OSS2018 – 14th International Conference on Open Source Systems
June 8-10, 2018,
Harokopio University, Athens, Greece

Developer Dynamics and Syntactic Quality of Commit Messages in OSS Projects

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Open Source Software Development

- Community plays an important role
- Volunteer participation
- Dynamic Community
  - No fixed roles
  - People can leave/join any time
    - Lean/active periods
- to investigate community dynamics and its impact on OSS development process.
  - understand the impact of community dynamics on the quality of contributions committed to a project‘s repository.

Existing work related to Commit Analysis, Community Dynamics and Software Quality

- Most of the works in the research literature on commit analysis of OSS projects deal with identifying
  - commit size distribution [3],
  - commit frequency distribution [13],
  - commit characterization [17, 23], and
  - Contributor's commit activity distribution [8].
    - Chełkowski *et al.* [8] analysed commit contributions of Apache contributors to highlight inequalities among open source contributors' in producing content in the OSS paradigm which is often described as collaborative.
- Code quality decreases as the number of contributors increases [2]
- Quality of components (measured using the number of defects) developed by distributed teams was bad in comparison to the quality of components developed by collocated teams[7].

The Research Agenda

- Lack of literature on the subject and the broad nature of practitioner recommendations
  - the Multi-vocal Literature Review (MLR) approach [8].
- Measuring commit message quality by using 11 metrics related to the syntax of a commit message.
- To explore if there is any relation between community dynamics and the commit message quality of the OSS projects.

What is a Good Commit?

- A good quality commit contains a well-crafted message with all the necessary details (meta-data) to effectively convey the change to current or future developers [5].
- A good commit message should follow a simple and consistent style for specifying commit meta-data and content.

Table 1. Rules for writing a good commit

1.	Title (subject line) of commit message should be short (between 50-72 characters).
2.	Subject line should end with a dot.
3.	Capitalize the subject line i.e. first character of the subject line should be capital.
4.	Use imperative mood in the subject line for example use words like fix, add, update in place of fixing, adding, and updating etc.
5.	Subject line should be concise and limit the number of “and”, “or”.
6.	Subject line should not include details such as bug number, file name, ticket number, and any other external references.
7.	Subject line and body must be separated by a blank line.
8.	Body of a commit message must have multiline description. It should be well explanatory detailing why and what is changed.
9.	Body of a commit message should not contain lots of bullets, hyphens, or asterisks.
10.	A Commit should have one logical change.

Table 2. Commit Message Syntactic Quality Measures

Commit Quality Measures	Commit Score					
	1	2	3	4	5	unit
Length of Title	=0 or >72	1-10	11-30	31-50	51-72	number of characters
Title ends with dots	No	Yes				y→1, n→0
Title first character capital	No	Yes				y→1, n→0
Count number of "and" "or" in Title	>6	5-6	3-4	1-2	0	count
Count number of "file name" in title	>6	5-6	3-4	1-2	0	count
Count number of external references in title	>6	5-6	3-4	1-2	0	count
Imperative mode in title	No	Yes				y→1, n→0
Commit body existence	No	Yes				y→1, n→0
Count number of "file name" in body	0	10>	6-10	3-5	1-2	count
Count number of external references in body	0	10>	6-10	3-5	1-2	count
Count number of paragraph in body	0	10>	5-10	3-4	1-2	count

Measuring the Commit Message Quality

1. Normalize the scores of individual measures to a common scale [0, 1].
2. Calculate the weighted average to find the total commit score
3. Validated the Metric definitions using survey based approach
   - 20 participants
   - 16 graduate and 4 under-graduate
   - 5 to 7 years experience in software projects based on Java/C#
   - The participants were asked to upvote a rule if they agree, downvote a rule if they don't agree, or post a neutral response if it does not matter to them while reading a commit message.
   - to further validate the results of the commit message quality score, the results of the proposed model for a sample of 100 commits messages (50 with commit messages as per the rules and 50 otherwise) were compared with the assessment results made available by the same survey participants.
   - The results show that 84% of the commit messages were correctly judged by the proposed model. Specifically, for commit messages with good quality, about 88% of messages were correctly judged, and about 80% of messages with poor quality were correctly judged by the proposed model.

Table 4. Descriptive Statistics of the OSS projects

OSS Projects	Origin Date	Number of Months	Number of Contributors	Commit messages	
PostgreSQL	Jul, 1996	239	43	54355	
glibc	Feb, 1989	321	410	43313	
Eclipse-CDT	Jun, 2002	168	203	28817	
GnuCash	Nov, 1997	222	105	21969	
WordPress	Apr, 2003	158	73	37333	
Firebug	Aug, 2007	181	45	13043	
Rhino	Apr, 1999	105	56	3721	

