DESIGN PATTERNS

COURSE 11

PREVIOUS COURSE

- ❑ J2EE Design Patterns

CURRENT COURSE

- **Refactoring**
  - Way refactoring
  - Some refactoring examples

SOFTWARE EVOLUTION

- **Problem: You need to modify existing code**
  - extend/adapt/correct/…

- **(Bad) Solution:**
  - Just add new features

- **Consequence:**
  - Design decays
  - Duplicated code
  - Long methods / classes , …

- **(Good) Solution:**
  - First make code simpler => Refactor
  - Add new features

- **Consequence:**
  - Code stays simple

REFACTORING CONSIDERED HARMFUL

- **From the standpoint of a manager, refactoring can appear to be dangerous!**
    - If my developers spend their time “cleaning up the code” then that's less time implementing required functionality
        - …and my schedule is slipping as it is!

- **To address these concerns, refactoring needs to be**
    - systematic
    - incremental
    - safe

WHAT IS REFACTORING?

- ❑ **“The process of changing a software system in such a way that it does not alter the external behaviour of the code, yet improves its internal structure.”**

  Martin Fowler, “Refactoring: Improving the Design of Existing Code”, Addison-Wesley,1999.

- ❑ **“A behaviour-preserving source-to-source program transformation.”**

  Don Roberts, “Practical analysis for Refactoring”, PhD Thesis, University of Illinois, 1999.

- ❑ **“A change to the system that leaves its behaviour unchanged, but enhances some non-functional quality - simplicity, flexibility, understandability, …”**

  Kent Beck, “eXtreme Programming Explain: Embrace Change”, Addison-Wesley, 2000.

WAY TO REFACTOR?

- ❑ **Refactoring improves the design of your system**
- ❑ **Refactoring makes your software easier to understand**
  - ❑ because structure is improved
  - ❑ duplicated code is removed
  - ❑ etc.
- ❑ **Refactoring helps you find bugs**
  - ❑ because it promotes a deep understanding of the code
- ❑ **Refactoring helps you program faster**
  - ❑ because a good design enables progress
- ❑ **Prevent “design decay”**
- ❑ **Clean up messes in the code**
- ❑ **Simplify the code**
- ❑ **Reduce debugging time**
- ❑ **Redoing things is fundamental to every creative process**

HOW TO MAKE A SAFE REFACTORING

- **First, make it systematic**
  - e.g. use refactoring patterns, like the ones discussed in Fowler's book
  - Follow a refactoring process

- **Second, test constantly!**
  - Each time you finish a refactoring, you run your test suite to confirm that your system's functionality has stayed the same
  - This assumes, you have test already!

PREREQUISITES FOR REFACTORING

- Tests
- Coding standards
- Continuous integration
- Collective code ownership
- Pair programming
- Simple design

THE REFACTORING PROCESS

- **When you systematically apply refactoring, you wear two hats**
  - add functionality
  - refactoring

- **Don't try to clean the code when doing the former**
- **Don't try to add features whesn doing the latter**

- **Refactoring is not just arbitrary restructuring**
  - Code must still work
  - Small steps only so the semantics are preserved (i.e. not a major re-write)
  - Unit tests to prove the code still works
  - Code is
    - More loosely coupled
    - More cohesive modules
    - More comprehensible

WHEN TO REFACTOR

- **You should refactor:**
  - Any time that you see a better way to do things
    - "Better" means making the code easier to understand and to modify in the future
  - You can do so without breaking the code
    - Unit tests are essential for this

- **You should not refactor:**
  - Stable code that won't need to change
  - Someone else's code
  - Unless the other person agrees to it or it belongs to you
  - Not an issue in Agile Programming since code is commun

WHEN TO REFACTOR

- **When should you refactor?**
  - Any time you find that you can improve the design of existing code
  - You detect a “bad smell” (an indication that something is wrong) in the code

- **When can you refactor?**
  - You should be in a supportive environment (agile programming team, or doing your own work)
  - You are familiar with common refactorings
  - Refactoring tools also help
  - You should have an adequate set of unit tests

WHAT TO REFACTOR?

