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6.092 Introduction to Software Engineering in Java
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6.092: Intro to Java

4: Classes, Objects

Assignment 3

A group of friends participate in the Boston Marathon.

- Find the best performer.
- Find the second-best performer.

Solution (I)

```
public static int getMinIndex(int[] values) {

   int minValue = Integer.MAX_VALUE;
   int minIndex = -1;

   for(int i=0; i<values.length; i++)
      if(values[i] < minValue) {
         minValue = values[i];
         minIndex = i;
      }

   return minIndex;
}
```

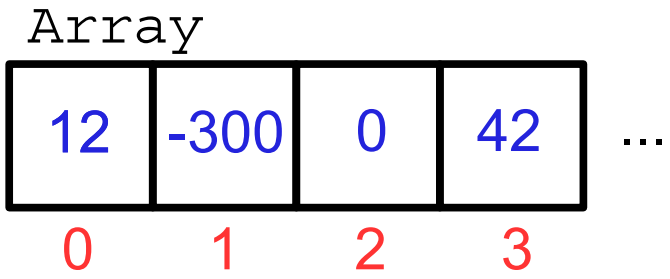
Solution (II)

```
public static int getSecondMinIndex(int[] values)
{
   int secondMinValue = Integer.MAX_VALUE;
   int secondMinIndex = -1;
   int minIndex = getMinIndex(values);

   for(int i=0; i<values.length; i++) {
      if(i == minIndex)
         continue;
      if(values[i] < secondMinValue) {
         secondMinValue = values[i];
         secondMinIndex = i;
      }
   }
   return secondMinIndex;
}
```

Frequent Issues (I)

Array index VS array values

```
for(int i=0; i< array.length; i++) {

   System.out.println(i) // index
   System.out.println(array[i]) // value @ i

}
```



Frequent Issues (II)

Curly braces { … } in loops

- Without braces, only one statement is in the loop

```
int i=0;
for(i=0; i<10; i++)
   System.out.println("Inside loop"); // executed 10x
System.out.println(i); // executed 1x only

for(i=0; i<10; i++) {
   System.out.println("Inside loop"); // executed 10x
   System.out.println(i); // executed 10x
}
```

- Similarly for *if* / *else* blocks...

Frequent Issues (III)

Be careful when initializing variables

```
public static int getMin(int[] values) {
   int minValue;
   minValue = 0; // X
   minValue = 1000; // ✓ if ∃ value<=1000
   minValue = values[0]; // ✓
   minValue = Integer.MAX_VALUE; // ✓

   for(int i=0; i< values.length; i++)
      if(values[i] < minValue)
         minValue = values[i];

   return minValue;
}
```

Frequent Issues (IV)

Second min & variable initialization

```
public static int getSecondMin(int[] values) {
   int min = getMin(values);
   int secondMin;
   if(values[0] == min)
      secondMin = values[1];
   else
      secondMin = values[0];

   for(int i=0; i<values.length; i++) {
      if(values[i] == min)
         continue;
      if(values[i] < secondMin)
         secondMin = values[i];
   }
   return secondMin;
}
```

Building & Debugging Programs

- Write programs block by block
- Use *println*s to ensure that your block is correct

```
for(int i=0; i< values.length; i++)
   if(values[i] < minValue) {
      System.out.println("Current min: " + minValue);
      System.out.println("New min: " + values[i]);
      minValue = values[i];
   }

System.out.println("Final min: " + minValue);
```

What we have learned so far...

- Variables & types
- Operators
- Type conversions & casting
- Methods & parameters
- *If* statement
- Loops
- Arrays

What we are going to learn today...

- Classes & Objects

(object-oriented programming OOP)

Object-Oriented Programming

How do you represent the world on your computer?

Object-Oriented Programming

`int`, `float`, `double`, `strings` are low-level.

Can we do things at a higher level?

Objects

Objects are a collection of related data and methods.

Objects

Example: Strings

A string is a collection of characters (letters) and has a set of methods built in.

```
String nextTrip = “Mexico”;
int size = nextTrip.length(); // 6
```

Objects

To create a new object, use the `new` operator.

If you do not use `new`, you are making a *reference* to an object (i.e a pointer to the same object).

