Guide to exploring the SStuBs dataset

Wenhan Zhu (Cosmos)

University of Waterloo

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Single statement bugs (***S**imple **St**upid **B**ug**s***)

Source:

- top 100 Java Maven Projects
  - SStuBs: 10,231
  - Bugs: 25,539
- top 1000 Java Projects
  - SStuBs: 63,923
  - Bugs: 153,698

Lots of effort in bug fixing by developers

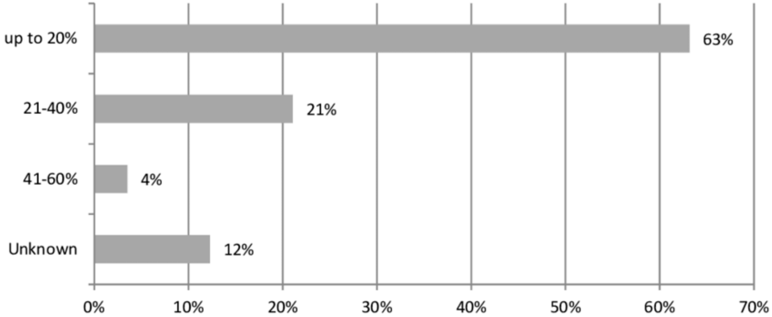


Figure 1: Ratio of total project effort spent on bug fixing by developers.[1]

[1] Software Quality Assurance During Implementation: Results of a Survey in Software Houses from Germany, Austria and Switzerland ICSQ 17

For auto program repair

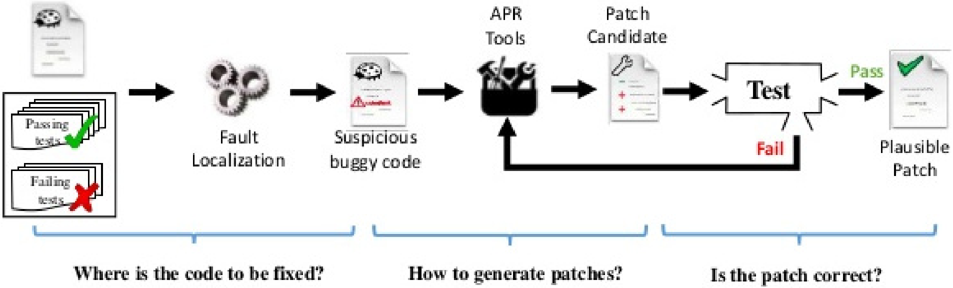


Figure 2: Basic process of automated program repair(APR) [2]

[2] LSRepair: Live Search of Fix Ingredients for Automated Program Repair APSEC 18

Existing dataset size

Table 1: Stats on selected datasets for APR[3]

Name	Domain	Size
DroixBench	Android	24
Codeflaws	C/C++	3,902
BugsJS	JavaScript	453
QuixBugs	Multiple	40
Refactory	Python	1,783
SStubBs	***Java***	***10k+/10k+***

[3] https://program-repair.org/benchmarks.html

The creation of the dataset

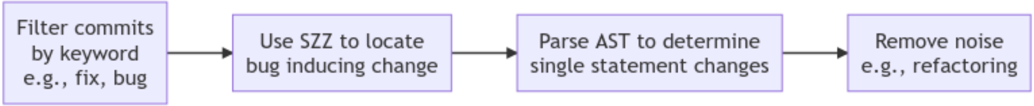
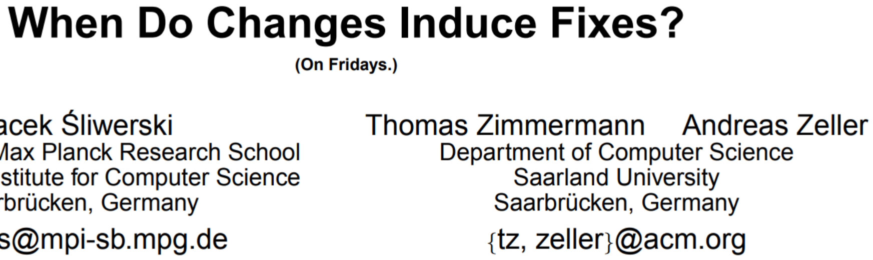

Filter commits by keyword e.g., fix, bug
Use SZZ to locate bug inducing change
Parse AST to determine single statement changes
Remove noise e.g., refactoring

Figure 3: Bug collection process

SZZ algorithm



When Do Changes Induce Fixes?

