LEO-II

A Higher-Order Theorem Prover

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with thanks to:
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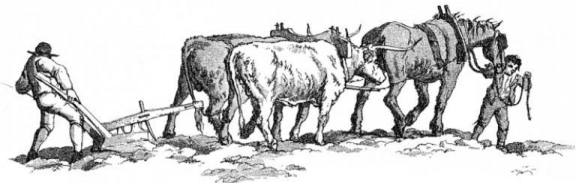
Overview on LEO-II

LEO-II is a standalone, resolution-based higher-order theorem prover that is designed for fruitful cooperation with specialist provers for first-order and propositional logic. The idea is to combine the strengths of the different systems. On the other hand, LEO-II itself, as an external reasoner, wants to support interactive proof assistants such as Isabelle/HOL, HOL, and OMEGA by efficiently automating subproblems and thereby reducing user effort.
LEO-II predominantly addresses higher-order aspects in its reasoning process with the aim to quickly remove higher-order clauses from the search space and to turn them into essentially first-order clauses which can then be refuted with a first-order prover. For this LEO-II cooperates with the first-order theorem provers E, Spass or Vampire.



LEO-II also provides an interactive mode in which user and system can interact to produce resolution proofs in simple type theory.
LEO-II is implemented in Objective Caml and it can be downloaded from the LEO-II website `http://www.ags.uni-sb.de/~leo/`.

LEO-II and TPTP

The LEO-II project closely collaborates with the project THFTPTP (EU grant PIIF-GA-2008-219982) and Prof. G. Sutcliffe (University of Miami). In THFTPTP an infrastructure for typed higher-order form automated theorem proving is being developed. This infrastructure includes:

- The THF problem representation language for higher-order logic [4], which is employed as input language by LEO-II.
- The provision of 'System on TPTP' support tools for higher-order logic. Examples are the tptp2X and tptp4X utilities, which read, analyze, transform, and output TPTP problems and a THF type checking tool based on the logical framework Twelf [6].
- Online access to the higher-order automated theorem provers LEO-II and TPS [1] via the 'System on TPTP' website (`http://www.cs.miami.edu/~tptp/cgi-bin/SystemOnTPTP`)
- Online access to a library of problems for higher-order provers.
- A TSTP proof representation format for higher-order logic.
- Support tools for the evaluation and comparison of higher-order automated theorem provers.

Moreover, LEO-II exploits the existing first-order TPTP infrastructure. For example, the FOF syntax and the SZS result ontology are employed in LEO-II's cooperation with first-order theorem provers.

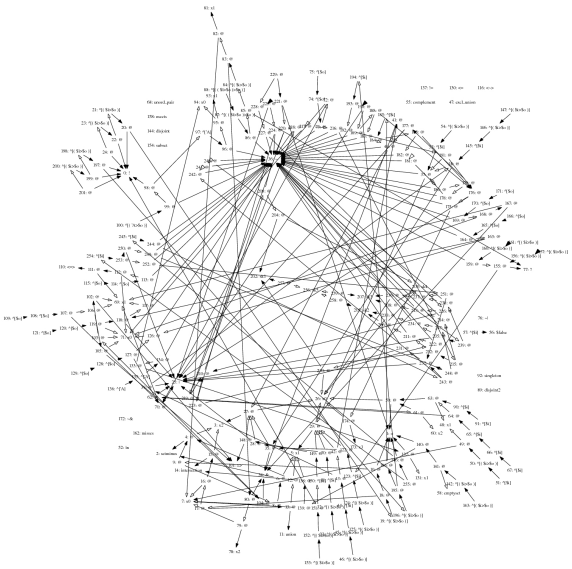
Applications

LEO-II has been applied, with promising first results, in the following domains:

- Sets, Relations and Functions [3]
- Reasoning in and about Multimodal Logics [5]
- Reasoning in and about Access Control Logics [2]
- Higher-order Abstract Syntax [8]
- Logical Puzzles [3]

LEO-II's Data Structures

LEO-II provides efficient term data structures based on a perfectly shared term graph, i.e., syntactically equal terms are represented by a single instance. Ideas from first-order term sharing are adapted to higher-order logic by (i) keeping indexed terms in $\beta\eta$ normal form (i.e., η short and β normal) and (ii) using de Bruijn indices to allow λ-abstracted terms to be shared.



LEO-II also provides analysis tools for exploring its proof object, term graph and term index. This includes tools for the statistical analysis of the term graph and for its visualization.

Recent Improvements of LEO-II

The latest version (v0.99) of LEO-II runs under Linux, Solaris, Mac OS X, and Windows with Cygwin.
LEO-II can now also be employed as a pre-processor for other reasoning tools: when called with a specific timeout in this mode, it returns after termination the full set of first-order clauses it has derived from the negated higher-order input problem up to that point. In this mode, LEO-II is thus a tool for quantifier elimination and reduction to first-order clauses.

References

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