

CS 4530

Fundamentals of Software Engineering

Lesson 11: Refactoring, Code Smells and Technical Debt

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Learning Goals

By the end of this lesson, you should be able to...

- Describe different kinds of “Refactoring”: restructuring of code to improve structure.
- Review some common code “smells” (anti-patterns).
- Identify the “technical debt” metaphor; Indicate when and where technical debt is appropriate to accrue versus retire.

Refactoring

- **refactoring** is the process of applying transformations (refactorings) to a program, with the goal of improving its design
- goals:
 - keep program readable, understandable, and maintainable
 - by eliminating small problems soon, you can avoid big trouble later
- characteristics:
 - **behavior-preserving**: make sure the program works after each step
 - **small steps**

History of Refactoring

- refactoring is something good programmers have always done
 - Opdyke's PhD thesis (1990): refactoring tools for Smalltalk
 - popularized by various agile development methodologies
- especially popular in the context of object-oriented languages
 - OO features are well-suited to make designs flexible & reusable
 - but refactoring is not specific to OO

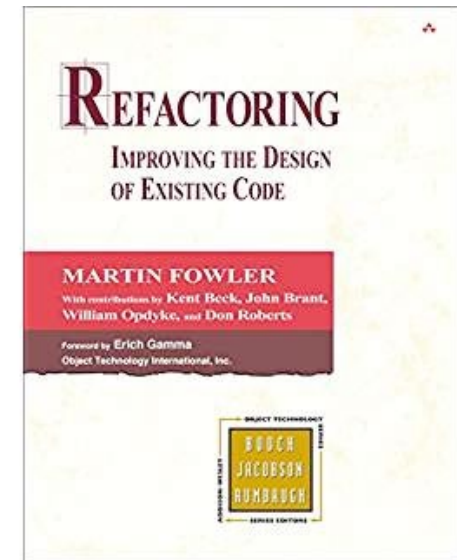
Refactoring

Martin Fowler

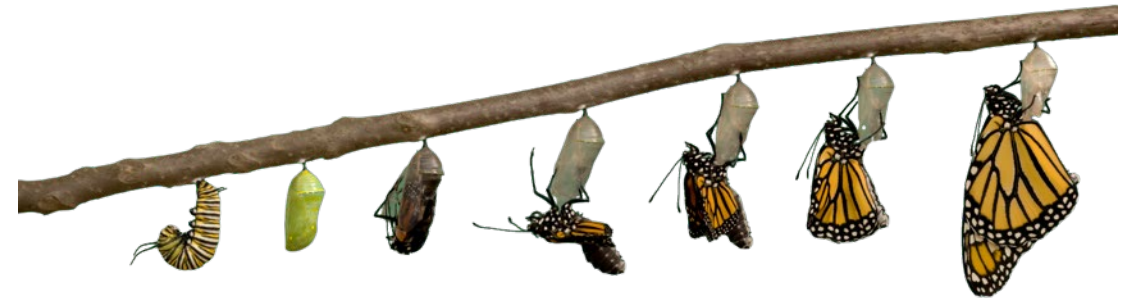


“Any fool can write code that a computer can understand. Good programmers write code that humans can understand.”

Fowler's book



- presents a **catalogue of refactorings**, similar to the catalogue of design patterns in the GoF book
 - catalogues “bad smells” - indications that refactoring may be needed
 - explains when and how to apply refactorings
- many of Fowler's refactorings are the inverse of another refactoring
 - often there is not a unique “best” solution
 - discussion of the tradeoffs



Why Refactor?

- requirements have changed, and a different design is needed
- design needs to be more flexible (so new features can be added)
 - design patterns are often a target for refactoring
- address sloppiness by programmers

Example Refactoring

Consolidating duplicate conditional fragments

Original Code

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

Refactored Code

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


Observations

- **small incremental steps** that preserve program behavior
- most steps are so simple that they can be **automated**
 - automation limited in complex cases
- refactoring does not always proceed “in a straight line”
 - sometimes, undo a step you did earlier...
 - ...when you have insights for a better design

When to refactor?

Refactoring is incremental redesign

- Acknowledge that it will be difficult to get design right the first time
- When adding new functionality, fixing a bug, doing code review, or any time
- Refactoring evolves design in increments
- Refactoring reduces technical debt
- What do you refactor?

Code Smells

A complete list (links to book!)

[Mysterious Name](#)

[Duplicated Code](#)

[Long Function](#)

[Long Parameter List](#)

[Global Data](#)

[Mutable Data](#)

[Divergent Change](#)

[Shotgun Surgery](#)

[Feature Envy](#)

[Data Clumps](#)

[Primitive Obsession](#)

[Repeated Switches](#)

[Loops](#)

[Lazy Element](#)

[Speculative Generality](#)

[Temporary Field](#)

[Message Chains](#)

[Middle Man](#)

[Insider Trading](#)

[Large Class](#)

[Alternative Classes with Different Interfaces](#)

[Data Class](#)

[Refused Bequest](#)

