloc, yLoc);
        this.damage = damage;
    }
    @Override
    public void use() {
        System.out.println("Damage dealt: " + this.damage);
    }
}
```

```java
public class HealthPotion extends GameItem {
    private int increase;
    public HealthPotion(double xLoc, double yLoc, int increase) {
        super(xLoc, yLoc);
        this.increase = increase;
    }
}
```

Override

- The @Override annotation is optional [but recommended]
- When overriding a method, your method must have the same *signature* as the method being overwritten
  - Same name
  - Same number of parameters
  - Same parameter types
  - Same return type
- If there are any differences between the methods, the method is not overridden

```java
public class GameItem {
    private double xLoc;
    private double yLoc;
    public GameItem(double xLoc, double yLoc) {
        this.xLoc = xLoc;
        this.yLoc = yLoc;
    }
    public void use() {
        System.out.println("Item Used");
    }
}
```

```java
public class Weapon extends GameItem {
    private int damage;
    public Weapon(double xloc, double yLoc, int damage) {
        super(xloc, yLoc);
        this.damage = damage;
    }

    public void use() {
        System.out.println("Damage dealt: " + this.damage);
    }
}
```

```java
public class HealthPotion extends GameItem {
    private int increase;
    public HealthPotion(double xLoc, double yLoc, int increase) {
        super(xLoc, yLoc);
        this.increase = increase;
    }
}
```

Override

- If you have the @Override annotation
  - The compiler will let you know if you have mistakes in the method signature

- This code will not compile since uSe does not match the signature of any inherited method
- Without the @Override annotation:
  - This code will compile and run, but will not do what you want or expect

```java
public class GameItem {
    private double xLoc;
    private double yLoc;
    public GameItem(double xLoc, double yLoc) {
        this.xLoc = xLoc;
        this.yLoc = yLoc;
    }
    public void use() {
        System.out.println("Item Used");
    }
}
```

```java
public class Weapon extends GameItem {
    private int damage;
    public Weapon(double xloc, double yLoc, int damage) {
        super(xloc, yLoc);
        this.damage = damage;
    }
    @Override
    public void uSe() {
        System.out.println("Damage dealt: " + this.damage);
    }
}
```

```java
public class HealthPotion extends GameItem {
    private int increase;
    public HealthPotion(double xLoc, double yLoc, int increase) {
        super(xLoc, yLoc);
        this.increase = increase;
    }
}
```

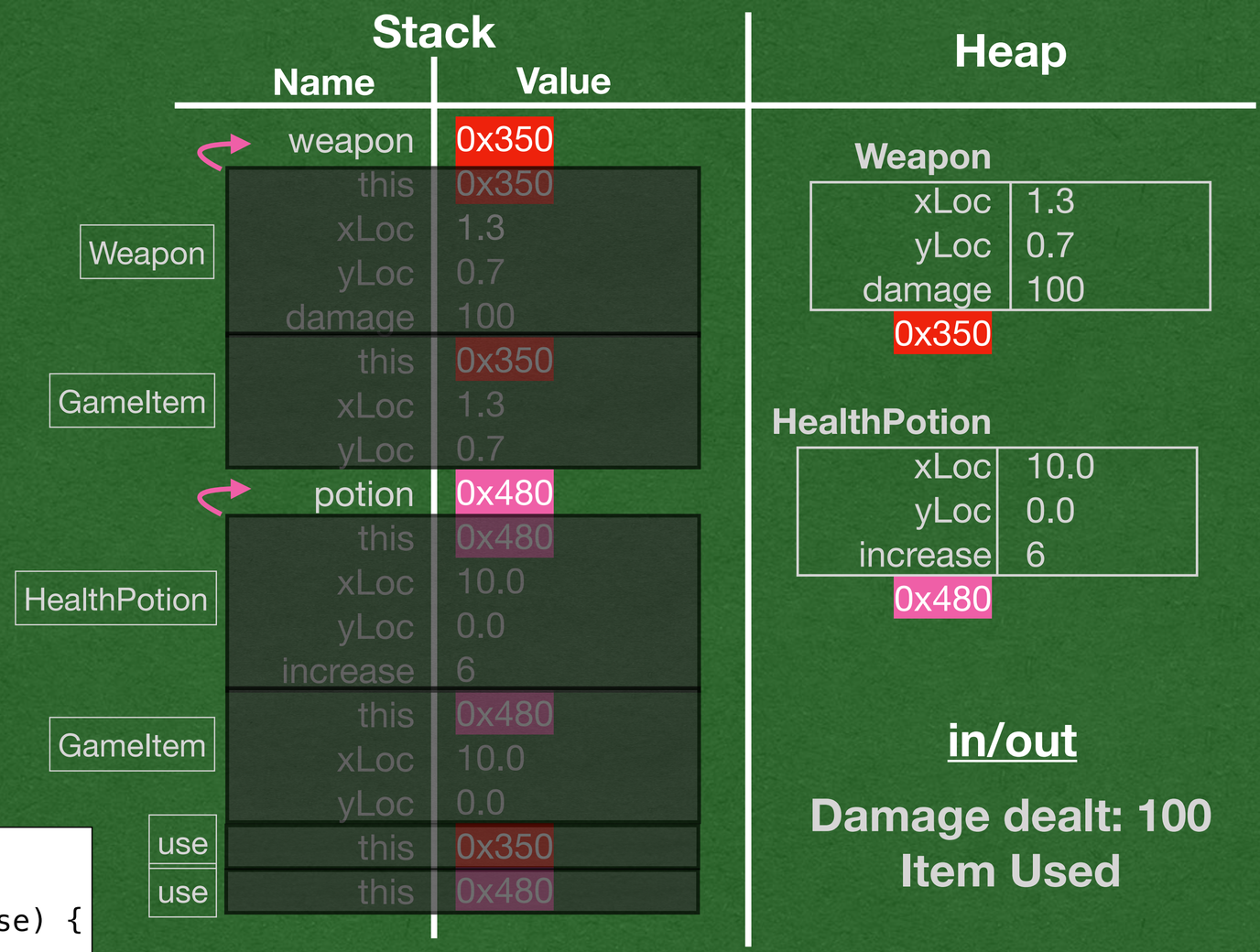
Incoming Memory Diagram!!

