CS 4530: Fundamentals of Software Engineering

Lesson 11 Code Smells, Refactoring and Technical Debt

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Outline of this lesson

1. Some common code “smells” (anti-patterns).
2. “Refactoring”: restructuring of code to improve structure.
3. “Technical Debt”: generalization covering all internal problems in a code-base.

Learning Objectives for this Lesson

- By the end of this lesson, you should be able to:
  - Review several classes of code smells;
  - Describe several kinds of refactoring;
  - Identify the “technical debt” metaphor;
  - Indicate when and where technical debt is appropriate to accrue versus retire.

“Code Smells” are Anti-Patterns

- Cases of **poor** code:
  - Likely to harbor faults;
  - Difficult to use;
  - Expensive to maintain.
- Common and Known:
  - Each code smell has a name,
  - … and a recommended fix.
- Example catalog:

https://refactoring.guru/refactoring/smells

(figure courtesy of Refactoring Guru)

Code Smell Example (1 of 3)

```
class Product {
    private _id : string;
    private _desc : string;
    private _weight : number;

    public get id() { return                this._id      ; }
    public set id(          newID ) {
        this._id        =  newID ;
    }
    public get desc() {
        return      this._desc      ;
    }
    // set desc
    // get weight, set weight
}
```

- DATA CLASS
- A class has public properties (or public getters and setters) and few if any methods.
- How to fix:
  - Determine what is being done with class properties;
  - Make some properties immutable;
  - Define methods to perform tasks;
  - Reduce getters/setters.

Code Smell Example (2 of 3)

```
if (     this.width         >  lineSize      ) {
     warn('at beginning, too big');
     this.width         - = OVERFULL;
}

// more code

if (     this.width         >  lineSize      ) {
     warn('before return, too big');
     this.width         - = OVERFULL;
}
```

- DUPLICATED CODE
- The same (or very similar code) occurs more than once.
  - Multiplies maintenance work.
- How to Fix:
  - Extract the common code in a method;
  - Use that method where code was.

Code Smell Example (3 of 3)

```
setUpPage
    ( USLetter.width       ,
      USLetter.height      ,
      recipe.getTitle      (),
      recipe.getContents        (),
      defaultFont      ,
      2, /* number of columns
      true, /* number pages? */
      false, /* balance? */
      1.4, /* PDF level */
      outputFile      );
```

- TOOMANYPARAMETERS
- A method has a long list of parameters; difficult for clients to keep order and number straight.
- How to Fix:
  - Package up groups of related parameters in objects, or
  - Separate method into parts with fewer arguments.

Refactoring is Code Restructuring

- Code is reorganized:
  - No (executable) code is added or removed;
  - Code's behavior is preserved;
    - (not for fixing bugs!)
  - Change is reversible;
- Metaphor: topology-preserving transformations:

Refactoring Can Improve Code

- Refactoring can remove “smells”:
  - Bring together similar responsibilities;
  - Separate disjoint responsibilities.
- Refactoring can improve code flexibility:
  - It can add generality/abstraction;
  - This prepares for changes to come later.
- Refactoring can break code, if done wrong:
  - IDEs provide (usually) safe refactorings;
  - Use regression tests to double-check.

Refactoring Example (1 of 3)

- EXTRACT LOCAL
- Pull an expression out into a named local variable.
- (In this case, preparing for next step so that duplicates can become identical.)

```
if (     this.width         >  lineSize      ) {
    warn('at begin, too big');
    this.width         - = OVERFULL;
}
```

```
const msg =                    ;
if (     this.width         >  lineSize      ) {
    warn(  'at begin, too big'
                                    msg);
    this.width         - = OVERFULL;
}
```

Refactoring Example (2 of 3)

- EXTRACT METHOD
- Pull out code with locals becoming formal parameters.

```
checkWidth    ( lineSize:number      ,
                msg:string     ) {




}
```

```
const msg = 'at begin, too big';
if (     this.width         >  lineSize     ) {
    warn(msg);
    this.width         - = OVERFULL;
}
```

```
const msg = 'at begin, too big';
if (     this.width         >  lineSize     ) {
    warn(msg);
    this.width         - = OVERFULL;
}
```

Refactoring Example (3 of 3)

- INLINE LOCAL
- Replace name with value.
- Inverse of EXTRACT LOCAL.