“Local” Refactorings

Rename	rename variables, fields methods, classes, packages provide better intuition for the renamed element's purpose
Extract Method	extract statements into a new method enables reuse; avoid cut-and-paste programming improve readability
Inline Method	replace a method call with the method's body often useful as intermediate step
Extract Local	introduce a new local variable for a designated expression
Inline Local	replace a local variable with the expression that defines its value
Change Method Signature	reorder a method's parameters
Encapsulate Field	introduce getter/setter methods
Convert Local Variable to Field	convert local variable to field sometimes useful to enable application of Extract Method

Type-Related Refactorings

Generalize Declared Type	replace the type of a declaration with a more general type
Extract Interface	create a new interface, and update declarations to use it where possible
Pull Up Members	move methods and fields to a superclass
Infer Generic Type Arguments	infer type arguments for “raw” uses of generic types

Refactoring Risks

- Developer time is valuable: is this the best use of time *today*?
- Despite best intentions, may not be safe
- Potential for version control conflicts

Technical Debt is Sum of Internal Problems in Project Codebase

- Internal because they don't show as user-visible failures.
- Examples:
- Code Smells;
- Missing tests;
- Missing documentation;
- Dependency on old versions of third-party systems;
- Inefficient and/or non-scalable algorithms.

Not just code!



Technical Debt is Sum of Internal Problems in Project Codebase

Example of Debt

- Code Smells;
- Missing tests;
- Missing documentation;
- Dependency on old versions of third-party systems;
- Inefficient and/or non-scalable algorithms.

Example of Cost

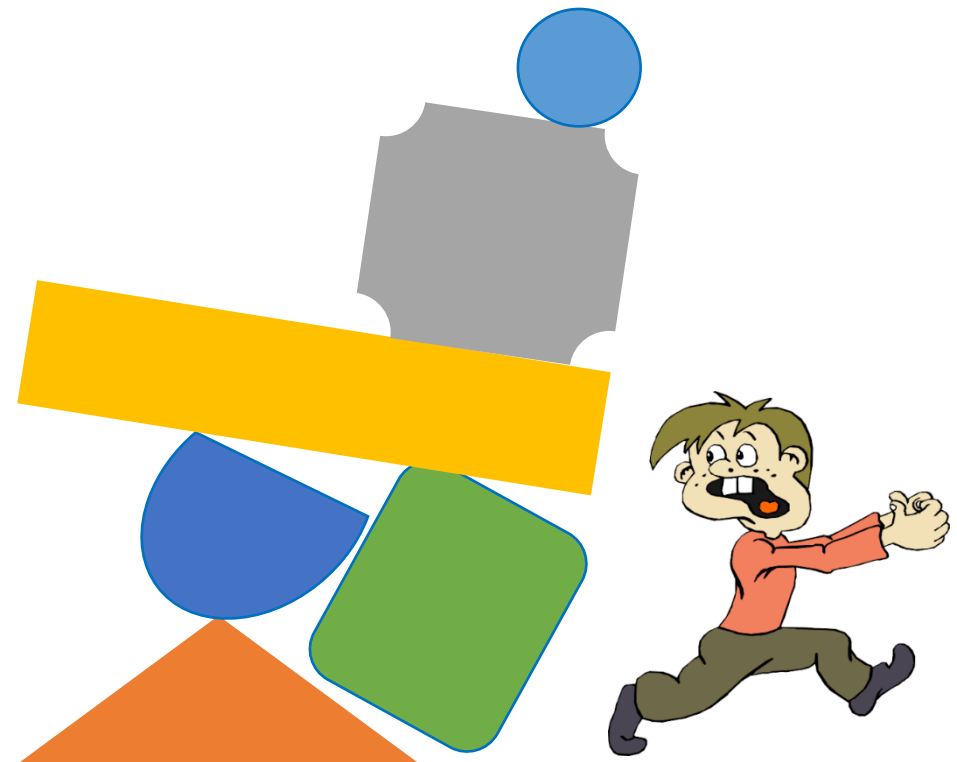
- “Smelly” code is less flexible;
- Need to revert breaking change;
- Can’t figure out how to use;
- May have take over maintenance of old system;
- Lose potential customers.

Good Reasons to Go Into Technical Debt

- Prototyping:
 - If code will be discarded, or drastically rewritten, don't waste time perfecting it.
- Getting a product out the door:
 - Time is often crucial in a competitive environment.
- Fixing a critical failure:
 - People are waiting.
- Maybe a simple algorithm is good enough:
 - “Premature optimization is the root of all evil”
 - Tony Hoare, Donald Knuth

Retire Technical Debt at Leisure

- Set aside time to pay off technical debt:
 - Google has (had?) “20%-time” for tasks such as this.
- A new initiative can take on some technical debt:
 - Refactoring at the start of a project.
- Don’t keep on putting off!
 - When a crisis hits, it’s too late;
 - Hasty fixes to unmaintainable code multiplies problems;
 - Eventually mounting technical debt can bury the team.



Review: Learning Objectives for this Lesson

- You should now be able to:
 - Describe different kinds of “Refactoring”: restructuring of code to improve structure.
 - Review some common code “smells” (anti-patterns).
 - Identify the “technical debt” metaphor; Indicate when and where technical debt is appropriate to accrue versus retire.