

Refactoring

- Martin Fowler (and Kent Beck, John Brant, William Opdyke, Don Roberts), *Refactoring- Improving the Design of Existing Code*, Addison Wesley, 1999.
- **Refactoring** (noun):
a change made to the internal structure of software to make it easier to understand and cheaper to modify without changing its observable behavior.
- **Refactor** (verb):
to restructure software by applying a series of refactorings.

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Refactoring, applied

- Straight from the book:

"a program to calculate and print a statement of a customer's charges at a video store"

...price depends on how long the movie is rented and the category of the movie

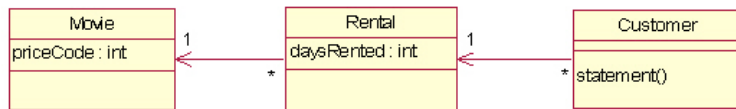
...also compute frequent renter points

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Refactoring: Movie

- Class diagram of the starting point classes.



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Refactoring: Movie Class

```
public class Movie {
    public static final int CHILDREN=2;
    public static final int REGULARS=0;
    public static final int NEW_RELEASE=1;

    private String _title;
    private int _priceCode;

    public Movie(String title, int priceCode) {
        _title=title;
        _priceCode = priceCode;
    }

    public int getPriceCode() {
        return _priceCode;
    }

    public void setPriceCode(int arg) {
        _priceCode = arg;
    }

    public String getTitle() {
        return _title;
    }
}
```

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Refactoring: Rental Class

```
public class Rental {
    private Movie _movie;
    private int _daysRented;

    public Rental(Movie movie,
                 int daysRented) {
        _movie = movie;
        _daysRented = daysRented;
    }

    public int getDaysRented() {
        return _daysRented;
    }

    public Movie getMovie() {
        return _movie;
    }
}
```

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Refactoring: Customer Class

```
public class Customer {
    private String _name;
    private Vector _rentals = new Vector();

    public Customer(String name) {
        _name = name;
    }

    public void addRental(Rental arg) {
        _rentals.addElement(arg);
    }

    public String getName() {
        return _name;
    }
}
```

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Refactoring: Customer Class

```
public class Customer
...
    public String statement() {
        double totalAmount = 0;
        int frequentRenterPoints = 0;
        Enumeration rentals = _rental.elements();
        String result = "Rental Record for " + getName() + "\n";
        while (rentals.hasMoreElements()) {
            double thisAmount = 0;
            Rental each = (Rental) rentals.nextElement();

            // determine amounts for each line
            switch (each.getMovie().getPriceCode()) {
                case Movie.REGULAR:
                    thisAmount += 2;
                    if (each.getDaysRented() > 2)
                        thisAmount += (each.getDaysRented() - 2) *
1.5;
                    break;
```

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Refactoring: Customer Class

```
public class Customer
    public String statement()
...
        case Movie.NEW_RELEASE:
            thisAmount += each.getDaysRented() * 3;
            break;
        case Movie.CHILDRENS:
            thisAmount += 1.5;
            if (each.getDaysRented() > 3)
                thisAmount += (each.getDaysRented() - 3) *
1.5;
            break;
    }
    // add frequent renter points
    frequentRenterPoints++;
    // add bonus for a two day new release rental
    if ((each.getMovie().getPriceCode() == Movie.NEW_RELEASE) &&
        each.getDaysRented() > 1) frequentRenterPoints++;
```

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Refactoring: Customer Class

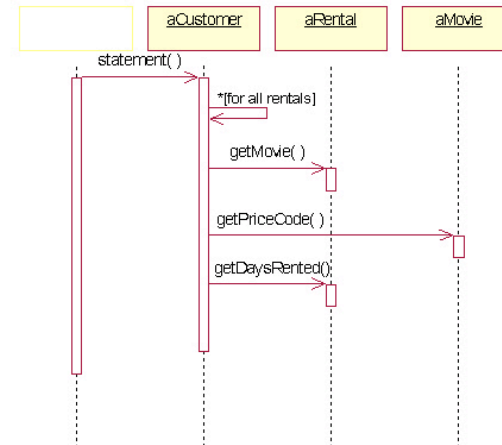
```
public class Customer
{
    public String statement()
    ...
        //show figures for this rental
        result += "\t" + each.getMovie().getTitle() + "\t" +
            String.valueOf(thisAmount) + "\n";
        totalAmount += thisAmount;
    }
    // add footer lines
    result += "Amount owed is "+String.valueOf(totalAmount) + "\n";
    result += "You earned "+String.valueOf(frequentRenterPoints)
        + "frequent renter points\n";
    return result;
}
```

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Refactoring

- Interaction diagram for the statement method.



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Refactoring: problem statement

Add a `htmlStatement` method which returns a customer statement string containing html tags.

...and there will be some changes to the way movies are classified
...affecting frequent renter points and charging.

