Supporting Software Evolution Analysis with Historical Dependencies and Defect Information

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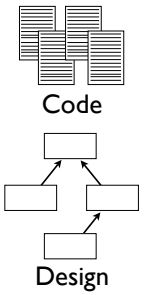
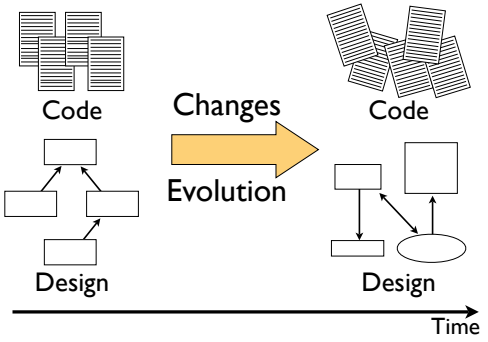
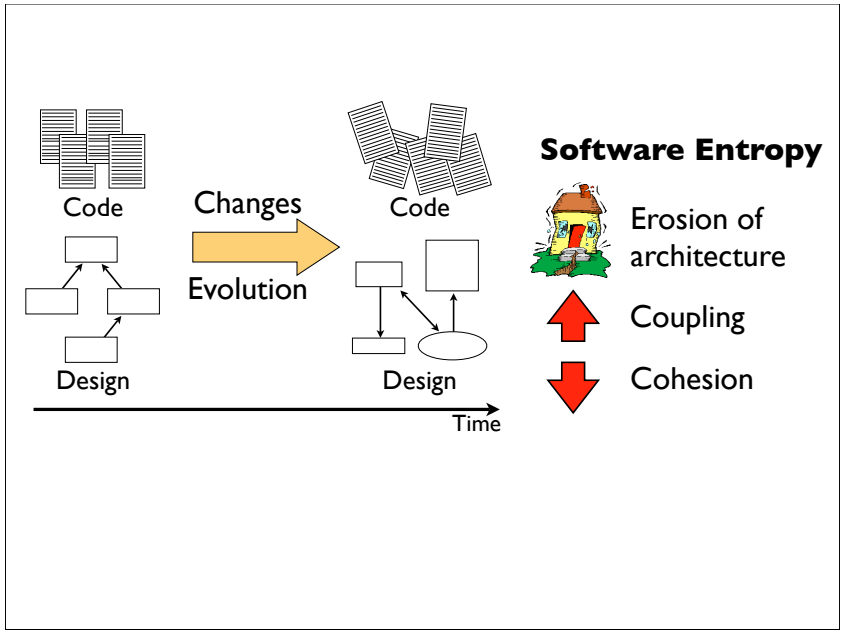
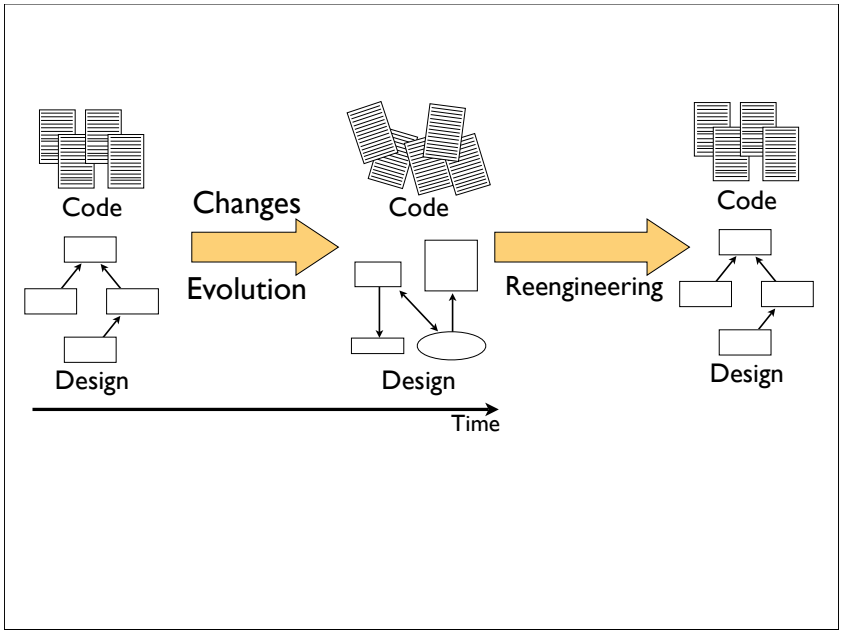
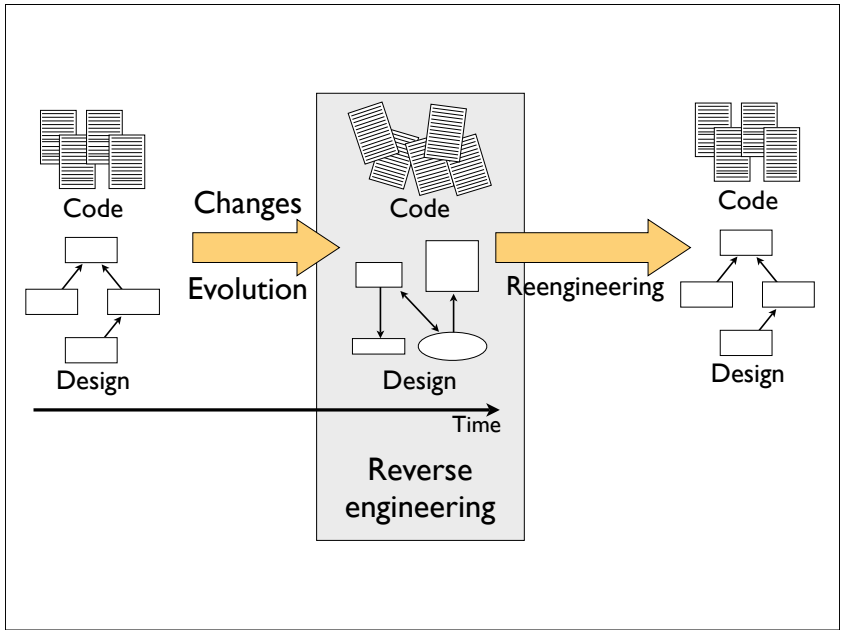
University of Lugano
Switzerland

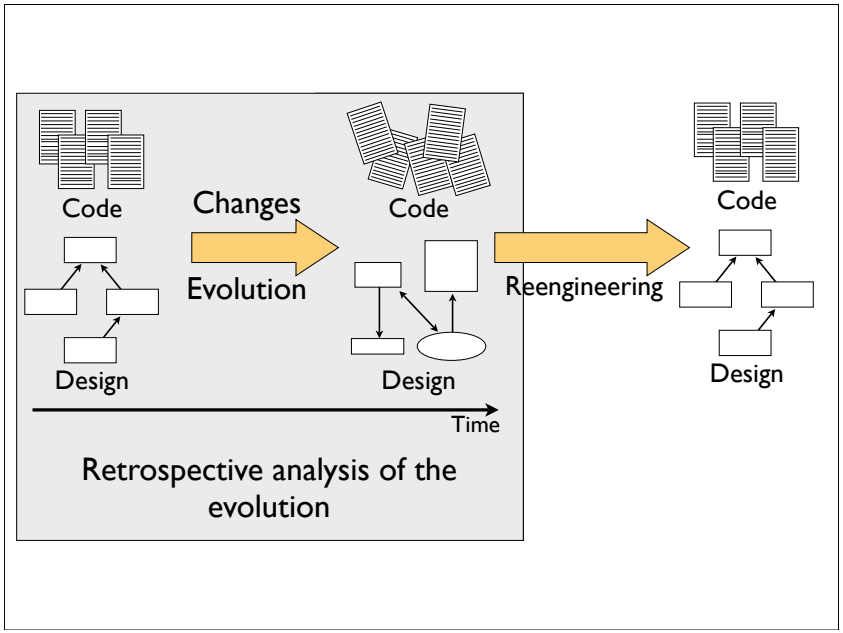





Code
Changes
Code
Evolution
Design
Design
Time
Software Entropy
Erosion of architecture
Coupling
Cohesion


Code
Changes
Code
Code
Evolution
Reengineering
Design
Design
Design
Time


Code
Changes
Code
Code
Evolution
Reengineering
Design
Design
Design
Time
Reverse engineering


Code
Changes
Code
Code
Evolution
Reengineering
Design
Design
Design
Time
Retrospective analysis of the evolution

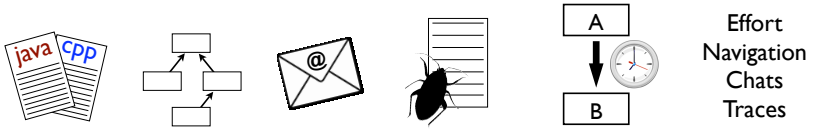
Detecting problematic areas in an *evolving* software system to prioritize the reengineering effort

Problem

Software Evolution concerns several releases of a software

Software Evolution concerns a process

Software Evolution concerns a process

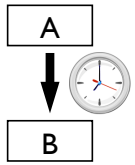


Code
Design documents
Email archives
Problem reports
Historical dependencies
Effort
Navigation
Chats
Traces
...

