Mechanization and Overhaul of Feature Featherweight Java

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Abstract. Specifying a language in an Interactive Theorem Prover (ITP) is seldom faithful to its original pen-and-paper specification. However the process of mechanizing the language and type safety proofs might unearth insights for clearer overall specification. In the present we discuss the process of extending a mechanization of *Featherweight Java (FJ)* with *Feature Featherweight Java (FFJ)* in `Coq` and how that lead us to a clearer, unambiguous and equivalent syntax and semantics while keeping the proofs as simple as possible. This is also the first mechanization of a *Feature Oriented Programming (FOP)* language to date.

Keywords: Language Design, Language Semantics, Java, FOP, Coq

1 Introduction

Feature Oriented Programming (FOP) [11] is a design methodology and tools for program synthesis [6]. It aims at the modularization of software systems in terms of features. A *feature* implements a stakeholder's requirement and is typically an increment in program functionality. When added to a software system, a feature introduce new structures, such as classes and methods, and refines existing ones, such as extending methods bodies.

There are several FOP languages and tools that provides varying mechanisms that support the specification and composition of features properly, such as AHEAD [4], FSTComposer [3], FeatureC++ [2], and more recently Delta-Oriented Programming [12]. FOP has also been used to develop *product-lines* in disparate domains, including compilers for extensible Java dialects [5], fire support simulators for U.S. Army [7], high-performance network [8], and program verification tools [10].

Due to the relevance of FOP, falar sobre lps...

Several attempts to formalize the type system of FOP languages have been made. For instance, *Feature Featherweight Java (FFJ)* [1] is a proposed type system for FOP languages and tools, which is developed on top of *Featherweight Java (FJ)* [9] to provide a simple syntax and semantics conforming with common FOP languages, incorporating constructs for feature composition.

Nevertheless, none of the existing efforts for specifying FOP type system have been mechanized to date. Which means that we have no formal guarantees that

the specification is type-safe other than peer review. Such a method is known for enabling small errors to remain hidden for several years, specially as the proofs grow larger and harder to follow. The idea behind mechanization is to check these proofs with the aid of a computer, reducing significantly the risk of errors, while taking full use of automation for the tedious or straightforward steps of the proof.

In this paper, we present an implementation of FJ which we extend with FFJ using `Coq`. The process of scrutinizing FFJ and defining *unambigously* its semantics in `Coq` lead us to some language specification and implementation improvements. Altogether these improvements makes more natural the transition between FJ and FFJ, simplifying the auxiliary functions used in the language specification as well as the type safety proofs and lemmas. Not only to be easier to increment FJ syntax and semantics, but also easier increment its proofs leading to a clearer and simpler specification of *FFJ*. Hence we can sumarize the main contribution of this paper as follows:

1. The first mechanization of a FOP type system
2. A better specification of FFJ, which may help other researchers to reason about software product lines properties.
3. A report about the benefits of using a proof assistant to revamp an existing specification of a non-mechanized language type system.

This paper is organized as follows: in the Section 2 we give a brief introduction to `Coq` Section 3 briefly introduces software product lines, FOP and FFJ, Section 4 formally describes our revamped FFJ and states the lemmas needed to preserve FJ increment to FFJ type safety, Section 5 discuss the implications of these results to the product line research and Section 6 is the conclusion and shows possible future works.

2 Coq

Lorem Ipsum

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