

The Locally Nameless Representation

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Abstract This paper provides an introduction to the locally nameless approach to the representation of syntax with variable binding, focusing in particular on the use of this technique in formal proofs. First, we explain the benefits of representing bound variables with de Bruijn indices while retaining names for free variables. Then, we explain how to describe and manipulate syntax in that form, and show how to define and reason about judgments on locally nameless terms.

Keywords Locally nameless · Cofinite quantification · Formal proofs · Binders · Metatheory

1 Introduction

Most programming languages, type systems and logical systems make use of variables. Many different techniques are available to represent syntax with variable bindings in a given programming language or in a given formal theory. This paper focuses on one particular representation of bindings, called the *locally nameless* representation. It has been successfully used to mechanize soundness proofs of type systems, properties of the semantics of λ -calculi, and correctness proofs of program transformations [4, 21]. This representation has also been shown useful in the implementation of type checkers and proof checkers, among which Coq [9], LEGO [22], Isabelle [27], HOL 4 [28] and EPIGRAM [1].

The locally nameless representation relies on de Bruijn indices to represent bound variables but uses names to represent free variables. Such a mixed syntax allows for

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