CSE403 ● Software engineering ● sp12

Week 7-10				
Monday	Tuesday	Wednesday	Thursday	Friday
• Reading due	• Groups • Beta due		• Section	• Progress report due • Readings out (see next slide)
• Midterm review	• Groups	• Midterm II • Reading covered [Notkin gone]	• No section	• Information on final presentations, etc. • Course evals • Progress report due
Memorial Day Holiday	• Groups	• Final release due • **Project Pres. I**	• **Project Pres. II**	• **Project Pres. III**

Reading for Midterm II

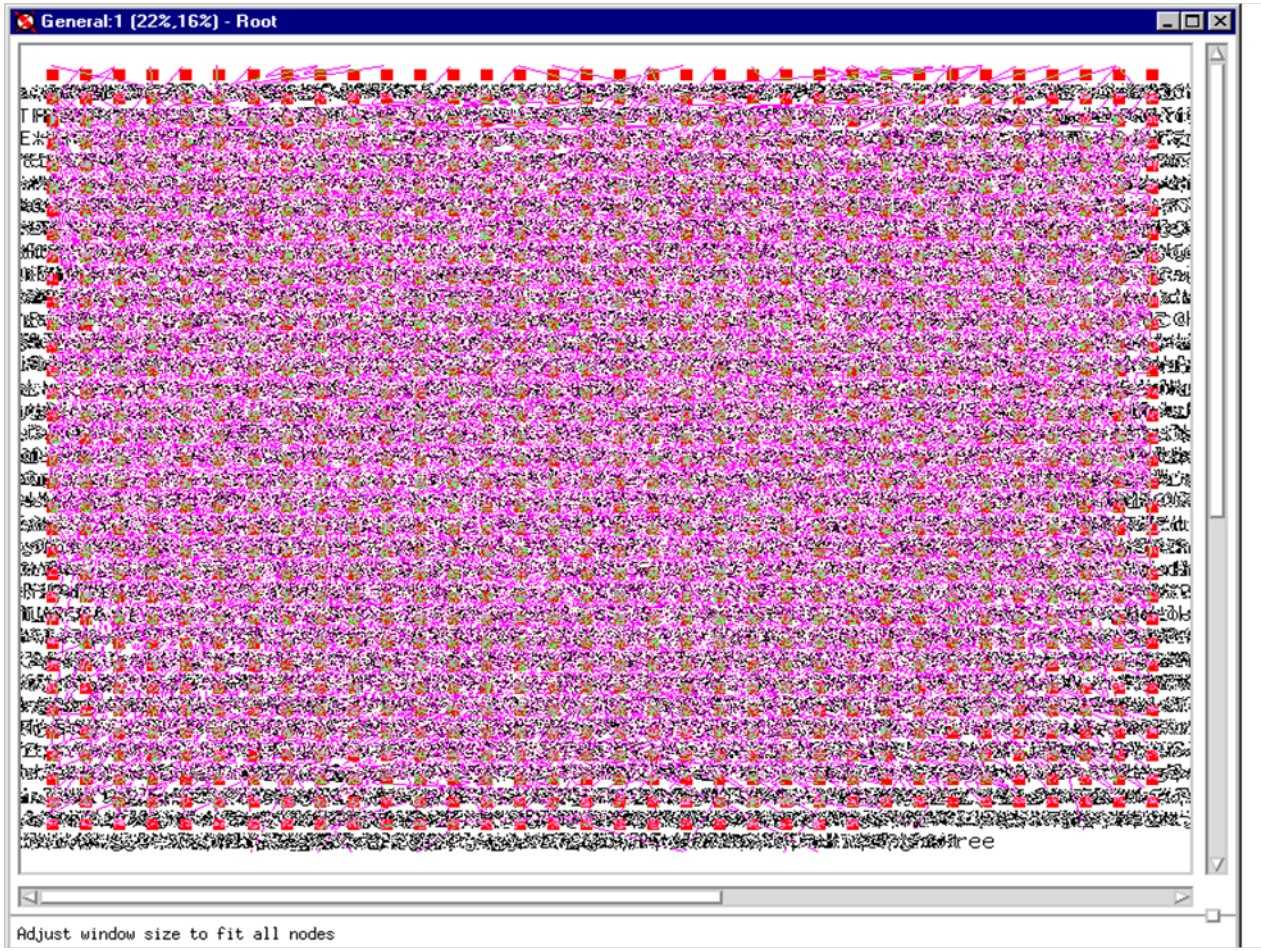
- **Managing Technical Debt**
  Eric Allman
  Communications of the ACM
  Vol. 55 No. 5, Pages 50-55
  10.1145/2160718.2160733
  http://cacm.acm.org/magazines/2012/5/148568-managing-technical-debt/fulltext