(On Fridays.)

Jacek Śliwerski
International Max Planck Research School
Max Planck Institute for Computer Science
Saarbrücken, Germany
sliwers@mpi-sb.mpg.de

Thomas Zimmermann Andreas Zeller
Department of Computer Science
Saarland University
Saarbrücken, Germany
{tz, zeller}@acm.org

Figure 4: Initial publication of the SZZ algorithm at MSR 05'[4]

[4] For reference the initial release of Git was in Apr. 07, 2005

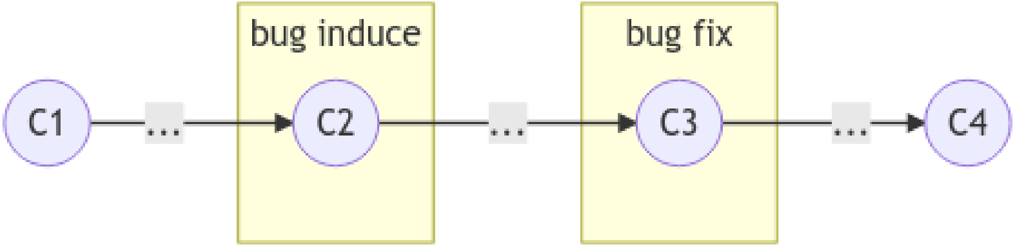
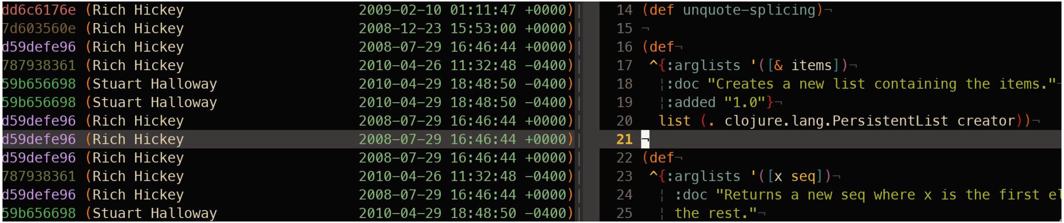


Figure 5: SZZ algorithm

1. We start with a bug report in the bug database, indicating a *fixed problem*.
2. We extract the associated change from the version archive, thus giving us the *location* of the fix.
3. We determine the *earlier change* at this location that was applied before the bug was reported

git blame



```
dd6c6176e (Rich Hickey                2009-02-10 01:11:47 +0000)| (def unquote-splicing)
7d603560e (Rich Hickey                2008-12-23 15:53:00 +0000)|
d59defe96 (Rich Hickey                2008-07-29 16:46:44 +0000)| (def
787938361 (Rich Hickey                2010-04-26 11:32:48 -0400)|  ^{:arglists '([& items])
59b656698 (Stuart Halloway            2010-04-29 18:48:50 -0400)|    :doc "Creates a new list containing the items."
59b656698 (Stuart Halloway            2010-04-29 18:48:50 -0400)|    :added "1.0"}
d59defe96 (Rich Hickey                2008-07-29 16:46:44 +0000)|   list (. clojure.lang.PersistentList creator))
d59defe96 (Rich Hickey                2008-07-29 16:46:44 +0000)|
d59defe96 (Rich Hickey                2008-07-29 16:46:44 +0000)| (def
787938361 (Rich Hickey                2010-04-26 11:32:48 -0400)|  ^{:arglists '([x seq])
d59defe96 (Rich Hickey                2008-07-29 16:46:44 +0000)|     :doc "Returns a new seq where x is the first el
59b656698 (Stuart Halloway            2010-04-29 18:48:50 -0400)|     the rest."
```

Figure 6: Example with git blame[5]

[5] https://github.com/clojure/clojure/blob/master/src/clj/clojure/core.clj at commit 0df3d8e2e27fb06fa53398754cac2be4878b12d1

