Refactoring

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Index

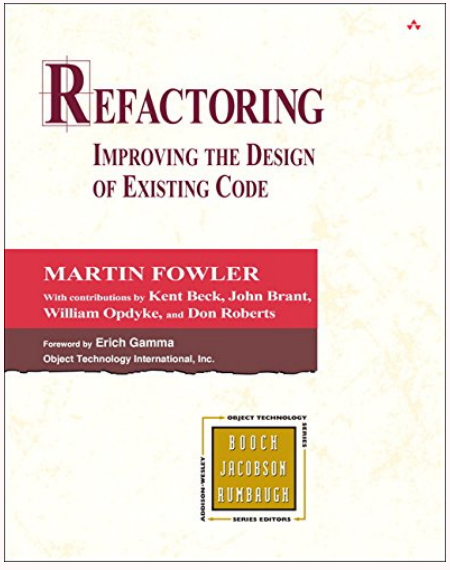
Reference

- Fowler, Martin. Refactoring: Improving the design of existing code. Addison-Wesley Professional, 1999. And also the accompanying website and online catalog.
- Kerievsky, Joshua. Refactoring to Patterns. Pearson Deutschland GmbH, 2005.
- Refactoring Guru

Introduction

Refactoring

- Refactoring is a **controlled** technique for **improving** the **design** of an **existing** code base.
- Its essence is applying a series of **small behavior-preserving transformations**, each of which "*too small to be worth doing*".
- However the **cumulative** effect of each of these transformations is quite **significant**.



Two Hats

> *A methaphor by Kent Beck*

When your are developing, you divide your time into **two distinct activities**:

- When you are **adding** functionalities, you **shouldn't** be **changing code**.
- When you are **refactoring**, you **shouldn't** be adding **new capabilities**.

Why Refactor?

- It **improves** the design of software. It prevents the design of software from decaying.
- It makes software easier to **understand**.
- It helps you find **bugs**. Refactoring forces you to think deeply about your code.
- It helps you program **faster**. A good design is essential to maintaining speed in software development.

Importance of Testing

- Refactoring is intended to improve **nonfunctional** attributes of the software.
- Having a good **testing suite** is of paramount importance **before** refactoring to ensure the code still behaves as expected.

Code Smells

Code Smells

- A code smell is a **surface indication** that usually corresponds to a **deeper problem** in the system.
- A code smell is something that's **quick to spot** (*sniffable*).
- A code smell **doesn't always** indicate a **problem**. Smells aren't inherently bad on their own, they are often an **indicator** of a **problem** rather than the problem themselves.

1. Bloaters

Code, methods and classes that are so large and complex that they are hard to work with.

- **Long Method** A method that contains too many lines of code.
- **Large Class** A class that contains many fields/methods/lines of code.
- **Primitive Obsession** Use of primitives instead of small objects for simple tasks.
- **Long Parameter List** More than three or four parameters for a method.
- **Data Clumps** Different parts of the code containing identical groups of variables.

2. Object-Orientation Abusers

Incorrect application of object-oriented programming.

- **Switch Statements** Complex switch/if operators.
- **Temporary Field** Temporary fields that get their values only under certain circumstances.
- **Refused Bequest** If a subclass uses only some of the methods and properties inherited from its parents.
- **Alternative Classes with Different Interfaces** Two classes perform identical functions but have different method names.

3. Change Preventers

Make changing the code harder.

- **Divergent Change** Changing many unrelated methods when you make changes to a class.
- **Shotgun Surgery** Many small changes to many different classes.
- **Parallel Inheritance Hierarchies** Whenever you create a subclass for a class, you find yourself needing to create a subclass for another class.

4. Dispensables

Things that would make the code cleaner if they didn't exist.

- **Comments** A method is filled with explanatory comments.
- **Duplicate Code** Two code fragments look almost identical.
- **Lazy Class** Classes that don't do much.
- **Data Class** Class that contains only fields and crude methods for accessing them.
- **Dead Code** A variable, parameter, field, method or class that is no longer used.
- **Speculative Generality** There’s an unused class, method, field or parameter that was created to support anticipated future features

5. Couplers

Excessive coupling between classes.

- **Feature Envy** A method accesses the data of another object more than its own data.
- **Inappropriate Intimacy** One class uses the internal fields and methods of another class.
- **Message Chains** In code you see a series of calls resembling: `a->b()->c()->d()`.
- **Middle Man** If a class only delegates work to another class, why does it exist at all?

