Objectives

Set up Assignment 7 Project

- Code Smells
- Refactoring

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Review

1. What is guaranteed in software development?
   - This informs how we design our code
2. What are some of the best practices in object-oriented design?
   - Provide an example of the practice (in our assignments, in our discussions, in Java, …)
3. What are code smells?
4. What is refactoring?
5. What is the process for writing maintainable code?

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Review: 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

Review: Best Practices Overview

- (DRY): Don't repeat yourself
- Shy Code, Avoid Coupling
- Tell, Don't Ask
- Avoid code smells
- SOLID
  - Single Responsibility Principle
  - Open-closed principle
  - Liskov Substitution Principle
  - Interface Segregation Principle
  - Dependency Inversion Principle

A lot of related fundamental principles

Review: Process to Write Maintainable Code

Apply the design principles, but as your code evolves, you'll see that you didn't always adhere to the principles

1. Identify code smell

2. ***Refactor*** code to remove code smell
   - Refactoring: Updating a program to improve its design and maintainability *without changing its current functionality significantly*

Review: Code Smells

A hint in the code that something could be designed better

- Duplicated code
- Long method
- Large class
- Long parameter list
- Very similar child classes
- Too many public variables
- Empty catch clauses
- Switch statements/long if statements
- Shotgun surgery
- Literals
- Global variables
- Side effects
- Using `instanceof`

Code Smell Case Study: Duplicated Code

- What's the problem with duplicated code?
- Why do we like it?
  - What made us write the duplicated code?
- Refactor: How can we get rid of the duplicate code?
  - Consider different possibilities for where the duplicate code is
    - Same expression multiple times in a class
    - Duplicate code in 2 sibling child classes
    - Duplicate code in unrelated classes

Problem of Duplicated Code

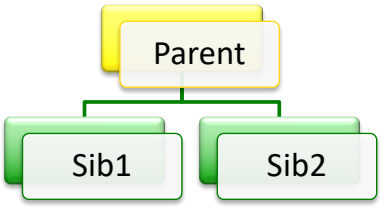
- If code changes, need to change in every location
- Duplicate effort to test code to make sure it works
  - More statements for test suite to test!
- When trying to search for code, may find a duplicate code→ not the one you're looking for
  - Increased effort in debugging

Duplicated Code Refactorings

- Consider: same expression multiple times in one class
- Solution: Extract method
  - Call method from those two places
- Benefits:
  - Reduces redundant code
  - Makes code easier to debug, test

Duplicated Code Refactorings

- Consider: duplicated code in 2 sibling child classes
- Solution: Extract method, put into parent class
  - Eclipse: extract method, pull up
- If similar but not duplicate, extract the duplicate code or parameterize



Duplicated Code Refactorings

- Consider: duplicated code in unrelated classes
- Ask: where does method belong?
- One solution:
  - Extract class
  - Use new class in current classes
- Another solution:
  - Keep in one class
  - Other class calls that method

Why so much time on duplicated code? It's a common yet costly problem.

Refactoring: Solution to Code Smells

Refactoring: Updating a program to improve its design and maintainability *without changing its current functionality significantly*

After refactoring your code, what should you do next?

Revised Process to Write Maintainable Code

Apply the design principles, but as your code evolves, you'll see that you didn't always adhere to the principles

1. Identify code smell
2. ***Refactor*** code to remove code smell
3. ***Test*** to confirm code still works!

Code Smells

- For each of the following code smells, state
  - Why these may occur in code
  - Why they are a problem in terms of maintaining code
    - Cite design principles
  - How to fix them
- Code smells:
  1. Long methods
  2. Large class
  3. Magic numbers (e.g., -1 or 480 in code)
  4. Comments (non-API/Javadoc comments)

Front two rows: 1, 3
Back two rows: 2, 4
Window side: swap order

Code Smell: Long Methods

- What's the problem with long methods?
- What made us write them?
- How can we fix them?
- What is an issue with lots of short methods?

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Long Methods: Issues and Solutions

- Issues:
  - Hard to understand (see) what method does
  - Smaller methods have reader overhead
    - Look at code for called methods
    - But, should use descriptive names
    - In Eclipse, use F3 to jump to a method's definition
- Solutions:
  - Find lines of code that go together (may be identified by a comment) and extract method

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Code Smell: Large Class

- What's the problem?

