Preface

The papers contained in this volume were presented at the fourth edition of the IFIP International Conference on Theoretical Computer Science (IFIP TCS), held August 23–24, 2006 in Santiago, Chile. They were selected from 44 papers submitted from 17 countries in response to the call for papers. A total of 16 submissions were accepted as full papers, yielding an acceptance rate of about 36%. Papers solicited for IFIP TCS 2006 were meant to constitute original contributions in two general areas: Algorithms, Complexity and Models of Computation; and Logic, Semantics, Specification and Verification.

The conference also included six invited presentations: Marcelo Arenas (Pontificia Universidad Católica de Chile, Chile), Jozef Gruska (Masaryk University, Czech Republic), Claudio Gutiérrez (Universidad de Chile, Chile), Marcos Kiwi (Universidad de Chile, Chile), Nicola Santoro (Carleton University, Canada), and Mihalis Yannakakis (Columbia University, USA). The abstracts of those presentations are included in this volume. In addition, Jozef Gruska and Nicola Santoro accepted our invitation to write full papers related to their talks. Those two surveys are included in the present volume as well.

TCS is a biannual conference. The first edition was held in Sendai (Japan, 2000), followed by Montreal (Canada, 2002) and Toulouse (France, 2004). TCS is organized by IFIP TC1 (Technical Committee 1: Foundations of Computer Science). TCS 2006 was part of the 19th IFIP World Computer Congress (WCC 2006), constituting the TC1 Track of WCC 2006, and it was sponsored by TC1 and the Center for Web Research (CWR), at the Department of Computer Science of the University of Chile.

We thank the local WCC organizers and TC1 for their support in the organization of IFIP TCS. We also thank the members of the Program Committee and the additional reviewers for providing timely and detailed reviews. Finally, we thank TC1 for inviting us to chair this edition of TCS.

Santiago, Chile,
August 2006

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Part I

Invited Talks

Locality of Queries and Transformations
(Invited Talk)

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Abstract

Locality notions in logic say that the truth value of a formula can be determined locally, by looking at the isomorphism type of a small neighborhood of its free variables. Such notions have proved to be useful in many applications especially in computer science. They all, however, refer to isomorphism of neighborhoods, which most local logics cannot test. A more relaxed notion of locality says that the truth value of a formula is determined by what the logic itself can say about that small neighborhood. Or, since most logics are characterized by games, the truth value of a formula is determined by the type, with respect to a game, of that small neighborhood. Such game-based notions of locality can often be applied when traditional isomorphism-based locality cannot.

In the first part of this talk, we show some recent results on game-based notions of locality. We look at two, progressively more complicated locality notions, and we show that the overall picture is much more complicated than in the case of isomorphism-based notions of locality.

In the second part of this talk, we concentrate on the locality of transformations, rather than queries definable by formulas. In particular, we show how the game-based notions of locality can be used in data exchange settings to prove inexpressibility results.

* Partially supported by FONDECYT grant 1050701 and the Millennium Nucleus Center for Web Research, Grant P04-067-F, Mideplan, Chile.

From Informatics to Quantum Informatics
(Invited Talk)

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Abstract

During the recent years, exploration of the quantum information processing and communication science and technology got a significant momentum, and it has turned out quite clearly that paradigms, concepts, models, tools, methods and outcomes of informatics play by that a very important role. They not only help to solve problems quantum information processing and communication encounters, but they bring into these investigations a new quality to such an extend that one can now acknowledge an emergence of a quantum informatics as of an important area of fundamental science with contributions not only to quantum physics, but also to (classical) informatics.

The main goal of the talk will be to demonstrate the emergence of quantum informatics, as of a very fundamental, deep and broad science, its outcomes and especially its main new fascinating challenges, from informatics and physics point of view. Especially challenges in the search for new primitives, computation modes, new quality concerning efficiency and feasibility of computation and communication, new quality concerning quantum cryptographic protocols in a broad sense and also in a very new and promising area of quantum formal systems for programming, semantics, reasoning and verification.

The talk is targeted to informaticians that are pedestrians in quantum world, but would like to see what are new driving forces in informatics, where they drive us and how.

* Support of the grants GAČR 201/04/1153 and MSM0021622419 is acknowledged.

RDF as a Data Model

(Invited Talk)

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Abstract

The Resource Description Framework (RDF) is the W3C recommendation language for representing metadata about Web resources. It is the basic data layer of the Semantic Web. The original design was influenced by the Web, library, XML and Knowledge representation communities. The driving idea was a language to represent information in a minimally constraining and flexible way. It turns out that the impact of the proposal goes far beyond the initial goal, particularly as a model for representing information with a graph-like structure.

In the first half of the talk we will review RDF as a database model, that is, from a data management perspective. We will compare it with two data models developed by the database community which have strong similarities with RDF, namely, the semistructured and the graph data models. We will focus the comparison on data structures and query languages.