SStuBs and general bugs

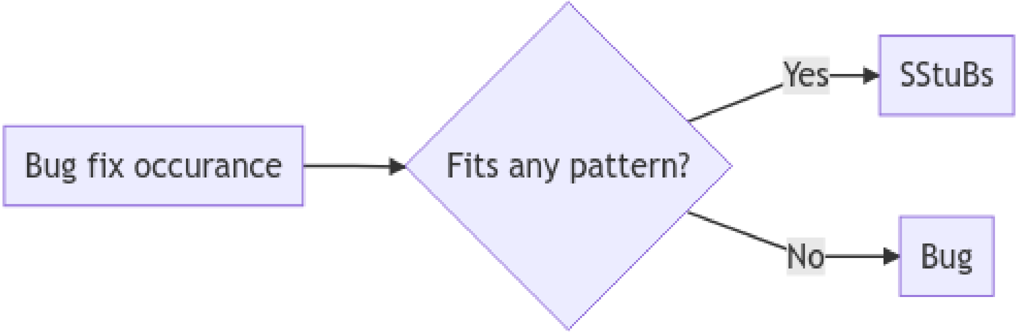


Figure 7: SStuBs or Bugs

Example pattern matched

Change Numeric Literal: `3.14` to `3.1415926`

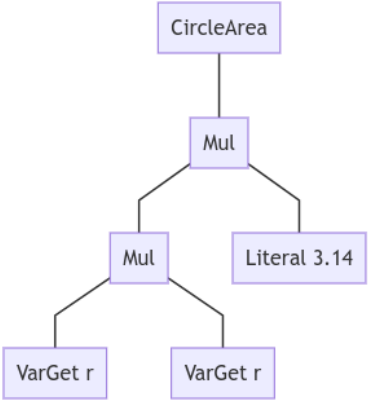


Figure 8: AST pre bug fix

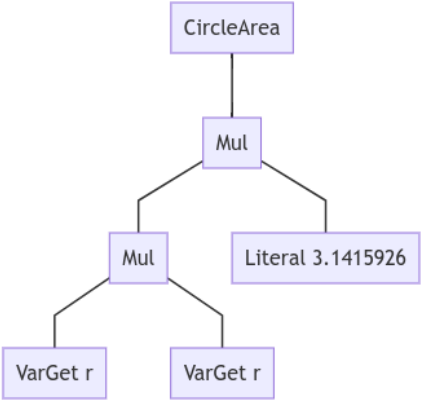


Figure 9: AST post bug fix

```
circleArea = r*r*3.14
```

```
circleArea = r*r*3.1415926
```

An example exploration: Commit pattern and bug fix authorship

Tasks

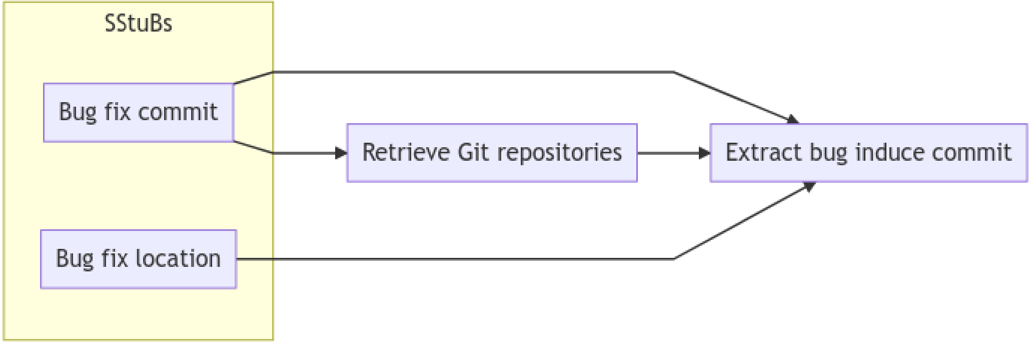


Figure 10: Workflow

Immediate catches in SStuBs dataset

- `b3log/solo` migrated to `88250/solo`
- `dropwizard/metrics` have “ghost” commits

Going beyond the “naive” SZZ algorithm

Integration (e.g., C6) vs Implementation (e.g., C4)

