Refactoring

CPSC 501: Advanced Programming Techniques
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We’re actually doing it?

We’re actually doing it!

Refactoring Tools

- **Automate the refactoring process**
    - Restructures code while preserving behavior
    - Reduces the need to test

- Are incorporated into some IDEs
    - Xcode supports 6 common refactorings:
        - Rename, Extract, Create Superclass, Move up, Move down, Encapsulate
    - Eclipse supports ~18 refactorings

    - But note that **Fowler (text) lists ~72 refactorings**
        - Manual refactoring will still often be necessary

Refactoring Principles

- **Refactoring:** is the **disciplined process** of **changing** the **internal structure** of software to make it easier to understand and maintain, **without changing** its **external** observable behavior

Refactoring Principles

- **Why refactor?**
  1. **Improves the design of software**
     - Reverses the "**decay**" of cumulative ad hoc changes
  2. **Makes software more readable**
     - A clear design is easier to understand and maintain
     - Use refactoring to learn about unfamiliar code
  3. **Helps you find and eliminate bugs**
  4. **Helps you program faster**
     - A **poor design** prevents rapid development

Refactoring Principles

- **When should you refactor?**
  1. Continuously, as you develop or modify code
  2. Whenever you duplicate code
  3. When adding functionality to code
     - i.e. change the design to make adding features easy
  4. As you find and fix bugs
     - It's easier to spot bugs when the design is clear
  5. As you do a code review

Not so fast

Refactoring Principles

- **Problems with Refactoring**

  - **Many refactorings change a class’s public interface**
    - E.g. methods may be renamed or removed
    - Not a problem if you can edit all calling code

  - **If the interface is published, you need a transition period** where the old interface is kept until clients adopt the new interface
    - Mark an old method as **deprecated** and have it call the new method

Refactoring Principles

- **You may not be able to refactor your way out of a design mistake**
  - May be necessary to do more upfront design

- **If software is tightly coupled to a database, changing the object model may cause changes to the database schema**
  - Forces you to migrate data, which is difficult and expensive
  - Isolate changes by putting a layer between the database and object model

Rule of thumb

Which thumb?

Refactoring Principles

- **Don't refactor when:**
  - Its easier to rewrite from scratch
  - You are close to a release deadline

- Refactoring and design
  - **Refactoring is not a replacement for upfront design**
  - But it **lets you create a simple, upfront design** that does not build in unneeded flexibility
    - i.e. you can always refactor later if necessary

Refactoring Principles

- Refactoring and performance
  - **Refactoring often makes software run more slowly**
    - **More function structure is complexity with runtime cost**
  - **But also more amenable to performance tuning**
    - If well factored, **“hot spots”** will be isolated to a few short methods
      - Found using a profiler late in development
    - **Tune the hot spots only**
      - Tuning the other code is a waste

When to Refactor

- **No hard and fast rules**
  - Best to use informed intuition
    - i.e. try to detect **“Bad smells in code”**

Ok lots of ‘rules’

Lots of thumbs?

Names may be slightly different between these edition 1 and 2018 edition 2

Duplicated Code

When to Refactor - Duplicated code

- **Duplicated code**
  - If the same code in two or more places in the same class
    - **Extract Method**, and call it from each place
  - If the same code in two sibling classes
    - **Extract Method**, if necessary
    - **Pull Up Method** into common superclass

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When to Refactor - Duplicated code

- **Duplicated code**
  - If similar code in sibling classes
    - **Extract Method**, if necessary
    - **Form Template Method** to put common code in superclass, differing code in subclasses
  - If the same code in unrelated classes
    - **Extract Class** in one class, and use the new class in the other classes

Long Code

When to Refactor – Long Method

- **Long method**
  - Decompose into small methods
    - Sometimes just one line long
  - **Extract Method** on blocks of code that can be separated out
    - Look for “clumps”
      - E.g. Commented blocks, loops, conditionals, etc.
    - May need to **Replace Temp with Query** to enable the extraction

Long Code – Replace temp with query

Replace Temp with Query

- You have parameter initialization that is temporary
  - Replace this code with a function query that returns the result that was initialization

Replace Temp with Query

```
int basePrice = this._quantity * this._itemPrice;
if (basePrice > 1000)
   ...
```

- Change above into the following

```
int getBasePrice() {this._quantity * this._itemPrice;}
...
int basePrice = getBasePrice();
if (basePrice > 1000)
   ...
```