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Refactoring: step 1

- Write a test suite !
- Refactoring should not affect the outcome of tests. The test suite must exercise the published interface of the classes.
- Obviously, refactoring should not affect the published interface. So, avoid publishing interfaces too early.

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Refactoring: step 2

- statement() is overly long, apply the *Extract Method* refactoring

```
public String statement() {
    double totalAmount = 0;
    int frequentRenterPoints = 0;
    Enumeration rentals = _rental.elements();
    String result = "Rental Record for " + getName() + "\n";
    while (rentals.hasMoreElements()) {
        double thisAmount = 0;
        Rental each = (Rental) rentals.nextElement();
        // determine amounts for each line
        switch (each.getMovie().getPriceCode()) {
            case Movie.REGULAR:
                thisAmount += 2;
                if (each.getDaysRented() > 2)
                    thisAmount += (each.getDaysRented() - 2) * 1.5;
                break;
            case Movie.NEW_RELEASE:
                thisAmount += each.getDaysRented() * 3; break;
            case Movie.CHILDRENS:
                thisAmount += 1.5;
                if (each.getDaysRented() > 3)
                    thisAmount += (each.getDaysRented() - 3) * 1.5;
                break;
        }
    }
}
```

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Refactoring: step 2

```
public String statement() {
    double totalAmount = 0;
    int frequentRenterPoints = 0;
    Enumeration rentals = _rental.elements();
    String result = "Rental Record for " + getName() + "\n";
    while (rentals.hasMoreElements()) {
        double thisAmount = 0;
        Rental each = (Rental) rentals.nextElement();

        thisAmount = amountFor(each);
        // add frequent renter points
        frequentRenterPoints++;
        // add bonus for a two day new release rental
        if ((each.getMovie().getPriceCode() == Movie.NEW_RELEASE) &&
            each.getDaysRented() > 1) frequentRenterPoints++;
        // show figures for this rental
        result += "\t" + each.getMovie().getTitle() + "\t" +
            String.valueOf(thisAmount) + "\n";
        totalAmount += thisAmount;
    }
    // add footer lines
    result += "Amount owed is " + String.valueOf(totalAmount) + "\n";
    result += "earned " + String.valueOf(frequentRenterPoints)
        + " frequent renter points\n";
    return result;
}
```

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Refactoring: step 2

```
public int amountFor(Rental each) {
    int thisAmount = 0;
    switch (each.getMovie().getPriceCode()) {
        case Movie.REGULAR:
            thisAmount += 2;
            if (each.getDaysRented() > 2)
                thisAmount += (each.getDaysRented() - 2) * 1.5;
            break;
        case Movie.NEW_RELEASE:
            thisAmount += each.getDaysRented() * 3;
            break;
        case Movie.CHILDRENS:
            thisAmount += 1.5;
            if (each.getDaysRented() > 3)
                thisAmount += (each.getDaysRented() - 3) * 1.5;
            break;
    }
    return thisAmount;
}
```

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Refactoring: step 3

- TEST

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Refactoring: step 4

- oops, (double) -> (int) bug!

```
public double amountFor(Rental each) {
    double thisAmount = 0;
    switch (each.getMovie().getPriceCode()) {
        case Movie.REGULAR:
            thisAmount += 2;
            if (each.getDaysRented() > 2)
                thisAmount+=(each.getDaysRented()-2) * 1.5;
            break;
        case Movie.NEW_RELEASE:
            thisAmount += each.getDaysRented() * 3;
            break;
        case Movie.CHILDRENS:
            thisAmount += 1.5;
            if (each.getDaysRented() > 3)
                thisAmount+=(each.getDaysRented()-3) * 1.5;
            break;
    }
    return thisAmount;
}
```

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Refactoring: step 5

- Variable names not helpful

```
public double amountFor(Rental each) {
    double thisAmount = 0;
    switch (each.getMovie().getPriceCode()) {
        case Movie.REGULAR:
            thisAmount += 2;
            if (each.getDaysRented() > 2)
                thisAmount+=(each.getDaysRented()-2) * 1.5;
            break;
        case Movie.NEW_RELEASE:
            thisAmount += each.getDaysRented() * 3;
            break;
        case Movie.CHILDRENS:
            thisAmount += 1.5;
            if (each.getDaysRented() > 3)
                thisAmount+=(each.getDaysRented()-3) * 1.5;
            break;
    }
    return thisAmount;
}
```

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Refactoring: step 5

```
public double amountFor(Rental aRental) {
    double result = 0;
    switch (aRental.getMovie().getPriceCode()) {
        case Movie.REGULAR:
            result += 2;
            if (aRental.getDaysRented() > 2)
                result +=(aRental.getDaysRented()-2) * 1.5;
            break;
        case Movie.NEW_RELEASE:
            result += aRental.getDaysRented() * 3;
            break;
        case Movie.CHILDRENS:
            result += 1.5;
            if (aRental.getDaysRented() > 3)
                result +=(aRental.getDaysRented()-3) * 1.5;
            break;
    }
    return result ;
}
```