Refactoring

Some Examples

Categories

The *Refactoring* book by Martin Fowler, divides refactoring into **7** categories:

1. **Composing** Methods
2. **Moving** Features Between Objects
3. **Organizing** Data
4. **Simplifying** Conditional Expressions
5. Making Methods Calls **Simpler**
6. Dealing With **Generalization**
7. **Big** Refactorings

In total, the book presents **70** different refactorings.

Refactoring Structure

- **Name**: so we can build a vocabulary of refactorings.
- **Summary**: the situation in which you need the refactoring and what it does.
- **Motivation**: why the refactoring should be done (and when it shouldn't).
- **Mechanics**: concise instructions on how to do the refactoring.
- **Example**: simple and normally with before and after code.

Normally with code smells that are resolved using the refactoring and other related refactorings.

1. Composing Methods (I)

Streamlining methods, removing **code duplication** and making **future improvements** easier.

These ones deal with **classes** and **methods**:

- **Extract Method** You have a code fragment that can be grouped together.
- **Inline Method** When a method body is more obvious than the method itself.
- **Replace Method with Method Object** You have a long method that uses local variables in such a way that you cannot apply *Extract Method*.
- **Substitute Algorithm** You want to replace an algorithm with one that is clearer.

1. Composing Methods (II)

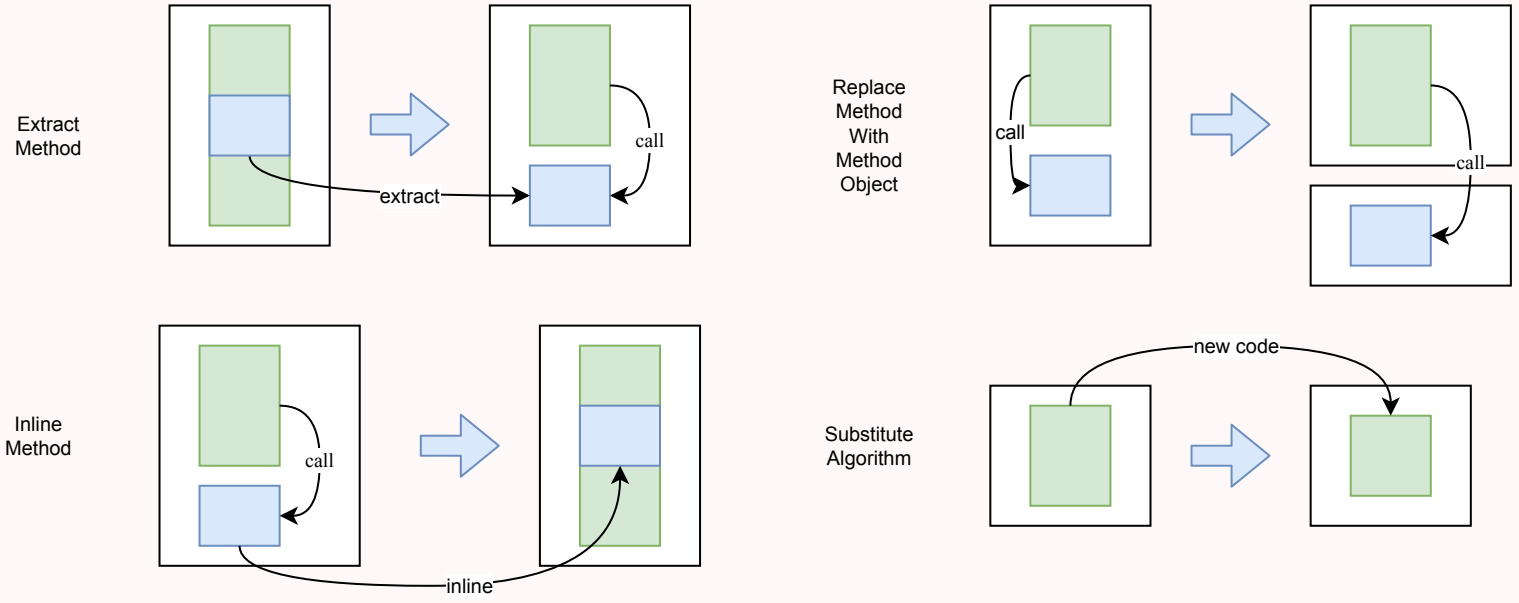
Streamlining methods, removing **code duplication** and making **future improvements** easier.

