A methodology to recover feature models from object-oriented source code

Ra'Fat Ahmad Al-Msie'Deen, Abdelhak-Djamel Seriai, Marianne Huchard, Christelle Urtado, Sylvain Vauttier, Hamzeh Eyal-Salman

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Ra'fat AL-MSIE'DEEN*, Abdelhak Djamel SERIAI*, Marianne HUCHARD*,

Christelle URTADO, Sylvain VAUTTIER**, Hamzeh EYAL SALMAN***

***LIRMM, UMR 5506, CNRS and UM2, Montpellier, France**
{Rafat.Al-msiedeen, Abdelhak.Seriai, Marianne.Huchard, eyalsalman}@lirmm.fr

****LGI2P, Ecole des Mines d'Alès, Nîmes, France**
{Christelle.Urtado, Sylvain.Vauttier}@mines-ales.fr

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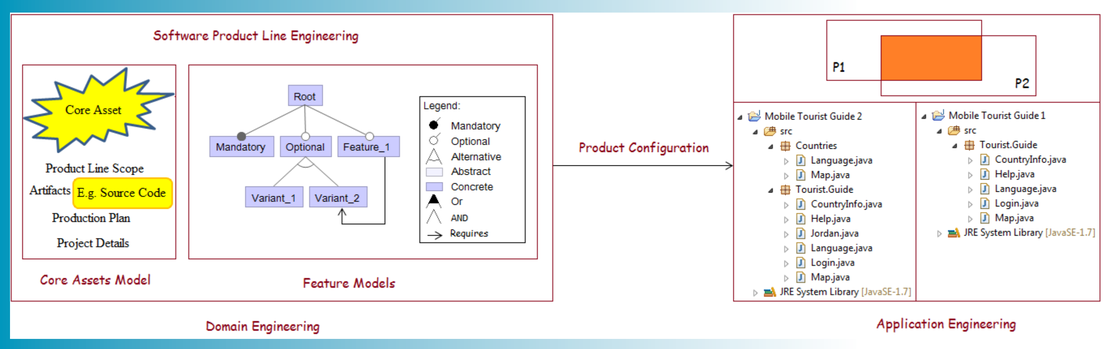
Software Product Line Engineering

A Software Product Line is "a ***set of software intensive systems*** sharing a common, managed set of ***features*** that satisfy the ***specific needs of a particular market segment or mission*** and are developed from a common set of core assets in a ***prescribed way***" [1].

SPLE (Software Product Line Engineering) focuses on capturing the **commonalities** and **variations** between several software products that belong to the same family. Capturing variants is the key activity that distinguishes SPLE from other software development approaches: it is called variability management.



Software product line engineering steps

Variations among software families are modeled and variability managed in most cases using a *de facto* standard formalism called **feature models** [2].

Motivations

SPLs are often designed after a number of product variants have been implemented using ***ad hoc*** techniques such as **copy** / **paste** / **modify**.

In order to migrate software products which are deemed similar to a product line, it is necessary to detect common features and variations between a set of product variants. Reverse engineering a feature model from existing software is a **challenging activity**.

Creating manually a feature model for an existing system is **time-consuming**, **error-prone**, and **requires substantial effort from a modeler** [3]. Automatic extraction of feature models from source code would improve **product maintenance**, **ease system migration**, and the **extracted feature model may lead to the production of new products**.

