School of Computing
FACULTY OF ENGINEERING & PHYSICAL SCIENCES

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COMP5911M
Advanced Software Engineering

6: Fundamentals of Refactoring

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Previously…

- We introduced refactoring via a small case study
- We saw that design could be improved by a series of **small, well-defined, carefully controlled steps**
- We saw that **unit tests are essential in supporting this process**; without them, we won’t be able to tell whether we are breaking things!

REMEMBER: you need to continue refactoring this code yourself – see Exercise 3

Objectives

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- To go deeper into why, how and when we refactor code
- To consider the limitations of refactoring, and identify situations in which we don't refactor

Reminder

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 behaviour.

Refactor (verb): To restructure software via a series of refactorings, without changing its observable behaviour.

Structural Decay

- As changes are made over time to realize short-term goals, code loses its structure
- System accumulates **technical debt** – which, if not addressed, can eventually make it impossible to modify
- ‘Paying off’ the technical debt is much easier if you do so by ‘small installments’ – i.e., frequent small changes
- Refactoring is a rigorous way of doing this!

Improved Understanding

- Code is written once but read and modified *many* times
- So the cost of being hard to understand can be high
    - For new developers joining your team
    - For you, returning to your code after a long time
- Refactoring **embeds your understanding into the code**, for the benefit of others / yourself in future

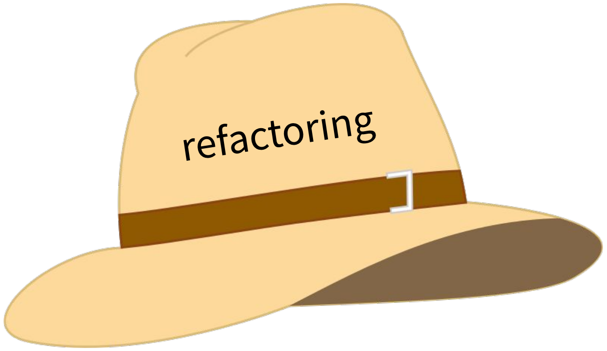
‘Two Hats’ Metaphor

Adding features

- Generally don’t change existing code
- Measure progress by creating tests and getting them to pass

Refactoring

- Change existing code and don’t add any new features
- Generally don’t add tests, and only change them when needed



Refactorings Covered Elsewhere

- Extract Method
- Move Method
- Inline Temp
- Replace Temp with Query
- Replace Conditional with Polymorphism