Analyzing the quality of commit messages in the OSS projects

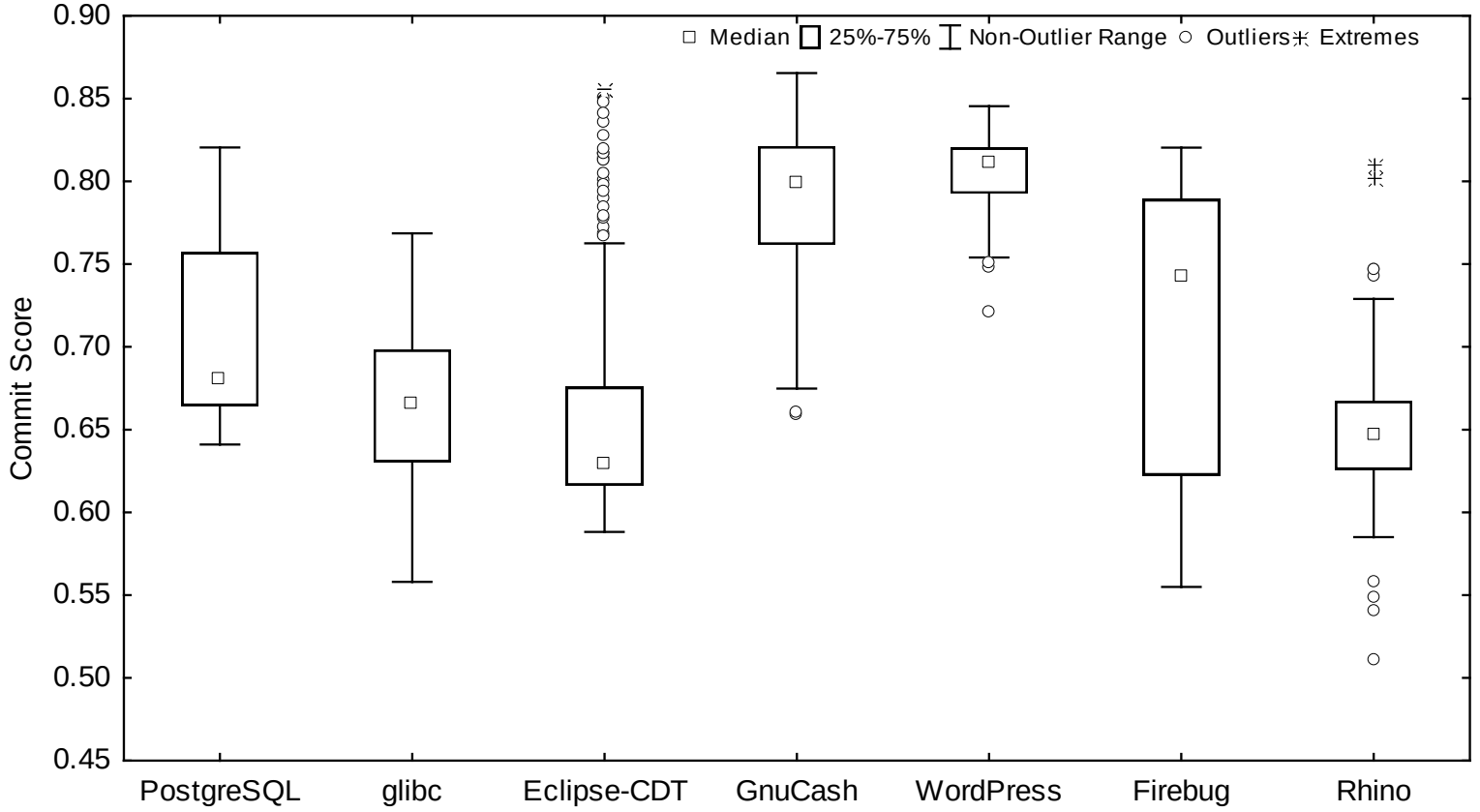
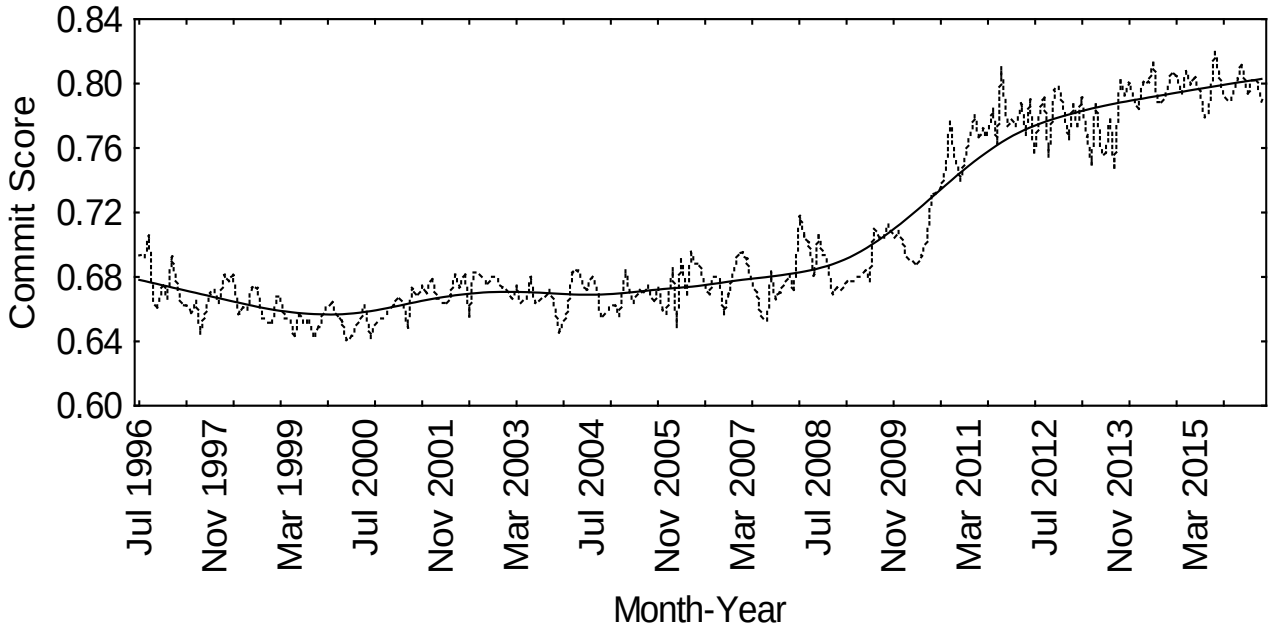
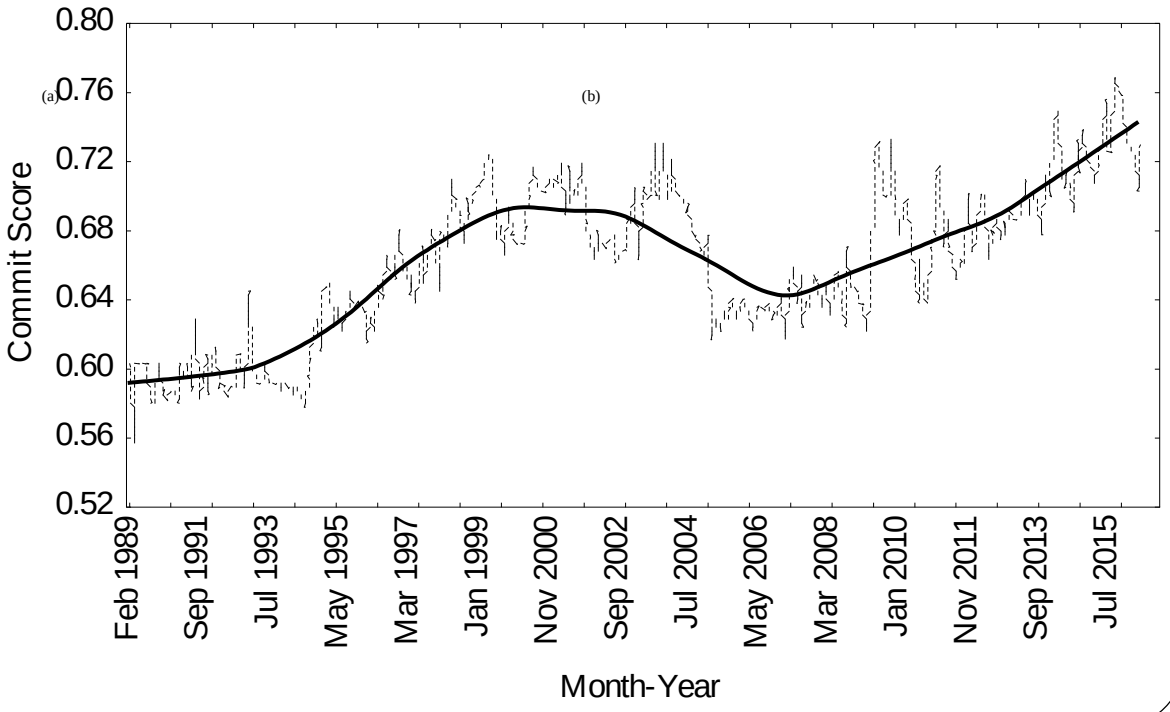


Fig. 1. Variation in commit quality of the OSS projects



PostgreSQL

glibc



Commit Score
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Month-Year

Commit Score
0.88
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0.88
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Commit Score
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Nov 2007
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Sep 2009
Aug 2010
Jul 2011
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May 2013
Apr 2014
Mar 2015
Feb 2016
Month-Year

0.84
0.80
0.76
0.72
0.68
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Commit Score
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Does the number of contributors affect the commit message syntactic quality?

