CS 61B Spring 2018

Scope, Pass-by-Value, Static

Discussion 2: January 23, 2018

1 Pass-by-What?

```
1  public class Pokemon {
2      public String name;
3      public int level;
4
5      public Pokemon(String name, int level) {
6          this.name = name;
7          this.level = level;
8      }
9
10     public static void main(String[] args) {
11         Pokemon p = new Pokemon("Pikachu", 17);
12         int level = 100;
13         change(p, level);
14         System.out.println("Name: " + p.name + ", Level: " + p.level);
15     }
16
17     public static void change(Pokemon poke, int level) {
18         poke.level = level;
19         level = 50;
20         poke = new Pokemon("Gengar", 1);
21     }
22 }
```

1.1 (a) What would Java display?

```
Name: Pikachu, Level: 100
```

(b) Draw the box-and-pointer diagram after Java evaluates the `main` method.

```
https://cscircles.cemc.uwaterloo.ca/java_visualize/#code=public+
class+Pokemon+%7B%0A++++public+String+name%3B%0A++++public+int+
level%3B%0A%0A++++public+Pokemon(String+name,+int+level)+%7B%0A+++
+++++this.name+%3D+name%3B%0A++++++++this.level+%3D+level%3B%0A+++
+%7D%0A%0A++++public+static+void+main(String%5B%5D+args)+%7B%0A+++
+++++Pokemon+p+%3D+new+Pokemon(%22Pikachu%22,+17)%3B%0A++++++++int+
level+%3D+100%3B%0A++++++++change(p,+level)%3B%0A++++++++System.
out.println(%22Name%3A+%22+%2B+p.name+%2B+%22,+Level%3A+%22+%2B+p.
level)%3B%0A++++%7D%0A++++%0A++++public+static+void+change(Pokemon+
poke,+int+level)+%7B%0A++++++++poke.level+%3D+level%3B%0A+++++++
+level+%3D+50%3B%0A++++++++poke+%3D+new+Pokemon(%22Gengar%22,+1)
%3B%0A++++%7D%0A%7D&mode=display&curInstr=0&showStringsAsObjects=1
```

(c) On line 19, we set `level` equal to `50`. What `level` do we mean? An instance variable of the `Pokemon` class? The local variable containing the parameter to the `change` method? The local variable in the `main` method? Something else?

It is the local variable in the `change` method and does not have any effect on the other variables of the same name in the `Pokemon` class or the `main` method.

2 Static Methods and Variables

```
1  public class Cat {
2     public String name;
3     public static String noise;
4
5     public Cat(String name, String noise) {
6         this.name = name;
7         this.noise = noise;
8     }
9
10    public void play() {
11       System.out.println(noise + " I'm " + name + " the cat!");
12    }
13
14    public static void anger() {
15       noise = noise.toUpperCase();
16    }
17    public static void calm() {
18       noise = noise.toLowerCase();
19    }
20 }
```

2.1 Write what will happen after each call of `play()` in the following method.

```
1  public static void main(String[] args) {
2      Cat a = new Cat("Cream", "Meow!");
3      Cat b = new Cat("Tubbs", "Nyan!");
4      a.play();
5      b.play();
6      Cat.anger();
7      a.calm();
8      a.play();
9      b.play();
10 }
```

```
Nyan! I'm Cream the cat!
Nyan! I'm Tubbs the cat!
nyan! I'm Cream the cat!
nyan! I'm Tubbs the cat!
```

Explanation: Notice that the variable `noise` was declared to be a static variable. What this means is that there is only one `noise` variable for the entire `Cat` class. In contrast, every time a `Cat` object is created, it gets its own `name`.

Another common use of static variables is for storing the total number of objects that have been created of a class. There needs to be only one variable per class for storing something like this!

Since there is only `noise` variable, it first gets set to `Meow!` in line 2. Then it changes to `Nyan!` in line 3 and `Meow!` is forgotten forever.

Line 6 eventually changes our one and only `noise` to `nyan!`.