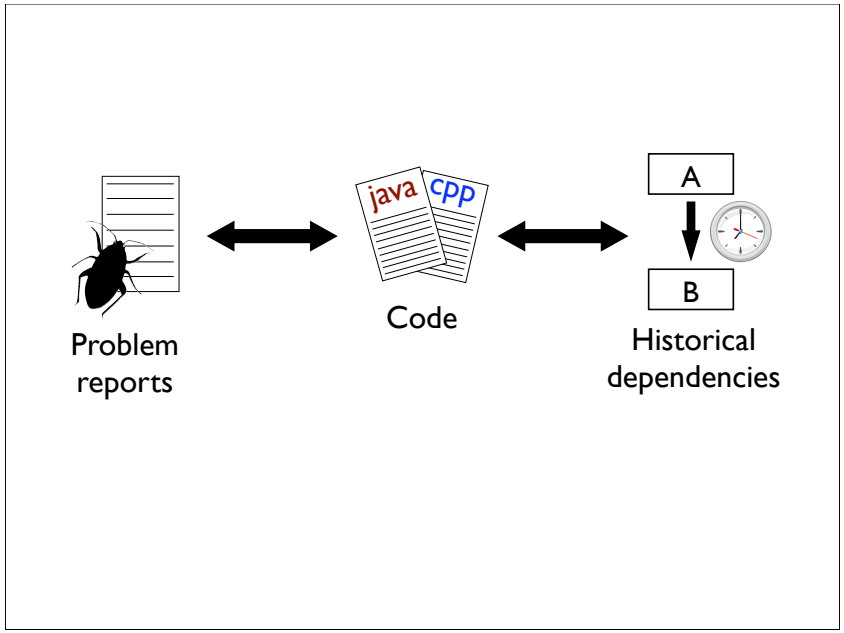
Problem reports
Design documents
Email archives
Code
Historical dependencies
Effort
Navigation
Chats
Traces
...

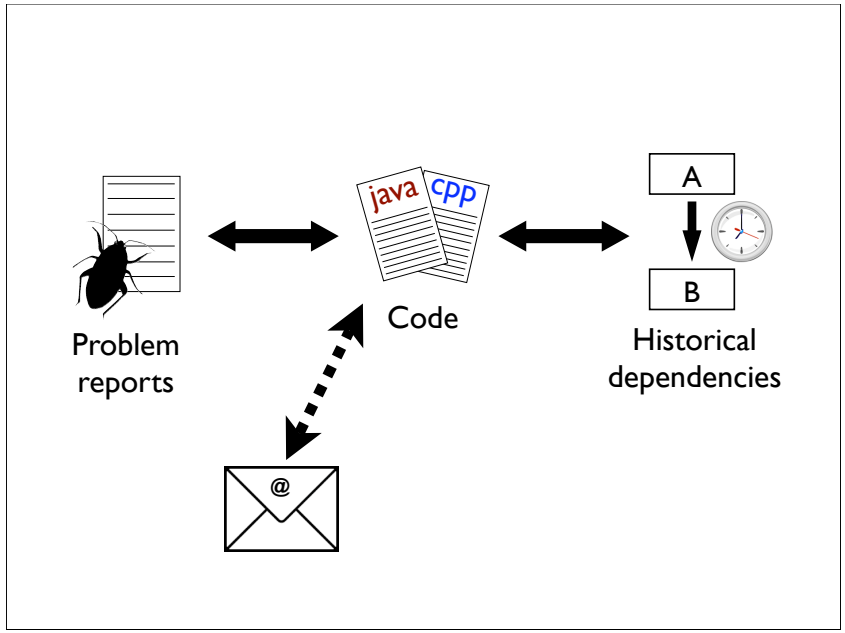
Problem reports

Code



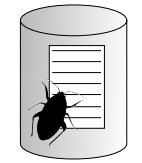
Historical dependencies

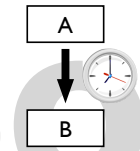




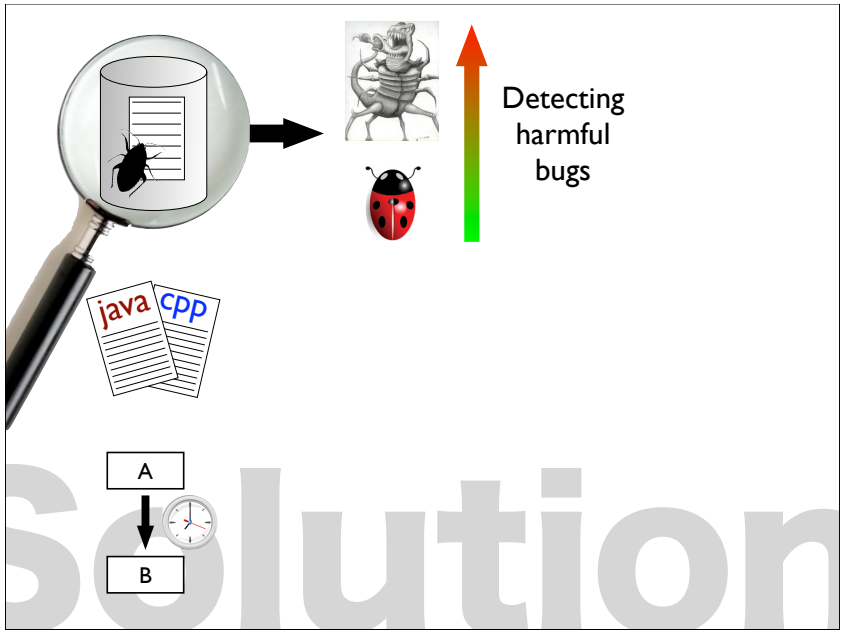
Combining source code, bug reports, and change coupling analyses reveals problematic areas in evolving software systems

