Extended Feature models
Assignment for Bachelor referaat by Pim van den Broek

Feature models are used to denote software product lines. A software product line is a set of software products, and a software product is a set of features. An example of a feature model is:
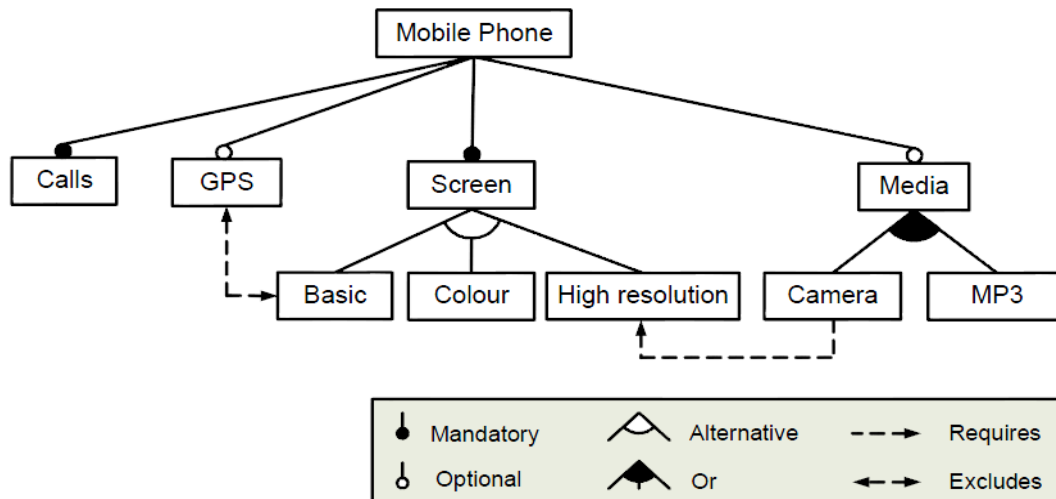

Figure 1: A sample feature model

- The root feature (Mobile Phone) belongs to every product.
- For every other feature than the root, it cannot be in a product without its parent. So, a product which contains MP3, also contains Media.
- A mandatory feature belongs to the product if its parent does. So, Calls and Screen belong to every product.
- An optional feature may or may not belong to a product. So, GPS and Media may or may not belong to a product.
- From an alternative group, a product contains exactly one feature (provided the parent is in the product). So a product has either Basic, or Colour , or High resolution.
- From an Or group, a product contains one or more features (provided the parent is in the product). So, If a product contains Media, it contains Camera, or it contains MP3, or it contains both Camera and MP3
- Constraint of the form A requires B: If a product contains A then it contains B as well. So, If a product contains Camera, it contains High Resolution as well.
- Constraint of the form A excludes B: a product may not contain A and B at the same time. So,there are no products with both GPS and Basic.

This example comes from the paper "Automated Analysis of Feature Models 20 Years Later: A Literature Review" by David Benavides, Sergio Segura and Antonio Ruiz-Cortes. It is available at http://www.lsi.us.es/~dbc/en/?Research.

Assignment, part 1: Study (the relevant parts of) this paper.

Section 2.3 of this paper discusses extended feature models. Extended feature models are feature models whose features can have attributes, just like objects in OO programming can have attributes.

Assignment, part 2: Study the literature on extended feature models, and compile a survey report..
The literature encompasses:
1 The paper above
2 The papers referred to in section 2.3 of the paper above, especially [11].
3 The paper by Karatas et al. http://www.springerlink.com/content/26v8384w234uxuh1/
4 Any other literature that you can find.

Analysis of feature models is usually done by using a Constraint Solver, which is a tool which solves Constraint Satisfaction Problems. Recently, it has been shown that feature models can be analyzed using Integer Programming by van den Broek: http://eprints.eemcs.utwente.nl/18086/

In situations of practical interest, the number of products of a feature model is very large. To solve an optimization problem, (to find the best product according to some goal), a constraint solver can only iterate through the large set of products. An optimization approach, like Integer Programming, solves optimization problems without iteration through all products.

In the case of extended feature models, analysis can be done with Constraint Solvers, or, when all constraints are linear, with Mixed Integer Programming. Using a constraint solver is now even more problematic, since it will not only iterate through all products, but also through all attribute valuations of each product. Mixed Integer Programming does not have this drawback.

Assignment, part 3. Choose a number of examples of extended feature models with linear constraints.

Assignment, part 4. Download a Constraint Solver and a Mixed Integer Programming tool, and execute the examples of part 3 on both tools. Provide a detailed comparison of the two analysis methods. In particular, verify the hypothesis that Mixed Integer Programming solves problems where a Constraint Solver fails.