These ones deal with **methods** and **temporary** variables:

- **Inline Temp** You have a temporary variable that is assigned the result of a simple expression and nothing more.
- **Extract Variable** You have an expression that is hard to understand.
- **Split Temp Variable** You have a local variable that is used to store various intermediate values inside a method.
- **Replace Temp with Query** You place the result of an expression in a local variable for later use in your code.
- **Remove Assignments to Parameters** Some value is assigned to a parameter inside method's body.

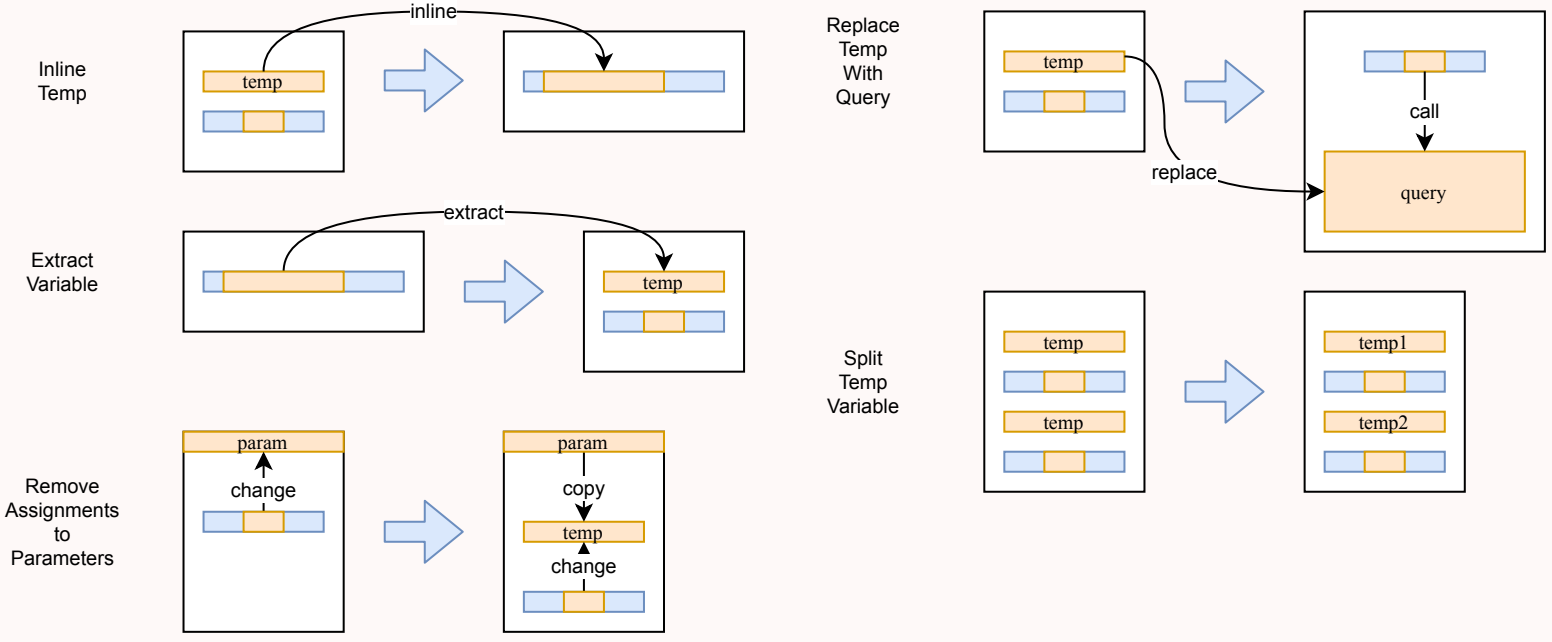
1. Composing Methods (III)

These ones deal with **classes** and **methods**.



1. Composing Methods (IV)

These ones deal with **methods** and temporary **variables**.



