

Software Process Recovery: Picking the Fruit of Empirical Software Engineering

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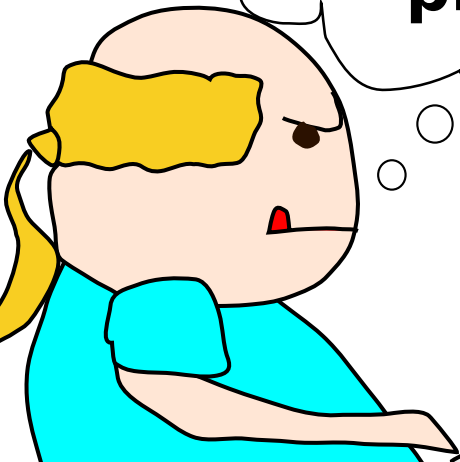
Edmonton, Alberta

Canada

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abram.hindle@softwareprocess.es

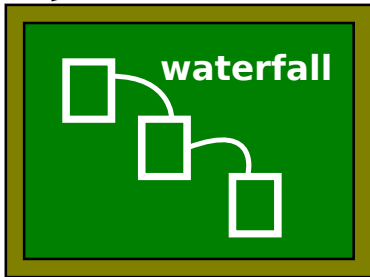
**Are we following
any development
process?**



prescribed processes

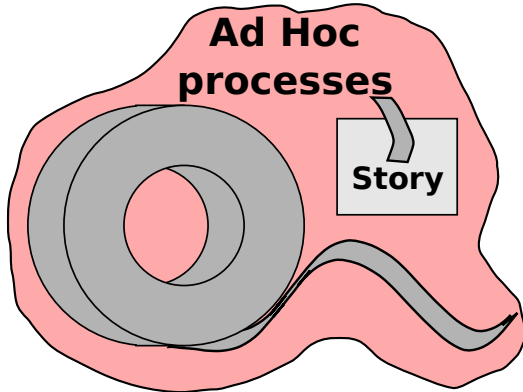
Rx

- Test First
- Scrums
- Story Cards

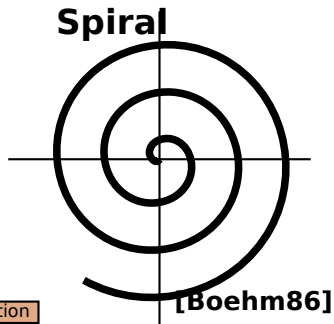
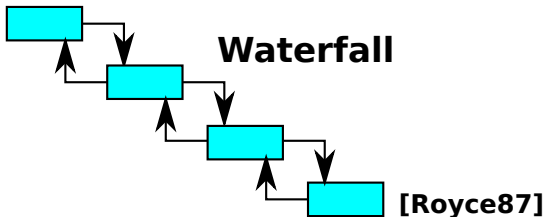


Formal Processes

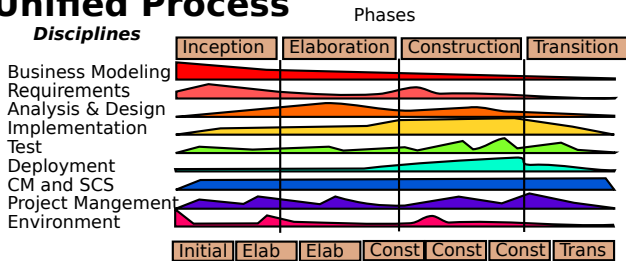
Process



Software Development Processes

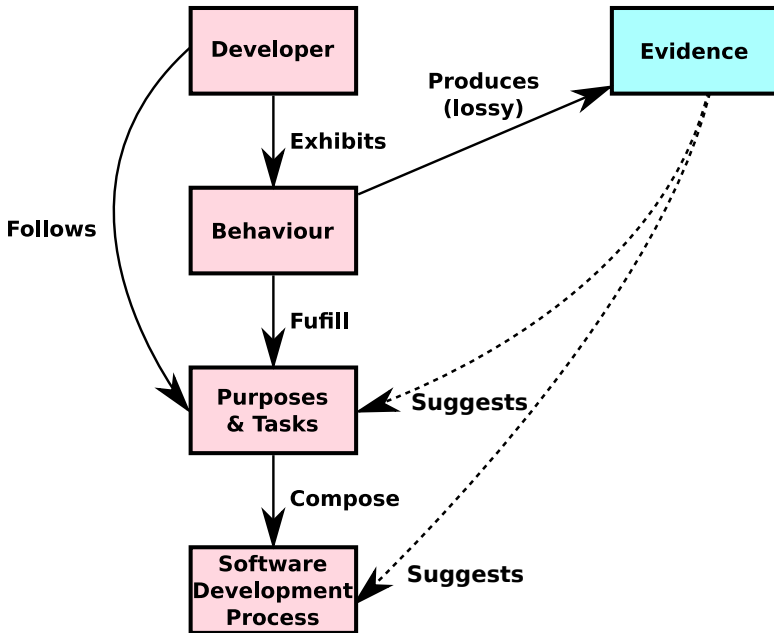


Unified Process

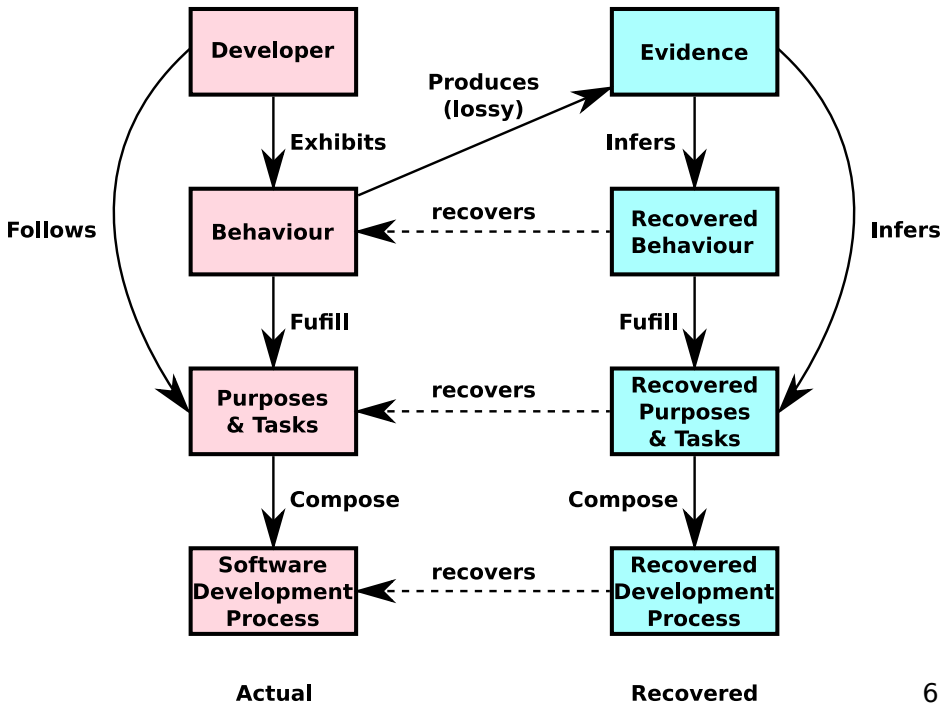


[Jacobson99]







* **CMM**
* **SDLC**



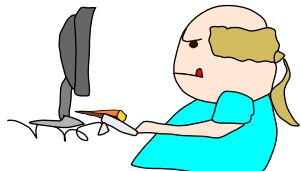
Actual



Research Relationships

	Behaviour	Intent, Purpose and Tasks	Software Development Process
Release Patterns: Source/Test/ Build/Docs			
Large Changes			
Topic Analysis			
Recovered Unified Process Views			

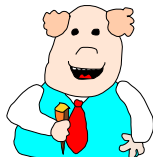
Motivation: Stakeholders



**Fixers or
Star Programmers**



**Investors and
Acquisitions**



Managers



New Developers

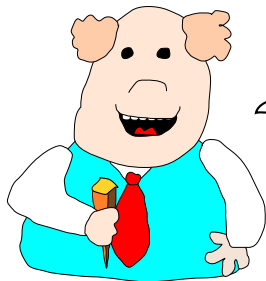
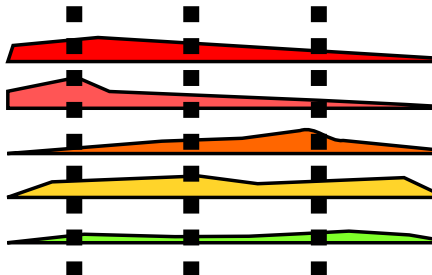
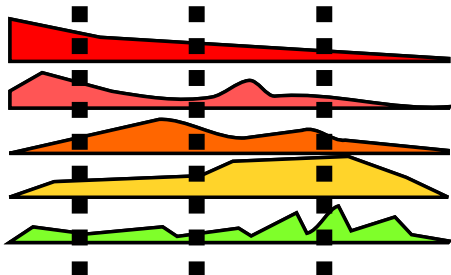


**Employees assigned
to a ISO9000
conformance project**

Proposed Process

Recovered Process

Workflows

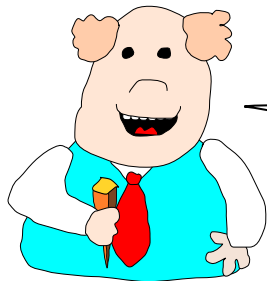
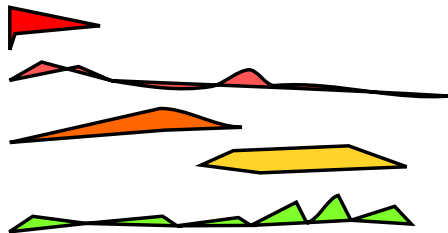


