

Empirical Study of Crash-inducing Commits in Mozilla Firefox

Le An and Foutse Khomh
Polytechnique Montréal

21 October, Beijing, China



POLYTECHNIQUE
MONTRÉAL

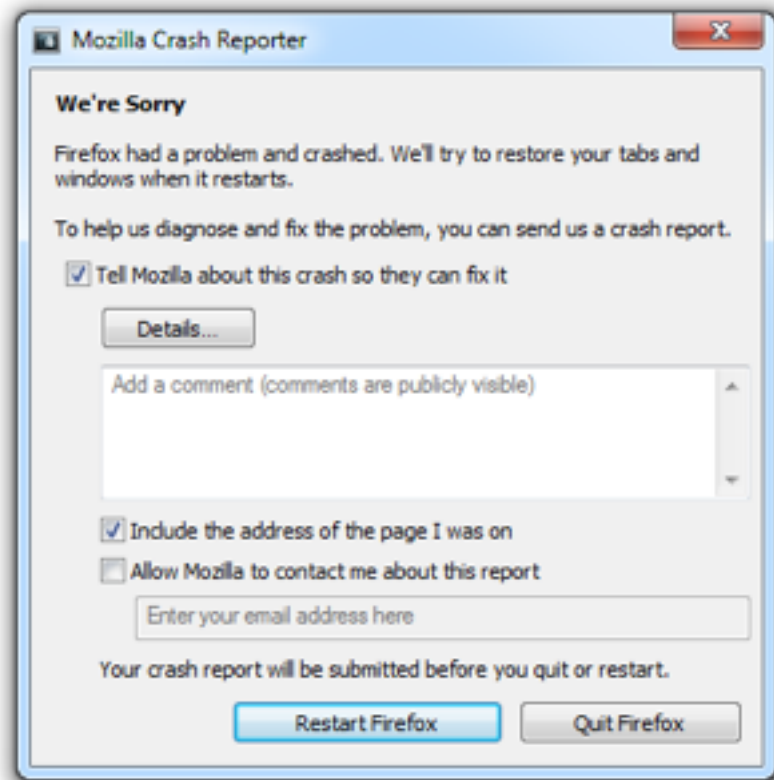
WORLD-CLASS
ENGINEERING



Outline

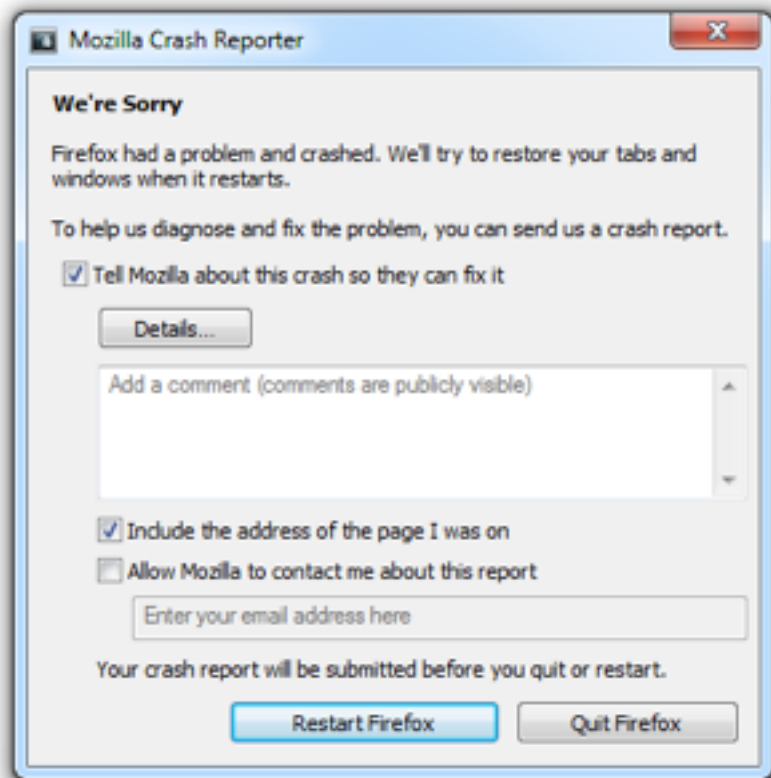
- Background (Mozilla crash collecting system)
- Challenge
- Research questions
- Study design
- Case study results
- Future work
- Conclusion

Crash Collecting System

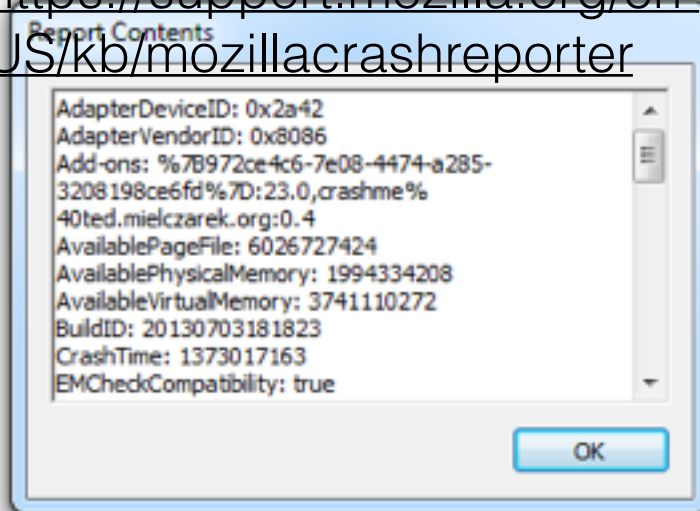


<https://support.mozilla.org/en-US/kb/mozillacrashreporter>

Crash Collecting System

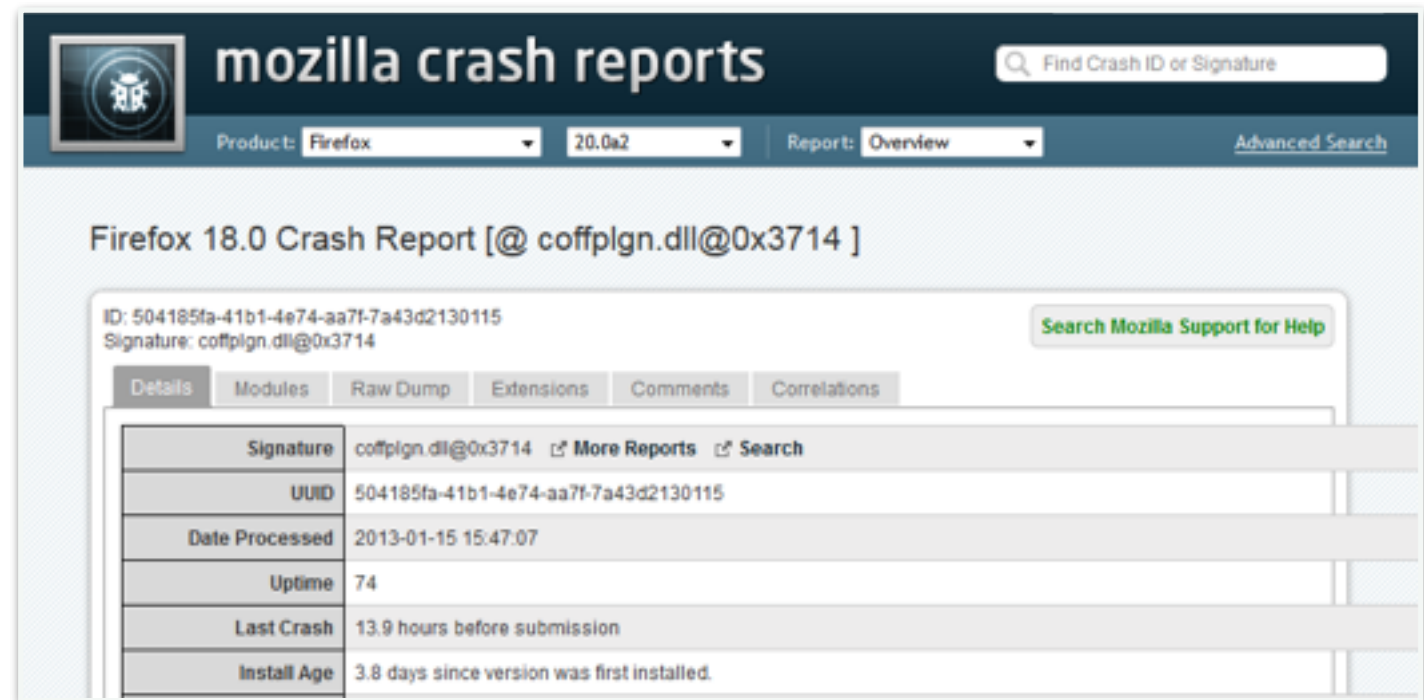
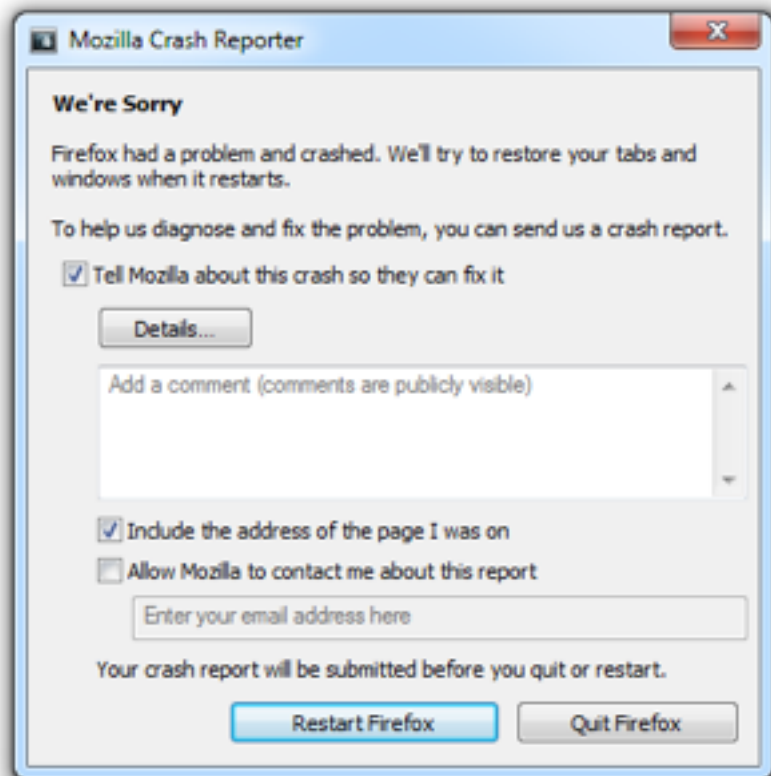


<https://support.mozilla.org/en-US/kb/mozillacrashreporter>

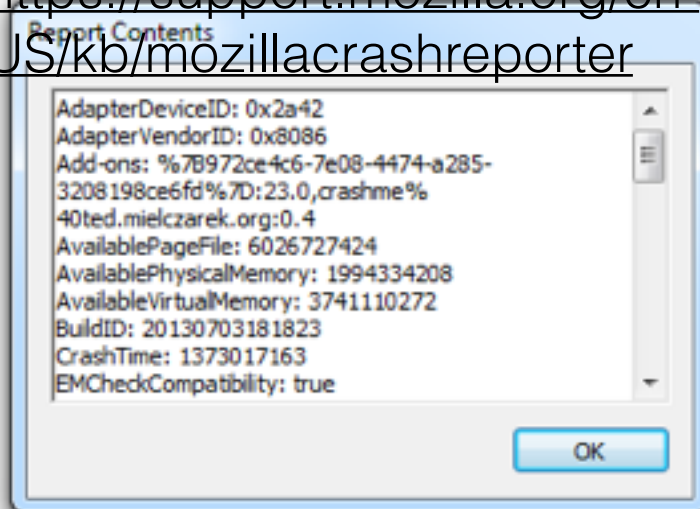


Crash Collecting System

Socorro

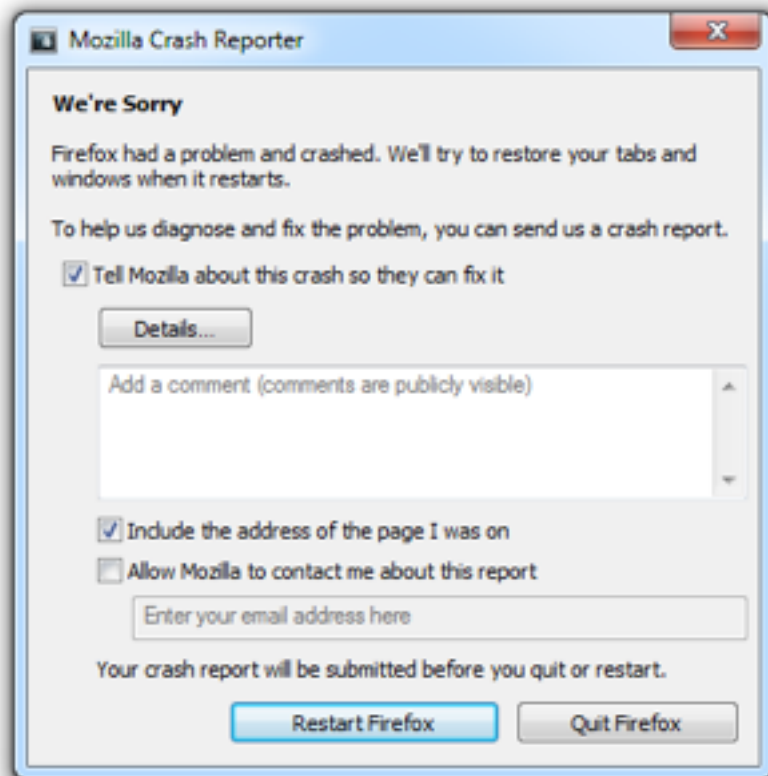


<https://support.mozilla.org/en-US/kb/mozillacrashreporter>



Crash Collecting System

Socorro



Mozilla Crash Reporter

We're Sorry

Firefox had a problem and crashed. We'll try to restore your tabs and windows when it restarts.

To help us diagnose and fix the problem, you can send us a crash report.

☒ Tell Mozilla about this crash so they can fix it

[Details...](#)

Add a comment (comments are publicly visible)

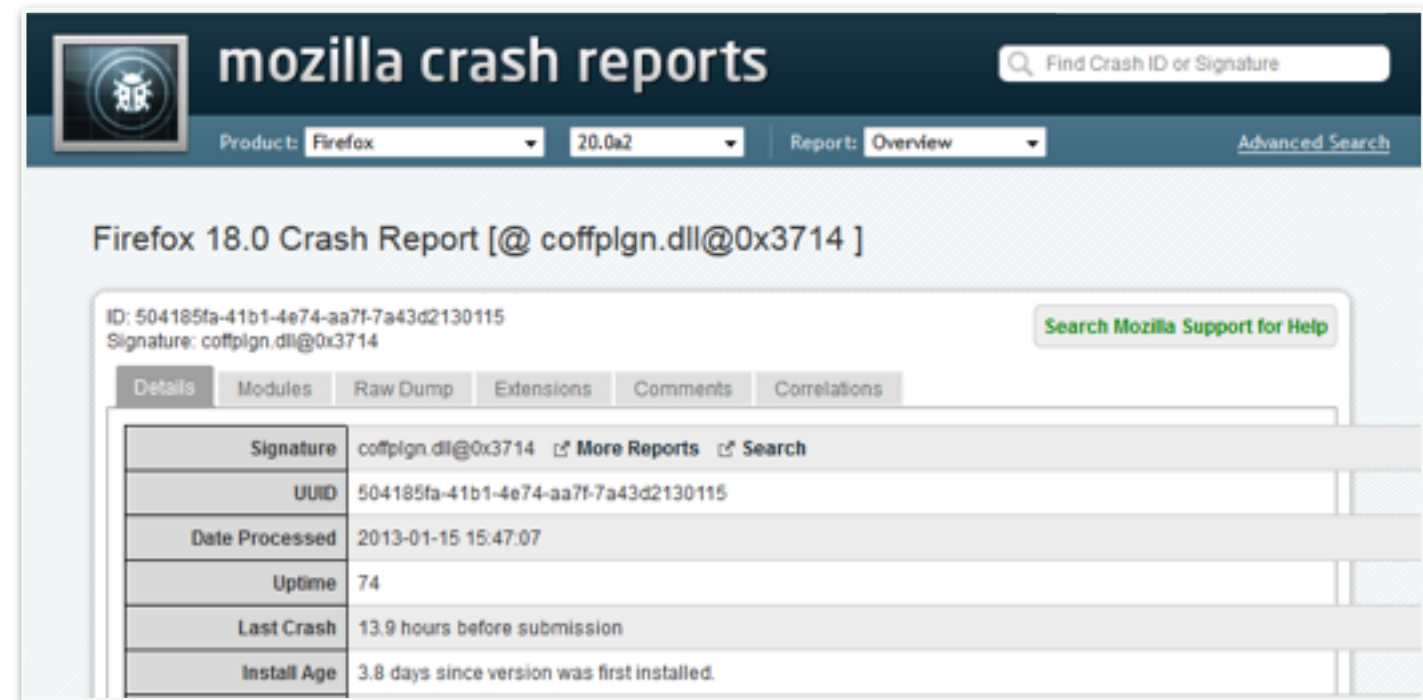
☒ Include the address of the page I was on

☐ Allow Mozilla to contact me about this report

Enter your email address here

Your crash report will be submitted before you quit or restart.