1. Composing Methods: Extract Method

```
void printOwing() {
  printBanner();

  // Print details.
  System.out.println("name: " + name);
  System.out.println("amount: " + getOutstanding());
}
```

1. Composing Methods: Extract Method

```
void printOwing() {
  printBanner();

  // Print details.
  System.out.println("name: " + name);
  System.out.println("amount: " + getOutstanding());
}
```

Refactored into:

```
void printOwing() {
  printBanner();
  printDetails(getOutstanding());
}

void printDetails(double outstanding) {
  System.out.println("name: " + name);
  System.out.println("amount: " + outstanding);
}
```

Can be used to eliminate: **Duplicate Code**, **Long Method**, **Feature Envy**, **Switch Statements**, **Message Chains**, **Comments** and **Data Class**.

1. Composing Methods: Inline Method

```
class PizzaDelivery {
  // ...
  int getRating() {
    return moreThanFiveLateDeliveries() ? 2 : 1;
  }
  boolean moreThanFiveLateDeliveries() {
    return numberOfLateDeliveries > 5;
  }
}
```

1. Composing Methods: Inline Method

```
class PizzaDelivery {
  // ...
  int getRating() {
    return moreThanFiveLateDeliveries() ? 2 : 1;
  }
  boolean moreThanFiveLateDeliveries() {
    return numberOfLateDeliveries > 5;
  }
}
```

Refactored into:

```
class PizzaDelivery {
  // ...
  int getRating() {
    return numberOfLateDeliveries > 5 ? 2 : 1;
  }
}
```

Can be used to eliminate: **Speculative Generality**.

1. Composing Methods: Extract Variable

You have an expression that’s hard to understand.

```
void renderBanner() {
  if ((platform.toUpperCase().indexOf("MAC") > -1) &&
       (browser.toUpperCase().indexOf("IE") > -1) &&
        wasInitialized() && resize > 0 )
  {
    // do something
  }
}
```

1. Composing Methods: Extract Variable

You have an expression that's hard to understand.

```
void renderBanner() {
  if ((platform.toUpperCase().indexOf("MAC") > -1) &&
       (browser.toUpperCase().indexOf("IE") > -1) &&
        wasInitialized() && resize > 0 )
  {
    // do something
  }
}
```

Refactored into:

```
void renderBanner() {
  final boolean isMacOs = platform.toUpperCase().indexOf("MAC") > -1;
  final boolean isIE = browser.toUpperCase().indexOf("IE") > -1;
  final boolean wasResized = resize > 0;

  if (isMacOs && isIE && wasInitialized() && wasResized) {
    // do something
  }
}
```

Can be used to eliminate: **Comment**.

1. Composing Methods: Split Temporary Variable

```
double temp = 2 * (height + width);
System.out.println(temp);

temp = height * width;
System.out.println(temp);
```

1. Composing Methods: Split Temporary Variable

```
double temp = 2 * (height + width);
System.out.println(temp);

temp = height * width;
System.out.println(temp);
```

Refactored into:

```
final double perimeter = 2 * (height + width);
final double area = height * width;

System.out.println(perimeter);
System.out.println(area);
```

2. Moving Features between Objects (I)

Move **functionality** between classes, create new classes, and hide implementation details from public access.

These ones are about **moving** methods, fields and classes to their **correct** place:

- **Move Method** A method is used more in another class than in its own class.
- **Move Field** A field is used more in another class than in its own class.
- **Extract Class** When one class does the work of two, awkwardness results.
- **Inline Class** A class does almost nothing and is not responsible for anything, and no additional responsibilities are planned for it.