Large Class

When to Refactor – Large Class

- **Large class**
  - **Tries to do too many different things (not cohesive)**
    - Too many instance variables, and/or
    - Too much code
  - **Extract Class** or **Extract Subclass** to separate out “bundles” of data and responsibilities

Long Parameter List

When to Refactor - Long Parameter List

- **Long parameter list**
  - Better to pass in an object, so the method can get the data it needs
  - Shorten list with **Preserve Whole Object** (pass in object instead of pulling of data as multiple parameters) or **Introduce Parameter Object**

Divergent Change

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When to Refactor – Divergent Change

- **Divergent change**
  - Occurs when a class changes in distinct ways for differing reasons
    - E.g. You change 3 methods together for one reason, and 5 other methods for another
  - Determine what changes for a single cause, and **Extract Class** to bundle these together

Shotgun Surgery

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When to Refactor – Shotgun surgery

- **Shotgun surgery**
  - A single change causes many little changes to several different classes
  - Use **Move Method** and **Move Field** to put changes into a single class
    - Sometimes best to **Inline Class**

Feature Envy

When to Refactor – Feature Envy

- **Feature Envy**
  - A class does a calculation that belongs elsewhere
    - i.e. it uses too much data from another class
  - Put it into the proper class with **Move Method**

Data Clumps

When to Refactor – Data clumps

- **Data clumps**
  - Data clusters together in fields or parameter lists
  - **Extract Class** to change clumps into an object
  - Shrink parameter lists with **Introduce Parameter Object** or **Preserve Whole Object**

Primitive Obsession

When to Refactor – Primitive Obsession

- **Primitive Obsession**
  - Often better to use a class instead of a primitive type
    - Allows things like range checking, formatting, etc.
    - Done with **Replace Data Value with Object**
  - If the primitive is a type code, use
    - **Replace Type Code** with
      - **Class, or**
      - **Subclasses, or**
      - **State/Strategy**

Switch Statements

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When to Refactor – Switch statements

- **Switch statements**
  - Are rare in good OO code
  - If switching on a type code, **Replace Conditional with Polymorphism**
    - Easier to add subclasses than changing many switch statements

Parallel Inheritance

When to Refactor – Parallel inheritance

- **Parallel inheritance hierarchies**
  - When you make a subclass of one class, you also make a subclass of another
    - Special case of shotgun surgery
  - Eliminate one hierarchy by shifting data and responsibilities to the other
    - **Move Method** and **Move Field**

Lazy Class

When to Refactor – Lazy class

- **Lazy class**
  - A class doesn't do enough to justify its existence
    - May result from other refactorings like **Move Method**
  - Eliminate it with **Collapse Hierarchy** or **Inline Class**

Speculative Generality

When to Refactor – Speculative generality

- **Speculative generality**
  - You added code for future expansion that never occurred
    - Remove useless abstract classes with **Collapse Hierarchy**
    - Remove unneeded delegation with **Inline Class**
    - Remove unused parameters with **Remove Parameter**

Temporary Field

When to Refactor – Temporary Field

- **Temporary field**
  - An instance variable is set and used only part of the time
  - **Extract Class**, moving over the “orphan variables” and related methods

Message Chains

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When to Refactor – Message chains

