Announcements

- Quiz 3 out all day tomorrow – Honorlock based open notes
- Code smells assignment due today. Work in class.
- Project check in day this Thursday. Ensure 4 of your MMFs are completely implemented.
- Last lecture next Tuesday.
- Project Due soon. Please check the class website.

CS3300 Introduction to Software Engineering

Lecture 19: Code Smells

Dr. Nimisha Roy ▸ nroy9@gatech.edu

Slides adapted from Alessandro Orso

Refactoring discussed last lecture..

Program Refactored Program

Small, independent techniques to apply transformations to a program, with the goal of improving its design without changing its functionality

Goal: Keep program readable, understandable, and maintainable. Avoid small problems soon.

Key Feature: Behavior Preserving- make sure the program works after each step; typically small steps

How to know code needs Refactoring/Indicators of Problems in code : Code Smells

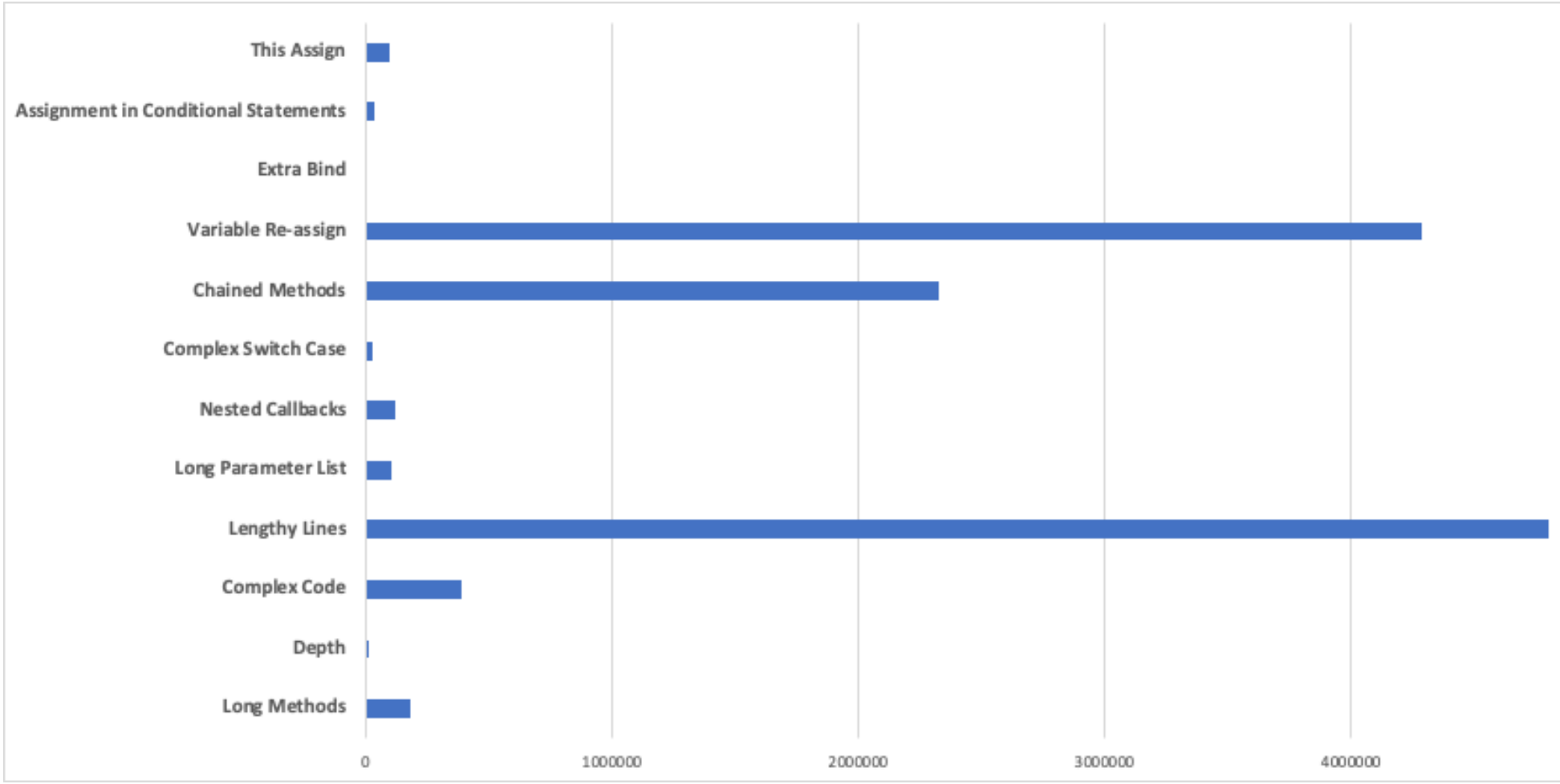
What is a Code Smell?

- Martin Fowler: "*a code smell is a surface indication that usually corresponds to a deeper problem in the system*"
  - Something that is quick to spot
  - Indicator of a bigger problem with your code