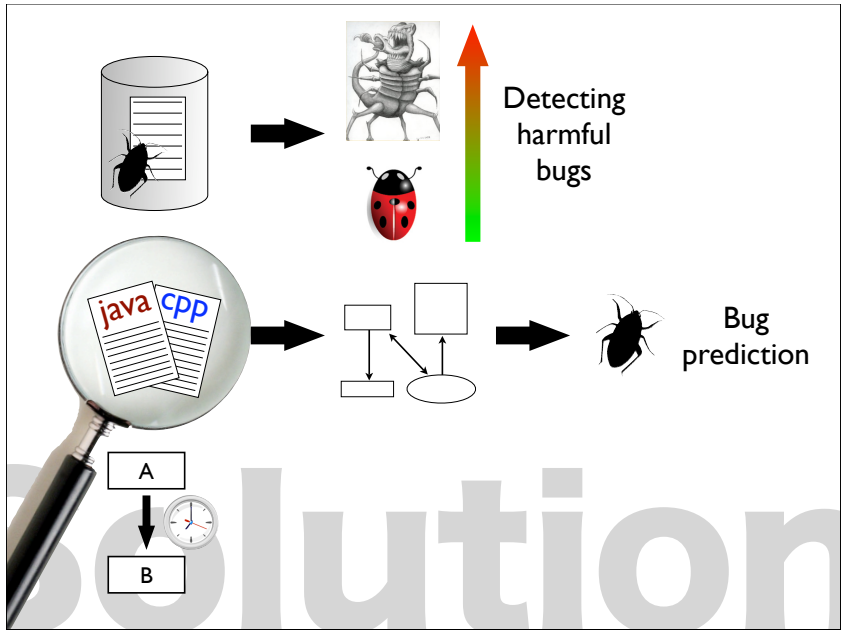
Thesis

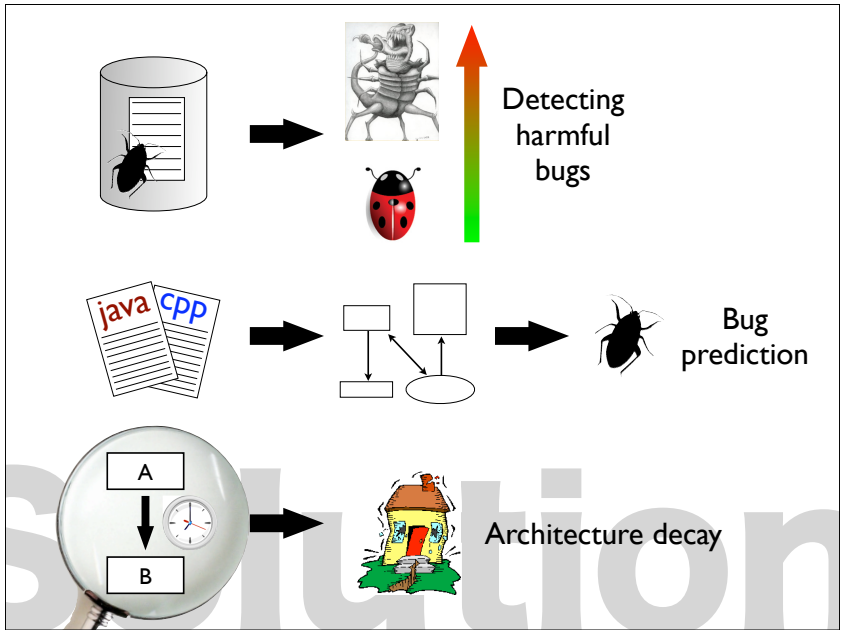


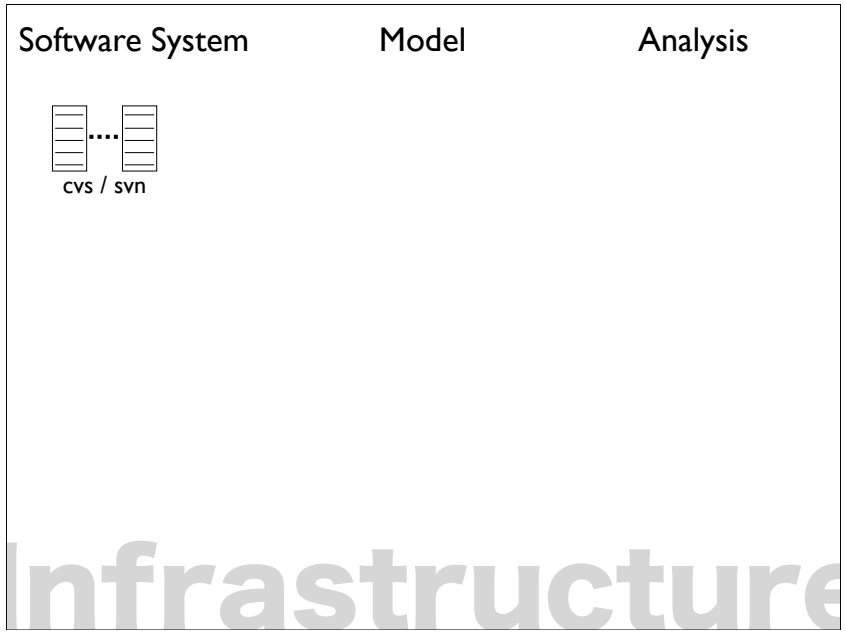


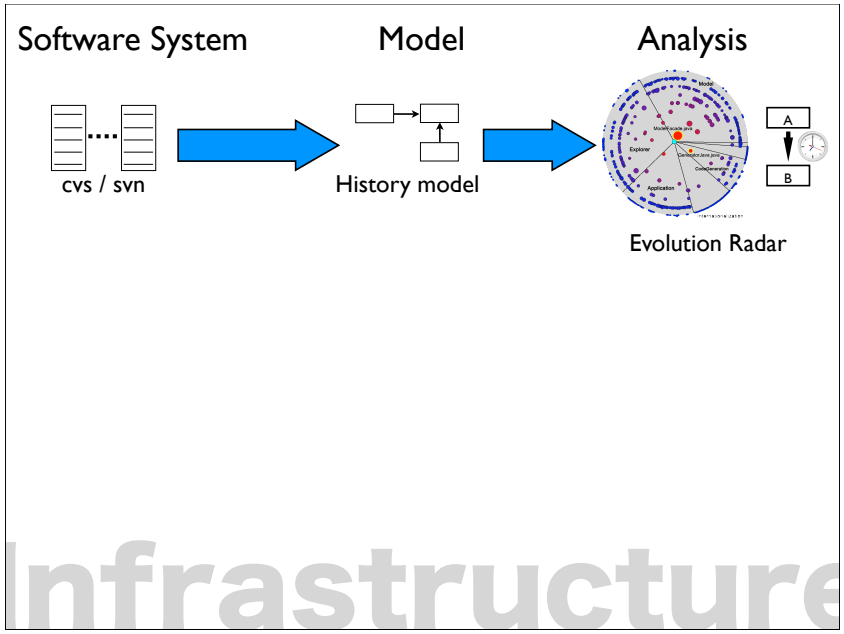
Solution

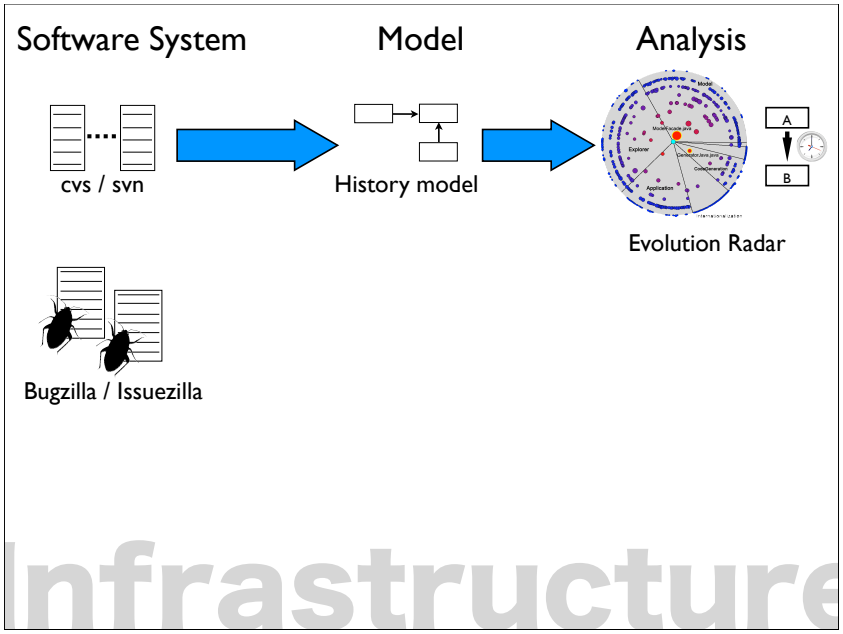

Detecting
harmful
bugs
java
cpp
A
B
Solution


Detecting
harmful
bugs
java
cpp
Bug
prediction
A
B
Solution


Detecting
harmful
bugs
java
cpp
Bug
prediction
A
B
Architecture decay
Solution


Software System
Model
Analysis
cvs / svn
Infrastructure


Software System
Model
Analysis
cvs / svn
History model
A
B
Evolution Radar
Infrastructure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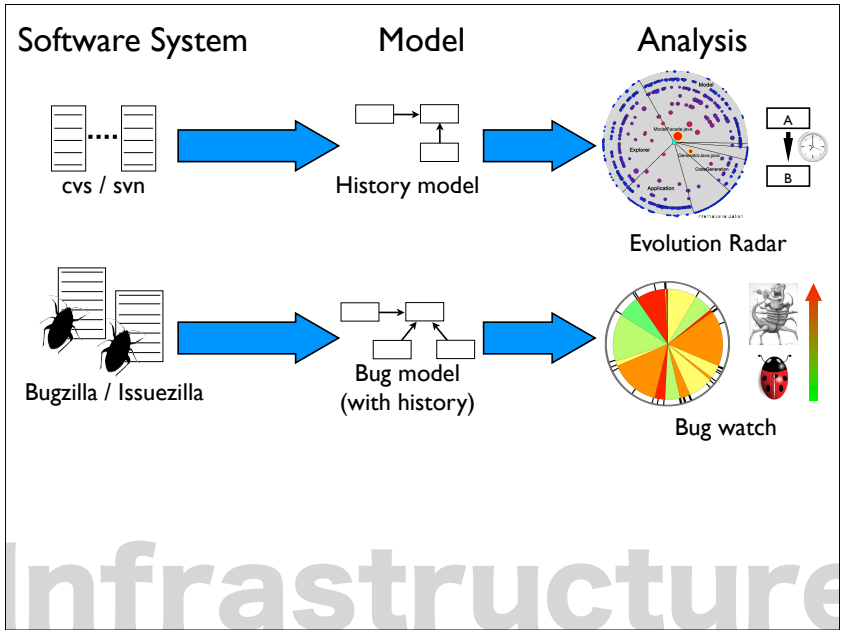
Bugzilla / Issuezilla
Infrastructure


