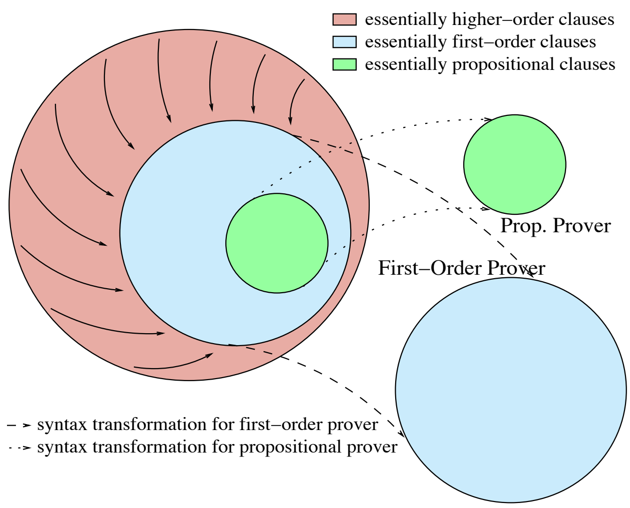
LEO II: A Higher-Order Theorem Prover

Automatic theorem provers (ATPs) are sophisticated and efficient. They can find long proofs and cope with thousands of irrelevant facts. However, they are limited to first-order logic. *Higher-order logic*, which includes function and predicate variables, is widely used in formal verification. Its λ-notation can express sets as well as functions. Moving from first-order to higher-order logic requires a more complicated proof calculus, but it often allows much simpler problem statements. Higher-order logic's built-in support for functions and sets often leads to shorter proofs. For example, facts about union and intersection that are hard to prove if expressed in first-order form become trivial when expressed in higher-order logic.

Our higher-order theorem prover, LEO II, is designed to co-operate with other provers. It removes higher-order features from the problem, transforming it to a first-order one. Thus the higher-order prover does not have to duplicate the complicated technologies used in first-order provers, and it immediately benefits from improvements made to them. We also envisage calling propositional provers.



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Our research objectives cover many areas.

- *Logic and Calculus*. First-order proof systems do not easily generalize to the higher-order case. Ordered paramodulation and superposition can reduce the search space, but they require a notion of term ordering.
- *Term Sharing and Indexing.* Structure sharing is an old idea in first-order logic, which we have adapted for higher-order logic using de Bruijn indices.
- *Architecture*. Search strategies for higher-order logic are not well understood. We have tried an agent-based architecture, but more work is needed.
- *Proof Objects*. We shall return sufficient information about a proof to allow it to be verified independently.
- *Applications*. We intend to allow LEO II to be invoked by interactive theorem provers, such as HOL4 and Isabelle.

The Team

Christoph Benzmüller heads the OMEGA group at Saarland University (Saarbrücken, Germany). He has served as principal investigator of several research projects concerning assistance systems for mathematics. In this project, he is assisted by Saarland University students Frank Theiß and Arnaud Fietzke.

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