

# Formalizing Adequacy: A Case Study for Higher-order Abstract Syntax

James Cheney · Michael Norrish · René Vestergaard

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**Abstract** Adequacy is an important criterion for judging whether a formalization is suitable for reasoning about the actual object of study. The issue is particularly subtle in the expansive case of approaches to languages with name-binding. In prior work, adequacy has been formalized only with respect to specific representation techniques. In this article, we give a general formal definition based on model-theoretic *isomorphisms* or *interpretations*. We investigate and formalize an adequate interpretation of untyped lambda-calculus within a higher-order metalanguage in Isabelle/HOL using the Nominal Datatype Package. Formalization elucidates some subtle issues that have been neglected in informal arguments concerning adequacy.

**Keywords** Adequacy · Isomorphism · Interpretation · Nominal abstract syntax · Higher-order abstract syntax

*One can't proceed from the informal to the formal by formal means.*  
—Alan Perlis

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J. Cheney (✉)  
Laboratory for Foundations of Computer Science, University of Edinburgh,  
Edinburgh, Scotland, UK  
e-mail: jcheney@inf.ed.ac.uk

M. Norrish  
Canberra Research Lab, NICTA, Canberra, Australia

M. Norrish  
Australian National University, Canberra, Australia  
e-mail: Michael.Norrish@nicta.com.au

R. Vestergaard  
Research Center for Integrated Science, JAIST, Ishikawa, Japan  
e-mail: vester@jaist.ac.jp