

Compiling Natural Semantics Into ML

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Abstract. This paper presents a compilation scheme from natural semantics specifications to ML. Permutations of premises allow, for a class of specifications, a purely functional execution and can reduce non-determinism. This method uses some specific features of ML, like exceptions, closures and pattern-matching.

1 Introduction

Natural semantics [2, 7] is a formalism used to specify the semantics of programming languages. A specification in natural semantics describes one or several relations between abstract syntax trees and semantic values (evaluations results, types, environments, ...). For instance, a typing relation establishes the link between a typing environment, an expression, and the type of this expression. These relations, also called predicates, are defined by inference rules.

The next two rules define the evaluation relation for a small language of arithmetic expressions with identifiers. The formula $E \vdash_{eval} exp : v$ stands for: “the value of exp within the environment E is v ”.

$$\frac{}{E \vdash_{eval} id(str) : \mathbf{find}(E, str)}$$
$$\frac{E \vdash_{eval} exp_1 : v_1 \quad E \vdash_{eval} exp_2 : v_2}{E \vdash_{eval} plus(exp_1, exp_2) : \mathbf{add}(v_1, v_2)}$$

In this example, the built-in functions **find** and **add** are used to handle environments and integers.

Inference rules make up a system that can be seen as a logic program: natural semantics is then an executable formalism.

Typol [5], the main tool of the CENTAUR environment, was the first implementation of natural semantics. It is based on a simple compilation to Prolog, where relations become Prolog predicates, inference rules are translated into Horn clauses, and variables are processed as logical variables. Compiling natural semantics into logic programs allows to use unification, backtracking, and various variable modes (input/output), in specifications. For example, the rules specifying a type system can be used to verify that an expression has a given type, but also to infer a correct one, if the term which denotes the type is left

Compiling Natural Semantics

Neil D. Jones



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Compiling Natural Semantics Mikael Pettersson, 1999-05-05 Natural Semantics has become a popular tool among programming language researchers for specifying many aspects of programming languages. However, due to the lack of practical tools for implementation, the natural semantics formalism has so far largely been limited to theoretical applications. This book introduces the rational meta language RML as a practical language for natural semantics specifications. The main part of the work is devoted to the problem of compiling natural semantics actually RML into highly efficient code. For this purpose, an effective compilation strategy for RML is developed and implemented in the rml2c compiler. This compiler ultimately produces low level C code. Benchmarking results show that rml2c produced code is much faster than code resulting from compilers based on alternative implementation approaches.

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[A Compiler for Natural Semantics](#) Mikael Pettersson, 1996 Abstract Natural semantics is a formalism used for specifying both semantics and implementations of programming languages. Until recently, no practical implementation of the formalism existed. We have defined the Relational Meta Language RML as an executable specification language for natural semantics. After a brief outline of the language, we describe the compilation strategy used by our rml2c compiler. Transformations are applied to minimize non-determinism and a continuation passing style form is produced and simplified. Finally, the CPS is emitted as low level C code using an efficient technique for implementing tailcalls. We also present performance measurements that support

our choice of compilation strategy Lazy Evaluation: From natural semantics to a machine-checked compiler transformation Breitner, Joachim, 2016-09-20 In order to solve a long standing problem with list fusion a new compiler transformation Call Arity is developed and implemented in the Haskell compiler GHC It is formally proven to not degrade program performance the proof is machine checked using the interactive theorem prover Isabelle To that end a formalization of Launchbury s Natural Semantics for Lazy Evaluation is modelled in Isabelle including a correctness and adequacy proof

Translating Natural Semantic Specifications to Attribute Grammars Victor Enrique Tavernini, University of Illinois at Urbana-Champaign. Department of Computer Science, 1988 Compiler Construction , 1996 **ACM Transactions on Programming Languages and Systems** Association for Computing Machinery, 2004 **Programming Language Implementation and Logic Programming** , 1994 **Crafting a Compiler** Charles N. Fischer, Ronald Kaplan Cytron, Richard Joseph LeBlanc, 2010 Crafting a Compiler is an undergraduate level text that presents a practical approach to compiler construction with thorough coverage of the material and examples that clearly illustrate the concepts in the book Unlike other texts on the market Fischer Cytron LeBlanc uses object oriented design patterns and incorporates an algorithmic exposition with modern software practices The text and its package of accompanying resources allow any instructor to teach a thorough and compelling course in compiler construction in a single semester An ideal reference and tutorial TAPSOFT , 1989 **TAPSOFT '87. Proceedings of the International Joint Conference on Theory and Practice of Software Development, Pisa, Italy, March 23 - 27 1987** Hartmut Ehrig, Robert A. Kowalski, Giorgio Levi, Ugo Montanari, 1987-02-27 **Semantics-directed Compiler Generation** Neil D. Jones, 1980 Lazy Evaluation Joachim Breitner, 2020-10-09 In order to solve a long standing problem with list fusion a new compiler transformation Call Arity is developed and implemented in the Haskell compiler GHC It is formally proven to not degrade program performance the proof is machine checked using the interactive theorem prover Isabelle To that end a formalization of Launchbury s Natural Semantics for Lazy Evaluation is modelled in Isabelle including a correctness and adequacy proof This work was published by Saint Philip Street Press pursuant to a Creative Commons license permitting commercial use All rights not granted by the work s license are retained by the author or authors **AADEBUG 2005** , 2005 **InfoJapan'90** Haruhisa Ishida, 1990 Information technology will continue to be a powerful factor in the sustained growth of the world economy As our societies come to depend more heavily on information there is a natural desire for free access to and exchange of information We need correct information from secure and reliable services Information technology is affecting many aspects of our lives and has a growing impact on politics society and history Presented in these two volumes are 122 papers from Japan the USA and twenty other countries discussing progress in information technology with the theme Information Technology Harmonizing with Society It is the result of conference held at the end of 1990 with the cooperation of the Information Processing Society of Japan IFIP ACM and the IEEE Computer Society **Annales Societatis Mathematicae Polonae** Polskie Towarzystwo

Matematyczne,1981 **Compilation and Equivalence of Imperative Objects** Andrew D. Gordon,Paul D. Hankin,Søren B. Lassen,1997 Abstract We adopt the untyped imperative object calculus of Abadi and Cardelli as a minimal setting in which to study problems of compilation and program equivalence that arise when compiling object oriented languages We present both a big step and a small step substitution based operational semantics for the calculus and prove them equivalent to the closure based operational semantics given by Abadi and Cardelli Our first result is a direct proof of the correctness of compilation to a stack based abstract machine via a small step decompilation algorithm Our second result is that contextual equivalence of objects coincides with a form of Mason and Talcott s CIU equivalence the latter provides a tractable means of establishing operational equivalences Finally we prove correct an algorithm used in our prototype compiler for statically resolving method offsets This is the first study of correctness of an object oriented abstract machine and of operational equivalence for the imperative object calculus **Design, Implementation and Use of the MIRV Experimental Compiler for Computer Architecture Research** David Anthony Greene,2003 **Semantic Formalisms in Natural Language Processing** Manfred Pinkal,Remko Scha,Lenhart Schubert,1993

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