- ❑ **Make sure your tests pass**
- ❑ **Find some code that “smells”**
- ❑ **Determine how to simplify this code**
- ❑ **Make the simplifications**
- ❑ **Run tests to ensure things still work correctly**
    - ❑ You eventually have to adapt your tests
- ❑ **Repeat the simplify/test cycle until the smell is gone**

REFACTORING STEPS

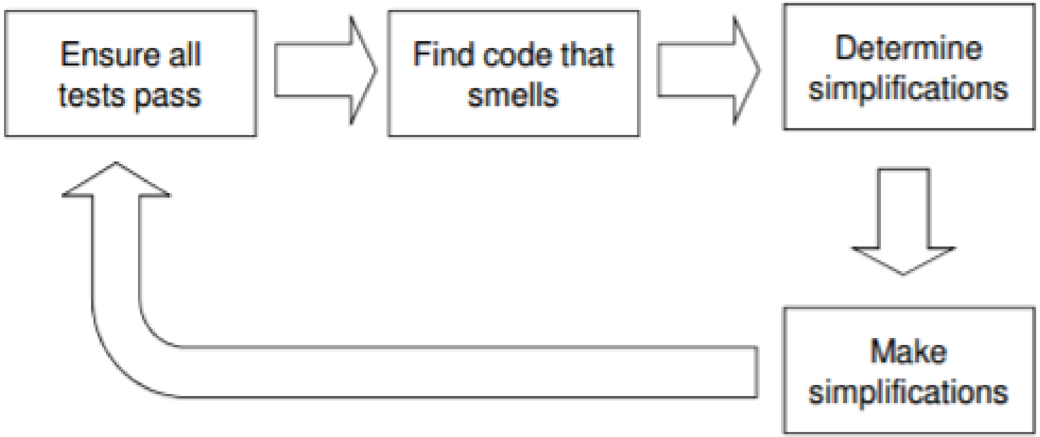
- **Save / backup / checkin the code before you mess with it.**
  - If you use a well-managed version control repo, this is done.

- **Write unit tests that verify the code's external correctness.**
  - They should pass on the current poorly designed code.
  - Having unit tests helps make sure any refactor doesn't break existing behavior (regressions).

- **Analyze the code to decide the risk and benefit of refactoring.**
  - If it is too risky, not enough time remains, or the refactor will not produce enough benefit to the project, don't do it.

REFACTORING PROCESS

- **Make a small change**
  - a single refactoring
- **Run all the tests to ensure everything still works**
- **If everything works, move on to the next refactoring**
- **If not, fix the problem, or undo the change, so you still have a working system**



PROBLEMS WITH REFACTORING

- **Taken too far, refactoring can lead to incessant tinkering with the code, trying to make it perfect**

- **Refactoring code when the tests don’t work or tests when the application doesn’t work leads to potentially dangerous situations**

- **Databases can be difficult to refactor**
  - code is easy to change; databases are not

- **Refactoring published interfaces can cause problems for the code that uses those interfaces**

WHY (SOME) DEVELOPERS DON’T LIKE IT

❑Lack of understanding

❑Short-term focus

❑Not paid for overhead tasks like refactoring

❑Fear of breaking current program

CODE SMELLS EXAMPLES

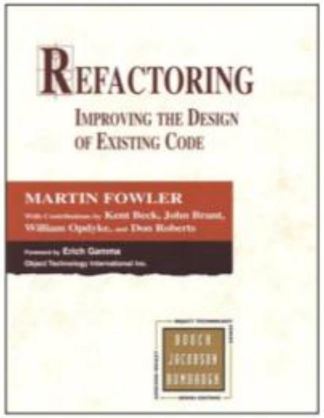
- **If it stinks, change it**
  - Code that can make the design harder to change

