How Developers Debug Software
The DbgBench Dataset

www.bit.do/dbgbench

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Experiment

Main Objective

- to develop a **dataset** that allows **to evaluate** novel debugging **techniques** w.r.t. **humans.**
- How do **developers explain** the bug?
  - Which **fault locations** do experts point to?
  - Do developers **agree** on a single explanation?
- How do **developers patch** the bug?
  - Do **patch** and **fault locations overlap**?
  - How many human-generated **patches** are **plausible but incorrect**?

Demography

27 real bugs
with simplified bug report and test cases

12 software professionals
11 developers + 1 researcher

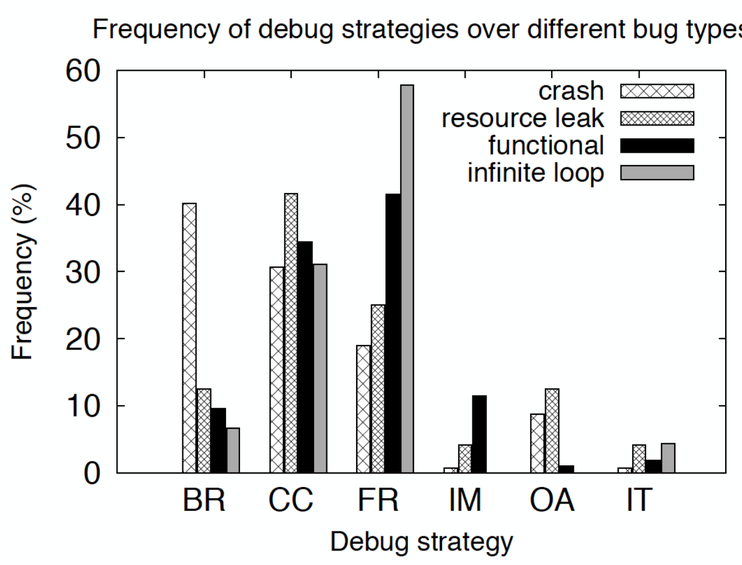
07 plus years experience

06 countries
Russia, India, Slovenia, Spain, Canada, Ukraine

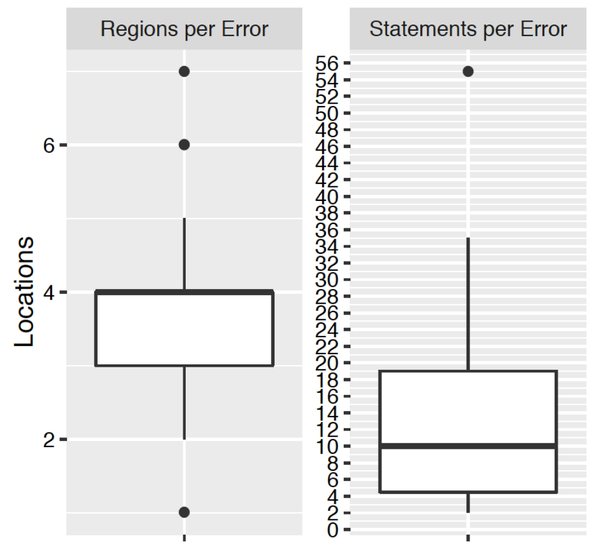
02 Open Source Software
GNU Grep, GNU Find, each with ~17KLOC

29 working days spent debugging these bugs
About 27 hours per developer

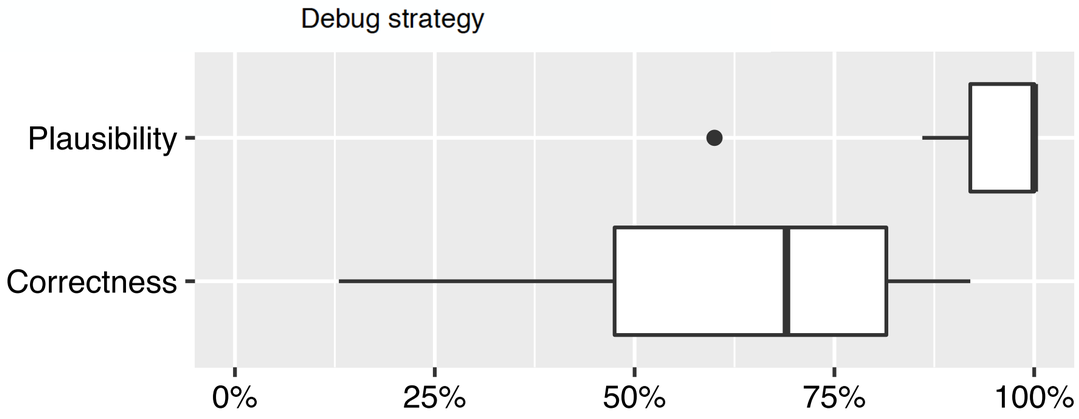
Evaluating debugging aids is difficult and time consuming.

