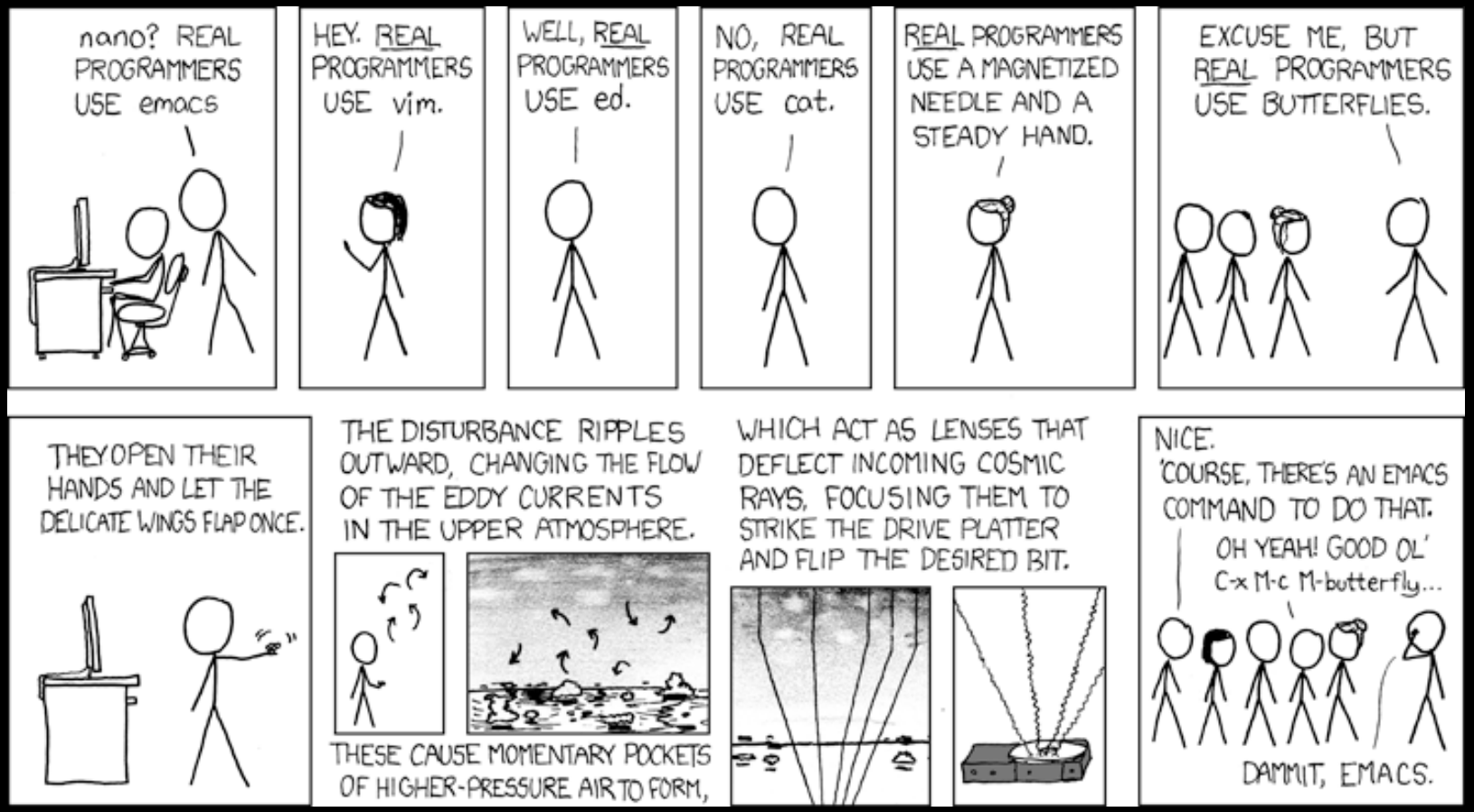


http://xkcd.com/378/

CS 152: *Programming Language Paradigms*

Returning to Java

Prof. Tom Austin
San José State University

Let's do something simple in Java…

…sort a list of numbers.

