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Non-Monotonic Extensions of Logic Programming

Second International Workshop, NMELP '96
Bad Honnef, Germany, September 5-6, 1996
Selected Papers

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Preface

This book is the outcome of the compilation of extended and revised versions of selected papers presented at the workshop on *Non-Monotonic Extensions of Logic Programming* held in Bad Honnef, Germany, on September 5–6, 1996. A total of 18 papers were submitted, 9 of which were finally accepted and published in this volume.

The impressive research progress of the last few years as well as the significant advances made in logic programming implementation techniques now provide us with a great opportunity to bring to fruition computationally efficient implementations of the recent extensions to logic programming and their applications. The resulting programming systems must not only ensure the increased expressiveness and declarative transparency of the evolving paradigm of logic programming, but should also be suitable to serve as inference engines for other non-monotonic reasoning formalisms and deductive databases, as well as specification languages for software engineering.

This workshop was the sixth in a series of workshops held in conjunction with Logic Programming conferences (NACLP '90, ILPS '91, ILPS '93, ICLP '94, and ICLP '95) and dealt with all three aspects of extended logic programming: *theory*, *applications* and *implementation*. As a result, the collected papers are naturally divided into three sections

- Semantics
- Applications
- Computation.

This volume starts with a short overview of the presented papers, and an article entitled *"Prolegomena to logic programming for non-monotonic reasoning"*. This article was written by the editors, and its purpose was to provide an introduction to and motivation for the area of extended logic programming.

We would like to thank the members of the program committee and the additional reviewers listed below.

February 1997

Jürgen Dix, Koblenz
Luís Moniz Pereira, Lisboa
Teodor C. Przymusinski, Riverside

Organization

Previous Workshops

1990 WS at NACLP '90, U.S.A.	1991 WS at ILPS '91, U.S.A.
1993 WS at ILPS '93, U.S.A.	1994 WS at ICLP '94, Italy
1995 WS at ICLP '95, Japan	1996 WS at JICSLP '96, Germany

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Papers in this Book

In order to facilitate reading of this volume, we now present a brief overview of the content of the presented papers. We follow our classification of papers into three categories: *semantics*, *applications* and *computation*.

Semantics

While Bochman and Pearce are concerned with characterizations of classical semantics, the other two papers deal with *aggregation* (Osorio/Jayaraman), and *constraints* (Wang/You/Yuan).

A. Bochman: In his paper *"On Logics and Semantics for General Logic Programs"* the author introduces a 4-valued monotonic logic which, when augmented with a non-monotonic operator of minimization (or circumscription), allows us to obtain, depending on the additional assumptions about the logic, various semantics of logic programs. In this way, differences between many proposed semantics for logic programs are reduced to the differences between the underlying monotonic logics while the non-monotonic part, namely circumscription, remains the same.
In this sense, Bochan's paper is similar to Przymusinski's formalism of *Autoepistemic Logic of Knowledge and Beliefs* [Prz94,Prz95] in which the underlying modal logic is also monotonic. After being augmented with a minimal belief operator it leads, depending on the additional logical axioms, to the characterization of different semantics for logic programs.

D. Pearce: The paper "A New Logical Characterization of Stable Model" is devoted to a characterization of the stable model semantics. It introduces a non-monotonic logic, called the "equilibrium logic", which is the least constructive extension of the modal logic "here-and-there", and shows that on logic programs it coincides with the stable model semantics. However, the proposed formalism applies to all first-order theories. Moreover, as opposed to the original definition of stable models or its characterization via autoepistemic expansions, it does not involve any fixed-point definition.

M. Osorio and B. Jayaraman: The paper *"Aggregation and WFS$^+$"* considers the problem of representing aggregate operations, such as taking maximum or minimum over a given set of values, by means of normal logic programs. The main result of the paper is the description of a natural translation of partial-order programs with aggregate operations into normal logic programs which transforms any cost-monotonic partial-order program into a stratified normal program so that their respective semantics are preserved. As a result, aggregate operations present in the original program do not explicitly appear in the translated normal program.