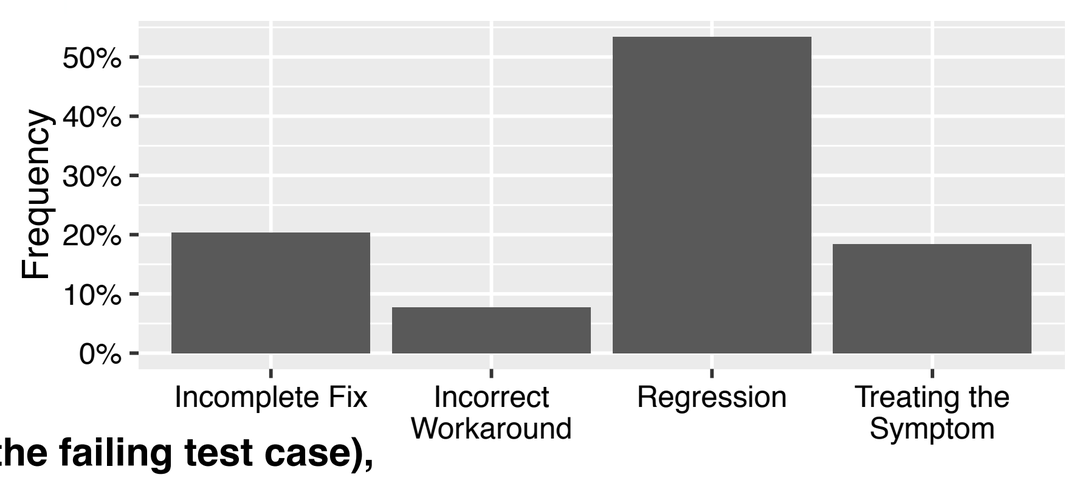


Debugging Strategies
BR - Backward Reasoning
CC - Code Comprehension
FR - Forward Reasoning
IM - Input Manipulation
OA - Offline Analysis
IT - Intuition



For a **single bug**, developers identify **4-20 faulty stmts** in **3-4 distinct regions** distributed across several functions.





While for most bugs *all* submitted patches are *plausible* (i.e., pass the failing test case), for most bugs *30%* of patches are *incorrect* (i.e., fail the code review)!

DbgBench allows for effective evaluation of debugging aids.

Find "-mtime [+-n]" is broken (behaves as "-mtime n")

```
Lets say we created 1 file each day in the last 3 days:
$ mkdir tmp
$ touch tmp/a -t $(date --date="yesterday" +"%y%m%d%H%M")
$ touch tmp/b -t $(date --date="2 days ago" +"%y%m%d%H%M")
$ touch tmp/c -t $(date --date="3 days ago" +"%y%m%d%H%M")

Running a search for files younger than 2 days, we expect
$ ./find tmp -mtime -2
tmp
tmp/a

However, with the current grep-version, I get
$ ./find tmp -mtime -2
tmp/b

Results are the same if I replace -n with +n, or just n.
```

(a) Bug Report and Test Case

If `find` is set to print files that are strictly younger than n days (-mtime -n), it will instead print files that are exactly n days old. The function get_comp_type actually increments the argument pointer timearg (`parser.c:3175`). So, when the function is called the first time (`parser.c:3109`), timearg still points to '-'. However, when it is called the second time (`parser.c:3038`), timearg already points to 'n' such that it is incorrectly classified as COMP_EQ (`parser.c:3178`; exactly n days).

(b) Bug diagnosis and Fault Locations

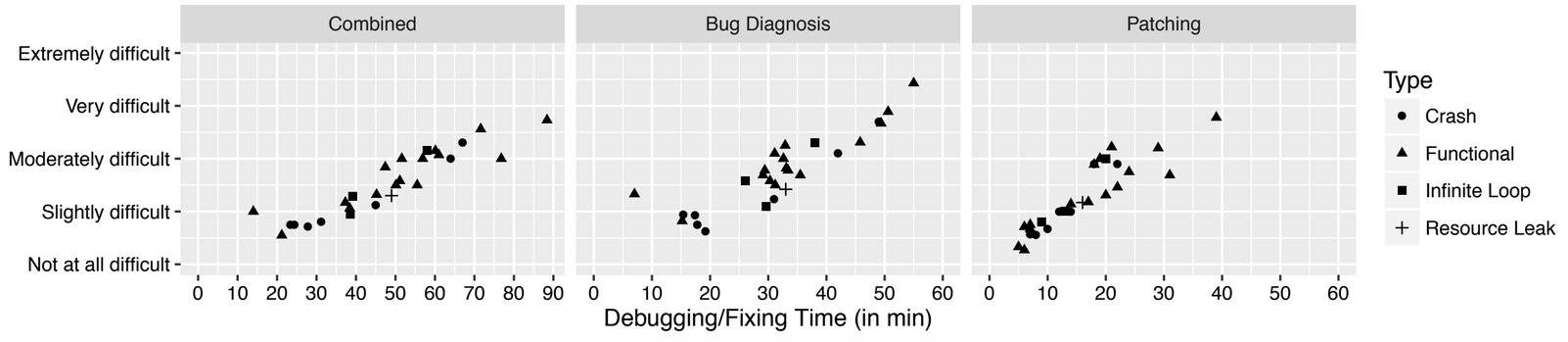
Example Correct Patches

- Copy timearg and restore after first call to get_comp_type.
- Pass a copy of timearg into first call of get_comp_type.
- Pass a copy of timearg into call of get_relative_timestamp.
- Decrement timearg after the first call to get_comp_type.

Example an Incorrect Patch

- Restore timearg only if classified as COMP_LT (*Incomplete Fix* because it does not solve the problem for -mtime +n).

(c) Examples of (in-)correct Patches



DBGBENCH helps to evaluate:

- automated **fault localisation,**
- automated **bug diagnosis,** and
- automated **repair** techniques.

DBGBENCH helps to compare:

- how much **faster** a developer is **diagnosing** and **repairing** a bug using a **novel debugging aid**.

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