[Restart Firefox](#) [Quit Firefox](#)



mozilla crash reports

Find Crash ID or Signature

Product: **Firefox** 20.0a2 Report: **Overview** [Advanced Search](#)

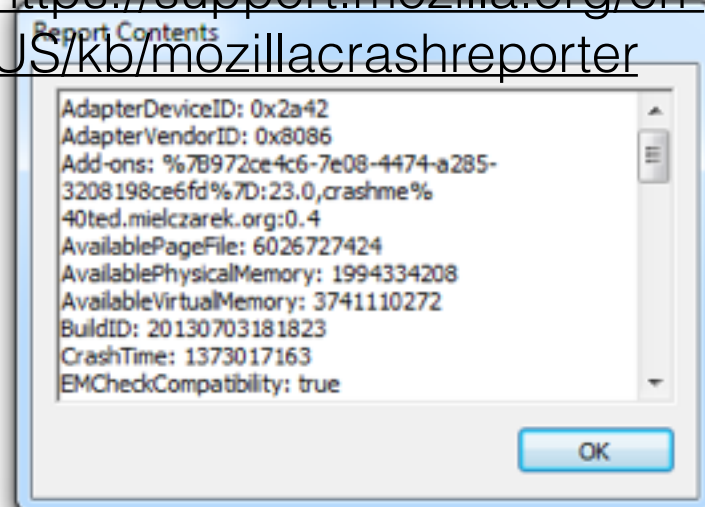
Firefox 18.0 Crash Report [@ coffplgn.dll@0x3714]

ID: 504185fa-41b1-4e74-aa7f-7a43d2130115
Signature: coffplgn.dll@0x3714 [Search Mozilla Support for Help](#)

[Details](#) [Modules](#) [Raw Dump](#) [Extensions](#) [Comments](#) [Correlations](#)

Signature	coffplgn.dll@0x3714 More Reports Search
UUID	504185fa-41b1-4e74-aa7f-7a43d2130115
Date Processed	2013-01-15 15:47:07
Uptime	74
Last Crash	13.9 hours before submission
Install Age	3.8 days since version was first installed.

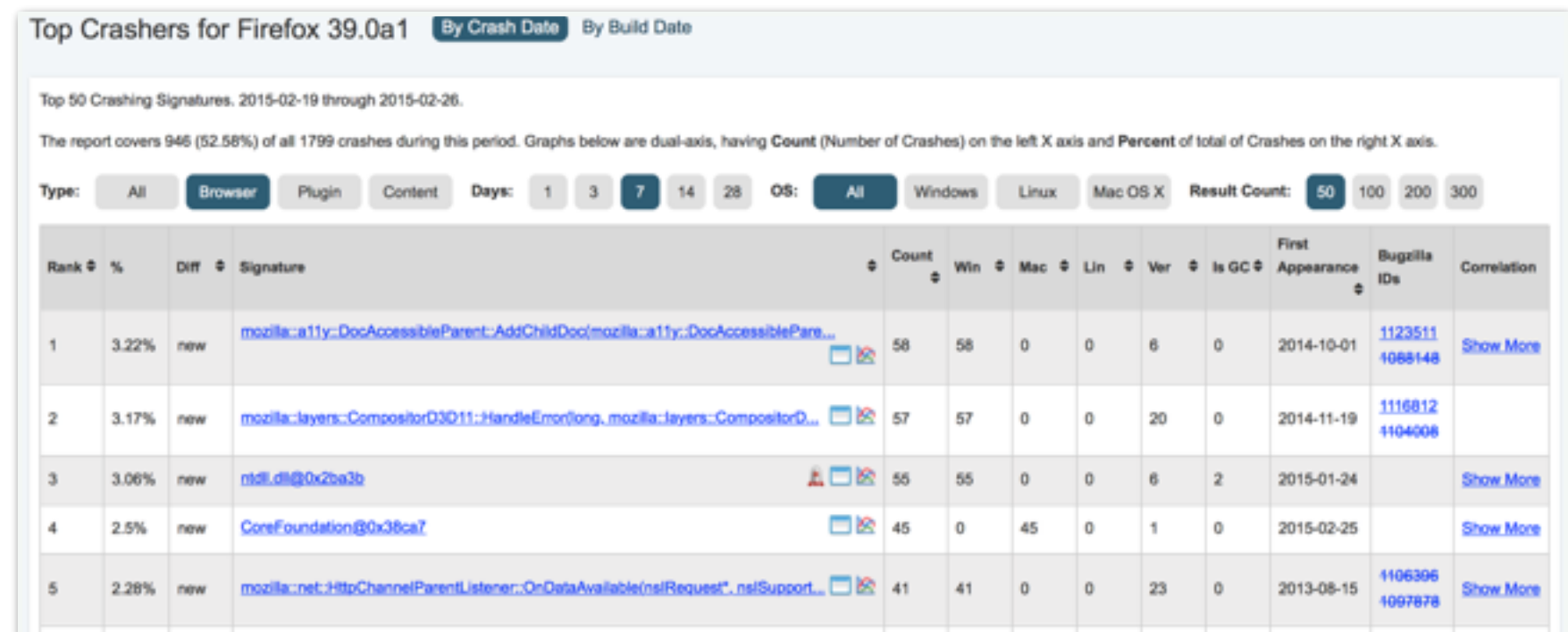
<https://support.mozilla.org/en-US/kb/mozillacrashreporter>



Report Contents

AdapterDeviceID: 0x2a42
AdapterVendorID: 0x8086
Add-ons: %7B972ce4c6-7e08-4474-a285-3208198ce6fd%7D:23.0,crashme%40ted.mielczarek.org:0.4
AvailablePageFile: 6026727424
AvailablePhysicalMemory: 1994334208
AvailableVirtualMemory: 3741110272
BuildID: 20130703181823
CrashTime: 1373017163
EMCheckCompatibility: true

[OK](#)



Top Crashers for Firefox 39.0a1 [By Crash Date](#) [By Build Date](#)

Top 50 Crashing Signatures, 2015-02-19 through 2015-02-26.

The report covers 946 (52.58%) of all 1799 crashes during this period. Graphs below are dual-axis, having Count (Number of Crashes) on the left X axis and Percent of total of Crashes on the right X axis.

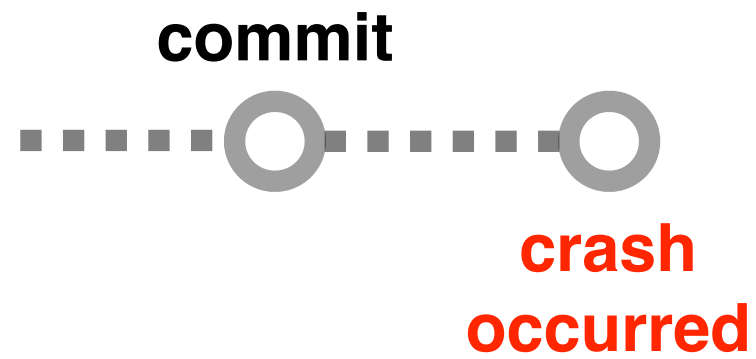
Type: [All](#) [Browser](#) [Plugin](#) [Content](#) Days: [1](#) [3](#) [7](#) [14](#) [28](#) OS: [All](#) [Windows](#) [Linux](#) [Mac OS X](#) Result Count: [50](#) [100](#) [200](#) [300](#)

Rank	%	Diff	Signature	Count	Win	Mac	Lin	Ver	Is GC	First Appearance	Bugzilla IDs	Correlation
1	3.22%	new	mozilla::a11y::DocAccessibleParent::AddChildDoc(mozilla::a11y::DocAccessiblePare...	58	58	0	0	6	0	2014-10-01	1123511 1088148	Show More
2	3.17%	new	mozilla::layers::CompositorO3D11::HandleError(long, mozilla::layers::CompositorD...	57	57	0	0	20	0	2014-11-19	1116812 1104908	
3	3.06%	new	ntdll.dll@0x2ba3b	55	55	0	0	6	2	2015-01-24		Show More
4	2.5%	new	CoreFoundation@0x38ca7	45	0	45	0	1	0	2015-02-25		Show More
5	2.28%	new	mozilla::net::HttpChannelParentListener::OnDataAvailable(nsIRequest*, nsISupport...	41	41	0	0	23	0	2013-08-15	1106396 1097878	Show More