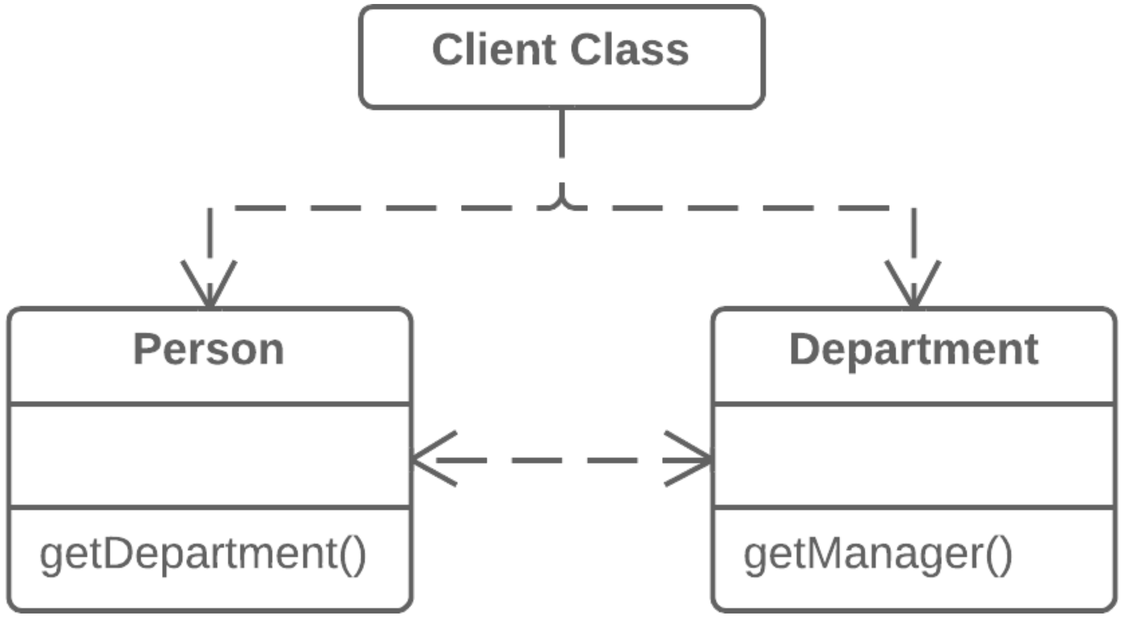
- **Message chains**
  - A client follows a chain of referring objects, and sends a message to the last object
    - Any change to intermediate relationships causes client code to change
  - **Hide Delegate** on the first object in the chain so it returns the last object

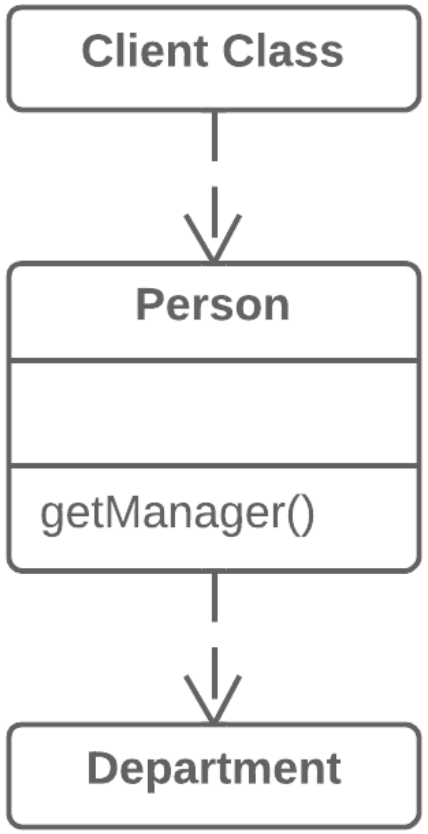
Message Chains – Hide delegate

Hide Delegate

- Client talks to one object to get data, then talks to object in that data to do something
  - Maybe farther down chain
- Put method in first object that is in charge of passing on message (detaches client from chain structure)

Hide Delegate





Middle Man

When to Refactor – Middle Man

- **Middle Man**
  - Where most methods of a class delegate to another class
  - **Remove Middle Man**, so you talk to the delegated object directly

Inappropriate Intimacy

When to Refactor - Inappropriate intimacy

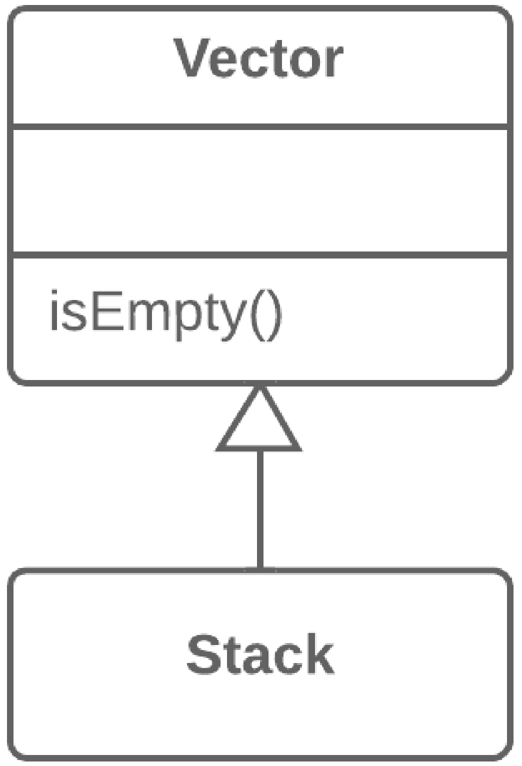
- **Inappropriate intimacy**
  - A class knows too much about another class's private parts
  - **Move Method** and **Move Field** to the first class
  - Or **Extract Class** to put commonality in a safe place
  - **Replace Inheritance with Delegation** if a subclass knows too much about its parents

