Introduction

• Credit where Credit is Due
  • Some of the material for this lecture is taken from “Refactoring: Improving the Design of Existing Code” by Martin Fowler; as such some material is copyright © Addison Wesley, 1999

• Last Lecture
  • Refactoring
    • Introduced core ideas
      • Improve design without changing functionality
      • Watch out for “bad smells” in code
    • Covered several examples

• Goals for this Lecture
  • Present a longer, more detailed example
Start of a refactoring project...

- I didn’t finish the refactoring of my program that generates the “Grades” page on the class website
  - But my initial steps have some lessons to impart…
  - Quick demo
Tutorial

• A simple program for a video store
  • Movie
  • Rental
  • Customer
    • customer object can print a statement (in ASCII)
• We’d like to modify the code to also print a statement in HTML and have discovered that none of the existing code can be reused!
• See example code (available on class website)
  • Added a test case! We will test our code after each refactoring
Does this code need refactoring?

• For such a simple system
  • probably not

• but imagine that these three classes are part of a larger system
  • then the refactorings we do during the tutorial can indeed be useful
    • the point is to imagine following this process on a daily basis in a larger system project
  • refactoring needs to be incremental, systematic, and safe
**Initial Class Diagram**

```
Movie
  priceCode: int

Rental
  daysRented: int

Customer
  statement()
```

`statement()` works by looping through all rentals; for each rental, it retrieves its movie and the number of days it was rented; it also retrieves the price code of the movie.

It then calculates the price for each movie rental and the number of frequent renter points and returns the generated statement as a string; (see next slide)
Initial statement() algorithm

*for all rentals*
Step 1: refactor statement()

• Why?

  • It’s a “long method” which is one of the “bad smells” covered last lecture

• Also:

  • our purpose is to add a new method to Customer that generates a statement formatted in HTML

  • refactoring statement() may lead to code that can be shared with this new function

    • This matches one of Fowler’s conditions for refactoring: cleaning up the code to make it possible to add a new function
How to start?

• We want to decompose the statement() method into smaller pieces
• We’ll start with “Extract Method”
  • and target the switch statement first
  • look for local variables: each and thisAmount
  • each is not modified, thisAmount is
    • non-modified variables can be passed as parameters (if required)
    • modified variables require more care; since there is only one, we can make it the return value of the new method
• Pitfalls
  • be careful about return types;
    • in the original statement, thisAmount is a double
    • but it would be easy to make the mistake of having the new method return an int; if you do, your test will fail because the rounding of ints to doubles would cause some of your amounts to change; try it and see with the Customer class in the step1 directory
Step 2: rename variables

• The variable names in the new `amountFor()` method don’t make sense, now that they have been moved out of the `statement()` method

  • “Any fool can write code that a computer can understand. Good programmers write code that humans can understand”

• Lets rename them and run our test

  • so far so good!
Step 3: move method

• amountFor() uses information from the Rental class
  • It does NOT use any information from the Customer class

• Methods should be located close to the data they use, so let's move amountFor() to the Rental class
  • We get rid of a parameter this way
  • Let's also rename the method to getCharge() to clarify what it is doing
  • As a result, back in Customer, we must delete the old method and change the call to amountFor(each) to each.getCharge()

• Then we need to compile and test; all good!
No major changes; however Customer is now a smaller class and an operation has been moved to the class that has the data it needs to do its job;

Definitely making progress!
Step 4: Replace Temp with Query

• In the statement() method, thisAmount is now redundant. It is set once with the call to each.getCharge() and is not changed afterward
  
  • lets get rid of it.
  
  • Don’t forget to run your test!

• Removing temp variables is a good thing, because they often cause the need for parameters where none are required and can also cause problems in long methods;
  
  • of course the charge is now calculated twice through the loop, but we can optimize the calculation later (but only if we determine that it is slowing us down)
Step 5: frequent renter points

• Lets do the same thing with the logic to calculate frequent renter points

  • Step 5a: extract method

    • each can be a parameter, as in step1

    • frequentRenterPoints has a value before the method is invoked, but the new method does not read it; we simply need to use appending assignment outside the method

  • Step 5b: move method

    • Again, we are only using information from Rental, not Customer, so let's move getFrequentRenterPoints() to the Rental class

• Be sure to run your test case after each step
New class diagram

Customer continues to get smaller, Rental continues to get larger; but Rental now has operations that change it from being a “data holder” to a useful object.