See Lecture 5 &
Exercise 3

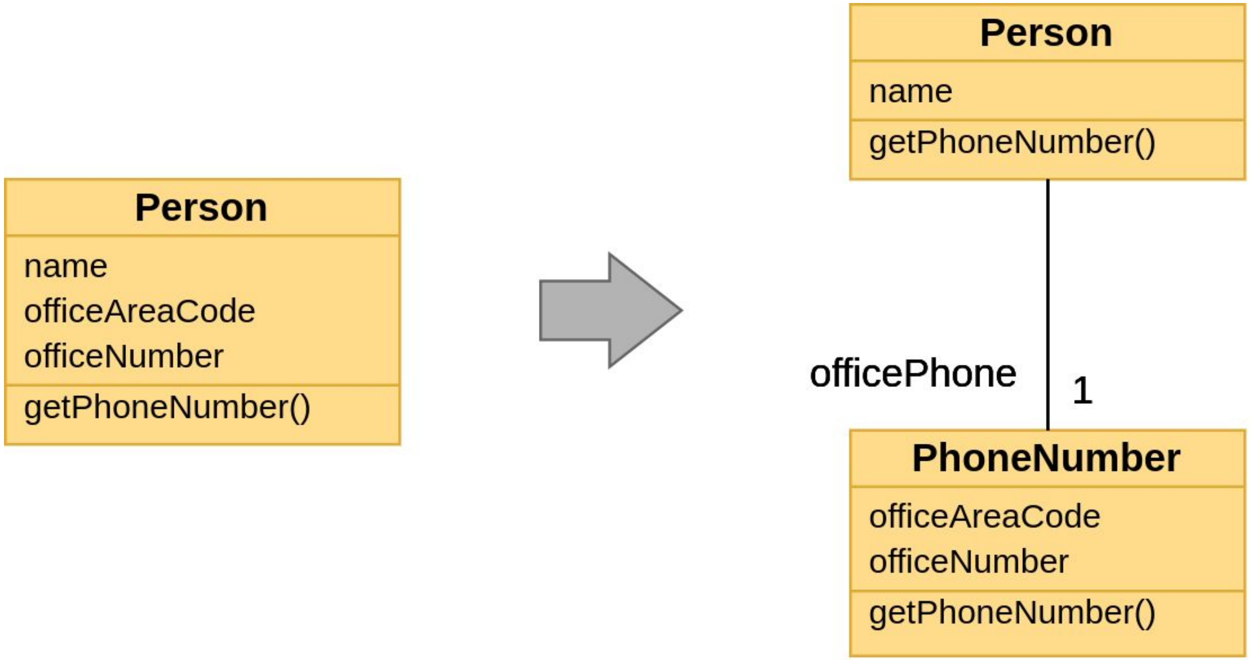
Refactoring Categories

- Composing methods
- Moving features between objects
- Organising data
- Simplifying conditional logic
- Simplifying method calls
- Manipulating inheritance hierarchies

Example: Extract Class

You have one class doing work that should be done by two.

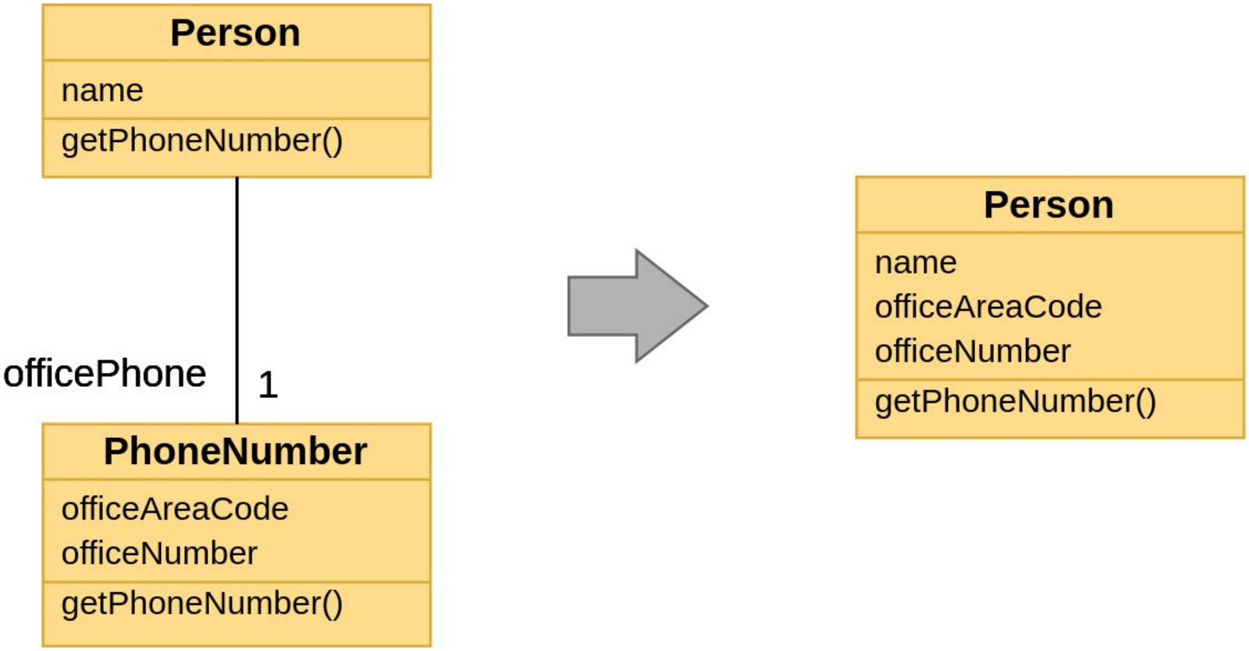
Create a new class and move the relevant fields and/or methods from the old class to the new class.



Example: Inline Class

A class isn’t doing very much.

Move all its features to another class, then delete it.