**Is my proposed
process actually
being used?**

Proposed and Recovered
Process Overlaid

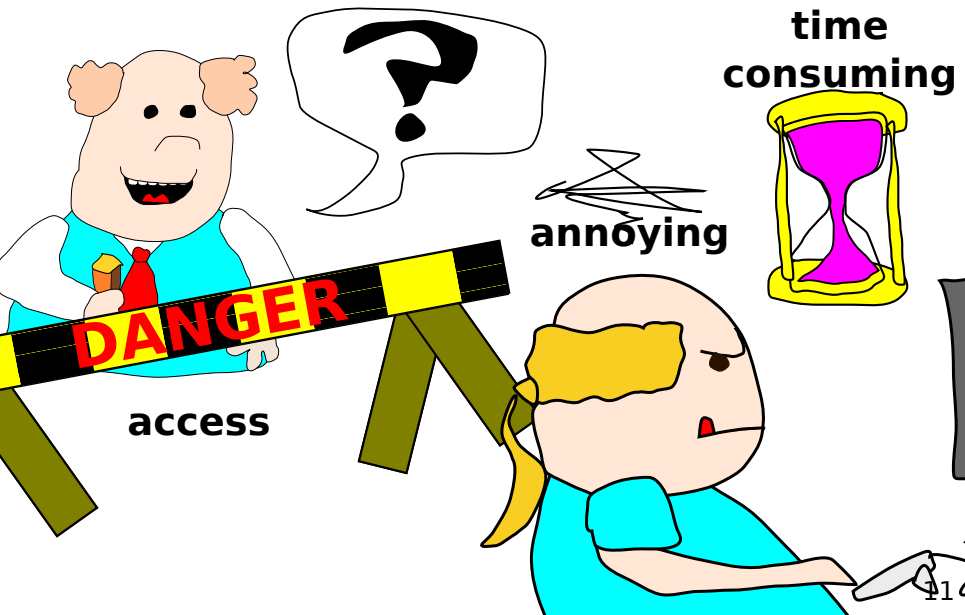


Differences between
Proposed and Recovered

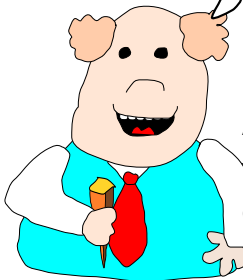


**I can compare
and contrast the
observed process
versus the
expected process!**

How to get an overview: Interviews

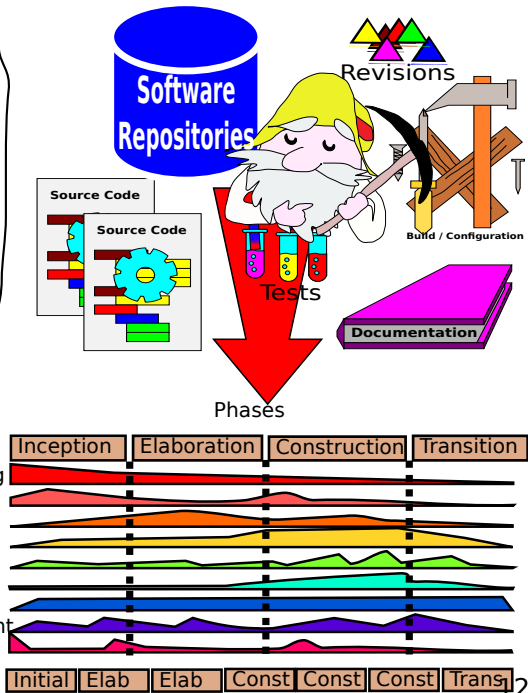


Can't we just summarize what is going on within this project?



Disciplines

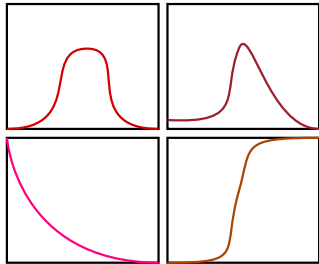
Business Modeling
Requirements
Analysis & Design
Implementation
Test
Deployment
CM and SCS
Project Mangement
Environment



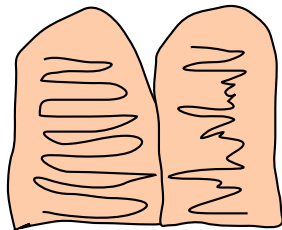
PREVIOUS WORK

RELATED RESEARCH

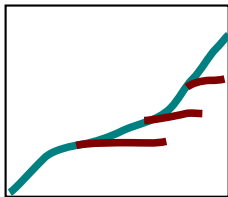
Stochastic Processes and Software Evolution



[Herraiz]

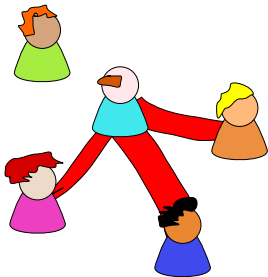


[Lehman]

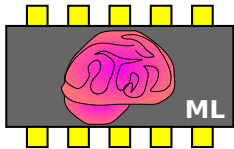


**[Turksi]
[Tu]**

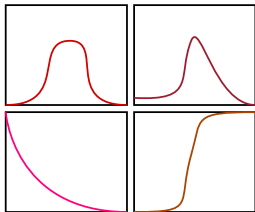
Analysis



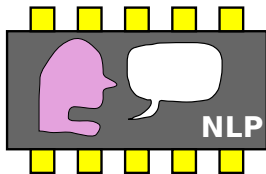
SNA



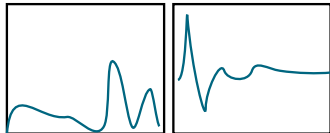
ML



Statistics

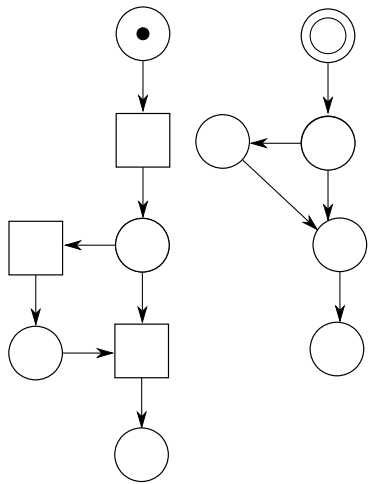


NLP



Timeseries

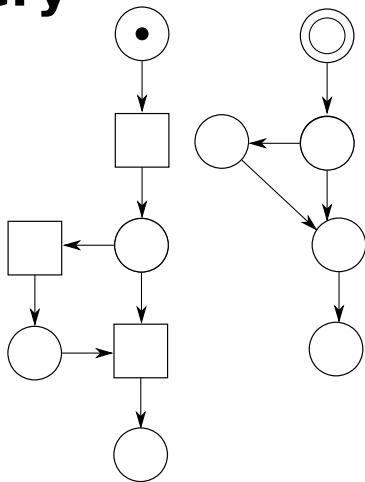
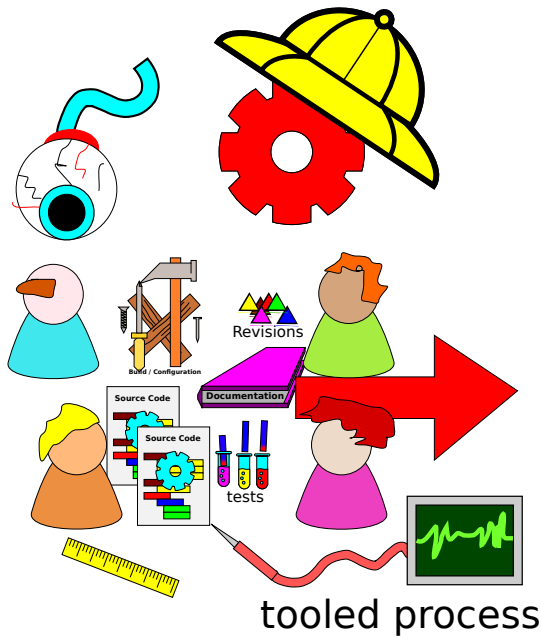
Process Mining



Petrinet FSM

[Van der Aalst 2003]₆

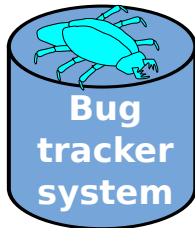
Process Discovery



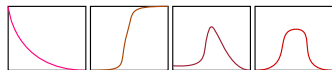
Petri net FSM

[Cook96]

Process Recovery



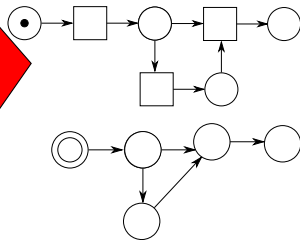
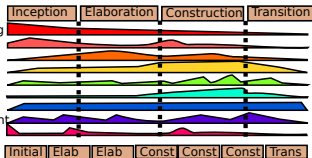
**after
the fact**



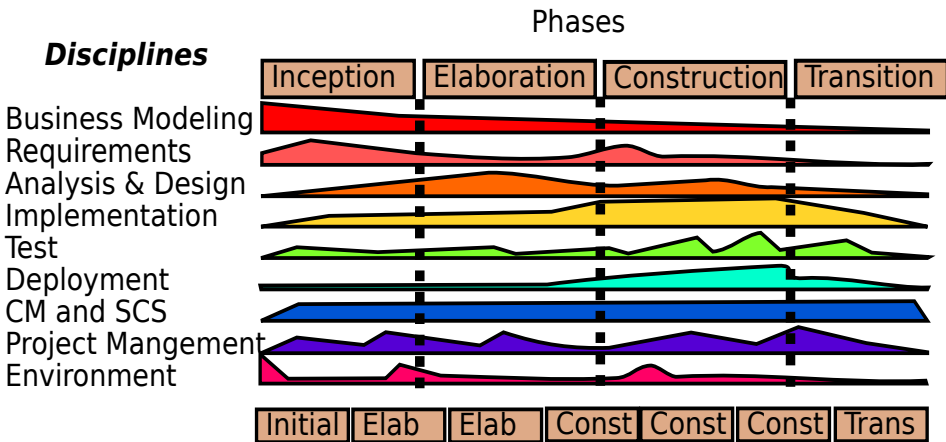
Phases

Disciplines

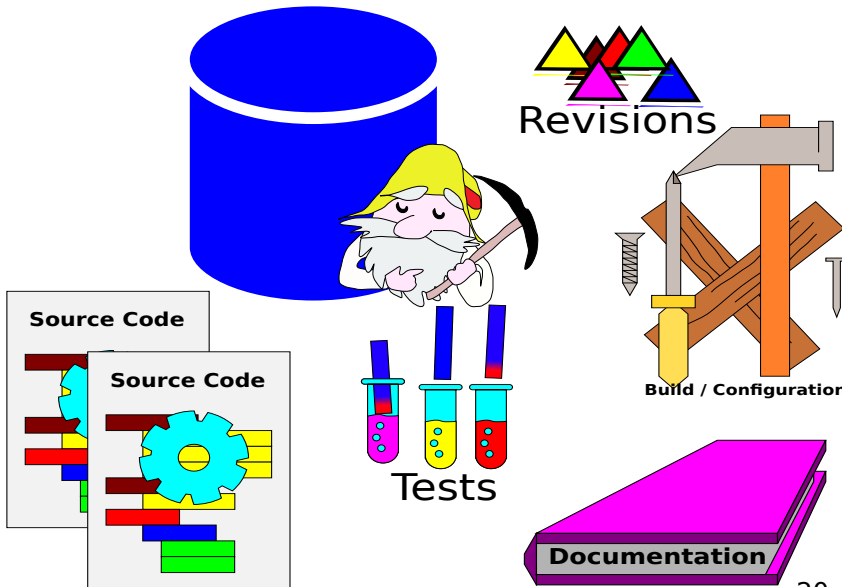
Business Modeling
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Deployment
CM and SCS
Project Mangement
Environment



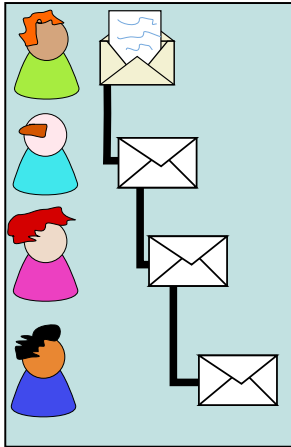
Unified Process Diagram



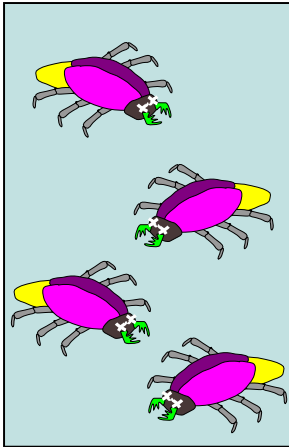
Mining Software Repositories



Source Acquisition



discussions



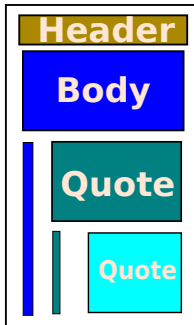
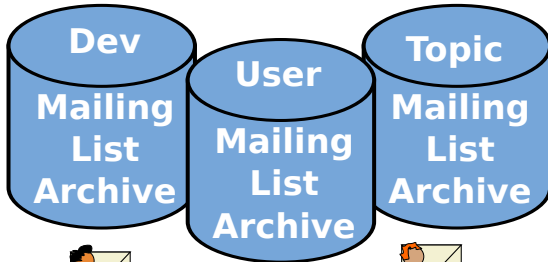
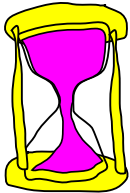
bugs