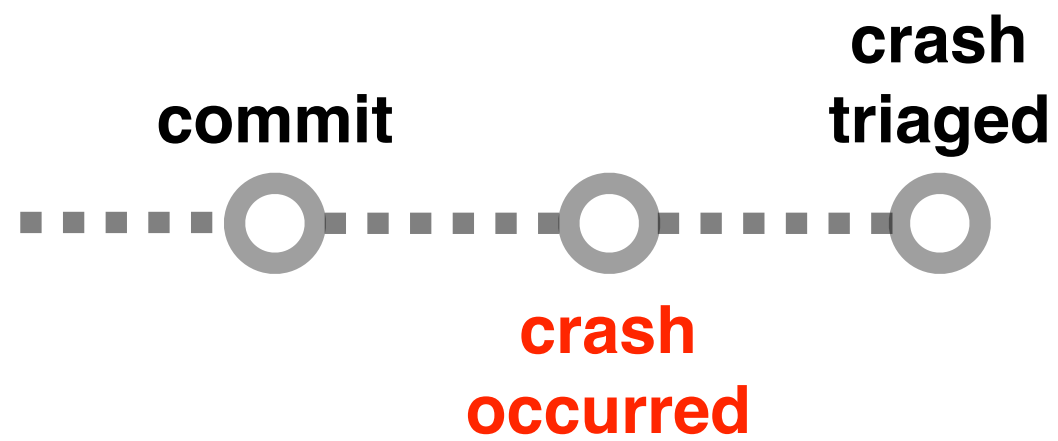
Challenge



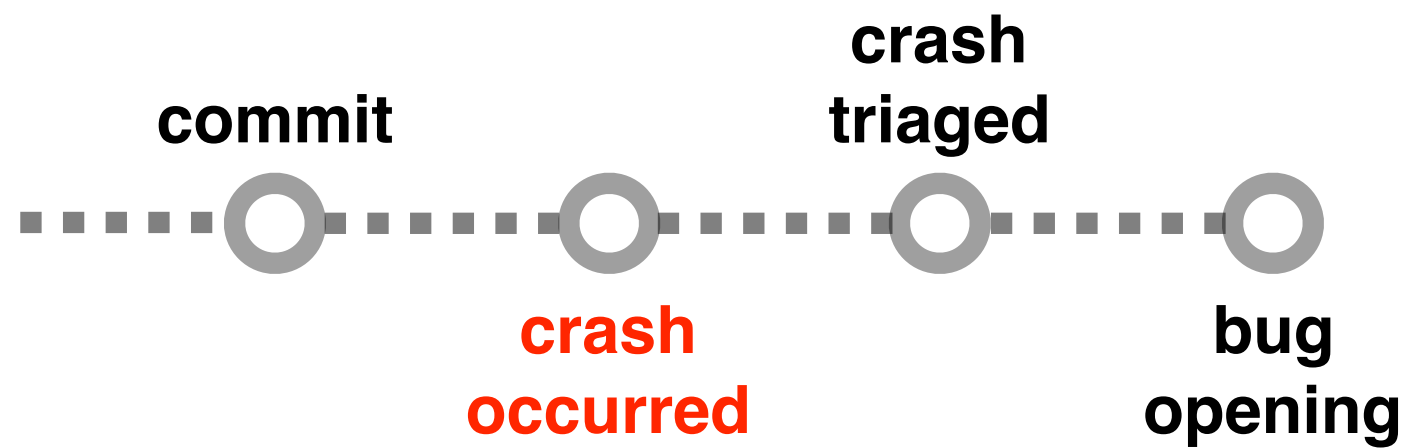
Challenge



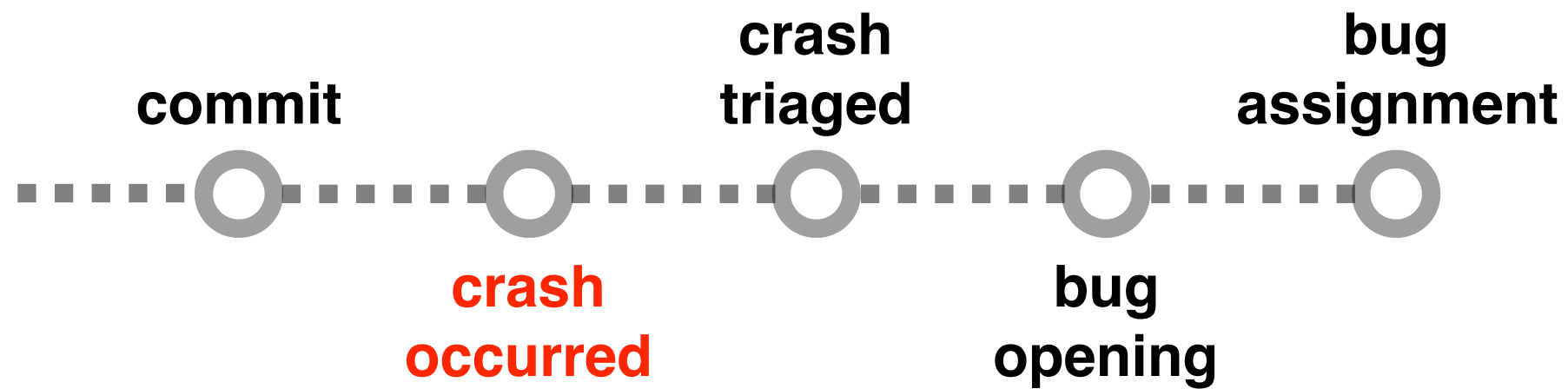
Challenge



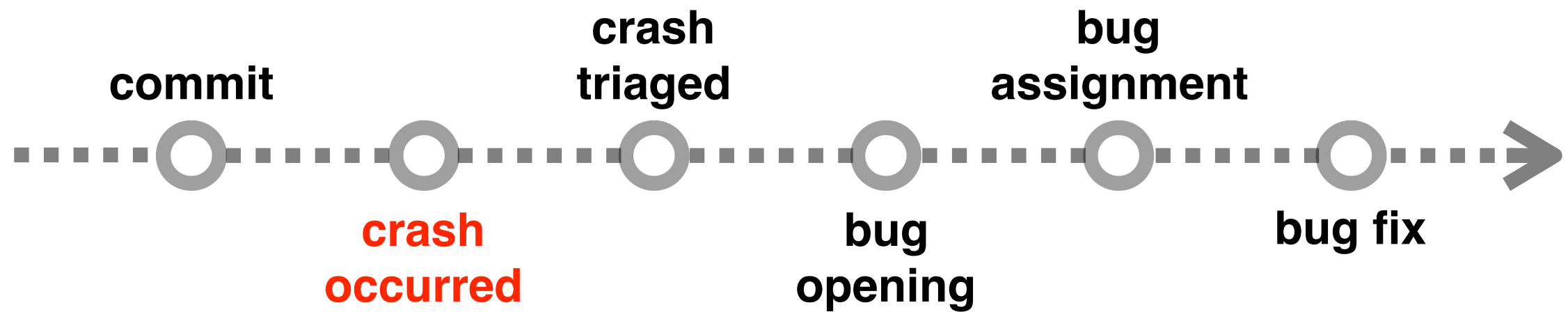
Challenge



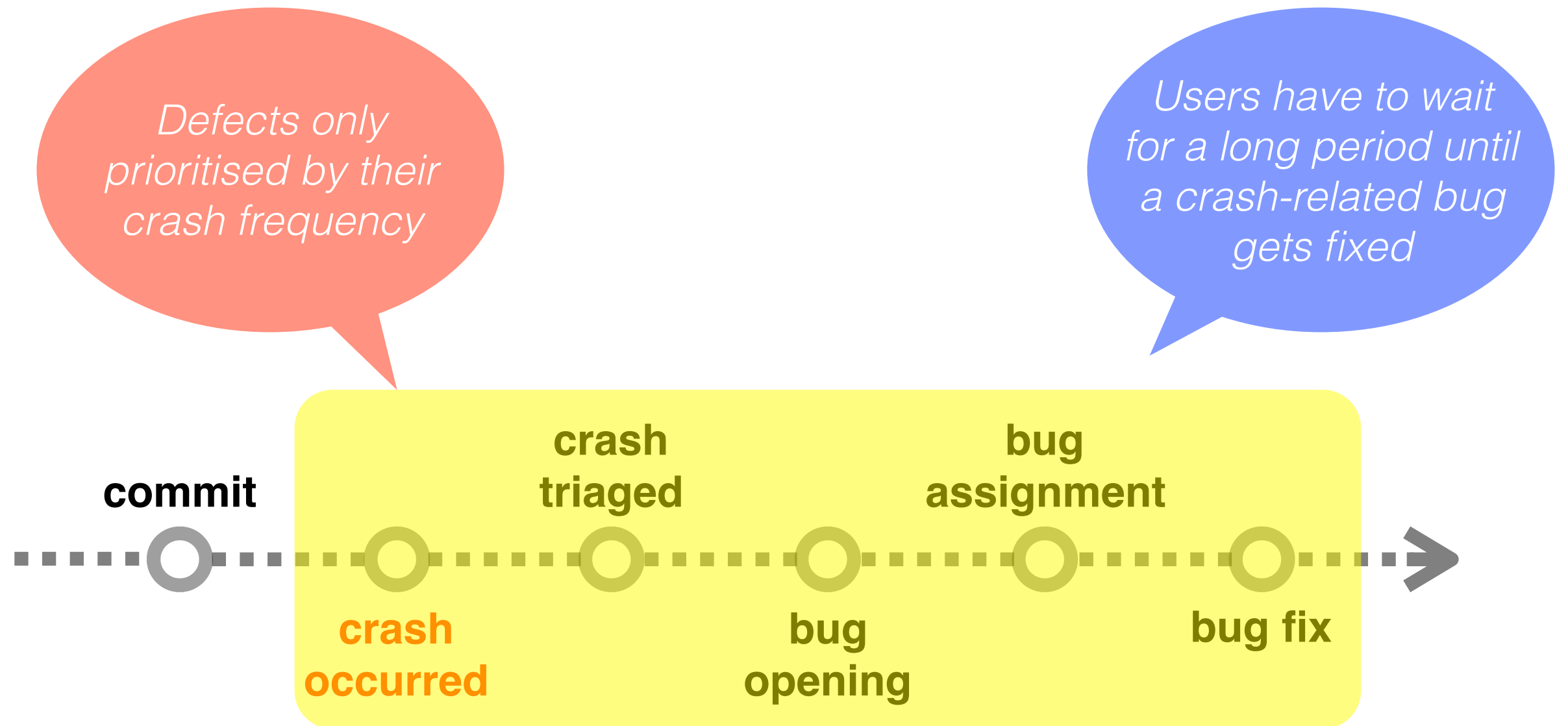
Challenge



Challenge

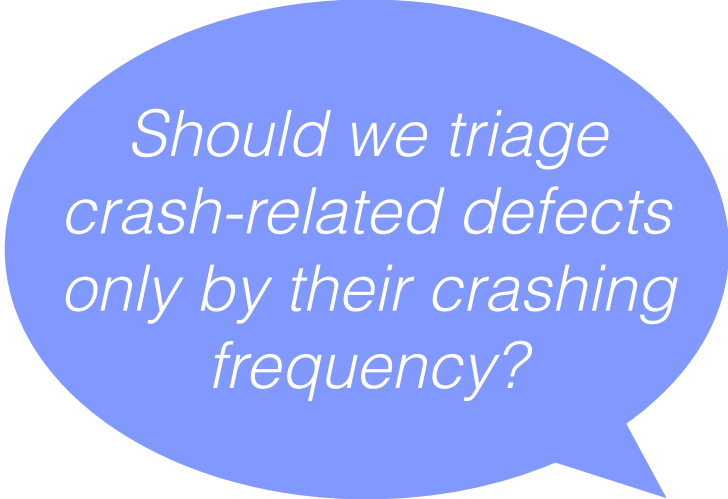


Challenge



Related Work

Foutse Khomh, Brian Chan, Ying Zou, Ahmed E. Hassan, **An Entropy Evaluation Approach for Triageing Field Crashes**, Proceedings of the 18th Working Conference on Reverse Engineering (WCRE)



*Should we triage
crash-related defects
only by their crashing
frequency?*

Related Work

Foutse Khomh, Brian Chan, Ying Zou, Ahmed E. Hassan, **An Entropy Evaluation Approach for Triaging Field Crashes**, Proceedings of the 18th Working Conference on Reverse Engineering (WCRE)

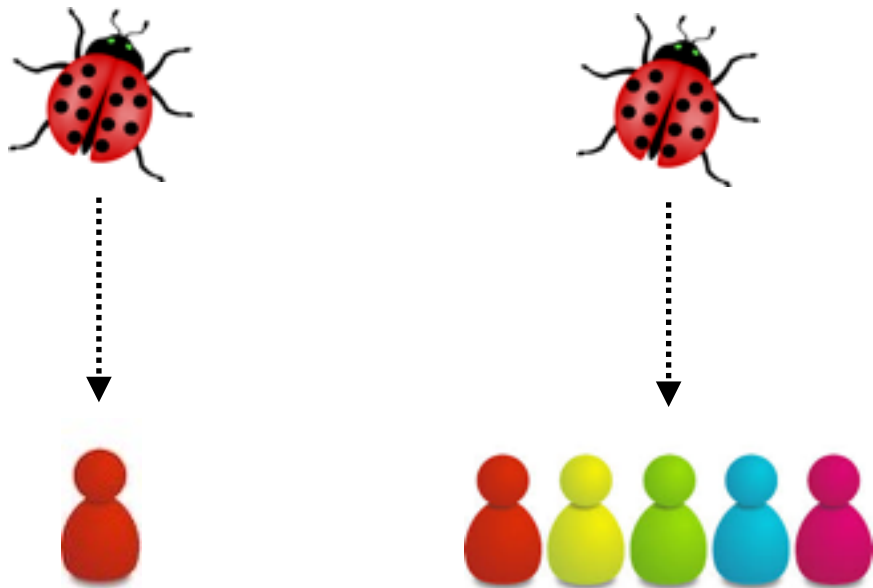
*Should we triage
crash-related defects
only by their crashing
frequency?*



Related Work

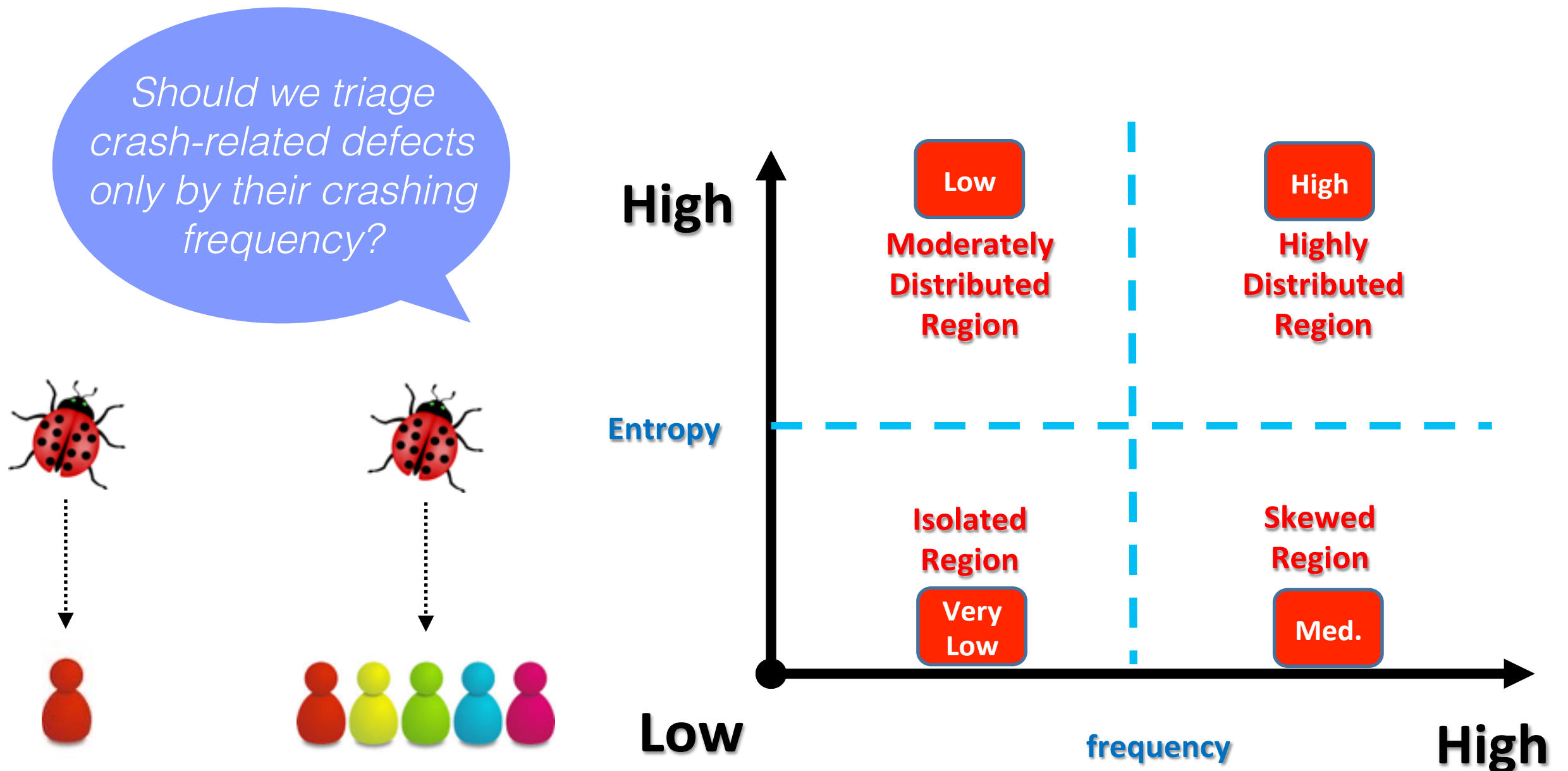
Foutse Khomh, Brian Chan, Ying Zou, Ahmed E. Hassan, **An Entropy Evaluation Approach for Triageing Field Crashes**, Proceedings of the 18th Working Conference on Reverse Engineering (WCRE)

Should we triage crash-related defects only by their crashing frequency?



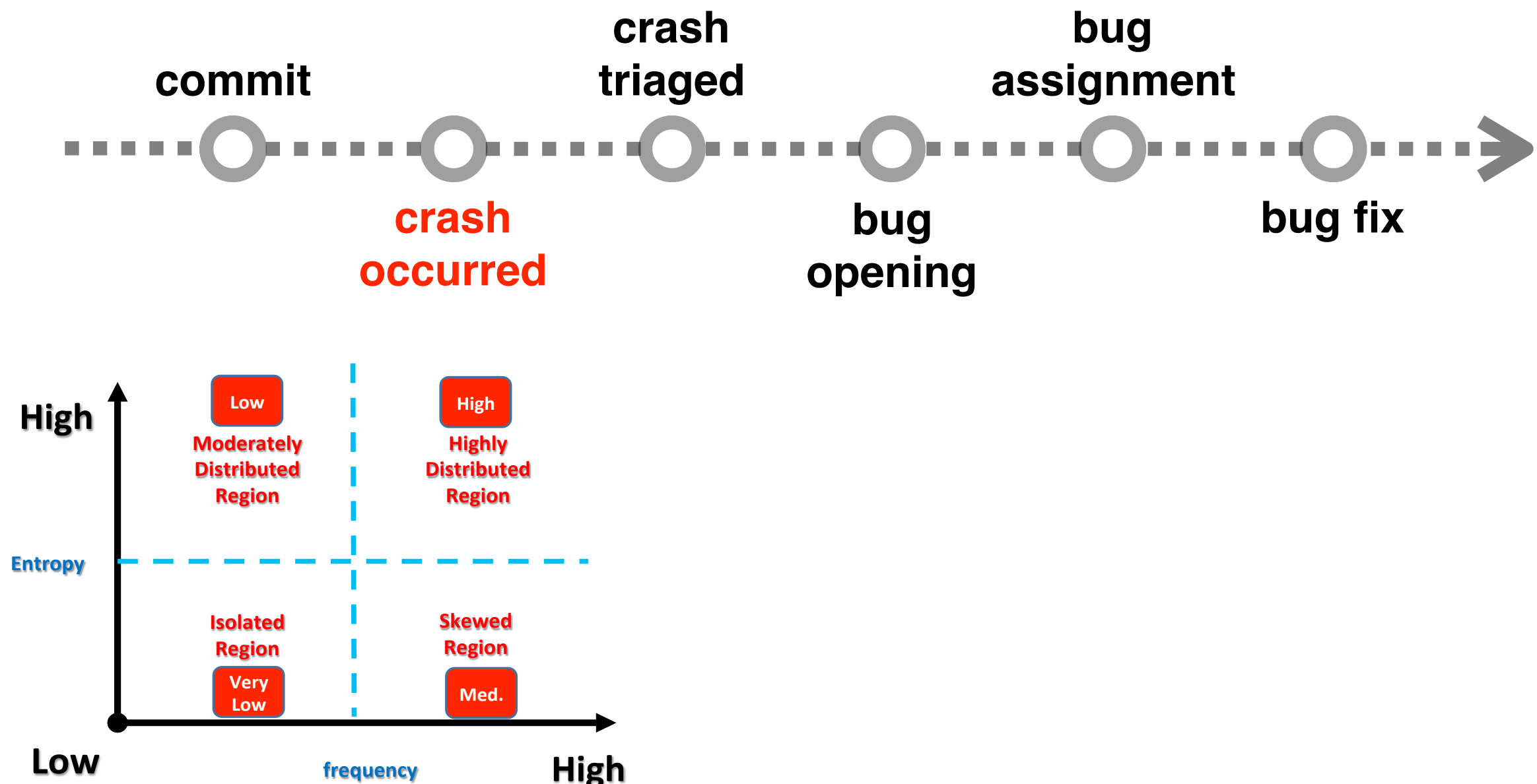
Related Work

Foutse Khomh, Brian Chan, Ying Zou, Ahmed E. Hassan, **An Entropy Evaluation Approach for Triageing Field Crashes**, Proceedings of the 18th Working Conference on Reverse Engineering (WCRE)



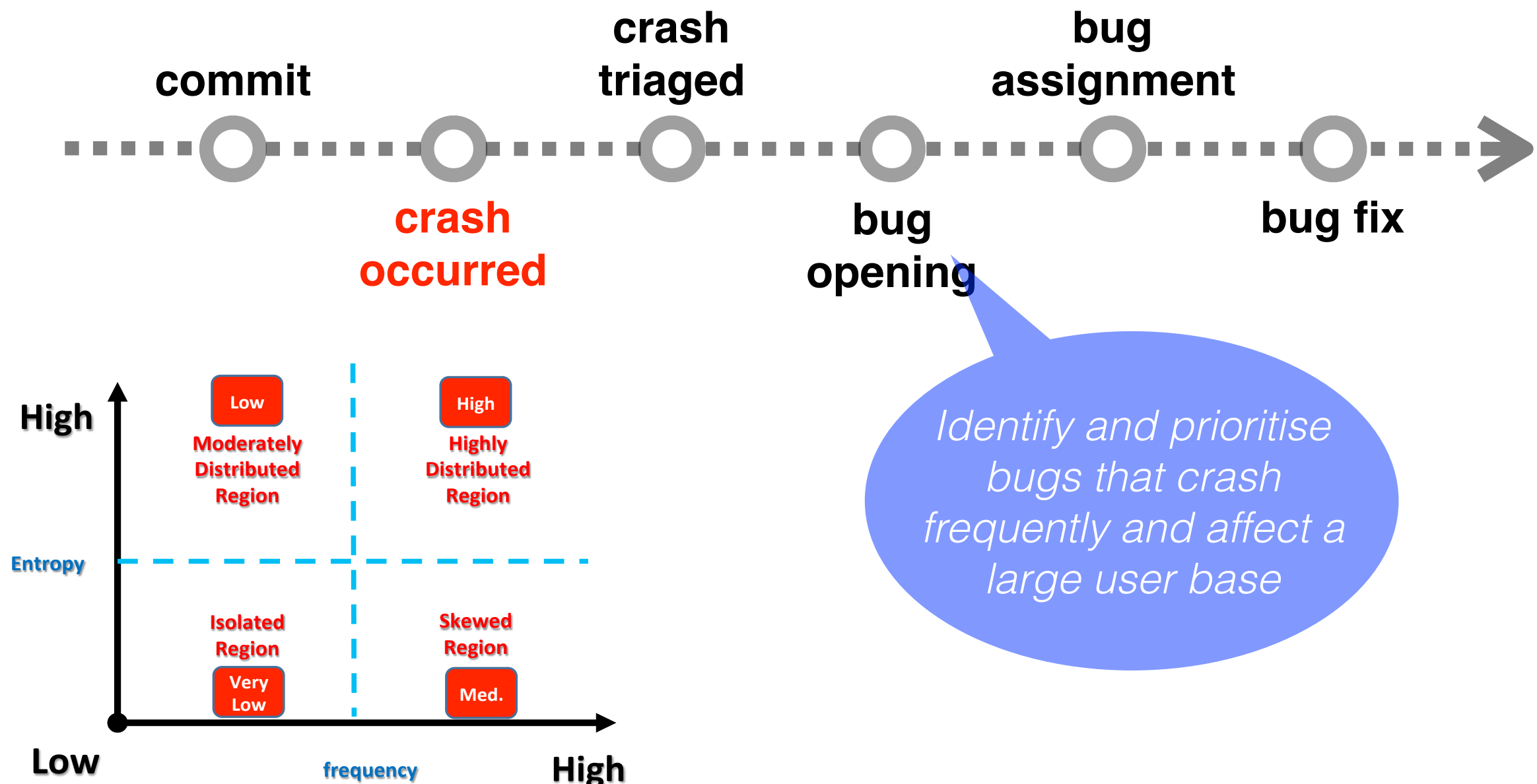
Related Work

Le An and Foutse Khomh, **An Empirical Study of Highly-impactful Bugs in Mozilla Projects**, Proceedings of the 2015 IEEE International Conference on Software Quality, Reliability and Security (QRS)



