# Lab 11

1. Consider the following code fragments. For each, if there is a compiler error, identify where it occurs.

   a. First fragment:

   ```
   List<Integer> ints = new ArrayList<>();
   ints.add(1);
   ints.add(2);
   List<Number> nums = ints; //Yes, Compiler error is here
   nums.add(3.14);
   ```

   A list of a parent

   b. Second fragment:

   ```
   List<Integer> ints = new ArrayList<>();
   ints.add(1);
   ints.add(2);
   List<? extends Number> nums = ints;
    nums.add(3.14); //Yes, Compiler error is here
   ```

   Get and Put Principle for Bounded for Bounded Wildcards, **? Extends T** only works to get

2. A *group* is a collection of elements having one special element. An example of a group is the set of integers {. . . -2, -1, 0, 1, 2, . . . }, with special element 0.

   Here is a representation of a group as a Java class:

```
public class Group<T> {
    private T specialElement;
    private List<T> elements = new ArrayList<>();
    public Group(T special, List<T> elements) {
        this.specialElement = special;
        this.elements = elements;
    }
}
```

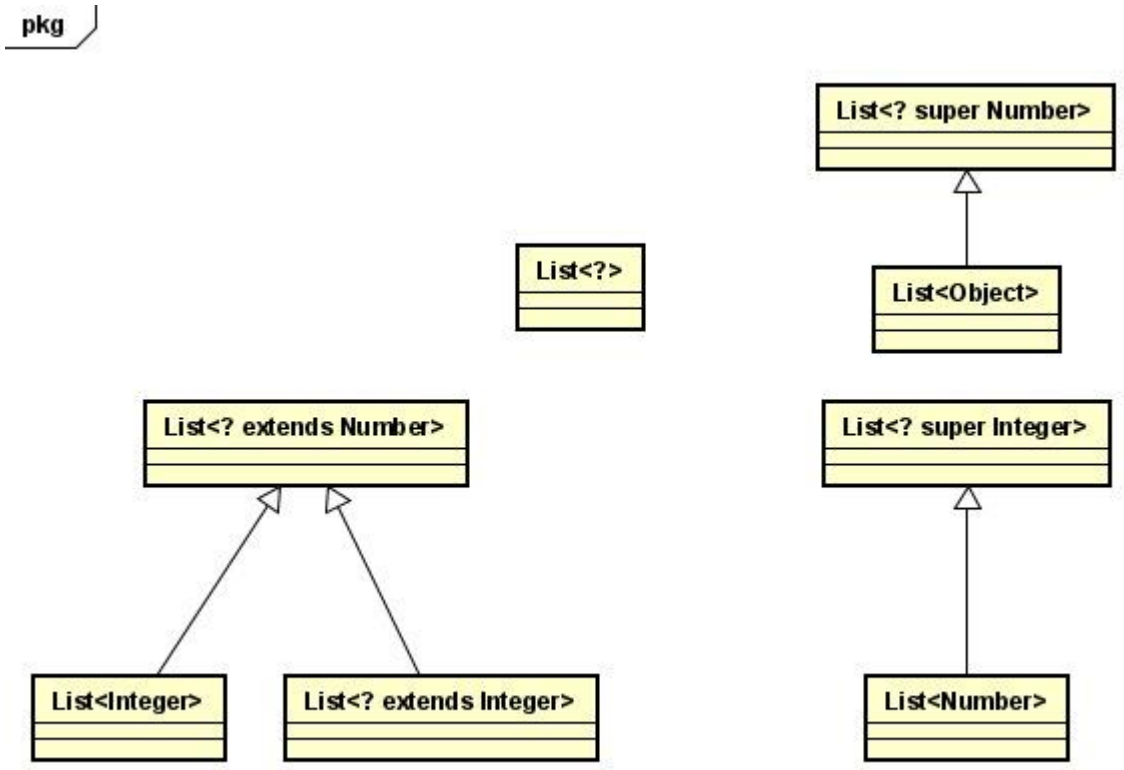
   The following static method attempts to make a copy of a given instance of a Group, reproducing the state of the group in the copy.

```
public static Group<?> copy(Group<?> group) {
    List<?> elements = group.getElements();
    Group<?> grp = new Group<?>(group.getSpecialElement(), elements);
    return grp;
}
```

The code does not compile. Fix the code by capturing the wildcard with a helper method. Startup code is provided in the directory for this lab problem. Use the main method provided there to test your implementation. Note that the Group class has a `toString` method that will help in your test.

3. Draw a class diagram showing the inheritance relationships among the following types:

```
List<Integer>, List<Number>, List<? extends Integer>,
List<? extends Number>, List<? super Integer>, List<? super Number>,
List<?>, List<Object>
```



4. Recall the definition of `sum` given in the slides:

```
public static double sum(Collection<? extends Number> nums {
    double s = 0.0;
    for(Number num : nums) s += num.doubleValue();
    return s;

}
```

   a. Is there a compiler error in the following lines of code? If so, where?

```
List<Integer> ints = new ArrayList<>();
ints.add(1);
ints.add(2);
List<? extends Number> nums = ints;
double dbl = sum(nums);
nums.add(3.14);   //Yes, compiler error here
```

Get and Put Principle for Bounded for Bounded Wildcards, **? Extends T** only works to get

   b. Is there a compiler error in the following lines of code? If so, where?

```
List<Object> objs = new ArrayList<>();
objs.add(1);
objs.add("two");
List<? super Integer> ints = objs;
ints.add(3);
double dbl = sum(ints); //Yes, compiler error here
```

5. Create a generic programming solution to the problem of finding the second smallest element in a list. In other words, devise a `public static` method `secondSmallest` so that it can handle the biggest possible range of types.

6. Generalize the `contains` method for a `List` in the following way. First consider a simple implementation for a `List` of `Strings`:

```
public static boolean contains1(List<String> list, String s) {
    for(String x: list) {
        if(x == null && s == null) return true;
        if(s == null || x == null) continue;
        if(x.equals(s)) return true;
    }
    return false;
}
```

This `contains` method is tested in the following test method:

```
public static void test1() {
    List<String> list = Arrays.asList("Bob", "Joe", "Tom");
    boolean result = Main.contains1(list, "Tom");
    System.out.println(result);
}
```

We would like to generalize to a type variable `T`. Write the code for the most general possible `contains` method so that the type T can represent Employees, Accounts, Managers, and other types. Note that in more general lists, the objects in the `List` may not have overridden the `equals` method. Note also that classes like Employee and Account, which are provided in your startup code, do not have their own equals method, and you are not allowed to modify entity classes by overriding equals in them. To handle the lack of an equals method, you must find an alternative strategy.