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Refactoring: step 6

- Moving amount computation (does not use info from Customer only Rental)

```
class Customer ...
public double amountFor(Rental aRental) {
    double result = 0;
    switch (aRental.getMovie().getPriceCode()) {
        case Movie.REGULAR:
            result += 2;
            if (aRental.getDaysRented() > 2)
                result +=(aRental.getDaysRented()-2) * 1.5;
            break;
        case Movie.NEW_RELEASE:
            result += aRental.getDaysRented() * 3;
            break;
        case Movie.CHILDRENS:
            result += 1.5;
            if (aRental.getDaysRented() > 3)
                result +=(aRental.getDaysRented()-3) * 1.5;
            break;
    }
    return result ;
}
```

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Refactoring: step 6

```
class Rental ...
public double getCharge() {
    double result = 0;
    switch (getMovie().getPriceCode()) {
        case Movie.REGULAR:
            result += 2;
            if (getDaysRented() > 2)
                result += (getDaysRented()-2) * 1.5;
            break;
        case Movie.NEW_RELEASE:
            result += getDaysRented() * 3;
            break;
        case Movie.CHILDRENS:
            result += 1.5;
            if (getDaysRented() > 3)
                result += (getDaysRented()-3) * 1.5;
            break;
    }
    return result ;
}
```

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Refactoring: step 6

```
class Customer ...
public double amountFor(Rental aRental) {
    return aRental.getCharge();
}
```

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Refactoring: step 7

```
class Customer ...
public String statement() {
    double totalAmount = 0;
    int frequentRenterPoints = 0;
    Enumeration rentals = _rental.elements();
    String result = "Rental Record for " + getName() + "\n";
    while (rentals.hasMoreElements()) {
        double thisAmount = 0;
        Rental each = (Rental) rentals.nextElement();
        thisAmount = amountFor(each);
        // add frequent renter points
        frequentRenterPoints++;
        // add bonus for a two day new release rental
        if ((each.getMovie().getPriceCode() == Movie.NEW_RELEASE) &&
            each.getDaysRented() > 1) frequentRenterPoints++;
        //show figures for this rental
        result += "\t" + each.getMovie().getTitle() + "\t" +
            String.valueOf(thisAmount) + "\n";
        totalAmount += thisAmount;
    }
    // add footer lines
    result += "Amount owed is " +String.valueOf(totalAmount) + "\n";
    earned +=String.valueOf(frequentRenterPoints)
        + "frequent renter points\n";
    return result;
}
```

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Refactoring: step 7

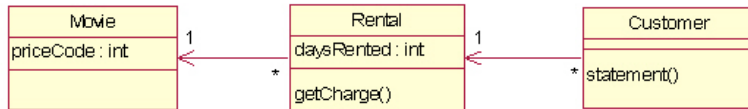
```
class Customer ...
public String statement() {
    double totalAmount = 0;
    int frequentRenterPoints = 0;
    Enumeration rentals = _rental.elements();
    String result = "Rental Record for " + getName() + "\n";
    while (rentals.hasMoreElements()) {
        double thisAmount = 0;
        Rental each = (Rental) rentals.nextElement();
        thisAmount = each.getCharge();
        // add frequent renter points
        frequentRenterPoints++;
        // add bonus for a two day new release rental
        if ((each.getMovie().getPriceCode() == Movie.NEW_RELEASE) &&
            each.getDaysRented() > 1) frequentRenterPoints++;
        //show figures for this rental
        result += "\t" + each.getMovie().getTitle() + "\t" +
            String.valueOf(thisAmount) + "\n";
        totalAmount += thisAmount;
    }
    // add footer lines
    result += "Amount owed is " +String.valueOf(totalAmount) + "\n";
    earned +=String.valueOf(frequentRenterPoints)
        + "frequent renter points\n";
    return result;
}
```

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Refactoring

- State of classes after moving the charge method. `amountFor` has been deleted.