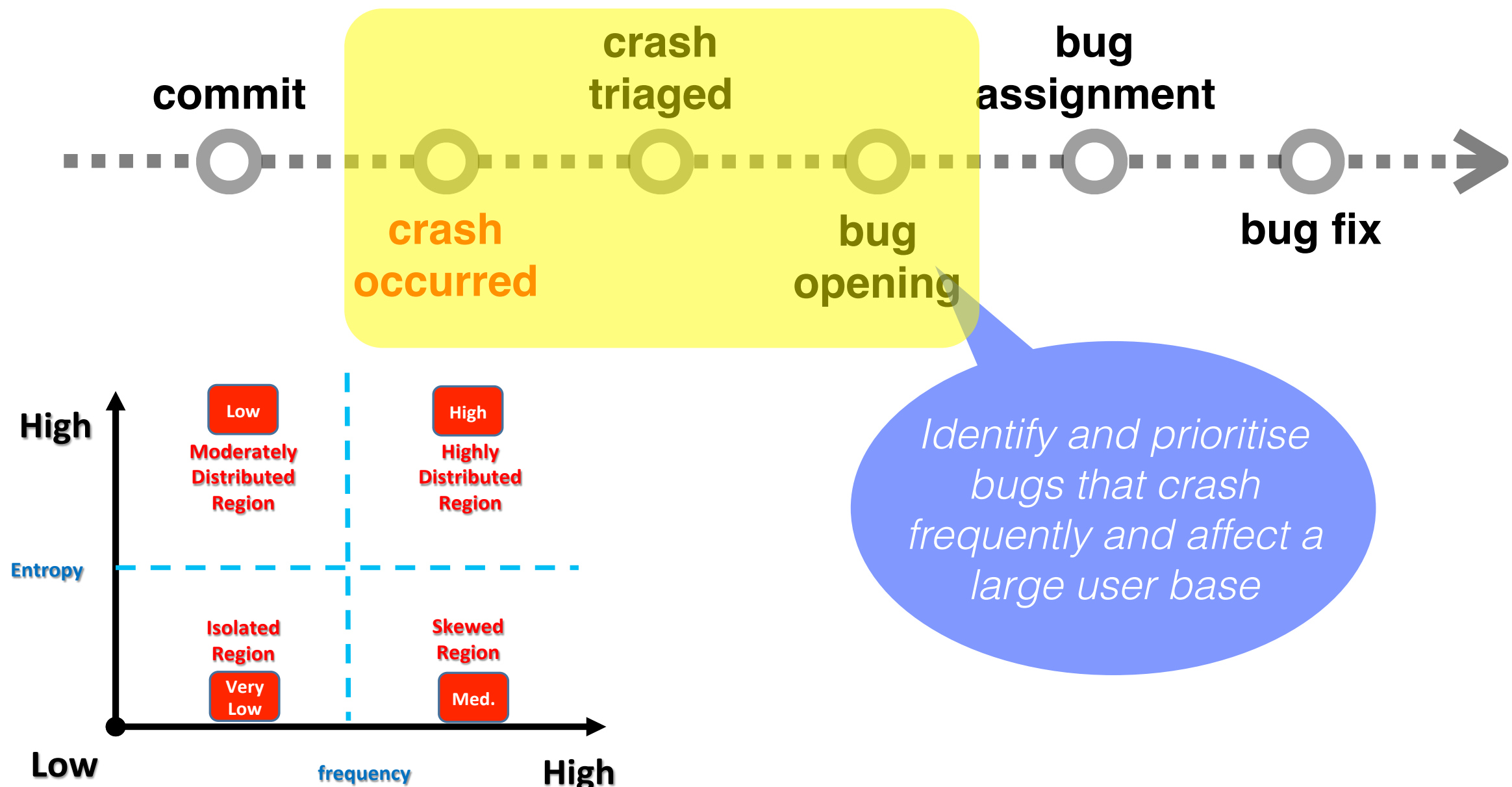
Related Work

Le An and Foutse Khomh, **An Empirical Study of Highly-impactful Bugs in Mozilla Projects**, Proceedings of the 2015 IEEE International Conference on Software Quality, Reliability and Security (QRS)



Related Work

Le An and Foutse Khomh, **An Empirical Study of Highly-impactful Bugs in Mozilla Projects**, Proceedings of the 2015 IEEE International Conference on Software Quality, Reliability and Security (QRS)



Research Questions?



What is the percentage of crash-inducing commits?



What are the characteristics of crash-inducing commits?



How well could we predict crash-inducing commits?

Study Design

Subject System



Mozilla Firefox

Identifying Crash-inducing Commits

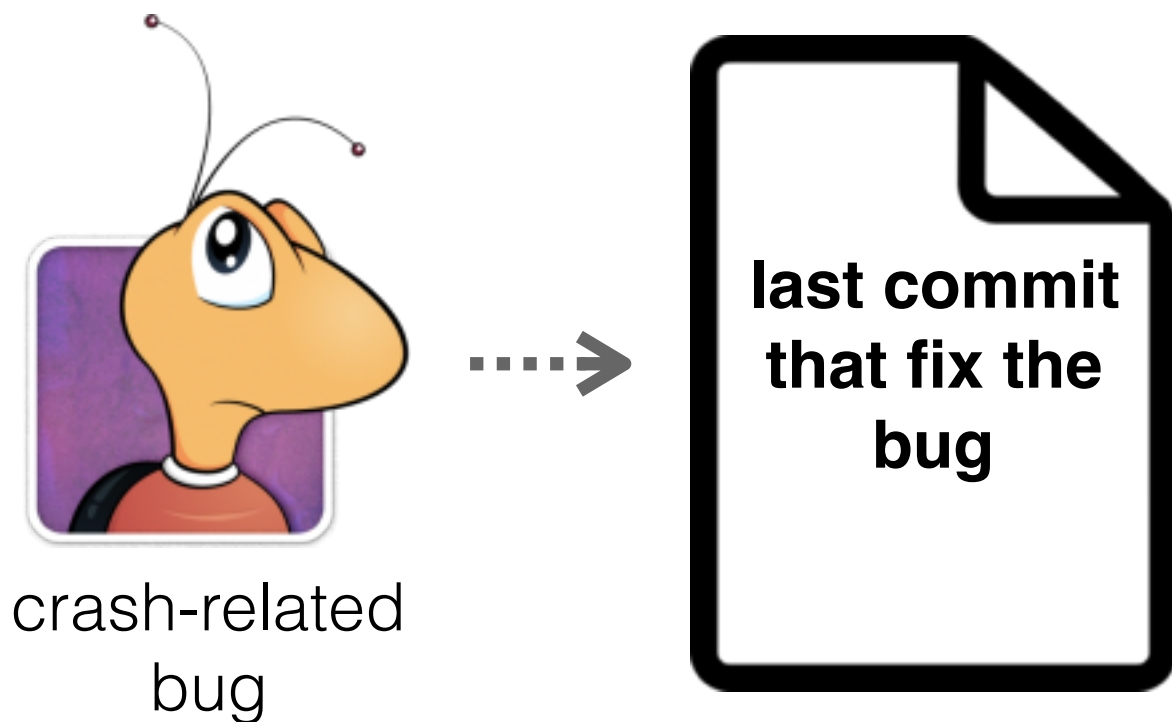
J. **S**liwerski, T. **Z**immermann, and A. **Z**eller. **When do changes induce fixes?**
In ACM sigsoft software engineering notes (SZZ algorithm)



crash-related
bug

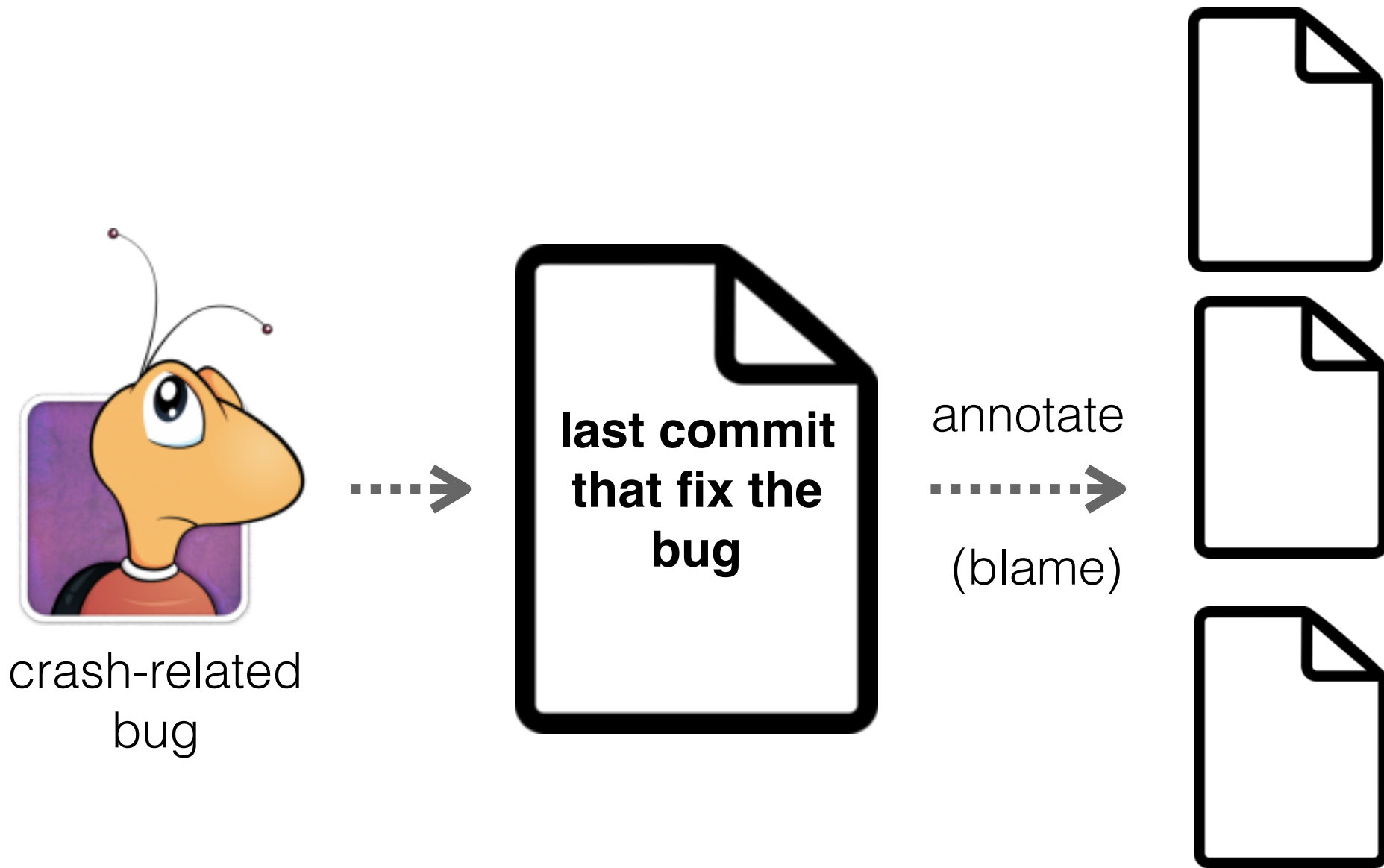
Identifying Crash-inducing Commits

J. **S**liwerski, T. **Z**immermann, and A. **Z**eller. **When do changes induce fixes?**
In ACM sigsoft software engineering notes (SZZ algorithm)



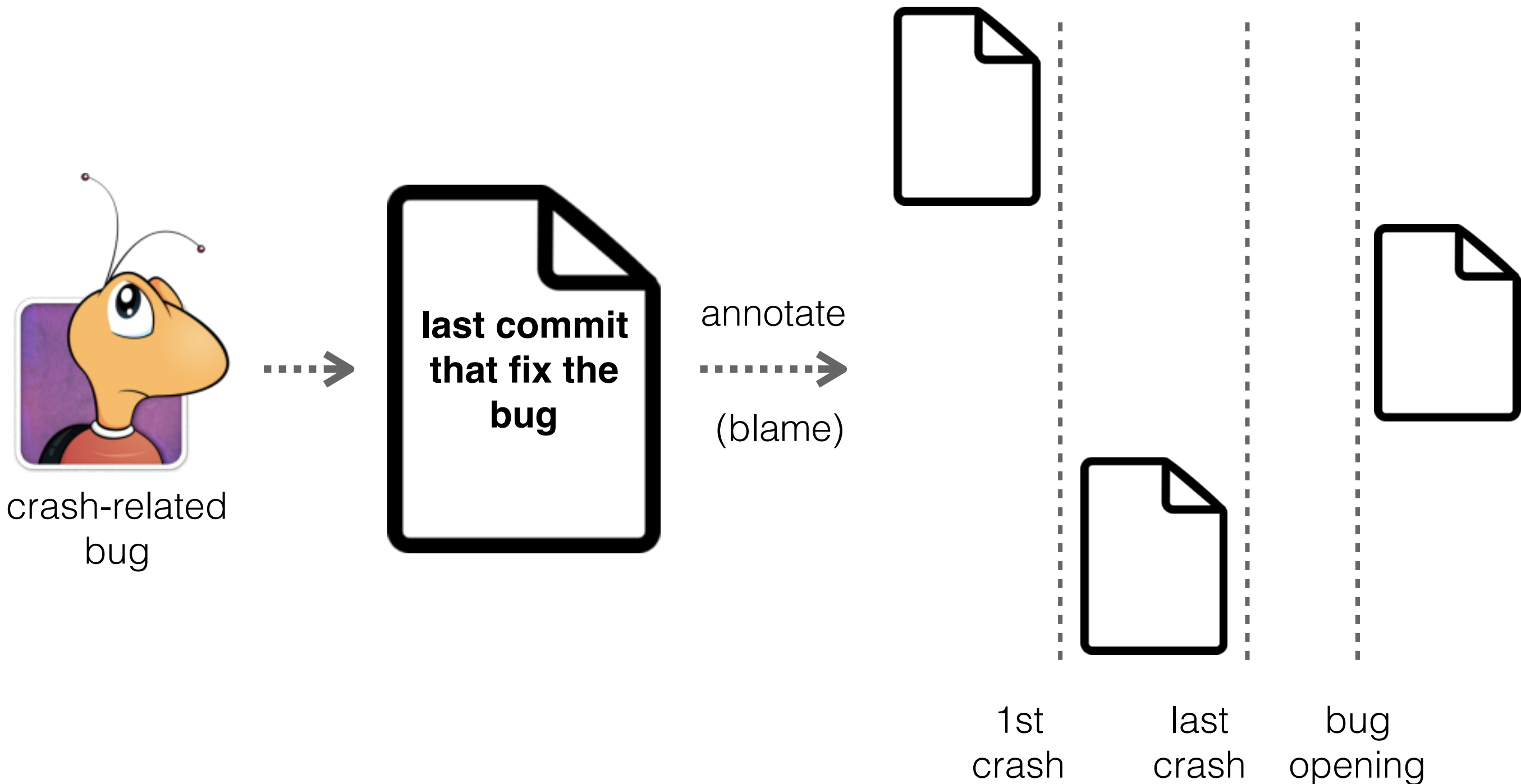
Identifying Crash-inducing Commits

J. Sliwerski, T. Zimmermann, and A. Zeller. **When do changes induce fixes?**
In ACM sigsoft software engineering notes (SZZ algorithm)



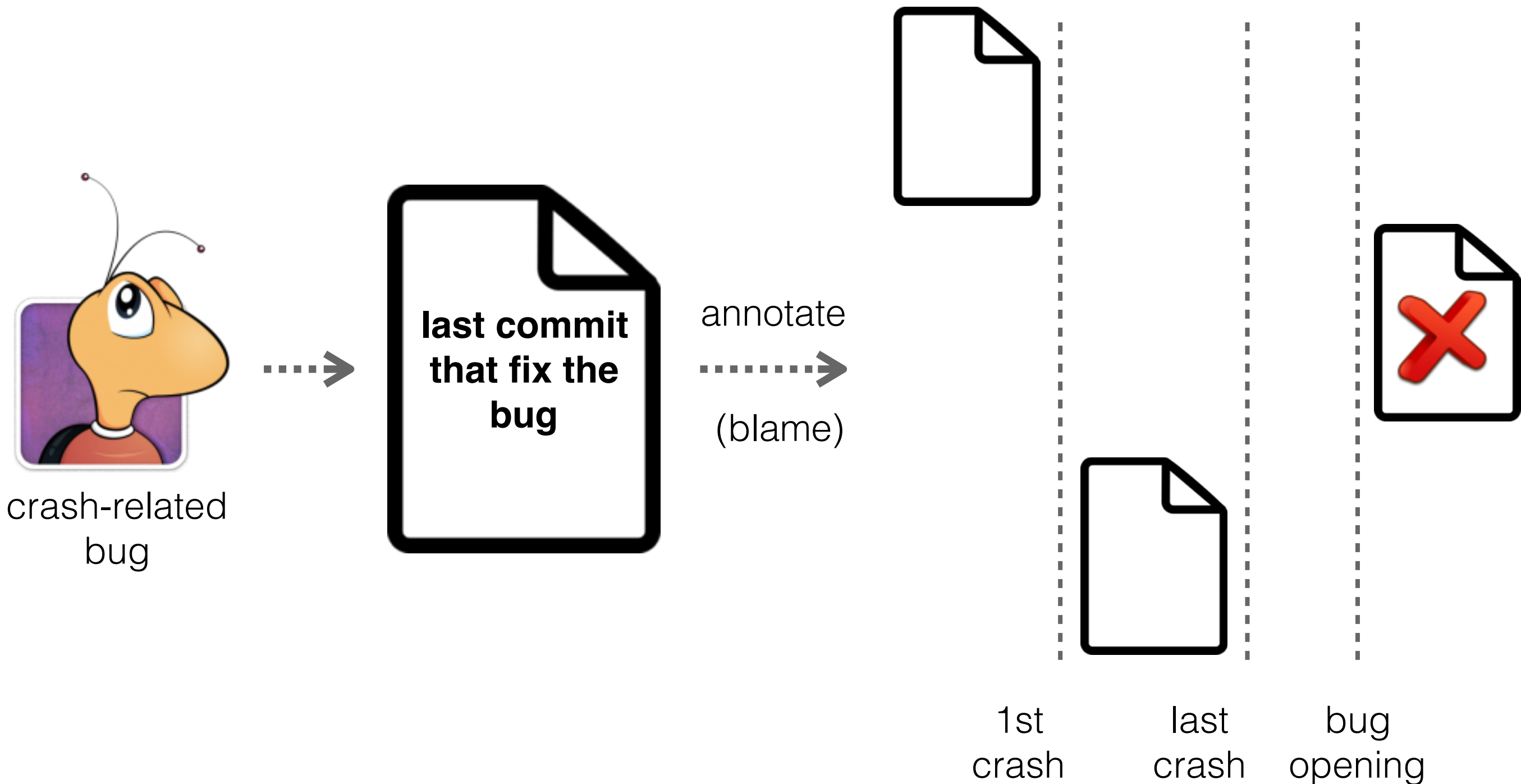
Identifying Crash-inducing Commits

J. Sliwerski, T. Zimmermann, and A. Zeller. **When do changes induce fixes?**
In ACM sigsoft software engineering notes (SZZ algorithm)



