CMSC 150
INTRODUCTION TO COMPUTING

LAB – WEEK 11

- ADVANCED TOPICS
  - Generics
  - ArrayList, Map
  - Range-based For loop
  - Lambdas

GENERIC PROGRAMMING

- Generic programming – programming in terms of operations of types only. Any type that satisfies the operational constraints may be used.
- In Java – Multiple methods to do this. Polymorphism (at runtime) and Generics (at compile time)
  - A note on Java…no primitive types can be used in generic programming. This is not true of something like C++

PIECE OF CAKE…JUST TREAT EVERYTHING AS AN OBJECT!

```
1. public class GenericArray {
2.     Object[] objs;
3.     …
4.    /* Other stuff.
5.       But it is limited because Object doesn't offer much.
6.       Still…we can store anything!
7.    */
8.    …
9. }
```

JAVA GENERICS

- Can be better using "Generics":

```
1. public class GenericArray<T> { //T is an non primitive type
2.     T[] objs;
3.     /* Make assumptions on the operations of T, e.g.,
4.        all T have function draw(). Now any type that
5.        satisfies this requirement may be used, regardless of
6.        inheritance tree.
7.     */
8. }
```

- Use like:

```
GenericArray<String> = new GenericArray<String>();
```

Types are explicitly written by the programmer

JAVA GENERICS

- Can also be used in functions:

```
1. public static <T, S> int compare(T t, S s) {
2.     //make assumptions on the types.
3.     //Any type that satisfies operation constraints may be used!
4.     return t.compareTo(s);
5. }
```

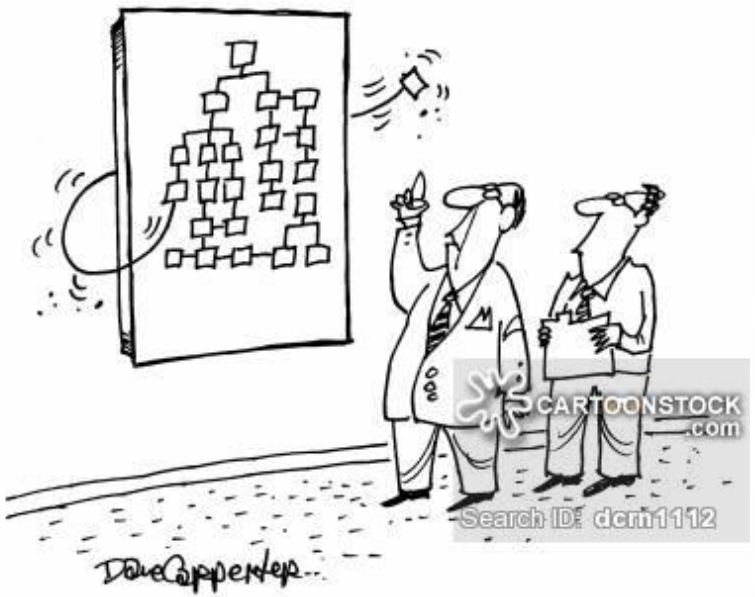
- Used like:

```
1. MyObject1 a;
2. MyObject2 b; //MyObject1 has function "compareTo(MyObject2)"
3. int c = compareTo(a, b);
```

Types are implicitly determined by compiler

DATA STRUCTURES

- Data types specifically designed to have “flexible” storage and to do so efficiently
- Here I define some common ones. CMSC 221 delves into how these would be implemented.



“Find out what he’s up to.”

ARRAYLIST

- A “growable” array
- Generic class
- Found in **`java.util.ArrayList`** (use **`import`**)
- Common functions: add, remove, size, contains
- Can also use related classes **`Vector`**, **`LinkedList`**

```
1. import java.util.ArrayList;
2. …/*in the code somewhere*/…
3. ArrayList<String> list =
       new ArrayList<String>();
4. list.add(“Hello”);
5. list.add(“There”);
6. list.remove(“Hello”);
```

MAPS

- Associative containers relate pairs of data, referred to as key, value pairs
- Example: student id to student record
- Provides very fast lookup!
- Can use **HashMap** or **TreeMap** (remember to **import**)
- Common functions: put, get, remove, size, containsKey, containsValue, etc.

```
1. import java.util.HashMap;
2. …/*Somewhere in the code*/…
3. HashMap<Integer, String> h =
     new HashMap<Integer, String>();
4. h.put(4, "JLDiablo");
5. h.put(2, "HelloWorld!");
6. String x = h.get(2);
```

RANGE-BASED FOR LOOP

- "For-each"
- Works on arrays and all data structures

```
1.int[] nums = {2, 4, 6, 8, 10};
2.for(int item : nums) {
3.    System.out.println(item);
4.}
```

Read as "for each int item **in** nums"

JAVA WILDCARDS

- A very related note, wildcards… "?" represents an unknown type. You can put extends or super constraints on ?, "? **extends X**" or "? **super Y**", then:

```
1.public static void printArrayList(ArrayList<?> l) {
2.    for(Object e : l)
3.        System.out.print(e + " ");
4.}
```

EXCEPTIONS AND TRY-CATCH

- We have seen exceptions in our code. Sometimes they are unavoidable, e.g., user does something wrong. Instead of crashing we would like to handle the error, fix the mistake, and continue the program if possible

- Throwing an exception (e.g., you detect an error):

```
throw Exception("My error msg");
```

- Catching exception:

```
try {
    functionThatMightThrowException();
}
catch(SpecificExceptionType e) {
    howeverYouHandleThis();
}
finally {
    DoSomethingToCleanup();
}
```

LAMBDA FUNCTIONS

- Nameless functions, written directly where they are used
- Example:

```
1. ArrayList<Integer> numbers = new ArrayList<Integer>();
2. for(int i = 0; i < 1000; ++i)
3.     numbers.add((int)(Math.random()*10000));
4. Collections.sort(numbers, (Integer i1, Integer i2) -> i1.compareTo(i2));
```

MUCH, MUCH, MORE

- Threading/parallel computation
- Networking
- Databases
- Other libraries (e.g., advanced graphics)
- Etc., etc.

EXERCISES

- This is your time to work on your final project. Ask lots of questions now and make significant progress so you can enjoy your break!