Automated Analysis of Feature Models 20 Years Later: A Literature Review

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Abstract. Software product line engineering is about producing a set of related products that share more commonalities than variabilities. Feature models are widely used for variability and commonality management in software product lines. Feature models are information models where a set of products are represented as a set of features in a single model. The automated analysis of feature models deals with the computer-aided extraction of information from feature models. The literature on this topic has contributed with a set of operations, techniques, tools and empirical results which have not been surveyed until now. The paper associated to this contribution provides a comprehensive literature review on the automated analysis of feature models 20 years after of their invention. It contributes by bringing together previously disparate streams of work to help shed light on this thriving area. We also present a conceptual framework to understand the different proposals as well as categorise future contributions. We finally discuss the different studies and propose some challenges to be faced in the future.
Fifty three primary studies were analysed from where we report 30 operations of analysis and four different groups of proposals to automate those operations. The main target audience of this literature review are researchers in the field of automated analysis, tool developers or practitioners who are interested in analysis of feature models as well as researchers and professionals of information systems interested in software product lines, their models and analyses. [1]

1 Summary

In this literature review we performed a comprehensive review of the existing works on the field of automated analysis of feature models.

In outline, software product line engineering is about the systematic reuse of software by managing a set of similar products in a concrete domain. It covers

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specific processes, models or techniques supporting software product line development. It is recognized that it is very useful to have modelling facilities to express variability. To this end, feature models were proposed back in 1990 by Kang et al. Feature models are a special kind of variability model that represent a software product line in terms of features and relationships among them. An example of a software product line for mobile phones is shown in Figure 1.
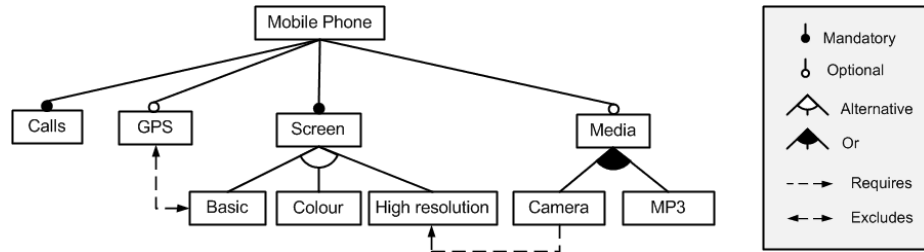

Fig. 1. A sample feature model

We defined the automated analysis of feature models as "the computer–aided extraction of information from feature models". The analysis is performed using *analysis operations*. There are different techniques and tools to perform those analyses and we reviewed those in this paper. The aim of this review was to answer the following research questions:

– *RQ1: What operations of analysis on feature models have been proposed?* This question motivated the following sub-questions:
  • What operations have been formally described?
– *RQ2: What kind of automated support has been proposed and how is it performed?* This question motivated the following sub-questions:
  • Which techniques have been proposed to automate the analysis?
  • What is the feature modelling notation supported by each approach?
  • Which analysis operations have been automated?
  • Which proposals present a performance evaluation of their results?

After reviewing all this information we also wanted to answer a more general question:

– *RQ3: What are the challenges to be faced in the future?*

We give an answer to all these questions using literature review techniques proposed by experts in the area.