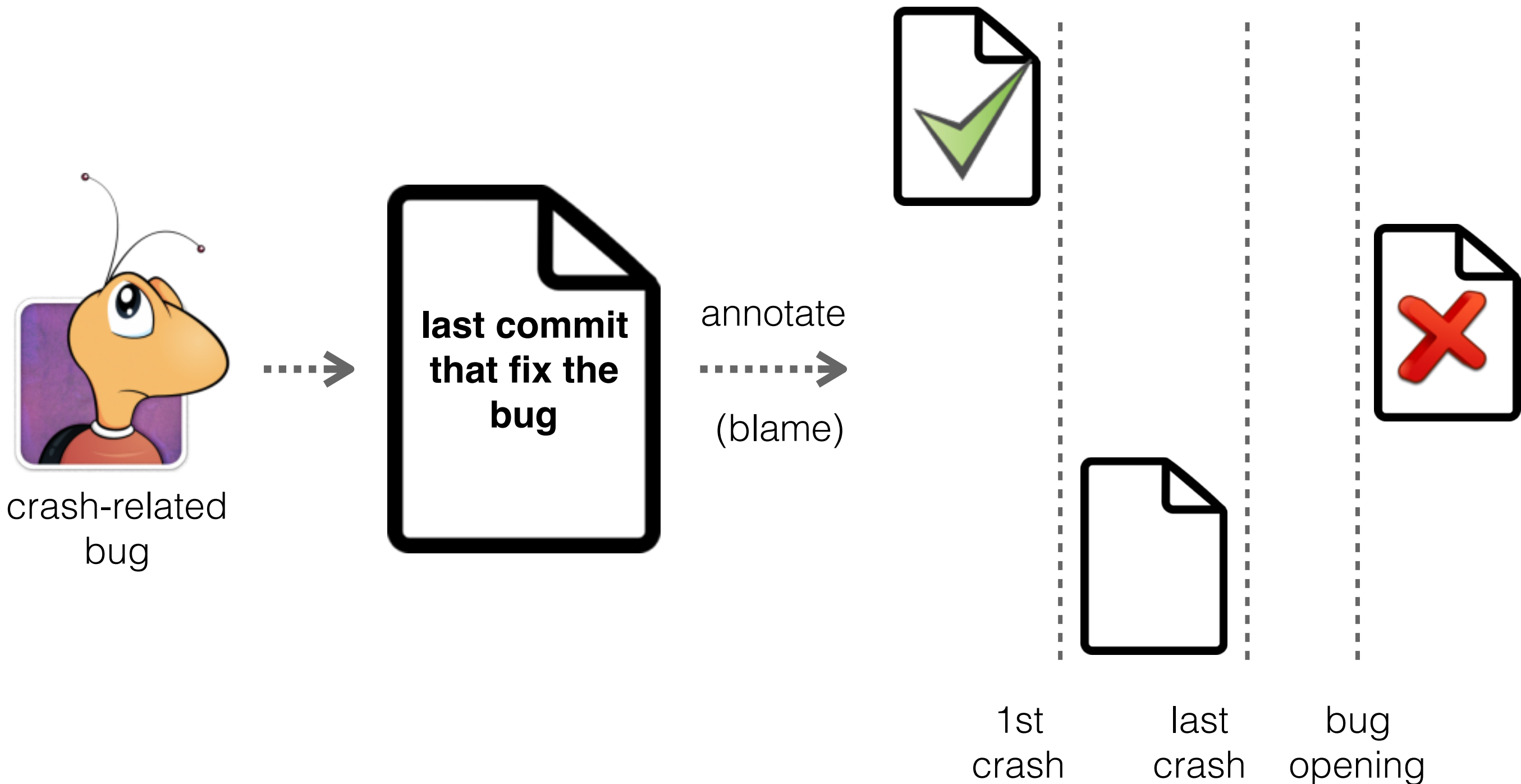
Identifying Crash-inducing Commits

J. Sliwerski, T. Zimmermann, and A. Zeller. **When do changes induce fixes?**
In ACM sigsoft software engineering notes (SZZ algorithm)



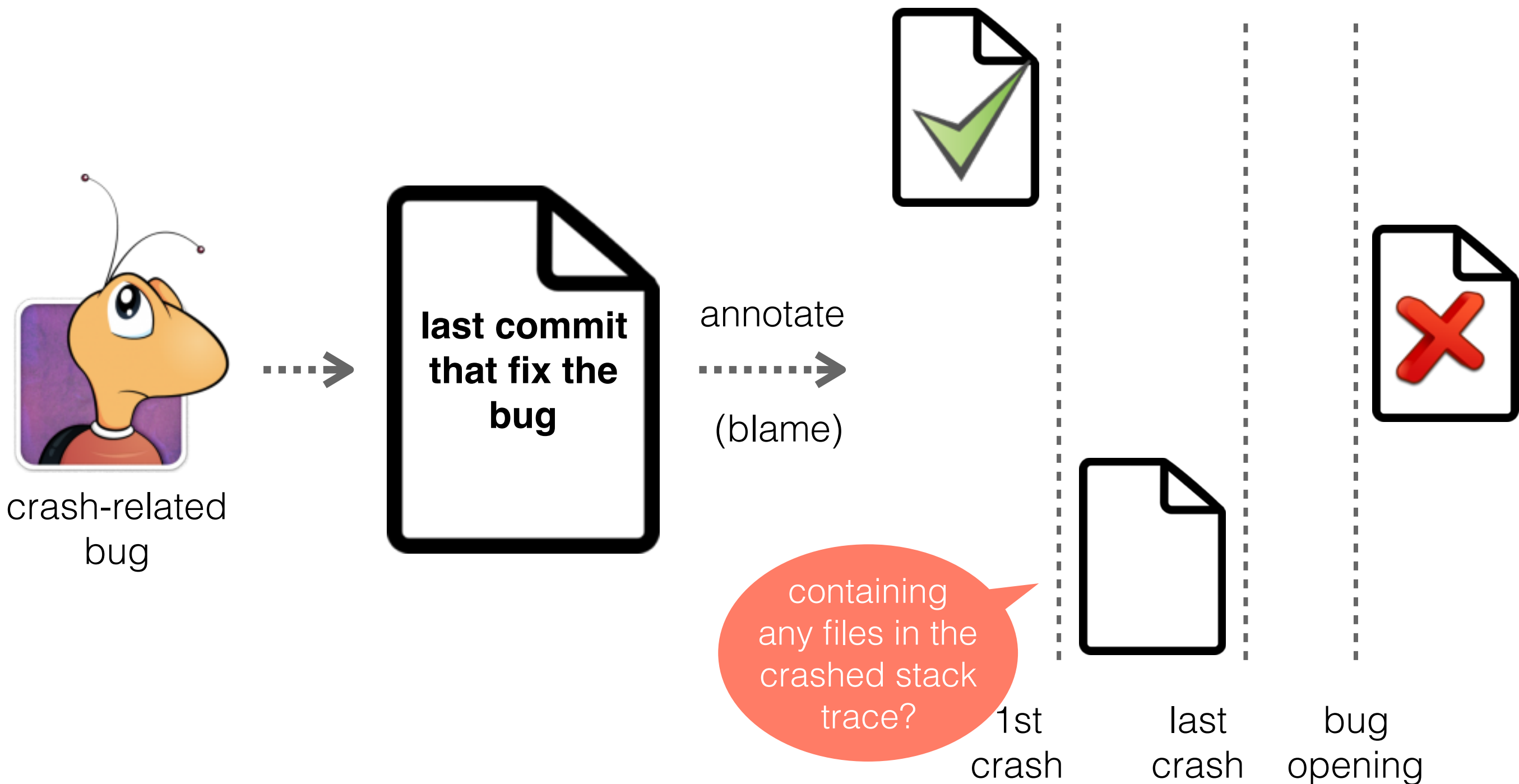
Identifying Crash-inducing Commits

J. Sliwerski, T. Zimmermann, and A. Zeller. **When do changes induce fixes?**
In ACM sigsoft software engineering notes (SZZ algorithm)



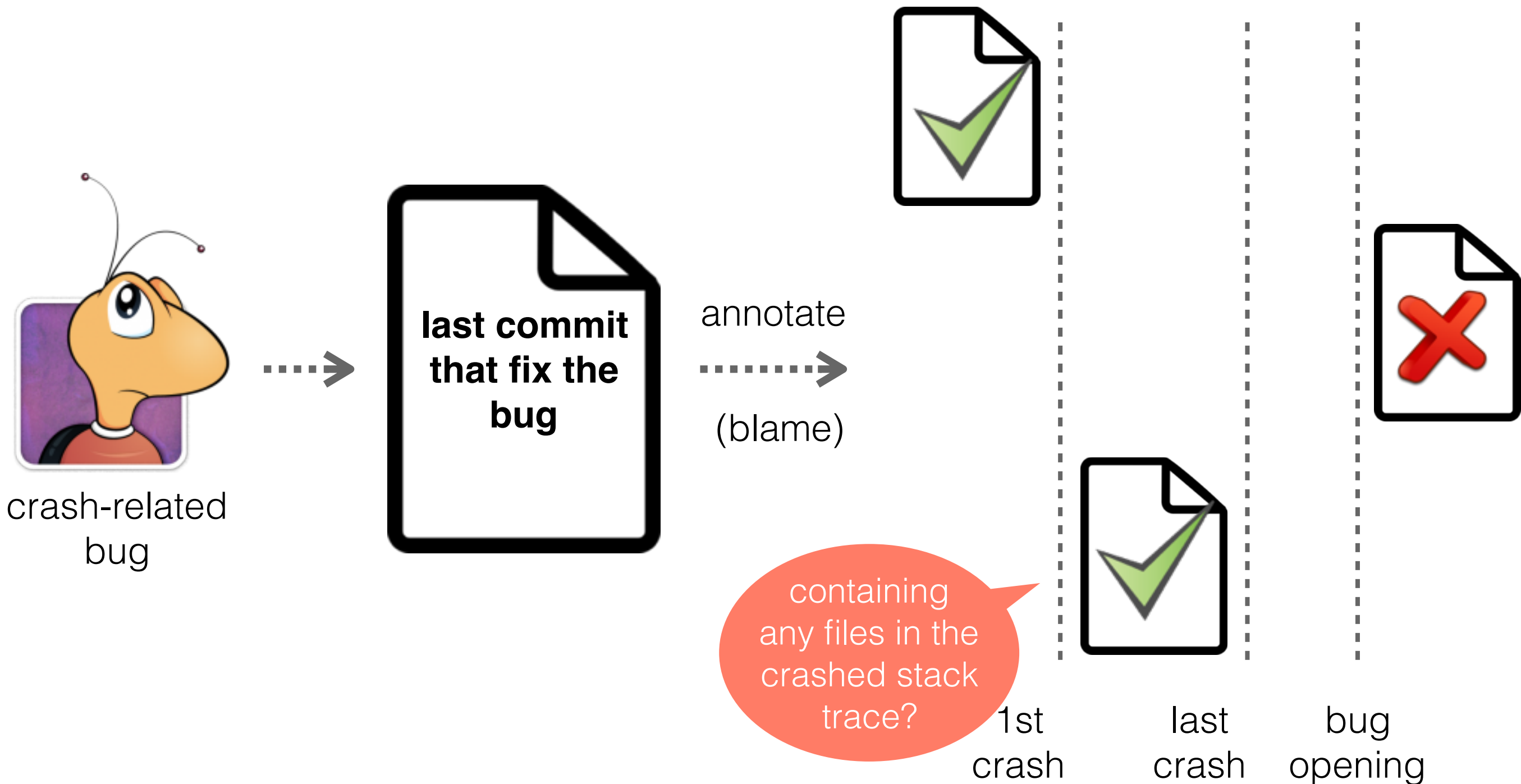
Identifying Crash-inducing Commits

J. Sliwerski, T. Zimmermann, and A. Zeller. **When do changes induce fixes?**
In ACM sigsoft software engineering notes (SZZ algorithm)



Identifying Crash-inducing Commits

J. Sliwerski, T. Zimmermann, and A. Zeller. **When do changes induce fixes?**
In ACM sigsoft software engineering notes (SZZ algorithm)



Computing Code Complexity Metrics

cyclomatic complexity

LOC

Understand scitools™

of functions

comment lines / code lines

max nesting

Computing Code Complexity Metrics

cyclomatic complexity

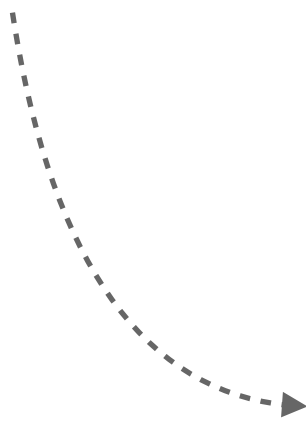
LOC

Understand scitools™

of functions

comment lines / code lines

max nesting



UDB

Computing Code Complexity Metrics

cyclomatic complexity

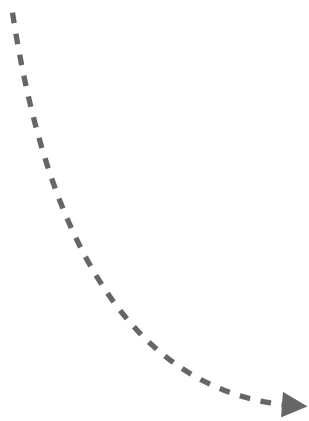
LOC

Understand scitools™

of functions

comment lines / code lines

max nesting



UDB

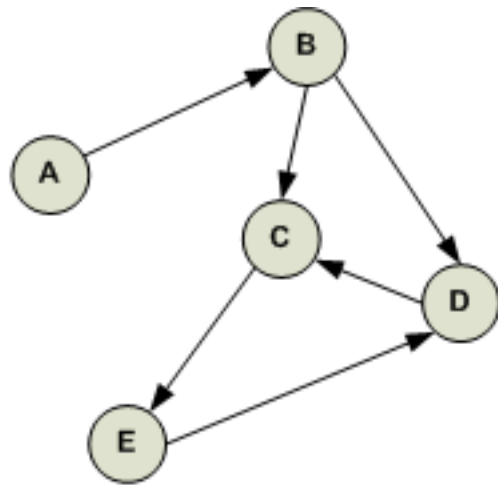


Computing Social Network Analysis (SNA) Metrics

SNA can assess the extent of centrality of a specific class in a software system.

PageRank
betweenness
closeness
indegree
outdegree

Computing Social Network Analysis (SNA) Metrics

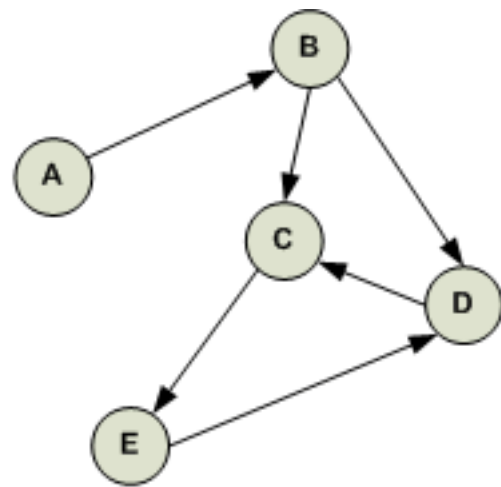


dependency graph
among classes

SNA can assess the extent of centrality of a specific class in a software system.

PageRank
betweenness
closeness
indegree
outdegree

Computing Social Network Analysis (SNA) Metrics



dependency graph
among classes

Understand scitools

.....➔

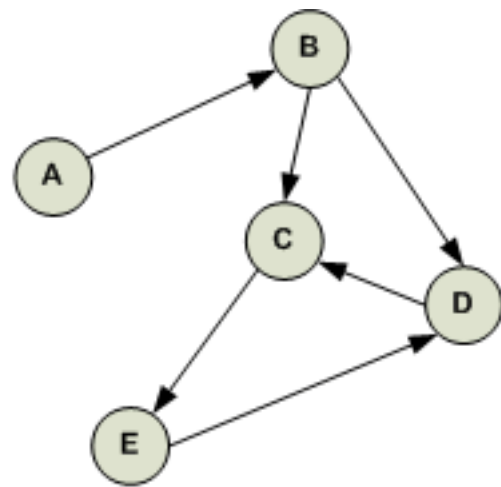
	a	b	c	d	e
a	0	1	0	0	0
b	0	0	1	1	0
c	0	0	0	0	1
d	0	0	1	0	0
e	0	0	0	1	0

adjacency matrix

SNA can assess the extent of centrality of a specific class in a software system.