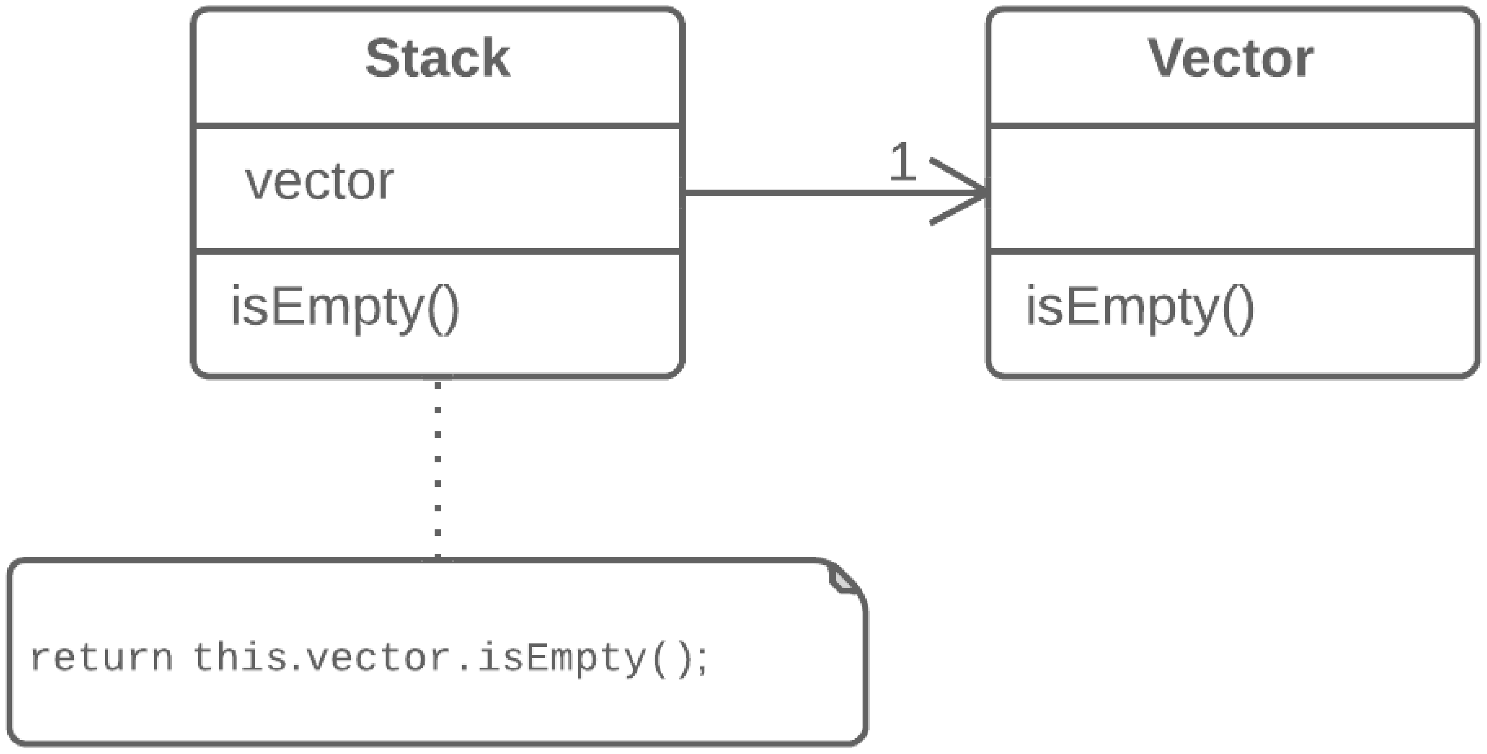
Inappropriate Intimacy – Replace Inheritance with Delegation

Replace Inheritance with Delegation

- Inheritance structures can leave parts of a super-class exposed by a sub-class
  - Instead of a class extending a parent, the previous super-class can instead be initialized as a data object in the previous sub-class
  - This protects things exposed via regular inheritance

