AUTOMATED SOFTWARE ENGINEERING-791: Final Reading

Abstract

This paper will cover the recent development in the field of static security analysis in Product Line Engineering. In this paper I will explore the various works previously detailed and look to explore the ideas they were aimed at solving while exploring how the papers contributed to addressing the previously stated issues. I will then try to generate a thorough "Bigger Picture" of how the various related (and unrelated works) together contribute to the solving of issues and what, if any, new issues have been created by the same for future explorations. I will then try to recommend a path of exploration for future that would aim to explore all the solvable issues, while trying to objectify the issues that can not or should not be solved at present with reasoning to support my decisions.

1. Keywords

Feature, Feature Interaction, Software Product Line, Feature Aware Verification, Product Line Verification, Feature Algebra, Feature composition, Model Checking, Variability, Feature Structure Tree, Super Imposition and Software Composition.

2. INTRODUCTION

In the modern world modularity is key ingredient in good development practices. While modularity in both code and ***software features*** is desirable and produces manageable software products within given time frames it also produces additional security concerns, the primary of which is the unintended characteristics that may be born off the interactions of these modular features known as ***feature interaction***. Thus a ***feature interaction*** is a situation in which the composition of multiple features leads to emergent behavior that does not occur when one of them is absent. While this problem has been studied thoroughly before it still persists as a major challenge for researchers. Multiple works on feature interaction detection have been carried out ranging from the use of ***superimposition*** (the practice of imposing various features on each other to see all possible characteristics) to ***Feature-aware verification*** (The detection of feature interaction based on specifications that do not have global feature system knowledge). While all works address some part of the problem, no comprehensive solution to the above mentioned problem statement has been developed yet.

Feature Interaction detection and elimination has a couple of major challenges: A first challenge, which was formulated by Hall, is to detect feature interactions based on specifications that do not have global system knowledge. The background is that the specification of a feature should not need to be aware of all other features of the system. It is desirable to specify and implement features in separate and composable units, while still being able to detect feature interactions.

A second challenge, which applies to product-line analysis in general, is to detect feature interactions without the need of generating and checking all individual products. Typically, many different feature combinations are possible, so detecting feature interactions by generating all possible combinations may not be feasible.

Since feature interaction detection and eliminations remains a fairly new area of research, it remains a area with multiple issues yet to be addressed satisfyingly.

3. Motivation

Feature-OrientedSoftwareDevelopment (FOSD) is a paradigm that provides attributes(formalisma, methods, languages and tools) that allow for the building of complex modular software systems.The main abstraction mechanism in FOSD is a feature.

Features are used to represent the requirement of the end user and per say are used to denote an increment in functionality. They are also used to clearly define

the various components of a program or a software system thus helping in modularize all programs.

Feature Composition is thus the practice of composing code consistent with feature definition.

Research along different lines has been undertaken to realize the vision of FOSD. While most research paradigms agree on the common notion of Feature and Feature Composition, no common ground had been established in the case of techniques, representations and formalisms.

All modern programing paradigms are FOSD based. FOSD also forms the basis of the all modern good programming practices theory of modularity and building software in composable blocks.

In this paper I will try to relate the previously explored works and see how they as a single unit work to solve issues they were aimed at solving while exploring the individual contributions of the papers to the bigger problem statement. We will walk through the papers in the same order that we generated the previous readings and then will try to summarize their contributions as a single entity at the end of the section.

4. Approaches and State of Research

Feature Interaction Detection and Removal is a major problem that has been approached in multiple ways by each approach trying to solve the problem in the most general and optimized way possible.While some approaches aim to make the test systems more feature aware, others have tried to solve this problem by extracting meaning from the features themselves while maintaining their isolation properties and then solving for their interactions in a single pass. As we can see both these approaches are highly contrasting in nature.

In this section I will discuss the various techinques that have been presented and discuss the state of research in these areas:

4.1. Feature Interaction

Feature Interaction is defined as the generation of unintended characteristics in a software system when two or more features interact with each other. This uncharacteristic behaviour is non existent if a single component (or interacting feature) is missing.

Feature Interaction is an unintended characteristic in a software system and thus generally not good as it produces undesired effects that may have dire consequences such as the introduction of security risks etc.

Feature Interaction

4.2. Feature Structure Tree

4.3. Software Composition

4.4. Superimposition

4.5. Model Checking

4.6. Variability

4.7. Domain Artifact Verification

4.8. Domain Artifact Verification

4.9. Feature composition

4.10. Feature Algebra

4.11. Feature-aware verification

4.12. Product-lineverification

5. Blah

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Please see below for details on each of these items.

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Submission to ICML 2013 will be entirely electronic, via a web site (not email). The URL and information about the submission process are available on the conference web site at

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Paper Deadline: The deadline for paper submission to ICML 2013 is at 23:59 Universal Time (3:59 Pacific Daylight Time) on the due date (October 1, December 15, or February 15, depending on the review cycle). If

your full submission does not reach us by this time, it will not be considered for publication. There is no separate abstract submission.

