Welcome to SENG 371 Software Evolution Spring 2013

A Core Course of the BSEng Program

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Announcements

- Marking
  - Midterm will be returned on Thu in class
  - A1 graded
  - Thu office hours reserved for marking questions —1:30-2:30 ECS 660
- Course website
  - http://www.engr.uvic.ca/~seng371
  - Lecture notes posted
  - Lab slides and activities are posted
- Assignment 2
  - Due March 11 — revised
  - Reverse engineering and program understanding
    - Part I—Summarize three papers
    - Part II—Define terms
    - Part III—Reverse engineer a C program (gawk)
  - Cite your sources
  - Submit by e-mail to seng371@uvic.ca

Reading assignments

- Chikofsky, Cross: Reverse Engineering and Design Recovery: A Taxonomy, IEEE Software 7(1):13-17 (1990) http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=43044
- Kienle, Müller: Rigi—An Environment for Software Reverse Engineering, Exploration, Visualization, and Redocumentation, *Science of Computer Programming* 75(4):247-263, Elsevier, Apr. 2010. http://www.sciencedirect.com/science/article/pii/S016764230900149X
- Müller, Jahnke, Smith, Storey, Tilley, Wong, Reverse Engineering: A Roadmap, in *The Future of Software Engineering, ICSE 2000 Millennium Celebration,* 2000. http://dl.acm.org/citation.cfm?id=336526

Lehman and Belady's System Classification

- S-type programs
  - Can be specified formally.
- P-type programs
  - Cannot be specified.
  - An iterative process is needed to find a working solution.
- E-type programs
  - Are embedded in the real world and become part of it, thereby changing the real world.
  - This leads to a feedback system where the program and its environment evolve in concert.

IBM OS360/370 Case Studies

- The laws of software evolution were originally based on observations regarding the evolution of IBM's OS/360 and OS/370.
- The laws were not presented as laws of nature, but rather as general observations that are expected to hold for all E-type systems, regardless of specific programming or management practices.

http://en.wikipedia.org/wiki/Meir_M._Lehman
http://www.doc.ic.ac.uk/~mml/

Lehman, M. M. : On Understanding Laws, Evolution, and Conservation in the Large-Program Life Cycle, *Journal of Systems and Software* 1:213–221 (1980)

Laws of software evolution

1. Law of Continuing Change (1974)
   - "E-type systems must be continually adapted or they become progressively less satisfactory."
   - Software which is used in a real-world environment must change or become less and less useful in that environment.
2. Law of Increasing Complexity (1974)
   - "As an E-type system evolves its complexity increases unless work is done to maintain or reduce it."
   - As an evolving program changes, its structure becomes more complex, unless active efforts are made to avoid this phenomenon.

Laws of software evolution …

3. Law of Self Regulation (1978)
   - "E-type system evolution process is self regulating with distribution of product and process measures close to normal."
   - System attributes such as size, time between releases, and the number of reported errors are approximately invariant for each system release.
4. Law of Conservation of Organisational Stability
   - "The average effective global activity rate in an evolving E-type system is invariant over product lifetime."
   - Over a program's lifetime, its rate of development is approximately constant and independent of the resources devoted to system development.

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Laws of software evolution …

5. Law of Conservation of Familiarity (1978)
   - "As an E-type system evolves all associated with it, developers, sales personnel, users, for example, must maintain mastery of its content and behaviour to achieve satisfactory evolution. Excessive growth diminishes that mastery."
   - Over the lifetime of a system, the incremental system change in each release is approximately constant.
   - The average incremental growth of systems tends to remain constant or decline over time.
6. Law of Continuing Growth (1991)
   - "The functional content of E-type systems must be continually increased to maintain user satisfaction over their lifetime."
   - Functional capability must increase over the lifetime of a system to maintain user satisfaction.

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Laws of software evolution …

7. Law Declining Quality (1996)
   - "The quality of E-type systems will appear to be declining unless they are rigorously maintained and adapted to operational environment changes."
   - Unless rigorously adapted, quality will appear to decline over time.
8. Law of Feedback System (1996)
   - "E-type evolution processes constitute multi-level, multi-loop, multi-agent feedback systems and must be treated as such to achieve significant improvement over any reasonable base"
   - Evolution systems are multi-level, multi-agent, multi-loop feedback systems.

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Laws of software evolution …

- Lehman's Fifth Law of Software Evolution
  - "Over the lifetime of a system, the incremental system change in each release is approximately constant."
- What can we say about the complexity of the software systems developed over the past 50 years?
  - Constant?
  - Increase?

http://en.wikipedia.org/wiki/Lehman's_laws_of_software_evolution

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Seven basic questions…[Erdos/Sneed]

A maintenance programmer must ask to be able to maintain programs that are only partially understood:

1. Where is a particular subroutine or procedure invoked?
2. What are the arguments and results of a particular function?
3. How does the flow of control reach a particular location?
4. Where is a particular variable set, used or queried?
5. Where is a particular variable declared?
6. Where is a particular data object accessed, i.e. created, read, updated, or deleted?
7. What are the inputs and outputs of a particular module?

What tools do you use to answer these questions?

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Learning objectives

- Understand differences between reverse engineering, forward engineering and reengineering
- Learn the concepts of design discovery/recovery and re-documentation
- Discuss the application of reverse engineering techniques to software maintenance problems
- Understand the weaknesses in reverse engineering techniques
- Learn about different tools to support reverse engineering

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Software reverse engineering

- **Def**. A two-step process
  - Information extraction
  - Information abstraction
- **Def**. A three-step process [Tilley95]
  - Information gathering
  - Knowledge organization
  - Information navigation, analysis, and presentation
- **Def**. Analyzing subject system [CC90]
  - to identify its current components and their dependencies
  - to extract and create system abstractions and design information
- The subject system is not altered; however, additional knowledge about the system is produced

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