Objectives

- Coverage tools
- Object-oriented Design Principles
  - Design in the Small

Project 1 Questions?

Project 1 Notes

- Test-driven development
  - Incomplete comments, pre-/post conditions
  - Make reasonable assumptions
    - Document assumptions in your test code
  - Write the specification that code has to pass
- Organizing tests
  - Can have multiple test classes
    - Organize by fixture, functionality, all pass, all errors

Project 1 Notes

- *Independent* test cases
  - Each tests different functionality
  - Should only have one failure
    - Easier to locate the bug
- Handling error cases
  - Sometimes an exception is the expected result

Add an "expected" attribute:

```
@Test(expected=IndexOutOfBoundsException.class)
public void testIndexOutOfBoundsException() {
   ArrayList emptyList = new ArrayList();
   Object o = emptyList.get(0);
}
```

Project 1 Notes

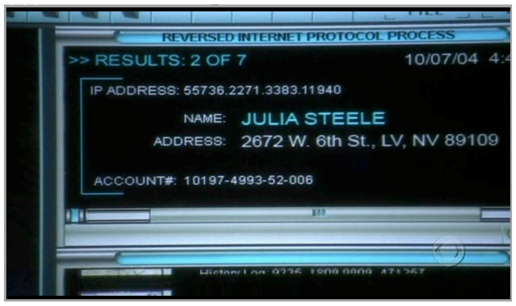
- Do **not** change the `Car` class's API or it's package
  - Otherwise, won't work with my `Car` class
- May want to write code for `Car` class to help you figure out tests

Review

- How do we know when we've tested enough?
- How can we use coverage criteria?
- Why is coverage not enough?
  - What can we do to improve testing?

Analogy: Map coverage

On CSI


REVERSED INTERNET PROTOCOL PROCESS
>> RESULTS: 2 OF 7
10/07/04
IP ADDRESS: 55736.2271.3383.11940
NAME: JULIA STEELE
ADDRESS: 2672 W. 6th St., LV, NV 89109
ACCOUNT#: 10197-4993-52-006

http://i.imgur.com/prFIq.jpg

Coverage Tools

- Coverage is used in practice
- You don't need to figure out coverage manually
- Available tools to calculate coverage
  - Examples for Java programs: Clover, JCoverage, **Emma**
  - Measure statement, branch/conditional, method coverage

Eclipse Plugin: EclEmma for Coverage

- Eclipse can be extended through plugins
  - Provide additional functionality
- EclEmma Plugin
  - Records executing program's (or JUnit test case's) coverage
  - Displays coverage graphically

Demonstration

- Execute `MediaItemTest` with Coverage

Installing Emma in Eclipse At Home

- Under `Help` → `Install New Software`
- Add… a new remote site
  - Name: EclEmma
  - URL: http://update.eclemma.org/
- Select to install Emma
  - Go through process
- Restart Eclipse

OVERRIDE ANNOTATIONS

What Happens in This Program?

```
public class Bigram {

        private final char first;
        private final char second;

        public Bigram(char first, char second) {
                this.first = first;
                this.second = second;
        }

        public boolean equals(Bigram b) {
                return b.first == first && b.second == second;
        }

        public static void main(String[] args) {
                Set<Bigram> s = new HashSet<Bigram>();
                for( int i=0; i < 10; i++ )
                        for( char ch='a'; ch <= 'z'; ch++ )
                                s.add(new Bigram(ch, ch));
                System.out.println(s.size());
        }
}
```

What's the bug?

The Bug

Set is calling `equals(Object o)` when it `adds` an element

What method did we define?

```
public boolean equals(Bigram b) {
        return b.first == first && b.second == second;
}
```

We ***overloaded*** the `equals` method.

Using @Override annotation

```
@Override
public boolean equals(Bigram b) {
        return b.first == first && b.second == second;
}
```

Compiler tells us there is a problem.

How do we fix?

OBJECT-ORIENTED DESIGN PRINCIPLES

Designing Systems

- All systems change during their life cycle
  - Changes in requirements
  - Misunderstandings in requirements
- Code must be *soft*
  - Flexible
  - Easy to change
    - New or revised circumstances
    - New contexts

Designing Systems

- All systems change during their life cycle
- Questions to consider:
  - How can we create designs that are stable in the face of change?
  - How do we know if our designs aren't maintainable?
  - What can we do if our code isn't maintainable?
- Answers will help us
  - Design our own code
  - Understand others' code

Best Practices

- (DRY): Don't repeat yourself
- Single Responsibility Principle
- Shy
  - Avoid Coupling
- Tell, Don't Ask
- Open-closed principle
- Avoid code smells

A lot of similar, related fundamental principles

DRY: Knowledge Representation

- **Intuition**: when need to change code, make in only one place

Every piece of knowledge must have a single, unambiguous, and authoritative representation within a system

- Requires planning
  - What data needed, how represented (e.g., type)

Single Responsibility Principle

There should never be more than one reason for a class to change

- **Intuition**:
  - Each responsibility is an axis of change
    - More than one reason to change
  - Responsibilities become coupled
    - Changing one may affect the other
    - Code breaks in unexpected ways

Example

```
interface Network {
      public void connect();
      public void disconnect();
      public void send(String s);
      public String receive();
}
```

- Reasonable interface
- But has two responsibilities
  - Can you group the functionality into two responsibilities?
- Check:
  - Change for different reasons? Called from different parts of program?

Shy Code

- Won't reveal too much of itself
- Otherwise: get *coupling*
  - Static, dynamic, domain, temporal
- Coupling isn't always bad…

Achieving Shy Code

- What techniques have we discussed about how to keep our code shy?

Achieving Shy Code

- Private instance variables
  - Especially mutable fields

How can you make any field immutable?

- Make classes public only when need to be public
  - i.e., accessible by other classes→ part of API
- Getter methods shouldn't return private, mutable state/objects
  - Use clone() before returning

Tell, Don't Ask

- Think of methods as "sending a message"
  - Method call: sends a request to do something
    - Don't ask about details
    - Black-box, encapsulation, information hiding
  - Return: answer

Static Coupling

- Code requires other code to compile
  - Not really a bad thing
  - BUT don't drag in more than you need
- Example: poor use of inheritance
  - Brings excess baggage
  - Inheritance is reserved for "is-a" relationships
    - Base class should not include optional behavior
    - Not "uses-a" or "has-a"
  - Want *composition* or *delegation* instead

Dynamic Coupling

- Code uses other code at runtime
  - `getOrder().getCustomer().getAddress().getState()`
  - Relies on several objects/classes and their state
- Talk *directly* to code

Domain Coupling

- Business rules, policies are embedded in code
  - Problem if change frequently
  - Code will have to change frequently
- Put into another place (metadata)
  - Database, property file ⇐
  - Process the rules

Temporal Coupling

- Dependencies on time
  - Order that things occur
  - Occur at a certain time
  - Occur by a certain time
  - Occur at the same time

➥Write *concurrent* code

Project 1 Due on Friday