One more thing to note is the functions `anger` and `calm` are decalared static themselves. Static methods can be called using the name of the class, as in line 6, whereas non-static methods cannot. The golden rule for static methods to know is that **static methods can only modify static variables**. Why? Well, if we had a static method, say, `changeNameToBob` and called `Cat.changeNameToBob()`, whose name would we change? `Cat a`? `Cat b`? We don't know. Thus the golden rule must be obeyed.

3 Practice with Linked Lists

3.1 Draw the box-and-pointer diagram that results from running the following code. A `StringList` is similar to an `IntList`. It has two instance variables, `first` and `rest`.

```
1  StringList L = new StringList("eat", null);
2  L = new StringList("shouldn't", L);
3  L = new StringList("you", L);
4  L = new StringList("sometimes", L);
5  StringList M = L.rest;
6  StringList R = new StringList("many", null);
7  R = new StringList("potatoes", R);
8  R.rest.rest = R;
9  M.rest.rest.rest = R.rest;
10 L.rest.rest = L.rest.rest.rest;
11 L = M.rest;
```

http://cscircles.cemc.uwaterloo.ca/java_visualize/#code=public+class+StringList+%7B%0A+++String+head%3B%0A+++StringList+tail%3B%0A+++public+StringList(String+head,+StringList+tail)+%7B%0A++++++this.head+%3D+head%3B%0A++++++this.tail%3Dtail%3B%0A+++%7D%0A+++public+static+void+main(String%5B%5D+args)+%7B%0A+++StringList+L+%3D+new+StringList(%22eat%22,+null)%3B%0A%09L+%3D+new+StringList(%22shouldn't%22,+L)%3B%0A%09L+%3D+new+StringList(%22you%22,+L)%3B%0A%09L+%3D+new+StringList(%22sometimes%22,+L)%3B%0A%09StringList+M+%3D+L.tail%3B%0A%09StringList+R+%3D+new+StringList(%22many%22,+null)%3B%0A%09R+%3D+new+StringList(%22potatoes%22,+R)%3B%0A%09R.tail.tail+%3D+R%3B%0A%09M.tail.tail.tail+%3D+R.tail%3B%0A%09L.tail.tail+%3D+L.tail.tail.tail%3B%0A%09L+%3D+M.tail%3B%0A+++%7D%0A%7D%0A&mode=display&showStringsAsObjects=&curInstr=52

4 Squaring a List *Extra*

4.1 Implement `square` and `squareDestructive` which are static methods that both take in an `IntList L` and return an `IntList` with its integer values all squared. `square` does this non-destructively with recursion by creating new `IntLists` while `squareDestructive` uses a recursive approach to change the instance variables of the input `IntList L`.

```
1  public static IntList square(IntList L) {
```

```
1      if (L == null) {
2          return L;
3      } else {
4          IntList rest = square(L.rest);
5          IntList M = new IntList(L.first * L.first, rest);
6          return M;
7      }
8  }
```

Explanation: This is a recursive function relying on the famous recursive leap of faith. Lines 1-2 take care of the base case. Line 4 takes the recursive leap of faith. It assumes that the `square` function correctly squares the rest of the linked list. Line 5 then uses the correct result from line 4 to create a new `IntList` with the first element squared.

```
1  public static IntList squareDestructive(IntList L) {
```

```
1      IntList B = L;
2      while (B != null) {
3          B.first *= B.first;
4          B = B.rest
5      }
6      return L;
7  }
```

Explanation: This method walks through the linked list, one part at a time, and squares each element in place. `B` is used as a position variable to keep track of where we are in the linked list. Once `B` becomes **`null`**, we have hit the end of the linked list.

4.2 *Extra*: Now, implement `square` iteratively, and `squareDestructive` recursively.

```
public static IntList square(IntList L) {
    if (L == null) {
        return L;
    }
    IntList B = L.rest;
    IntList LSquared = new IntList(L.first * L.first, null);
    IntList C = LSquared;
    while (B != null) {
        C.rest = new IntList(B.first * B.first, null);
        B = B.rest;
        C = C.rest;
    }
    return LSquared;
}
```

```
public static IntList squareDestructive(IntList L) {
    if (L == null) {
        return L;
    } else {
        L.first = L.first * L.first;
        squareMutative(L.rest);
    }
    return L;
}
```