- **Examples:**
  - Duplicate code
  - Long methods
  - Big classes
  - Big switch statements
  - Long navigations (e.g., a.b().c().d())
  - Lots of checking for null objects
  - Data clumps (e.g., a Contact class that has fields for address, phone, email etc.) - similar to non-normalized tables in relational design
  - Data classes (classes that have mainly fields/properties and little or no methods)
  - Un-encapsulated fields (public member variables)

SOME TYPES OF REFACTORING

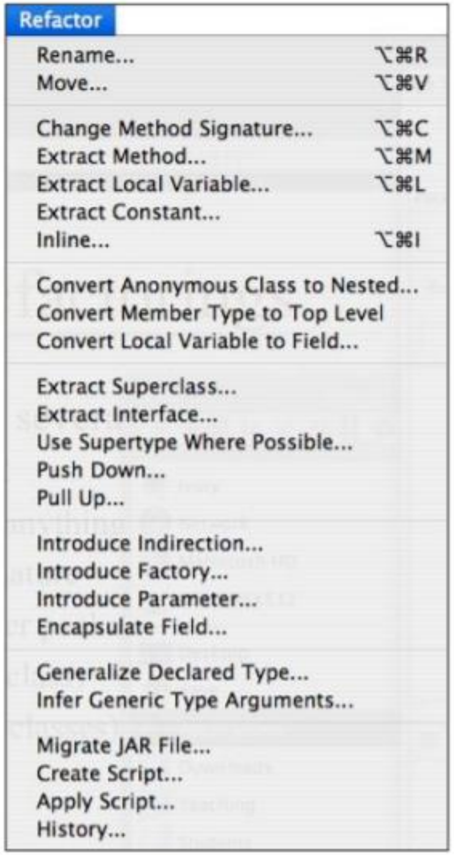
- refactoring to fit design patterns
- renaming (methods, variables)
- extracting code into a method or module
- splitting one method into several to improve cohesion and readability
- changing method signatures
- performance optimization
- moving statements that semantically belong together near each other
- naming (extracting) "magic" constants
- exchanging idioms that are risky with safer alternatives
- clarifying a statement that has evolved over time or is uncl

- See also http://www.refactoring.org/catalog/


REFACTORING
IMPROVING THE DESIGN OF EXISTING CODE
MARTIN FOWLER
Kent Beck, John Brant, William Opdyke, Don Roberts
Erich Gamma

HOW TO REFACTOR

- ❑ **Manualy**
- ❑ **Refactoring tool**
  - ❑ Eclipse (and some other IDEs) provide significant support for refactoring



EXTRACT METHOD

- You have a code fragment that can be grouped together.
- Turn the fragment into a method whose name explains the purpose of the method.
- Inverse of Inline Method

```
void printOwing() {
      printBanner();
      //print details
      System.out.println ("name: " +_name);
      System.out.println("amount " + getOutstanding());
}
```

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

INLINE METHOD

- A method's body is just as clear as its name.
- Put the method's body into the body of its callers and remove the method.
- Inverse of Exact Method

```
int getRating() {
 return (moreThanFiveLateDeliveries()) ? 2 : 1;
}
boolean moreThanFiveLateDeliveries() {
 return _numberOfLateDeliveries > 5;
}
```

```
int getRating() {
 return (_numberOfLateDeliveries > 5) ? 2 : 1;
}
```