Software System
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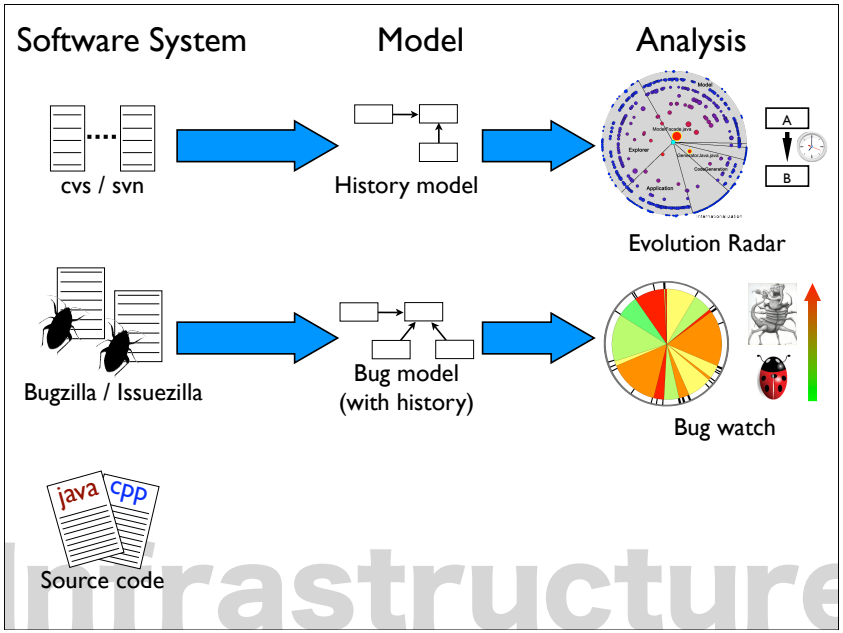
History model
A
B
Evolution Radar
Bugzilla / Issuezilla
Bug model
(with history)
Bug watch
Infrastructure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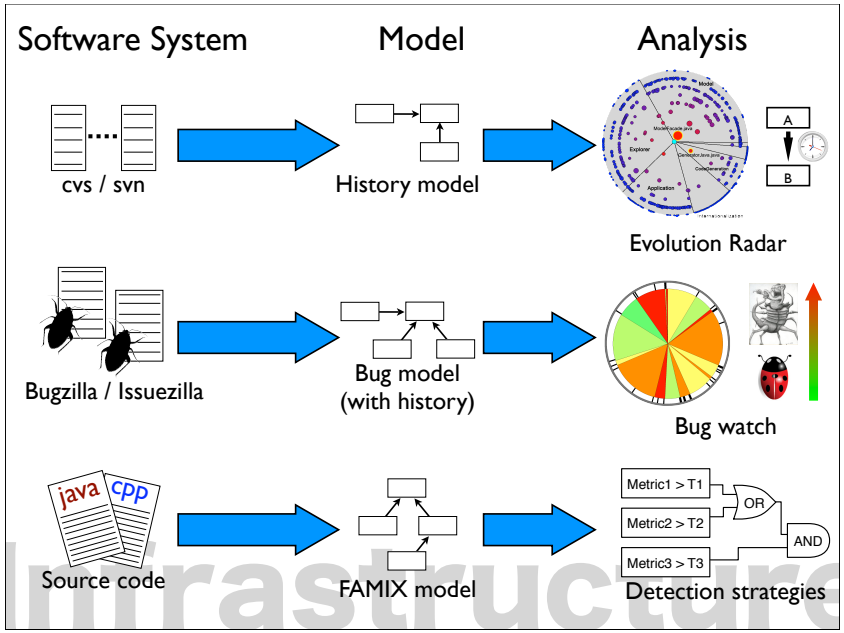
Bug model
(with history)
Bug watch
java
cpp
Source code
Infrastructure


Software System
Model
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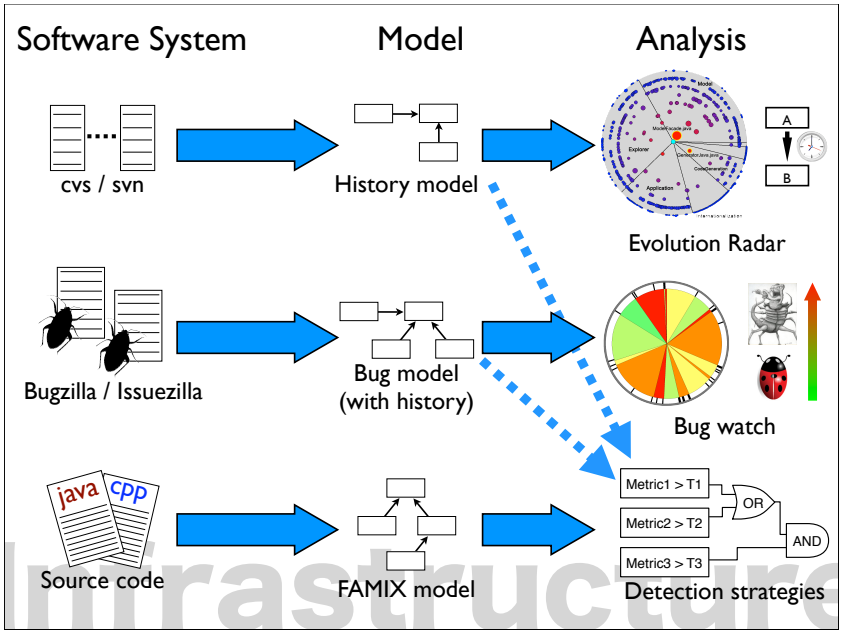
History model
Evolution Radar
Bugzilla / Issuezilla
Bug model
(with history)
Bug watch
java
cpp
Source code
FAMIX model
Metric1 > T1
Metric2 > T2
Metric3 > T3
OR
AND
Detection strategies
A
B


