Do Time of Day and Developer Experience Affect Commit Bugginess?

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May 22, 2011
Goal

- Find correlation between commit “bugginess” vs. time-of-day, day-of-week and experience/commit frequency of developers

- Perhaps build prediction models to identify bugs or better allocate developer time

- Construct and make available database of bug introducing/fixing commits with useful metadata
Summary of Findings

- Data is available at http://www.eyolfson.com/scc/
- Commits between midnight and 4 AM are more likely to be buggy
- Commits between 7 AM and noon are less likely to be buggy
- More active developers commit fewer bugs
- More experienced developers commit fewer bugs
- The worst day of the week varies between projects
Example

Bug-fixing commit

Commit: 2cdc03fe...
Author: Alice <alice@project.com>
Message: I fixed a bug!
@@ −100,1 +100,1 @@
− if (i <= 128) {
+ if (i < 128) {

Blame of previous version

f4ce718c... 100 if (i <= 128) {
Creating Connections

Definition

A “buggy” or introducing commit is a commit changed by at least one fixing commit

Find the bug fixing commits using a keyword search for “fix”
Keyword search precision of 86%–87% and recall of 71%–73%
Additional Information

- Record the following
  - Commit times (local and UTC)
  - Authors merged by same name/email
  - Number of lines changed in code/comments/other in commit

- We can now determine
  - Whether a commit contains a bug and how many fixes were applied
  - Developer experience
  - Bug lifetime
<table>
<thead>
<tr>
<th></th>
<th>Linux kernel</th>
<th>PostgreSQL</th>
</tr>
</thead>
<tbody>
<tr>
<td>First commit</td>
<td>April 16, 2005</td>
<td>July 9, 1996</td>
</tr>
<tr>
<td>Last commit</td>
<td>Nov. 21, 2010</td>
<td>Jan. 24, 2011</td>
</tr>
<tr>
<td>Lines of code</td>
<td>over 5 million</td>
<td>over 750,000</td>
</tr>
<tr>
<td>Number of authors</td>
<td>6,504</td>
<td>34</td>
</tr>
<tr>
<td>Total commits</td>
<td>222,332</td>
<td>31,098</td>
</tr>
<tr>
<td>Introducing commits</td>
<td>56,590 (25.5%)</td>
<td>7,388 (23.8%)</td>
</tr>
<tr>
<td>Fixing commits</td>
<td>61,044</td>
<td>6,578</td>
</tr>
</tbody>
</table>

Note: these are the up-to-date results at [http://www.eyolfson.com/scc/](http://www.eyolfson.com/scc/)
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## Results

### Time-of-day

**Linux - Most Commits Late Afternoon**

- **Graph**
  - **X-axis**: Time of day (hour)
  - **Y-axis**: Percentage of buggy commits
  - **Legend**: Total commits

- **Observation**: Most commits are made late in the afternoon.

- **Data**
  - Hours: 1 to 23
  - Percentage of buggy commits: 0% to 32%
  - Total commits: 0 to 18000
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Time-of-day

Linux - Late Night Commits are Up To 21% More Buggy

[Bar chart showing percentage of buggy commits by time of day for Linux, with late night commits being up to 21% more buggy.]
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Results

Linux - Early Morning Commits Produce Up To 25% Fewer Bugs
PostgreSQL - Most Commits In Evening
Results

Time-of-day

PostgreSQL - Late Night Commits are Up To 27% More Buggy
PostgreSQL - Early Morning Commits Produce Up To 28% Fewer Bugs
Our Definition of Experience

**Definition**

Experience is the number of days from the author’s first commit to the current commit

- Consider two of an author’s commits who started on May 1st
  - May 1st
  - May 22nd
- First commit would be 0 days experience and second 21 days
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Results

Developer Experience

Linux - More Experienced Developers Commit Fewer Bugs
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**Results**

**Developer Experience**

PostgreSQL - More Experienced Developers Commit Fewer Bugs
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Results

Developer Commit Frequency

Our Frequency Classifications

- Based on frequency
- Daily, weekly, monthly, single

Definition

“Job” is a daily committer with the majority of commits between working hours

Definition

“Other” is a committer with fewer than 20 commits
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**Results**

**Developer Commit Frequency**

*Linux - More Active Developers Commit Fewer Bugs*

*Graph showing the percentage of buggy commits and the number of commits for different author classifications: Job, Daily, Weekly, Monthly, Other, Single.*

- **Number of commits**:
  - Job: 180000
  - Daily: 160000
  - Weekly: 140000
  - Monthly: 120000
  - Other: 100000
  - Single: 80000

- **Percentage of buggy commits**:
  - Job: 20%
  - Daily: 30%
  - Weekly: 40%
  - Monthly: 50%
  - Other: 60%
  - Single: 70%
Results

Combined Time-of-day and Experience

Linux - Inexperienced Developers Have More Late Night Commits
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Results

Combined Time-of-day and Experience

Linux - Both Sets of Developers Have Similar Good and Bad Hours
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Day-of-week

Linux - More Bugs Committed on Monday

[Bar chart showing percentage of buggy commits by day of the week, with Monday having a significantly higher percentage compared to other days.]
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Day-of-week

Linux - Fewer Bugs Commited on Sunday
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Results

Day of the week

PostgreSQL - More Bugs Committed on Sunday
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Results

PostgreSQL - Fewer Bugs Commited on Tuesday

![Graph showing percentage of buggy commits by day of the week for PostgreSQL. Tuesday has the lowest percentage, indicating fewer bugs committed on that day.](image-url)
Definition

Bug lifetime is the number of days from a fixing commit to the earliest bug introducing commit

- Found the average bug lifetime was
  - 1.38 years ($\sigma = 1.35$) for Linux
  - 3.07 years ($\sigma = 3.19$) for PostgreSQL
Previous Studies

- Commits for Eclipse and Mozilla were found to be buggiest on Fridays [Śliwerski et al., 2005, MSR]
- Classification of commits into different categories [Hindle et al., 2008, MSR]
- Bug lifetimes for PostgreSQL [Kim and Whitehead Jr, 2006, MSR]
  - Average of 2 years
For the Future

- Study individual developers
  - Are commits outside their normal schedule worse?
  - Experience including other open-source projects?
- More software projects
- Correlations involving code quality
- Prediction models
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