In the second half of the talk, we will discuss some of the challenges posed by RDF to the Computer Science Theory Community:

1. RDF as data model: Database or knowledge base?
2. Abstract model for RDF: What is a good foundation?
3. Concrete –real life– RDF data: What are the interesting fragments?
4. Theoretical novelties of the RDF data model: Are there any?
5. RDF Query Language: Can the database experience be of any help?
6. Infrastructure for large-scale evaluation of data management methodologies and tools for RDF: Waiting for something?
7. Storing, Indexing, Integrity Constraints, Visualization et al.: Theory is required.

* The speaker acknowledges the support of Millennium Nucleus Center for Web Research, Grant P04-067-F, Mideplan, Chile.

Adversarial Queueing Theory Revisited
(Invited Talk)

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Abstract

We survey over a decade of work on a classical Queueing Theory problem; the long–term equilibrium of routing networks. However, we do so from the perspective of Adversarial Queueing Theory where no probabilistic assumptions about traffic patterns are made. Instead, one considers a scenario where an adversary controls service requests and tries to congest the network. Under mild restrictions on the adversary, one can often still guarantee the network's stability. We illustrate other applications of an adversarial perspective to standard algorithmic problems. We conclude with a discussion of new potential domains of applicability of such an adversarial view of common computational tasks.

Background

In 1996 Borodin et al. [9] proposed a robust model of queueing theory in network traffic. The gist of their proposal is to replace stochastic assumptions about the packet traffic by restrictions on the packet arrival rate, which otherwise can be under the control of an adversary. Thus, they gave rise to what is currently termed Adversarial Queueing Theory (AQT). In it, the time–evolution of the routing network is viewed as a game between an adversary and a packet scheduling protocol.

The AQT framework originally focussed on the issue of stability of queueing policies and network topologies. Characterizations and efficient algorithms were developed for deciding stability of a collection of networks for specific families of scheduling policies. Generalizations of the AQT framework were proposed. End–to–end packet delay issues were addressed. Time–dependent network topology variants were considered, etc.

We survey a decade of results in AQT. We point to other work where a similar adversarial approach has been successfully developed. We conclude with a discussions of other computational domains where a similar adversarial approach might be fruitfully applied.

* Gratefully acknowledges the support of CONICYT via FONDAP in Applied Mathematics and Anillo en Redes.

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Distributed Algorithms for Autonomous Mobile Robots

(Invited Talk)

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Abstract

The distributed coordination and control of a team of autonomous mobile robots is a problem widely studied in a variety of fields, such as engineering, artificial intelligence, artificial life, robotics. Generally, in these areas, the problem is studied mostly from an empirical point of view. Recently, a significant research effort has been and continues to be spent on understanding the fundamental algorithmic limitations on what a set of autonomous mobile robots can achieve. In particular, the focus is to identify the minimal robot capabilities (sensorial, motorial, computational) that allow a problem to be solvable and a task to be performed. In this talk we describe the current investigations on the interplay between robots capabilities, computability, and algorithmic solutions of coordination problems by autonomous mobile robots.

Recursion and Probability
(Invited Talk)

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Abstract

We discuss recent work on the algorithmic analysis of systems involving recursion and probability. Recursive Markov chains extend ordinary finite state Markov chains with the ability to invoke other Markov chains in a potentially recursive manner. They offer a natural abstract model of probabilistic programs with procedures, and generalize other classical well-studied stochastic models, eg. Multi-type Branching Processes and Stochastic Context-free Grammars. Recursive Markov Decision Processes and Recursive Stochastic Games similarly extend ordinary finite Markov decision processes and stochastic games, and they are natural models for recursive systems involving both probabilistic and nonprobabilistic actions. In a series of recent papers with Kousha Etessami (U. of Edinburgh), we have introduced these models and studied central algorithmic problems regarding questions of termination, reachability, and analysis of the properties of their executions. In this talk we will present some of the basic theory and algorithms.

* Research partially supported by NSF Grant CCF-4-30946.

Part II

Invited Papers

From Informatics to Quantum Informatics

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* Support of the grants GAČR 201/04/1153 and MSM0021622419 is acknowledged.

Distributed Algorithms for Autonomous Mobile Robots

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Part III

Contributed Papers

The Unsplittable Stable Marriage Problem

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Variations on an Ordering Theme with Constraints

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BuST-Bundled Suffix Trees

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An O(1) Solution to the Prefix Sum Problem on a Specialized Memory Architecture

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An Algorithm to Reduce the Communication Traffic for Multi-Word Searches in a Distributed Hash Table

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Exploring an Unknown Graph to Locate a Black Hole Using Tokens

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Fast Cellular Automata with Restricted Inter-Cell Communication

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Asynchonous Distributed Components: Concurrency and Determinacy

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Decidable Properties for Regular Cellular Automata

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Symbolic Determinisation of Extended Automata

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Regular Hedge Model Checking

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Completing Categorical Algebras
(Extended Abstract)

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Reusing Optimal TSP Solutions for Locally Modified Input Instances*

(Extended Abstract)

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** This author was staying at ETH Zurich when this work was done.

Spectral Partitioning of Random Graphs with Given Expected Degrees

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A Connectivity Rating for Vertices in Networks

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On PTAS for Planar Graph Problems

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