Software System
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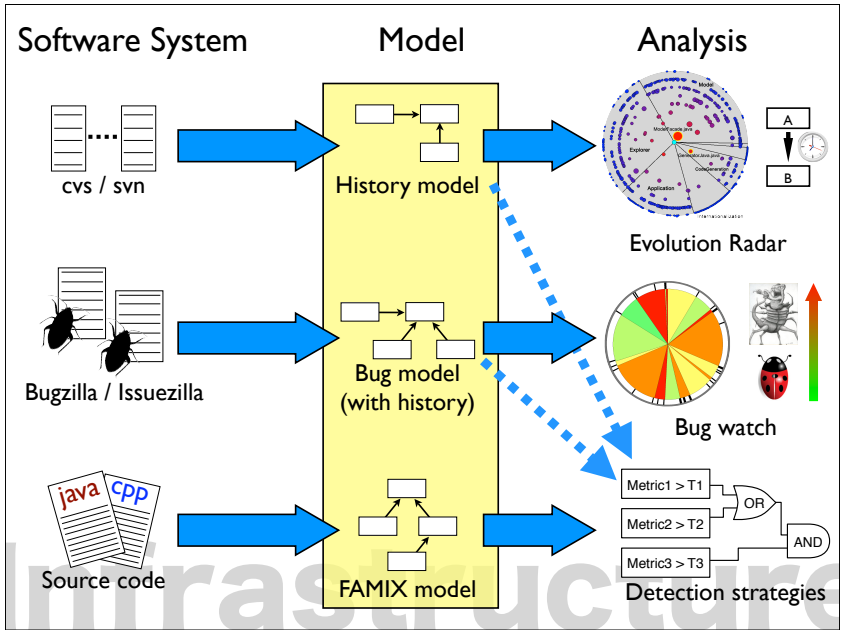
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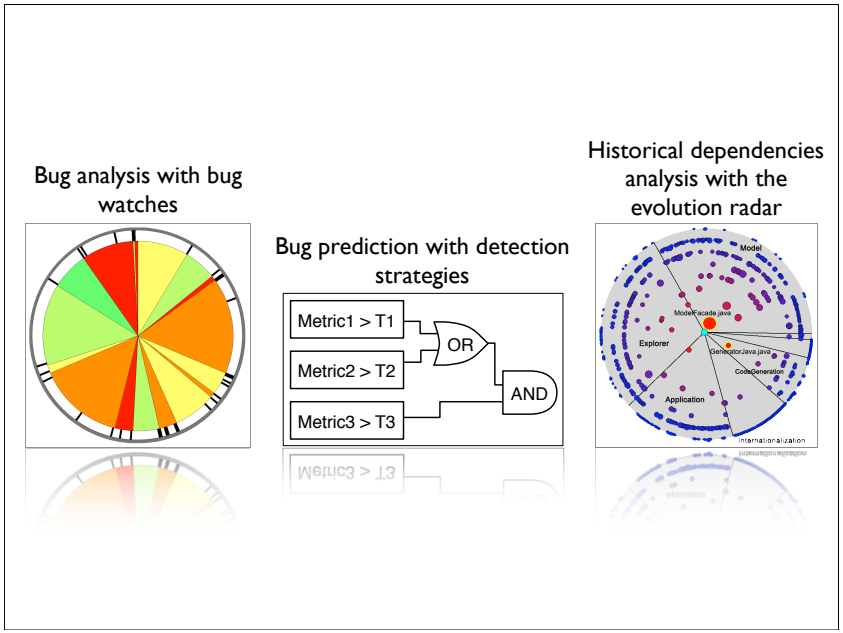
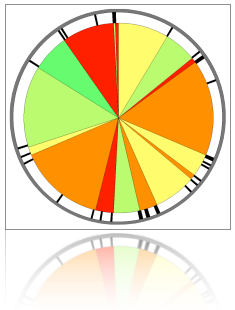

Bug analysis with bug watches
Bug prediction with detection strategies
Metric1 > T1
Metric2 > T2
Metric3 > T3
OR
AND
Historical dependencies analysis with the evolution radar

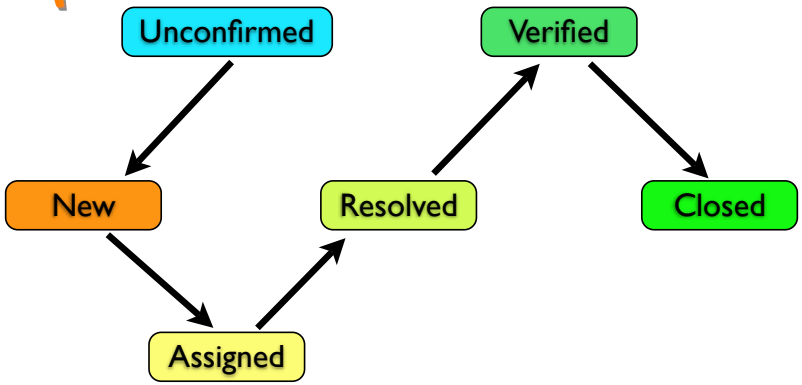
Bug analysis with bug watches



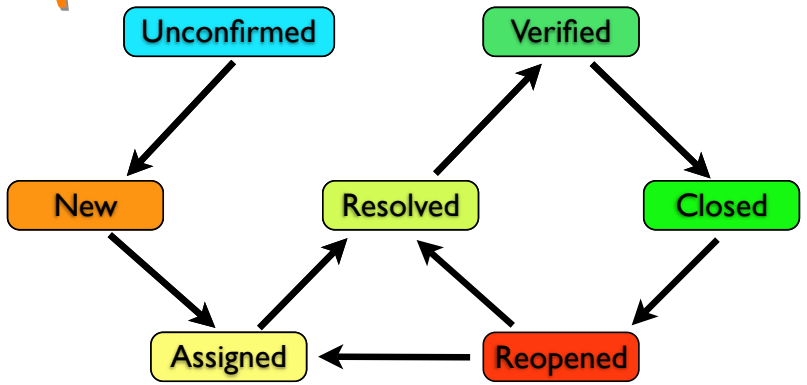
Bugs are complex entities which evolve

Unconfirmed

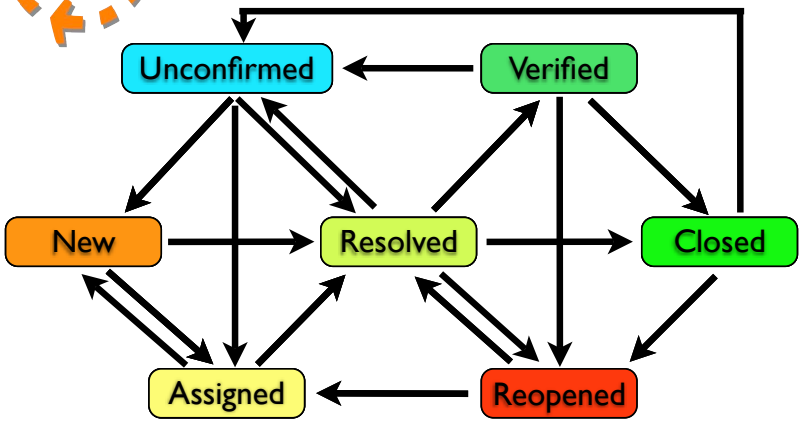
Bugs are complex entities which evolve



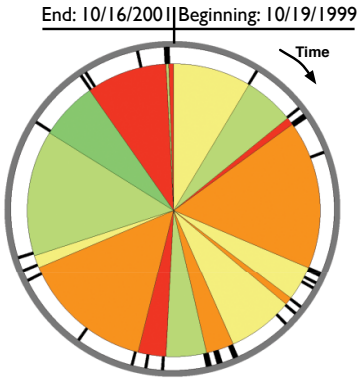
Bugs are complex entities which evolve



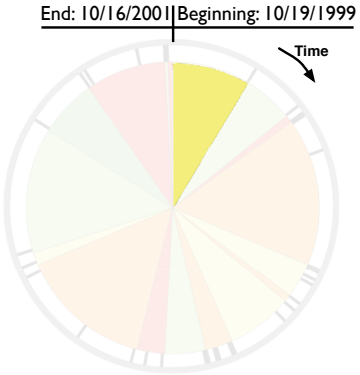
Bugs are complex entities which **evolve**



Bug watch visualization [VISSOFT '07]

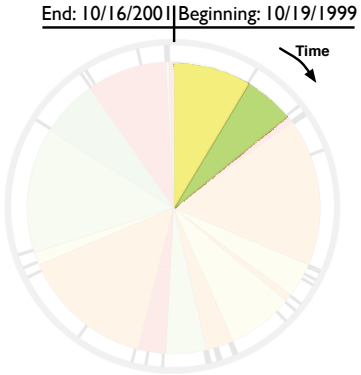


Bug watch visualization [VISSOFT '07]



Status	From	To
Assigned	10/19/99	12/21/99

Bug watch visualization [VISSOFT '07]



Status	From	To
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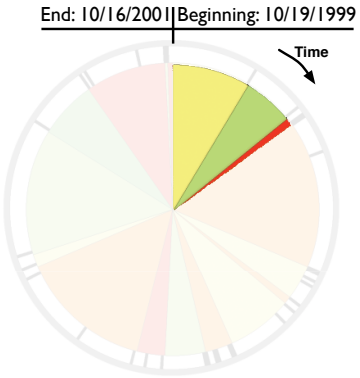
Resolved	12/21/99	1/31/00