RENAME METHOD

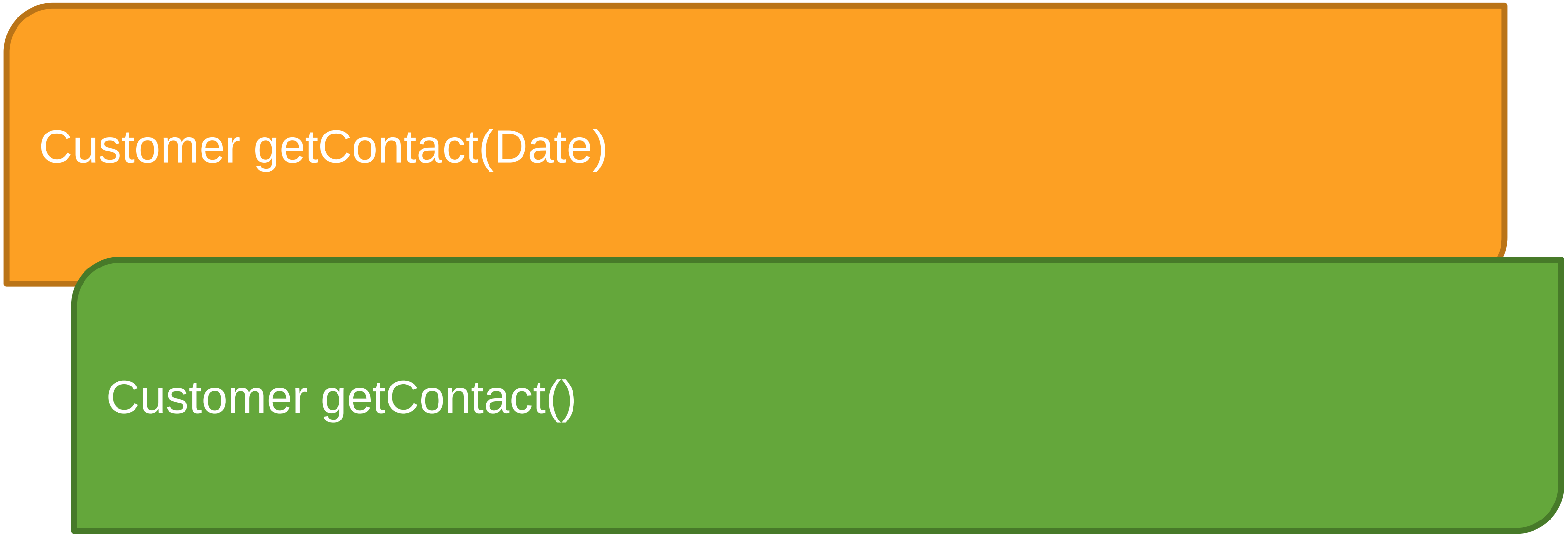
- ❑ The name of a method does not reveal its purpose.
- ❑ Change the name of the method.

```
class Customer {
 double getInvcdtlmt();
}
```

```
class Customer {
 double getInvoiceableCreditLimit();
}
```

REMOVE PARAMETER

- A parameter is no longer used by the method body.
- Remove it.
- inverse of Add Parameter
- Naming: In IDEs this refactoring is usually done as part of "Change Method Signature”



Customer getContact(Date)

Customer getContact()

ADD PARAMETER

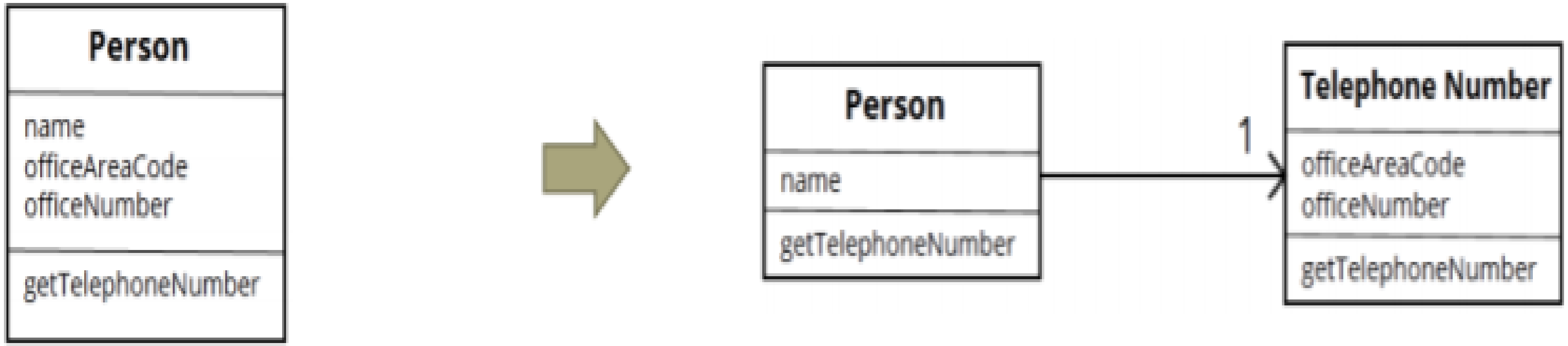
- ❑ A method needs more information from its caller.
- ❑ Add a parameter for an object that can pass on this information.
- ❑ Inverse of Remove Parameter
- ❑ Naming: In IDEs this refactoring is usually done as part of "Change Method Signature"

