Objectives

- Code Critique
  - Identifying smells
- Refactoring
- Liskov Substitution Principle

Review

- What goal are we designing to?
- What is the typical fix for code smells?
  - What is a limitation of those fixes?
- How do we address change in general?

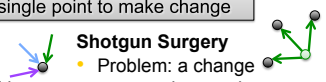
Literals or Magic Numbers

- If a number has a special meaning, make it a constant
  - Distinguish between 0 and NO_VALUE_ASSIGNED
  - If value changes (-1 instead of 0), only one place to change

Eclipse: Refactor → Extract Constant

Divergent Change & Shotgun Surgery

Problem: when make a change, can't identify single point to make change



Divergent Change

- Problem: one class commonly changed in different ways for different reasons
- Solution:
  - Identify changes for a particular cause
  - Put into a class (extract)

Shotgun Surgery

- Problem: a change causes changes in many classes
- Solution:
  - Identify class that changes should belong to

Goal: 1-to-1 mapping of common changes to classes

Data Clumps

- Problem: You have some data that always "hangs out together"
- Possible Solution: Maybe they should be an object
  - Check: if you deleted one of those pieces of data, would the others make sense?
    - If answer is no, should be an object

Eclipse: Refactor → Extract Class

Message Chaining

- Dynamic coupling:
  `getOrder().getCustomer().getAddress().getState()`
- Problem: client coupled to navigation structure
  - Depends on too many other classes
  - Change to intermediate class → Change in this class
- Fix: add delegate method
  - Example: add method `getShippingState()`
  - Can go too far if adding too many methods

Eclipse: Check references
Refactor → Extract Method

Middle Man

- Issue:
  - Many methods of one class are delegating to another class
- Possible Solutions
  - Inline method into caller
  - If there is additional behavior, replace delegation with inheritance to turn the middle man into a subclass of the real object

Lazy Class

- Problem
  - Class in question doesn't do much
  - Classes cost time, money to maintain & understand
- How could this happen?
  - Refactoring!
  - Planned to be implemented but never happened
- Solution
  - Get rid of class
    - Inline or collapse subclass into parent class

Speculative Generality

- Beware of too much abstraction, allowing for too much flexibility that isn't required
- Solution: Collapse classes

Comments

Problem: Comments used as Febreze to cover up smells

- Describe what the code or method is doing
- Should be reserved for *why*, not what
- Solutions:
  - If need a comment for a block of code (or a long statement) → create a method with a descriptive name
  - If need a comment to describe method, rename method with more descriptive name

Other Code Smells

- Discuss more code smells and solutions (Design Patterns) later

Rules of Thumb

- Code smells are not ***always*** bad
  - Do not always mean code is poorly designed
- Open code is not ***always*** bad
- Need to use your judgment
  - Good judgment comes from experience.
  - How do you get experience? *Bad judgment* works every time

Goal: Gain experience to improve your judgment

Discussion of Abstraction

- What does abstraction allow?
- Are there any limitations to abstraction?

Liskov Substitution Principle (LSP)

- Named after Barbara Liskov
  - MIT Professor of Engineering
  - 2008 ACM Turing Award
  - Contributions to programming languages, pervasive computing
  - Trivia: first woman in the United States to receive a Ph.D. from a computer science department (Stanford, 1968)

Liskov Substitution Principle (LSP)

- The substitution principle:

If for each object o_1 of type S there is an object o_2 of type T such that for all programs P defined in terms of T, the behavior of P is unchanged when o_1 is substituted for o_2, then S is a subtype of T.

- In other words…

If a module is using a Base class, then it should be able to replace the Base class with a Derived class *without affecting the functioning of the module.*

 Wing & Liskov, 1994

Code Smell: Using `instanceof`

```
public void drawShape( Shape shape ) {
    if ( shape instanceof Square ) {
        drawSquare(shape);
    }
    else if( shape instanceof Circle ) {
        drawCircle(shape);
    }
}
```

- Why isn't this good code?
- How could we write this in a better way?

Code Smell: Using `instanceof`

- Previous example: had to know all of the Shape classes
  - Update whenever a Shape is added or removed
- Better code: ***Polymorphic***!

```
public void drawShape( Shape shape ) {
    shape.draw();
}
```


Another Example: Rectangle Class

```
public class Rectangle {
   private int myHeight;
   private int myWidth;

   public void setWidth( int w ) {
      myWeight = w;
   }

   public void setHeight( int h ) {
      myHeight = h;
   }

   // getters…

}
```

Square Class

- A square is a rectangle
  - But a rectangle is not a square
- In the interest of code reuse

```
public class Square extends Rectangle
```

- Any problems with this implementation?
  - Inherits:

```
private int myHeight;
private int myWidth;
public void setWidth( int w );
public void setHeight( int h );
```


To Keep Square Consistent…

```
public void setWidth( int w ) {
    super.setWidth(w);
    super.setHeight(w);
}

public void setHeight( int h ) {
    super.setWidth(h);
    super.setHeight(h);
}
```


But What About Users of Classes?

- Consider the function:

```
public void testMethod( Rectangle r ) {
    r.setWidth(5);
    r.setHeight(4);
    assertEquals(20, r.getWidth()*r.getHeight());
}
```

- What happens if it's called with a Square?

The Problem

- A `Square` object is ***not*** a `Rectangle` object
- Behaviors are different
- Clients depend on behaviors

Lesson: All derivatives of class **must** have the same *behavior*

Design by Contract

- Methods of classes declare preconditions and postconditions
  - Preconditions must be met for method to execute
  - After executing, postconditions must be true
  - Example for Rectangle's `setWidth`:
    - myWidth == newWidth && myHeight == oldHeight
- For derivatives
  - Preconditions can only be weakened
  - Postconditions can only be strengthened
  - ➥ Derivatives must adhere to constraints for base class

Summary of LSP

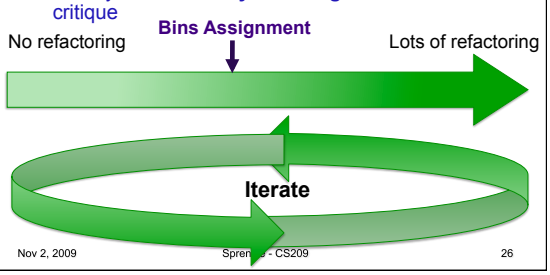
- Liskov Substitution Principle (a.k.a. design by contract) is an important feature of programs that conform to the Open-Closed Principle
  - Derived types must be completely substitutable for their base types
  - Derived types can then be modified without consequence

CODE CRITIQUE

Notes on Assignment 10

- No "right" answer
  - Many design decisions
  - Want you to **defend your design** decision in code critique

Focus: Readability



Discussion of `Bins` Solution

- What does the code do?
  - What is the purpose/responsibility of each class?
- What are the good parts of the code?
- What are some of the code smells?

Assignment 10: Code Critique & Refactoring

- Given: a problem specification and a solution to the problem
  - You refactoring your own code is emotional
  - More objective with someone else's solution
- Goals
  - Read and understand someone else's code
    - Haven't done much of this in Java
  - Critique code (do you smell something?)
    - Identify, articulate problems
  - Refactor code to solve problems identified
  - Write tests to verify the code