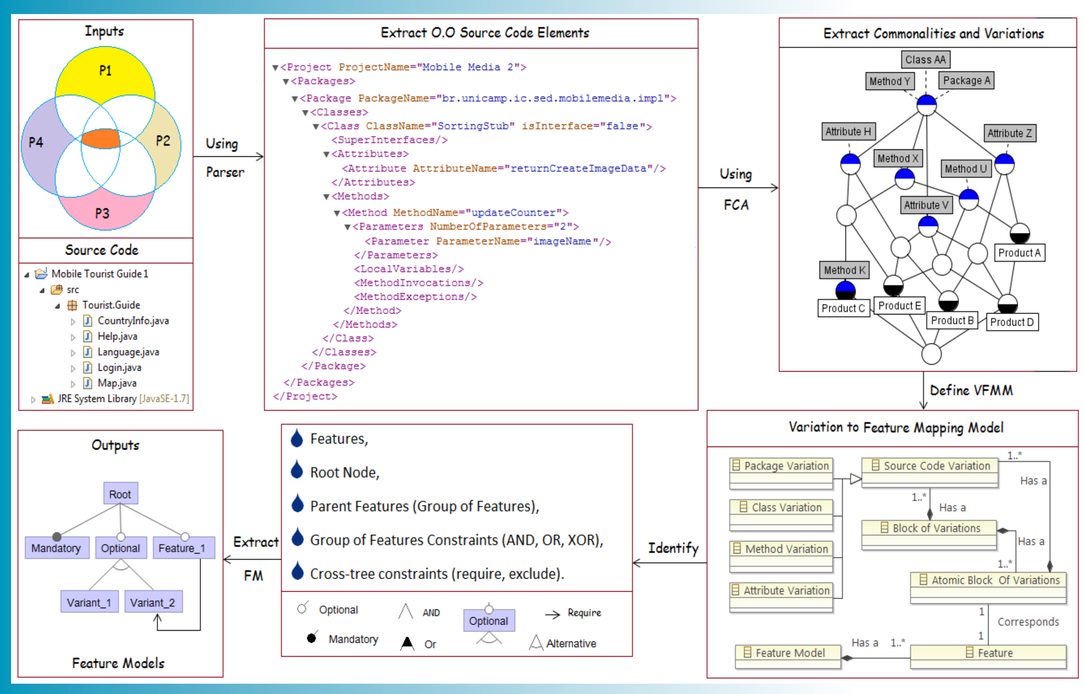
In recent years, a lot of work on reverse engineering has addressed the extraction of feature models from **different artifacts** but not from **source code for a set of software product variants** except [6].

Here, we present a methodology to **extract a feature model from O.O. source code for a set of product variants** to support the migration process from **conventional** software development to **SPLE**.

Overview of our Methodology

So our aim is the **extraction of feature models that represent variations among a set of product variants, and enable to calculate product configurations** using formal concept analysis (FCA).

We investigate products in which variability is represented by the **names** of packages, classes, attributes, methods, and bodies of methods (*i.e.* different choices for algorithms, methods invocation). We also investigate products in which variability lies in the **contents** of packages, classes, attributes, and methods.



Overview of our methodology

➢ ***Methodology Steps:***

Step 1: *O.O. source code is analyzed* to extract **source code elements** (packages, classes, methods, attributes) for all product variants.

Step 2: **Commonalities** and **variations** are extracted for all product variants using **FCA**. FCA is a mathematical method that provides a way to identify "**meaningful groupings of objects that have common attributes**" [5]. We have tested it on a mobile media[1] case study and obtained promising results.

[1] http://www.ic.unicamp.br/~tizzei/mobilemedia/index.html

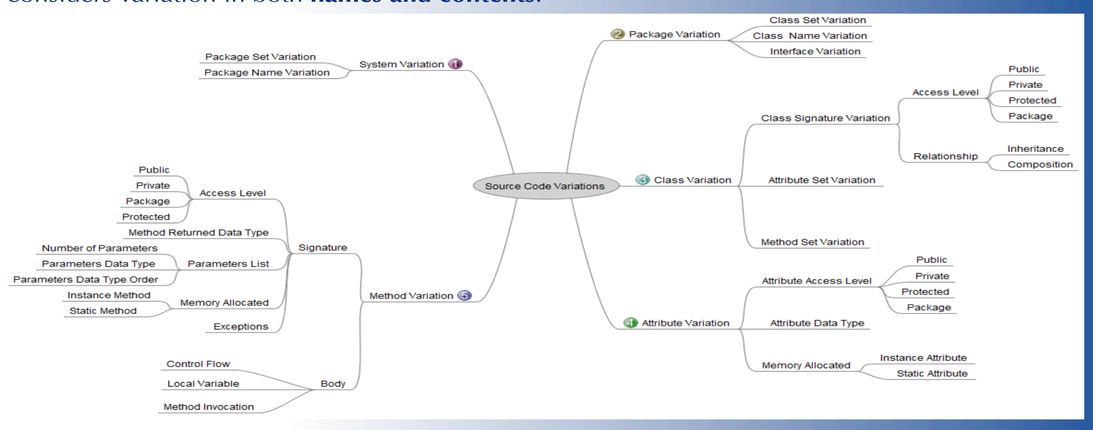
Step 3: **Variation to feature mapping model** is defined. The aims of this model are to identify **block of variations** and **atomic block of variations**. Each block of variation in the model contains **one or more** atomic block of variations and each atomic block of variations represents **one and only one** feature. Source code elements has one or more source code variation, and each block of variations have one or more source code variation.