Person

name

getPhoneNumber()

officePhone

1

PhoneNumber

officeAreaCode
officeNumber

getPhoneNumber()

Person

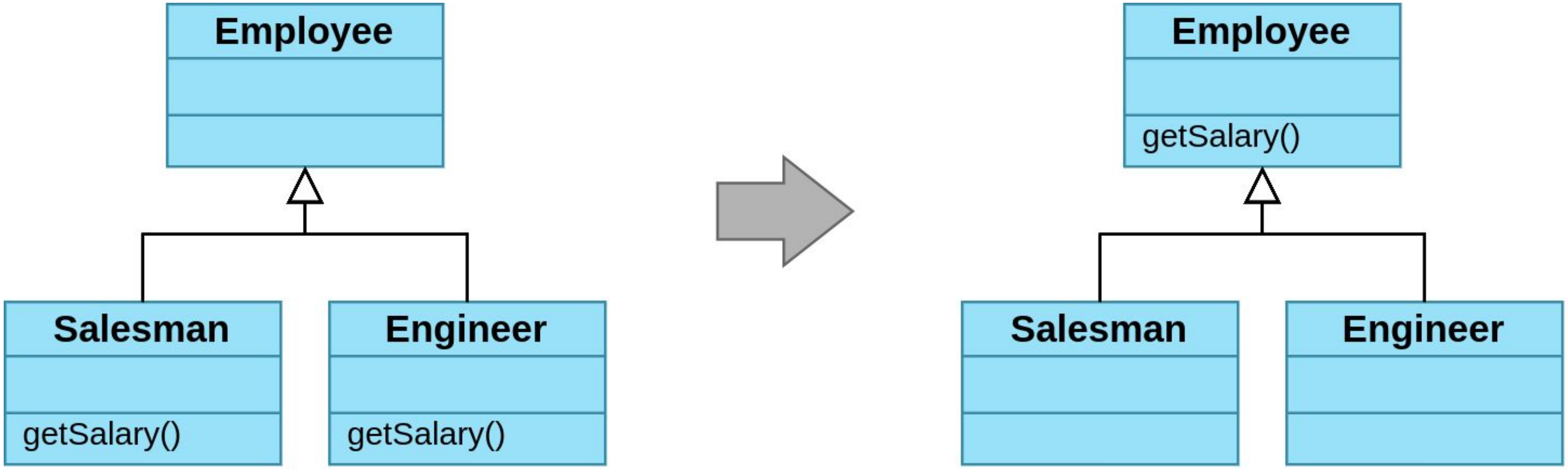
name
officeAreaCode
officeNumber

getPhoneNumber()

Example: Pull Up Method

You have methods with identical results on subclasses.

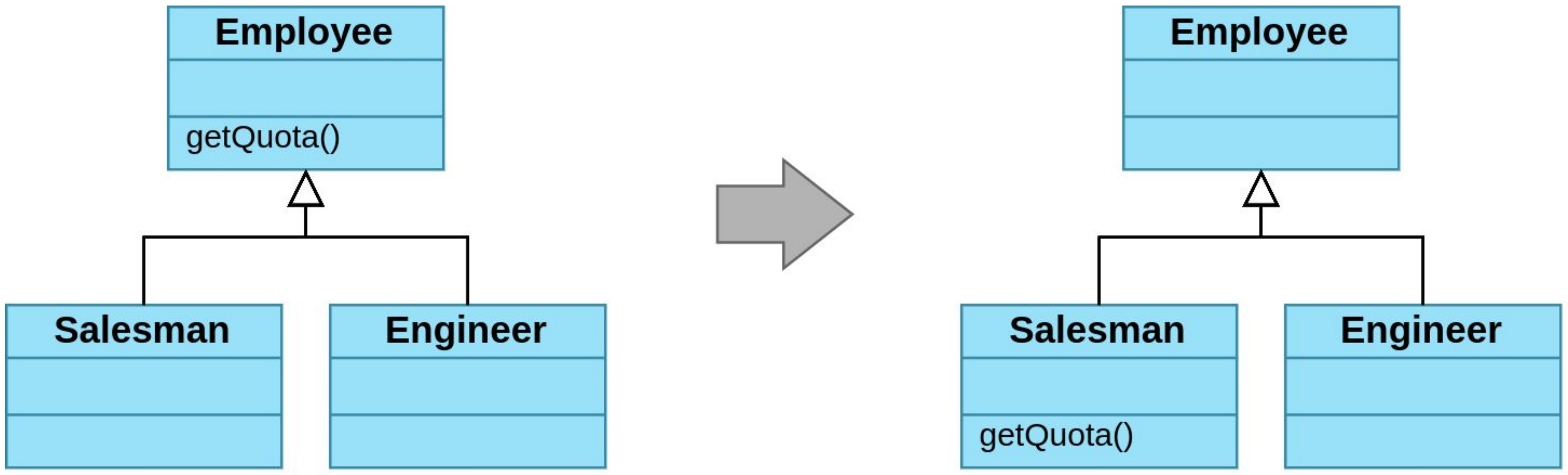
Move them to the superclass.