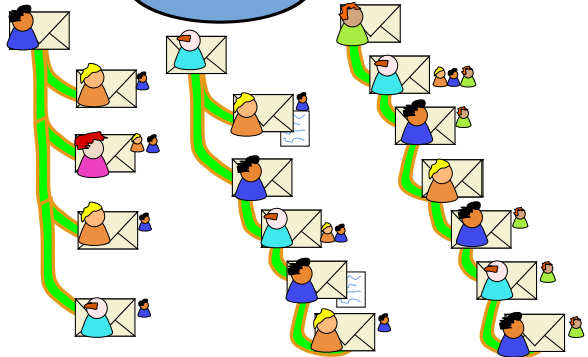
source

Initial Repositories and artifacts

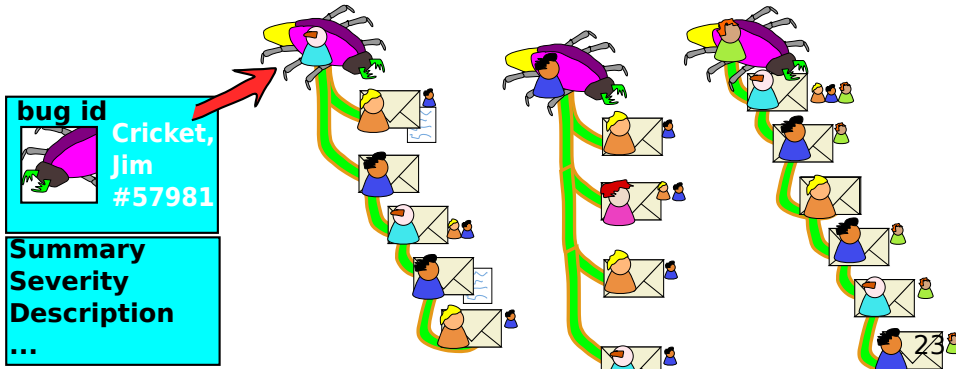
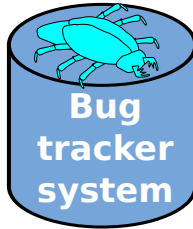
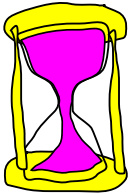
Extraction: Mailing list archives



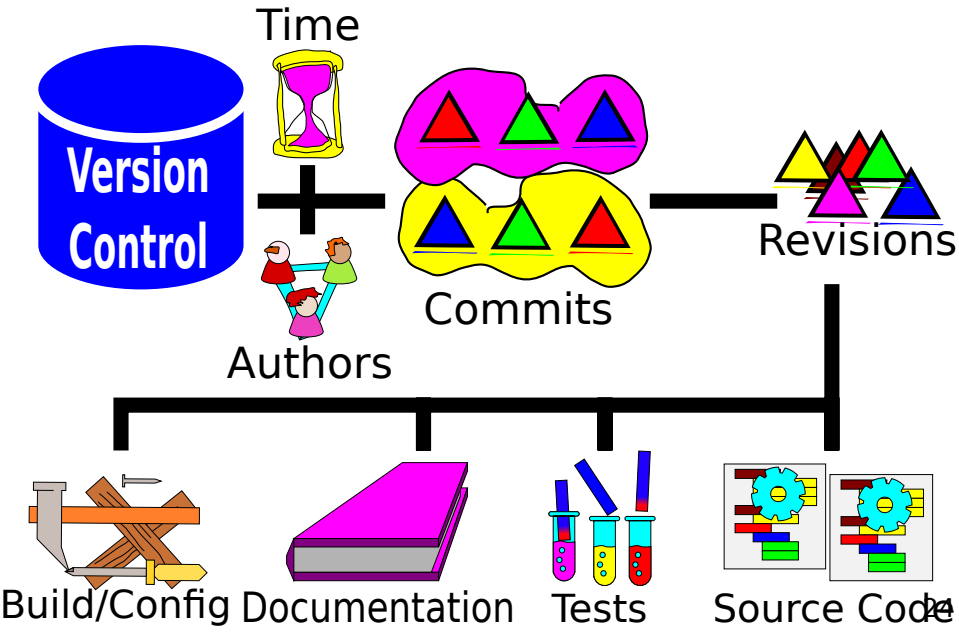
Email



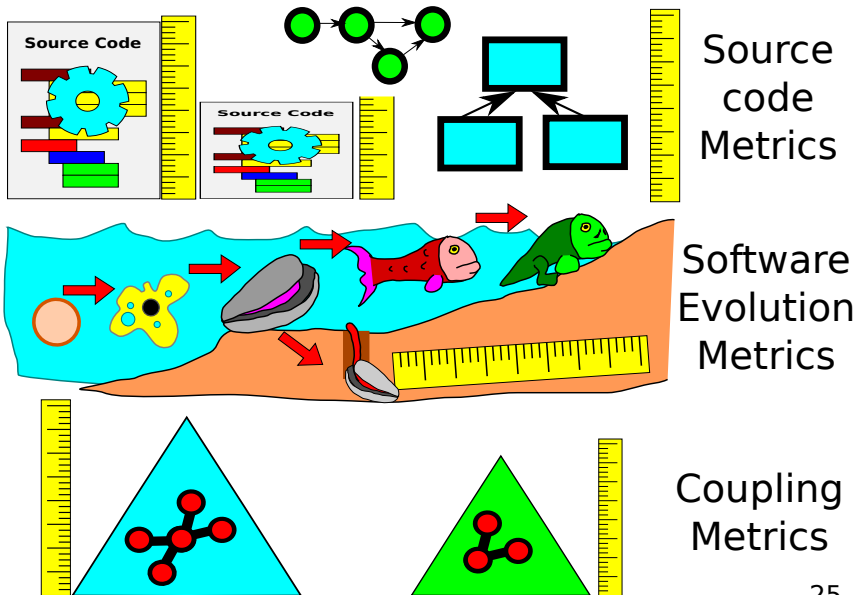
Extraction: Bug trackers



Extraction: Version Control



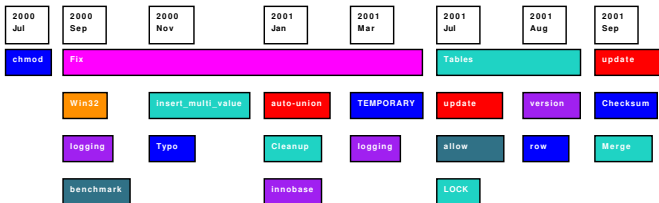
Metrics



Topic/Concept Analysis

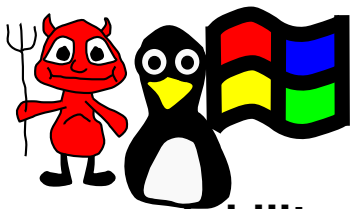
	Entity1	Entity2	Entity3	Entity4	Entity5	Entity6	Entity7	Entity8
Concept 1								
Concept 2								
Concept 3								
Concept 4								
Concept 5								

[Lukins]
[Linstead]
[Maletic]
[Poshyvanik]
[Marcus]
[Hindle]



Quality Related

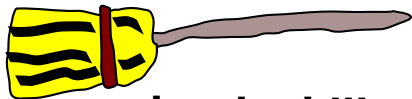
Non functional requirements



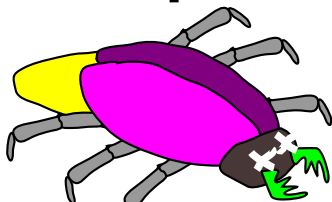
portability



usability



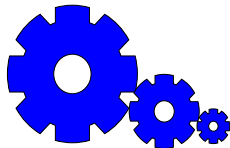
maintainability



**reliability and
functionality**

(includes correctness)

efficiency

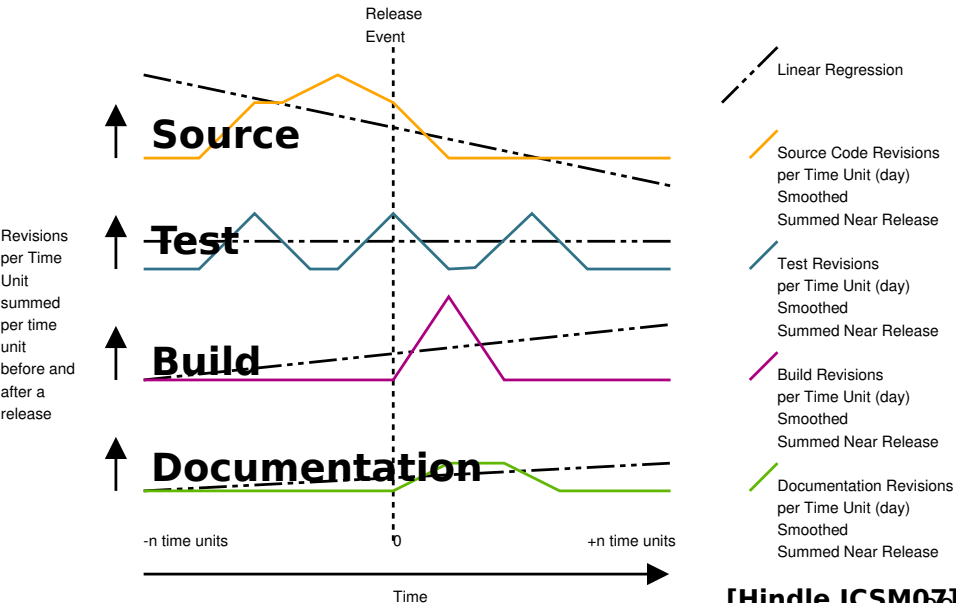


[cleland-huang03]

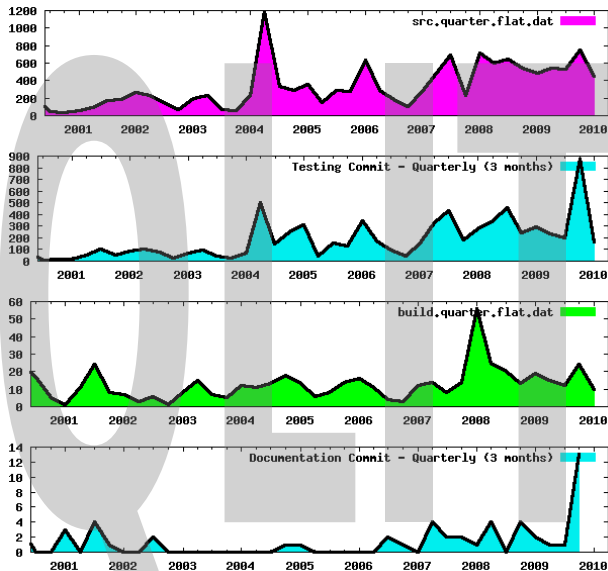
[ernst10]

SOFTWARE PROCESS RECOVERY

Release Patterns: STBD



STBD applied to SQLite



What is this commit about?