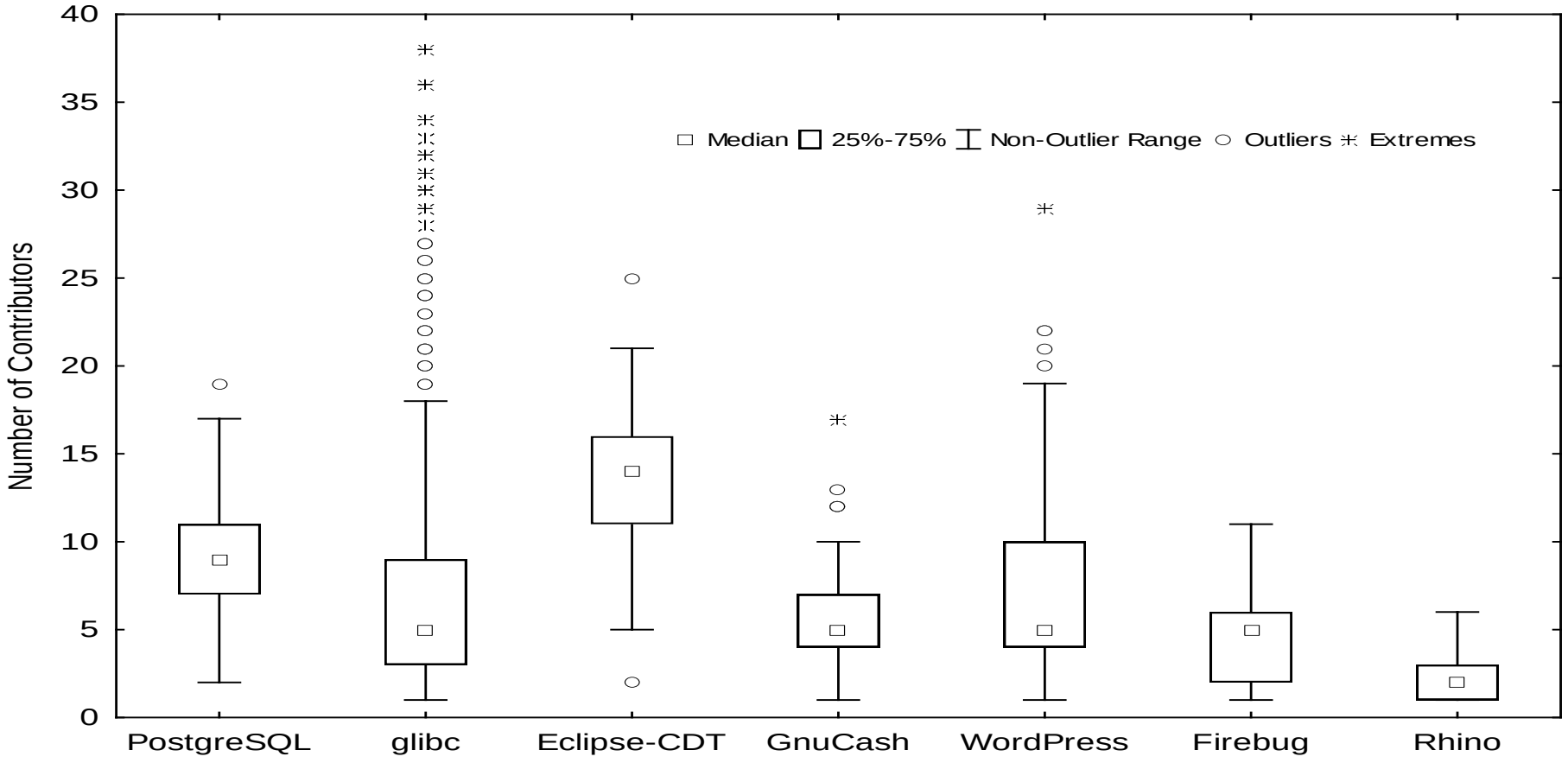
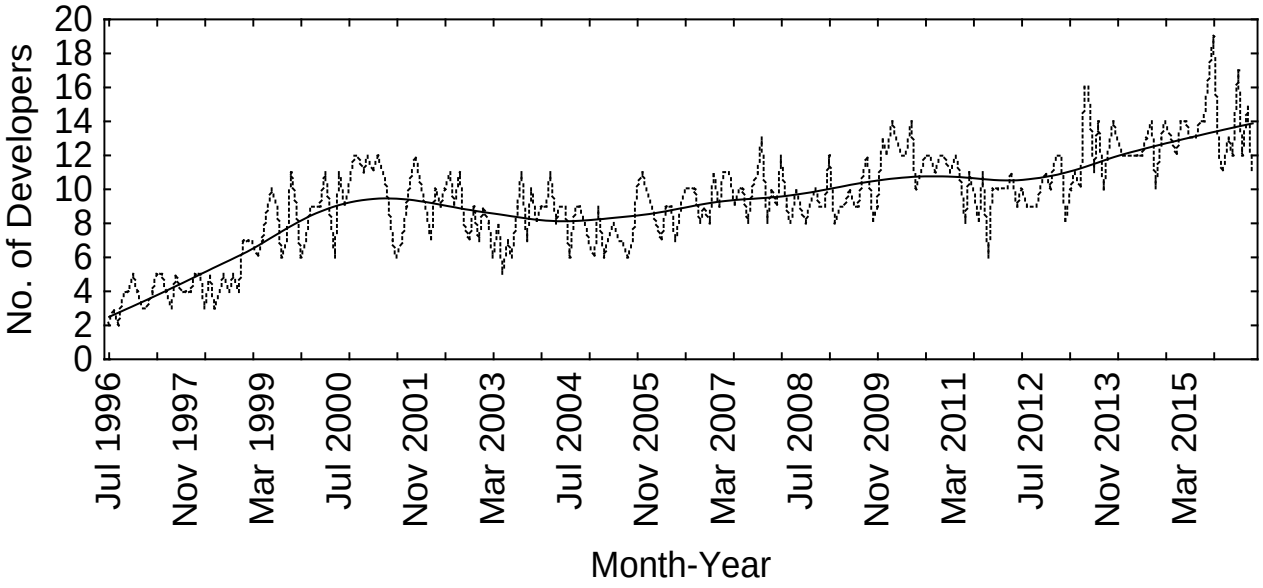


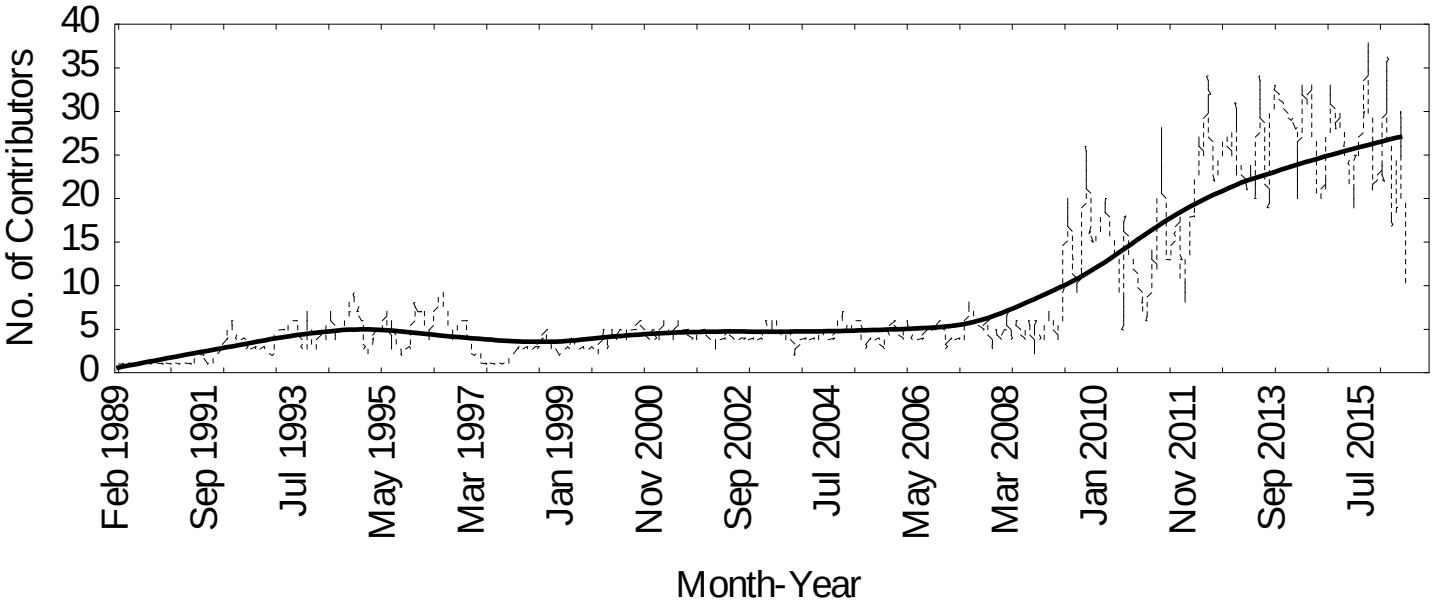
Fig. 3. Variation in the number of contributors of the OSS projects

Contributor churn of the OSS projects over the period of time



PostgreSQL

glibc



No. of Contributors
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No. of Contributors
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No. of Contributors
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Understanding the Contribution Pattern