Customer getContact()

Customer getContact(Date data)

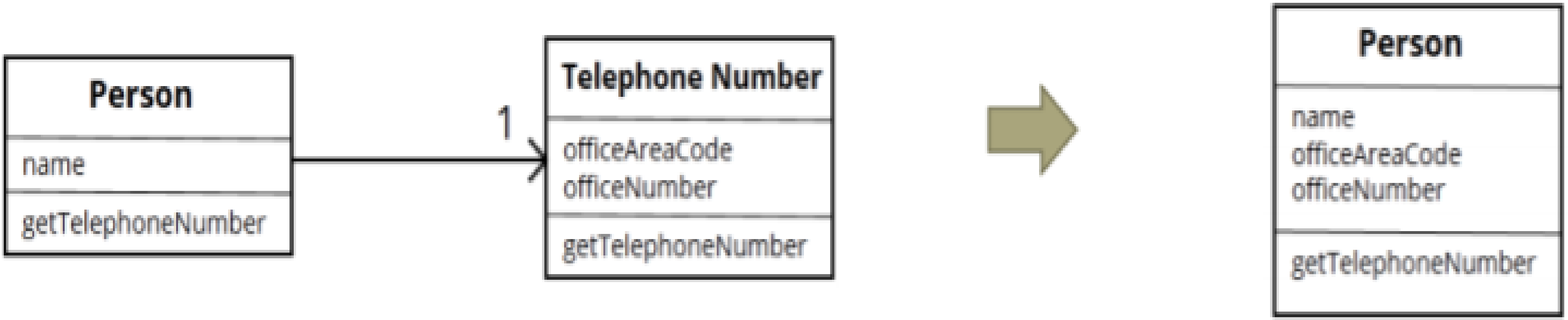
EXTRACT CLASS

- ❑ You have one class doing work that should be done by two.
- ❑ Create a new class and move the relevant fields and methods from the old class into the new class.
- ❑ Inverse of Inline Class