Objects

```
Point p;
p.x = 23;
p.y = -12;

public static Point middlePoint (Point p1, Point p2) {
   Point q = new Point ((p1.x+p2.x)/2, (p1.y+p2.y)/2);
   return q;
}
```

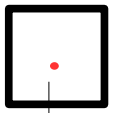
Objects and references

```
Point p1 = new Point (12,34);
Point p2 = p1;

System.out.println("x = " + p2.x); // 12

p1.x = 24;
System.out.println("x = " + p2.x); // 24!
```

Objects and references

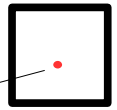
```
Point p1 = new Point(12, 34);
```

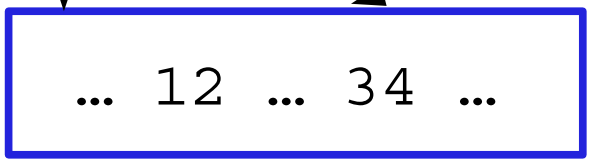
Point p1



```
Point p2 = p1;
```

Point p2





The `null` object

`null` simply represents no object. It is convenient as a return value to mean that a method failed for example. It may also be used to "remove" an element from an array.

```
String values[] = { "Adam", "Bob", "Mary" };
values[1] = null;
```

Classes

A class is a prototype to design objects.

It is a set of variables and methods that *encapsulates* the properties of the class of objects.

Classes

In Java, you can (will) create several classes in a project.

Syntax Issues

- Class names begin with a capital letter

  (e.g `WeeklyPay`)

- One class = one file

- Only one class has the `main` method

  (*startup class*)

```
class Bicycle {
   int speed;
   int gear;

   void changeGear () {
      gear += 1;
   }

   void speedUp () {
      speed += 10;
   }

   void slowDown () {
      speed -= 10;
   }
}
```

Here we create two separate objects of the class Bicycle.

```
class CambridgeBicycleStore {

public static void main (String arguments[])
{
   Bicycle bike1 = new Bicycle();
   Bicycle bike2 = new Bicycle();
   bike1.speedUp();
}
```

Class constructors

A class constructor is called each time an object of the class is *instantiated* (created).

Class constructors

```
class Bicycle {
   public int speed;
   public int gear;

   public Bicycle() {
      speed = 0;
      gear = 1;
   }
}
```

Class constructors

```
public static void main (String[] arguments) {
   Bicycle bike = new Bicycle ();
   System.out.println (bike.speed); // 0
   System.out.println (bike.gear);  // 1
}
```

Constructors with arguments

```
class Bicycle {
   int speed;
   int gear;

   public Bicycle(int speedval, int gearval) {
      speed = speedval;
      gear = gearval;
   }
}
```

Constructors with arguments

```
public static void main (String[] arguments) {
   Bicycle bike = new Bike (10,3);
   System.out.println (bike.speed); // 10
   System.out.println (bike.gear);  // 3
}
```

Reference vs primitive

- Primitive types are the basic types of data
- byte, short, int, long, float, double, boolean, char
- primitive variables store primitive values

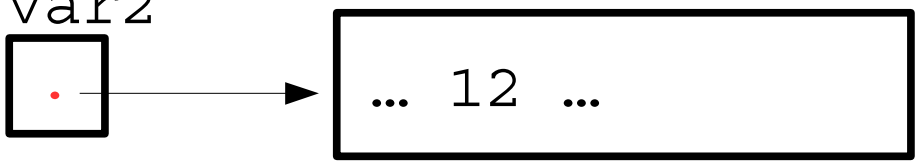
- Reference types are any instantiable class as well as arrays
- String, Scanner, Random, Point, int[], String[], etc.
- reference variables store addresses

```
int var1 = 12;
```