Our sequence diagram has changed (see next slide); statement() used to call the Movie class to get the price code for each movie. Now Rental takes care of that. And statement() now calls methods that have names that mean something rather than presenting lots of code whose purpose may not be clear.
new statement() algorithm
Step 6: Remove temp variables

- `statement()` still has temp variables
  - `totalAmount` and `frequentRentalPoints`
- Both of these values are going to be needed by `statement()` and `htmlStatement()`
  - Let's replace them with query methods
    - little more difficult because they were calculated within a loop; we have to move the loop to the query methods
- Step 6a: replace `totalAmount`
- Step 6b: replace `frequentRentalPoints`
  - test after each step
Customer class is now bigger; but has two methods that can be shared between the existing `statement()` method and the planned `htmlStatement()` method.

Our sequence diagram has changed again (see next slide) because now we have three loops instead of one; again, performance can be a concern but we should wait until a profiler tells us so!
latest statement() algorithm

```
:getTotalCharge():Customer

:Rental

getCharge():[for all rentals]

getFRPs():[for all rentals]

getPriceCode()

:Movie

getPriceCode()
```

```
:getTotalFRPs():Customer

:Rental

getPriceCode()

:Movie

getPriceCode()
```
Step 7: add **htmlStatement()**

- We are now ready to add the **htmlStatement()** function

  - Note: I’m not going to test this function, but I will add it, so you can see how our refactorings so far, have made it easy to add this function

    - I added a file to the step7 directory that prints out the results of calling **htmlStatement();** you can send the output to a web browser if you want

- You can actually improve these two methods using a refactoring called **Form Template Method**, but I will not cover that today

  - You can probably guess how to do it, however, by reviewing the template method design pattern that we discussed in Lecture 22
New Requirements

• It is now anticipated that the store is going to have more than the three initial types of movies;
  • as a result of these new classifications, renter points and charges will vary with each new movie type
  • as a result, we should probably move the getCharge() and getFrequentRenterPoints() methods to the Movie class
Step 8: move methods

• Step 8a: move `getCharge()` to Movie
  - `getCharge()` needs to know the number of days the movie was rented; since this is information that Rental has, it needs to be passed as a parameter

• Step 8b: move `getFrequentRenterPoints()` to Movie
  - ditto!
Movie has new methods, allowing it to finally make the transition from data holder to object;

These methods will allow us to handle new types of movie easily.
How to handle new Movies?

But movies can change type! A children’s movie when it is first released is a “new release”; later it becomes a children’s movie. So this approach won’t work!
State pattern to the rescue!

A movie has a particular state: its charge (and its renter points) depend on that state; so we can use the state pattern to handle new types of movies (for now, at least)
Step 9: Replace Type Code with State/Strategy

• We need to get rid of our type code (e.g. Movie.CHILDRENS) and replace it with a Price object

  • We first modify Movie to get rid of its _priceCode field and replace it with a _price object

    • this involves changing the constructor to make use of the setPriceCode() method; before it was setting _priceCode directly

    • we also have to change getPriceCode() and setPriceCode() to access the Price object

• (We of course need to create Price and its subclasses)
Step 10: Move Method

- Now we need to move the method `getCharge()` to the newly created `Price` class

  - It's a very simple move, we just need to remember to change `Movie` to delegate its `getCharge()` operation to `Price`
Step 11: Replace Conditional with Polymorphism

• Now, we move each branch of the switch statement into the appropriate subclass
  • I do this in one move;
    • Fowler actually recommends moving one branch at a time!
• After you have done the move, change Price’s `getCharge()` to an abstract method
• Don’t forget to test; everything still works!
Step 12: handle renter points

- Now we repeat step 10 and 11, this time applying them to frequent renter points.

- I combine both steps into one:
  - We move the method over to Price, and use polymorphism to handle the logic.
    - Note: this time we leave a default implementation in Price and have NewRelease override that implementation, since it is the only class that returns a different value.

- Run the test and everything still works!
We’re done!

- We’ve added new functionality, changed “data holders” to “objects” and made it very easy to add new types of movies with special charges and frequent rental points

- The final version of the code is in the after directory; compile it and run the test: test passed!
Final class diagram

Note: not all methods and attributes are shown; getFRP() is an abbreviation of getFrequentRenterPoints()

See next slide for final sequence diagram
Final statement() algorithm

```plaintext
:Customer

g getTotalCharge()

* [for all rentals] getCharge()

getTotalFRPs()

* [for all rentals] getFRPs()

:Rental

getCharge(days)

:Movie

getFRPs(days)

:price

getFRPs(days)
```
Wrapping Up

• Lecture 28: Test Driven Design

• Lecture 29: Scala Traits

• Lecture 30: Concurrency in OO Systems