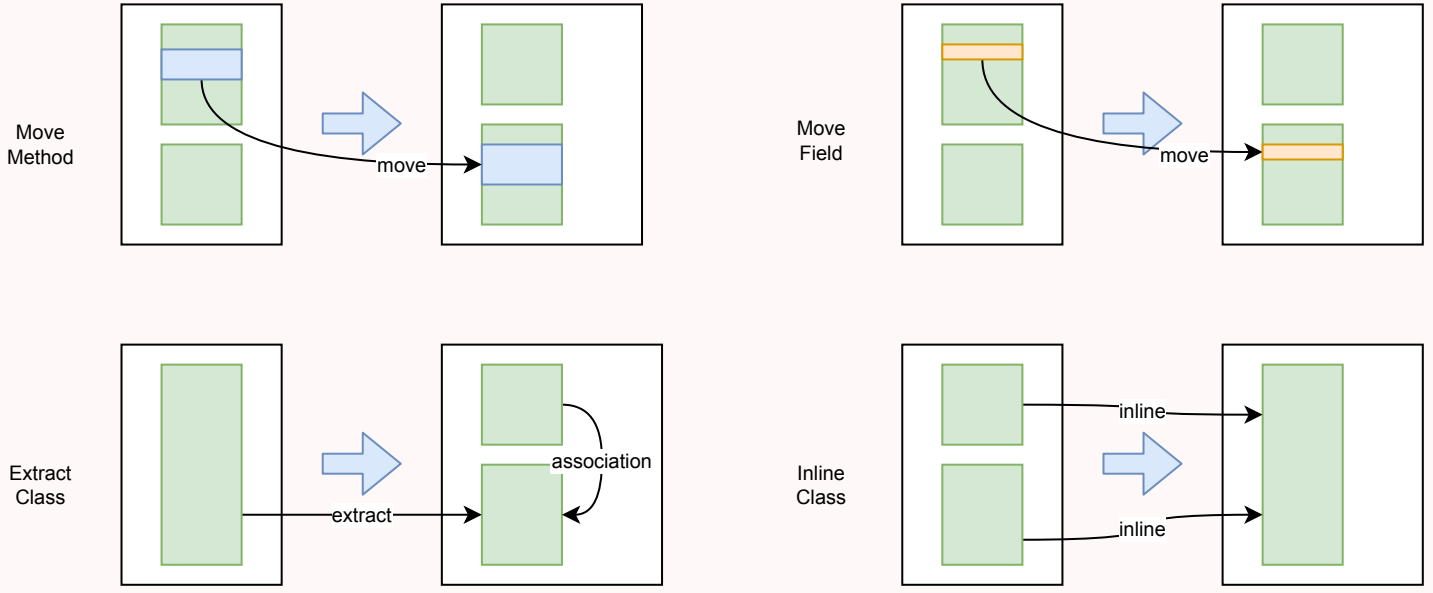
2. Moving Features between Objects (II)

Move **functionality** between classes, create new classes, and hide implementation details from public access.

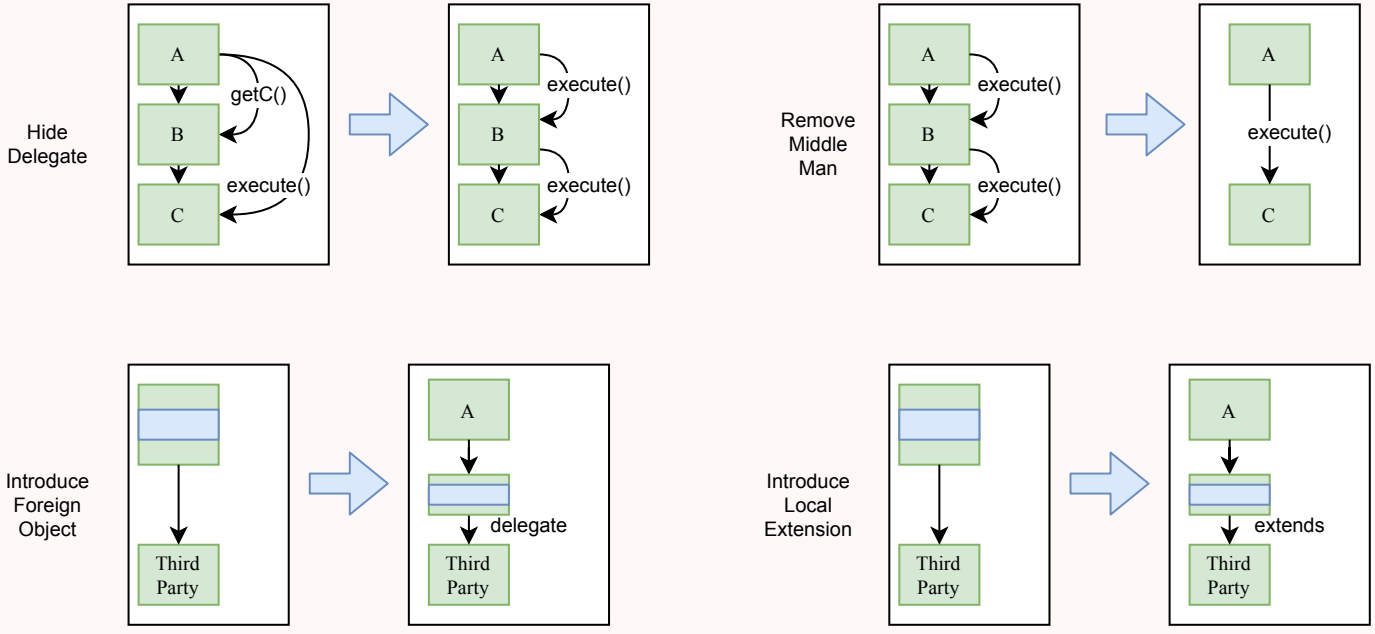
These ones are about **untangling** class associations by changing the way they are organized:

