Book Review

Title: Handbook of Logic in Artificial Intelligence and Logic Programming, Volume 2: Deduction Methodologies
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This volume is one of the eleven volumes which make up the series “Handbooks of Logic in Computer Science, and Artificial Intelligence and Logic Programming”. These two series aim to cover the field of computational logic in depth as well as in breadth. These volumes are not introductory texts but rather dense overviews, which require a fair degree of mathematical understanding. The intended audience is advanced graduate students and researchers in the areas of computing and logic.

The present volume, which is concerned with deduction methodologies, is made up of six chapters, which are written by renowned experts, and have been validated by a second reader, also an expert in the field. Great effort has been paid to co-ordinating the contents of the various chapters. All contributors have jointly agreed to the tables of content for each chapter, and each chapter has been presented to the authors of the other chapters for feedback and criticism before the final version was written.

Chapter 1: Logical Basis for the Automation of Reasoning: Case Studies (Larry Wos and Robert Veroff) is about the Clause Language Paradigm (CLP) in Automated Reasoning (AR) as opposed to other approaches, e.g. Logic Programming. After the presentation of the principles and components of, and present obstacles for, such systems, the authors give in section 4 a number of areas in which AR in its CLP form has shown impressive results, to the extent that such systems outperform even experts in their field in some non-trivial cases: equational calculus, combinatory logic and sentential logic. For instance the reduction proof of one sentential logic system to another was shortened from 46 steps, by a human expert (Łukasiewicz), by more than a third to 29 steps by a CLP system. The chapter also contains a list of basic research problems to be solved and sources for AR programs, books in this field and a problem database, which is very useful for students and researchers. The authors also emphasize that AR works very differently from human reasoners. At the same time they express the hope that mathematicians and logicians increasingly use AR systems as assisting them in their proof search, which in turn would help in the development of more efficient AR systems.
Chapter 2: Unification Theory (Franz Baader and Jörg Siekmann) gives a very broad and deep overview of the area of unification, which plays a central role in automated deduction as the central operation for the matching of descriptions. Many theorems, unification strategies and algorithms are covered in great depth, and related topics such as higher-order and order-sorted unification are also discussed. The chapter concludes with an overview of applications of unification in computer science and artificial intelligence.

Chapter 3: Mathematical Induction (Christoph Walther), which is with 100 pages the longest one in the book, deals with a paradigm in automated induction called “explicit induction” (in contrast to the other leading paradigm “implicit induction” or “proof by consistency”) which resembles most closely what mathematicians do. People, when doing induction proofs, make many decisions intuitively that have to be made explicit for an automated reasoning system to efficiently search for proofs by induction - such as the variable of induction, which induction axiom to use (e.g. strong or weak induction), the representation of the domain as well-founded data structures (“admissible specifications”), and the generalization of induction formulas (sometimes only a stronger, generalized version of an induction formula can be proved, of which the given one is an instance). Each of these questions is addressed in much detail in separate sections that close with a very useful summary.

Chapter 4: Higher Order Logic (Daniel Leivant). This fairly long chapter falls into two parts. The first part presents higher order logic in the usual way: motivation, syntax, semantics and proof theory. The second part comprises a variety of interesting topics that range from philosophy of mathematics to mathematical practice to the significance of higher order logic for computing and programming. The chapter closes with a very extensive 20 page bibliography.

Chapter 5: Metalanguages, Reflection Principles and Self-Reference (Donald Perlis and V.S. Subrahmanian). In this chapter the authors present a good argument for why these traditionally philosophical concepts are of considerable importance for AI and Logic Programming. For AI is concerned with modeling rational agents and it is often argued by workers in this field that “reasoning agents must be able to reflect upon their own knowledge and beliefs” (p. 351). The remaining concept of the title, metalanguage, is relevant since reflection requires the ability to talk about our beliefs, which are expressed in the primary object language.

In the final chapter on classical vs. non-classical logics, Dov Gabbay makes a strong point that the translation of non-classical logics to classical logic provides a solid foundation for automated reasoning and for the combination of logics. This chapter differs from the others, which provide an overview and foundations of the area, by making a strong claim and giving extensive examples and arguments making use of his labelled deductive systems and the logic programming language HFP.

All six chapters of the book share an emphasis on foundational issues and present a comprehensive overview of each field in a uniform framework. By relating all different approaches to their foundations, they can cover the field in breadth without having to com-