

Categorizing Bugs with Social Networks: A Case Study on Four Open Source Software Communities

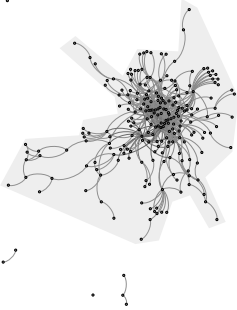
Ingo Scholtes, Marcelo Serrano Zanetti, Claudio Juan Tessone, Frank Schweitzer

Chair of Systems Design
ETH Zürich, Switzerland
{ischoltes, mzanetti, tessonec, fschweitzer}@ethz.ch

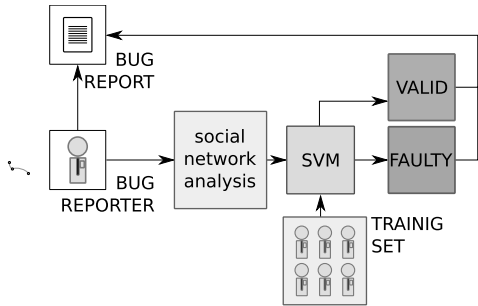
Abstract: Efficient bug triaging procedures are an important precondition for successful collaborative software engineering projects. Summarizing the results of a recent study [ZSTS13], in this paper we present a method to automatically identify *valid* bug reports which a) contain enough information to be reproduced, b) refer to actual software issues, and c) are not duplicates. Focusing on the social dimension of bug handling communities, we use network analytic measures to quantify the position of bug reporters in the collaboration networks of Open Source Software (OSS) communities. Based on machine learning techniques we then use these measures to predict whether bugs reported by users will eventually be identified as *valid*. A study on a large-scale data set covering more than 700,000 bug reports that have been collected from the BUGZILLA installations of four major OSS communities shows that our method achieves a remarkable precision of up to 90%.

In large collaborative software engineering projects, the process of triaging, categorizing and prioritizing bug reports can become a laborious and difficult task that consumes considerable resources. The magnitude of this problem calls for (semi-)automated techniques that assist bug handling communities in the filtering of important bug reports. Due to the importance for practitioners, different approaches for the automated classification of bug reports have been studied, most of which have been focused on the information provided in the bug report itself. Fewer studies have focused on human aspects like, e.g., coordination patterns or the reputation of bug reporters. Based on data covering the full history of 700,000 bug reports in the BUGZILLA installation of the four OSS projects ECLIPSE, NETBEANS, FIREFOX and THUNDERBIRD, in this work we study whether quantitative measures for the position of bug reporters in a project's social organization can be used to predict whether reported bugs will eventually be classified as helpful by the community. Our approach is based on the extraction of evolving collaboration networks from time-stamped collaboration events between community members that can be inferred from a forwarding of information (i.e. updates in the CC field of bug reports) as well as the assignment of tasks (i.e. updates of the ASSIGNEE field of bug reports). By means of a sliding time window with a width of 30 days and an increment of one day, we build evolving monthly collaboration networks for each of the four studied communities. An example for such a monthly collaboration network can be seen in Figure 1(a). For each user reporting a bug at time t we then compute nine quantitative measures that capture the social position of the reporting user in the collaboration network for the 30 days pre-

ceding t . Based on their final status when they were closed, we categorize all bug reports either as *valid* (final status FIXED or WONTFIX) or *faulty* (final status INVALID, INCOMPLETE or DUPLICATE). Based on a random subset of 5% of all reports we use this information to train a support vector machine and - using the nine network-analytic measures - utilize the trained machine to predict which of the remaining bug reports will eventually be identified as *valid* by the community. We then use the ground truth in our data set to evaluate the precision and recall of our prediction. The evaluation results of this method are shown in Table 1. Our prediction method achieves a remarkable high precision ranging between 78 and 90 percent. Remarkably, for communities in which the fraction of *valid* reports is as low as 21%, our classifier still achieves a precision of more than 80%. For a detailed description of our methods and data sets, the network measures used in our study, as well as the full discussion of results we refer the reader to [ZSTS13].



(a) Collaboration network covering June 2006 in the NETBEANS Bugzilla community



(b) Outline of the prediction methodology

Table 1: Precision (p) and recall (r) of prediction of valid bug reports based on social networks

	FIREFOX	THUNDERBIRD	ECLIPSE	NETBEANS
Valid reports	21.0%	23.3%	74.3%	62.4%
p	82.5%	90.3%	88.7%	78.9%
r	44.5%	38.9%	91.0%	87.0%

In summary, we show that the social layer of support infrastructures like BUGZILLA contains valuable information about the reputation and/or abilities of community members that can be used to efficiently mitigate the information overload in bug handling communities. Our study highlights the potential of quantitative measures of social organization in collaborative software engineering and opens interesting perspectives for the integration of network analysis in the design of support infrastructures and social information systems.

References

- [ZSTS13] Marcelo Serrano Zanetti, Ingo Scholtes, Claudio Juan Tessone, and Frank Schweitzer. Categorizing bugs with social networks: A case study on four open source software communities. In *Proceedings of the 35th International Conference on Software Engineering, ICSE '13, San Francisco, CA, USA, May 18-26, 2013*, pages 1032–1041, 2013.