- **Hide Delegate** The client gets object B from a field or method of object A. Then the client calls a method of object B.
- **Remove Middle Man** A class has too many methods that simply delegate to other objects.
- **Introduce Foreign Method** A utility class does not contain the method that you need and you cannot add the method to the class.
- **Introduce Local Extension** Add the method to a client class and pass an object of the utility class to it as an argument.

2. Moving Features between Objects (III)



2. Moving Features between Objects (IV)



3. Organizing Data (I)

Helping with data handling by replacing primitives with rich class functionality.

- **Self Encapsulate Field** You use direct access to private fields inside a class.
- **Replace Data Value with Object** A class contains a data field that has its own behavior and associated data.
- **Change Value to Reference** You have many identical instances of a single class that you need to replace with a single object.
- **Change Reference to Value** You have a reference object that is too small and infrequently changed to justify managing its life cycle.

3. Organizing Data (II)

Helping with data handling by replacing primitives with rich class functionality.

- **Replace Array with Object** You have an array that contains various types of data.
- **Duplicate Observed Data** Is domain data stored in classes responsible for the GUI?
- **Change Unidirectional Association to Bidirectional** You have two classes that each need to use the features of the other, but the association between them is only unidirectional.
- **Change Bidirectional Association to Unidirectional** You have a bidirectional association between classes, but one of the classes does not use the other's features.

3. Organizing Data (III)

Helping with data handling by replacing primitives with rich class functionality.

- **Replace Magic Number with Symbolic Constant** Your code uses a number that has a certain meaning to it.
- **Encapsulate Field** You have a public field.
- **Encapsulate Collection** A class contains a collection field and a simple getter and setter for working with the collection.
- **Replace Type Code with Class** A class has a field that contains type code. The values of this type are not used in operator conditions and do not affect the behavior of the program.

3. Organizing Data (IV)

Helping with data handling by replacing primitives with rich class functionality.

- **Replace Type Code with Subclasses** You have a coded type that directly affects program behavior (values of this field trigger various code in conditionals).
- **Replace Type Code with State/Strategy** You have a coded type that affects behavior but you cannot use subclasses to get rid of it.
- **Replace Subclass with Fields** You have subclasses differing only in their (constant-returning) methods.

4. Simplifying Method Calls (I)

- **Rename Method** The name of a method does not explain what the method does.
- **Add Parameter** A method does not have enough data to perform certain actions.
- **Remove Parameter** A parameter is not used in the body of a method.
- **Separate Query from Modifier** Do you have a method that returns a value but also changes something inside an object?

4. Simplifying Method Calls (II)

- **Parameterize Method** Multiple methods perform similar actions that are different only in their internal values, numbers or operations.
- **Replace Parameter with Explicit Methods** A method is split into parts, each of which is run depending on the value of a parameter.
- **Preserve Whole Object** You get several values from an object and then pass them as parameters to a method.
- **Replace Parameter with Method Call** Before a method call, a second method is run and its result is sent back to the first method as an argument. But the parameter value could have been obtained inside the method being called.

4. Simplifying Method Calls (III)

- **Introduce Parameter Object** Your methods contain a repeating group of parameters.
- **Remove Setting Method** The value of a field should be set only when it is created, and not change at any time after that.
- **Hide Method** A method is not used by other classes or is used only inside its own class hierarchy.

4. Simplifying Method Calls (IV)

- **Replace Constructor with Factory Method** You have a complex constructor that does something more than just setting parameter values in object fields.
- **Replace Error Code with Exception** A method returns a special value that indicates an error?
- **Replace Exception with Test** You throw an exception in a place where a simple test would do the job?