Example: Push Down Method

Behaviour on a superclass is relevant only for some of its subclasses.

Move it to those subclasses.



Example: Decompose Conditional

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

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

When Do We Refactor?

- Before adding a feature
- As we do code review
- When there’s a ‘bad smell’ to the code

‘Code Smells’

- Originally the idea of **Kent Beck** (JUnit & XP)
- The sense that something ‘smells bad’ in the code – i.e., the design/implementation isn’t as good as it could be
- Based primarily on intuition, experience and personal judgement rather than anything scientific
- Fowler’s book lists 22 of them…

Typical Code Smells

- Duplicate Code
- Long Method
- Long Parameter List
- Temporary Field
- Switch Statement
- Excessive Comments

See Fowler Chapter 3 or Refactoring Guru for more examples

Link to Refactorings

Each code smell suggests one or more possible refactorings that can remove the problem:

- Duplicate code ⟶ **Extract Method** if code is in the methods of one class, **Extract Class** or **Extract Superclass** if code is in different classes
- Excessive Comments ⟶ **Extract Variable** if comment explains a complex expression, **Extract Method** if it explains a block of code, **Rename Method** if it explains a method
- Long Parameter List ⟶ **Preserve Whole Object** if params come from same object, or **Introduce Parameter Object** if not
- Temporary Field ⟶ **Extract Class**

Task

1. Get a copy of the 'Smells to Refactorings Cheatsheet' (physical handout, or Download from Minerva)
2. Study the `step1` code from Lecture 5, then use the Cheatsheet and refactoring.guru code smells page to identify two smells affecting the code
3. Study the `getCharge()` method in the `Rental` class in the `step3` code. Which refactoring technique from the 'Organizing Data' section on refactoring.guru can we use to improve the code?

getCharge()

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When Do We Refactor?