- Generally, you find code smells when examining the code, or doing refactoring

Smells count across 15 JavaScript projects

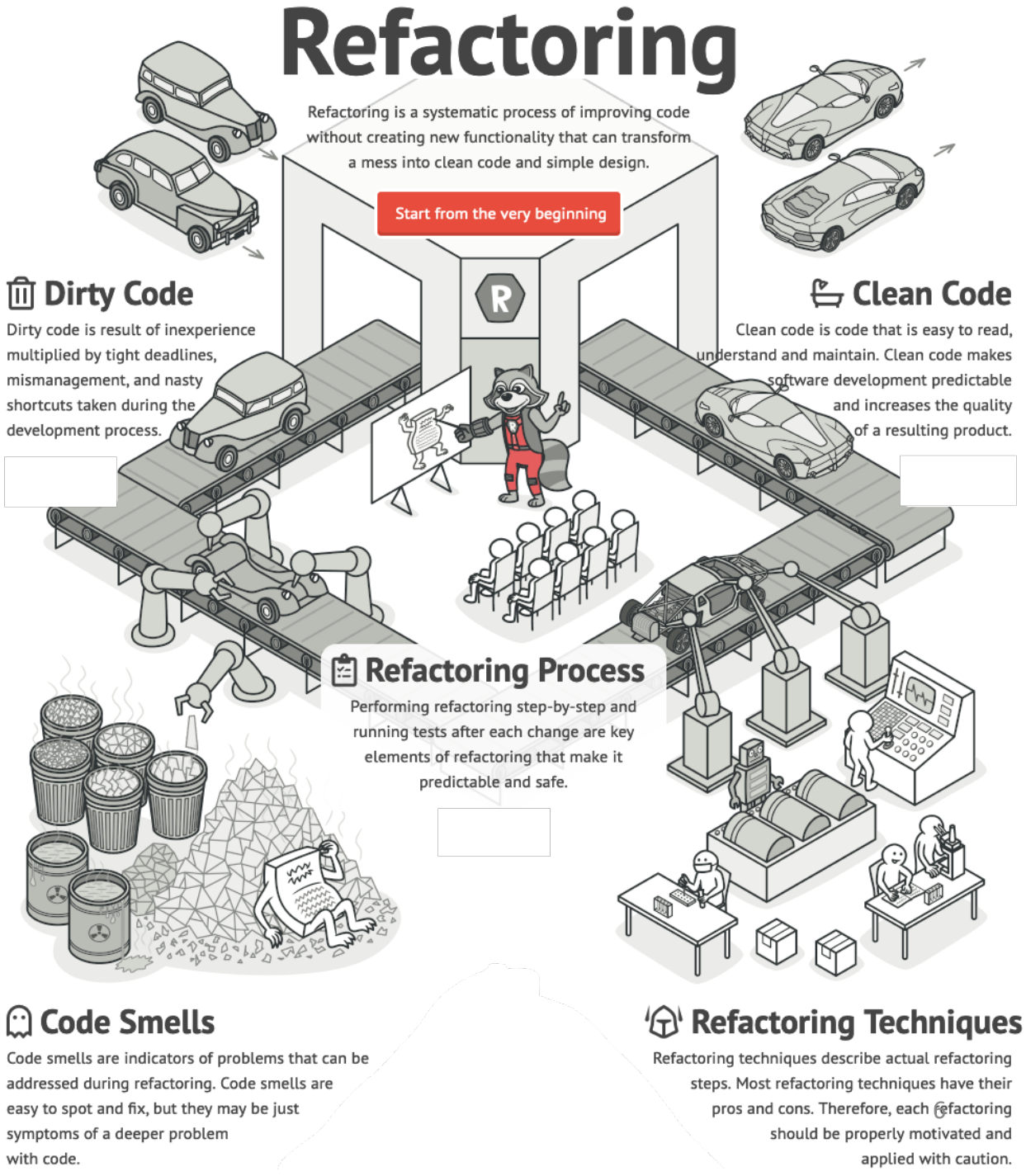
"A large-scale empirical study of code smells in JavaScript projects" by D. Johannes, et al., *Software Quality Journal*, 3/22/2019



Refactoring and Code Smells

Refactoring is a systematic process of improving code without creating new functionality that can transform a mess into clean code and simple design.

Code Smells help us find the problems



https://refactoring.guru/refactoring

Code Smell: Summary

Group name	Short description	Smells in group	Treatment/Refactoring
Bloaters	something that has grown so large that it cannot be effectively handled.	-Long method -Large class -Long parameter list -Data clumps	-Extract Method -Extract class -Replace parameters with method call/object - Preserve whole object
Object-Orientation Abusers	cases where the solution does not fully exploit the possibilities of object-oriented design.	-Switch statements -Refused Bequest (inheritance is being abused)	-Use polymorphism -Push down method/-Eliminate inheritance
Change Preventers	smells that hinder changing or further developing the software.	-Divergent Change -Shotgun surgery	-Extract Class, Method -Move methods and fields
Dispensables	represent something unnecessary that should be removed from the source code.	-Lazy class -Data class -Duplicated code	-Inline class -Move method/Extract Method/Encapsulation -Extract Method
Couplers	a measure of how closely connected two routines or modules are	-Feature envy -Inappropriate intimacy -Middle man	-Move method/field -Bidirectional to unidirectional association -Inline Class

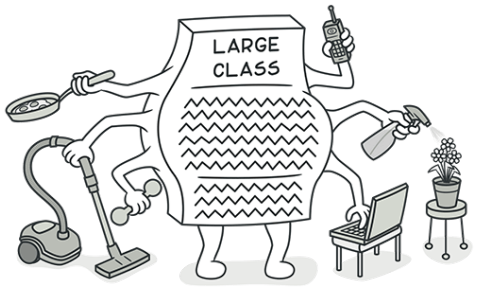
Work on the code smell activity

Bloaters

Large Classes, Long Methods, Data Clumps, and Long Parameter List

https://refactoring.guru/refactoring/smells

Bloaters: **Large Class**



Signs/Symptoms

A class contains many fields/methods/lines of code. May have duplicated code.

Reasons

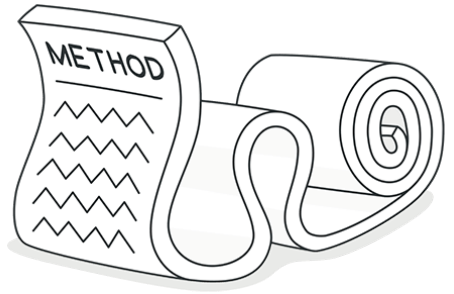
Developers may find it mentally less taxing to place a new feature in an existing class than to create a new class for the feature.