5. Simplifying Conditional Expressions (I)

- **Decompose Conditional** You have a complex conditional (if-then/else or switch).
- **Consolidate Conditional Expression** You have multiple conditionals that lead to the same result or action.
- **Consolidate Duplicate Conditional Fragments** Identical code can be found in all branches of a conditional.
- **Remove Control Flag** You have a boolean variable that acts as a control flag for multiple boolean expressions.

5. Simplifying Conditional Expressions (II)

- **Replace Nested Conditional with Guard Clauses** You have a group of nested conditionals and it is hard to determine the normal flow of code execution.
- **Replace Conditional with Polymorphism** You have a conditional that performs various actions depending on object type or properties.
- **Introduce Null Object** Since some methods return null instead of real objects, you have many checks for null in your code.
- **Introduce Assertion** For a portion of code to work correctly, certain conditions or values must be true.

Decompose Conditional

```
if (date.before(SUMMER_START) || date.after(SUMMER_END)) {
  charge = quantity * winterRate + winterServiceCharge;
}
else {
  charge = quantity * summerRate;
}
```

Decompose Conditional

```
if (date.before(SUMMER_START) || date.after(SUMMER_END)) {
  charge = quantity * winterRate + winterServiceCharge;
}
else {
  charge = quantity * summerRate;
}
```

Refactored into:

```
if (isSummer(date)) {
  charge = summerCharge(quantity);
}
else {
  charge = winterCharge(quantity);
}
```

Can be used to eliminate: **Long Method**.

Introduce Null Object

```
if (customer == null) {
  plan = BillingPlan.basic();
}
else {
  plan = customer.getPlan();
}
```

Introduce Null Object

```
if (customer == null) {
  plan = BillingPlan.basic();
}
else {
  plan = customer.getPlan();
}
```

Refactored into:

```
class NullCustomer extends Customer {
  boolean isNull() {
    return true;
  }
  Plan getPlan() {
    return new NullPlan();
  }
}

customer = (order.customer != null) ?
  order.customer : new NullCustomer();

plan = customer.getPlan();
```

Can be used to eliminate: **Switch Statements** and **Temporary Field**.

Replace Nested Conditional with Guard Clauses

```
public double getPayAmount() {
  double result;
  if (isDead){
    result = deadAmount();
  }
  else {
    if (isSeparated){
      result = separatedAmount();
    }
    else {
      if (isRetired){
        result = retiredAmount();
      }
      else{
        result = normalPayAmount();
      }
    }
  }
  return result;
}
```

```
public double getPayAmount() {
  if (isDead){
    return deadAmount();
  }
  if (isSeparated){
    return separatedAmount();
  }
  if (isRetired){
    return retiredAmount();
  }
  return normalPayAmount();
}
```

Consolidate Duplicate Conditional Fragments

```
if (isSpecialDeal()) {
  total = price * 0.95;
  send();
}
else {
  total = price * 0.98;
  send();
}
```

Consolidate Duplicate Conditional Fragments

```
if (isSpecialDeal()) {
  total = price * 0.95;
  send();
}
else {
  total = price * 0.98;
  send();
}
```

Refactored into:

```
if (isSpecialDeal()) {
  total = price * 0.95;
}
else {
  total = price * 0.98;
}
send();
```

Can be used to eliminate: **Duplicate Code**.

6. Dealing with Generalization (I)

- **Pull Up Field** Two classes have the same field.
- **Pull Up Method** Your subclasses have methods that perform similar work.
- **Pull Up Constructor Body** Your subclasses have constructors with code that is mostly identical.

6. Dealing with Generalization (II)

- **Push Down Method** Is behavior implemented in a superclass used by only one (or a few) subclasses?
- **Push Down Field** Is a field used only in a few subclasses?

6. Dealing with Generalization (III)

- **Extract Subclass** A class has features that are used only in certain cases.
- **Extract Superclass** You have two classes with common fields and methods.
- **Extract Interface** Multiple clients are using the same part of a class interface. Another case: part of the interface in two classes is the same.

6. Dealing with Generalization (IV)

- **Collapse Hierarchy** You have a class hierarchy in which a subclass is practically the same as its superclass.
- **Form Template Method** Your subclasses implement algorithms that contain similar steps in the same order.
- **Replace Inheritance with Delegation** You have a subclass that uses only a portion of the methods of its superclass (or it's not possible to inherit superclass data).
- **Replace Delegation with Inheritance** A class contains many simple methods that delegate to all methods of another class.