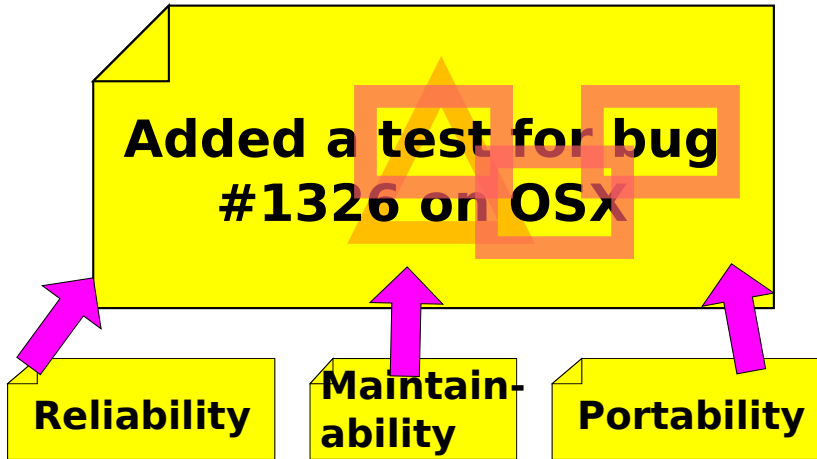
**Added a test for bug
#1326 on OSX**

What is this commit about?

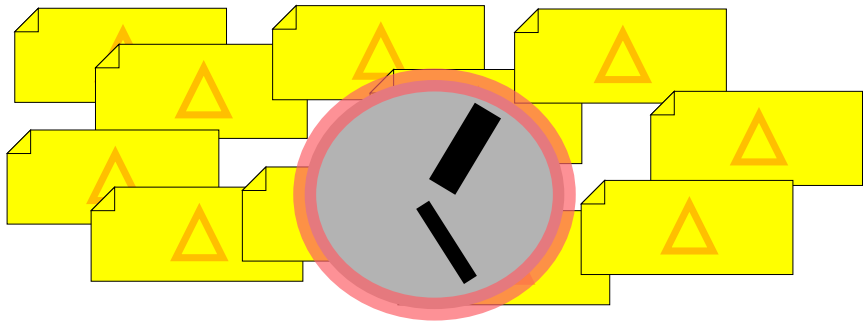


**Added a test for bug
#1326 on OSX**

What is this commit about?



But we have many commits..



Reliability

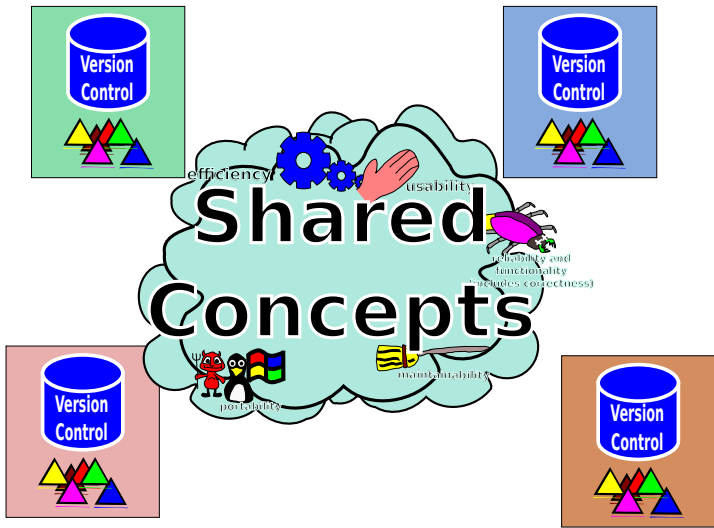


**Maintain-
ability**

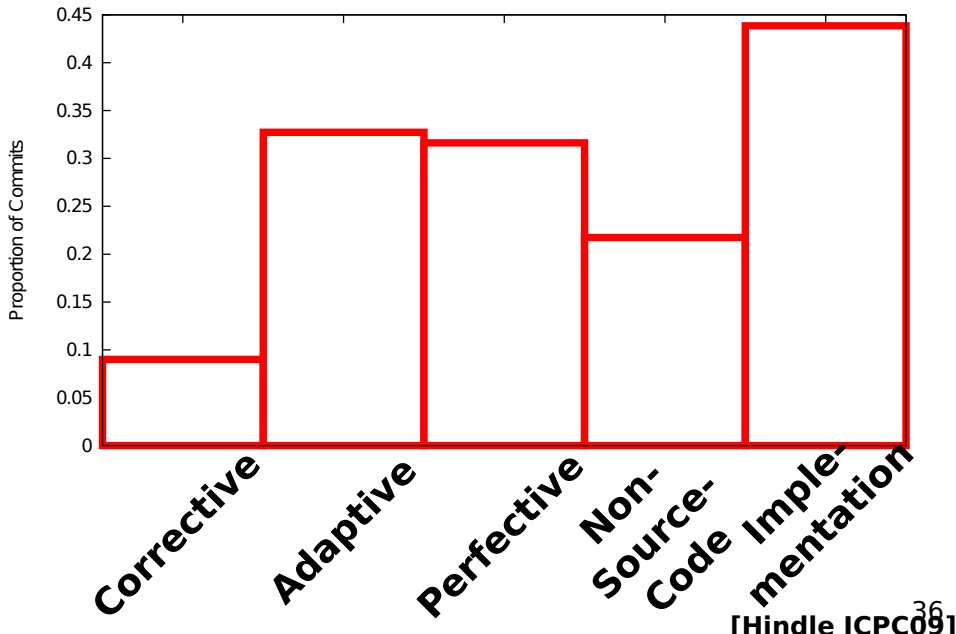


Portability

Cross Project Relevance



Maintenance Classes of Large Changes



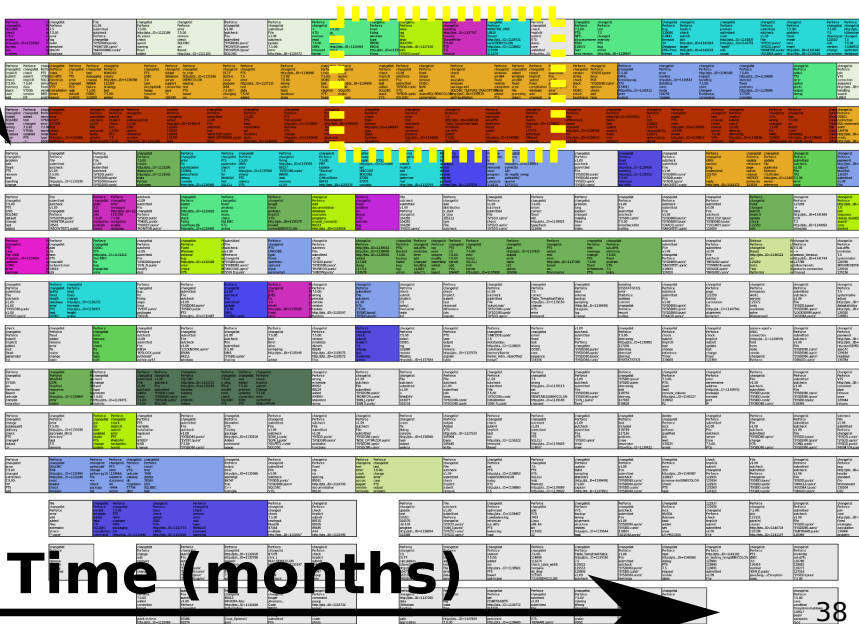
2004 Jun 2004 Jul 2004 Aug 2004 Sep 2004 Oct 2004 Nov 2004 Dec 2005 Jan 2005 Jun 2005 Jul 2005 Aug 2005 Oct 2005 Nov 2005 Dec 2006 Jan 2006 Feb 2006 Mar 2006 Apr 2006 Ma

Time (months)

Time (months)

Labelled Developer Topics

2004 Jun 2004 Jul 2004 Aug 2004 Sep 2004 Oct 2004 Nov 2004 Dec 2005 Jan 2005 Jun 2005 Jul 2005 Aug 2005 Oct 2005 Nov 2005 Dec 2006 Jan 2006 Feb 2006 Mar 2006 Apr 2006 May 2006



Unique Topics

Time (months)

Labelled Developer Topics

Unique Topics

changelist Perforce 7.5.00: tp PTS size dbmrfc http://pts...ID=1135493 stack Perl	changelist Perforce fixed fixing windows type 88936 89016 http://p...ID=1135493 Ullan	changelist Perforce view log file drop MAXCPU http://pts...ID=1137160	Perforce changelist handling http://pts...ID=1137767 resume TraceWriter 7.5.00: PTS 7.5 remove	changelist Perforce MONITOR_OMS LINUX thread http://pts...ID=1138731 serialSEMICOLON http://pts...ID=1138662 112030 111874
--	--	--	---	---

changelist Perforce Linux 7.5.00: ODBC test: fixes valgrind V75: fixed	Perforce changelist kernel http://pts...ID=1134856 7.5.00: SQLDBC make memory	changelist Perforce submit test 'SYSDBC unix' st k V...	Perforce changelist check set available window SQLDBC FEATURE TRACPTION LOMhttp://pts...ID=1133570 setTraceOption	Perforce changelist windows amd64 version subsys added PTS error file procentry object
---	--	---	---	---

changelist Perforce PTS Precompiler http://pts...ID=1140565 Tests *** PTS: duplicate Runtime	changelist Perforce check tests leftover http://pts...ID=1140567 type tasks, SysView sequence	changelist Perforce test testframe based removed protocol http://pts...ID=1140645 PTS	changelist Perforce 7.5 http://pts...ID=1140309 Table_TempHashTable minimize sut-diffs added 7.5.00, duplicate	Perforce changelist minimize sut-diffs testframe based added on: http://pts...ID=1140385 removed
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Time (months)

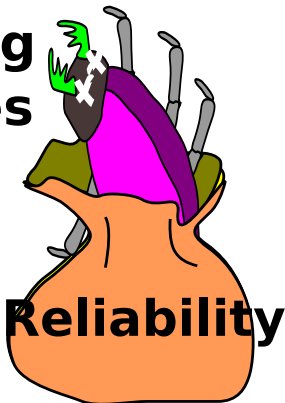
Word Bag Examples



Portability

portability
transferability
interoperability
documentation
internationalization
i18n

...



