Inf2: SEPP
Lecture 17: Refactoring

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Last two lectures:

Construction:

- High quality code
- Version control and system building

This lecture:

Refactoring, seen by some software development processes (e.g. XP) as integral part of the development process

- The problem
- Definitions
- Why?
- When?
- What?
- Refactoring in different IDEs:
  - IntelliJ
  - Eclipse
- Safe refactoring
- Bad smells in code

The Problem

As code evolves its quality naturally decays

- Initially code implementing a good design
- Changes often local, without full understanding of the context
- With loss of structure, code becomes harder to follow, harder to modify

Refactoring is about restoring good design in a disciplined way

- Expertise on refactoring captured in *refactoring patterns*
  - Enable rapid learning
  - Tool support

Refactoring definition

Refactoring (noun) is 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 by applying a series of refactorings *without changing its observable behaviour*

Fowler, *Refactoring*, 2000

Refactoring (noun) also used to refer to the general activity

Why refactor?

Refactoring

- makes software easier to understand
  - Your code, by you,
  - Your code, by others,
  - Others' code, by you
- helps you make subsequent modifications quicker
- helps you find bugs
  - Design becomes clearer and bugs easier to see

The result: refactoring helps you program *faster*

When to refactor?

Refactoring was once seen as a kind of maintenance. . .

For example:

- You've inherited legacy code that's a mess.
- A new feature is required that necessitates a change in the architecture.

But can also be an integral part of the development process

Agile methodologies (e.g. XP) advocate continual refactoring (XP maxim: "Refactor mercilessly").

What does refactoring do?

A refactoring is a *small* transformation which preserves correctness.

There are many examples.
For a catalogue of over 90 assembled by Martin Fowler, see
`http://refactoring.com/catalog/`.

A sample:

- Add Parameter
- Change Bidirectional Association to Unidirectional
- Extract Variable (Introduce Explaining Variable)
- Replace Conditional with Polymorphism

Extract Variable

Change

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

to

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

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

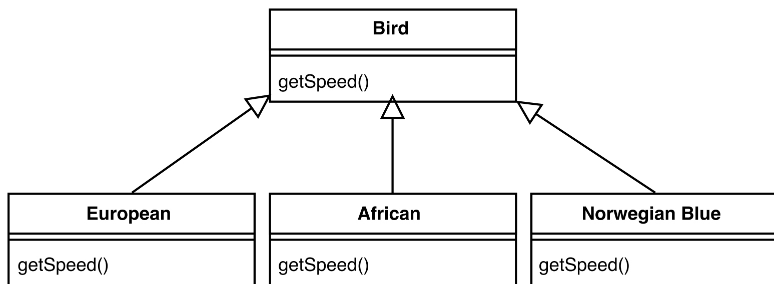
Replace Conditional with Polymorphism I

Change

```
double getSpeed() {
  switch (_type) {
    case EUROPEAN:
      return getBaseSpeed();
    case AFRICAN:
      return getBaseSpeed() - getLoadFactor() * _numberOfCoconuts;
    case NORWEGIAN_BLUE:
      return (_isNailed) ? 0 : getBaseSpeed(_voltage);
  }
  throw new RuntimeException ("Should be unreachable");
}
```

Replace Conditional with Polymorphism II

to



IntelliJ Refactoring

To see available refactorings in IntelliJ IDEA, you need to select an item to refactor and press Ctrl+ Alt+ Shift+ T, or use a keyboard shortcut for a specific refactoring.

Other features:

- For some refactorings, previewing
- If there are problems with the refactoring, conflicts are displayed
- For both of the above, excluding or removing any unnecessary changes

Most Popular IntelliJ Refactorings

- Safe delete: Alt + Delete
- Copy/move: F5/ F6
- Extract method: Ctrl+ Alt+ M
- Extract constant: Ctrl+ Alt+ C
- Extract field: Ctrl+ Alt+ F
- Extract parameter: Ctrl+ Alt+ P
- Introduce variable: Ctrl+ Alt+ V
- Rename: Shift+ F6
- Inline: Ctrl+ Alt +N
- Change signature: Ctrl+ F6

See more here as well as in subpages: `https://www.jetbrains.com/help/idea/refactoring-source-code.html`

Eclipse Refactoring

Eclipse has a built-in refactoring tool (on the Refactor menu).

Many of its refactoring operation can be grouped in three broad classes . . .

Eclipse Refactoring I: Renaming and physical reorganization

A variety of simple changes.

For example:

- Rename Java elements (classes, fields, methods, local variables)
  - On class rename, `import` directives updated
  - On field rename, getter and setter methods also renamed
- Move classes between packages

Eclipse applies these changes *semantically*

- Much better than syntactic search-and-replace

Eclipse Refactoring II: Modifying class relationships

Heavier weight changes. Less used, but seriously useful when they are used.

For example:

- Move methods or fields up and down a class inheritance hierarchy.
- Extract an interface from a class
- Turn an anonymous class into a nested class

Eclipse Refactoring III: Intra-class refactorings

The most used types of refactoring: rearranging code within a class to improve readability etc.

For example:

- Extract Method: pull code block into new method.
  - Good for shortening method or making block reusable
  - Can also extract local variables and constants
- Encapsulating fields in accessor methods.
- Change the type of a method parameter or return value

Safe refactoring

How do you know refactoring hasn't changed/broken something?

Perhaps somebody has *proved* that a refactoring operation is safe.

More realistically:

test, refactor, test

This works better the more tests you have: ideally, unit tests for every class.

Bad smells in code

Suggest that the quality of your code is decaying.

Examples:

- Duplicated code
- Long method
- Large class
- Long parameter list
- Lazy class
- Long message chains

Catalogues of bad smells explain how to recognise them and what refactorings can help.

Reading

Essential: 'Tutorial: Introduction to Refactoring' produced by IntelliJ: https://www.jetbrains.com/help/idea/tutorial-introduction-to-refactoring.html

Essential: Browse around Fowler's page at http://refactoring.com/. Some of his book *Refactoring* is available on Google Books e.g., details of some of the refactorings in the catalogue.

Essential: Search *code smells*. One catalogue can be found at https://refactoring.guru/refactoring/smells.

Reading

Recommended: Browse through the Code Refactoring page and subpages of IntelliJ IDEA for full information on IntelliJ's current capabilities: `https://www.jetbrains.com/help/idea/refactoring-source-code.html`

Recommended: If you are using Eclipse, browse through the Eclipse *Java development user guide* for full information on Eclipse's current capabilities: `https://www.linuxtopia.org/online_books/eclipse_documentation/eclipse_java_development_guide/topic/org.eclipse.jdt.doc.user/concepts/eclipse_java_concept-refactoring.htm`