Lecture 22

Knowledge Recovery and Software Reflexion Model

Today's Agenda (1)

- Recap of Chianti
- Software Reflexion Model

Today's Agenda (2)

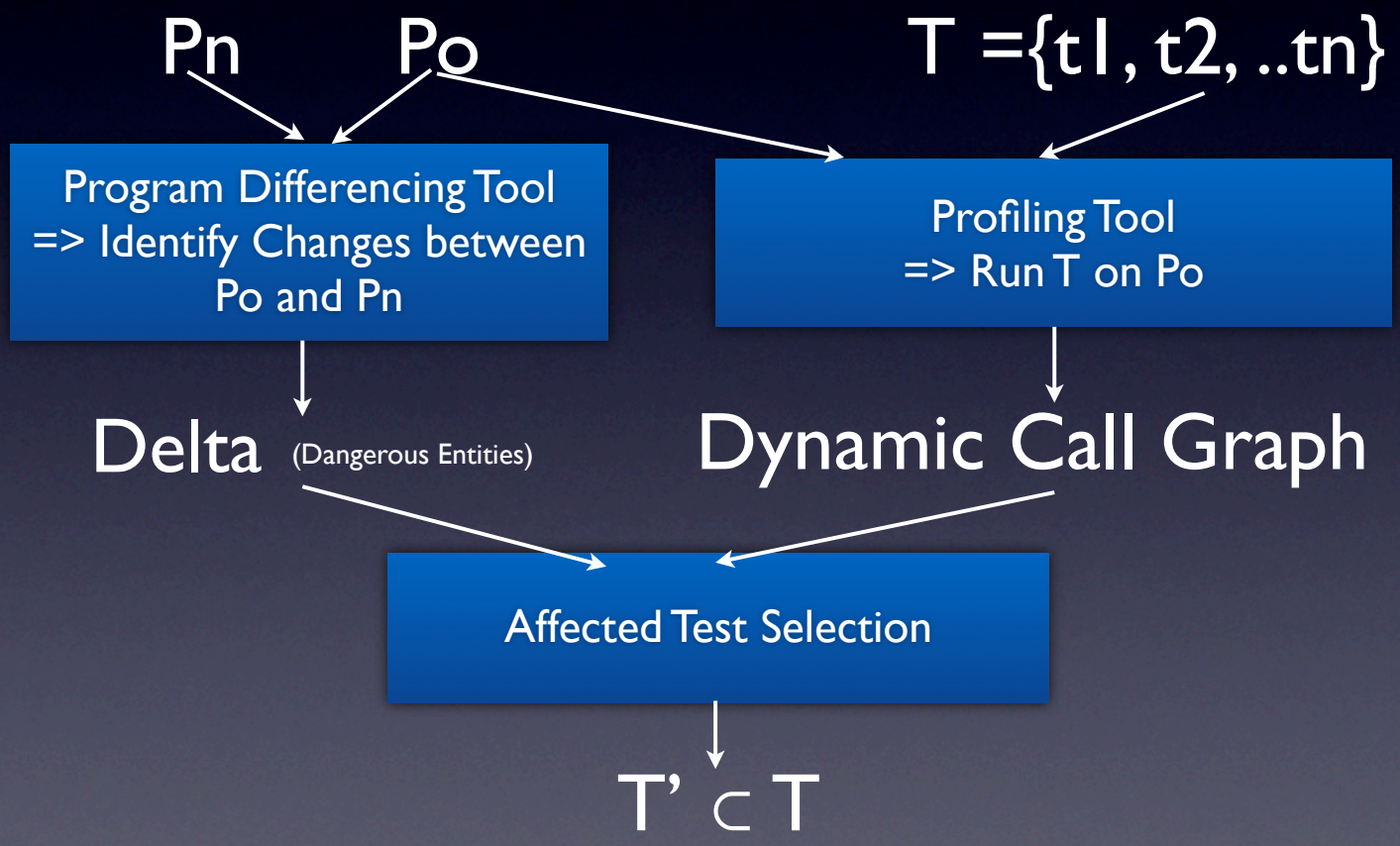
- Discussion on application of software evolution research to development practices.
  - Information hiding principle
  - Concern graph
  - Delta debugging
  - Regression test selection

Recap of Chianti (1)