Treatment

Extract Class, Extract Subclass, Extract Method

https://refactoring.guru/smells/large-class

Bloaters: **Long Method**



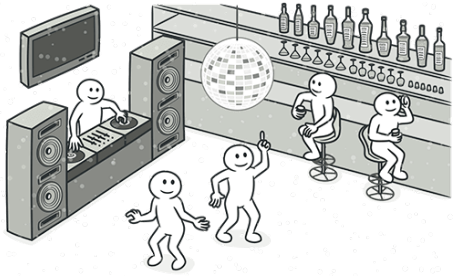
Signs/Symptoms

- A method contains too many lines of code. Generally, any method longer than ten lines should make you start asking questions.
- Conditional operators and loops are a good clue that code can be moved to a separate method
- A block of code with a comment that tells you what it is doing can be replaced by a method

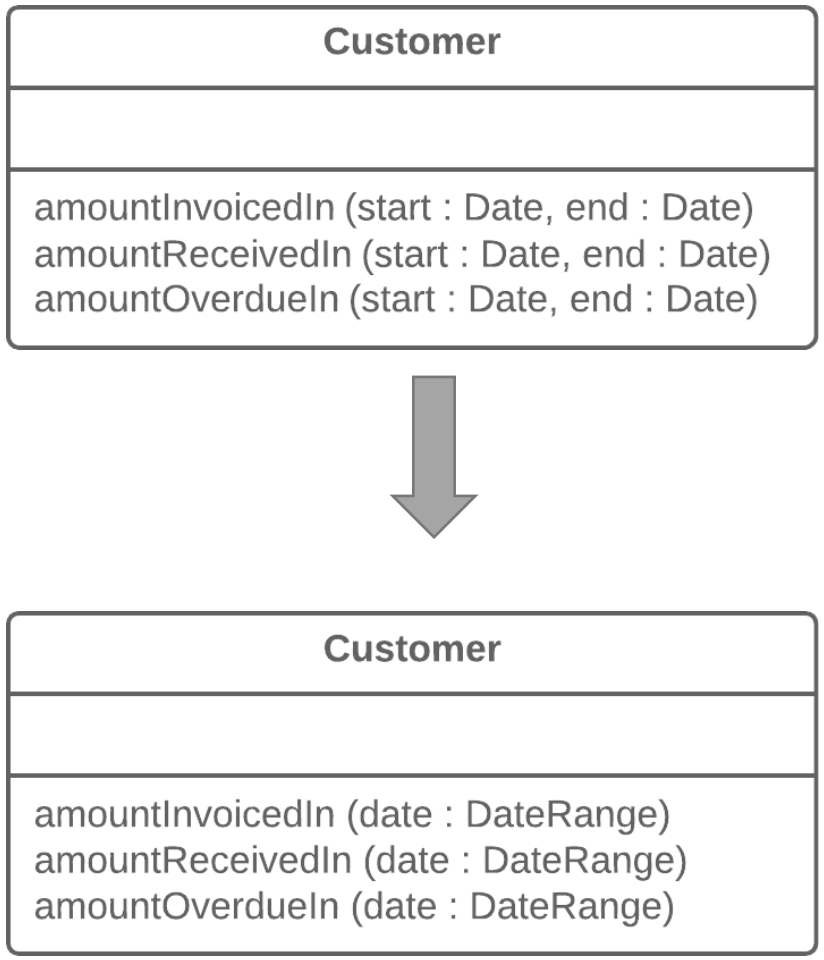
Treatment

- Extract Method

Bloaters: **Data Clumps**



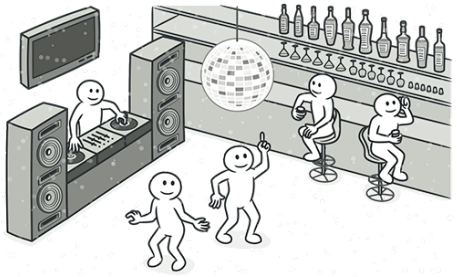
- Sometimes different parts of the code contain identical groups of variables called clumps. (e.g., 3 integers for RGB colors).
- Since these data items are not encapsulated in a class, this increases the sizes of methods and classes.
- To test for this, delete one of the values and see if the others still make sense.



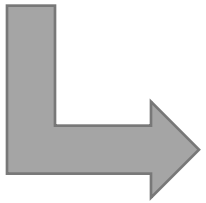
Treatment

- If these variables are passed as parameters, **replace them with an object**
- **Extract Class**

Bloaters: **Data Clumps**



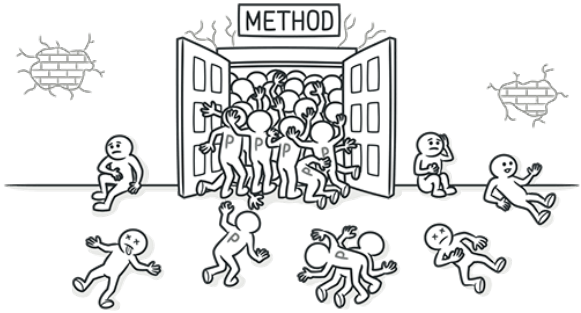
```
class DateUtil {
    boolean isAfter(int year1, int month1, int day1, int year2, int month2, int day2) {
        // implementation
    }

    int differenceInDays(int year1, int month1, int day1, int year2, int month2, int day2) {
        // implementation
    }

    // other date methods
}
```



```
class Date {
    int year;
    int month;
    int day;
}

class DateUtil {
    boolean isAfter(Date date1, Date date2) {
        // implementation
    }

    int differenceInDays(Date date1, Date date2) {
        // implementation
    }

    // other date methods
}
```

https://www.baeldung.com/cs/code-smells

Bloaters: Long Parameter List



Signs/Symptoms

- More than three or four parameters for a method
- Hard to understand such lists