X. Wang, J.-H. You and L.-Y. Yuan: In their paper titled *"Nonmonotonic Reasoning by Monotonic Inferences and Priority Constraints"* the authors introduce a a non-monotonic formalism called"priority logic" and based on a combination of a monotonic logic coupled with priority constraints. They

show that well known non-monotonic formalisms, such as default logic and defeasible inheritance networks, can be recast in this new logic. They also argue that such an approach has many advantages, including the fact that it allows us to represent knowledge by means of purely monotonic rules while achieving its non-monotonic behavior by superimposing priorities which often form a natural part of commonsense knowledge.

Applications

The paper, by Baldoni, Giordani, Martelli and Patti, is concerned with *abduction* and reasoning about actions. The two papers of Alferes and Pereira and Bidoit/Maabout discuss *update-programs* and *revision-programs*.

J. J. Alferes and L. M. Pereira: In the first part of the paper *"Update-programs Can Update Programs"* the authors extend the notion of a revision program, introduced in [MT94], by allowing partial revisions (for the sake of consistency with the established terminology, the authors propose to use the term *update* rather than revision) thus ensuring that consistent updates exist for a much wider class of update programs. Such an extension can also be obtained by using partial stable semantics (instead of stable semantics) in the translation of update programs into logic programs described in [PT95]. In the second part of the paper, the authors describe a mechanism for automatic transformation of logic programs into updated logic programs. Previous approaches were essentially restricted to the description of the set of models that the updated logic program should satisfy but they did not provide any direct way of construction of such a program.

M. Baldoni, L. Giordano, A. Martelli and V. Patti: In their paper *"Abductive Proof Procedure for Reasoning about Actions in Modal LP"* the authors investigate a modal approach to reasoning about actions. The proposed base language is a standard modal language with Kripke semantics. However, in order to deal with non-monotonic aspects of reasoning about actions, such as the frame problem, they augment their logic with an abductive semantics based on Dung's argumentation framework. They also define a sound and goal-directed procedure for answering queries in the abductive semantics.

N. Bidoit and S. Maabout: The paper *"Update Rule Programs Versus Revision Programs"* proposes a new approach to interpretation update via logic-program-type rules. As does Alferes and Pereira's paper, it extends and modifies the approach proposed by Marek and Truszczynski [MT94] (revision programs) in two ways. On the one hand, it adds premises of update rules which allow us to distinguish between facts holding in the interpretation that is being updated and those facts which are to be updated (either removed or added to the interpretation). On the other hand, it bases the whole update process on the well-founded semantics rather than on the stable semantics. In the process, it also reinterprets the heads of update (revision) rules by forcing them to intuitively mean that some facts cannot be true (false) rather than to be true (false) in the updated interpretation. This is an important consideration given the fact that the updates are usually partial models.

Computation

Both Brass, Zukowski and Freitag as well as Dix and Stolzenburg present computational frameworks for normal and disjunctive programs that are currently being implemented.

S. Brass, S. Zukowski and B. Freitag: The paper *"Transformation-Based Bottom-Up Computation of the WFS"* is devoted to the study of bottom-up methods of computation of the well-founded semantics (WFS). Its main result is the introduction of a rather simple and yet polynomial bottom-up method of computing the WFS of normal programs. The work builds upon previous approaches, such as SLG-resolution and the notion of residual programs, but it introduces a significant number of new elements. In some sense, the proposed method combines the good features of the residual approach and the alternating fixed-point approach, while avoiding their known efficiency problems.

J. Dix and F. Stolzenburg: The paper *"Computation of Non-Ground Disjunctive WFS with Constraint LP"* addresses the issue of computation of answers to queries to disjunctive programs with variables and functions, as opposed to dealing with instantiated, propositional programs only. While for semantic considerations, usually it suffices to consider instantiated programs, due to efficiency problems, such an approach is completely unsuitable for the purpose of general query answering. The authors attempt to solve the problem by introducing a calculus of transformations defined on disjunctive programs which extends the calculus developed earlier by Brass and Dix for ground programs [BD95]. The calculus, which is also proved to be confluent, in principle allows us to transform arbitrary disjunctive programs with variables and functions into much simpler, residual programs for which query answering is greatly simplified.

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