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Burkhard Freitag Hendrik Decker
Michael Kifer Andrei Voronkov (Eds.)

Transactions and Change in Logic Databases

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Volume Editors

Burkhard Freitag
University of Passau, Department of Mathematics and Computer Science
Innstraße 33, D-94032 Passau, Germany
E-mail: freitag@fmi.uni-passau.de

Hendrik Decker
Ludwig-Maximilians-University Munich, Institute of Computer Science
Oettingenstraße 67, D-80538 Munich, Germany
E-mail: hdecker@informatik.uni-muenchen.de

Michael Kifer
University at Stony Brook, Department of Computer Science
Stony Brook, NY 11794-4400, USA
E-mail: kifer@cs.sunysb.edu

Andrei Voronkov
Uppsala University, Computing Science Department
Box 311, S 751 05 Uppsala, Sweden
E-mail: voronkov@csd.uu.se

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Preface

Logic databases have been an exciting, dynamic field since the 1970s. Important results were achieved in the areas of query processing, constraints, and semantics, and several successful prototypes were developed. However, most of this work has been concerned with static aspects of data representation and querying. Thus, in spite of substantial progress in the theory and implementation of logic programming and deductive databases, the latter are likely to be ruled out as platforms for information systems unless viable and widely accepted solutions are found to the question of dynamics.

Although transactions and updates permeate any database system worth its salt, the consensus on how to treat updates in logic data and knowledge bases is slow to come. In fact, transactions are notoriously awkward and hard-to-understand parts of logic-based programming systems, which is a serious obstacle to gaining a foothold in traditional and emerging areas of information processing. It is also a blemish on a technology that purports to provide a solid methodology for building complex, robust, and intelligent systems.

Apart from the complex rule bases, there is also a need for standard database functionality, such as concurrent access, transaction isolation and atomicity, large amounts of data, data distribution, recovery from system failures, etc. Thus, the problems span all of logic programming and databases, from theory to implementation.

A sound but incomplete list of relevant issues includes:

- abduction
- active logic databases
- concurrency
- consistency and integrity
- cooperation, communication, interaction
- distributed (trans)actions
- dynamic agents
- dynamic constraints
- dynamics of logic and database systems
- evolution and versioning
- frame problem
- hypothetical query answering
- implementation issues
- intensional query answering
- logical transactions and updates
- planning
- reactive systems
- reasoning about update programs
- reasoning about workflows
- schema transformation
- semantics and proof theory
- transaction specification
- updating incomplete information
- update versus revision
- workflow specification

Fortunately, a number of solid approaches are beginning to emerge, and time is ripe to size them up. This volume contains invited contributions and survey articles accompanied by thoroughly revised selected papers, preliminary versions of which were presented at the Dagstuhl seminar on *Logic Databases and the Meaning of Change* in 1996 and the workshop DYNAMICS'97 on *(Trans)Actions*

and Change in Logic Programming and Deductive Databases held in connection with the International Logic Programming Symposium, October 1997, in Port Jefferson, New York, USA.

The book starts with a general survey of the field by A. Bonner and M. Kifer. A great number of logical theories have been developed in which the state of the underlying database can evolve with time. The paper by A. Bonner and M. Kifer reviews a number of these works, discusses their application domains, and highlights their strong and weak points.

The following paper by P. van Eck and his co-authors surveys a number of existing approaches to the specification of the dynamic reasoning behavior. The authors compare two languages from the information systems area, i.e., the Language for Conceptual Modeling (LCM) and the specification language TROLL, with well-known approaches to the specification of database updates and the dynamics of logic programs, i.e., transaction logic and dynamic database logic, and the formalism of abstract state machines.

The next four papers concentrate on rule-based update languages and their potential of transaction programming and reasoning about updates.

The paper written by G. Lausen and his co-authors gives an introduction to and an overview of the area of active deductive databases. Some of the major formal approaches to active rules are analyzed and compared to the corresponding concepts of the Statelog language, i.e., an extension of Datalog with states.

E. Bertino and her co-authors describe an approach to integrating deductive rules and active rules. They introduce a new language called Active-U-Datalog which is based on their U-Datalog language and extends it with support for active rules.

The logical transaction programming language ULTRA and its support of transaction isolation and atomicity is presented in the paper by C.-A. Wichert and his co-authors.

In their technical paper, A. Bonner and M. Kifer explore the potential of transaction logic as a formalism for reasoning about logic programs with updates.

The next two papers are based on the situation calculus as a formal foundation.

M. Arenas and L. Bertossi show how to derive action-effect based successor state axioms for views from the successor state axiom for the base tables of a given extensional database. They derive formal results and give examples of applications, e.g., to view maintenance.

The paper by E. Ternovskaia explores the situation calculus within the framework of inductive definability and establishes direct connections with different variants of the μ-calculus, structural operational semantics of concurrent processes, and logic programming.

The next group consists of four papers addressing various aspects of the dynamics of knowledge-based systems.

H. Decker's survey paper is intended to serve as a background for studies in the field of knowledge assimilation in deductive databases. Particular attention

is paid to the various kinds of hypotheses used in abductive logic programming for implementing knowledge assimilation.

Besides updating existing knowledge, belief revision provides support for intelligent information processing in general and decision making in particular. The objective of the survey paper by M.-A. Williams to illustrate how theoretical ideas in belief revision have laid the foundation for practical implementations and real world applications.

H. Bezzazi and his co-authors propose an abstract framework to analyze the rationality of change operators defined in a syntactical way. In particular, the authors investigate five change operators based on forward chaining. The use of forward chaining provides them with an efficient way to compute the revision of a knowledge base.

H. Christiansen and T. Andreasen address the topic of hypothetical queries, i.e., queries with embedded hypotheses about a future database state. The authors compare some of the approaches to hypothetical queries found in the literature and present their concept, called "counterfactual exceptions".

A thematic group of its own is formed by the survey paper by P. Flach on inductive logic which aims at demonstrating that inductive logic programming (ILP) combines very well with the area of deductive databases. In particular, the inductive inference of view definitions and the learning of integrity constraints, both relevant issues in the context of updates and change, are discussed.

August 1998

Burkhard Freitag
Hendrik Decker
Michael Kifer
Andrei Voronkov

Organization

Editors

Burkhard Freitag	Universität Passau, Germany
Hendrik Decker	Universität München, Germany
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