Refactoring

- Belady and Lehman's (1974) Law of Increasing Complexity
  - As a [software] system evolves its complexity increases unless work is done to maintain or reduce it
- In other words, it is natural for a program's structure to degrade over time
- Work done "to maintain or reduce" the program's complexity is not directly beneficial – it doesn't make the program do more, do it more quickly, or such

Hence…

- Software system structures tend to degrade in practice
- Not only are they complex, but they are highly likely to be incidentally complex more than essentially complex [Brooks]



Rewritten or abandoned

- As months pass and new versions are developed, 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 check-in, and even if check-ins are reviewed

“Bit rot”

- Why does the code structure degrade?
  - Systems evolve to meet new needs and add new features
  - If the code's structure does not also evolve, it will “rot”
  - And the value-proposition for maintaining or improving the code structure is hard to see and evaluate

Maintenance

- Modification of a software product after delivery
  - 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
  - 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

- Q: If maintenance is harder than writing new code, why is it assigned more frequently to newbies?

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

Why refactor?

- Each part of your code has three purposes
  - to execute its functionality,
  - to allow change,
  - to communicate well to developers who read it
- Code that is weak in any of these dimensions can be improved
- Refactoring improves software's design
  - more extensible, flexible, understandable, faster, …
  - Every design improvement has costs (and risks)

Code “smells”: Signs you should refactor

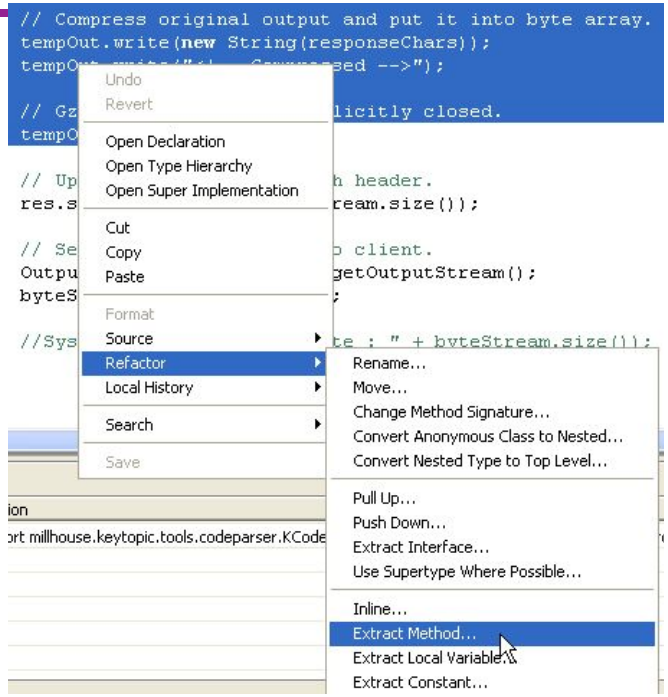
- Duplicated code
- Poor abstraction (change one place → must change others)
- Large loop, method, class, parameter list; deeply nested loop
- Module has too little cohesion
- Modules have too much coupling
- Module has poor encapsulation
- A “middle man” object doesn't do much (e.g., a “weak subclass”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

IDE support for refactoring

- 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!

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 management 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), ...

Refactoring: reprise

- “Improving a piece of software's internal structure without altering its external behavior”
- What does “*without altering its external behavior*” mean?
- How can we tell if a refactoring has left the behavior unchanged?
- Do we care?