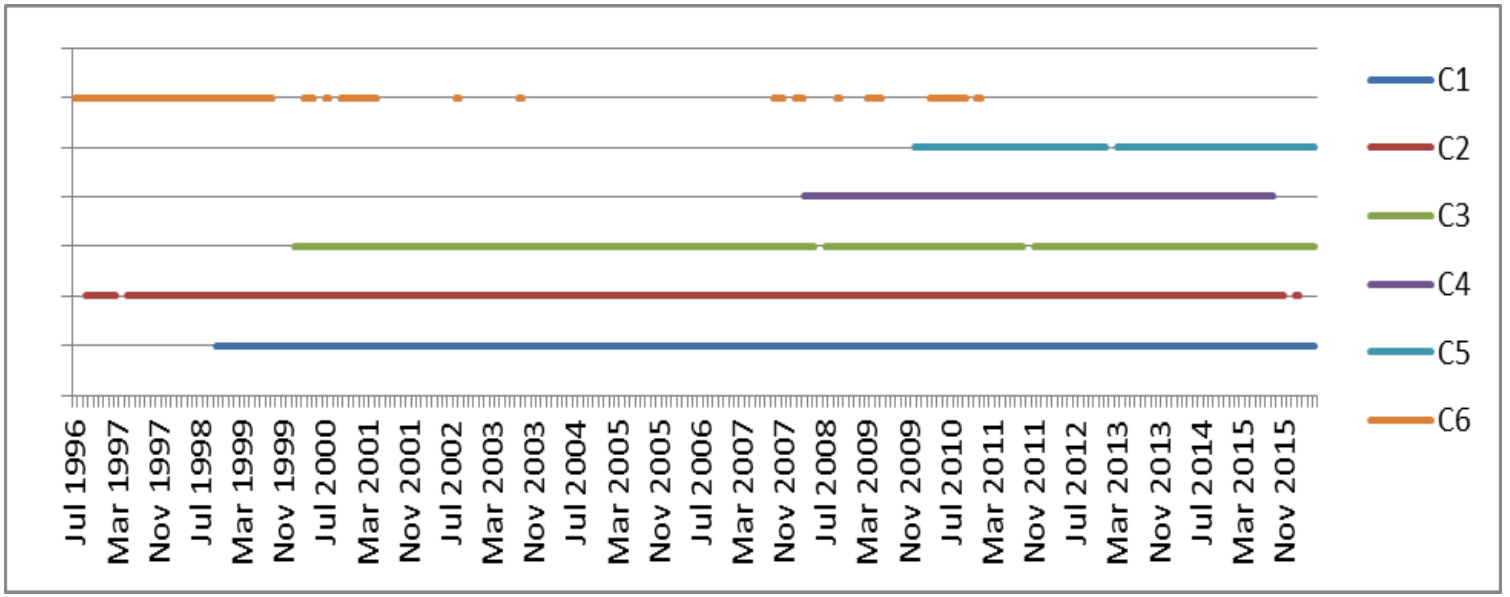
In this regard, the first step is to find commit distribution among different contributors of the OSS projects to identify the core group of contributors.

Next, we analyze their commit behavior from two perspectives – commitment (i.e. regularity to commit), and the level of skill (i.e. commit message quality)

Table 7. Contributor wise commits distribution (in %)

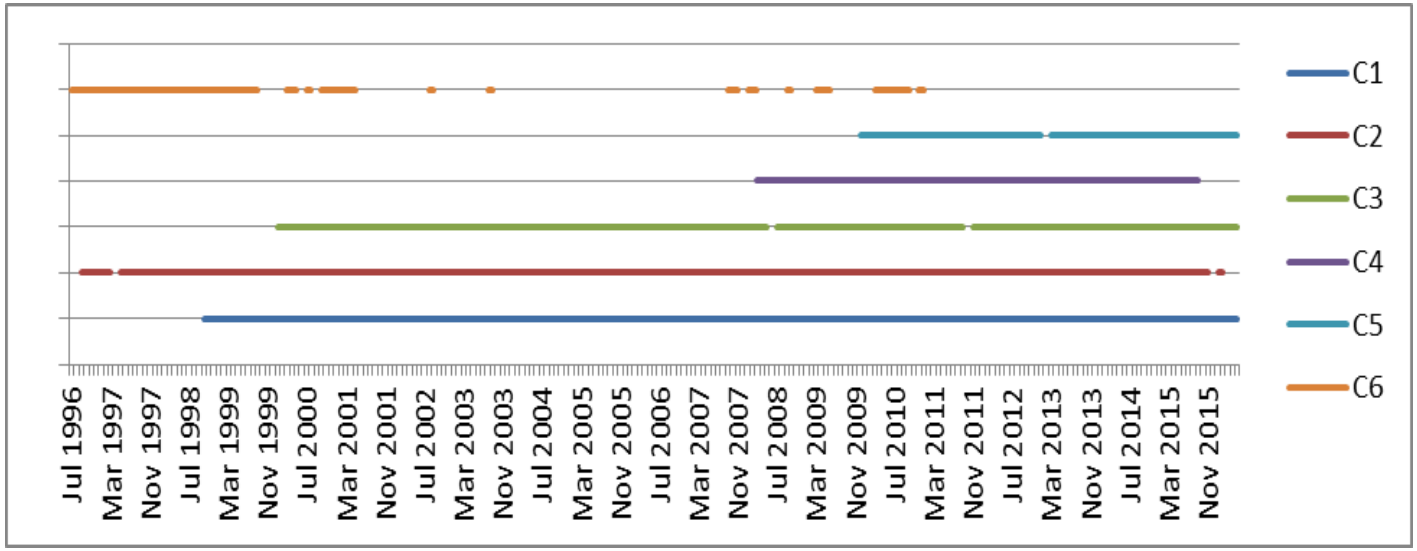
OSS Projects	C1	C2	C3	C4	C5	C6	Other
PostgreSQL	34.53	26.52	7.35	3.62	3.33	3.10	21.55
glibc	40.58	24.18	4.72	4.14	3.56	3.36	19.46
Eclipse-CDT	10.11	7.90	6.43	5.64	5.56	5.52	58.84
GnuCash	16.66	14.84	12.65	7.93	7.57	7.57	32.78
	22.1				4.7	3.8	

