First-order theorem proving and Vampire

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ABSTRACT:
In this tutorial we give a short introduction in first-order theorem proving and the use of the theorem prover Vampire.

The first part of the tutorial is intended for the audience with little or no knowledge in theorem proving. We will discuss the the resolution and superposition calculus, introduce the saturation principle, present various algorithms implementing redundancy elimination, preprocessing and clause form transformation and demonstrate how these concepts are implemented in Vampire.

The second part will cover more advanced topics and features. Some of these features are implemented only in Vampire. This includes reasoning with theories, such as arithmetic, answering queries to very large knowledge bases, interpolation, and an original technique of symbol elimination, which allows one to automatically discover invariants in programs with loops.

All the introduced concepts will be illustrated by running the first-order theorem prover Vampire.

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DETAILED OUTLINE OF THE TOPICS TO BE PRESENTED:

The tutorial serves the following purposes:
(1) to give an overview of first-order theorem proving using the resolution and superposition calculus;
(2) to show how this calculus and its modifications are implemented in Vampire;
(3) to explain the features of Vampire that can be used for purposes other than theorem proving.

The tutorial will cover the following topics (the list of topics may be slightly changed):

(1) First-order theorem proving.
   (a) The resolution and superposition calculus
   (b) Saturation algorithms
   (c) Redundancy elimination
   (d) Preprocessing and clause form transformation
   (e) Additional rules (splitting, definition introduction)

(2) Vampire
   (a) Basic principles of use
   (b) Implementation of the resolution and superposition calculus
   (c) Implementation of saturation
   (d) Options controlling proof search
   (e) Input and output syntax

(3) Advanced modes and features of Vampire
   (a) Working with very large knowledge bases
(b) Interpreted values and theories
(c) Consequence removal
(d) Colored proofs
(e) Interpolation
(f) Symbol Elimination
(g) Invariant generation and program analysis
(h) Multiple strategies and use of multi-core architectures

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TARGET AUDIENCE:

The tutorial is meant for graduate students, as well as for more experienced researchers in the field of formal methods. Participants are expected to have basic knowledge in first-order logic and formal methods. By the end of the tutorial, participants will have a better understanding in choosing the appropriate proving methodology for their specific application.

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BRIEF CV OF SPEAKERS:

Laura Kovacs is an FWF Hertha Firnberg Research Fellow at the Institute of Computer Languages of the Vienna University of Technology (TU Wien). Her research deals with the design and development of new theories, technologies, and tools for program verification, with a particular focus on automated assertion generation, symbolic summation, computer algebra, and automated theorem proving.
She holds an MSc from the Western University of Timisoara, Romania, and a PhD degree from the Research Institute for Symbolic Computation of the Johannes Kepler University, Linz, Austria.
Before joining TU Wien, she was a postdoctoral researcher in the Models and Theory of Computation research group of Prof. Dr. Thomas A. Henzinger at the Swiss Federal Institute of Technology Lausanne (EPFL), and at the Programming Methodology research group of Prof. Dr. Peter Muller at the Swiss Federal Institute of Technology Zürich (ETH).

Andrei Voronkov is a Professor of Formal Methods at the University of Manchester. He worked in several areas of computational logic, including theorem proving, logic programming decision procedures and program analysis. He is now also interested in text and document analysis and Web services. He is known for implementing the theorem prover Vampire (together with his PhD students) and the conference management system EasyChair.

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