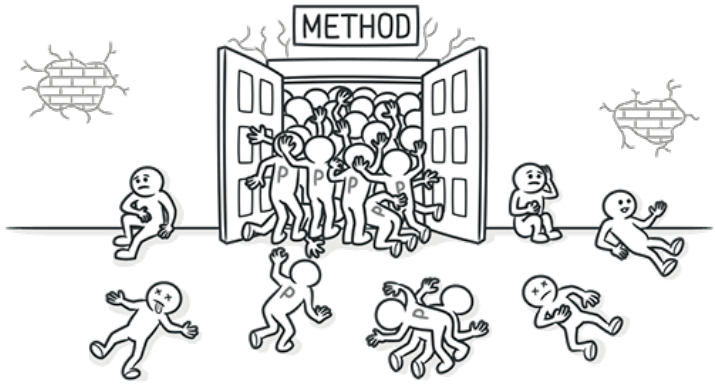
Reasons

- Several types of algorithm are merged in a single method
- A long list may have been created to control which algorithm (or path) is run

Treatment

- Breakup the algorithm
- **Replace Parameters with Method Call**.
- Instead of passing a group of data received from another object as parameters, pass the object itself to the method, by using **Preserve Whole Object**.

Bloaters: **Long Parameter List**



- You get several values from an object and then pass them as parameters to a method.
- Instead, try passing the whole object.

Long parameter lists:

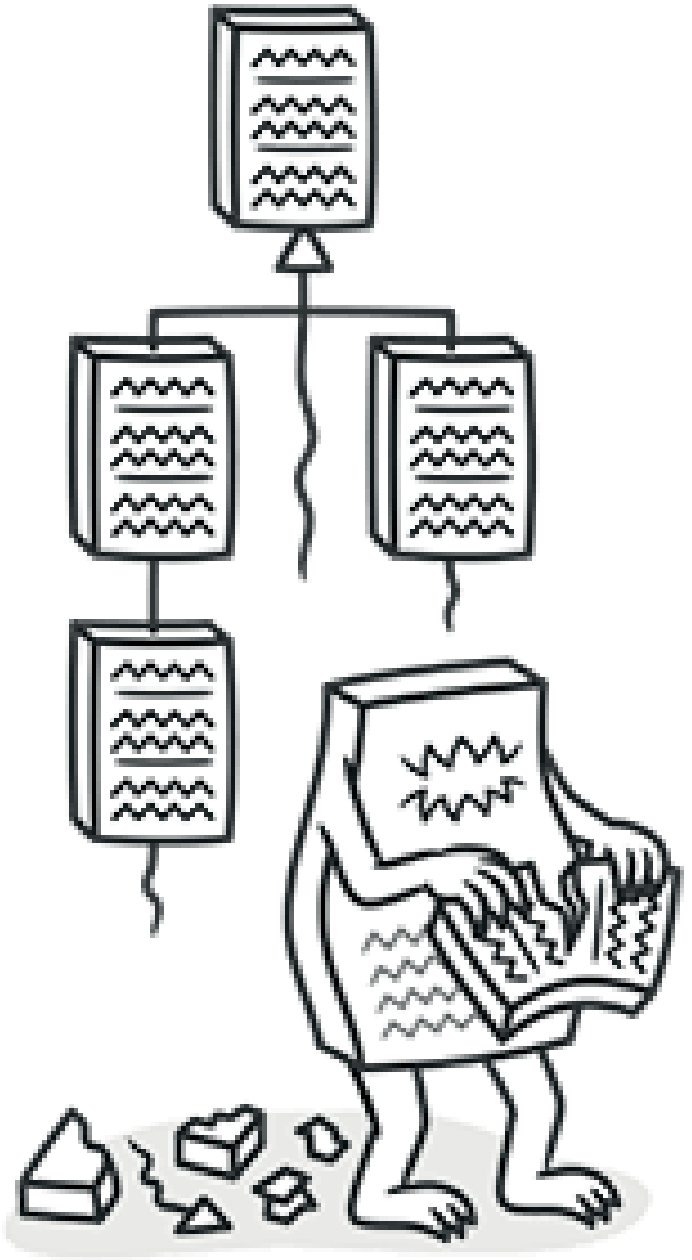
```
function createUser(name, email, phone, address, city, state,
country, zipcode) {
  // ...
}
```

Summary: Bloaters

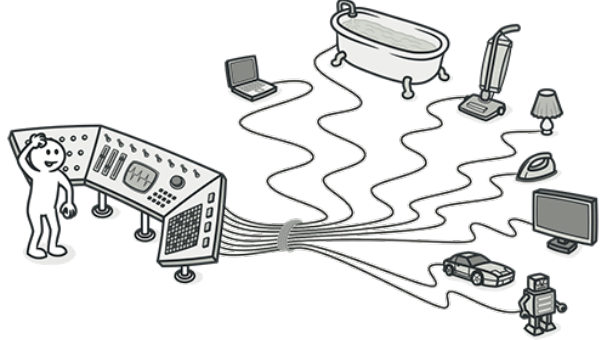
Group name	Short description	Smells in group	Treatment
Bloaters	something that has grown so large that it cannot be effectively handled.	-Long method -Large class -Long parameter list -Data clumps	-Extract Method -Extract class/subclass -Replace parameters with method call/preserve object - Replace with object/Extract Class

OO Abusers

Switch Statements, Refused bequest



OO Abusers: **Switch Statements**



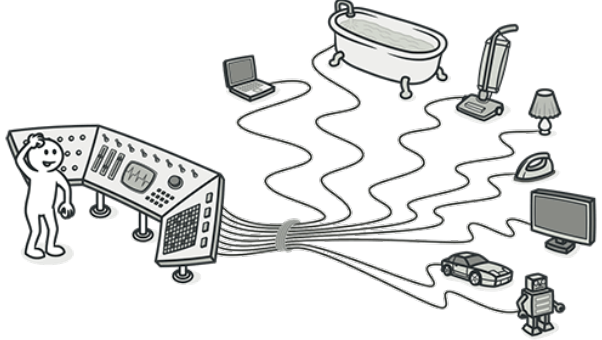
- You have a complex switch operator or sequence of if statements.

Relatively rare use of switch and case operators is one of the hallmarks of object-oriented code.