Commit regularity



Analyzing Commit Regularity and Commit Quality

PostgreSQL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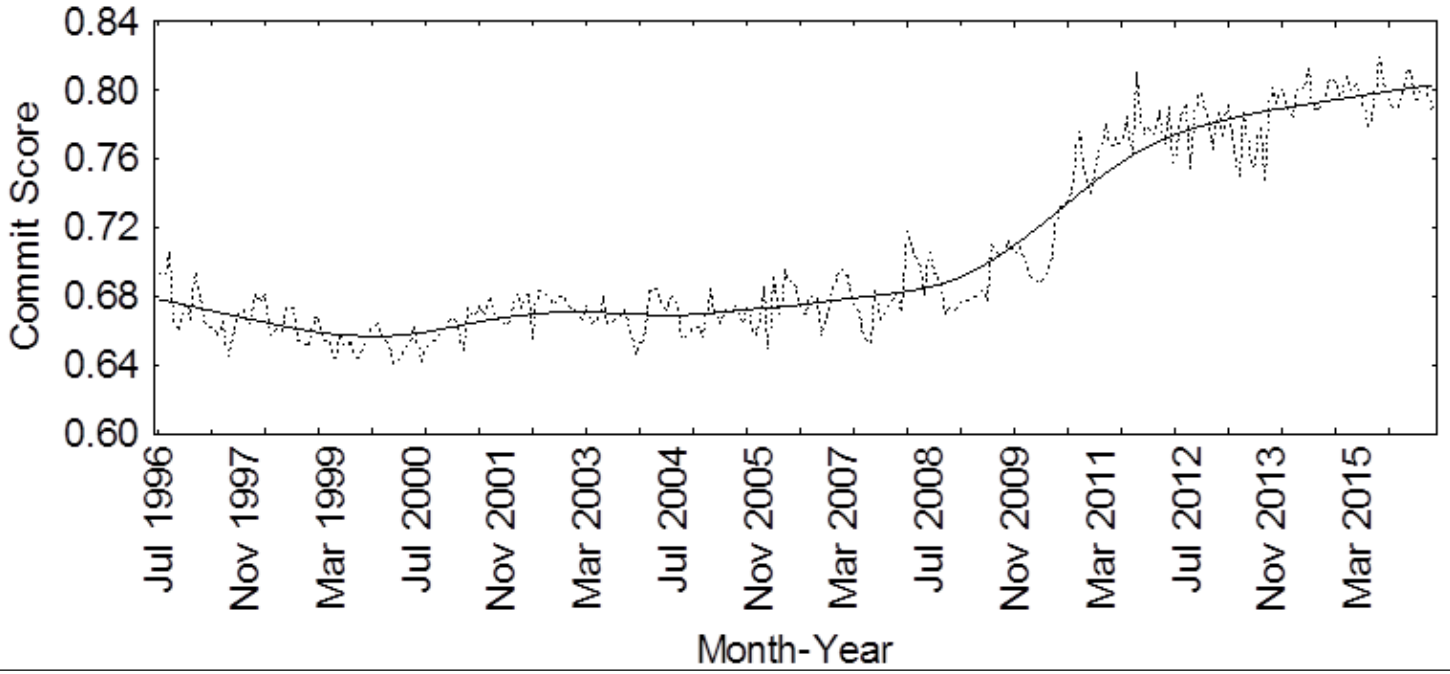
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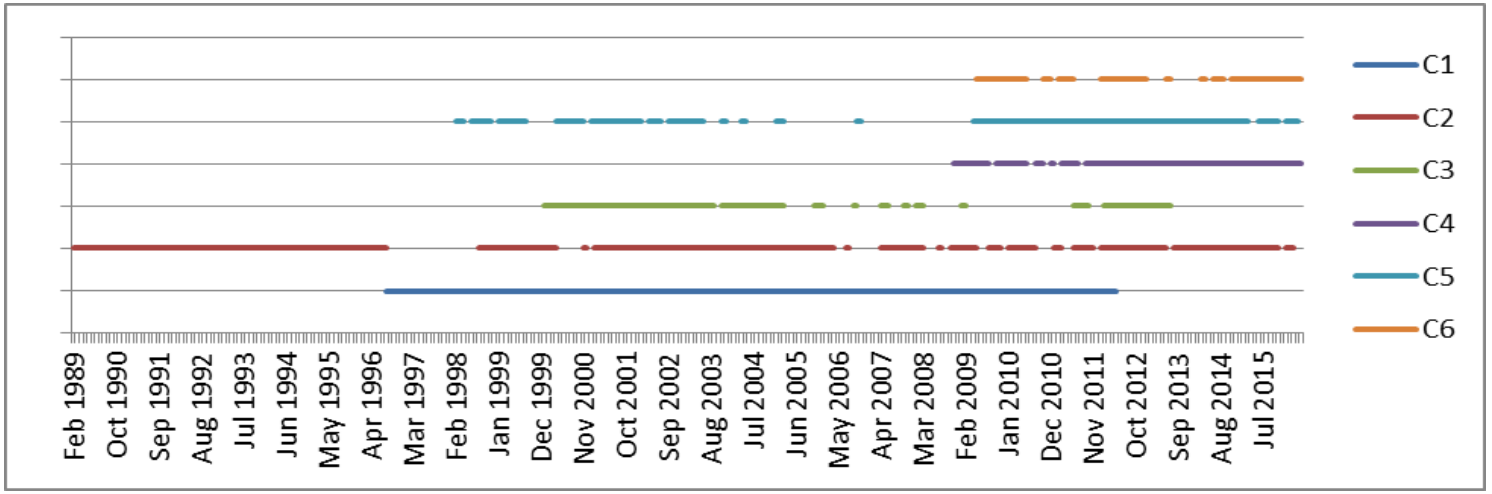
glibc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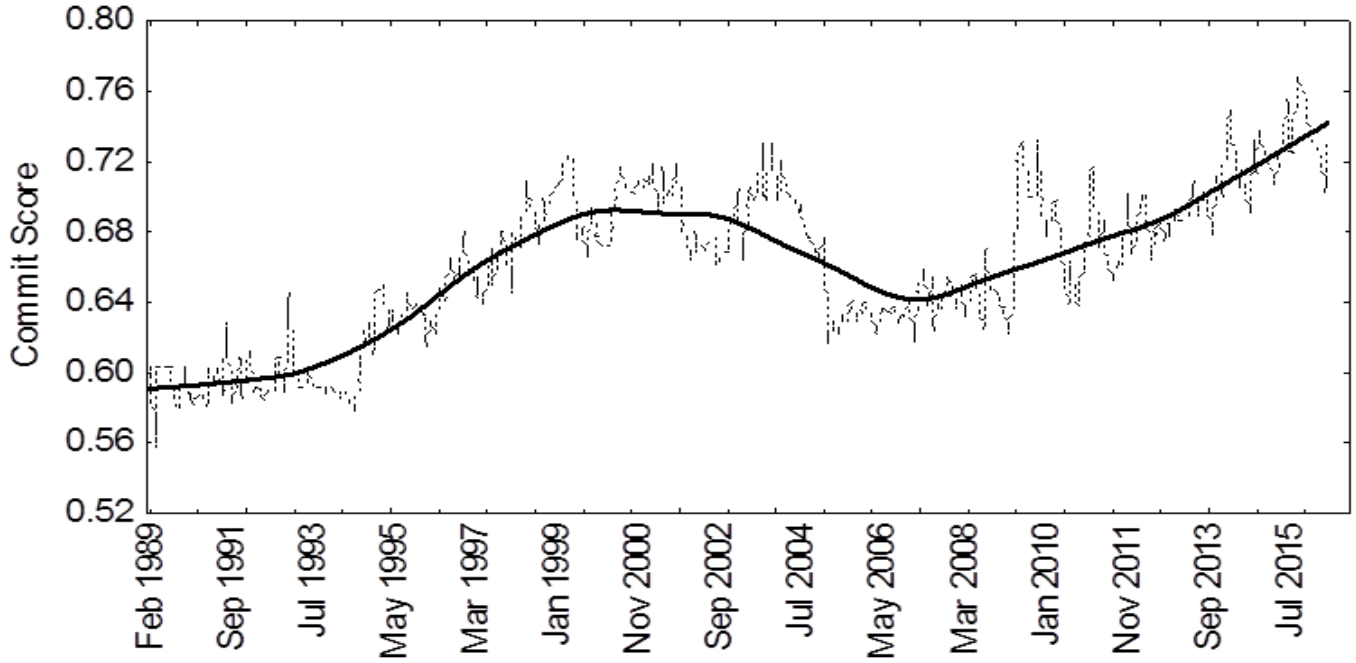
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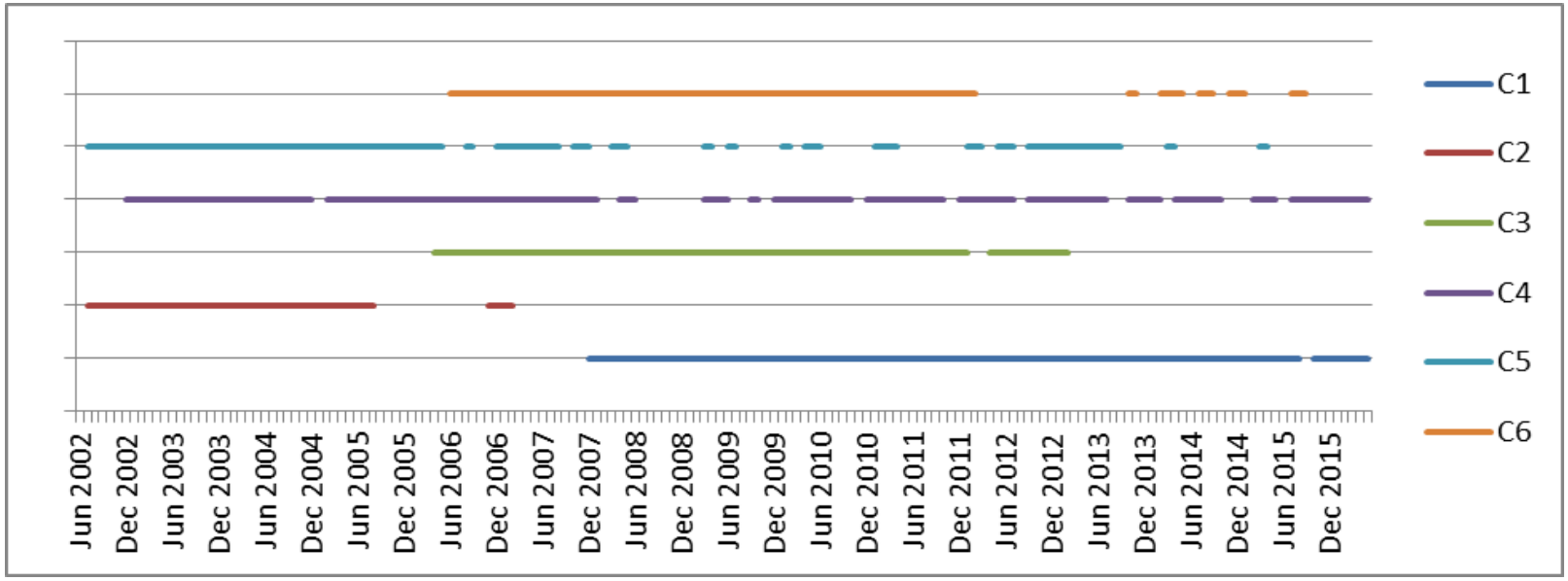
Eclipse-CDT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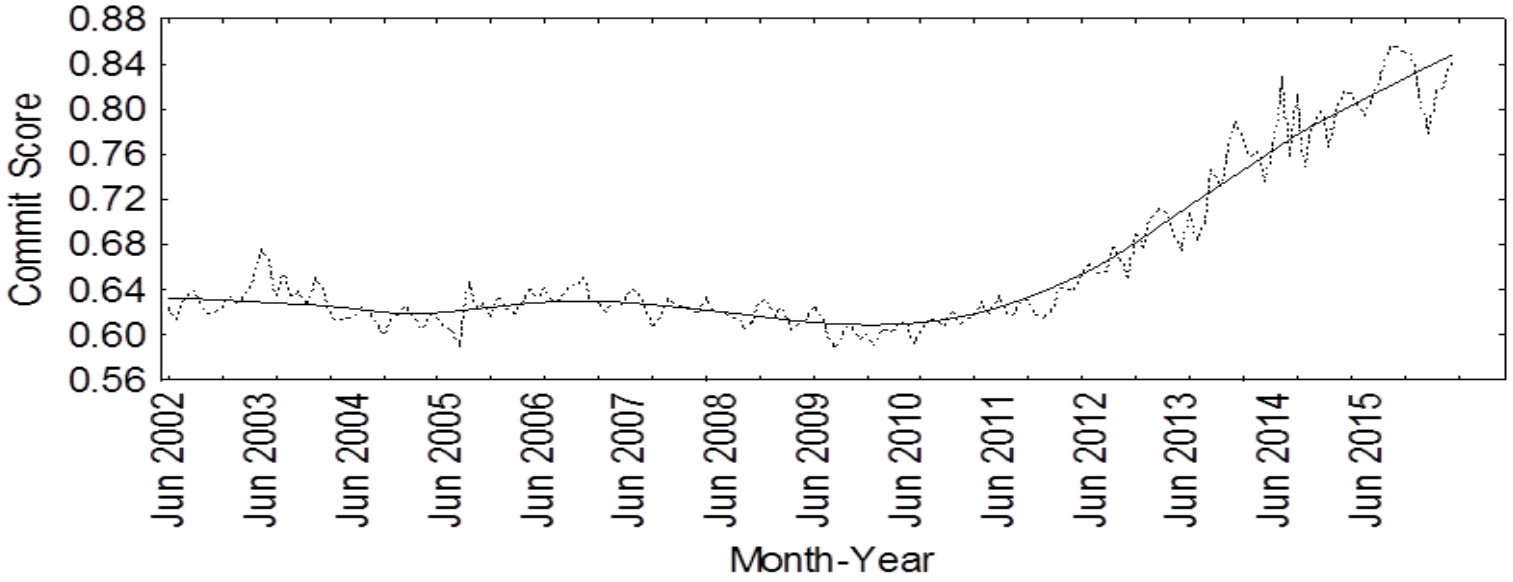