var1


```
NewC var2 = new NewC(12);
```

var2



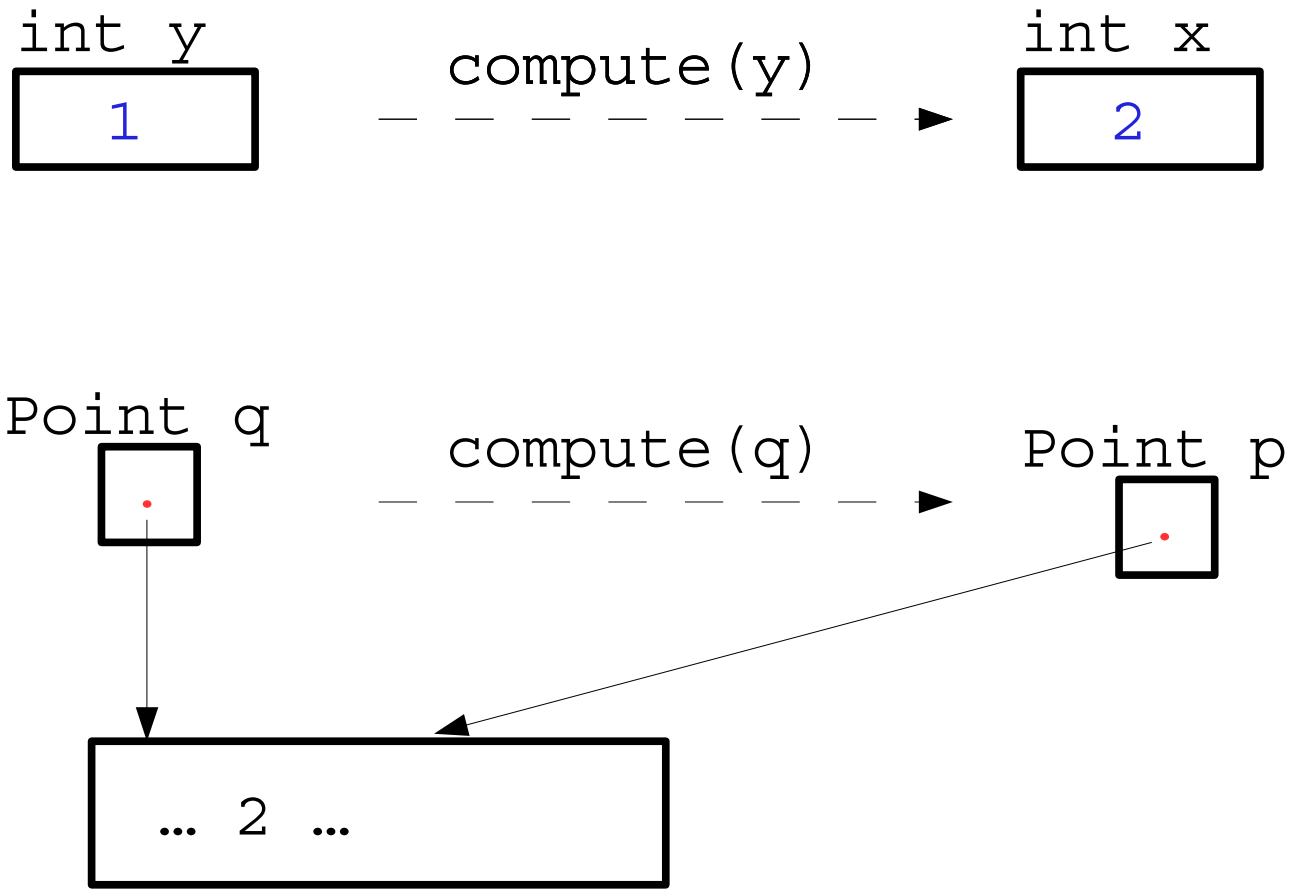
Reference vs primitive

```
class Example {
   public static void compute (int x) {
      x = 2;
   }

   public static void main(String[] arguments) {
      int y = 1;
      System.out.println(y); // 1
      compute (y);
      System.out.println(y); // 1
   }
}
```

Reference vs primitive

```
class Example {
   public static void compute (Point p) {
      p.x = 2;
   }

   public static void main(String[] arguments) {
      Point q = new Point(1,1);
      System.out.println(q.x); // 1
      compute (q);
      System.out.println(q.x); // 2!
   }
}
```

Reference vs primitive



Object methods vs class methods

So far, we have seen class methods.

Class methods are declared `static`.

```
class Bicycle {
   static int gear, speed;

   public static void speedUp (Bicycle b) {
      b.speed += 10;
   }

   public static void main (String[] arguments) {
      Bicycle bike1 = new Bicycle();
      speedUp (bike1);
   }
}
```

`static` means that the variable is going to be same for all objects of the class.

```
class Bicycle {
     static int gear, speed;

   public static void speedUp (Bicycle b) {
      b.speed += 10;
   }

   public static void main (String[] arguments) {
      Bicycle bike1 = new Bicycle();
      Bicycle bike2 = new Bicycle();
      System.out.println(bike2.speed); // 0
      speedUp (bike1);
      System.out.println(bike2.speed); // 10!
   }
}
```

This is not convenient!!

We changed the speed on bike 1 and it automatically changed the speed on bike 2!!

```
class Bicycle {
     static int gear, speed;

   public static void speedUp (Bicycle b) {
      b.speed += 10;
   }

   public static void main (String[] arguments) {
      Bicycle bike1 = new Bicycle();
      Bicycle bike2 = new Bicycle();

      System.out.println(bike2.speed); // 0

      speedUp (bike1);
      System.out.println(bike2.speed); // 0
   }
}
```

non-static means that the variable is going to be different for each object.

Object methods vs class methods

The same concept applies to methods.

`static` methods are defined for a class.

non-static methods are defined for an object.

```
class Bicycle {
    static int gear, speed;

   public static void speedUp () {
      speed += 10;
   }

   public static void main (String[] arguments) {
      Bicycle bike1 = new Bicycle();
      Bicycle bike2 = new Bicycle();

      System.out.println(bike2.speed); // 0

      bike1.speedUp ();
      System.out.println(bike2.speed); // 0
   }
}
```

static or non-static?