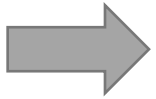
<u>Treatment</u>

- Extract and Move Method
- Use polymorphism to control implementation (method override)

OO Abusers: **Switch Statements**



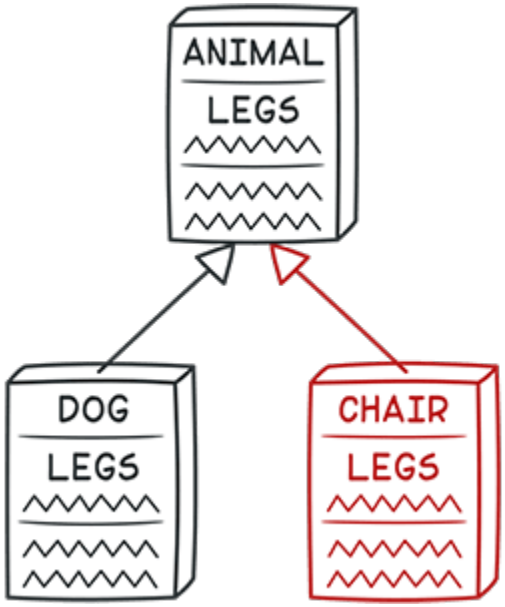
```java
class Animal {
    String type;

    String makeSound() {
        switch (type) {
            case "cat":
                return "meow";
            case "dog":
                return "woof";
            default:
                throw new IllegalStateException();
        }
    }
}
```



```java
abstract class Animal {
    abstract String makeSound();
}

class Cat extends Animal {
    @Override
    String makeSound() {
        return "meow";
    }
}

class Dog extends Animal {
    @Override
    String makeSound() {
        return "woof";
    }
}
```


https://www.baeldung.com/cs/code-smells

OO Abusers: **Refused bequest**



- Subclasses inherit the methods and data of their parents, but they use only a subset of the implemented parent methods. The unwanted methods may simply go unused or be redefined and throw exceptions
- Possible reason: someone was motivated to create inheritance between classes only by the desire to reuse the code in a superclass.
- Also violates the Liskov Substitution Principle.

Treatment

- **Push down method** - Remove the method or property from Base class and move it to that subclass where it fits.
- Use implementable interfaces
- If inheritance makes no sense and the subclass really does have nothing in common with the superclass, **eliminate inheritance**

OO Abusers: **Refused bequest**

Code with Refused Bequest.

```
01.  public class Vehicle
02.      {
03.          protected void Drive() { }
04.      }
05.
06.      public class Car : Vehicle
07.      {
08.      }
09.
10.      public class Plane : Vehicle
11.      {
12.      }
```

Code solving the problem of Refused Bequest.

```
01.  public class Vehicle
02.  {
03.  }
04.
05.  public class Car : Vehicle
06.  {
07.      void Drive() { }
08.  }
09.
10.  public class Plane : Vehicle
11.  {
12.  }
```

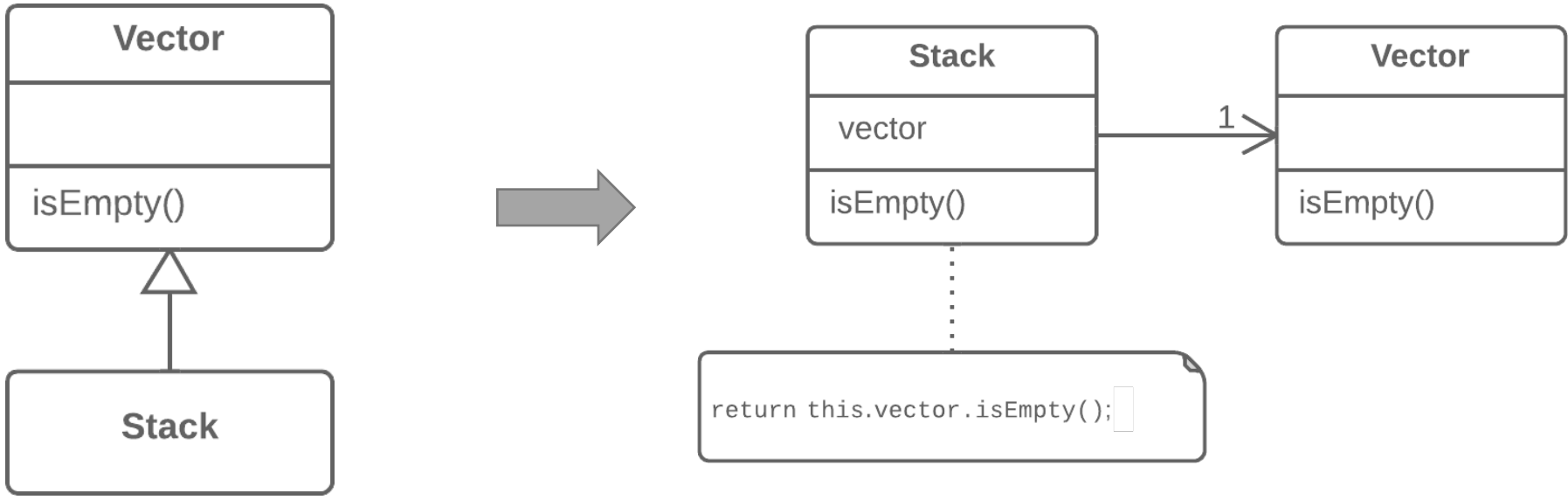
Push down method example

OO Abusers: **Refused bequest**

Remove Inheritance Example

You have a subclass that uses only a portion of the methods of its superclass (or it's not possible to inherit superclass data).

Create a field and put a superclass object in it, delegate methods to the superclass object, and get rid of inheritance.