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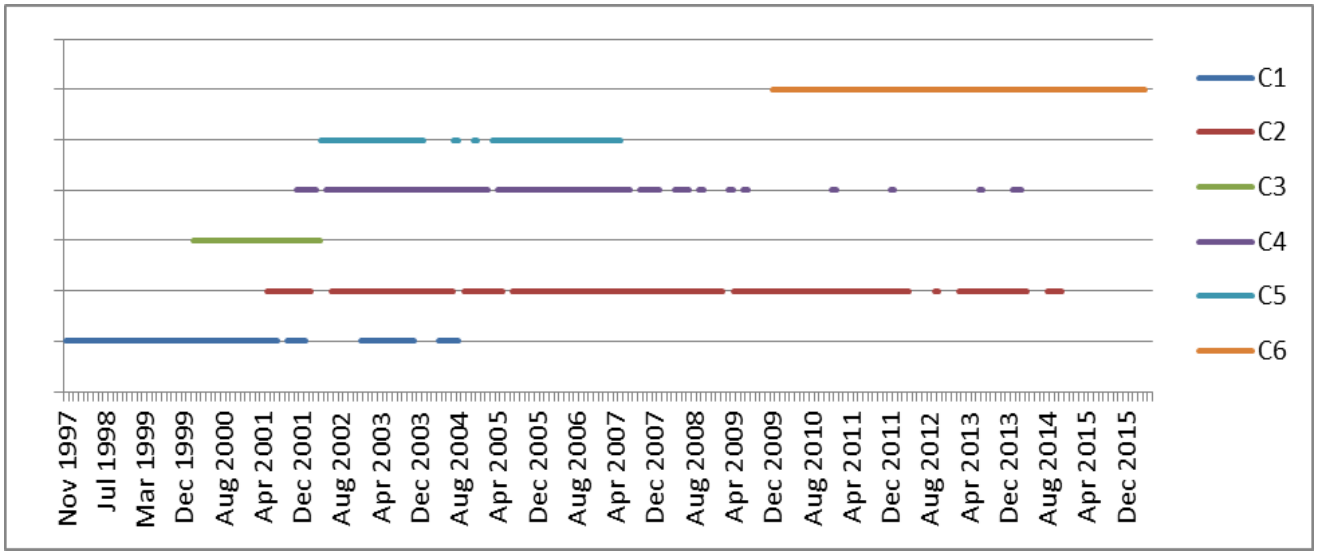
GnuCash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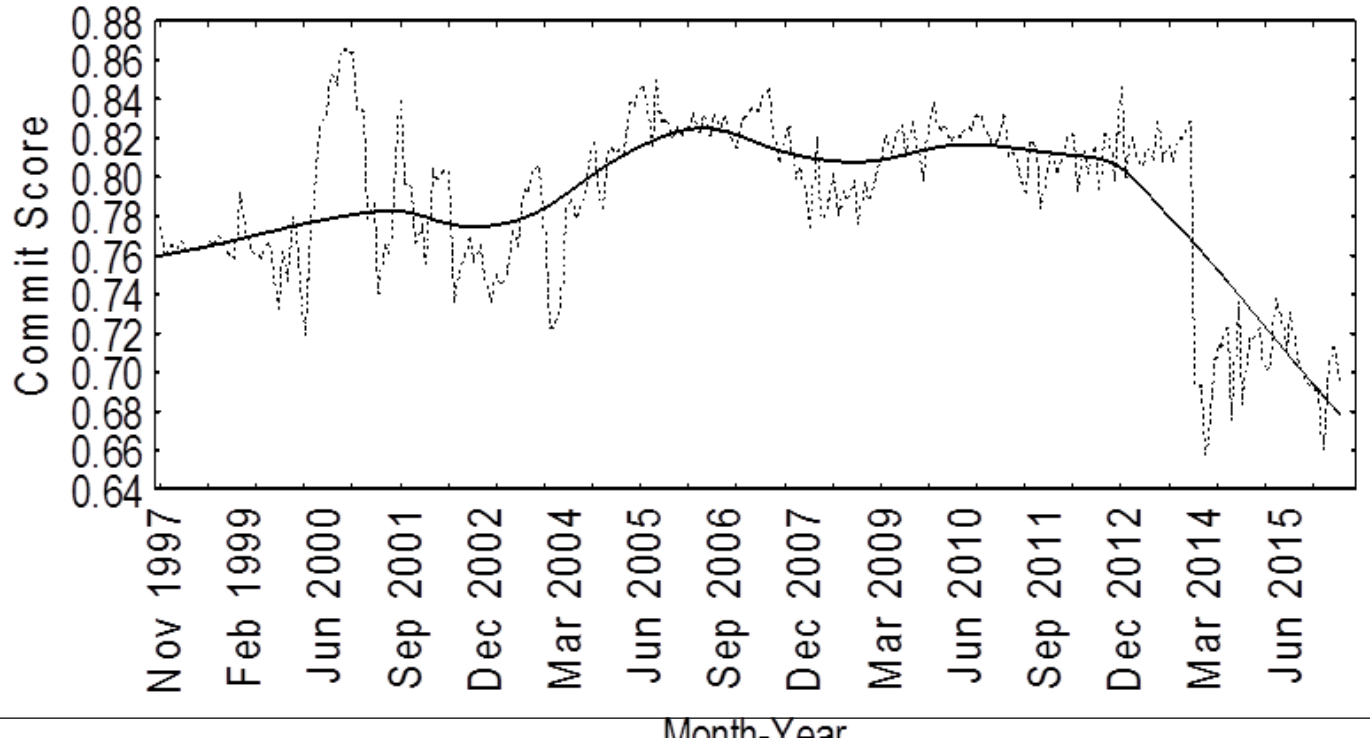
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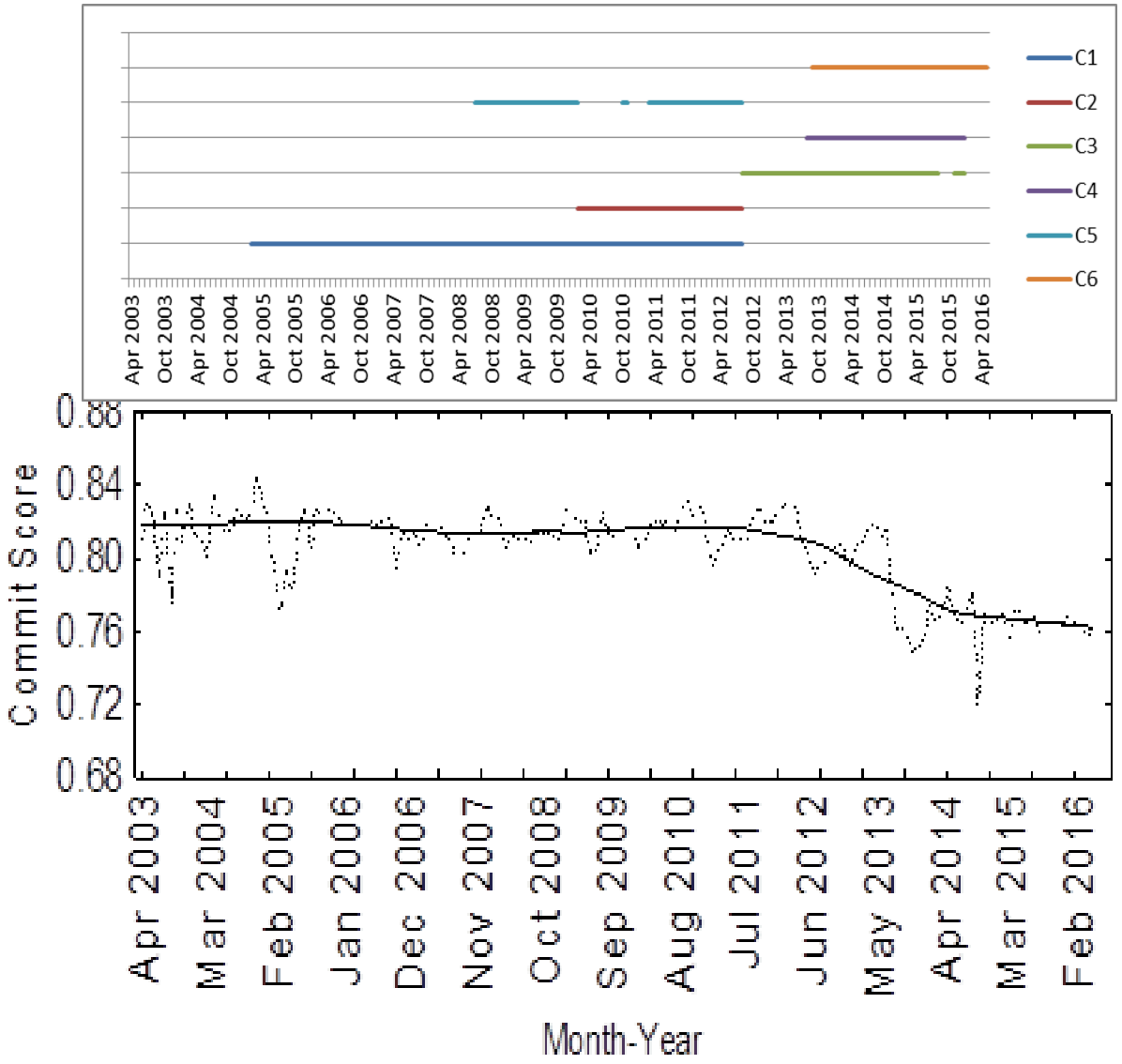
WordPress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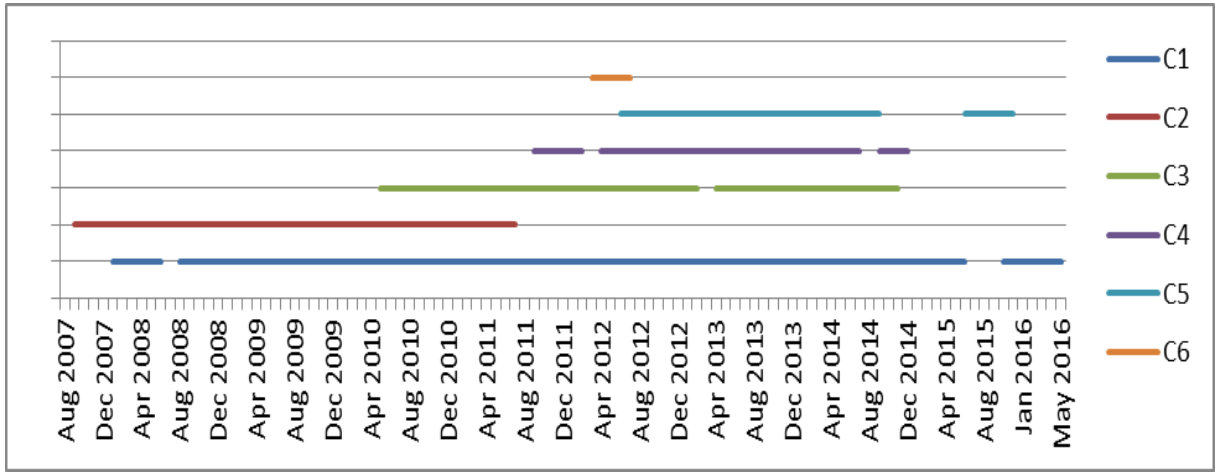
Firebug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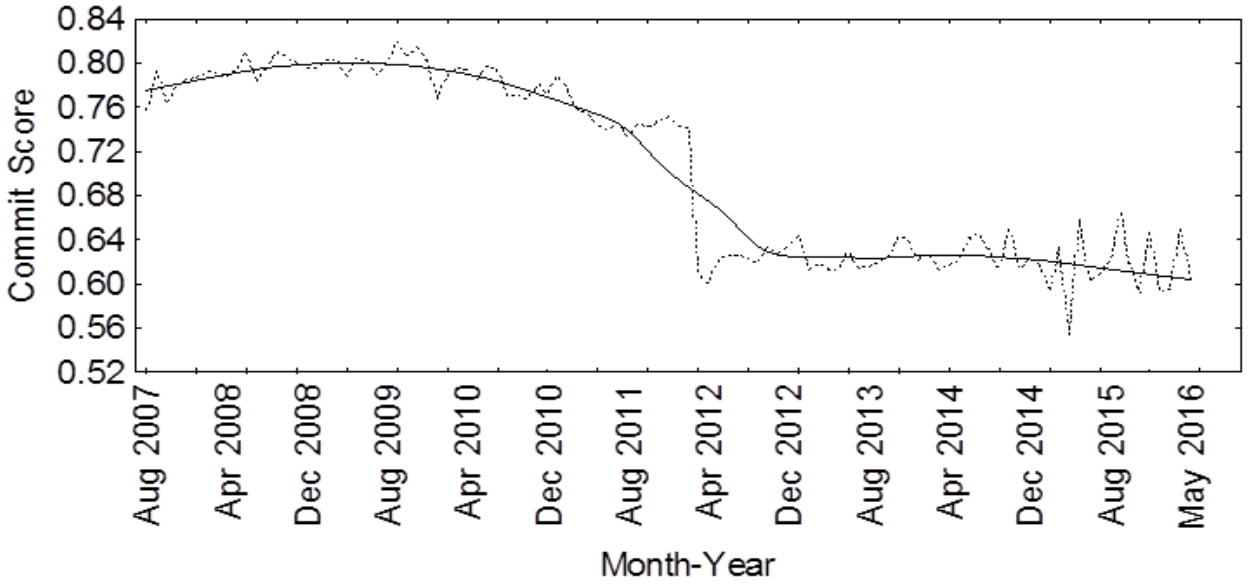
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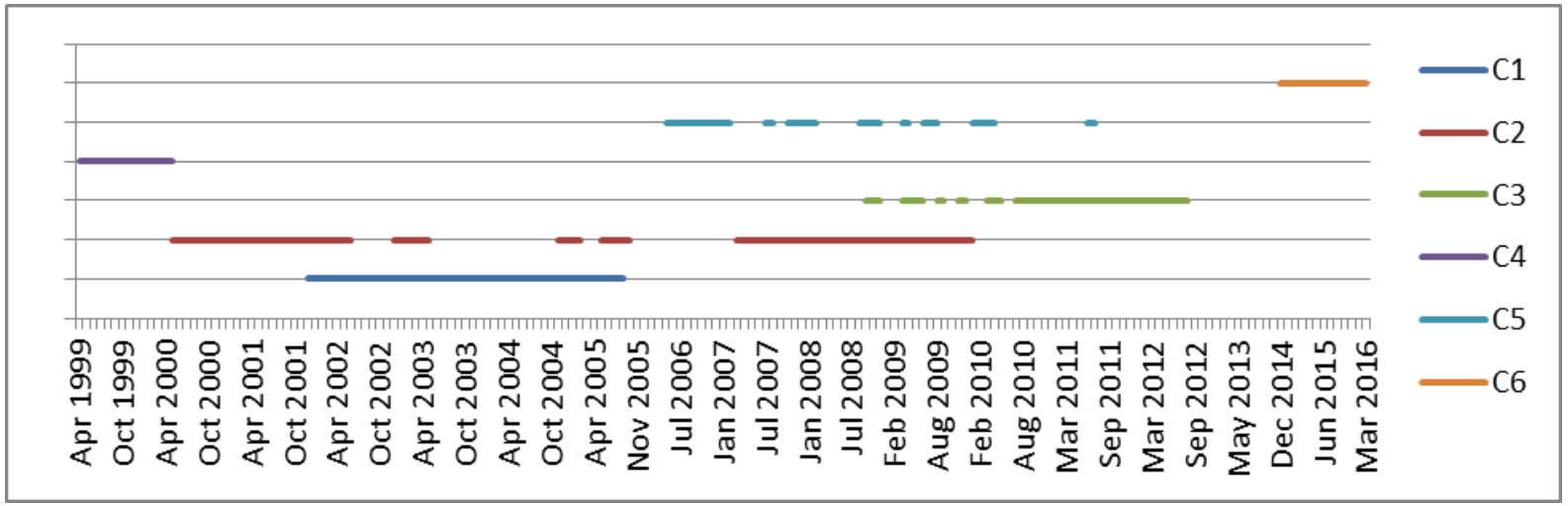