```java
public class GameItem {
    private double xLoc;
    private double yLoc;
    public GameItem(double xLoc, double yLoc) {
        this.xLoc = xLoc;
        this.yLoc = yLoc;
    }
    public void use() {
        System.out.println("Item Used");
    }
}
```

```java
public class Weapon extends GameItem {
    private int damage;
    public Weapon(double xloc, double yLoc, int damage) {
        super(xloc, yLoc);
        this.damage = damage;
    }
    @Override
    public void use() {
        System.out.println("Damage dealt: " + this.damage);
    }
}
```

```java
public class HealthPotion extends GameItem {
    private int increase;
    public HealthPotion(double xLoc, double yLoc, int increase) {
        super(xLoc, yLoc);
        this.increase = increase;
    }
}
```

```java
public static void main(String[] args) {
    Weapon weapon = new Weapon(1.3, 0.7, 100);
    HealthPotion potion = new HealthPotion(10.0, 0.0, 6);
    weapon.use();
    potion.use();
}
```



toString

The Object Class

- Every class in Java extends Object either directly or indirectly
- Every object in Java has a toString and equals method that it inherited from Object

- We can override toString if we want custom behavior

toString

- The toString method inherited from the Object class will return:
  - {object_type}@{hex_value}
  - week6.Weapon@452b3a41
  - week6.HealthPotion@4a574795

```java
public class GameItem {
    private double xLoc;
    private double yLoc;
    public GameItem(double xLoc, double yLoc) {
        this.xLoc = xLoc;
        this.yLoc = yLoc;
    }
}
```

```java
public class Weapon extends GameItem {
    private int damage;
    public Weapon(double xloc, double yLoc, int damage) {
        super(xloc, yLoc);
        this.damage = damage;
    }
}
```

```java
public class HealthPotion extends GameItem {
    private int increase;
    public HealthPotion(double xLoc, double yLoc, int increase) {
        super(xLoc, yLoc);
        this.increase = increase;
    }
}
```

```java
package java.lang;

// Most code removed for space
public class Object {

    public Object() {}

    public String toString() {
        return getClass().getName() + "@" + Integer.toHexString(hashCode());
    }
}
```

toString

- The default behavior of toString is mostly useless
  - Even the official documentation says - "*It is recommended that all subclasses override this method.*"
- We will override this method

```java
public class GameItem {
    private double xLoc;
    private double yLoc;
    public GameItem(double xLoc, double yLoc) {
        this.xLoc = xLoc;
        this.yLoc = yLoc;
    }
}
```

```java
public class Weapon extends GameItem {
    private int damage;
    public Weapon(double xloc, double yLoc, int damage) {
        super(xloc, yLoc);
        this.damage = damage;
    }
}
```

```java
public class HealthPotion extends GameItem {
    private int increase;
    public HealthPotion(double xLoc, double yLoc, int increase) {
        super(xLoc, yLoc);
        this.increase = increase;
    }
}
```

