Refactoring

CSE 403

Problem: "Bit rot"

- After several months and new versions, many codebases reach one of the following states:
  - *rewritten*: Nothing remains from the original code.
  - *abandoned*: The original code is thrown out and rewritten from scratch.

  …even if the code was initially reviewed and well-designed at the time of checkin, and even if checkins are reviewed

- Why is this?
  - Systems evolve to meet new needs and add new features
  - If the code's structure does not also evolve, it will "rot"

Code maintenance

- **maintenance**: Modification of a software product after it has been delivered.

Purposes:

  - fix bugs
  - improve performance
  - improve design
  - add features

  - ~80% of maintenance is for non-bug-fix-related activities such as adding functionality (Pigosky 1997)

Maintenance is hard

- It's harder to maintain code than write new code.
  - You must understand code written by another developer, or code you wrote at a different time with a different mindset
  - Danger of errors in fragile, poorly-understood code (don't touch it!)

- Maintenance is how devs spend most of their time
  - Many developers *hate* code maintenance. Why?

- With good design and advance planning, maintenance is less painful
  - Capacity for future change must be anticipated

Refactoring

- **refactoring**: Improving a piece of software's internal structure without altering its external behavior.
  - Incurs a short-term time/work cost to reap long-term benefits
  - A long-term investment in the overall quality of your system.
- refactoring is not the same thing as:
  - rewriting code
  - adding features
  - debugging code

Refactoring examples

Why refactor?

Why fix a part of your system that isn't broken?

- Each part of your system's code has 3 purposes:
  1. to execute its functionality,
  2. to allow change,
  3. to communicate well to developers who read it.

  If the code does not do one or more of these, it *is* broken.
- Refactoring improves software's design
  - more extensible, flexible, understandable, performant, …
  - Every design improvement has costs (and risks)

Code “smells”: Signs you should refactor

- Duplicated code
- Poor abstraction (change one place → must change others)
- Large loop, method, class, parameter list; deeply nested loop
- Module has too little cohesion
- Modules have too much coupling
- Module has poor encapsulation
- A "middle man" object doesn't do much;
  a “weak subclass” doesn’t use inherited functionality;
  a “data class” has little functionality
- Dead code
- Design is unnecessarily general
- Design is too specific

Low-level refactoring

Names:

- Renaming (methods, variables)
- Naming (extracting) "magic" constants

Procedures:

- Extracting code into a method
- Extracting common functionality (including duplicate code) into a module/method/etc.
- Inlining a method/procedure
- Changing method signatures

Reordering:

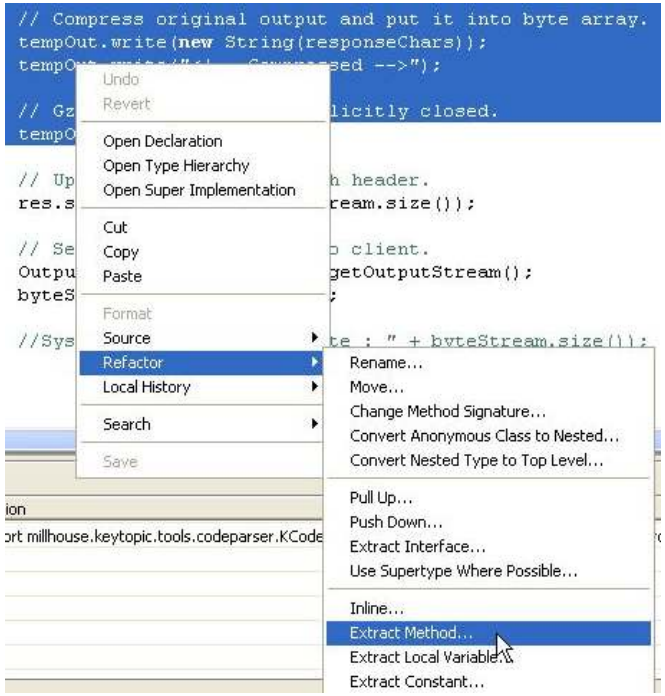
- Splitting one method into several to improve cohesion and readability (by reducing its size)
- Putting statements that semantically belong together near each other

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

IDEs support low-level refactoring

Eclipse / Visual Studio support:

- variable / method / class renaming
- method or constant extraction
- extraction of redundant code snippets
- method signature change
- extraction of an interface from a type
- method inlining
- providing warnings about method invocations with inconsistent parameters
- help with self-documenting code through auto-completion



Higher-level refactoring

- Refactoring to design patterns
- Exchanging risky language idioms with safer alternatives
- Performance optimization
- Clarifying a statement that has evolved over time or is unclear

- Compared to low-level refactoring, high-level is:
  - Not as well-supported by tools
  - Much more important!

Refactoring plan?

- When you identify an area of your system that:
  - is poorly designed
  - is poorly tested, but seems to work so far
  - now needs new features

- What should you do?
  - Let's assume that you have adequate time to "do things right."
    (Not always a valid assumption in software...)

Recommended refactor plan

- When you identify an area of your system that:
  - is poorly designed
  - is poorly tested, but seems to work so far
  - now needs new features

- What should you do?
  - Write unit tests that verify the code's external correctness.
    (They should pass on the current, badly designed code.)
  - Refactor the code.
    (Some unit tests may break. Fix the bugs.)
  - Add the new features.
  - As always, keep changes small, do code reviews, etc.

“I don't have time to refactor!”

- Refactoring incurs an up-front cost.
  - some developers don't want to do it
  - most managers don't like it, because they lose time and gain “nothing” (no new features)

- However...
  - well-written code is much more conducive to rapid development (some estimates put ROI at 500% or more for well-done code)
  - finishing refactoring increases programmer morale
    - developers prefer working in a “clean house”

- When to refactor?
  - best done continuously (like testing) as part of the SE process
  - hard to do well late in a project (like testing)
    - Why?

Should startups refactor?

- Many small companies and startups skip refactoring.
  - "We're too small to need it!"
  - "We can't afford it!"

- Reality:
  - Refactoring is an investment in quality of the company's product and code base, often their prime assets
  - Many web startups are using the most cutting-edge technologies, which evolve rapidly. So should the code.

  - If a key team member leaves (common in startups), ...
  - If a new team member joins (also common), ...