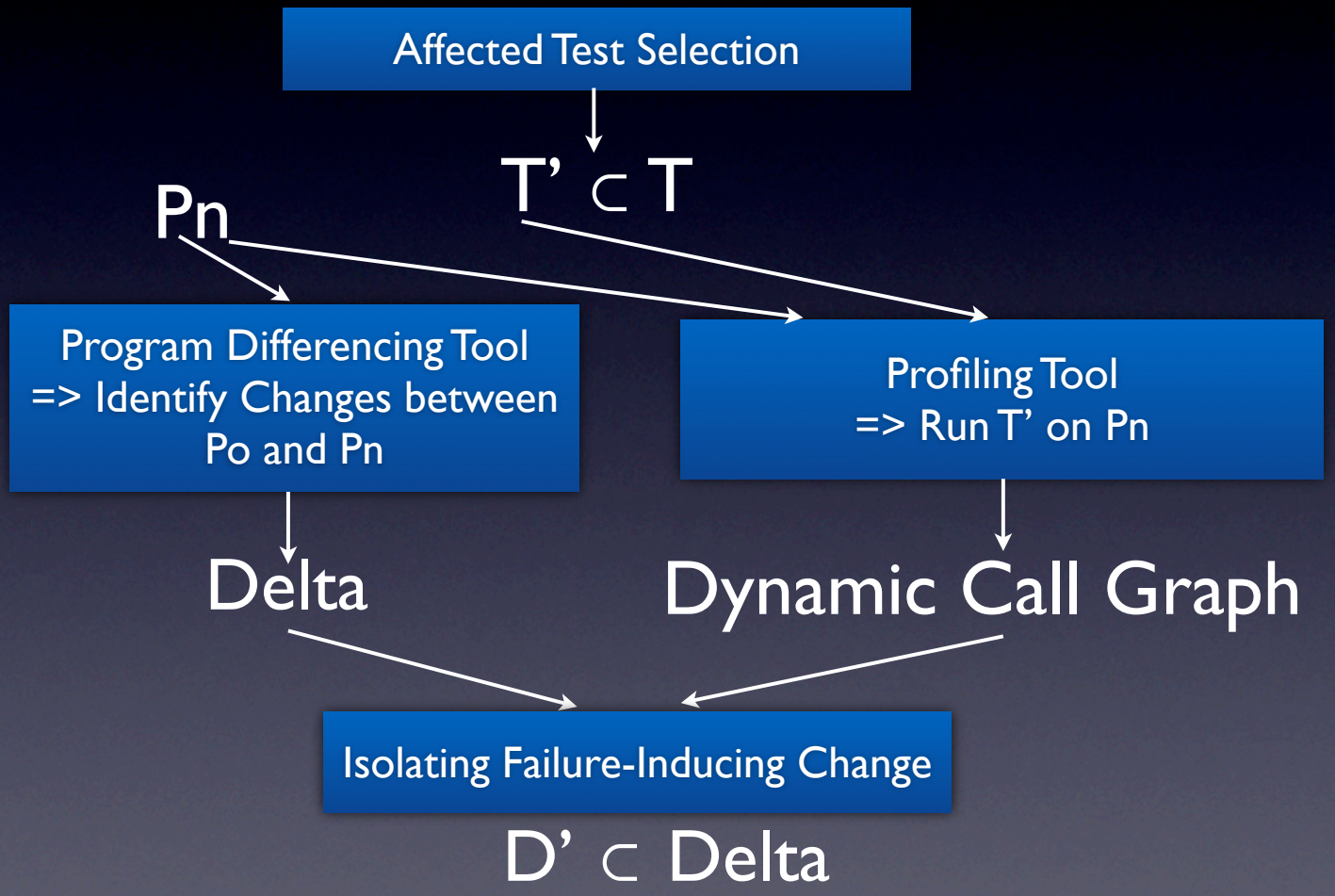
- Chianti is a dynamic change impact analysis tool.

1. Chianti analyzes differences between two versions as a set of atomic changes.
2. Chianti identifies a subset of regression tests that may change their behavior by identifying dynamic call graphs that include these changes. (Similar to RTS)
3. For each of those selected tests, Chianti identifies a subset of deltas that are responsible for behavior differences in those tests. (Similar to Isolation of fault-inducing changes)

Chianti Framework First Phase



Chianti Framework
Second Phase



Quiz

Software Reflexion Model

- Software Reflexion Models: Bridging the Gap between Design and Implementation, TSE 2001 (Extended Journal Version)
- Original published in 1995.
  - Software Reflexion Models: Bridging the Gap between Source and High-Level Models. FSE 1995

Motivation

- What is this paper's motivation?
  - The drift between design and implementation happens during software evolution.