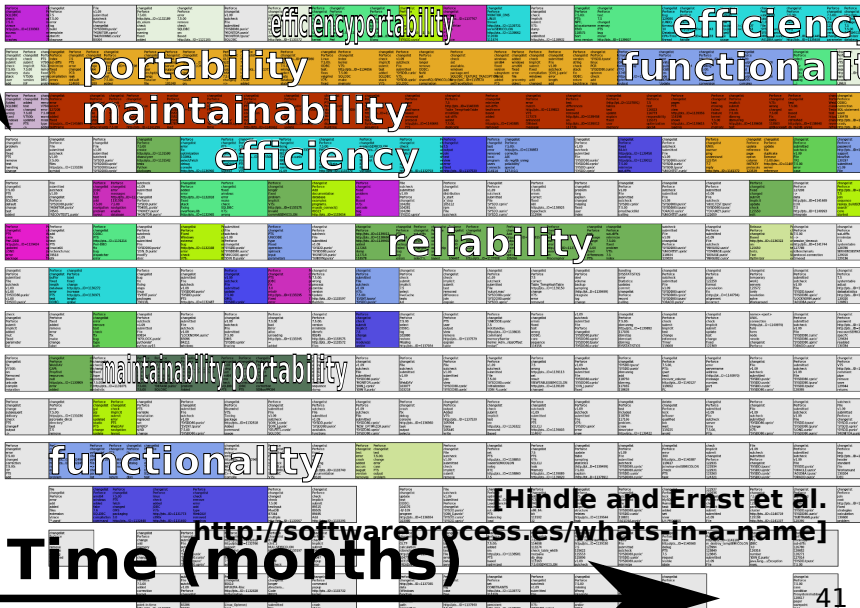
Reliability

reliability
failure
error
redundancy
fails
bug

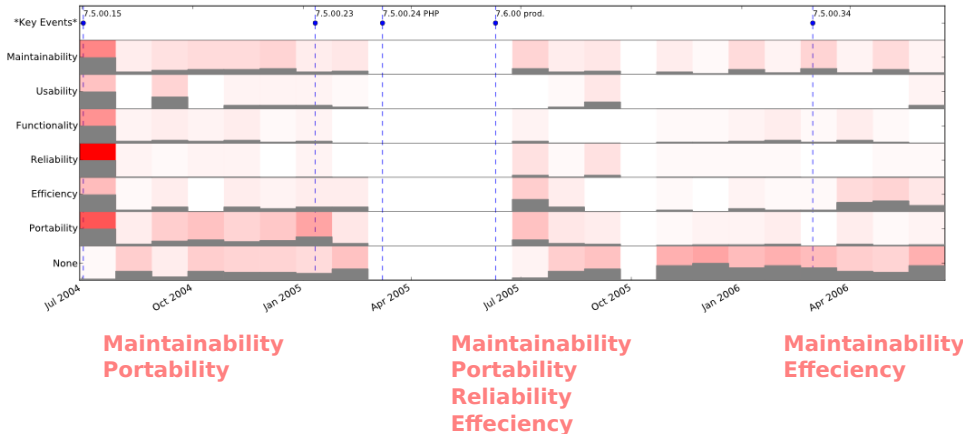
...

Labelled Developer Topics

2004 Jun 2004 Jul 2004 Aug 2004 Sep 2004 Oct 2004 Nov 2004 Dec 2005 Jan 2005 Jun 2005 Jul 2005 Aug 2005 Oct 2005 Nov 2005 Dec 2006 Jan 2006 Feb 2006 Mar 2006 Apr 2006 May 2006



MaxDB 7.500 Timeline



**SOFTWARE
PROCESS
RECOVERY:
INTEGRATION**

Recovered Unified Process Views

Theory

Business Modeling

Requirements

Analysis & Design

Implementation

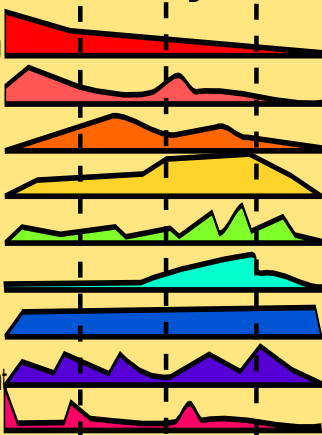
Test

Deployment

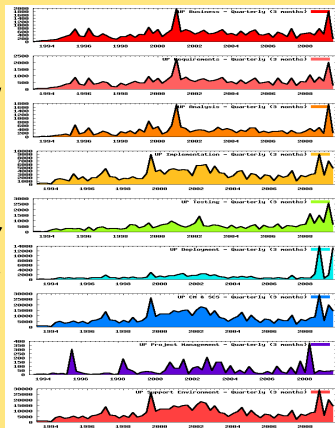
CM and SCS

Project Mangement

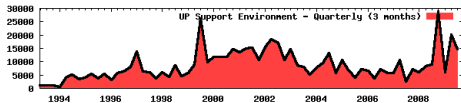
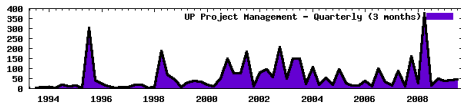
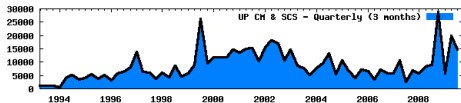
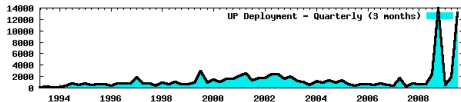
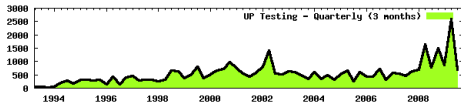
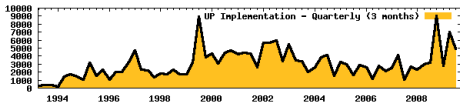
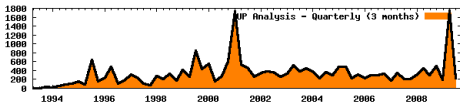
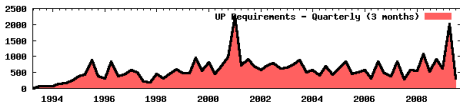
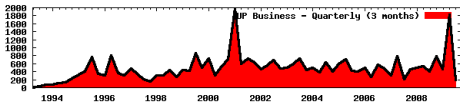
Environment



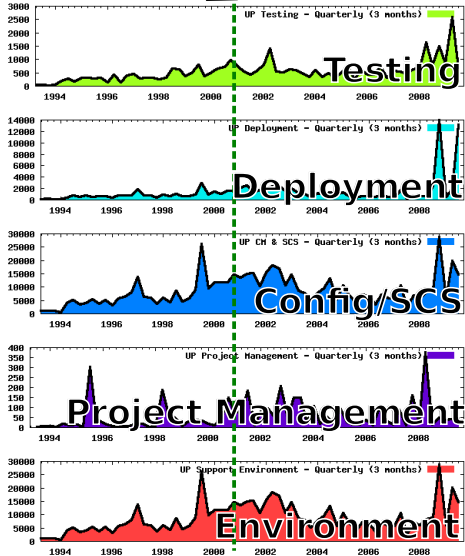
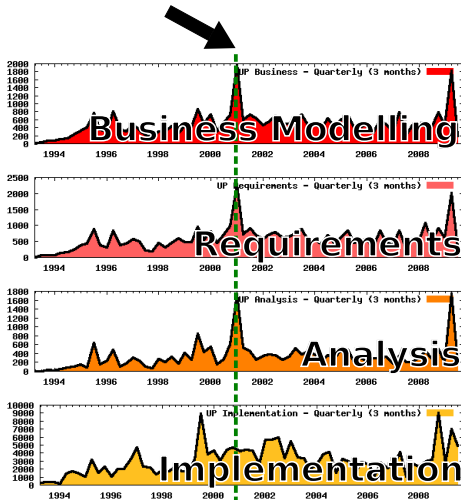
Practice



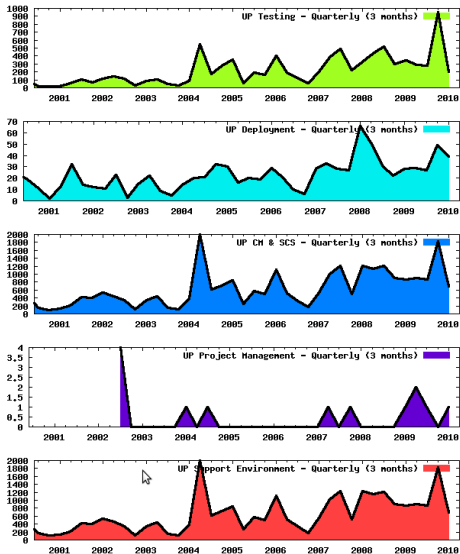
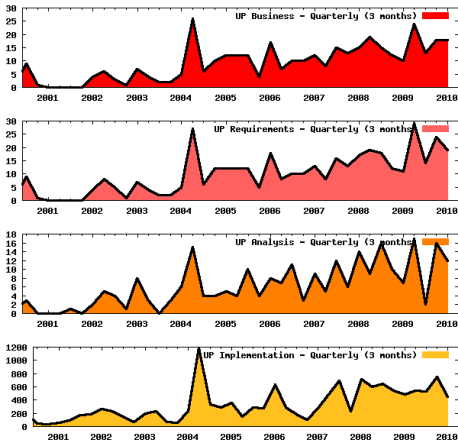
FreeBSD Case Study



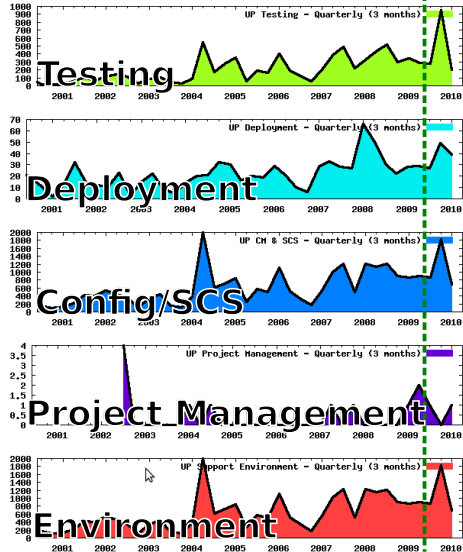
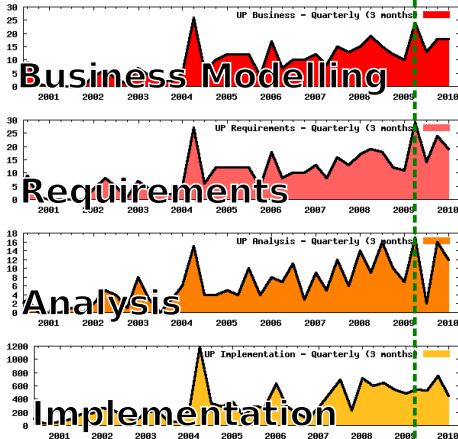
FreeBSD Case Study: 2001



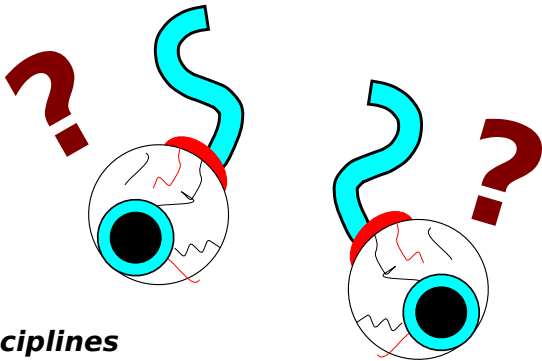
SQLite Case Study



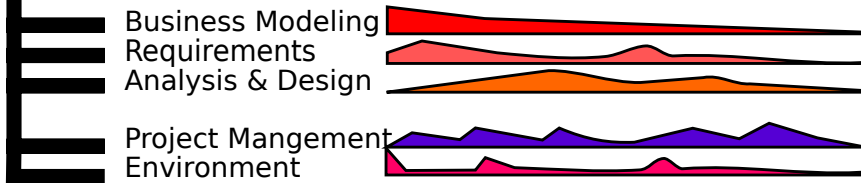
SQLite Case Study: 2009



UP Observability



Disciplines



Relating Requirements to Implementation via Topic Analysis

Do Topics Extracted from Requirements Make Sense to Managers and Developers?