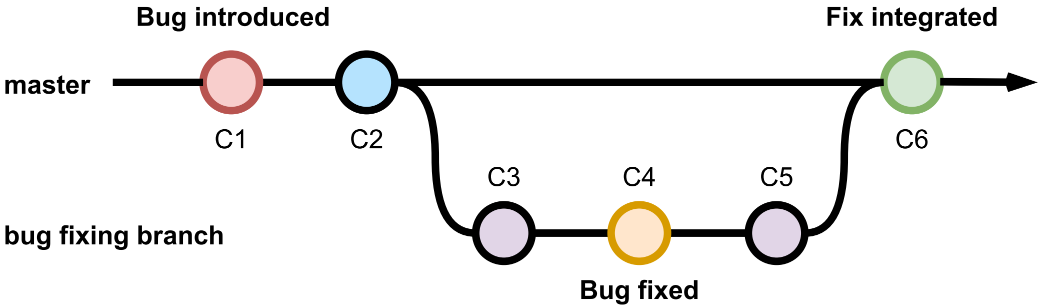
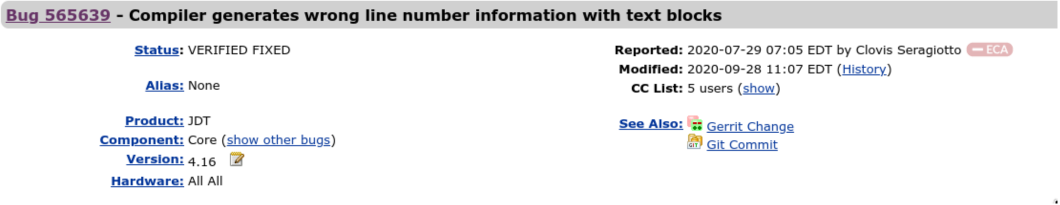


Figure 11: Complex Git history

Incorrect localization of Bug Fix Line number

```
final int oldLineNum = ((CompilationUnit)
↪   oldNode.getRoot()).getLineNumber( oldNodeStartChar );
```



Bug 565639 - Compiler generates wrong line number information with text blocks

Status: VERIFIED FIXED

Alias: None

Product: JDT
Component: Core (show other bugs)
Version: 4.16
Hardware: All All

Reported: 2020-07-29 07:05 EDT by Clovis Seragiotto ECA
Modified: 2020-09-28 11:07 EDT (History)
CC List: 5 users (show)

See Also: Gerrit Change
Git Commit

Figure 12: Bug report on Eclipse[6]

[6] https://bugs.eclipse.org/bugs/show_bug.cgi?id=565639

Determine commit attributes

- Authorship
- Commit size (i.e., Churn)
- Bug fixing time

Commit authorship

```
commit 1458db8e86332e0534e64869d452886472031633
Author:     Wenhan Zhu (Cosmos) <zhuwenhan950913@gmail.com>
AuthorDate: Thu Aug 20 00:46:30 2020 +0800
Commit:     Wenhan Zhu (Cosmos) <zhuwenhan950913@gmail.com>
CommitDate: Thu Aug 20 00:46:30 2020 +0800

    Update vim color settings for no numberline underscore and italic
 ↪  comments

diff --git a/vim/.vimrc b/vim/.vimrc
index d193be3..f8b8d8a 100644
```

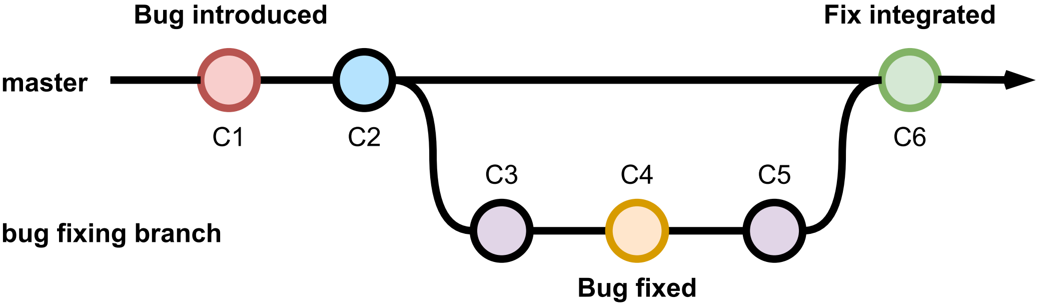
Commit change (Churn)

```
--- a/vim/.vimrc
+++ b/vim/.vimrc
@@ -442,5 +442,10 @@ nnoremap <silent> <space>p
 ↪  :<C-u>CocListResume<CR>

-" Makes vim transparent
+" === Color settngs =====
+" Transparency
 hi Normal guibg=NONE ctermbg=NONE
+" No underline for current line number
+hi CursorLineNr cterm=bold gui=bold
+" Italic comments
+hi Comment cterm=italic gui=italic
```