Research Problem

- Limitation of alternative existing approaches

1. Ignore the existing design document and rely on source code. => hard to understand source code (scalability) (initial investment on creating design doc does not pay off)
2. Rely on informal diagrams or design documents. => cannot have confidence / limited information inaccurate
3. Derive high-level models from source code. => cluttered,

Research Problem

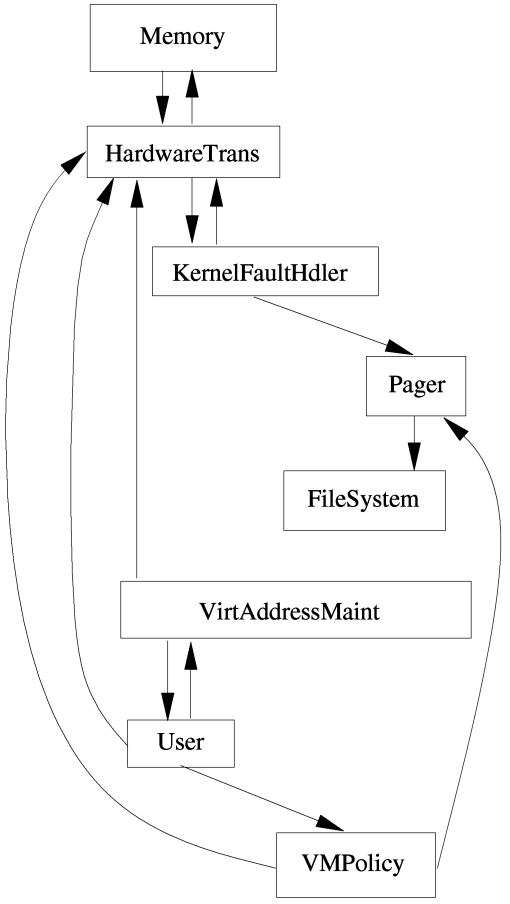
- Limitation of alternative / existing approaches

1. Ignore the existing design document and rely on source code. => Source code or what reverse engineering tools would extract is overwhelming to programmers.
2. Rely on informal diagrams or design documents => Models are not always accurate.
3. Derive high-level models from source code => These may be different from what programmers expect to see.

Reflexion Model Approach

1. Enable a software engineer to produce a reasonable first-cut of a high-level model.
2. Enable him to map the high-level model and source code.
3. Then the reflexion model tool computes agreement and disagreement between the high-level model and the source code.

Step 1. Write a high-level model



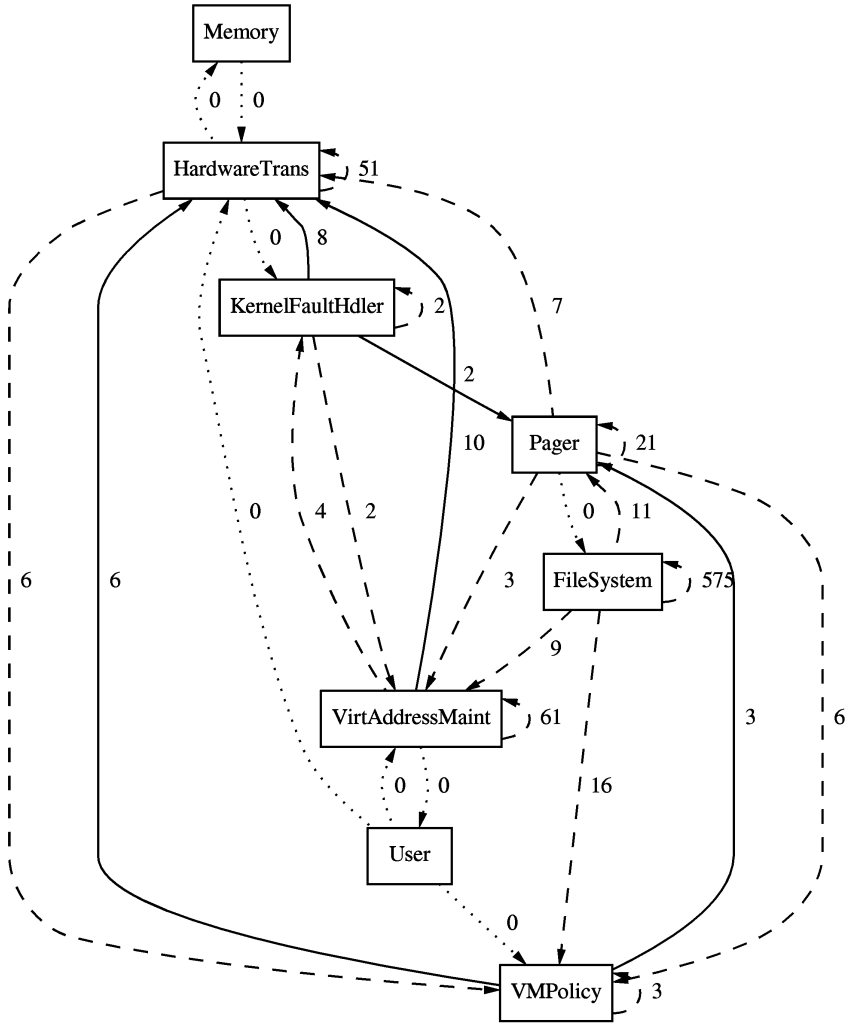
Step 2. Extract a model from the program