Step 4: Feature model elements such as root node, mandatory / optional features, parent features, cross-tree constraints or parent (group of features) constraints are extracted. Mandatory features appear on the common block, and optional features appear on the block of variations, the feature model constraints appear in block of variations. For example, if a single block has two features, it means that one requires the other. Finally, the feature model is synthesized.

Our methodology is based on **4 steps**, We already have implemented **step 1** (**extract source code elements**) and **step 2** (**extract commonalities** and **variations**). We have tested them on some standard case study and obtained promising results. We are still working on steps 3 & 4.

Source code analysis

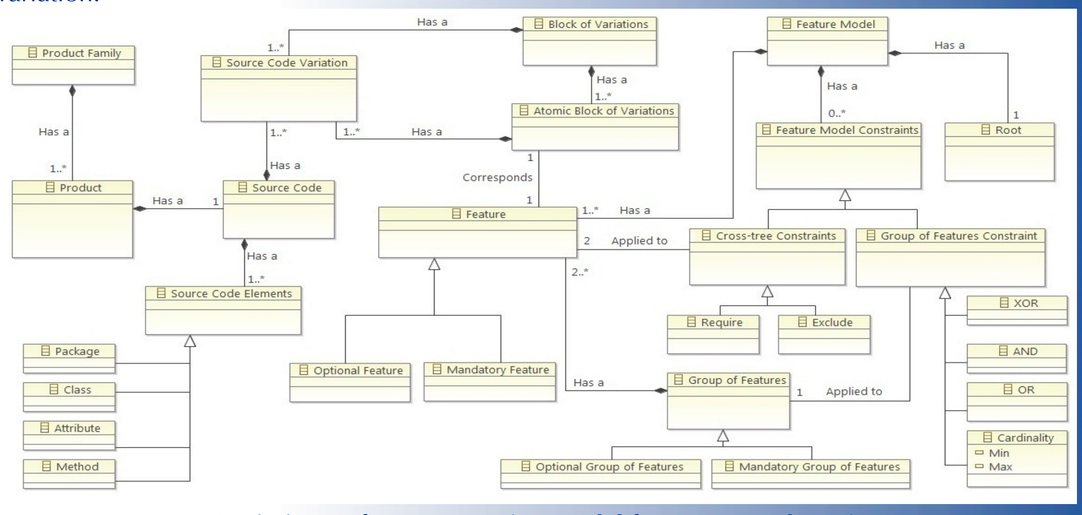
Source code analysis **plays an important role in our methodology**. Our analysis technique provides both **abstract and detailed information for each software product variant** and considers variation in both **names and contents**.



Source code analysis for product variants

Variation to feature mapping model

A block of variation is a set of variations that appear together in all products or in a single product. Each block of variation has one or more features. Each atomic block of variation represents a single atomic feature. We use partitioning techniques to identify atomic blocks of variation.



Variation to feature mapping model for source code variants

Related Work

Ryssel et al. [4] propose an approach to extract feature diagrams using **FCA from incidence matrix** that contain matching relation as input. It shows the parts of a set of function- block-oriented models that describe different controllers of a DC motor. Loesch et al. [5] present a new method based on FCA to **analyze the realized variability in a software product line**, and construct a lattice that provides a classification of the usage of variable features in real products derived from the product line. Ziadi *et al.* [6] propose an automatic approach for feature identification from source code for a set of product variants. This approach assumes that the **product variants use the same vocabulary to name** packages, classes, attributes and methods in its source code.

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