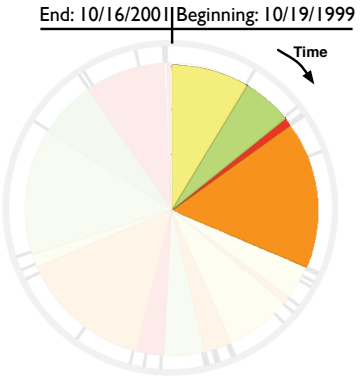
Bug watch visualization [VISSOFT '07]



Status	From	To
Assigned	10/19/99	12/21/99
Resolved	12/21/99	1/31/00
Reopened	1/31/00	2/6/00

Bug analysis Bug prediction Historical dependencies analysis

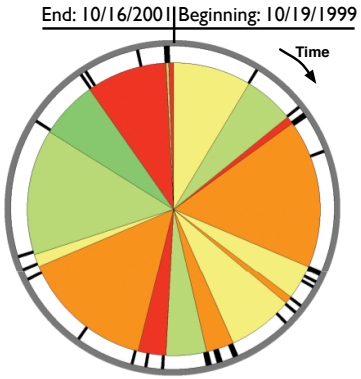
Bug watch visualization [VISSOFT '07]



Status	From	To
Assigned	10/19/99	12/21/99
Resolved	12/21/99	1/31/00
Reopened	1/31/00	2/6/00
New	2/6/00	6/5/00

Bug analysis Bug prediction Historical dependencies analysis

Bug watch visualization [VISSOFT '07]



Status	From	To
Assigned	10/19/99	12/21/99
Resolved	12/21/99	1/31/00
Reopened	1/31/00	2/6/00
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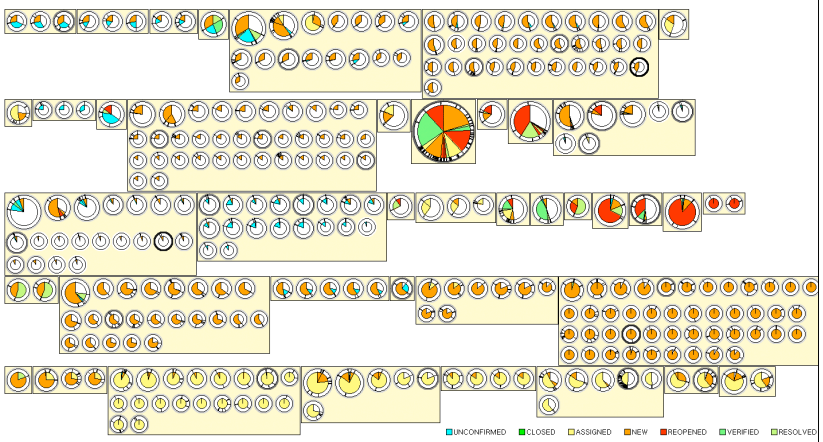
...	...	...

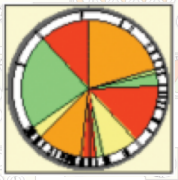
Bug analysis Bug prediction Historical dependencies analysis

Mozilla: Browser :: Networking [Nov '02- Apr '03]



Bug analysis Bug prediction Historical dependencies analysis

Mozilla: Browser :: Networking [Nov '02- Apr '03]

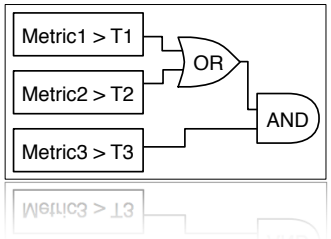


- Reopened 4 times
- Activities:
  - Developer in charge to fix it changed 6 times
  - Many people added in the CC

Bug analysis Bug prediction Historical dependencies analysis

Mozilla: Browser :: Networking [Nov '02- Apr '03]

Bug prediction with detection strategies

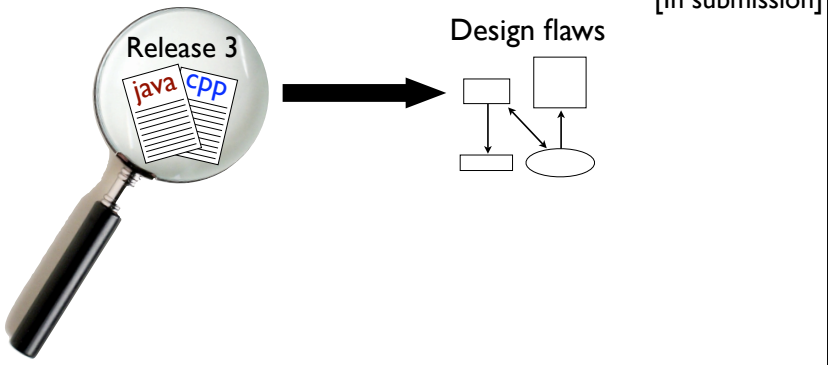


Bug analysis Bug prediction Historical dependencies analysis

[In submission]

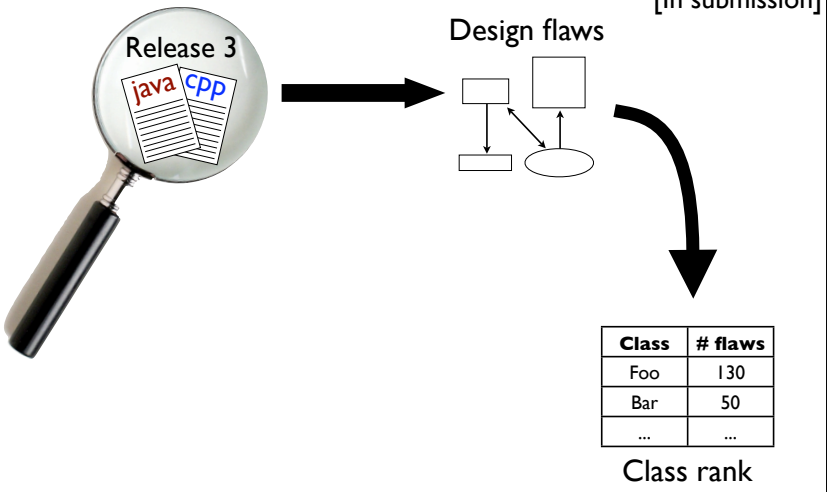
Bug analysis Bug prediction Historical dependencies analysis

[In submission]



Bug analysis Bug prediction Historical dependencies analysis

[In submission]

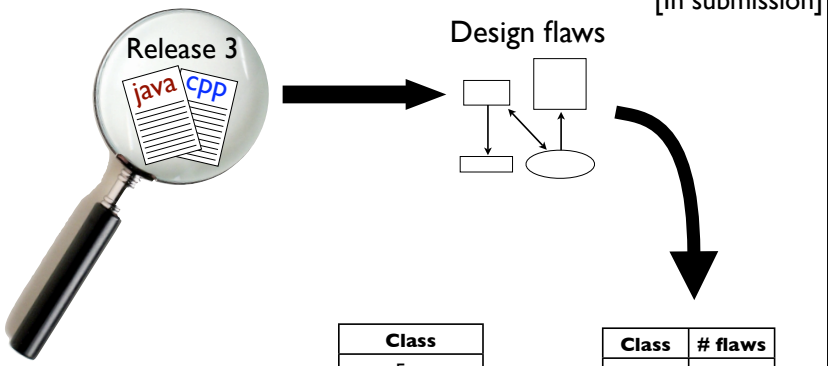


Class	# flaws
Foo	130
Bar	50
...	...

Class rank

Bug analysis Bug prediction Historical dependencies analysis

[In submission]



Class
Foo
Bar
...

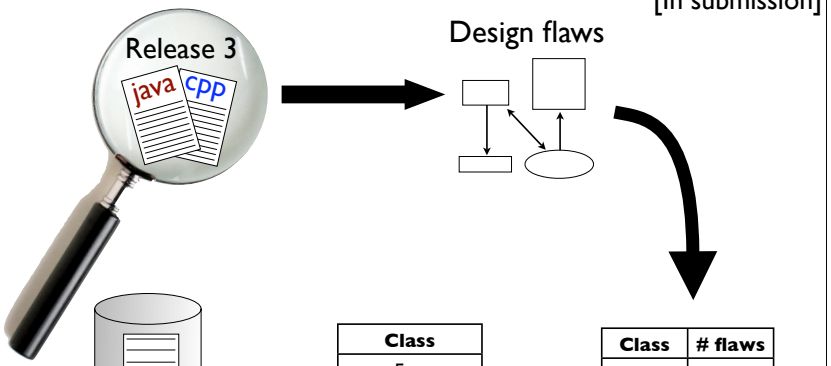
Bug prediction rank

Class	# flaws
Foo	130
Bar	50
...	...