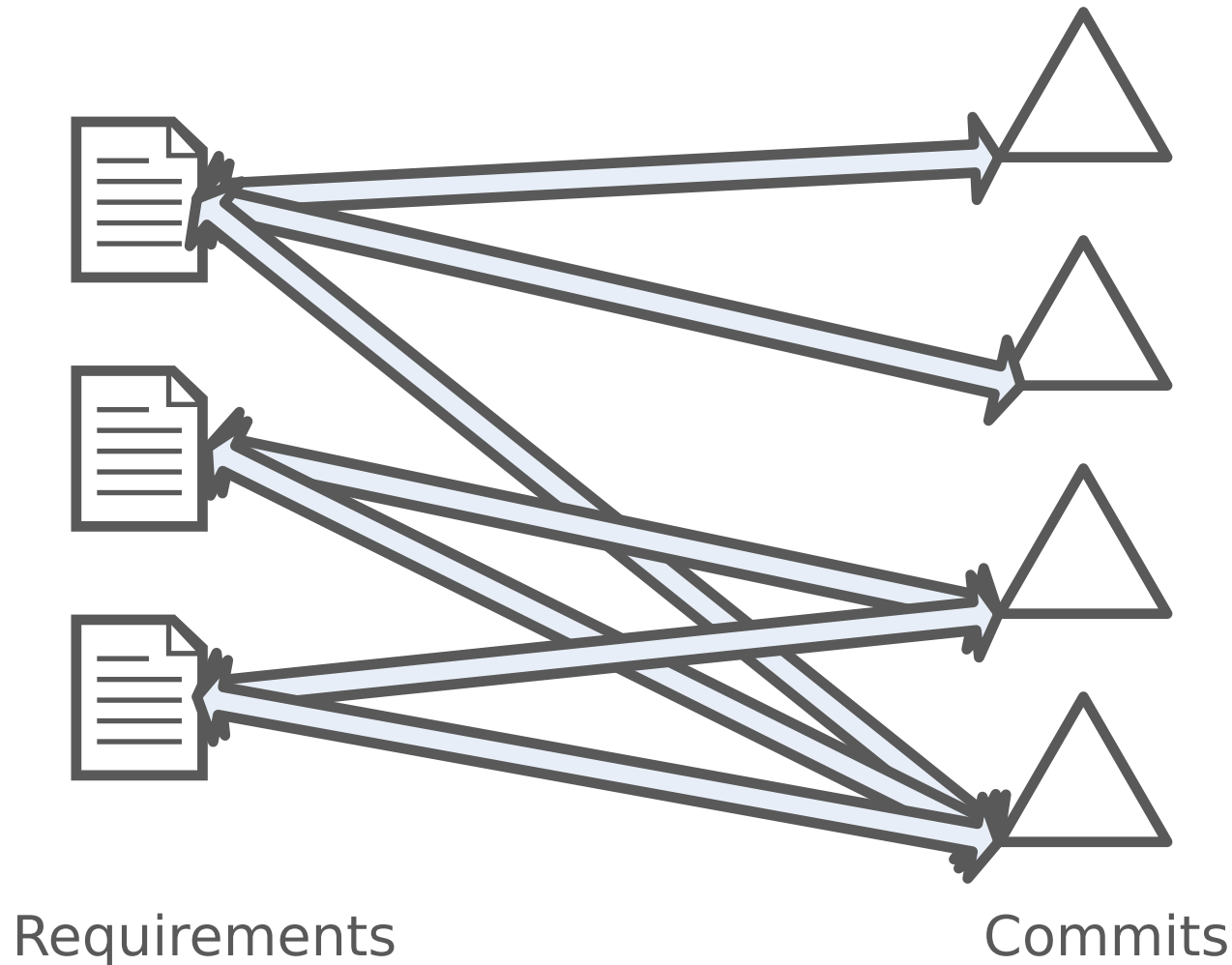
Abram Hindle
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Edmonton, CANADA
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Christian Bird, Thomas Zimmermann, Nachiappan Nagappan
Microsoft Research
Redmond, WA, USA
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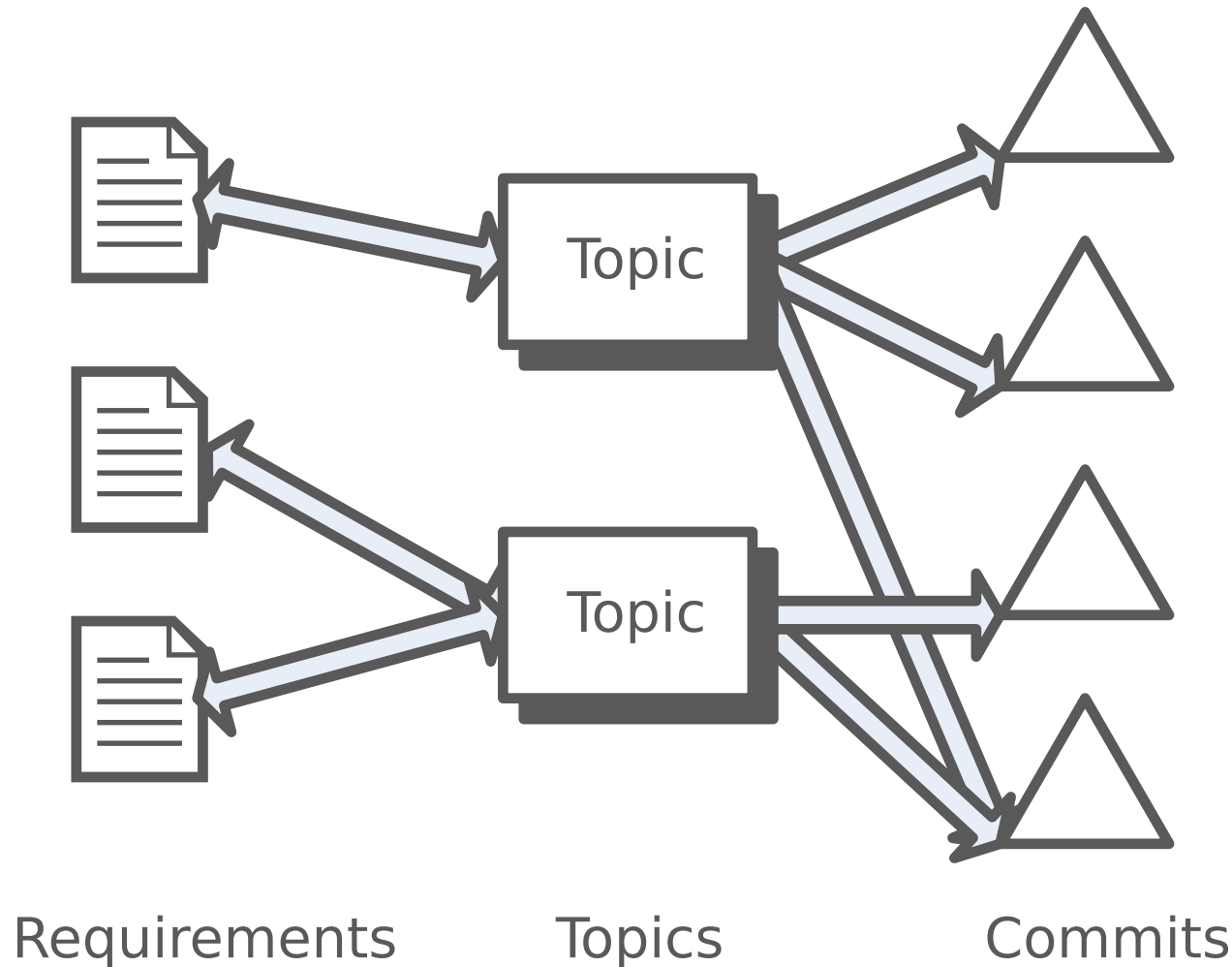
Research Goals

- Determine if stakeholders can understand and label topics extracted from requirements.
- Determine if the efforts relevant to a requirements topic, match the stakeholder's perception of what occurred.

Traceability: Requirements to Commits



Traceability: Requirements to Commits via Topics



Topics in Software Engineering

- Many software engineering researchers are leveraging topics for:
 - Traceability [Asuncion et al]
 - Code metrics [Poshyvanyk et al. Marcus et al.]
 - Discussion/Source code summaries [Linstead et al.]
 - Querying [Poshyvanyk et al. Marcus et al.]
- Some researchers have tried to validated the use of topics in software engineering:
 - Are topics aspects? [Baldi et al.]
 - Does topic evolution relate to software evolution? [Thomas et al.]