Rhino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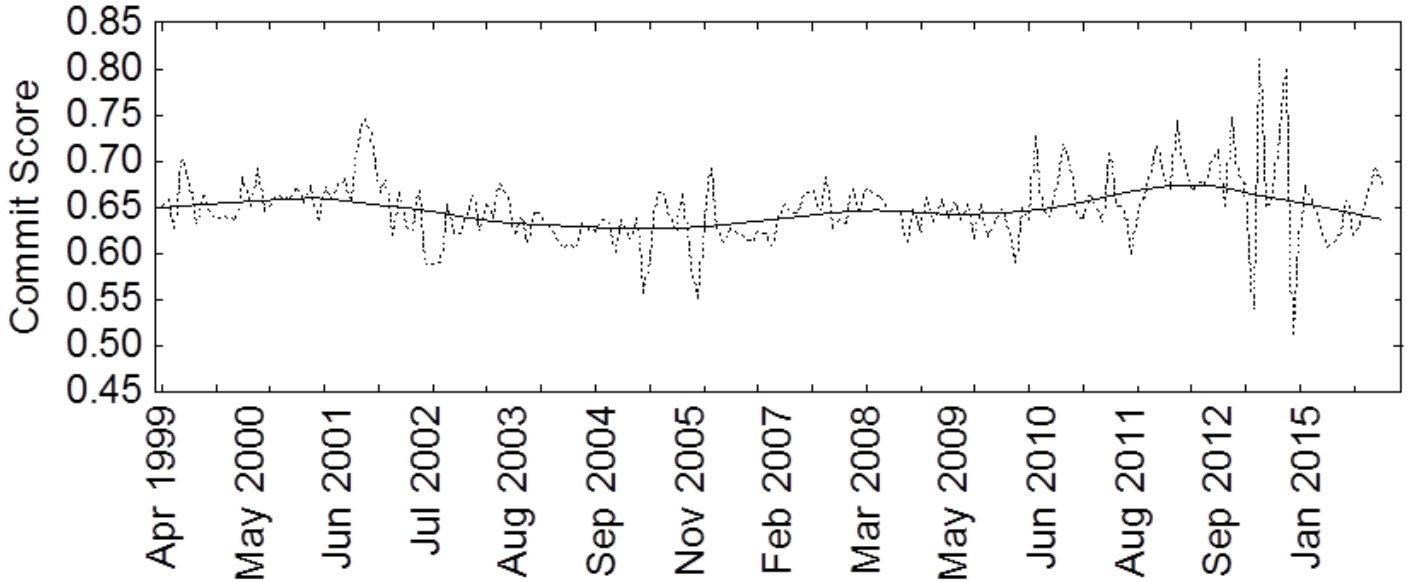
Commit Score
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Conclusions

- The major objective of this study was to understand the impact of community dynamics on the quality of contributions submitted to a source code management system of an OSS project.
- A commit message quality model is proposed to evaluate the syntactic quality of commit meta-data submitted by the contributors of an OSS project.
- Commit quality improves when multiple contributors become active at the same time (PostgreSQL, glibc, GnuCash).
- In some cases (Wordpress and Firebug), commit quality degrades when some contributors start contributing to the project repository.

Future Work

- To analyze the semantic quality of commits
- To analyze the commit message quality of different types of commits such as corrective v/s non-corrective
- To investigate the relevance of commit message quality with quality of the code contributed as part of commits
- To profile developers on the basis of the quality of their contributions for developer labeling.

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