



Method to Identify Corrections of Defects on Product Line Models

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Abstract

Software product line engineering is a promising paradigm for developing software intensive systems. Among their proven benefits are reduced time to market, better asset reuse and improved software quality. To achieve this, the collection of products of the product line are specified by means of product line models. Feature Models (FMs) are a common notation to represent product lines that express the set of feature combinations that software products can have. Experience shows that these models can have defects. Defects in FMs be inherited to the products configured from these models. Consequently, defects must be early identified and corrected. Several works reported in scientific literature, deal with identification of defects in FMs. However, only few of these proposals are able to explain how to fix defects, and only some corrections are suggested. This paper proposes a new method to detect all possible corrections from a defective product line model. The originality of the contribution is that corrections can be found when the method systematically eliminates dependencies from the FMs. The proposed method was applied on 78 distinct FMs with sizes up to 120 dependencies. Evaluation indicates that the method proposed in this paper scale up, is accurate, and sometimes useful in real scenarios.

Keywords: Software product lines, Features Models, Corrections, Defects, Software Engineering

1 Introduction

Product line engineering is a promising production approach used to manage in an efficient way a set of products that belong to a particular domain and have common and variable elements. This approach offers benefits such as reduced time to market, increased reuse and increased quality [29]. Benefits obtained with Product Lines (PL) are extensible to software engineering, due to in the software development area

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is also necessary to manage reuse and variability. Specifically, in the context of the software engineering, product lines are named Software Product Lines (SPL) [5].

Product line engineering represents in an intensive way all valid products belonging to a PL by means of product line models. In this sense, the feature models (FMs) is one of the available notations to represent product line models. FMs are designed during the early stages of the PL development, and they are a key input to identify common and variable elements of the PL [12]. In a FM, each feature is a prominent or distinctive user-visible aspect of a software system. Thus, FMs are useful to communicate effectively with customers and other stakeholders such as marketing representatives, managers, production engineers, system architects, etc. [12].

Having FMs that correctly represent the domain of the product line is of paramount importance for product line engineering success. However, as FM complexity grows, semantic defects may be unintentionally introduced, which decreases the quality of the FM, and consequently the benefits from the product line. Specifically, semantic defects are imperfections that affect the ability of FM to represent all the desired products [35].

The literature provides several approaches to automatically identify semantic defects in FMs [4, 25, 26, 35, 39, 40, 42–45]. However, only a few of these proposals are able to explain how to fix defects, and these approaches only find some of the possible corrections [25, 39, 40, 42, 44]. This means that once defects are found in a FM, it is necessary to manually inspect the model to detect available corrections. Nevertheless, this is a cumbersome task that depends on experience and skills of the model designer. Indeed, looking for the corrections of defects is almost as complicated as looking for defects themselves. In fact, the number of dependencies and interrelations among them make finding corrections an error-prone, tedious, and sometimes unfeasible task [26, 40, 45].

The general goal of our research is to find a generic technique that will point out the cause of various kinds of defects in product line models specified with different notations. In this paper, we propose a step towards this goal. Particularly, we present a new method that identifies defects in FMs, and detects possible corrections for each defect.

Specifically, the proposed contribution can be summarized as follows:

- (i) A method that identifies potential corrections of defects in FMs.
- (ii) We suggest to exploit *Minimal Correction Subsets (MCSEs)* to detect corrections of defects in FMs. The concept of MCSEs comes from the constraint programming area. To the best of our knowledge, it has never been used before for identifying corrections of defects in FMs.
- (iii) An automated tool to implement our approach.
- (iv) A preliminary evaluation was performed. It indicates that the proposed method is scalable, accurate and useful in real scenarios.

The remaining parts of this paper is structured as follows. Section 2, gives a brief overview of the necessary concepts for understanding the proposed contribution.

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