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Refactoring: step 8

- Replace Temp with Query (`thisAmount` is redundant)

```

class Customer ...
public String statement() {
    double totalAmount = 0;
    int frequentRenterPoints = 0;
    Enumeration rentals = _rental.elements();
    String result = "Rental Record for " + getName() + "\n";
    while (rentals.hasMoreElements()) {
        Rental each = (Rental) rentals.nextElement();
        // add frequent renter points
        frequentRenterPoints++;
        // add bonus for a two day new release rental
        if ((each.getMovie().getPriceCode() == Movie.NEW_RELEASE) &&
            each.getDaysRented() > 1) frequentRenterPoints++;
        //show figures for this rental
        result += "\t" + each.getMovie().getTitle() + "\t" +
            String.valueOf(each.getCharge()) + "\n";
        totalAmount += each.getCharge();
    }
    // add footer lines
    result += "Amount owed is " +String.valueOf(totalAmount) + "\n";
    earned "+String.valueOf(frequentRenterPoints)
        + "frequent renter points\n";
    return result;
}
  
```

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Refactoring: step 9

- Extract Method (frequent renter computation)

```

class Customer ...
public String statement() {
    double totalAmount = 0;
    int frequentRenterPoints = 0;
    Enumeration rentals = _rental.elements();
    String result = "Rental Record for " + getName() + "\n";
    while (rentals.hasMoreElements()) {
        Rental each = (Rental) rentals.nextElement();
        // add frequent renter points
        frequentRenterPoints++;
        // add bonus for a two day new release rental
        if ((each.getMovie().getPriceCode() == Movie.NEW_RELEASE) &&
            each.getDaysRented() > 1) frequentRenterPoints++;
        //show figures for this rental
        result += "\t" + each.getMovie().getTitle() + "\t" +
            String.valueOf(each.getCharge()) + "\n";
        totalAmount += each.getCharge();
    }
    // add footer lines
    result += "Amount owed is " +String.valueOf(totalAmount) + "\n";
    earned "+String.valueOf(frequentRenterPoints)
        + "frequent renter points\n";
    return result;
}
  
```

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Refactoring: step 9

```

class Customer ...
public String statement() {
    double totalAmount = 0;
    int frequentRenterPoints = 0;
    Enumeration rentals = _rental.elements();
    String result = "Rental Record for " + getName() + "\n";
    while (rentals.hasMoreElements()) {
        Rental each = (Rental) rentals.nextElement();
        frequentRenterPoints += each.getFrequentRenterPoints();

        //show figures for this rental
        result += "\t" + each.getMovie().getTitle() + "\t" +
            String.valueOf(each.getCharge()) + "\n";
        totalAmount += each.getCharge();
    }
    // add footer lines
    result += "Amount owed is " +String.valueOf(totalAmount) + "\n";
    earned "+String.valueOf(frequentRenterPoints)
        + "frequent renter points\n";
    return result;
}
  
```

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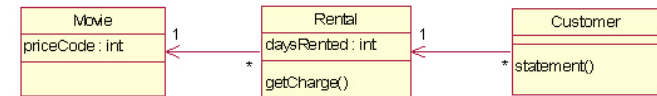
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Refactoring: step 9

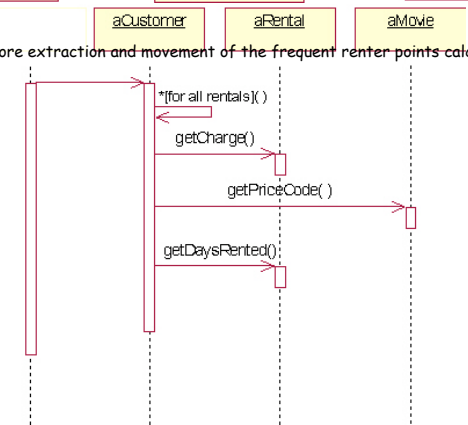
```
class Rental ...
public int getFrequentRenterPoints() {
    if ((getMovie().getPriceCode() == Movie.NEW_RELEASE)
        && getDaysRented() > 1)
        return 2;
    else
        return 1;
}
```

Refactoring

- Class diagram before extraction and movement of the frequent renter points calculation

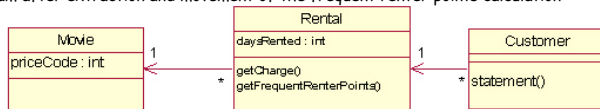


- Interaction diagram before extraction and movement of the frequent renter points calculation

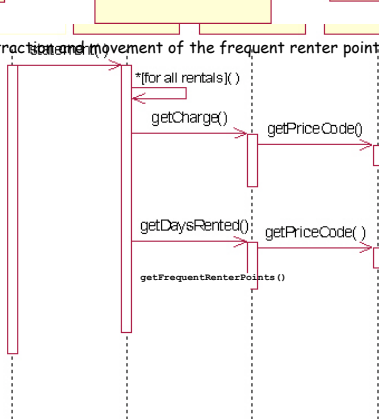


Refactoring

- Class diagram after extraction and movement of the frequent renter points calculation



- Interaction diagram after extraction and movement of the frequent renter points calculation