PageRank
betweenness
closeness
indegree
outdegree

Computing Social Network Analysis (SNA) Metrics



dependency graph
among classes

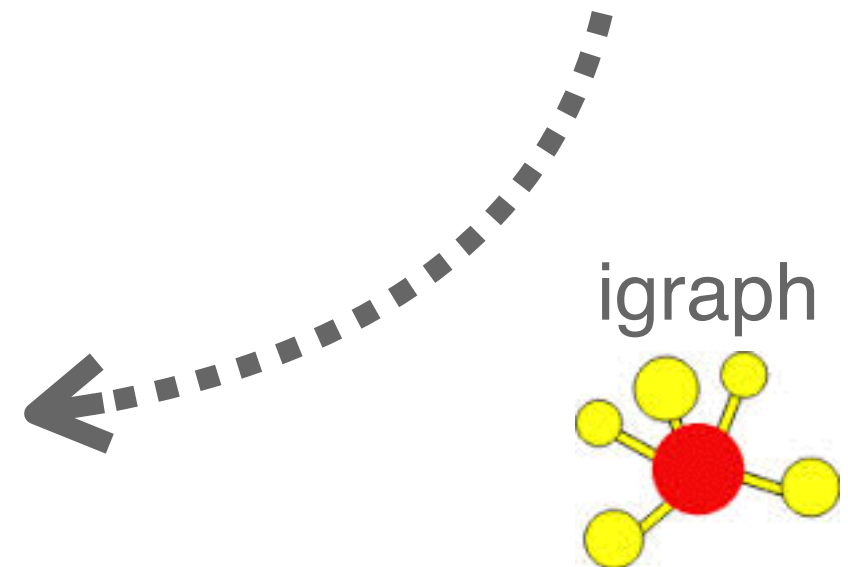
Understand scitools

	a	b	c	d	e
a	0	1	0	0	0
b	0	0	1	1	0
c	0	0	0	0	1
d	0	0	1	0	0
e	0	0	0	1	0

adjacency matrix

SNA can assess the extent of centrality of a specific class in a software system.

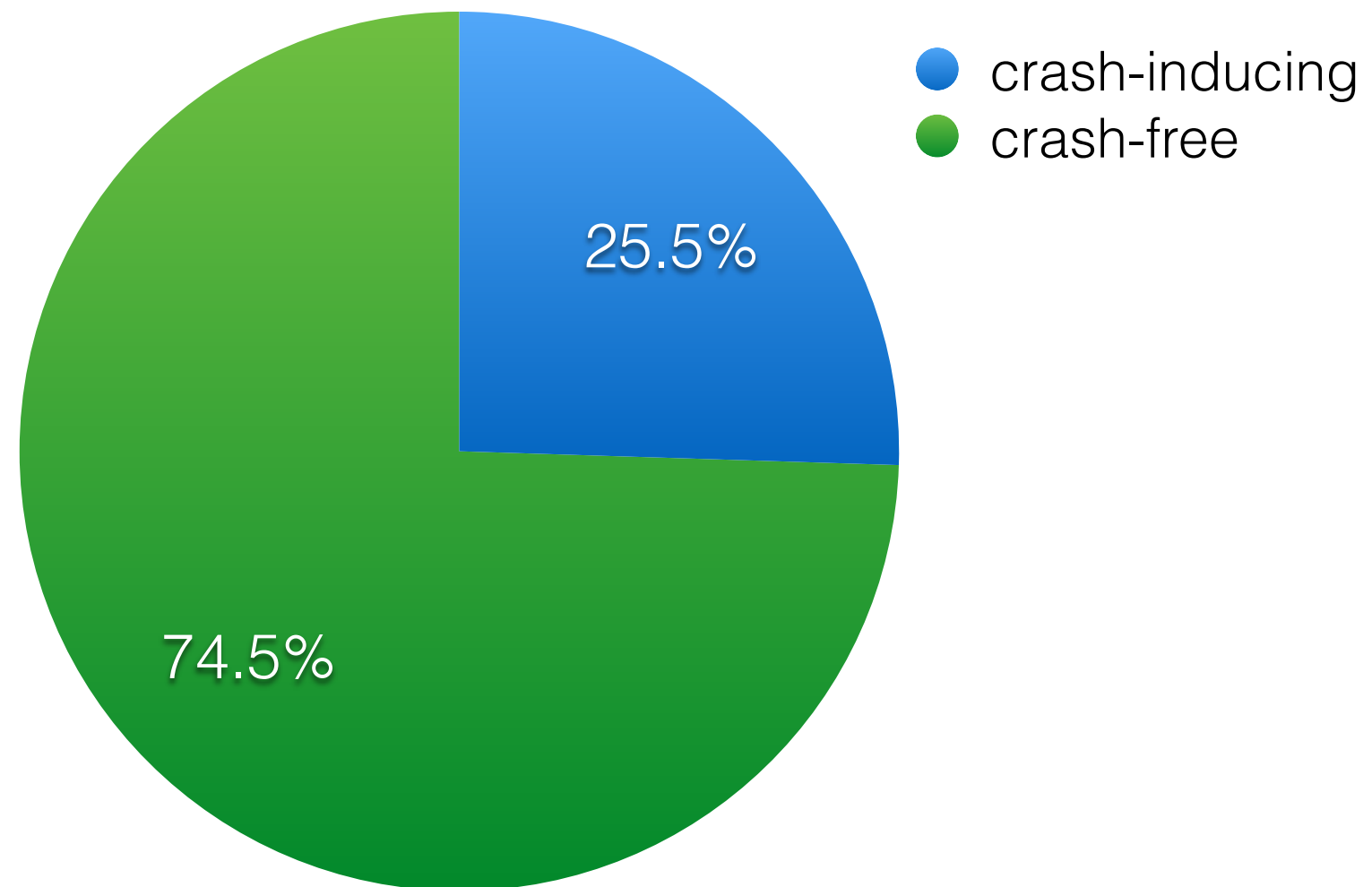
PageRank
betweenness
closeness
indegree
outdegree



Case Study Results



One Out of Four Commits in Firefox will Induce Future Crashes



Significant Difference between Crash-inducing commits and crash-free commits

Crash-inducing
commit



reporter experience



Crash-free
commits



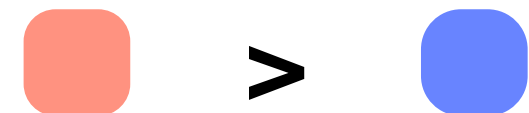
commit message



changed files & churn



Mozilla developers



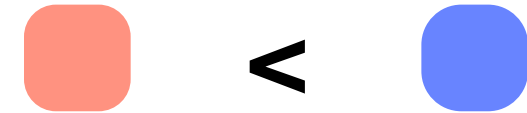
Significant Difference between Crash-inducing commits and crash-free commits

Crash-inducing
commit

Crash-free
commits



reporter experience



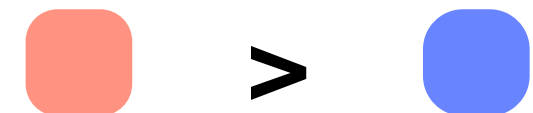
commit message



changed files & churn

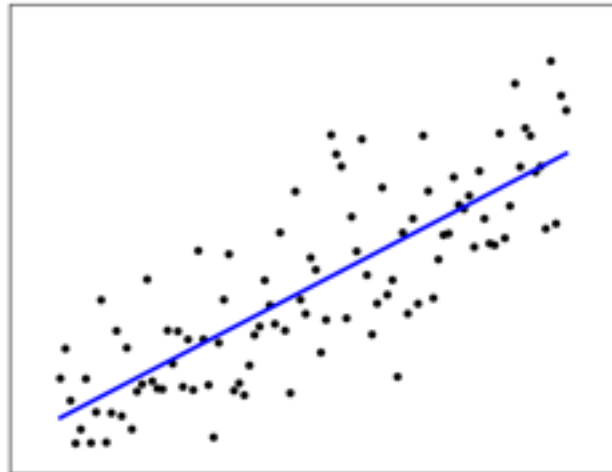


Mozilla developers



*Outside contributors
receive more scrutiny
(through code review
sessions) than those from
Mozilla developers*

Prediction of Crash-inducing Commits



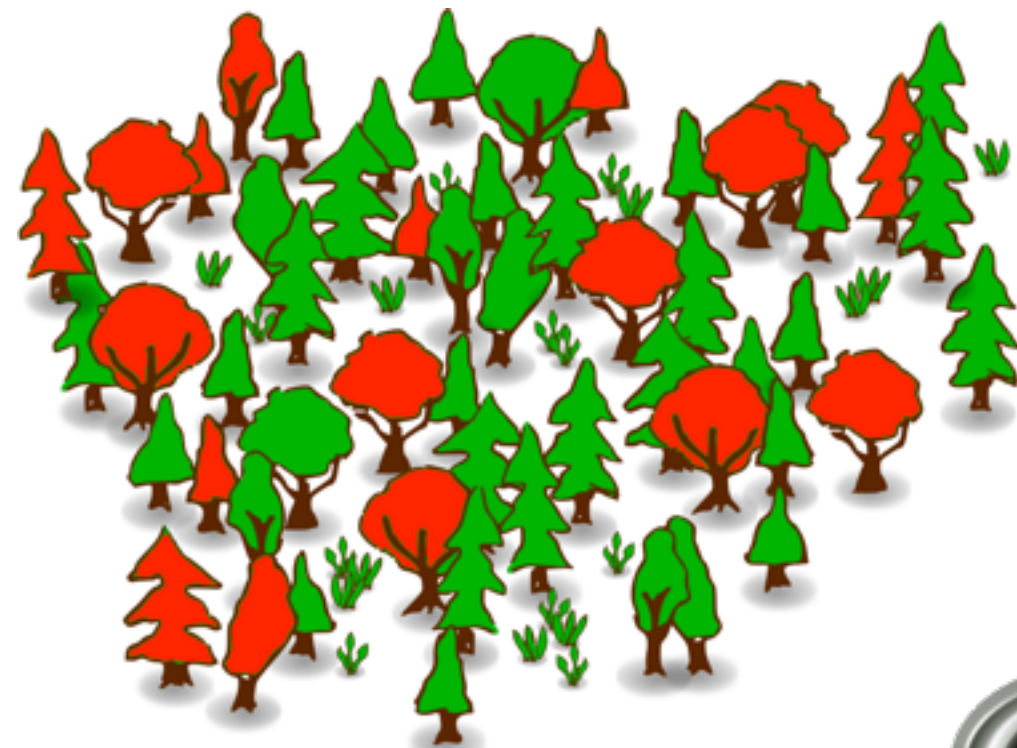
General Linear Model

$$P(X | C_i) = \prod_{k=1}^n P(x_k | C_i)$$

Naive Bayes



Decision tree



Random Forest



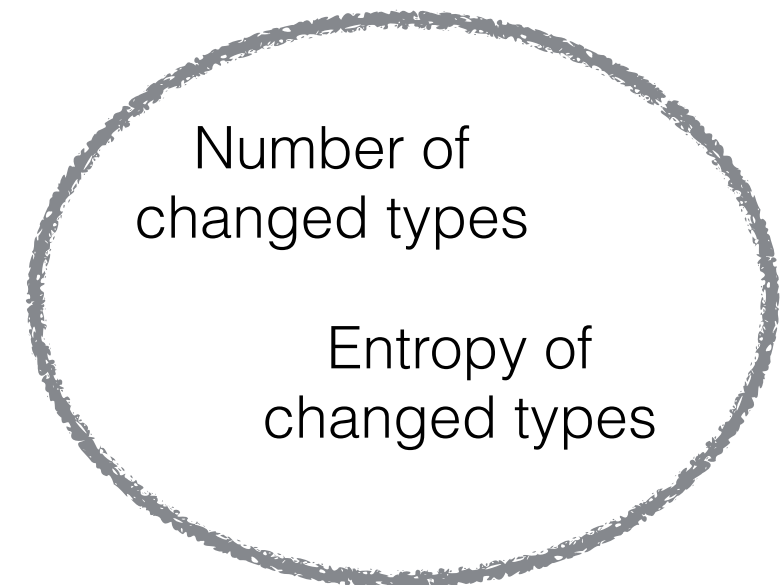
Predictive Metrics

(extracted at the level of commits)