Sorting a list of numbers in Java 1

```
public static void sortNums (List lst) {
  for (int i=0; i<lst.size()-1; i++) {
    for (int j=0; j<lst.size()-1; j++) {
      if (((Integer) lst.get(j)).intValue() >
          ((Integer) lst.get(j+1)).intValue()){
        Integer tmp = (Integer) lst.get(j);
        lst.set(j, lst.get(j+1));
        lst.set(j+1, tmp);
      }
    }
  }
}
```

Now we can call our sorting algorithm:

```
List lint = new ArrayList(
    Arrays.asList(1,2,93,-1,3));
sortNums(lint);
```

Except that we could also call:

```
List lstr = new ArrayList(
    Arrays.asList("hi","there"));
sortNums(lstr);
```

Generalizing our sort algorithm

```
public static void sort (List lst,
                         Comparator cmp) {
  for (int i=0; i<lst.size()-1; i++) {
    for (int j=0; j<lst.size()-1; j++) {
      if (cmp.compare(lst.get(j),
                      lst.get(j+1)) > 0) {
        Object tmp = lst.get(j);
        lst.set(j, lst.get(j+1));
        lst.set(j+1, tmp);
      }
    }
  }
}
```

But calling this function is a little ugly:

```
sort(lint, new Comparator() {
   public int compare(Object o1,
                      Object o2) {
      Integer x = (Integer) o1;
      Integer y = (Integer) o2;
      return x.intValue()
           - y.intValue();
}});
```

Using generics (Java 5)

```
public static <T> void sort (List<T> lst,
                             Comparator<T> cmp) {
  for (int i=0; i<lst.size()-1; i++) {
    for (int j=0; j<lst.size()-1; j++) {
      if (cmp.compare(lst.get(j),
                      lst.get(j+1)) > 0) {
        T tmp = lst.get(j);
        lst.set(j, lst.get(j+1));
        lst.set(j+1, tmp);
      }
    }
  }
}
```

And calling this gets a little better:

```
sort(lint, new Comparator<Integer>() {
  public int compare(Integer x,
                     Integer y) {
    return x - y;
 }});
```

Still, compare that to the equivalent in JavaScript:

```
sort(lint, function(x,y){
  return x-y;
});
```

Java 8 Closures

Java 8 introduces lambdas (closures).

We can now write this function more concisely:

```
sort(lint,
   (Integer x,Integer y) -> x-y);
```

More Complex Sorting

```
// Even, then odd
sort(lint, (Integer x, Integer y) -> {
    if (x%2 == 0 && y%2 == 0) return 0;
    else if (x%2 == 0) return -1;
    else if (y%2 == 0) return 1;
    else return 0;
});
```

A (Partial) List of Function Interfaces

Interface	Parameter types	Return type
`Supplier<T>`	`None`	`T`
`Consumer<T>`	`T`	`void`
`BiConsumer<T,U>`	`T, U`	`void`
`Predicate<T>`	`T`	`boolean`
`ToIntFunction<T>`	`T`	`int`
`Function<T,R>`	`T`	`R`
`BiFunction<T,U,R>`	`T, U`	`R`

Method references

Sometimes lambdas just call existing methods.

Method references offer a compact notation for doing so.

Simple method taking a lambda

```
public static void applyFunOnVar(
        Consumer<String> f, String s)
{
    f.accept(s);
}
```

Calling Function

```
// Passing lambda
applyFunOnVar(
   (s)->System.out.print(s),
   "Hello ");

// Passing method reference
applyFunOnVar(
   System.out::println,
   "world!");
```

Limitations of Java Lambdas

- Java lambdas are *not* objects

```
// COMPILE ERROR!
Object o = (x) -> x+1;
```

- Java lambdas only close over *values*, not variables

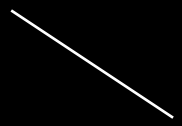
Counter class

```
Supplier<Integer> ctr =
        Counter.makeCounter();
out.println(ctr.get()); // 0
out.println(ctr.get()); // 1
out.println(ctr.get()); // 2
```

Broken `makeCounter` method

```
import java.util.function.Supplier;

public class Counter {
    public static Supplier<Integer> makeCounter() {
        int n = 0;
        return () -> n++; // error
    }
}
```



"Local variable n defined in an enclosing scope must be final or effectively final"

Working `makeCounter` method

```
import java.util.function.Supplier;

class IntHolder {
    int n = 0;
}

public class Counter {
    public static Supplier<Integer> makeCounter() {
        IntHolder ih = new IntHolder();
        return () -> ih.n++;
    }
}
```

Heap allocated memory, so modification is OK. The *reference* is not modified (effectively final).

Stream API

- Processes collections of objects
- Pipelines methods
- Each result returns a stream.

Putting it all together

```
List<String> nstr = Arrays.asList( "1",
     "2", "3", "4", "5", "six", "7");

int sum = nstr
     .stream()
     .filter(s -> s.matches("^\\d+$"))
     .map(Integer::parseInt)
     .reduce(0, (ans,i)->ans+i)
```

Lab: Lambdas

Today, you will write a class to list files using Java 8 lambdas.

Details are in Canvas.