

A Solution to the POPLMARK Challenge Based on de Bruijn Indices

Jérôme Vouillon

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Abstract The POPLMARK challenge proposes a set of benchmarks intended to assess the usability of proof assistants in the context of research on programming languages. It is based on the metatheory of System $F_{<}$. We present a solution to the challenge using de Bruijn indices, developed with the Coq proof assistant.

Keywords Proof assistants · Theorem proving · Metatheory · Variable binding · De Bruijn indices · Coq

1 Introduction

The POPLMARK challenge [5] is a set of benchmarks designed to evaluate the state of mechanization in the metatheory of programming languages. The challenge was timely: proof assistants are becoming mature and there is a raising interest among the programming language research community towards mechanized proofs.

In our experience [3, 27, 28], we are still at a stage where writing a full polished mechanized proof for a conference paper remains a huge undertaking and is usually not worthwhile. Still, we have found it very useful to have mechanized proofs of key results. Of course, it gives high confidence on the results. But, above all, it forces to think about every details: there can be no fuzzy definitions, no proofs by hand waving. As a consequence, one gets a much better understanding of what makes the proofs go through. Without the help of a proof assistant, we believe the papers mentioned above would have been very different, if written at all.

Mechanized proofs have other advantages compared to usual paper proofs. Writing paper proofs requires a lot of attention. As the formalization evolves, a lot of work is required to update the proofs properly and then convince oneself that they remain correct. Some obvious lemma whose proof was only sketched may well

J. Vouillon (✉)
PPS, UMR 7126, CNRS, Univ Paris Diderot, Sorbonne Paris Cité, 75205 Paris, France
e-mail: jerome.vouillon@pps.jussieu.fr