$$Churn = AddedLines + RemovedLines$$

Measuring fix time



Bug fix time: time difference between C1 and C6 (not C4)

Developers often fix other peoples simple bugs

Table 2: Bug fixes by authorship

Fixed by same author	Fixed by a different author	Total
5,674	4,508	10,182

Bug fix time

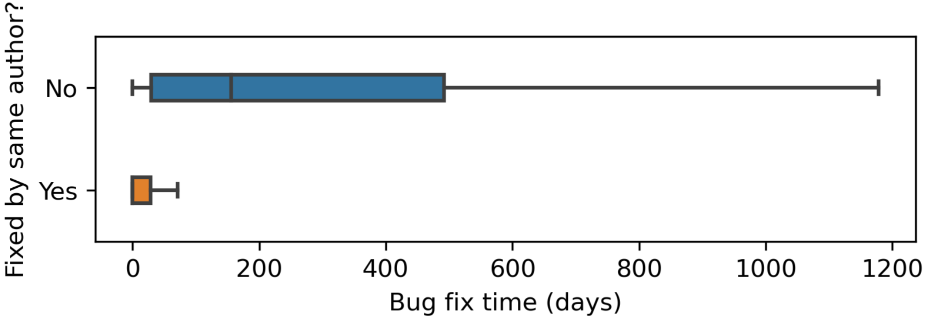


Figure 13: Distribution of bug fix time by authorship

Bug fix size

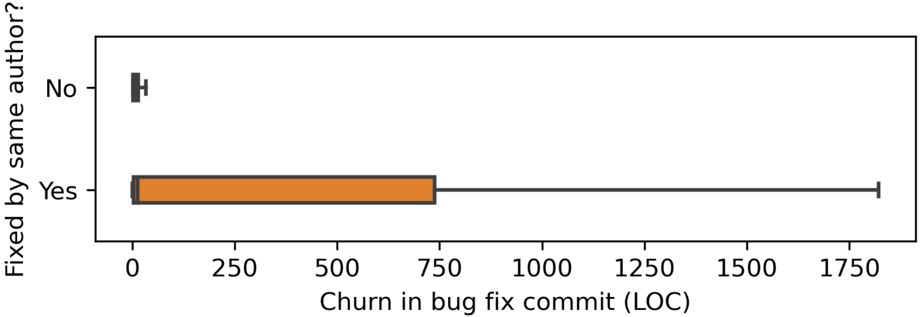


Figure 14: Distribution of bug fix size by authorship

Summary

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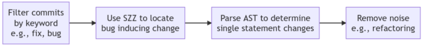

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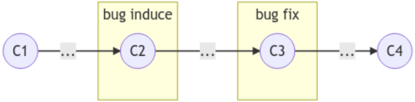

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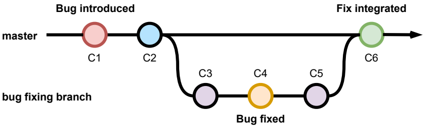

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Commit change (Churn)

```
--- a/vim/.vimrc
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@@ -442,5 +442,10 @@ nnoremap <silent> <space>p
 ↪  :<C-u>CocListResume<CR>

-" Makes vim transparent
+" === Color settngs =====
+" Transparency
 hi Normal guibg=NONE ctermbg=NONE
+" No underline for current line number
+hi CursorLineNr cterm=bold gui=bold
+" Italic comments
+hi Comment cterm=italic gui=italic
```

$$Churn = AddedLines + RemovedLines$$