Replace Inheritance with Delegation





```
return this.vector.isEmpty();
```

Alternative Classes

When to Refactor – Alternative classes

- **Alternative classes with different interfaces**
  - Two or more classes do the same thing, but have inconsistent interfaces
  - Use **Rename Method** and **Move Method** to give the classes identical interfaces
  - If redundant, **Extract Superclass**

Incomplete Library Class

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When to Refactor – Incomplete Library Class

- **Incomplete Library Class**
  - You can’t use **Move Method** on code you can’t change
  - **Introduce Foreign Method** into a client class
    - Best for only one or two methods
  - **Introduce Local Extension** to create a subclass or wrapper of the original

Incomplete Library Class – Introduce Foreign Method

Introduce Foreign Method

- A utility class doesn’t contain the method that you need and you can’t add the method to the class.
- Add the method to a client class and pass an object of the utility class to it as an argument.

Introduce Foreign Method

```
class Report {
  void sendReport() {
    Date nextDay = new Date(previousEnd.getYear(),
      previousEnd.getMonth(), previousEnd.getDate() + 1);
    ...
  }
}

class Report {
  void sendReport() {
    Date nextDay = nextDay(previousEnd);
    ...
  }
  private static Date nextDay(Date arg) {
    return new Date(arg.getYear(), arg.getMonth(), arg.getDate() + 1);
  }
}
```

Data Class

When to Refactor – Data Class

- **Data Class**
  - Is a class with no behavior
    - i.e. has only get and set methods
  - **Move Methods** (that apply to that data) into the data class
    - May need to **Extract Method** first

Refused Bequest

When to Refactor - Refused Bequest

- **Refused Bequest**
  - A subclass doesn’t use all the methods and data that it inherits
  - Reorganize the class hierarchy
    - **Push Down Method** and **Push Down Field** to create a sibling for the unused behavior
  - If the subclass does not support the superclass interface, **Replace Inheritance with Delegation**

Worrisome Comments

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When to Refactor - Worrisome comments

- **Comments that explain bad code**
  - **Extract Method** on commented blocks of code
  - **Rename Method** to make purpose clearer

That was a lot of things

I don’t remember all the changes

Catalog of Refactorings

- Format:
    - Name
    - Summary
    - Motivation
    - Mechanics
    - Examples

Catalog of Refactorings

- Organized into chapters with related refactorings:
  - **Composing Methods**
    - Are refactorings that reorganize the methods of a class
      - And deal with troublesome local variables
    - **Extract Method** most commonly used

Catalog of Refactorings

- Organized into chapters with related refactorings:
  - **Composing Methods**
    - Are refactorings that reorganize the methods of a class
      - And deal with troublesome local variables
    - **Extract Method** most commonly used
  - **Moving Features Between Objects**
    - Reassigns responsibilities to other classes
    - **Move Method, Move Field**, and **Extract Class** are commonly used

Catalog of Refactorings

- Organized into chapters with related refactorings:
  - **Organizing Data**
    - Make working with data easier
    - Some refactorings promote better encapsulation
      - E.g. **Encapsulate Field**
    - Others eliminate type codes
  - **Simplifying Conditional Expressions**
    - Used to make logic within a method clearer
      - E.g. **Decompose Conditional**
    - **Replace Conditional with Polymorphism** changes the class structure

Catalog of Refactorings

- Organized into chapters with related refactorings:
  - **Making Method Calls Simpler**
    - Use **Rename Method** to make intentions clearer
    - Some refactorings shorten parameter lists
      - E.g. **Preserve Whole Object**
    - Others simplify a class's interface
      - E.g. **Hide Method** and **Remove Setting Method**

Catalog of Refactorings

- Organized into chapters with related refactorings:
  - **Dealing with Generalization**
    - Some refactorings move responsibilities up/down the class hierarchy
      - E.g. **Pull Up Field, Push Down Method**
    - Other change the hierarchy by creating/destroying classes
      - E.g. **Extract Subclass, Collapse Hierarchy**

Catalog of Refactorings

- Organized into chapters with related refactorings:
  - **Big Refactorings**
    - Are much lengthier and time consuming than the previous refactorings
      - Involves many small refactorings
    - **Tease Apart Inheritance**
    - **Convert Procedural Design to Objects**
    - **Separate Domain from Presentation**
    - **Extract Hierarchy**

If you are reading textbook

- Fowler:
  - Read chapter 5 (Catalog of Refactorings)
  - Browse chapters 6 – 12 (individual methods)

Onward to … example.

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