ADVANCED TECHNIQUES

- INTEGRATED DEVELOPMENT ENVIRONMENTS
- JAVA GENERICS
- ARRAYLIST, MAP
- LAMBDAS

INTEGRATED DEVELOPMENT ENVIRONMENTS

- IDEs combine the compiler with the text editor
- Many also provide a symbolic debugger to facilitate finding errors
- Lets try HelloWorld together in one, Eclipse

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. }
```

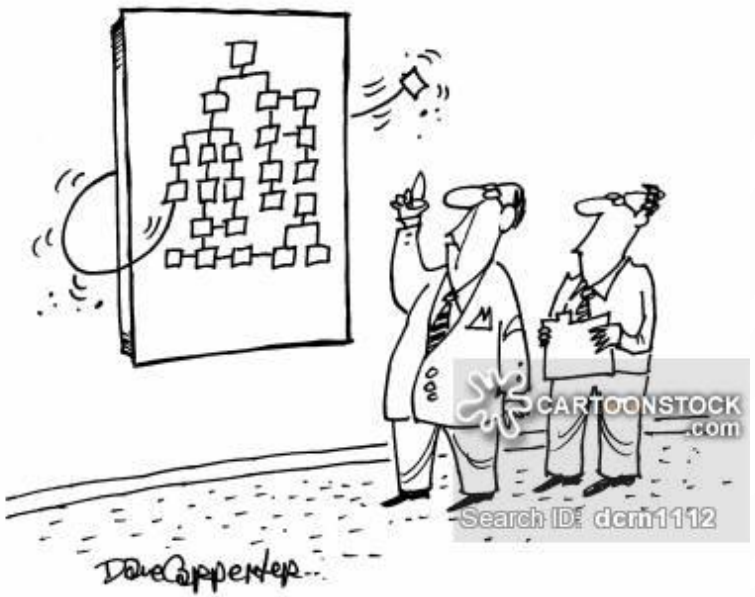
- Used like:

```
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);
```

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.}
```

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.