Data: Requirements and Implementation

Microsoft Product with Millions of Users

Millions of lines of code

10+ years of commits

4000+ unique authors managed by 1700+ managers

650000+ Change log messages/commits

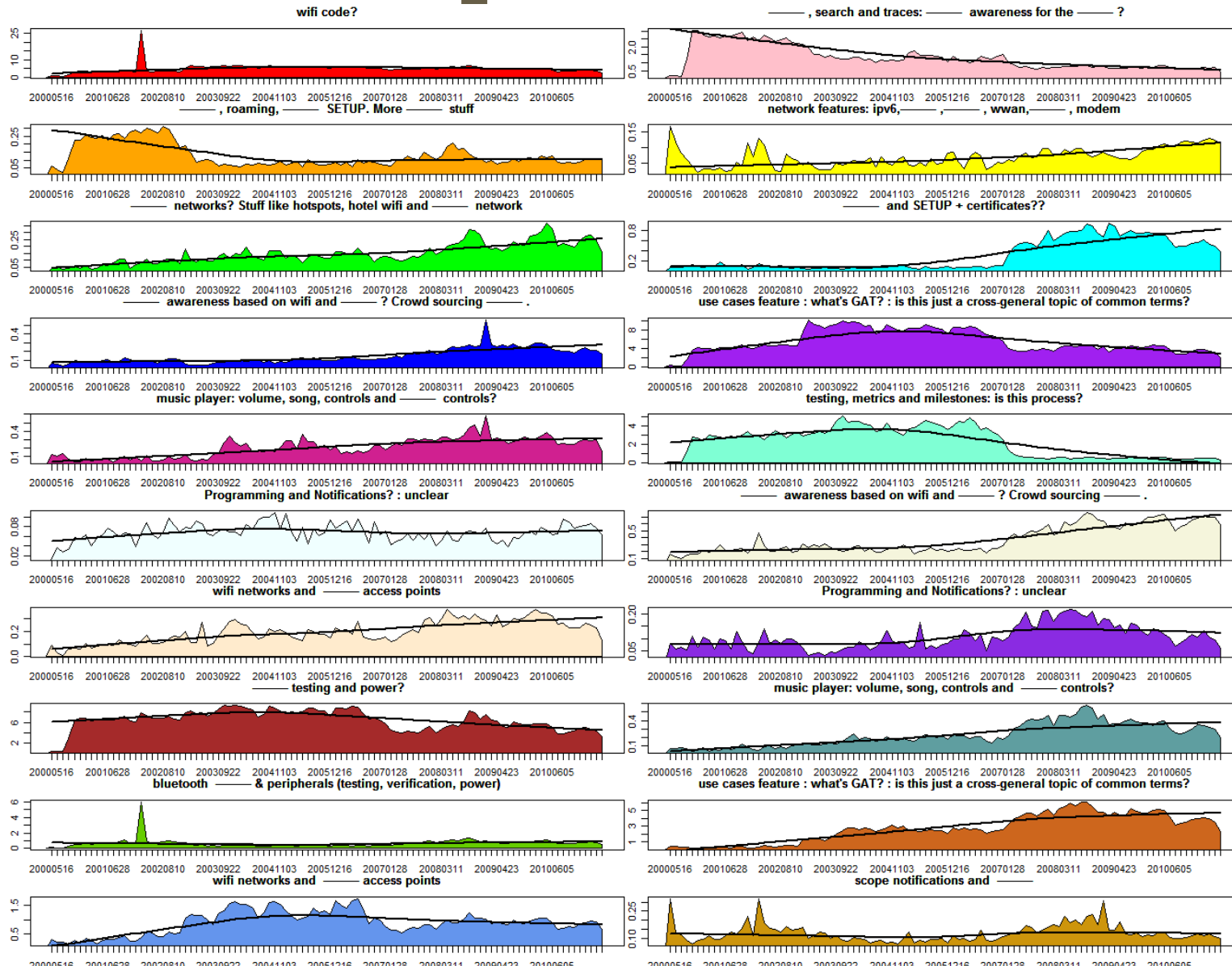
75 Requirements Documents

1500 pages of documentation

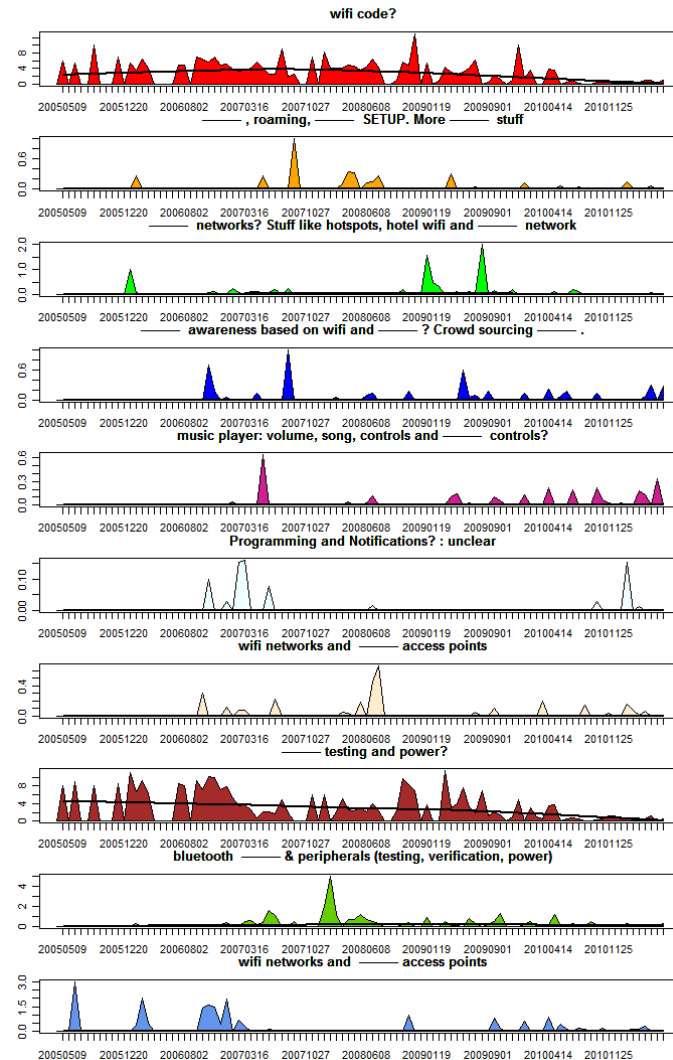
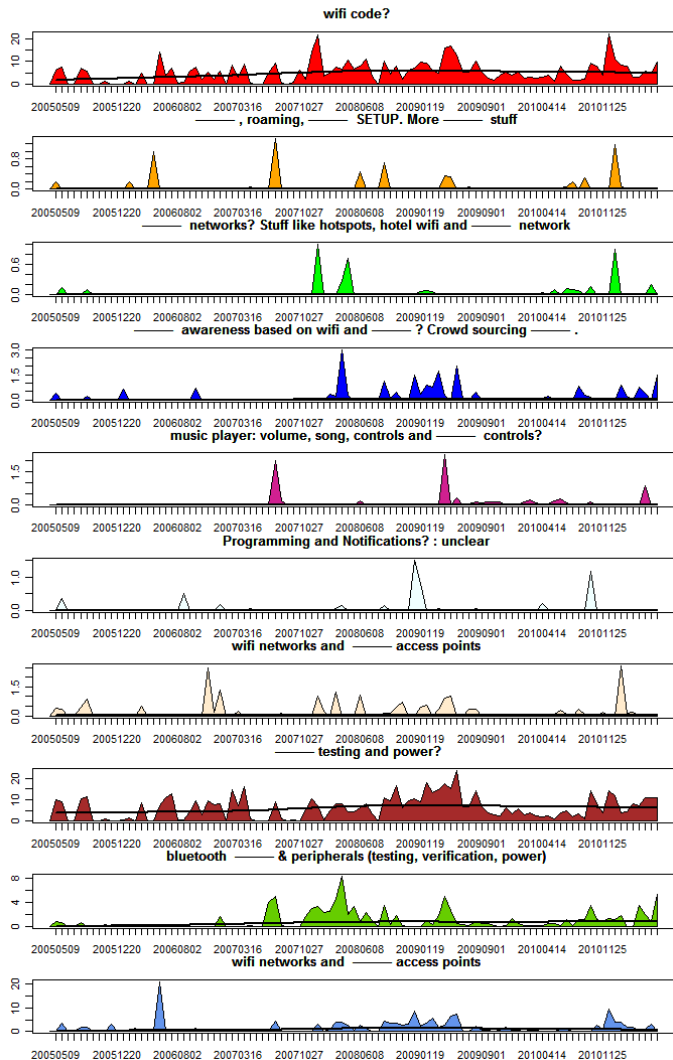
285000 words

Average Document Size: 20 pages & 3800 words

Global Topic Plot: Time



Per Authors



Survey

- Short
- 10 minutes
- 3 topics
- 3 plots
- Perception
- Utility

Question 1.1 Introduction: We wish to evaluate the meaning of extracted topics.

Question 1.1.1: Here's a topic extracted from — networking specifications. Based on **YOUR** expertise regarding — can you summarize or give us your feelings about what — concepts, issues, features that this topic might be describing? Do not worry if you cannot make sense of many of the words.

Topic 6: connection update state source connection —
— — support change plan status — device struct
use verify made change use ni

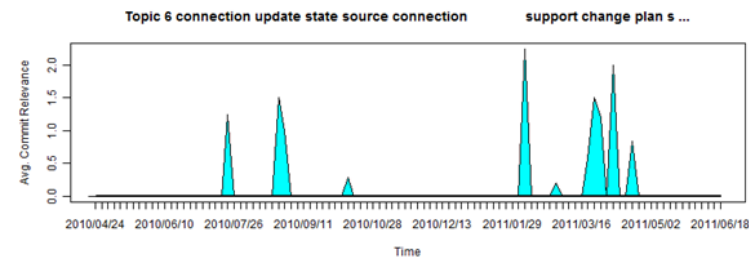
Question 1.1.2: Based on your experience, are these terms related to — development?

☐ Yes

☐ No

Question 1.2 Introduction:

Here is a plot of Source Depot commits you (REDMOND\—) have made who's change description match the topic you have just labeled. Please look over this plot, the next few questions will ask about your perception of what is depicted in this plot.



Question 1.2.1: Do you agree with this statement:

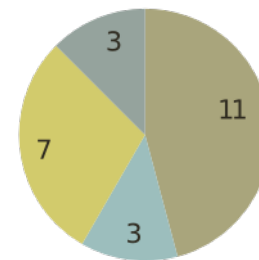
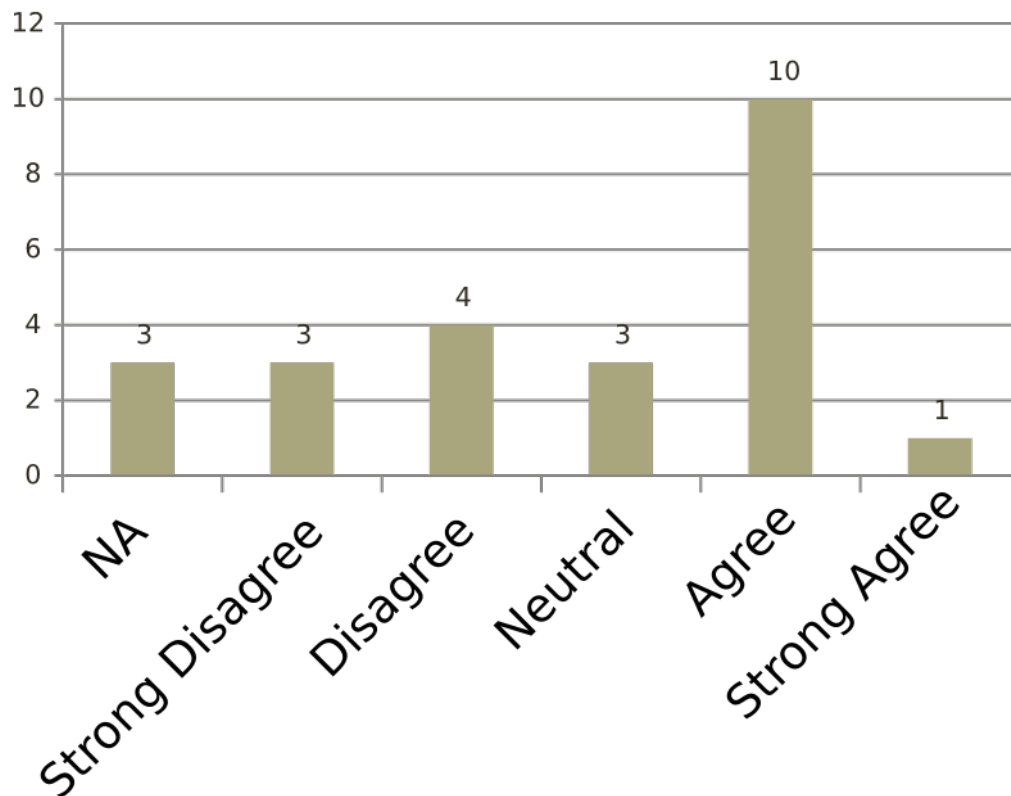
This plot matches my perception of the effort that went into that topic and/or its features.

- 1 – Strongly Disagree,
- 2 – Disagree,
- 3 – Neutral,
- 4 – Agree,
- 5 – Strongly Agree

Question 1.2.2: Do you recognize any of these spikes or dips in the timeline? Does the plot match events you are aware of?