Class rank

Bug analysis Bug prediction Historical dependencies analysis

[In submission]



Reported from release 3 to 4

Class
Foo
Bar
...

Bug prediction rank

Class	# flaws
Foo	130
Bar	50
...	...

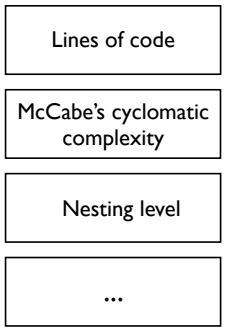
Class rank

Detection strategies [Lanza, Marinescu '06] are:

- formalized design flaws

Detection strategies [Lanza, Marinescu '06] are:

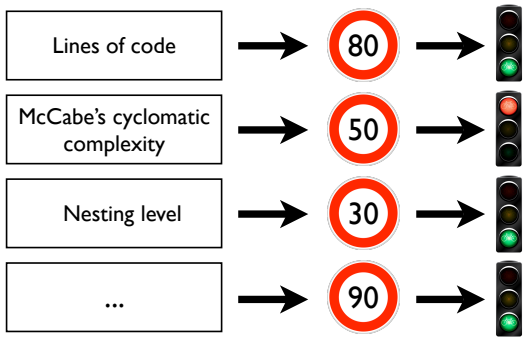
- formalized design flaws
- metrics-based



Metrics

Detection strategies [Lanza, Marinescu '06] are:

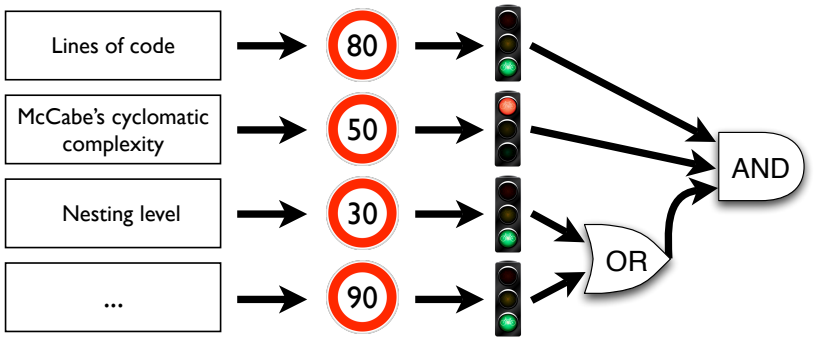
- formalized design flaws
- metrics-based



Metrics Thresholds

Detection strategies [Lanza, Marinescu '06] are:

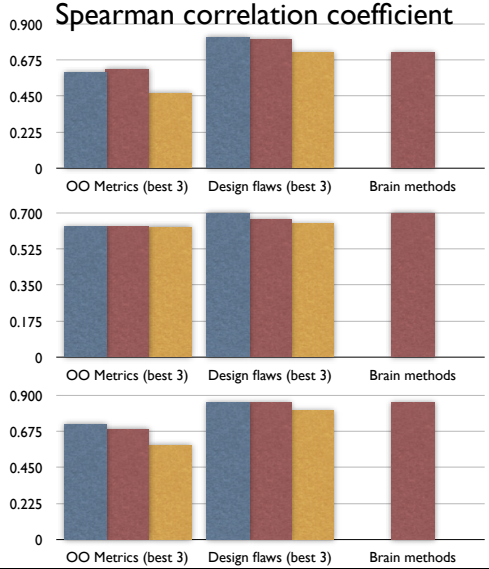
- formalized design flaws
- metrics-based composed logical conditions



Metrics Thresholds Logical conditions

Bug analysis Bug prediction Historical dependencies analysis

Spearman correlation coefficient



ArgoUML

Average for 7 releases
(7486 classes)

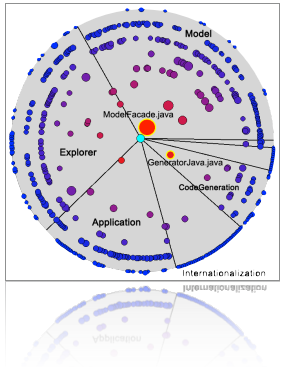
Eclipse
JDT Core

Average for 6 releases
(5881 classes)

AspectJ

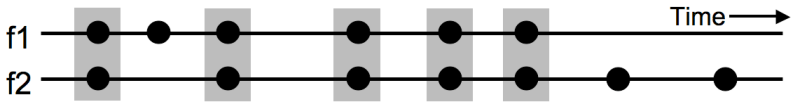
Average for 4 releases
(7732 classes)

Historical dependencies analysis
with the evolution radar



Bug analysis Bug prediction Historical dependencies analysis

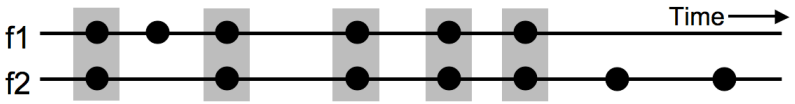
Change coupling* is ...



* [Ball et al. '97]
[Gall et al. '98]

Bug analysis Bug prediction Historical dependencies analysis

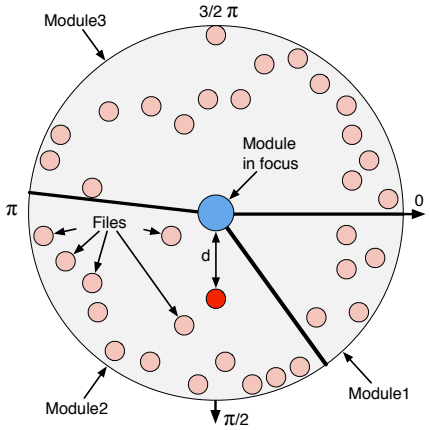
Change coupling* is ...

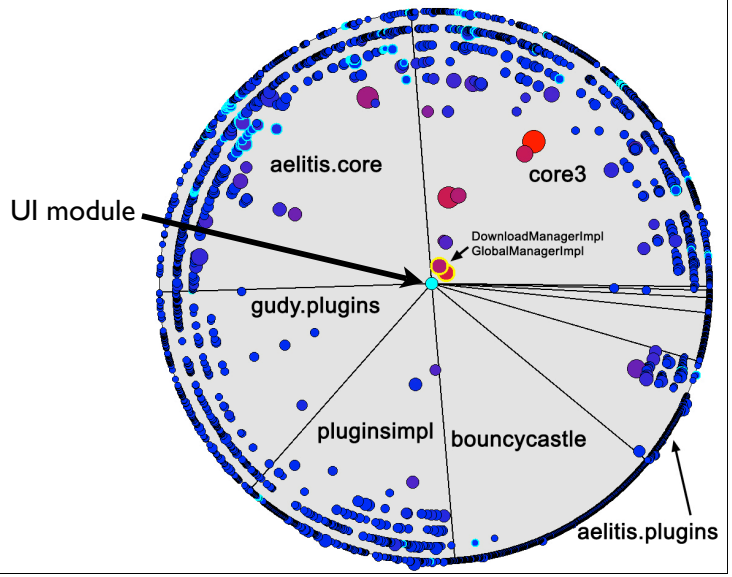


... an **implicit dependency** between artifacts
observed to change together

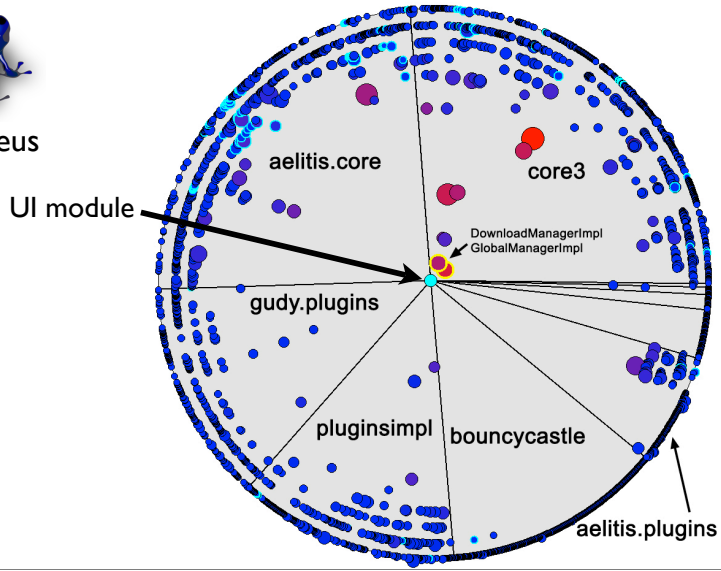
* [Ball et al. '97]
[Gall et al. '98]