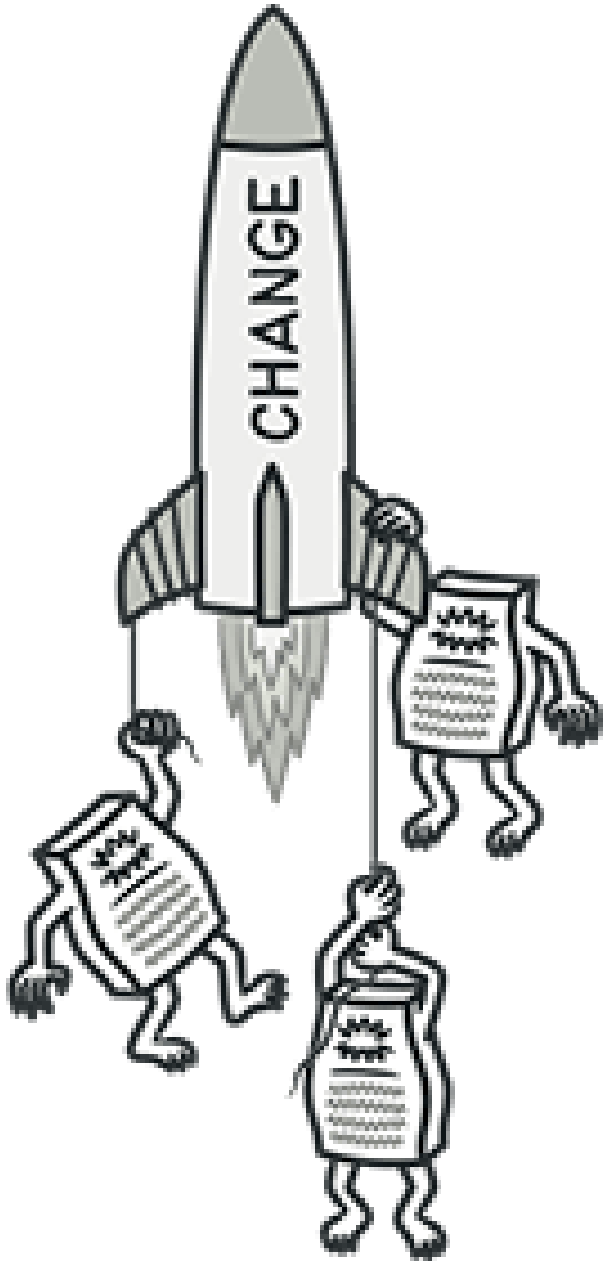


Summary: OO Abusers

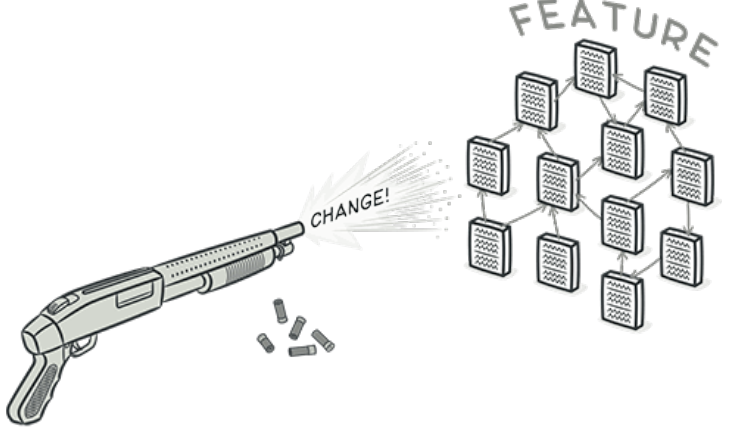
Group name	Short description	Smells in group	Treatment
Object-Orientation Abusers	cases where the solution does not fully exploit the possibilities of object-oriented design.	-Switch statements -Refused Bequest	-Use polymorphism or Extract and move method -Push down method or Eliminate inheritance or implement interfaces

Change Preventers

Shotgun Surgery & Divergent Change



Change Preventers: **Shotgun surgery**

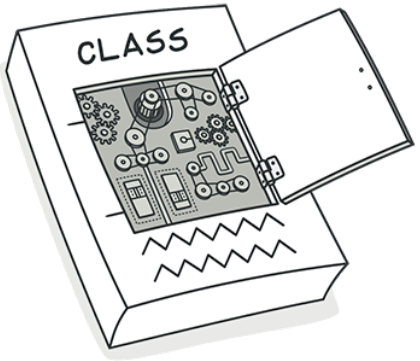


- Every time you make a modification, you must make many small changes to many classes
- Symptom that functionality is spread among classes, you have to change many classes for a small change
- Too much coupling between classes

Treatment

- move existing class behaviors into a single class. If there's no class appropriate for this, create a new one.

Change Preventers: **Divergent Change**



- Resembles Shotgun Surgery but is actually the opposite smell
- Divergent Change is when many changes are made to a single class. Shotgun Surgery refers to when a single change is made to many classes simultaneously.
- Possible reasons: due to poor program structure or “copypaste” programming.
- Violates High Cohesion; May violate Single Responsibility Principle

Treatment

- Extract Class/Method

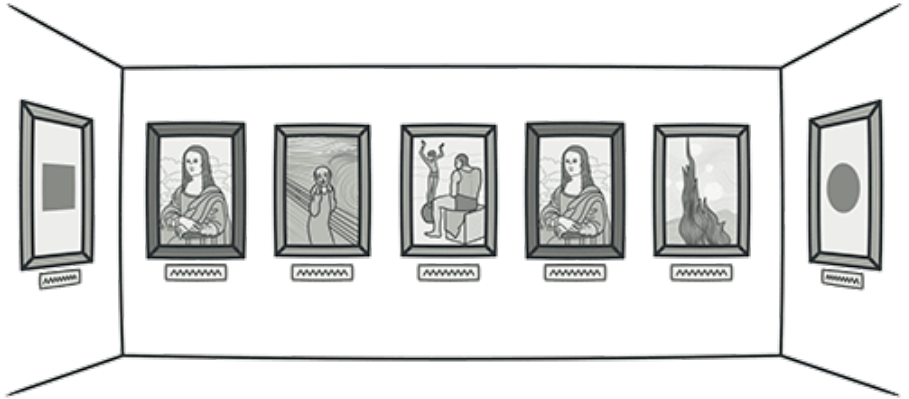
Summary: Change Preventers

Group name	Short description	Smells in group	Treatment
Change Preventers	smells that hinder changing or further developing the software.	-Divergent Change -Shotgun surgery	-Extract Class, Method -Move methods and fields