- Use either a static analysis (source code) or a dynamic analysis (runtime execution).
  - Call graph extraction
  - Run time analysis (function calls, call sequences, event monitoring, etc.)
  - e.g. Field, Rigi, Shrimp, etc.

Step 3. Define mappings between the high-level model and code.

```
[ file=.*pager.*          mapTo=Pager ]
[ file=vm_map.*           mapTo=VirtAddressMaint ]
[ file=vm_fault\.c        mapTo=KernelFaultHdler ]
[ dir=[un]fs              mapTo=FileSystem ]
[ dir=sparc/mem.*         mapTo=Memory ]
[ file=pmap.*             mapTo=HardwareTrans ]
[ file=vm_pageout\.c      mapTo=VMPolicy ]
```

Step 4. Compare the models



Convergence: interactions expected by the developer
Divergence: interactions that were not expected by the developer
Absences: interactions that were expected but not found

Case Studies at Microsoft

- Subject Program: Microsoft Excel (over one million lines of C source code.)
- Task: a reengineering task
- Four week period
- The engineer found the approach valuable for understanding the structure and planning the reengineering effort.

Case Studies at Microsoft

- Subject Program: B. Griswold's program restructuring tool (6000 lines C++ implementation)
- TasK: Design conformance -- which components do not adhere to layering principles?
- Divergences found by the reflexion model tool helped programmers revisit the locations and update the code to ensure the expected structure.
- There's a similar study using SPIN OS as a subject program.

Discussion

- When will you use it?
  - Check what you intended matches your source code
  - Working design document => program understanding
  - When not to use this - small program just read it
- What do you like about it?
  - Iterative design conformance checking

Discussion

- What are limitations of reflexion model?
  - mapping is painful.
  - mapping is only restricted to entities
  - high level models only captures structural aspects. (types, temporal semantics)
  - crosscutting concerns --> many high level models that model different aspects

Contributions

- ***Lightweight*** -- minimal burden on a programmer side
- ***Approximate*** -- can start with a coarse model and then refine it iteratively.
- ***Scalable*** -- can run a million lines of code

My general thoughts on Software Reflexion Model

- Software Reflexion Model allows programmers to check design conformance to a high-level mental model.
- A very simple idea, ***yet very powerful, and it has practical impact***
- It bridges the gap between software architecture (design) models and implementation models
- Its use as a design conformance tool is somewhat similar to program verification.

Practical Implications of Software Evolution Research

- Concern Graph
- Delta Debugging
- Regression Testing Selection

Preview for Next Monday

- We will continue to discuss reverse engineering and knowledge discovery => software metrics & visualization
  - Lanza et al. Polymetric Views (Mon, 4/20)

Announcement

- Preliminary grading guidelines for projects / literature surveys are uploaded on the blackboard.
- There is no class lecture on 29th. Use it for your project presentation / report preparation.