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ps2pdf paper.ps

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We will continue the ICML tradition in which the authors are given the option of providing a short reaction to the initial reviews. These reactions will be taken into account in the discussion among the reviewers and area chairs.

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The final versions of papers accepted for publication should follow the same format and naming convention as initial submissions, except of course that the normal author information (names and affiliations) should be given. See Section 6.3.2 for details of how to format this.

The footnote, "Preliminary work. Under review by the International Conference on Machine Learning (ICML). Do not distribute." must be modified to "*Proceedings of the 30th International Conference on Machine Learning*, Atlanta, Georgia, USA, 2013. JMLR: W&CP volume 28. Copyright 2013 by the author(s)."

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```
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```

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The text of the paper should be formatted in two columns, with an overall width of 6.75 inches, height of 9.0 inches, and 0.25 inches between the columns. The left margin should be 0.75 inches and the top margin 1.0 inch (2.54 cm). The right and bottom margins will depend on whether you print on US letter or A4 paper, but all final versions must be produced for US letter size.

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Label all distinct components of each figure. If the figure takes the form of a graph, then give a name for each axis and include a legend that briefly describes each curve. Do not include a title inside the figure; instead, the caption should serve this function.

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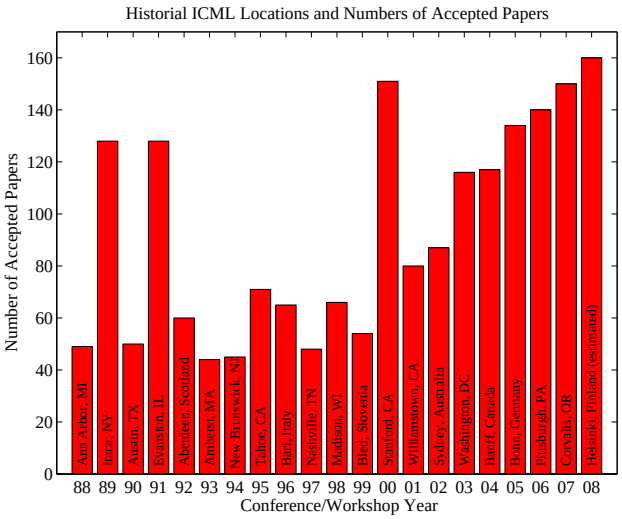

Figure 1. Historical locations and number of accepted papers for International Machine Learning Conferences (ICML 1993 – ICML 2008) and International Workshops on Machine Learning (ML 1988 – ML 1992). At the time this figure was produced, the number of accepted papers for ICML 2008 was unknown and instead estimated.

Algorithm 1 Bubble Sort

```
Input: data x_i, size m
repeat
  Initialize noChange = true.
  for i = 1 to m − 1 do
    if x_i > x_{i+1} then
      Swap x_i and x_{i+1}
      noChange = false
    end if
  end for
until noChange is true
```

6.7. Algorithms

If you are using LaTeX, please use the "algorithm" and "algorithmic" environments to format pseudocode. These require the corresponding stylefiles, algorithm.sty and algorithmic.sty, which are supplied with this package. Algorithm 1 shows an example.

[1] For the sake of readability, footnotes should be complete sentences.

[2] Multiple footnotes can appear in each column, in the same order as they appear in the text, but spread them across columns and pages if possible.

Table 1. Classification accuracies for naive Bayes and flexible Bayes on various data sets.

Data set	Naive	Flexible	Better?
Breast	95.9± 0.2	96.7± 0.2	√
Cleveland	83.3± 0.6	80.0± 0.6	×
Glass2	61.9± 1.4	83.8± 0.7	√
Credit	74.8± 0.5	78.3± 0.6	
Horse	73.3± 0.9	69.7± 1.0	×
Meta	67.1± 0.6	76.5± 0.5	√
Pima	75.1± 0.6	73.9± 0.5	
Vehicle	44.9± 0.6	61.5± 0.4	√

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Citations within the text should include the authors' last names and year. If the authors' names are included in the sentence, place only the year in parentheses, for example when referencing Arthur Samuel's pioneering work (1959). Otherwise place the entire reference in parentheses with the authors and year separated by a comma (Samuel, 1959). List multiple references separated by semicolons (Kearns, 1989; Samuel, 1959; Mitchell, 1980). Use the 'et al.' construct only for citations with three or more authors or after listing all authors to a publication in an earlier reference (Michalski et al., 1983).

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Use an unnumbered first-level section heading for the references, and use a hanging indent style, with the first line of the reference flush against the left margin and subsequent lines indented by 10 points. The references at the end of this document give examples for journal articles (Samuel, 1959), conference publications (Langley, 2000), book chapters (Newell & Rosenbloom, 1981), books (Duda et al., 2000), edited volumes (Michalski et al., 1983), technical reports (Mitchell, 1980), and dissertations (Kearns, 1989).

Alphabetize references by the surnames of the first authors, with single author entries preceding multiple author entries. Order references for the same authors by year of publication, with the earliest first. Make sure that each reference includes all relevant information (e.g., page numbers).

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