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Topics in Theoretical Computer Science

The First IFIP WG 1.8 International Conference, TTCS 2015
Tehran, Iran, August 26–28, 2015
Revised Selected Papers

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Preface

Welcome to the proceedings of the First IFIP International Conference on Topics in Theoretical Computer Science (TTCS 2015)!

This volume contains the revised papers presented at TTCS 2015. The conference was held during August 26–28, 2015, at the Institute for Research in Fundamental Sciences (IPM), Tehran, Iran.

For this first edition of TTCS, we received 48 submissions from 12 different countries. An international Program Committee comprising 45 leading scientists from 14 countries reviewed the papers thoroughly providing on average five review reports for each paper. We ended up accepting 11 submissions, which translates into less than 23 % of all submissions. This means that the process was highly selective and only very high quality papers were accepted.

The program also included three invited talks by the following world-renowned computer scientists:

– Prof. Anuj Dawar, Cambridge University, UK,
– Prof. Michael Fellows, Charles Darwin University, Australia, and
– Dr. Mehrnoosh Sadrzadeh, Queen Mary University of London, UK.

These invited lectures are also represented either by an abstract or by a full paper in the proceedings.

Additionally, the program featured four talks in the PhD Forum, which are not included in the proceedings.

We thank IPM, and in particular the Organizing Committee, for having provided various facilities and for their generous support. We believe that, thanks to their help, the conference organization was run smoothly and conveniently. We are also grateful to our program committee for their professional and hard work in providing expert review reports and thorough discussions leading to a very interesting and strong program. We also acknowledge the excellent facilities provided by the EasyChair system, which have been crucial in managing the process of submission, selection, revision, and publication of the manuscripts included in the proceedings.

November 2015

Mohammad Taghi Hajiaghayi
Mohammad Reza Mousavi

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Abstracts of Invited Talks

New Directions in Parameterized Algorithmics

Michael Fellows

Charles Darwin University, Australia

The talk will review some basics of the field, and then focus on some new directions in parameterized/multivariate algorithmics. These include:

- The systematic deconstruction of NP-hardness results for problems unrealistically legislated with real numbers, by parameterizing on the size of a relevant finitized arithmetic system.
- Fresh paradigms for deploying parameterization to FPT-turbocharge heuristics (such as greedy algorithms) and other subroutines of current approaches in practical computing for NP-hard problems.
- Aggressive aggregate parameterization including generative parameterization of typical instances of hard problems, building on and deepening the parameter ecology program.
- Parameterization in the context of *dynamic problems* where inputs change (a bit) and solutions need to be changed (a bit).
- The axiomatization of *groovy FPT*, where canonically structured kernelization is canonically convertible to: P-time approximation algorithms; inductive gradients for local search; sharper turbocharging for greedy algorithms, local search and genetic recombination heuristics — opening up a whole new level of *groovy* lower bound questions, such as the existence of *groovy polynomial kernels*. (Recent results show that some FPT parameterized problems admit polynomial kernels, but do not admit groovy polynomial kernelization unless P = NP.)
- The accidental origins of parameterized complexity in graph minor theory (well quasi-ordering + FPT order tests) is a general phenomenon: it has recently been shown that a parameterized problem is FPT if and only if this can be derived from a well-behaved WQO context. Where this leads is entirely open.

Distributional Sentence Entailment Using Density Matrices

Esma Balkr[1], Mehrnoosh Sadrzadeh[1], and Bob Coecke[2]

[1] Queen Mary University of London
[2] University of Oxford

Abstract. Categorical compositional distributional model of Clark, Coecke, and Sadrzadeh suggests a way to combine grammatical composition of the formal, type logical models with the corpus based, empirical word representations of distributional semantics. This paper contributes to the project by expanding the model to also capture entailment relations. This is achieved by extending the representations of words from points in meaning space to density operators, which are probability distributions on the subspaces of the space. A symmetric measure of similarity and an asymmetric measure of entailment is defined, where lexical entailment is measured using von Neumann entropy, the quantum variant of Kullback-Leibler divergence. Lexical entailment, combined with the composition map on word representations, provides a method to obtain entailment relations on the level of sentences. Truth theoretic and corpus-based examples are provided.

On Symmetric and Choiceless Computation

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Formal models of computation such as Turing machines are usually defined as performing operations on strings of symbols. Indeed, for most purposes, it suffices to consider strings over a two-letter alphabet $\{0, 1\}$. Decision problems are defined as sets of strings, and complexity classes as sets of decision problems. However, many natural algorithms are described on more abstract structure (such as graphs) because this is the natural level of abstraction at which to describe the problem being solved. Of course, we know that the abstract structures can be ultimately represented as strings (and, indeed, have to be in actual computational devices), but the representation comes at a cost. The same abstract structure may have many different string representations and the implementation of the algorithm may break the intended abstraction.

Research in the area of finite model theory and descriptive complexity (see [11, 13]) has, over the years, developed a number of techniques of describing algorithms and complexity classes directly on classes of relational structures, rather than strings. Along with this, many methods of proving inexpressiblity results have been shown, often described in terms of games. A key question that has been the focus of this research effort is whether the complexity class P admits a descriptive characterisation (see [10, Chap. 11]).

A recent paper [1] ties some of the logics studied in finite model theory to natural circuit complexity classes, and shows thereby that inexpressibility results obtained in finite model theory can be understood as lower bound results on such classes. In this presentation, I develop the methods for proving lower bound results in the form of combinatorial arguments on circuits, without reference to logical definability. The present abstract gives a brief account of the results and methods.

Contents