Refactoring: step 10

- **Replace Temp with Query** (the temporaries make the method complex and force code duplication)

```
class Customer ...
public String statement() {
    double totalAmount = 0;
    int frequentRenterPoints = 0;
    Enumeration rentals = _rental.elements();
    String result = "Rental Record for " + getName() + "\n";
    while (rentals.hasMoreElements()) {
        Rental each = (Rental) rentals.nextElement();
        frequentRenterPoints += each.getFrequentRenterPoints();

        //show figures for this rental
        result += "\t" + each.getMovie().getTitle() + "\t" +
            String.valueOf(each.getCharge()) + "\n";
        totalAmount += each.getCharge();
    }
    // add footer lines
    result += "Amount owed is " +String.valueOf(totalAmount) + "\n";
    earned "+String.valueOf(frequentRenterPoints)
        + "frequent renter points\n";
    return result;
}
```

Refactoring: step 10

```
class Customer ...
public String statement() {
    int frequentRenterPoints = 0;
    Enumeration rentals = _rental.elements();
    String result = "Rental Record for " + getName() + "\n";
    while (rentals.hasMoreElements()) {
        Rental each = (Rental) rentals.nextElement();
        frequentRenterPoints += each.getFrequentRenterPoints();
        //show figures for this rental
        result += "\t" + each.getMovie().getTitle() + "\t" +
            String.valueOf(each.getCharge()) + "\n";
    }
    // add footer lines
    result += "Amount owed is " +String.valueOf(getTotalCharge()) + "\n";
    result += "You earned "
    "+String.valueOf(frequentRenterPoints)+
        "frequent renter points\n";
    return result;
}
```

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Refactoring: step 10

```
class Customer ...
private double getTotalCharge() {
    double result = 0;
    Enumeration rentals = _rentals.elements();
    while (rentals.hasMoreElements()) {
        Rental each = (Rental) rentals.nextElement();
        result += each.getCharge();
    }
    return result;
}
```

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Refactoring: step 11

◆ Replace Temp with Query

```
class Customer ...
public String statement() {
    int frequentRenterPoints = 0;
    Enumeration rentals = _rental.elements();
    String result = "Rental Record for " + getName() + "\n";
    while (rentals.hasMoreElements()) {
        Rental each = (Rental) rentals.nextElement();
        frequentRenterPoints += each.getFrequentRenterPoints();
        //show figures for this rental
        result += "\t" + each.getMovie().getTitle() + "\t" +
            String.valueOf(each.getCharge()) + "\n";
    }
    // add footer lines
    result += "Amount owed is " +String.valueOf(getTotalCharge()) + "\n";
    result += "You earned " +String.valueOf(frequentRenterPoints)+
        "frequent renter points\n";
    return result;
}
```

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Refactoring: step 11

◆ Replace Temp with Query

```
class Customer ...
public String statement() {
    Enumeration rentals = _rental.elements();
    String result = "Rental Record for " + getName() + "\n";
    while (rentals.hasMoreElements()) {
        Rental each = (Rental) rentals.nextElement();
        //show figures for this rental
        result += "\t" + each.getMovie().getTitle() + "\t" +
            String.valueOf(each.getCharge()) + "\n";
    }
    // add footer lines
    result += "Amount owed is " +String.valueOf(getTotalCharge()) + "\n";

    result += "You earned " +String.valueOf(getFrequentRenterPoints())+
        "frequent renter points\n";
    return result;
}
```

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Refactoring: step 11

```

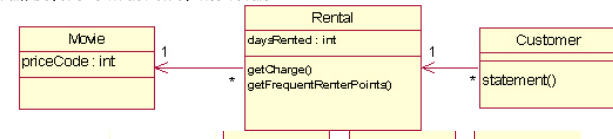
class Customer ...
private double getFrequentRenterPoints() {
    double result = 0;
    Enumeration rentals = _rentals.elements();
    while (rentals.hasMoreElements()) {
        Rental each = (Rental) rentals.nextElement();
        result += each.getFrequentRenterPoints();
    }
    return result;
}
    
```

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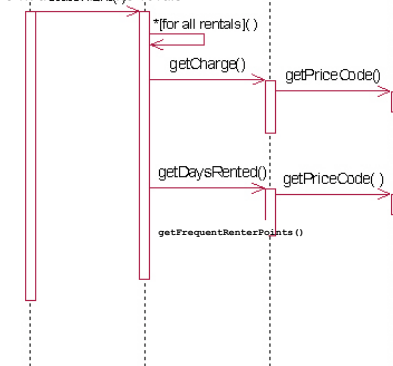
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Refactoring

- Class diagram before extraction of the totals



- Interaction diagram before extraction of the totals

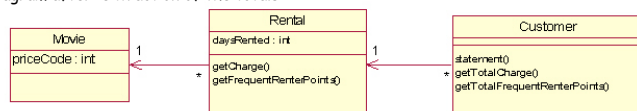


February 14, :

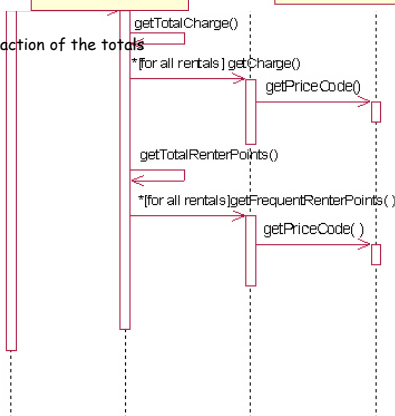
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Refactoring

- Class diagram after extraction of the totals



- Interaction diagram after extraction of the totals



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Refactoring

- Remarks

- Most refactoring reduce code size, but this is not necessarily the case. The point is to make code easier to modify and more readable.
- Performance gets a hit by running the same loop three times, or does it? Profile the program and find the answer.