Dispensables

Duplicated code, Lazy Classes, and Data Classes

Dispensables: **Duplicated code**



- Most common
- Sections of code repeated all over the place
- Sign of amateur work
- When refactoring duplicated code, you must effectively search for all instances of that code

<u>Treatment</u>

- Extract Method

Dispensables: **Lazy Class**

- If a class doesn’t do enough to earn your attention, it should be deleted
- Possible reasons:
  - class was designed to be fully functional but after some of the refactoring it has become ridiculously small
  - it was designed to support future development work that never got done

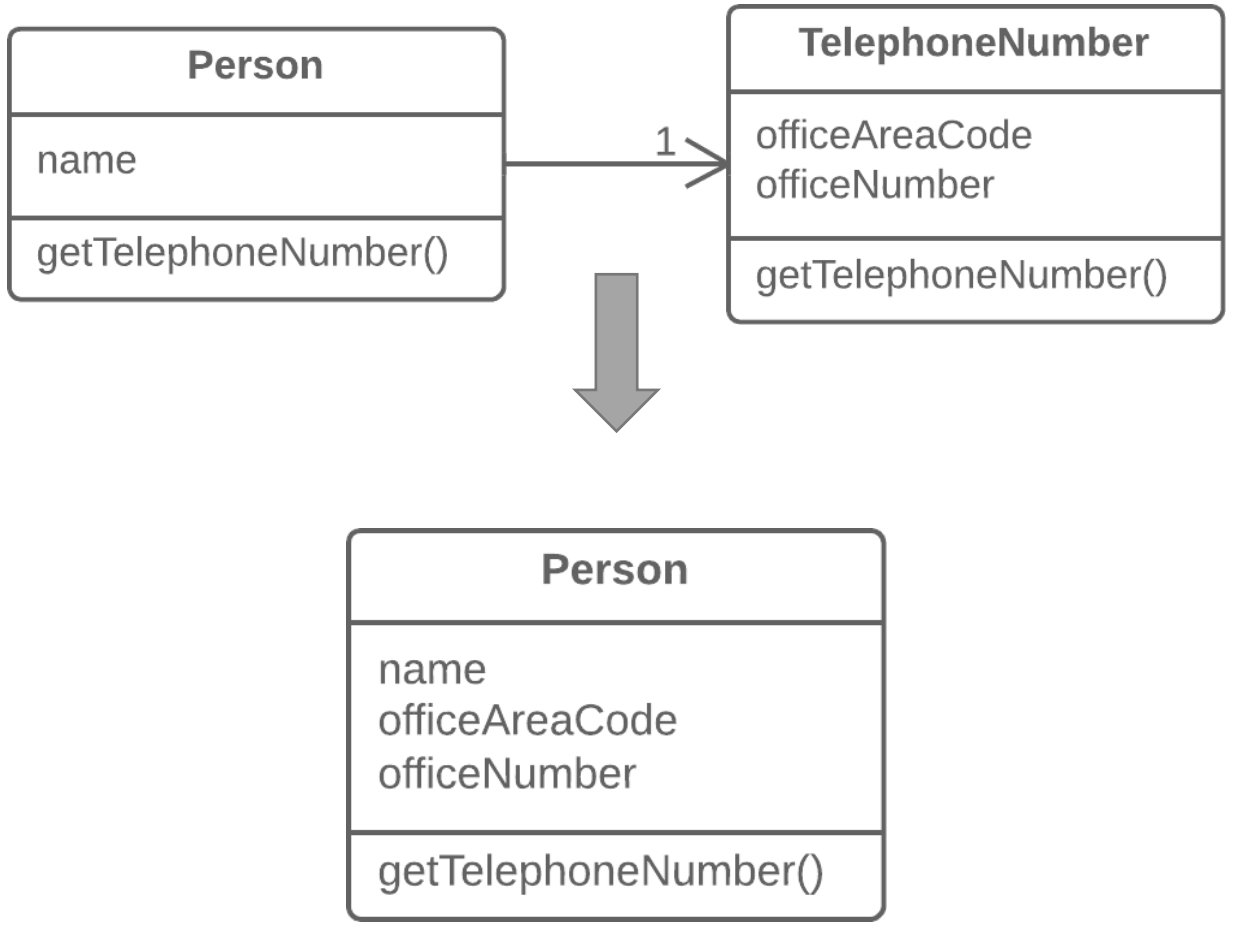
<u>Treatment</u>

- Inline Class

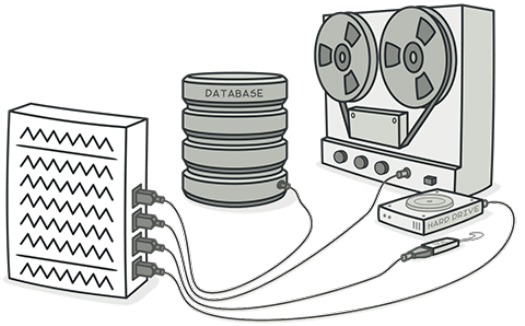
Dispensables: **Lazy Class**

Inline Class Example

A class does almost nothing and isn't responsible for anything, and no additional responsibilities are planned for it.



Dispensables: **Data Class**



- A class that contains only fields and crude methods for accessing them (getters and setters). These are simply containers for data used by other classes.
- These classes do not contain any additional functionality and can't independently operate on their data.

<u>Treatment</u>

- Move method and Extract Method to move functionality to the data class
- Encapsulations – to hide from direct access and require that access be performed via getters and setters only
  - Identify methods that operate on the data you're encapsulating and consider moving them to this new class.