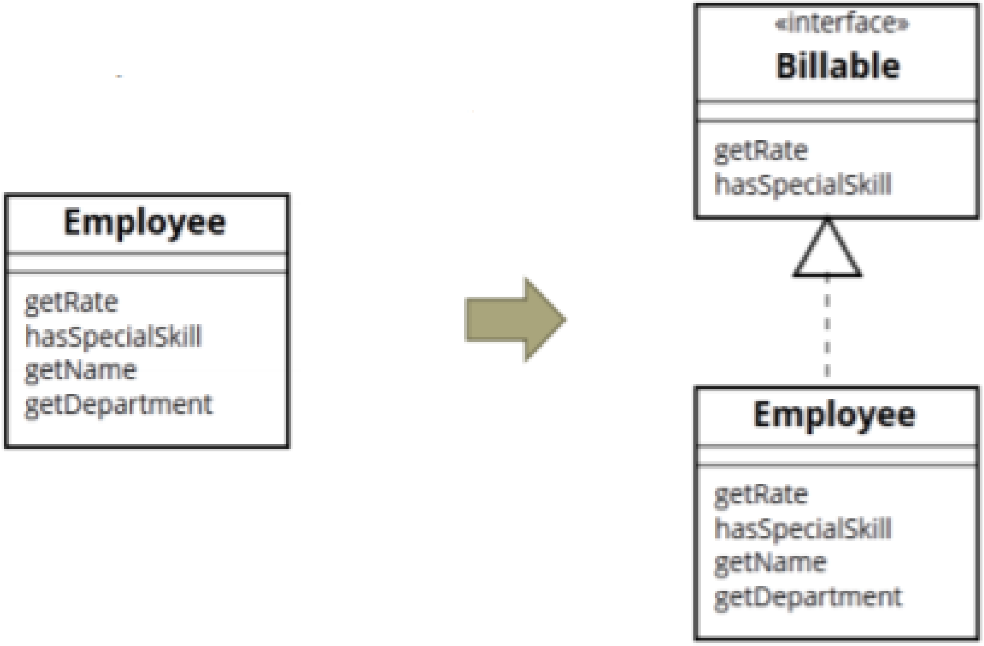
INLINE CLASS

- ❑ A class isn't doing very much.
- ❑ Move all its features into another class and delete it.
- ❑ Inverse of Extract Class, Extract Interface



EXTRACT INTERFACE

- ❑ Several clients use the same subset of a class's interface, or two classes have part of their interfaces in common.
- ❑ Extract the subset into an interface.
- ❑ Inverse of Inline Class



REPLACE ERROR CODE WITH AN EXCEPTION

A method returns a special code to indicate an error.

Throw an exception instead.

```
int withdraw(int amount) {
 if (amount > _balance)
     return -1;
 else
      _balance -= amount; return 0;
}
```

```
void withdraw(int amount) throws BalanceException {
    if (amount > _balance)
         throw new BalanceException();
    _balance -= amount;
}
```

REPLACE EXCEPTION WITH TEST

You are throwing an exception on a condition the caller could have checked first.

Change the caller to make the test first.

```
double getValueForPeriod (int periodNumber) {
  try {
     return _values[periodNumber];
   } catch (ArrayIndexOutOfBoundsException e) {
     return 0;
  }
}
```

```
double getValueForPeriod (int periodNumber) {
  if (periodNumber >= _values.length)
     return 0;
  return _values[periodNumber];
}
```

CONSOLIDATE CONDITIONAL EXPRESSION

- You have a sequence of conditional tests with the same result.
- Combine them into a single conditional expression and extract it.

```
double disabilityAmount() {
 if (_seniority < 2) return 0;
 if (_monthsDisabled > 12) return 0;
 if (_isPartTime) return 0;
 // compute the disability amount
```

```
double disabilityAmount() {
 if (isNotEligableForDisability()) return 0;
 // compute the disability amount
```

CONSOLIDATE DUPLICATE CONDITIONAL FRAGMENTS

- ❑ **The same fragment of code is in all branches of a conditional expression.**
- ❑ **Move it outside of the expression.**

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

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

OBSTACLES TO REFACTORING

- **Complexity**
  - Changing design is hard
  - Understanding code is hard
- **Possibility to introduce errors**
  - Run tests if possible
  - Build tests
- **Cultural Issues**
  - “We pay you to add new features, not to improve the code!”
- **Performance issue**
  - Refactoring may slow down the execution
- **Normally only 10% of your system consumes 90% of the resources so just focus on 10 %.**
  - Refactorings help to localize the part that need change
  - Refactorings help to concentrate the optimizations
- **Development is always under time pressure**
  - Refactoring takes time
  - Refactoring better after delivery

SUMMARY

- ❑ **“The process of changing a software system in such a way that it does not alter the external behavior of the code, yet improves its internal structure” [Fowler]**

- ❑ **Refactor to:**
  - ❑ Improve the software design
  - ❑ Make the software easier to understand
  - ❑ Help find bugs

- ❑ **A catalog of refactoring exists: Extract Method, Move Method, Replace Temp with Query, etc…**

- ❑ **Refactoring has some obstacles**

NEXT COURSE

Anti-patterns