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Software extension

- The requested method can be added with minimal code duplication

```
class Customer ...
public String htmlStatement() {
    Enumeration rentals = _rental.elements();
    String result = "<H1>Rental Record for<EM> " + getName() + "<EM></H1><P>\n";
    while (rentals.hasMoreElements()) {
        Rental each = (Rental) rentals.nextElement();
        //show figures for this rental
        result += each.getMovie().getTitle() + ": " +
            String.valueOf(each.getCharge()) + "<BR>\n";
    }
    // add footer lines
    result += "<P>Amount owed is<EM> "+String.valueOf(getTotalCharge()) +
"</EM><P>\n"; result += "You earned
<EM>"+String.valueOf(getFrequentRenterPoints())+
"</EM> frequent renter points<P>\n";
    return result;
}
```

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New functionality

- Getting ready to change the classification of the movies in the store.
- Perhaps new classification, perhaps modification to existing.
- Charging and frequent renting will be affected.

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Refactoring: step 12

- Replacing conditional logic on Price Code with polymorphism

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Refactoring: step 12

- Move getCharge

```
class Rental ...
public double getCharge() {
    double result = 0;
    switch (getMovie().getPriceCode()) {
        case Movie.REGULAR:
            result += 2;
            if (getDaysRented() > 2)
                result +=(getDaysRented()-2) * 1.5;
            break;
        case Movie.NEW_RELEASE:
            result += getDaysRented() * 3;
            break;
        case Movie.CHILDRENS:
            result += 1.5;
            if (getDaysRented() > 3)
                result +=(getDaysRented()-3) * 1.5;
            break;
    }
    return result ;
}
```

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Refactoring: step 12

```
class Movie ...
public double getCharge(int daysRented) {
    double result = 0;
    switch (getPriceCode()) {
        case REGULAR:
            result += 2;
            if (getDaysRented() > 2)
                result += (getDaysRented()-2) * 1.5;
            break;
        case NEW_RELEASE:
            result += getDaysRented() * 3;
            break;
        case CHILDRENS:
            result += 1.5;
            if (getDaysRented() > 3)
                result += (getDaysRented()-3) * 1.5;
            break;
    }
    return result ;
}
```

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Refactoring: step 12

```
class Rental ...
public double getCharge() {
    return _movie.getCharge(_daysRented);
}
```

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Refactoring: step 13

- Move getFrequentRenterPoints()

```
class Rental ...
public int getFrequentRenterPoints() {
    if ((getMovie().getPriceCode() == Movie.NEW_RELEASE)
        && getDaysRented() > 1)
        return 2;
    else
        return 1;
}
```

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Refactoring: step 13

```
class Movie ...
public int getFrequentRenterPoints(int daysRented) {
    if ((getPriceCode() == Movie.NEW_RELEASE) && daysRented > 1)
        return 2;
    else
        return 1;
}

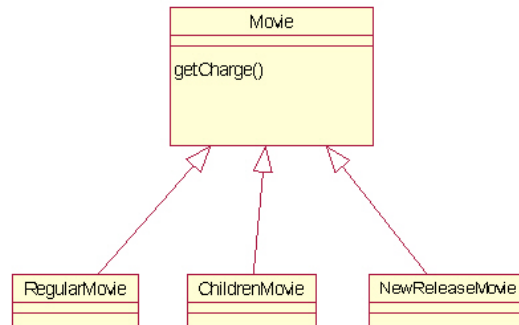
class Rental ...
public int getFrequentRenterPoints() {
    return _movie.getFrequentRenterPoints(_daysRented);
}
```