```java
package java.lang;

// Most code removed for space
public class Object {

    public Object() {}

    public String toString() {
        return getClass().getName() + "@" + Integer.toHexString(hashCode());
    }
}
```

toString

- GameItem implicitly extends Object and inherits toString
- We override this default behavior to return something meaningful to our GameItems
  - In previous lectures, we did this without the @Override annotation
- Weapon and HealthPotion inherit the override method from GameItem

```
public class GameItem {
    private double xLoc;
    private double yLoc;
    public GameItem(double xLoc, double yLoc) {
        this.xLoc = xLoc;
        this.yLoc = yLoc;
    }
    @Override
    public String toString() {
        return "x: " + this.xLoc + " y:" + this.yLoc;
    }
}
```

```
public class Weapon extends GameItem {
    private int damage;
    public Weapon(double xloc, double yLoc, int damage) {
        super(xloc, yLoc);
        this.damage = damage;
    }
}
```

```
public class HealthPotion extends GameItem {
    private int increase;
    public HealthPotion(double xLoc, double yLoc, int increase) {
        super(xLoc, yLoc);
        this.increase = increase;
    }
}
```

toString

- We can also override a method that has already been overridden

- In both Weapon and HealthPotion
  - Override toString again to return Strings specific to each type

- Note: In Weapon we omitted the annotation and in HealthPotion we used the annotation
  - Both have the same result on our program
  - No reason to mix using and not using the annotation except for an example

```java
public class GameItem {
    private double xLoc;
    private double yLoc;
    public GameItem(double xLoc, double yLoc) {
        this.xLoc = xLoc;
        this.yLoc = yLoc;
    }
    @Override
    public String toString() {
        return "x: " + this.xLoc + " y:" + this.yLoc;
    }
}
```

```java
public class Weapon extends GameItem {
    private int damage;
    public Weapon(double xloc, double yLoc, int damage) {
        super(xloc, yLoc);
        this.damage = damage;
    }
    public String toString() {
        return "Weapon Damage: " + this.damage;
    }
}
```

```java
public class HealthPotion extends GameItem {
    private int increase;
    public HealthPotion(double xLoc, double yLoc, int increase) {
        super(xLoc, yLoc);
        this.increase = increase;
    }
    @Override
    public String toString() {
        return super.toString() + " - Health Potion";
    }
}
```

super

- We saw the super keyword when calling the super classes constructor

- Another use is to call an override method
  - Here, we call the GameItem's toString method
- It's common to add functionality to a method instead of completely replacing it
  - Override the method, but still call the method you are replacing with *super*

```java
public class GameItem {
    private double xLoc;
    private double yLoc;
    public GameItem(double xLoc, double yLoc) {
        this.xLoc = xLoc;
        this.yLoc = yLoc;
    }
    @Override
    public String toString() {
        return "x: " + this.xLoc + " y:" + this.yLoc;
    }
}
```

```java
public class Weapon extends GameItem {
    private int damage;
    public Weapon(double xloc, double yLoc, int damage) {
        super(xloc, yLoc);
        this.damage = damage;
    }
    public String toString() {
        return "Weapon Damage: " + this.damage;
    }
}
```

```java
public class HealthPotion extends GameItem {
    private int increase;
    public HealthPotion(double xLoc, double yLoc, int increase) {
        super(xLoc, yLoc);
        this.increase = increase;
    }
    @Override
    public String toString() {
        return super.toString() + " - Health Potion";
    }
}
```

Another Memory Diagram

```java
public class GameItem {
    private double xLoc;
    private double yLoc;
    public GameItem(double xLoc, double yLoc) {
        this.xLoc = xLoc;
        this.yLoc = yLoc;
    }
    @Override
    public String toString() {
        return "x: " + this.xLoc + " y:" + this.yLoc;
    }
}
```

```java
public class Weapon extends GameItem {
    private int damage;
    public Weapon(double xloc, double yLoc, int damage) {
        super(xloc, yLoc);
        this.damage = damage;
    }
    public String toString() {
        return "Weapon Damage: " + this.damage;
    }
}
```

```java
public class HealthPotion extends GameItem {
    private int increase;
    public HealthPotion(double xLoc, double yLoc, int increase) {
        super(xLoc, yLoc);
        this.increase = increase;
    }
    @Override
    public String toString() {
        return super.toString() + " - Health Potion";
    }
}
```

```java
    Weapon weapon = new Weapon(1.3, 0.7, 100);
    HealthPotion potion = new HealthPotion(10.0, 0.0, 6);
    System.out.println(weapon);
    System.out.println(potion);
```