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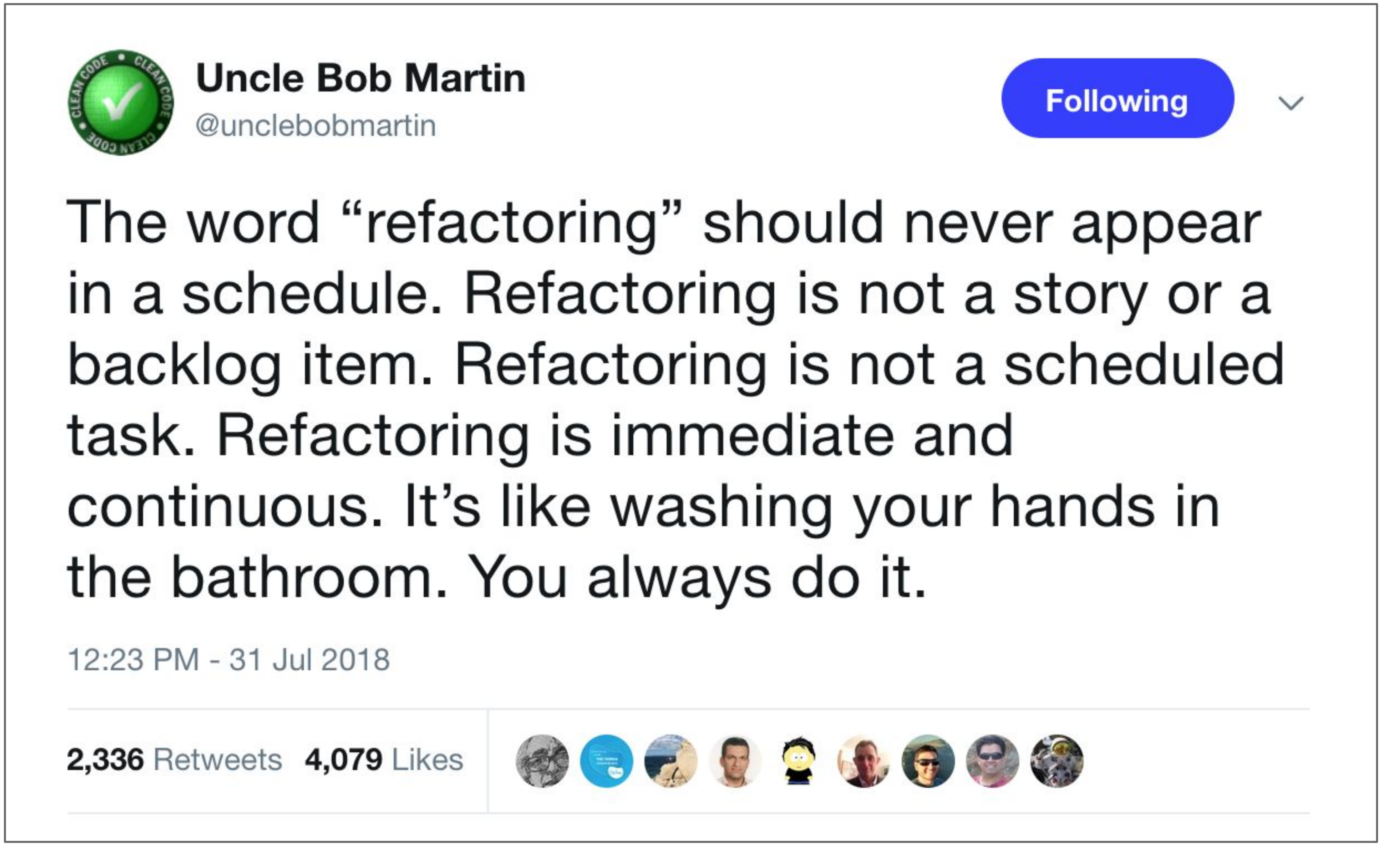

Uncle Bob Martin
@unclebobmartin

The word “refactoring” should never appear in a schedule. Refactoring is not a story or a backlog item. Refactoring is not a scheduled task. Refactoring is immediate and continuous. It’s like washing your hands in the bathroom. You always do it.

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Issues With Databases

- Business applications are often tightly coupled to the database schema
- … so refactoring the code can force schema changes
- … which then forces time-consuming **data migration**, if the database is already live
- Solution: insert a layer of software between the app's object model and database model
    - Refactoring may force changes to the intermediate layer, but schema can remain unchanged

API Changes

- Public methods of your classes define an API that can be depended on by other code
- If refactoring changes the API, that code will break!
- Solution: **retain the old API**, but have its methods delegate to the new API methods

```
/**
 * Method that does something.
 *
 * @deprecated Use {@link #newMethod()} instead.
 */
@Deprecated
public void oldMethod() {
  newMethod();
}
```

Performance Impact

- Refactoring such as **Inline Temp** can lead to code being called multiple times to compute a value
- Code clarity benefits can outweigh any performance loss
- Recommended strategy:
  - Refactor to improve clarity & structure
  - Profile code to find the poorly performing parts
  - Focus optimization efforts only on those parts – which should now be easier thanks to refactoring!

When Do We NOT Refactor?

- When structure is so bad that it would be easier to throw the code away and start again
- When the code doesn’t function correctly
- When a hard deadline is very close

Summary

We have

- Considered why we refactor, highlighting the goals of preventing structural decay and improving understanding
- Noted that developers constantly switch between ‘adding features’ and ‘refactoring’ mindsets (‘two hats’)
- Discussed some other common refactorings
- Introduced the idea of ‘code smells’ as a signal that we need to refactor the code
- Explored the limitations of refactoring

Follow-Up / Further Reading

- Chapters 2 and 3 of Fowler’s *Refactoring: Improving The Design of Existing Code* (available in EBL)
- Fowler’s articles on refactoring
- Catalog of code smells
- Catalog of refactoring techniques
- Exercise 3 and Exercise 4