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Refactoring

- Inheritance

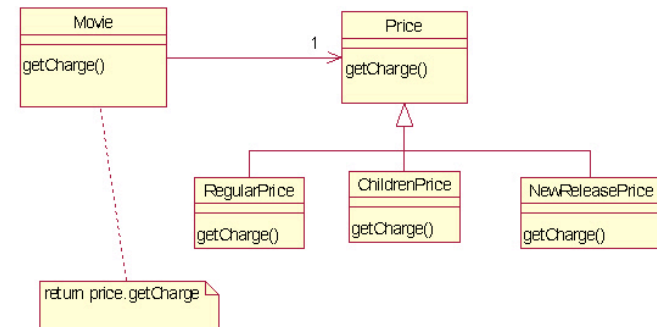


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Refactoring

- Inheritance

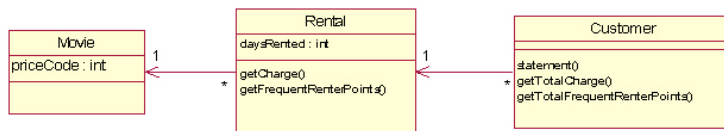


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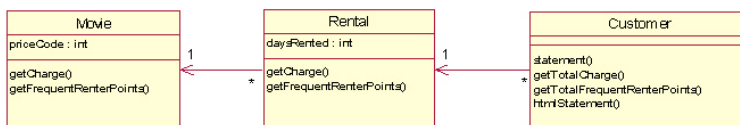
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Refactoring

- Class diagram before moving methods to movie



- Class diagram after moving methods to movie



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Refactoring: step 14

- Replace Type Code with State/Strategy

```

class Movie ...
public Movie(String name, int priceCode) {
    _name = name;
    _priceCode = priceCode;
}

```

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Refactoring: step 14

```
class Movie ...
public Movie(String name, int priceCode) {
    _name = name;
    setPriceCode(priceCode);
}
```

Refactoring: step 14

```
abstract class Price {
    abstract int getPriceCode();
}

class ChildrenPrice extends Price {
    int getPriceCode(){
        return MOVIE.CHILDREN;
    }
}

class NewReleasePrice extends Price {
    int getPriceCode(){
        return MOVIE.NEW_RELEASE;
    }
}

class RegularPrice extends Price {
    int getPriceCode(){
        return MOVIE.REGULAR;
    }
}
```

Refactoring: step 15

```
class Movie ...

public int getPriceCode() {
    return _priceCode;
}

public void setPriceCode(int arg) {
    _priceCode = arg;
}

private int _priceCode;
```

Refactoring: step 15

```
class Movie ...

public int getPriceCode() {
    return _price.getPriceCode();
}

public void setPriceCode(int arg) {
    switch (arg) {
        case REGULAR:
            _price = new RegularPrice();
            break;
        case CHILDREN:
            _price = new ChildrenPrice();
            break;
        case NEW_RELEASE:
            _price = new NewReleasePrice();
            break;
        default:
            throw new IllegalArgumentException("Incorrect Price Code");
    }
}

private Price _price;
```

Refactoring: step 16

◆ Move Method

```
class Movie ...
public double getCharge(int daysRented) {
    double result = 0;
    switch (getPriceCode()) {
        case REGULAR:
            result += 2;
            if (getDaysRented() > 2)
                result +=(getDaysRented()-2) * 1.5;
            break;
        case NEW_RELEASE:
            result += getDaysRented() * 3;
            break;
        case CHILDRENS:
            result += 1.5;
            if (getDaysRented() > 3)
                result +=(getDaysRented()-3) * 1.5;
            break;
    }
    return result ;
}
```

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Refactoring: step 16

```
class Movie ...
public double getCharge(int daysRented) {
    return _price.getCharge(daysRented);
}
```

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Refactoring: step 16

◆ Replace Conditional with Polymorphism

```
class Price ...
double getCharge(int daysRented) {
    double result = 0;
    switch (getPriceCode()) {
        case MOVIE.REGULAR:
            result += 2;
            if (getDaysRented() > 2)
                result +=(getDaysRented()-2) * 1.5;
            break;
        case MOVIE.NEW_RELEASE:
            result += getDaysRented() * 3;
            break;
        case MOVIE.CHILDRENS:
            result += 1.5;
            if (getDaysRented() > 3)
                result +=(getDaysRented()-3) * 1.5;
            break;
    }
    return result ;
}
```

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Refactoring: step 16

```
class RegularPrice ...
double getCharge(int daysRented) {
    double result = 2;
    if (getDaysRented() > 2)
        result +=(getDaysRented()-2) * 1.5;
    return result;
}
class NewReleasePrice ...
double getCharge(int daysRented) {
    return daysRented * 3;
}
class ChildrenPrice ...
double getCharge(int daysRented) {
    double result = 1.5;
    if (getDaysRented() > 3)
        result +=(getDaysRented()-3) * 1.5;
    return result ;
}
class Price...
abstract double getCharge(int daysRented);
```

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Refactoring: step 17

• Replace Conditional with Polymorphism

```
class Rental ...
int getFrequentRenterPoints(int daysRented) {
    if ((getPriceCode() == Movie.NEW_RELEASE) && daysRented > 1)
        return 2;
    else
        return 1;
}
```

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Refactoring: step 17

```
class Movie ...
int getFrequentRenterPoints(int daysRented) {
    return _price.getFrequentRenterPoints(daysRented);
}

class Price...
int getFrequentRenterPoints(int daysRented) {
    return 1;
}

class NewReleasePrice..
int getFrequentRenterPoints(int daysRented) {
    return (daysRented > 1) ? 2:1;
}
```

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Refactoring Principles

- Why do we refactor?
 - To improve the design of software
 - To make software easier to understand
 - To help you find bugs
 - To make you program faster
- When should we refactor?
 1. Refactor when you add functionality
 2. Refactor when you need to fix a bug
 3. Refactor as you do code reviews

- *Refactor when the code starts to smell.*
- What about performance?
 - Worry about performance only when you have **identified** a performance problem

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Bad Smells in Code

If it stinks, change it.