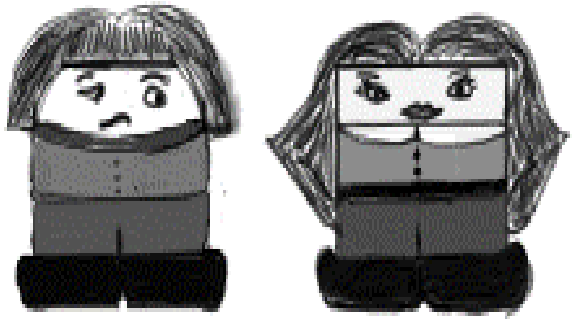
Summary: Dispensables

Group name	Short description	Smells in group	Treatment
Dispensables	represent something unnecessary that should be removed from the source code.	-Lazy class -Data class -Duplicated code	-Inline class -Move method/Extract Method/Encapsulation -Extract Method

Couplers

Feature envy, Inappropriate intimacy, & Middle man

Couplers: **Feature Envy**



- A method that seems more interested in a class other than the one it is in
- Most common focus of the envy is the data
- As a basic rule: if things change at the same time, you should keep them in the same place.

<u>Treatment</u>

- **Move Method**: determine which class has most of the data and put the method with that data

Couplers: **Feature Envy** - Example

```java
public class User {
    private ContactInfo contactInfo;
    public User(ContactInfo contactInfo) { this.contactInfo = contactInfo; }
    public String getFullAddress() {
        String streetName = contactInfo.getStreetName();
        String city = contactInfo.getCity();
        String state = contactInfo.getState();
        return streetName + ", " + city + ", " + state;
    }
}
```

What is the solution?

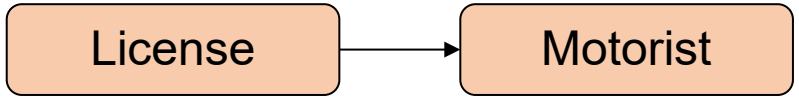
Couplers: Inappropriate Intimacy

- One class uses the internal fields and methods of another class. Classes know too much about each other
- Violating Low Coupling
- Bi-directional behavior between classes creates tight inter-dependency, i.e., classes are tightly coupled
- Good classes should know as little about each other as possible. Such classes are easier to maintain and reuse.

Treatment

- **Move Method/Move Field**: move parts of one class to the class in which those parts are used. But this works only if the first class truly doesn't need these parts.
- Change Bidirectional Association to Unidirectional

Couplers: **Inappropriate Intimacy** Example 1/2

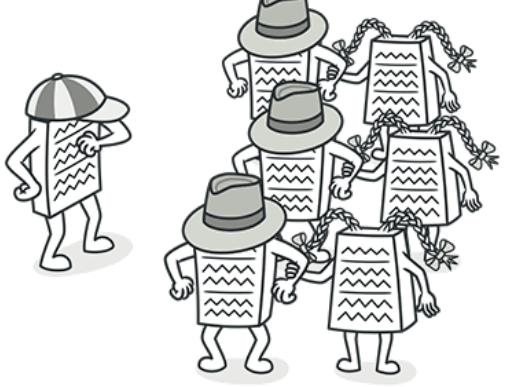



```
public class License {
    private Motorist motorist;
    private int points = 0;
    public void setMotorist(Motorist motorist) { this.motorist = motorist; }
    public int getPoints() { return points; }
    public void addPoints(int points) { this.points += points; }
    public String getSummary() {
        return motorist.getTitle() + " " + motorist.getFirstName()
                + " " + motorist.getLastName() + ", " + getPoints()
                + " points";
    }
```

Couplers: **Inappropriate Intimacy** Example 2/2


```
public class Motorist {
    private String title;
    private String firstName;
    private String lastName;
    private License license;
    public String getTitle() { return title; }
    public String getFirstName() { return firstName; }
    public String getLastName() { return lastName; }
    public RiskFactor getRiskFactor() {
        if (license.getPoints() > 3)
            return RiskFactor.HIGH_RISK;
        if (license.getPoints() > 0)
            return RiskFactor.MODERATE_RISK;
        return RiskFactor.LOW_RISK;
    }
```

Couplers: **Middle Man**



- If a class performs only one action, delegating work to another class, why does it exist at all?
- Violating SRP
- Possible reasons: it can be the result of the useful work of a class being gradually moved to other classes. The class remains as an empty shell that doesn't do anything other than delegate.

<u>Treatment</u>

- Inline Class

Summary: Couplers

Group name	Short description	Smells in group	Treatment
Couplers	a measure of how closely connected two routines or modules are	-Feature envy	-Move method/field
		-Inappropriate intimacy	-Move methods, Bidirectional to unidirectional association
		-Middle man	-Inline Class

Summary

Group name	Short description	Smells in group	Treatment
Bloaters	something that has grown so large that it cannot be effectively handled.	-Long method -Large class -Long parameter list -Data clumps	-Extract Method -Extract class -Replace parameters with method call/object - Preserve whole object
Object-Orientation Abusers	cases where the solution does not fully exploit the possibilities of object-oriented design.	-Switch statements -Refused Bequest	-Use polymorphism -Push down method -Eliminate inheritance
Change Preventers	smells that hinder changing or further developing the software.	-Divergent Change -Shotgun surgery	-Extract Class, Method -Move methods and fields
Dispensables	represent something unnecessary that should be removed from the source code.	-Lazy class -Data class -Duplicated code	-Inline class -Move method/Extract Method/Encapsulation -Extract Method
Couplers	a measure of how closely connected two routines or modules are	-Feature envy -Inappropriate intimacy -Middle man	-Move method/field -Bidirectional to unidirectional association -Inline Class

Top 10 Code Smells to Identify in PRs

https://axolo.co/blog/p/top-10-code-smells-to-identify-in-pull-requests-with-code-examples