Large Class

- Issue: Too many instance variables → trying to do too much
  - Violates **Single Responsibility Principle**
- Solutions:
  - Bundle groups of variables together into another class
    - Look for common prefixes or suffixes
  - If includes optional instance variables (only sometimes used), create child classes
  - Look at how users use the class for ideas of how to break it up

Eclipse: Refactor → Extract Class or Extract Superclass

Literals or Magic Numbers

- If a number has a special meaning, make it a constant
- Example: Distinguish between 0 and NO_VALUE_ASSIGNED
  - If value changes (e.g., -1 instead of 0), only one place to change
  - Less error-prone (e.g., was I using 1 or -1?)

Eclipse: Refactor → Extract Constant

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

These [internal] comments are different from API comments

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?
  - Always consider: how is this code likely to change?
- How could we write this in a better way?

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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***!
  - There was a draw method specific to each Shape
  - Refactor those methods into Shape child classes

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

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Code Smell: Lazy Class

- Problem
  - Class in question doesn't do much
  - Classes cost time and money to maintain and 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

Code Smell: Speculative Generality

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

More Code Smells

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

Software Design 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

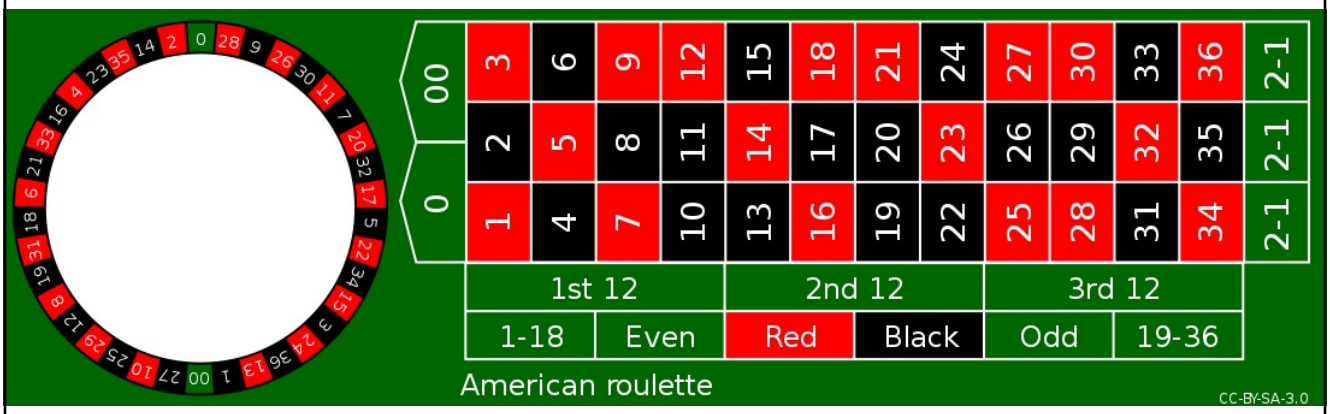
Refactoring Summary

- Write code and then *rewrite* code
  - Eye toward extensibility, flexibility, maintainability, and readability
  - Maintain correctness
- Reading/understanding other people's code can be difficult
  - Make your code readable, understandable
- Probably impossible to design/write "correctly" the first time
  - A lot harder to get the logic right, make sure you're not creating bugs, know/check the right answer…
  - Don't necessarily know what is likely to change

Extensibility, Maintainability, Readability

REFACTORING PRACTICE

Simulating a Roulette Game



Understanding Code

- Execute the code
  - What is the main driver for this project?
- What are each class's responsibilities?

Bug in the Code

- Determining if Odd/Even Bet was won is incorrect

Understanding Code

- Focus: how **open** is the code to adding **new** kinds of **bets** and how **closed** it is to **modification**?
  - How many classes know about the `Bet` class?
  - What code would need to be added to `Game` to allow the user to make another kind of bet that paid one to one odds and was based on whether the number spun was high (between 19 and 36) or low (between 1 and 18)?

Roulette

- Goals
  - Learn to read, understand someone else's code
    - Refactoring can help
  - Refactor for extensibility, readability
  - Justify decisions
  - Automated white-box testing practice
- No "right" answer
  - Many design decisions
  - Defend your design decisions in analysis

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Looking Ahead

- Roulette Assignment due next Thursday
- Exam next Friday

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