

## CSM Berkeley 61B, Spring 2015: Week 4

### 1. Bit Manipulation

File: `BitManips.java`

```
public class BitManips {
```

**1a. Rotate a 32-bit integer left by  $k$  bits. Assume that  $k$  is less than 32.**

```
    int rotate (int x, int k) {  
  
        return ;  
    }
```

**1b. Check if an integer is a multiple of 4 using only the  $\&$  operator and equality checks.**

```
    int isMultipleOfFour(int x) {  
  
        return ;  
    }
```

**1c. Check if an integer is odd using only bit shifting and equality checks.**

Assume that you do not know the number of bits in your number.

```
    int isOdd(int x) {  
  
        return ;  
    }
```

**1d. Write a one-line expression equivalent to  $x * 35$  without using  $*$ ,  $/$ , or  $\%$ .**

```
    int times35(int x) {  
  
        return ;  
    }  
}
```

**1e. What does  $n \& (n - 1) == 0$  test? (Fall 2013 Final Exam)**

## 2. Lists

### 2a. SLists

Write a method that, given an SList, an int j, and an int k, return an SList with elements at indexes k, k+j, k+2\*j, ....  
**Do not change the original list.**

File: `Slist.java`

```
class SListNode {
    Object item; SListNode next;
    SListNode(Object item, SListNode next) {
        this.item = item; this.next = next;
    }
    SListNode(Object item) {
        this(item, null);
    }
}

public class SList {
    private SListNode head;
    public SList(SListNode head) {
        this.head = head;
    }

    public static Object multiples(SList list, int j, int k) {

    }
}
```

**2b. Arrays**

1. [2 points] Assume that a `Point`'s `toString` method returns a string containing that `Point`'s coordinates (so that `System.out.println(x)` prints `"(4, 5)"` if `x` is new `Point(4, 5)` and `"null"` if `x` is null). What is the output of the following (valid) program?

```
import java.awt.Point;
public class Foo {
    public static void bar (Point[] arr, Point p) {
        arr[1] = p;
        arr[2] = arr[1];
        p.x = 1;
        p = new Point(2,2);
        p.y = 3;
        arr[3] = p;
    }
    public static void main(String[] args){
        Point[] points = new Point[4];
        Point p = new Point(0,0);
        bar(points, p);
        System.out.println(p);
        for (int i = 0; i < points.length; i += 1) {
            System.out.println(points[i]);
        }
    }
}
```

### 3. Static and dynamic types review

```
List l;
if (use_linked_list) {
    l = new LinkedList();
} else {
    l = new ArrayList();
}
```

**static types** = the **declared** type = checked at **compile time**

We don't need to run the code to know that `l` is a `List`.

**dynamic type** = the **actual** type = checked at **run time**

When we run the code, depending on the situation, `l` might either be a `LinkedList` or `ArrayList`.

```
// What would Java do?
Collection c;
if (use_set) {
    c = new HashSet();
} else {
    c = new ArrayList();
}
```

```
// Example 1: works!
c.isEmpty(); // works because Collection.isEmpty() exists
c.size();    // works because Collection.size() exists
```

```
// Example 2: compile time error
c.sort();    // compile-time error: Collection.sort() doesn't exist
c.get(0);    // compile-time error: Collection.get(int) doesn't exist
```

Static types are like guarantees or agreements. The declaration `Collection c` means that `c` is guaranteed to have `Collection`'s methods, including `isEmpty()` and `size()`. Even though `ArrayList` has some additional methods like `sort()` and `get(int)`, there was no agreement that `c` would be an `ArrayList`, so you can't use these methods. Java does this to prevent you from calling methods that might not exist at runtime – for example, what if `c` happens to be a `HashSet` and you called `c.sort()`?

Java follows simple rules (think: “Java is dumb”). Even when it's clear to you that `c` here is definitely an `ArrayList`, you still have to declare it as such. That is,

```
Collection c = new ArrayList();
c.sort();
```

will still fail at compile time. This is not necessarily a bad thing! When I declare `c` to be a `Collection` here, it kind of means I'm saying “I just want a `Collection`, it'll be an `ArrayList` here but I don't want to do any `ArrayList`-specific things.”

```
// Example 3: works, but has different results
c.add(1);
c.add(1);
c.size(); // Will this equal 1 or 2?
```

Note that `Collection` has no method implementation of its own. Java knows to look at the methods for `HashSet` or `ArrayList`, depending on what the dynamic type of `c` is.

#### 4. Static and dynamic types questions

##### 4a. Spot the compile time errors. (There are four!)

File: `CompileTimeErrorTest.java`

```
public class CompileTimeErrorTest {
    public string howOld(age) {
        if age <= 18 {
            return "Not very old";
        } else if (age > 21) {
            return "Really old";
        }
    }
}
```

##### 4b. Where is the runtime error?

File: `RuntimeErrorTest.java`

```
public class RuntimeErrorTest {
    private Person p;

    public RuntimeErrorTest() {
        String personName = p.getName();
        int nameLength = personName.length();
        System.out.println(nameLength);
    }

    public static void main(String[] args) {
        RuntimeErrorTest t = new RuntimeErrorTest();
    }
}

class Person {
    public String getName() {}
}
```

## 5. Vroom Vroom!

To get the car rolling!

File: `Vehicle.java`

```
import java.util.ArrayList;

public abstract class Vehicle {
    int seats;
    int wheels;
    int fuel;
    int mpg;
    int trunkSize;
    ArrayList<Object> trunk;

    public Vehicle(int seats, int wheels, int fuel, int mpg) {
        this.seats = seats;
        this.wheels = wheels;
        this.fuel = fuel;
        this.mpg = mpg;
        this.trunk = new ArrayList<Object>();
        this.trunkSize = 0;
    }

    public void putInTrunk(Object item) {
        System.out.println("There is no room in the Trunk");
    }

    float range() {
        return fuel * mpg;
    }
}

class Car extends Vehicle {
    public Car(int fuel, int mpg) {
        super(4, 4, fuel, mpg);
        this.trunkSize = 2;
    }

    public void putInTrunk(Object item) {
        if (this.trunk.size() < this.trunkSize) {
            trunk.add(item);
        } else {
            super.putInTrunk(item);
        }
    }
}

class Motorcycle extends Vehicle {
    public Motorcycle(int fuel, int mpg) {
        super(1, 2, fuel, mpg);
    }
}
```

```
/* Fill this class in assuming that the trunkSize of a Truck is 5 */
public class Truck extends Car {
    public Truck(int fuel, int mpg) {

    }
}
```

What will happen after each of these snippets of code are compiled/run?

#### 5.1

```
Vehicle v1 = new Vehicle(3,4,20,10);
System.out.println("Range of v1: " + v1.range());
```

#### 5.2

```
Vehicle v2 = new Car(20,20);
System.out.println("Range of v2: " + v2.range());
```

#### 5.3

```
Vehicle v3 = new Motorcycle(10,40);
System.out.println("Range of v3: " + v3.range());
```

#### 5.4

```
System.out.println("Number of seats of v2 " + v2.seats);
System.out.println("Number of seats of v3 " + v3.seats);
```

#### 5.5

```
System.out.println("Number of wheels of v2" + v2.wheels);
System.out.println("Number of wheels of v3" + v3.wheels);
```

#### 5.6

```
v2.putInTrunk("Backpack");
v2.putInTrunk("Laptop");
v2.putInTrunk("Shoes");
```

#### 5.7

```
v3.putInTrunk("Backpack");
v3.putInTrunk("Laptop");
v3.putInTrunk("Shoes");
```