Chapter 86
Exploration and Exploitation of Developers' Sentimental Variations in Software Engineering

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ABSTRACT

Software development is highly dependent on human efforts and collaborations, which are immensely affected by emotions. This paper presents a quantitative empirical study of the emotional variations in different types of development activities (e.g., bug-fixing tasks), development periods (i.e., days and times) and in projects of different sizes involving teams of variant sizes. The study also includes an in-depth investigation of emotions' impacts on software artifacts (i.e., commit messages) and exploration of scopes for exploiting emotional variations in software engineering activities. This work is based on careful analyses of emotions in more than 490 thousand commit comments across 50 open-source projects. The findings from this work add to our understanding of the role of emotions in software development, and expose scopes for exploitation of emotional awareness in improved task assignments and collaborations.

INTRODUCTION

Emotions are inseparable part of human nature, which influence people's activities and interactions, and thus emotions affect task quality, productivity, creativity, group rapport and job satisfaction (Choudhury & Counts, 2013; Feldt, Angelis, Torkara, & Samuelssonc, 2010; Palacios, LÓpez, Crespo, & Acosta, 2010). Software development, being highly dependent on human efforts and interactions, is more susceptible to emotions of the practitioners. Hence, a good understanding of the developers' emotions and

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their influencing factors can be exploited for effective collaborations, task assignments (Dewan, 2015), and in devising measures to boost up job satisfaction, which, in turn, can result in increased productivity and projects' success (Denning, 2012).

Several studies have been performed in the past for understanding the role of human aspects on software development and engineering. Some of those earlier studies address when and why employees get affected by emotions (Choudhury & Counts, 2013; Guzman, AzÓcar, & Li, 2014; Guzman & Bruegge, 2013; Pletea, Vasilescu, & Serebrenik, 2014; Tourani, Jiang, & Adams, 2014), whereas some other work address how (Graziotin, Wang, & Abrahamsson, 2013; Khan, Brinkman, & Hierons, 2010; Lesiuk, 2005; Murgia, Tourani, Adams, & Ortu, 2014; Wrobel, 2013) the emotions impact the employees' performance at work. Despite those earlier attempts, software engineering practices still lack theories and methodologies for addressing human factors such as, emotions, moods and feelings (Graziotin, Wang, & Abrahamsson, 2015; Guzman & Bruegge, 2013). Hence, the community calls for research on the role of emotions in software engineering (Khan et al., 2010; Palacios et al., 2010; Shaw, 2004).

Some software companies try to capture the developers' emotional attachments to their jobs by means of traditional approaches such as interviews and surveys (Wrobel, 2013). Capturing emotions with the traditional approaches is more challenging for projects relying on geographically distributed team settings and voluntary contributions (e.g., open-source projects) (Destefanis, Ortu, Counsell, Marchesi, & Tonelli, 2015; Guzman et al., 2014). Thus, to supplement or complement those traditional sources, software artifacts such as the developers' commit comments/messages have been identified for the extraction of important information including developers' emotional states (Guzman et al., 2014; Guzman & Bruegge, 2013; Pletea et al., 2014).

This work conducts a study of the polarity (i.e., positivity, negativity, and neutrality) of emotions expressed in commit messages as posted by developers contributing to open-source projects. In particular, following five research questions are addressed.

RQ1: Do developers express different levels (e.g., high, low) and polarity (i.e., positivity, negativity, and neutrality) of emotions when they commit different types (e.g., bug-fixing, new feature implementation, refactoring, and dealing with energy and security-related concerns) of development tasks?
- If development tasks can be distinguished at which the developers' express high negative emotions, low positive emotions, or an overall low emotional involvement, stipulating measures can be introduced to emotionally influence the emotions of the developers working on those particular types of development tasks resulting in higher success rate.

RQ2: Can a group of developers be distinguished who express more emotions (positive or negative) in committing a particular type (e.g., bug-fixing) of tasks?
- Programmers who develop in them positive emotions while carrying out a given development task can be more efficient and quicker in completing the task (Murgia et al., 2014) resulting in reduced software cost. Thus, distinguishing a group of practitioners having positive emotional attachment to a particular task can be useful in effective task assignments.

RQ3: Do the developers' polarity (i.e., positivity, negativity, and neutrality) of emotions vary in different days of a week and in different times of a day?
- If particular days and times can be identified when developers' express significant negative emotions, then managers can take motivating steps to boost up the developers' positive feelings on those days and times. Guzman et al. (2014) reported that commit comments posted