--Grandma Beck on child rearing

Duplicated Code

(stench 10)

If the same code structure is repeated

- **Extract Method** - gather duplicated code
- **Pull Up Field** - move to a common parent
- **Form Template Method** - gather similar parts, leaving holes
- **Substitute Algorithm** - choose the clearer algorithm
- **Extract class** - for unrelated classes, create a new class with functionality

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Bad Smells in Code

Long Method

(stench 7)

If the body of a method is over a page (choose your page size)

- **Extract Method** - extract related behavior
- **Replace Temp with Query** - remove temporaries when they obscure meaning
- **Introduce Parameter Object** - slim down parameter lists by making them into objects
- **Replace Method with Method Object** - still too many parameters
- **Decompose Conditionals** - conditional and loops can be moved to their own methods

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Bad Smells in Code

Large Class

(stench 7)

If a class has either too many variables or too many methods

- **Extract Class** - to bundle variables/methods

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Long Parameter List

(stench 6)

A method does not need many parameter, only enough to be able to retrieve what it needs

- **Replace Parameter with Method** - turn a parameter into a message
- **Introduce Parameter Object** - turn several parameters into an object

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Divergent Change

(stench 5)

If you find yourself repeatedly changing the same class then there is probably something wrong with it

- **Extract Class** - group functionality commonly changed into a class

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Shotgun Surgery

(stench 5)

If you find yourself making a lot of small changes for each desired change

- **Move Method/Field** - pull all the changes into a single class
- **Inline Class** - group a bunch of behaviors together

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Feature Envy

(stench 6)

If a method seems more interested in a class other than the class it actually is in

- **Move Method** - move the method to the desired class
- **Extract Method** - if only part of the method shows the symptoms

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Bad Smells in Code

Data Clumps

(stench 4)

Data items that are frequently together in method signatures and classes belong to a class of their own

- **Extract Class** - turn related fields into a class
- **Introduce Parameter Object** - for method signatures

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Primitive Obsession

(stench 3)

Primitive types inhibit change

- **Replace Data Value with Object** - on individual data values
- **Move Method/Field** - pull all the changes into a single class
- **Introduce Parameter Object** - for signatures
- **Replace Array with Object** - to get rid of arrays

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Switch Statements

(stench 5)

Switch statements lead to duplication and inhibit change

- **Extract method** - to remove the switch
- **Move method** - to get the method where polymorphism can apply
- **Replace Type Code with State/Strategy** - set up inheritance
- **Replace Conditional with Polymorphism** - get rid of the switch

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Parallel Inheritance Hierarchies

(stench 6)

If when ever you make a subclass in one corner of the hierarchy, you must create another subclass in another corner

- **Move Method/Field** - get one hierarchy to refer to the other

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Lazy Class

(stench 4)

If a class (e.g. after refactoring) does not do much, eliminate it.

- **Collapse Hierarchy**- for subclasses
- **Inline Class** - remove a single class

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Speculative Generality

(stench 4)

If a class has features that are only used in test cases, remove them.

- **Collapse Hierarchy**- for useless abstract classes
- **Inline Class** - for useless delegation
- **Rename Method** - methods with odd abstract names should be brought down to earth

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Temporary Field

(stench 3)

If a class has fields that are only set in special cases, extract them

- **Extract Class** - for the special fields

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Message Chains

(stench 3)

Long chains of messages to get to a value are brittle as any change in the intermittent structure will break the code

- **Hide Delegate** - remove one link in a chain
- **Extract Method** - change the behavior to avoid chains

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Middle Man

(stench 3)

An intermediary object is used too often to get at encapsulated values

- **Remove Middle Man** - to talk directly to the target
- **Replace Delegation with Inheritance** - turns the middle man into a subclass of the real object

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Inappropriate Intimacy

(stench 5)

Classes are too intimate and spend too much time delving in each other's private parts

- **Move Method/Field** - to separate pieces in order to reduce intimacy
- **Extract Class** - make a common class of shared behavior/data
- **Replace Inheritance with Delegation** - when a subclass is getting too cozy

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Comments

(stench 2)

Comments are often a sign of unclear code... consider refactoring