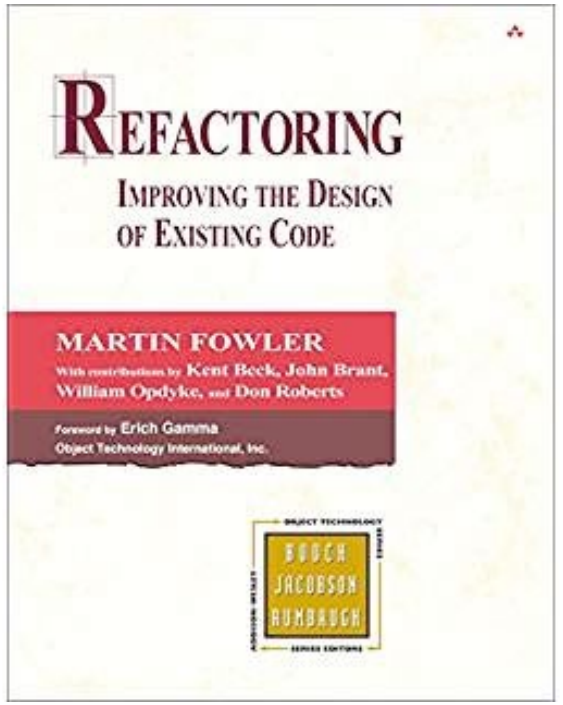
To avoid hard-coding, the next task would be to EXTRACT CONSTANT.

```
const msg = 'at begin, too big';
this.checkWidth      ( lineSize     , msg);
```

```
const msg =      'at begin,; too big'
this.checkWidth      ( lineSize     ,   msg);
```

More Refactoring

- Extract Interface / Extract Abstract Class
- Introduce Parameter
  - Take out special case from function into new argument.
- Make Static / Make Instance
- Move Method (to new class)
- […]



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 Exacts Interest During Maintenance (Usually)

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

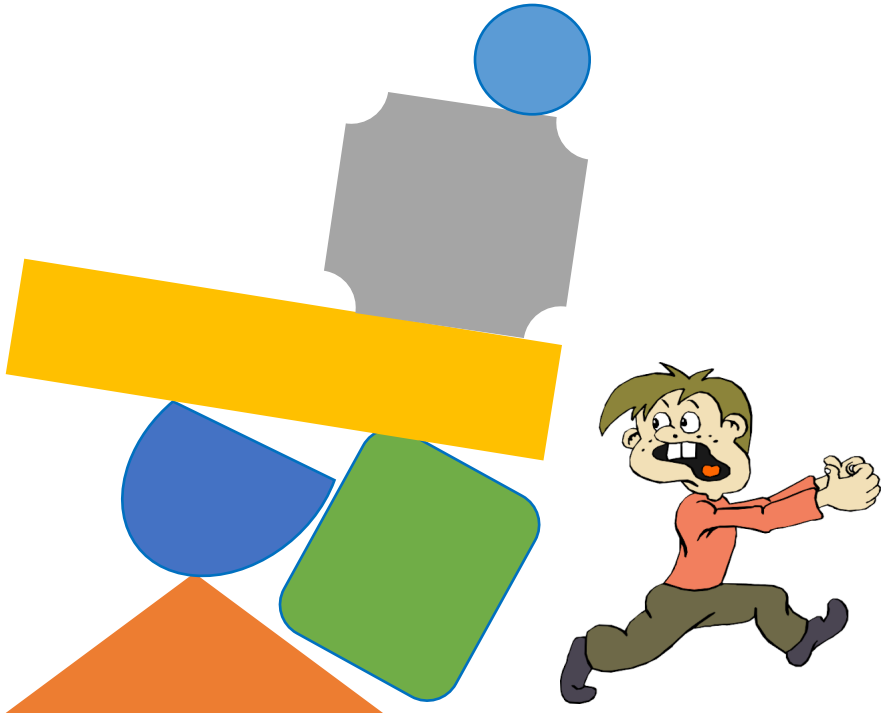
- “Smelly” code is less flexible;
- Need to revert breaking change;
- Can’t figure out how to use;
- May have take over maintenance of old system;
- Lose potential customers.

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:
  - Review several classes of code smells;
  - Describe several kinds of refactoring;
  - Identify the “technical debt” metaphor;
  - Indicate when and where technical debt is appropriate to accrue versus retire.