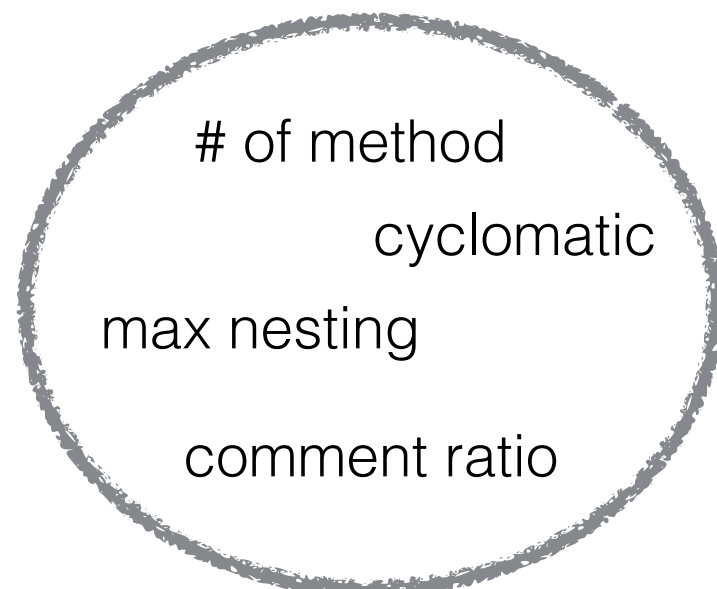
Commit log



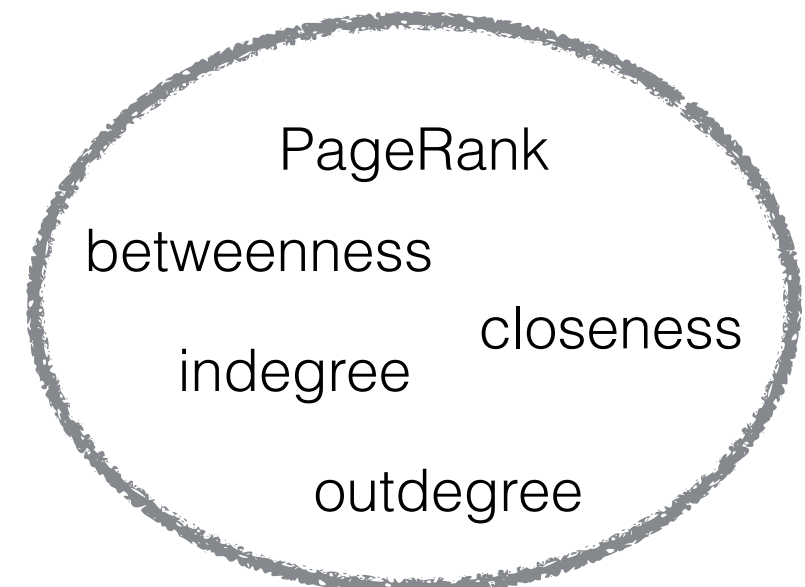
Changed type



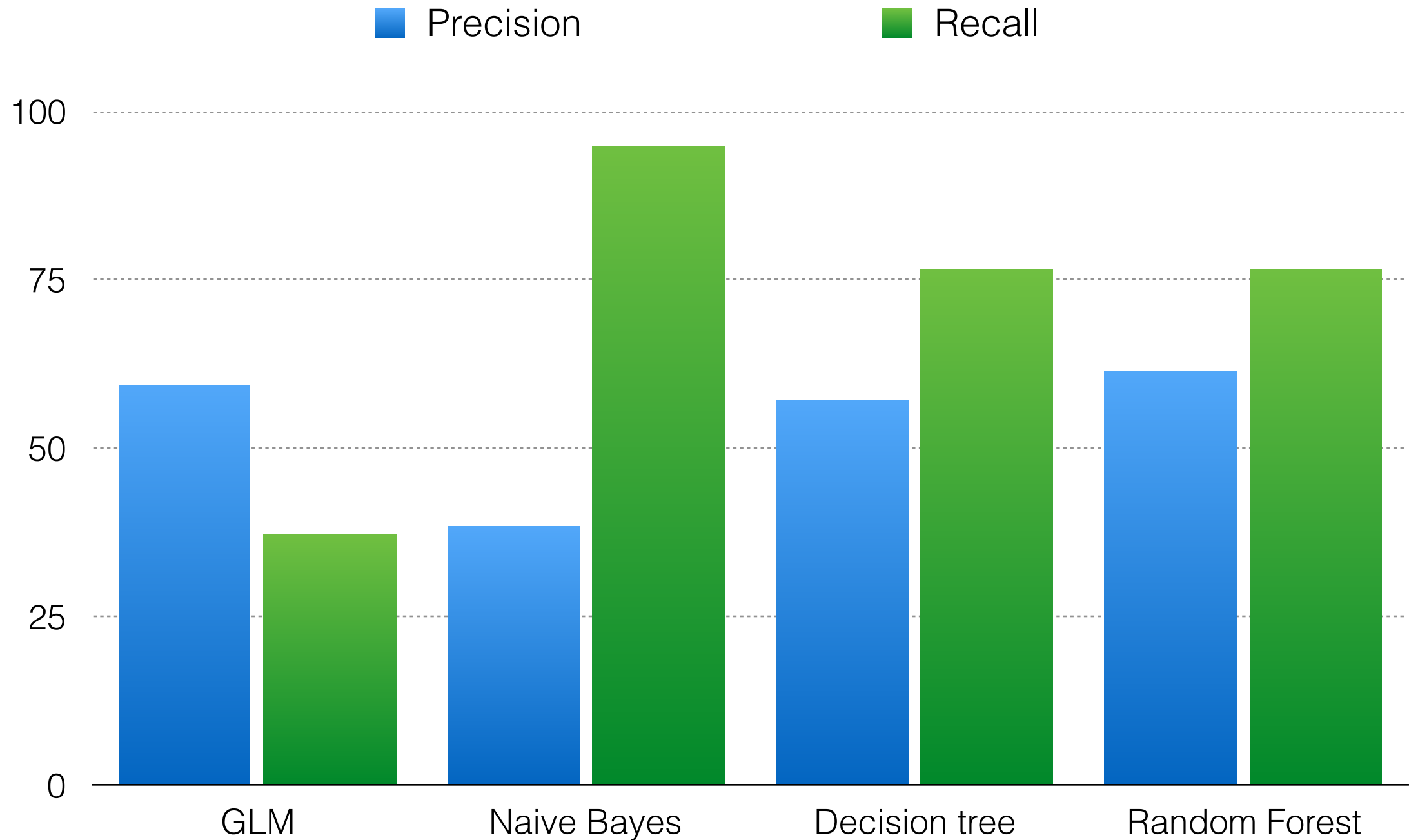
Code complexity



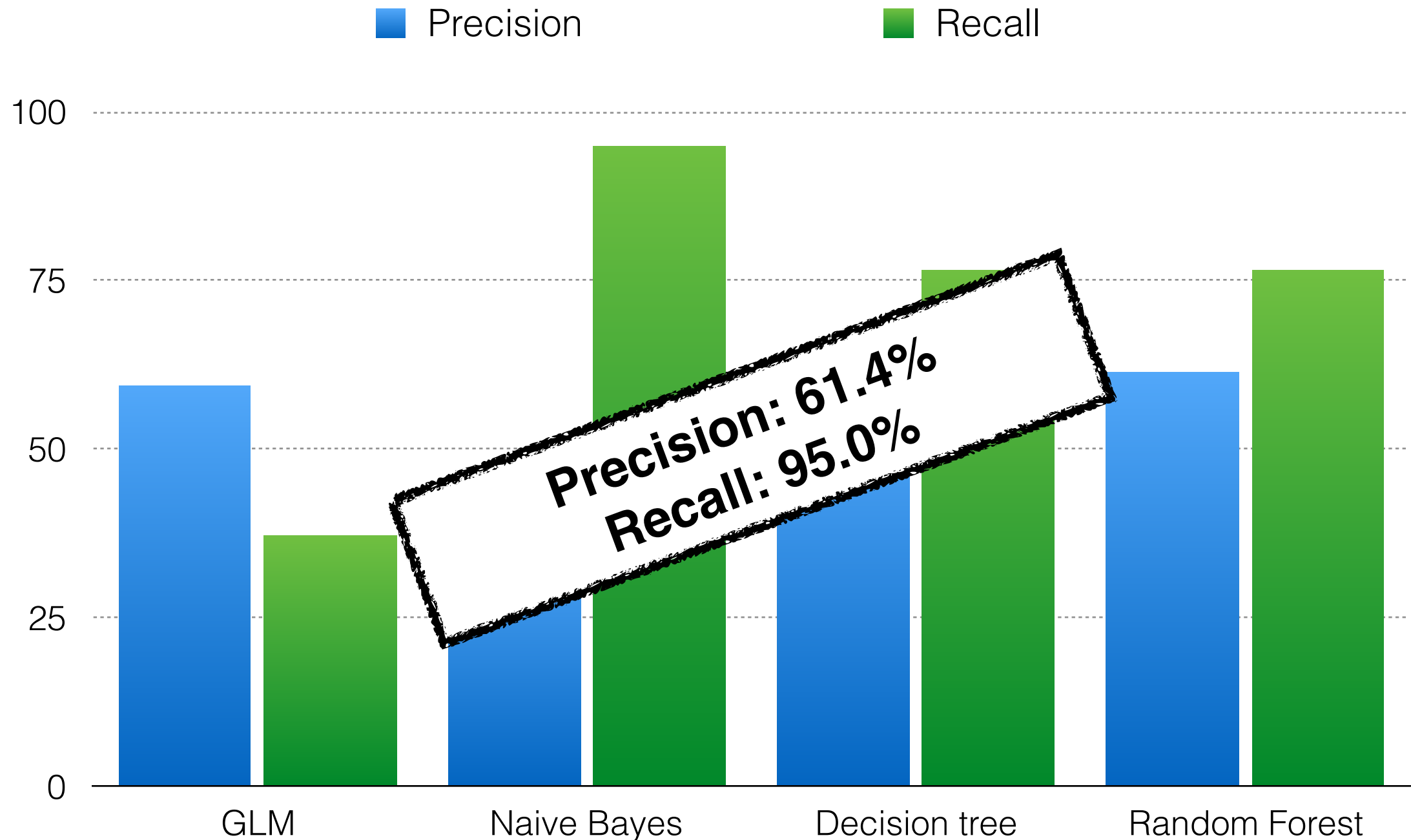
Social network analysis



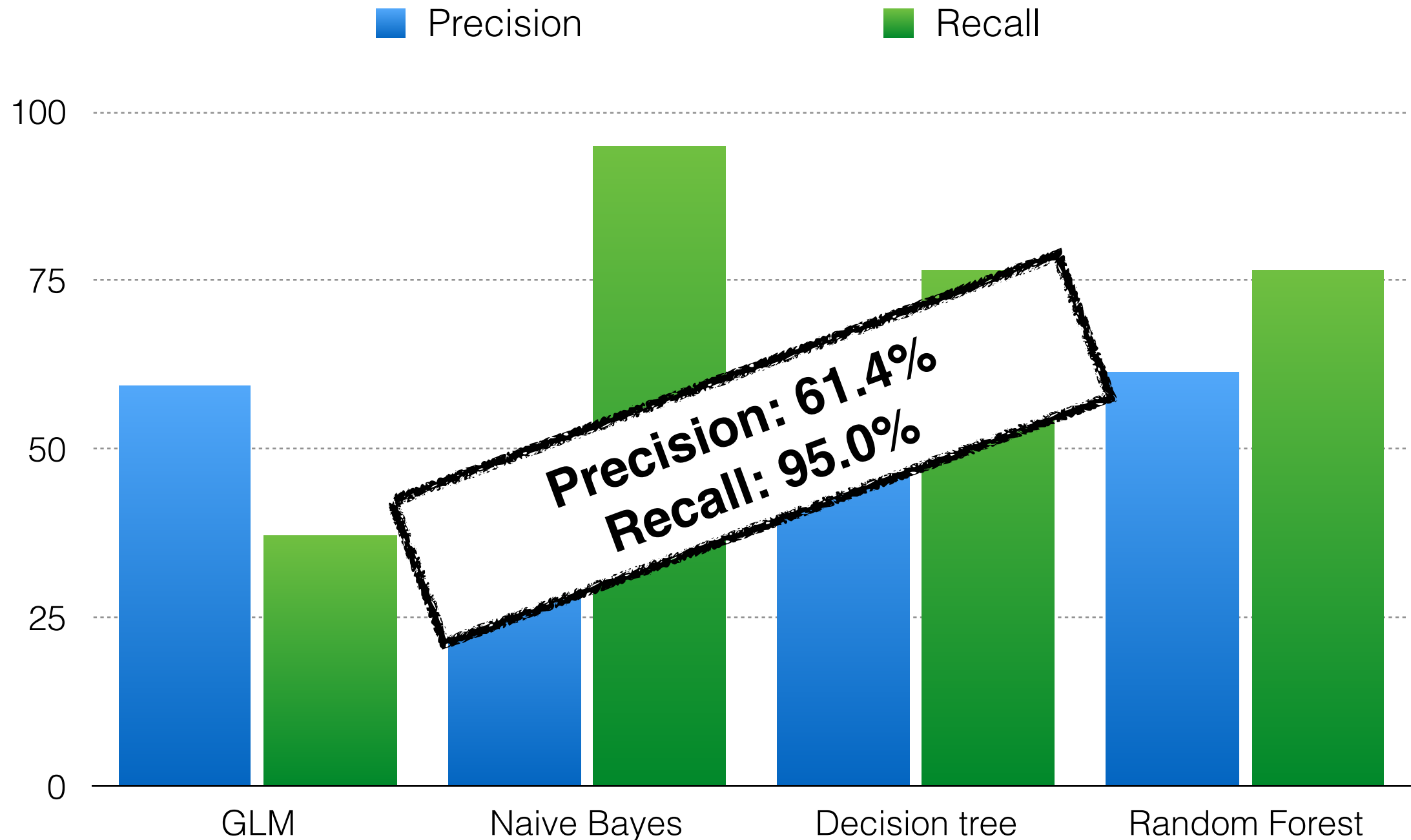
Prediction Result of Crash-inducing commits



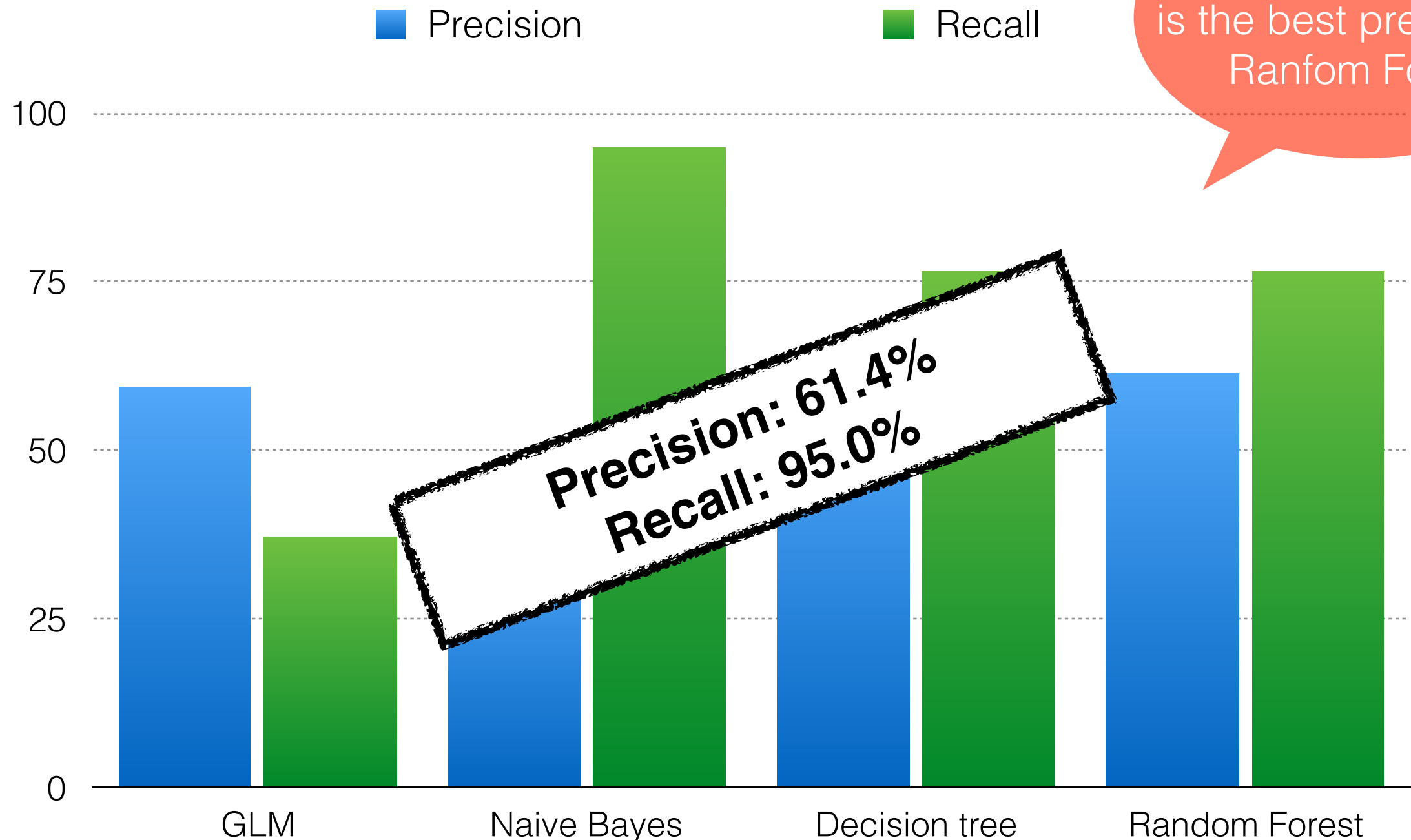
Prediction Result of Crash-inducing commits



Prediction Result of Crash-inducing commits



Prediction Result of Crash-inducing commits



Closeness (SNA)
is the best predictor in
Random Forest

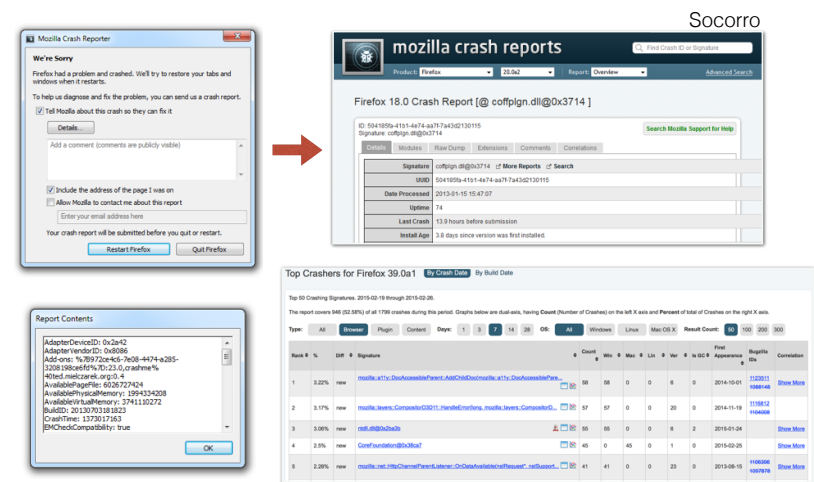


Future Work

- Generalisation of this approach to other software systems
- Study of crash-inducing code reviews
- Implementation of a crash detection tool suite

