2007-08-30

APPLIED LOGIC (10 hp) – Tillämpad logik

Methods of mathematical logic are becoming widely used in engineering of computer systems and programs in order to guarantee correctness of operation and simplify construction and modification. The formal specification and proof of correctness of systems require different logical languages such as modal logics, equational logic, predicate calculus or type theory, and often employ automatic tools: theorem provers, model checkers, proof support systems and methods for program extraction and synthesis. To build, and use, such tools reliably one need to understand the mathematics behind them — mathematical logic — to a larger or lesser extent. The aim of this course is to present some of the most accessible and relevant parts of mathematical logic for such applications. These include proof-theoretic methods and algorithmtic aspects of logic.

Contents

Propositional logic: combinatorial problems as propositional problems. Methods for efficient solution and representation of propositional problems (Davis–Putnam, BDDs).

Modal logic: possible worlds semantics, Kripke models. Interpretations of modal logic: Temporal logic and epistemic logic. Applications in model checking.

Equational logic: terms, unification, universal algebra, equational reasoning, term rewriting.

Predicate logic and proof search: the completeness theorem, proof search in some calculi (tableaux, resolution).

Solvable and unsolvable problems: complete and decidable theories, quantifier elimination, Gödel's incompleteness theorem (without proof).

Constructive logic and type theory: lambda calculus, simple type theory, intuitionistic logic, Martin-Löf type theory, propositions-as-types, program extraction from proofs, logical frameworks, proof support systems (Coq, Hol, Isabelle or Agda).

Literature

M R A Huth and M F Ryan. *Logic in Computer Science: Modelling and reasoning about systems.* Second edition. Cambridge University Press 2004.

J H Gallier. *Logic for Computer Science: Foundations of Automatic Theorem Proving.* Wiley 1986. Out of Print. Revised version available in electronic form from the author's webpage: www.cis.upenn.edu/~jean/gbooks/logic.html

T Coquand, P Dybjer and E Palmgren. *Constructive Interpretation of Logic* — a chapter of the book manuscript *Type-theoretic foundations of constructive mathematics*, Uppsala 2007.

Supplementary material on decidability, equational logic, term rewriting and intuitionistic logic.

Level and prerequisites. The course is at the advanced level in mathematics. Prerequisites are B.Sc., Logic and Proof Techniques I, Automata Theory

Course start: August 30, 13.15 – 15.00, in room 2145 MIC, Polacksbacken, Uppsala.

Examination: Written and, possibly, oral examination at the end of the course. Moreover, compulsory assignments may be given during the course.

Instructors

Professor Erik Palmgren, tel. 018-471 32 85, Email: palmgren@math.uu.se.
Teaching assistant: Anton Hedin, hedin@math.uu.se.
Web page of the course: www.math.uu.se/~palmgren/tillog .

Responsible departement: Department of Mathematics.