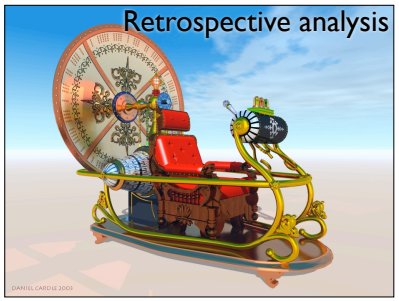
Visualizing **integrated** change coupling information



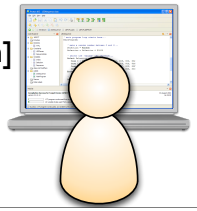


Azureus

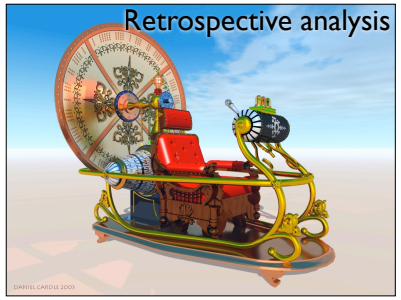


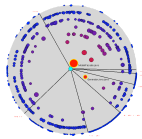


Supporting software maintenance [in submission]



Bug analysis Bug prediction Historical dependencies analysis





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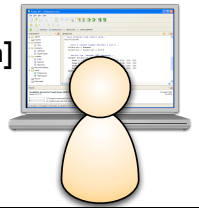

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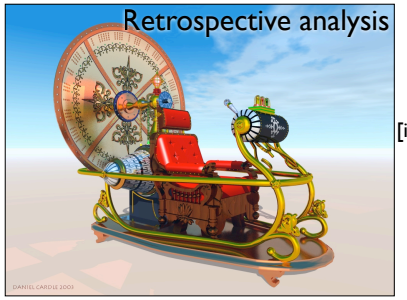
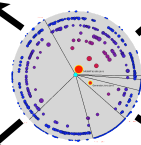


Azureus [in submission]



ArgoUML [WCRE '06]

Mozilla [MSR '06]

PostgreSQL [MSR Challenge '06]

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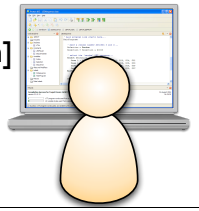

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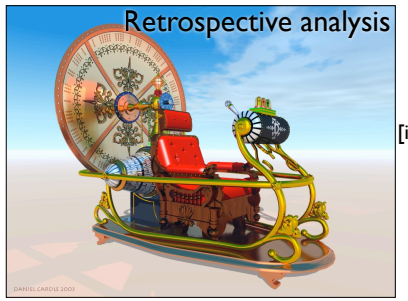

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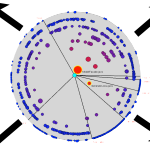

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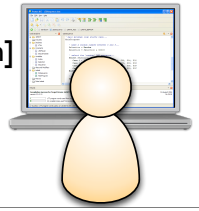
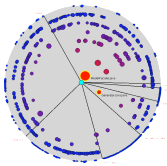
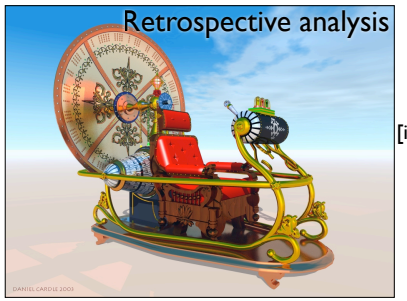




Bug analysis Bug prediction Historical dependencies analysis



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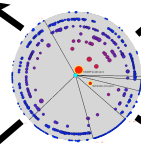

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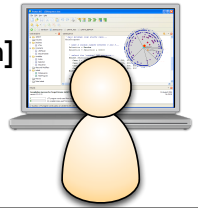
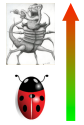
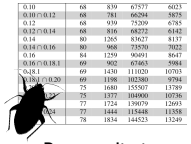




Bug analysis



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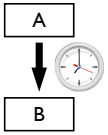
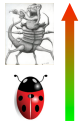


Historical dependencies analysis

Combining source code, bug reports, and change coupling analyses reveals problematic areas in evolving software systems



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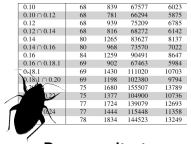

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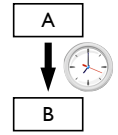

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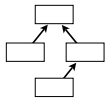
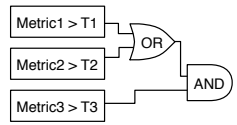
Contributions

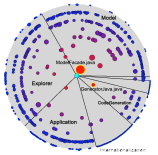
Bug watch visualization



Bug history meta-model



Bug prediction based on design flaws



Evolution Radar visualization

Bug analysis

Bug prediction

Historical dependencies analysis

Combining source code, bug reports, and change coupling analyses reveals problematic areas in evolving software systems

Future work

Bug analysis

Bug prediction

Historical dependencies analysis

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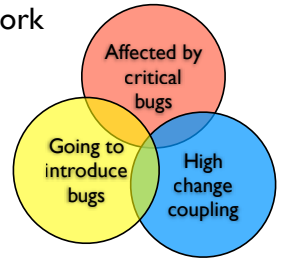
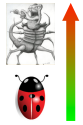
Future work

Combine bug and change coupling data





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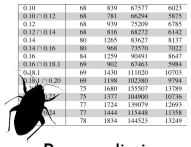

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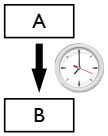

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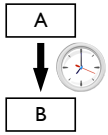
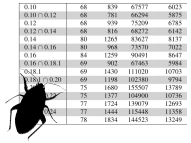
Future work

Combine bug and change coupling data

Does change coupling **correlate** with bugs?





Bug analysis

Bug prediction

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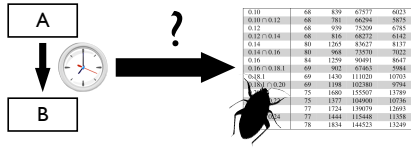

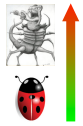

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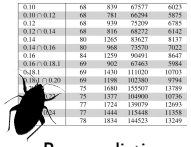

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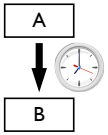

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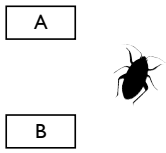
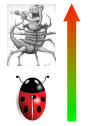
Explore bug-sharing dependencies





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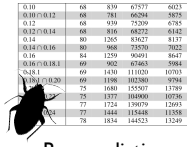

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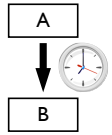

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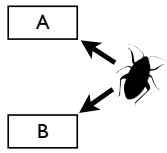

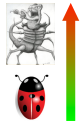

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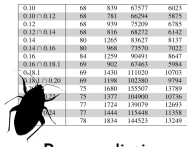

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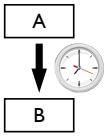

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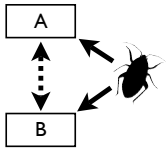
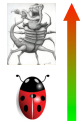
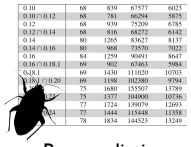
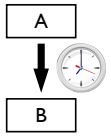




Bug analysis



Bug prediction



Historical dependencies analysis

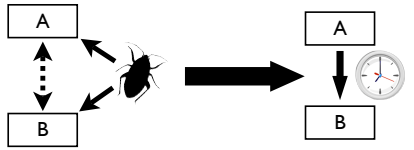
Combining source code, bug reports, and change coupling analyses reveals problematic areas in evolving software systems

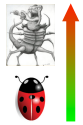
Future work

Combine bug and change coupling data

Does change coupling **correlate** with bugs?

Explore bug-sharing dependencies





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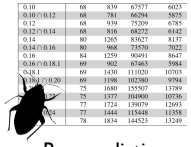

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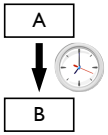

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