Perception of Effort Relevant to Topics

Rating of Topic-Plot Matching Perception of Effort



■ Agree
■ Neutral
■ Disagree
■ NA

■ Rating of Topic Plot Matching Perception of Effort

46% Agree

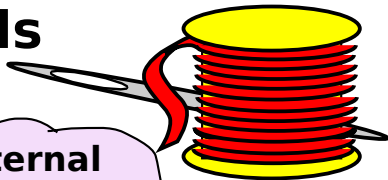
Ignoring neutral and NA:

63% Agree

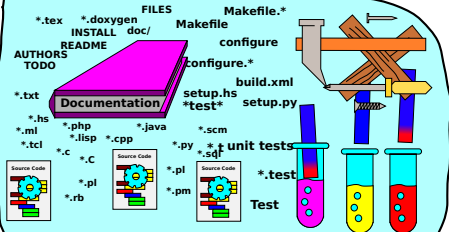
Recommendations on use of Topics in Software Engineering

- *Labels Matter* Topics can take 2-4 minutes each to label.
- *Topics can be confusing*
- *Remove irrelevant topics*
- Use relevant people to label topics
- Use *domain* experts

Common Threads



Idioms



External Project Language

shared vocabulary

vocabulary

Project

Internal Project Language

vocabulary

Project

Shared Terms




Future Work

A brown, irregularly shaped icon containing four stylized human figures with different colored hair (purple, orange, yellow, red) and clothing (blue, green, orange, pink).

People
and
teams

A purple, irregularly shaped icon containing several elements: three people with question marks above them, a central stack of three blue cylinders labeled 'Unknown Project' and 'Model Bench', and a vertical column of four yellow hard hats with red gears. A small character with a pickaxe is at the bottom right.

Validation

A dark red, irregularly shaped icon featuring a red bullseye target with a crosshair.

Accuracy

A dark green, irregularly shaped icon containing a stylized brown industrial building with a smokestack emitting a dark smoke plume.

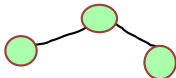
Industrial

A purple, irregularly shaped icon containing a series of concentric dashed orange circles.

Iteration
Identification

Future Directions

**Software
Engineering
Wordnet**



Leverage
apriori lexicons
for SE tasks

Software Lexicon
Domain Lexicon
Project Lexicon



MyDB

Effeciency
Optimizer
MyOptimizer

Future Directions: Determining Intent

commit

**Added a test for
bug #1326**

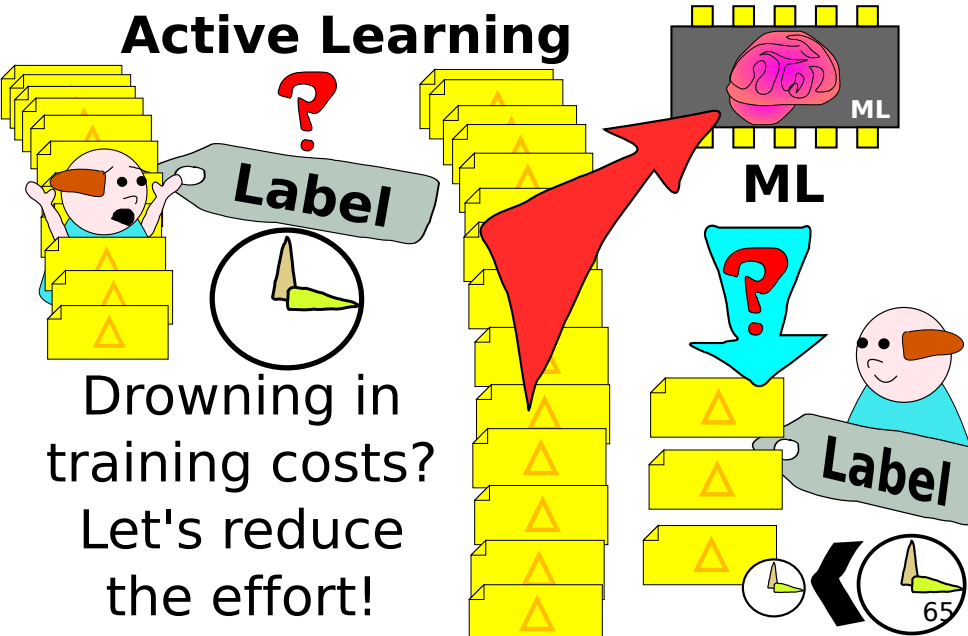
tests for
fixed bugs
->
regression test

prior knowledge

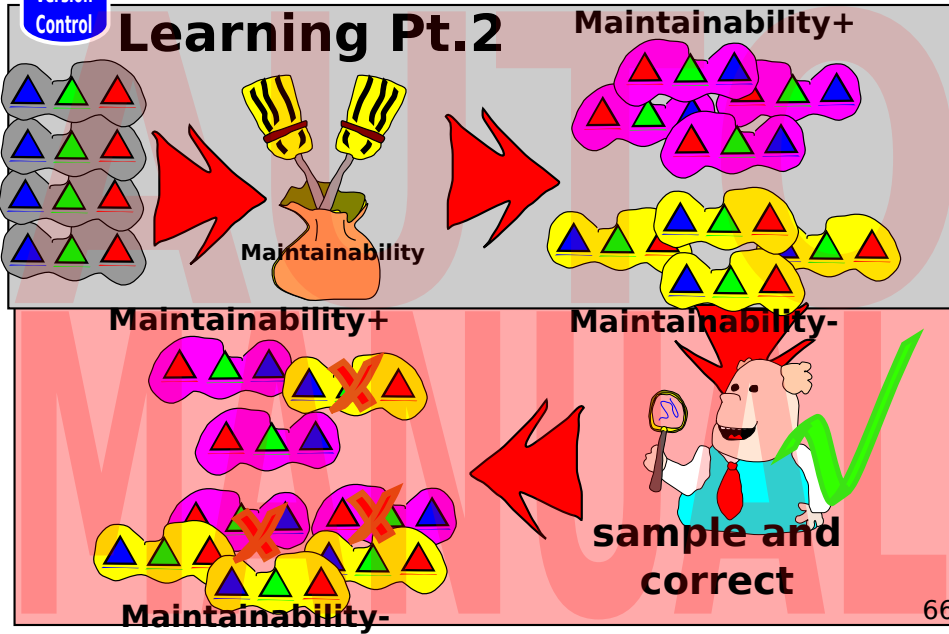
**Creating a
regression test**

tag

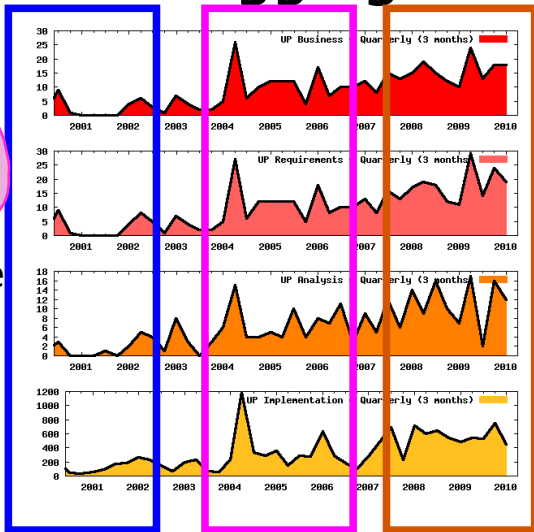
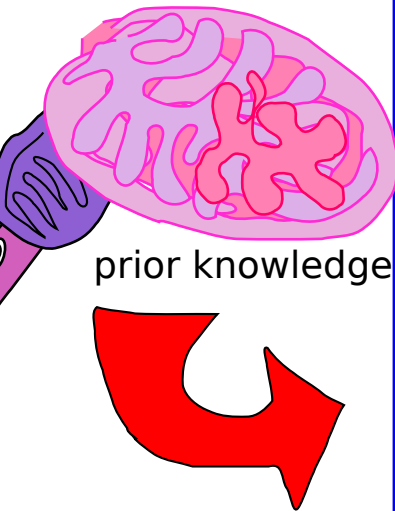
Future Directions: Active Learning



Future Directions: Active Learning Pt.2



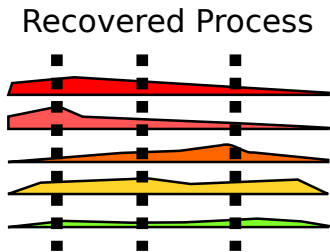
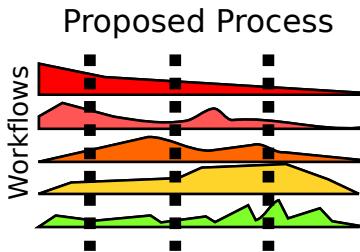
Future Directions: Process Identification / Tagging



10% XP 90% Agile 45% UP

Process Validation

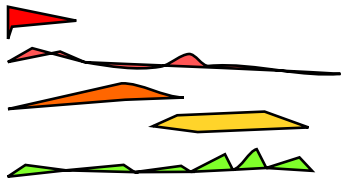
Is my
proposed
process
actually
being
used?



Proposed and Recovered
Process Overlayed



Differences between
Proposed and Recovered



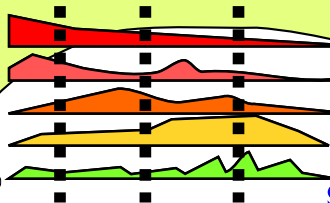
Process Refactoring

With
Feedback
can we
improve
our dev
processes
?

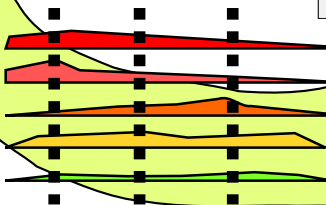
what if we
did this??



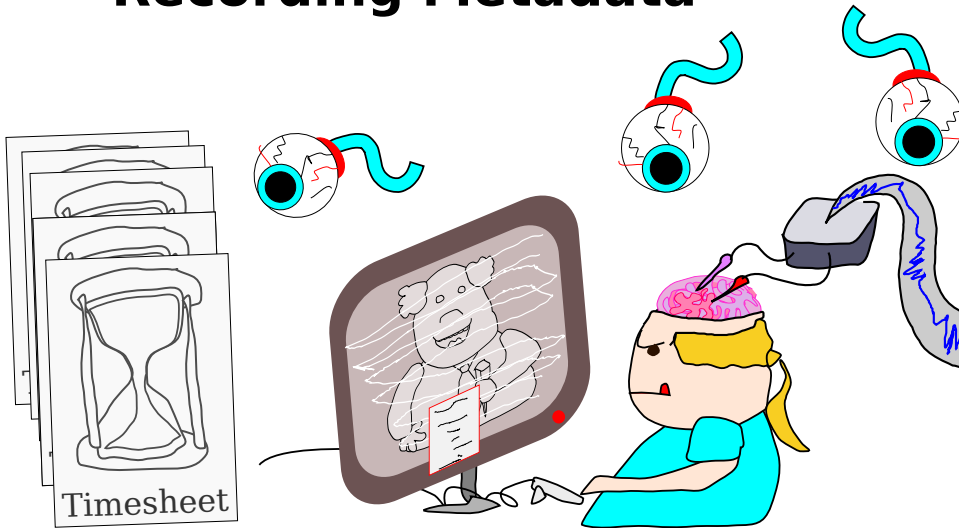
Proposed Process



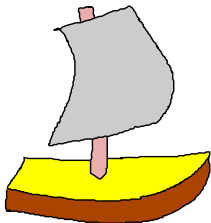
Extracted Process



Future Directions: Discreetly Recording Metadata



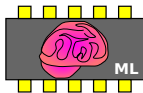
Future Directions: The Good, The Bad, The Ugly Processes



Problematic Projects

Successful Projects

Failed or Dangerous Projects



ML

Software Process Recovery

Process Recovery Summary