Conclusion

Crash Collecting System

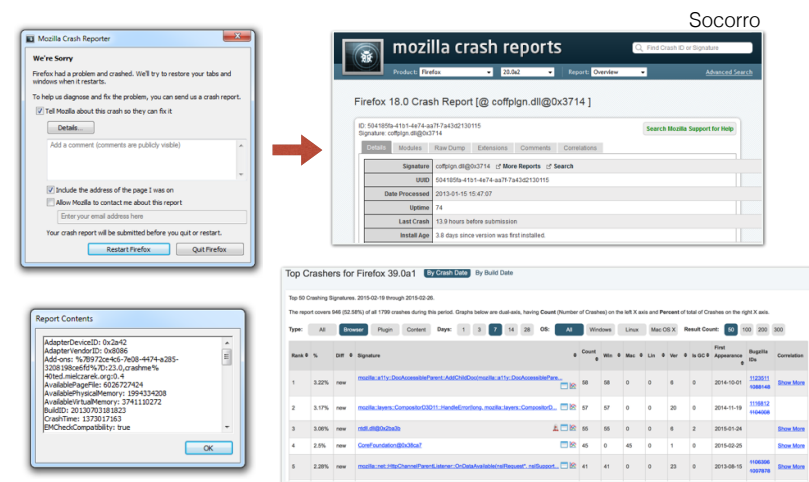


<https://support.mozilla.org/en-US/kb/mozillacrashreporter>

<https://crash-stats.mozilla.com/>

Conclusion

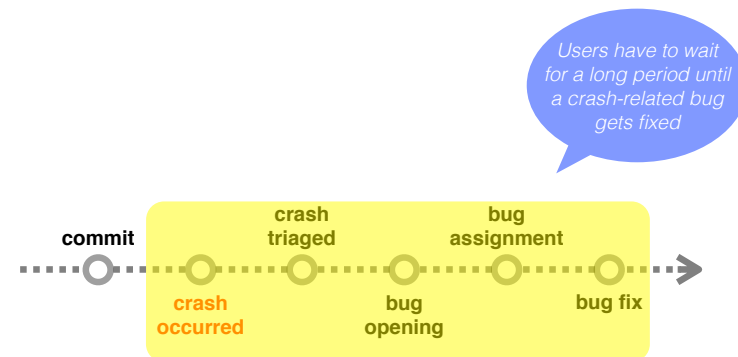
Crash Collecting System



<https://support.mozilla.org/en-US/kb/mozillacrashreporter>

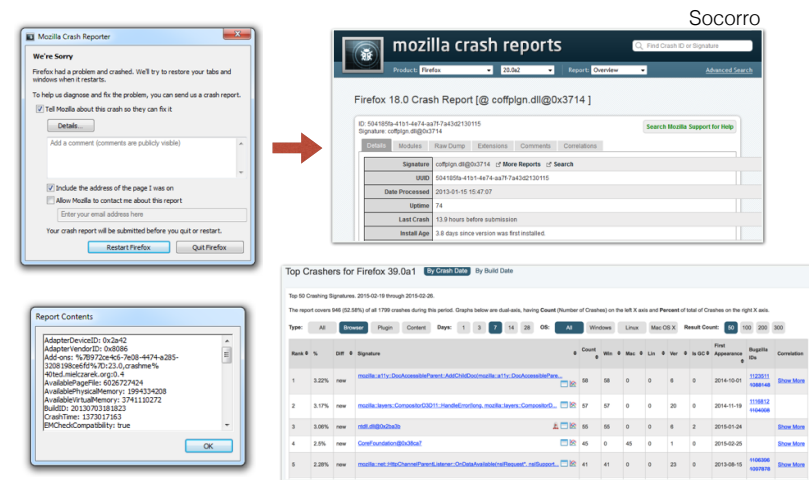
<https://crash-stats.mozilla.com/>

Challenge



Conclusion

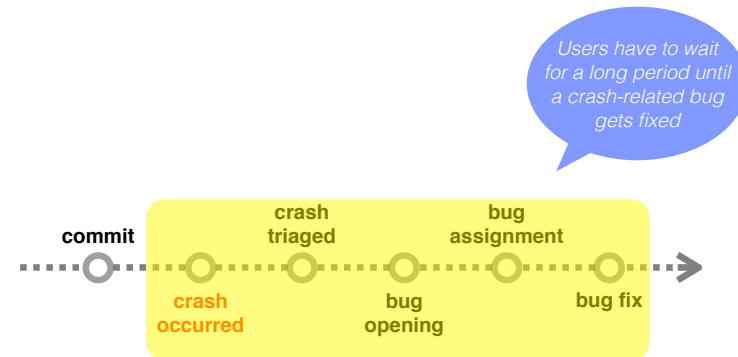
Crash Collecting System



<https://support.mozilla.org/en-US/kb/mozillacrashreporter>

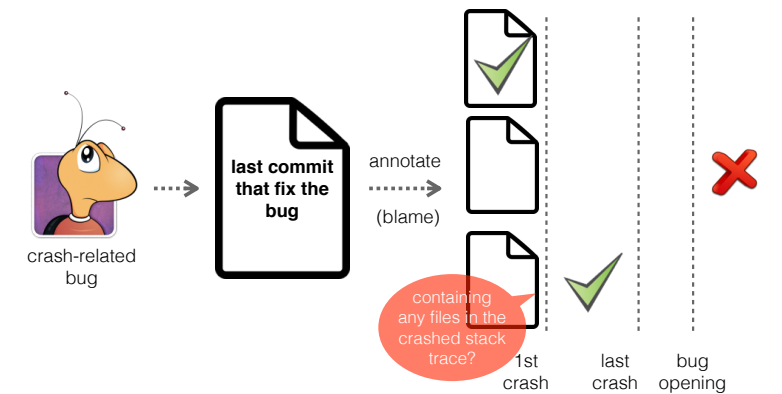
<https://crash-stats.mozilla.com/>

Challenge



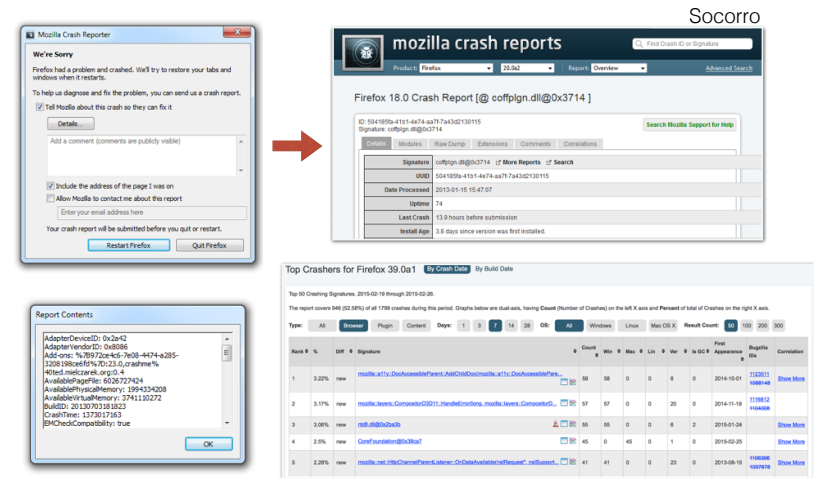
Identifying Crash-inducing Commits

J. Sliwinski, T. Zimmermann, and A. Zeller. **When do changes induce fixes?**
In ACM sigsoft software engineering notes (SZZ algorithm)



Conclusion

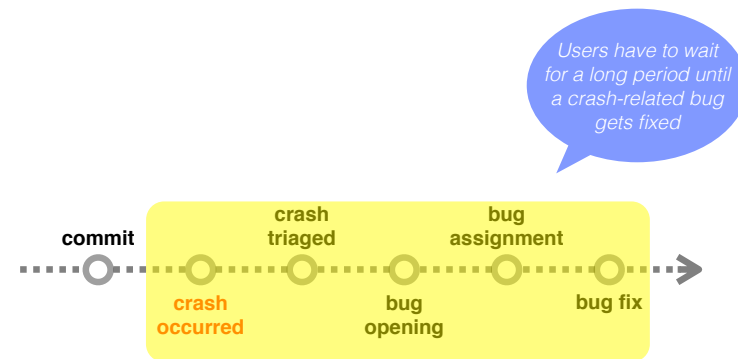
Crash Collecting System



<https://support.mozilla.org/en-US/kb/mozillacrashreporter>

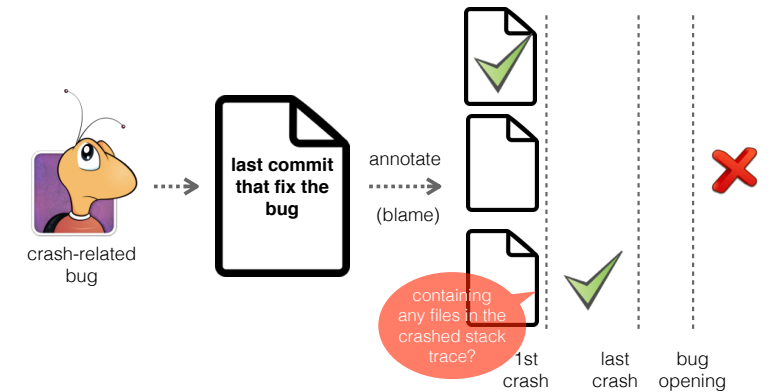
<https://crash-stats.mozilla.com/>

Challenge

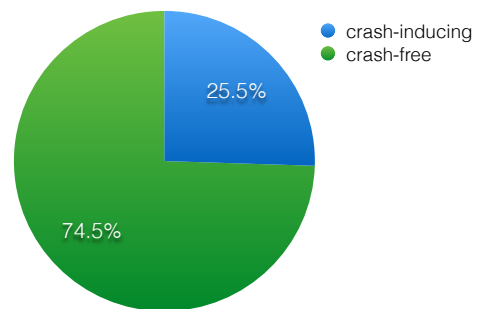


Identifying Crash-inducing Commits

J. Sliwinski, T. Zimmermann, and A. Zeller. **When do changes induce fixes?**
In ACM sigsoft software engineering notes (SZZ algorithm)

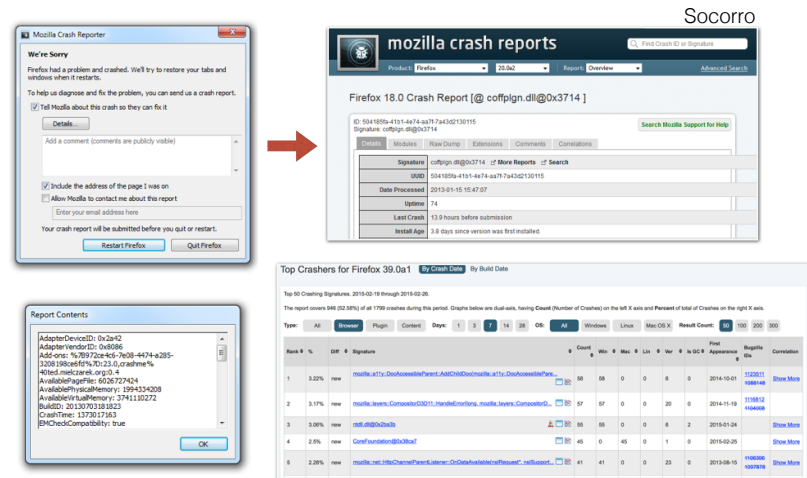


One Out of Four Commits in Firefox will Induce Future Crashes



Conclusion

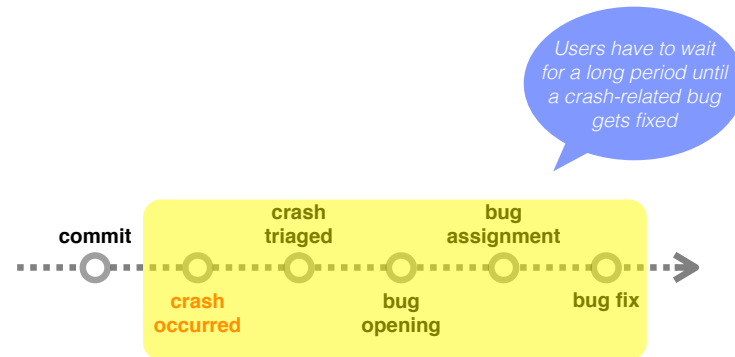
Crash Collecting System



<https://support.mozilla.org/en-US/kb/mozillacrashreporter>

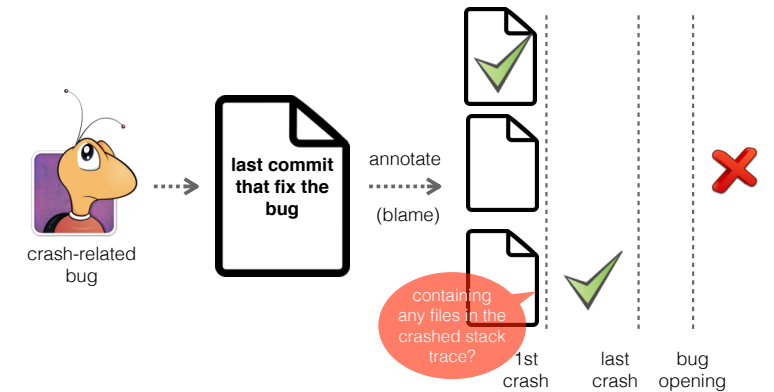
<https://crash-stats.mozilla.com/>

Challenge

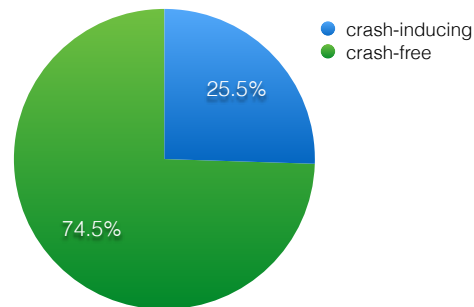


Identifying Crash-inducing Commits

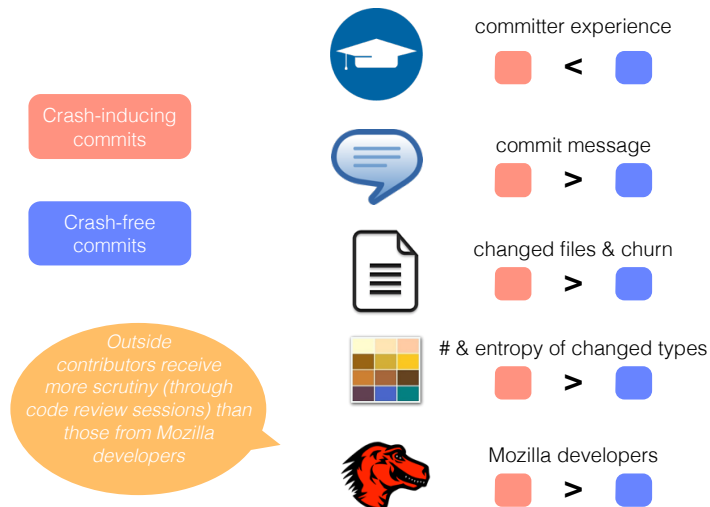
J. Sliwinski, T. Zimmermann, and A. Zeller. **When do changes induce fixes?**
In ACM sigsoft software engineering notes (SZZ algorithm)



One Out of Four Commits in Firefox will Induce Future Crashes

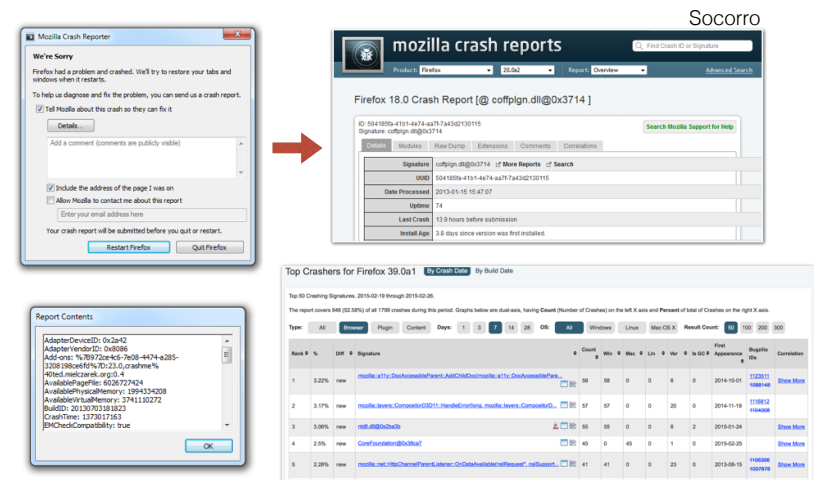


Significant Differences between Crash-inducing and Crash-free Commits



Conclusion

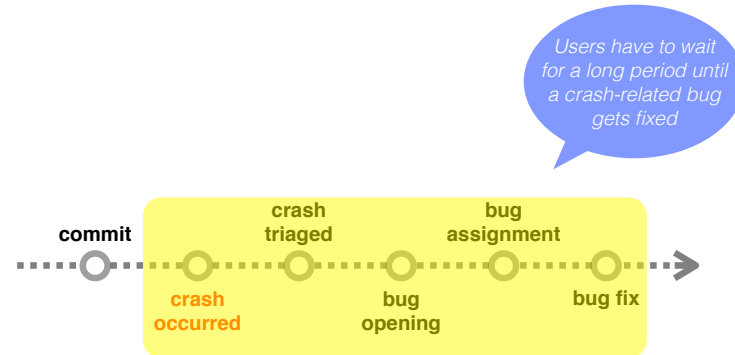
Crash Collecting System



<https://support.mozilla.org/en-US/kb/mozillacrashreporter>

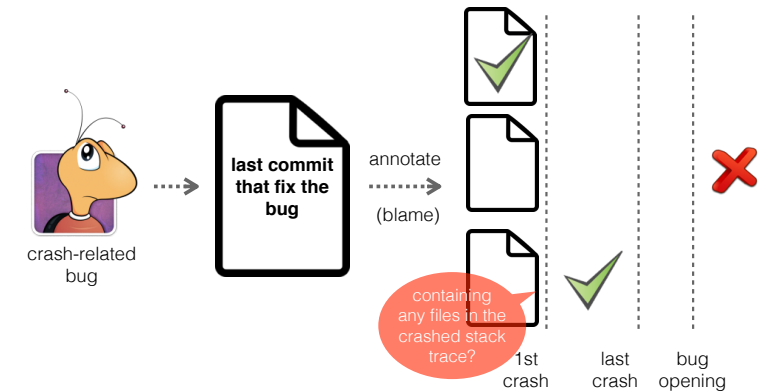
<https://crash-stats.mozilla.com/>

Challenge

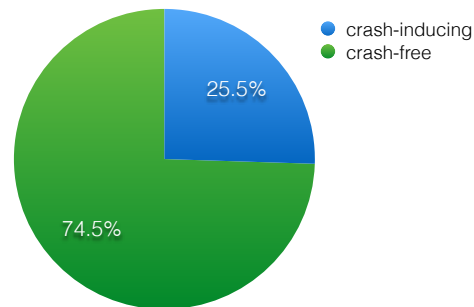


Identifying Crash-inducing Commits

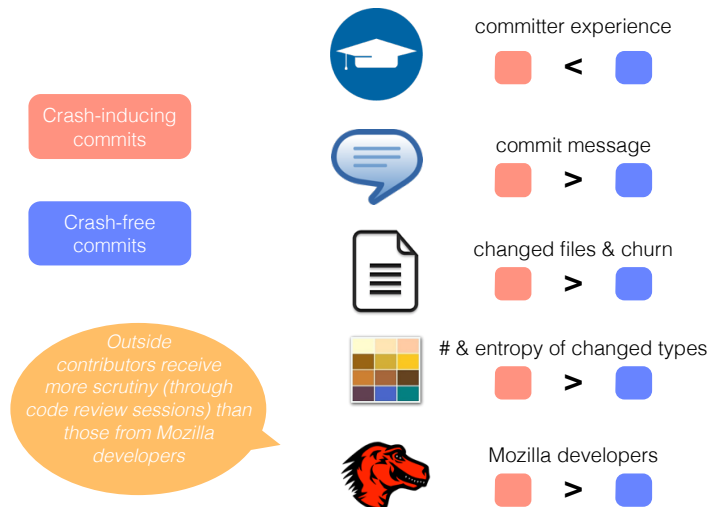
J. Sliwinski, T. Zimmermann, and A. Zeller. **When do changes induce fixes?**
In ACM sigsoft software engineering notes (SZZ algorithm)



One Out of Four Commits in Firefox will Induce Future Crashes



Significant Differences between Crash-inducing and Crash-free Commits



Just-in-time Quality Assurance