- As you like!
- Most of the time, both will work.

- However, one may make more sense than the other:

`speedUp` should be non-static (object)

`comparePrice(bike1, bike2)` should be `static` (class)

static (class)

```
static void speedUp (Bicycle b); //declare
speedUp (bike1); // call
```

---

non-static (object)

```
void speedUp(); // declare
bike1.speedUp(); // call
```

A common mistake

"non-static variable gear cannot be referenced from a static context "

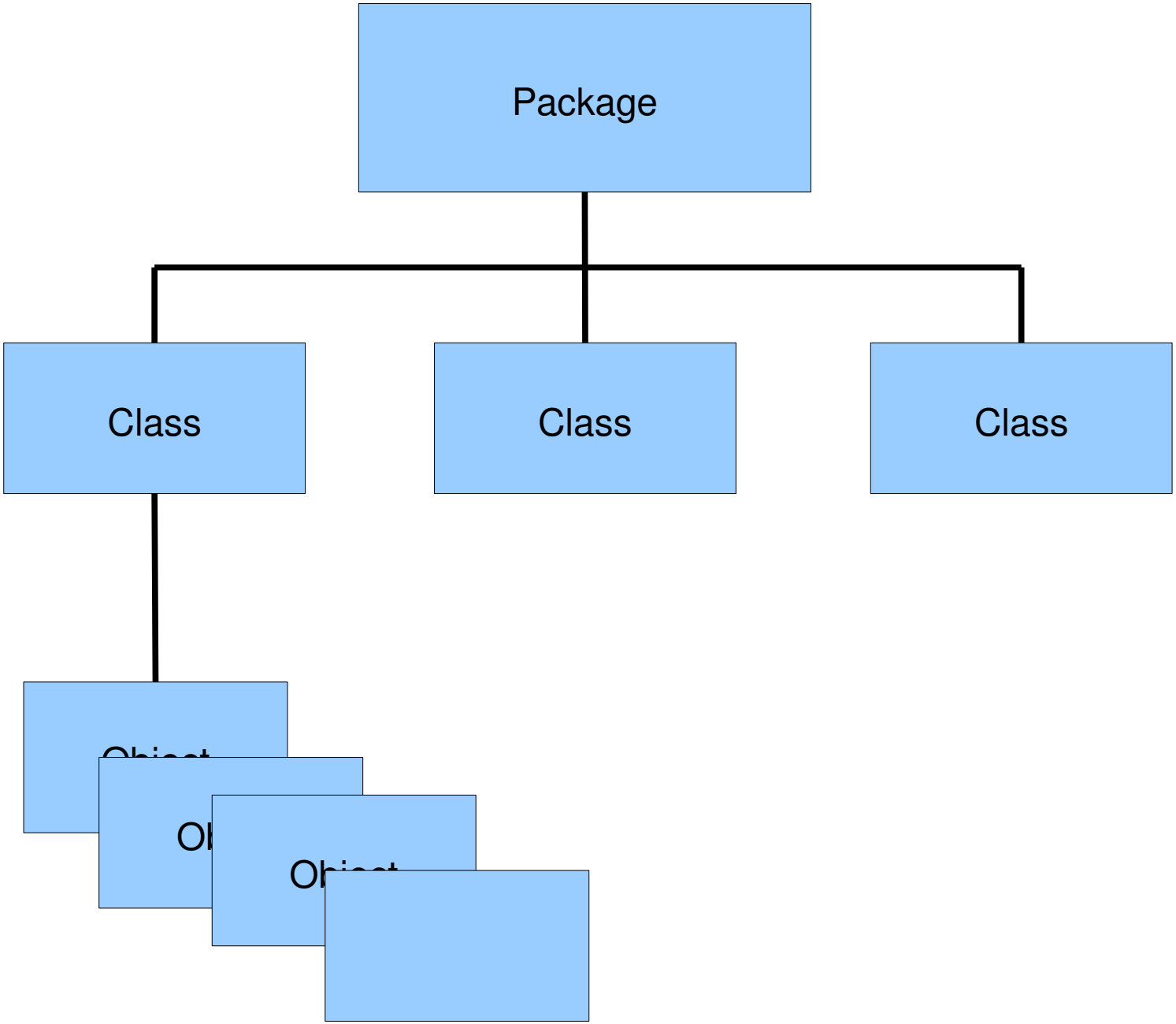
```
class Bicycle {
   int gear, speed;

   public static void speedUp () {
      speed += 10; // WRONG!!
   }
}
```

Packages

A package is a set of classes that relate to a same purpose.

Example: math, graphics, input/output...

In order to use a package, you have to *import* it.


Package
Class
Class
Class

Assignment 4

Electronic system to borrow / return books

- Book class
- Library class