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35th National Conference, NCTCS 2017
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Preface

The National Conference of Theoretical Computer Science (NCTCS) is the main academic activity in the area of theoretical computer science in China. To date, NCTCS has been successfully held 34 times in over 20 cities. It provides a platform for researchers in theoretical computer science or related areas to exchange ideas and start cooperations.

This volume contains the papers presented at NCTCS 2017: the 35th National Conference of Theoretical Computer Science held during October 14–15, 2017, in Wuhan, China. Sponsored by the China Computer Forum (CCF), NCTCS 2017 was hosted by the CCF Theoretical Computer Science Committee and School of Computer Science Technology at Huazhong University of Science (HUST).

NCTCS 2017 received 84 English submissions (including seven published papers accepted only for communication at the conference) in the area of algorithms and complexity, software theory and methods, data science and machine learning theory, web science base theory, parallel and distributed computing and computational models, etc. Each of the 77 submissions was reviewed by at least three Program Committee members. The committee decided to accept 25 papers that are included in these proceedings published Springer's *Communications in Computer and Information Science* (CCIS) series.

NCTCS 2017 invited well-reputed researchers in the field of theoretical computer science to give keynote speeches, carry out a wide range of academic activities, and introduce recent advanced research results. We had seven invited plenary speakers at NCTCS 2017: Wei Chen (Microsoft Research Asia), Jin-Kao Hao (University of Angers, France), Jian Li (Tsinghua University, China), Qing Li (City University of Hong Kong), Pinyan Lu (Shanghai University of Finance and Economics), Liwei Wang (Peking University), and Jianping Yin (National University of Defense Technology). We express our sincere thanks to them for their contributions to the conference and the proceedings.

We would like to thank the Program Committee members and external reviewers for their hard work in reviewing and selecting papers. We are also very grateful to all the editors at Springer and the local organization chairs for their hard work in the preparation of the conference.

September 2017

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Abstracts for Invited Talks

Combinatorial Online Learning

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Abstract. Combinatorial optimization is one of the core areas in theoretical computer science and operations research, with many classical problems such as graph shortest paths, minimum spanning trees, maximum weighted matchings, and it also has numerous modern applications such as in networking, online advertising, crowd sourcing, and viral marketing. However, in many of these modern applications, the exact parameters needed as inputs, such as link latencies in wireless networking, click-through rates in online advertising, worker-task performance in crowd sourcing, and diffusion probabilities in viral marketing, are stochastic and unknown, and thus have to be learned over time. On the other hand, well-studied online learning and optimization frameworks, exemplified by the classical multi-armed bandit problem, cannot be applied directly to address these problems due to the exponential blowup in the solution space. Therefore, it demands a new framework that could incorporate combinatorial learning seamlessly into the existing combinatorial optimization framework, without re-engineering the optimization tasks from scratch. In this talk, I will introduce a series of works I and my collaborators have done in the recent years to systematically build such a framework. I will first introduce our work on the general combinatorial multi-armed bandit (CMAB) framework that incorporates optimization tasks with non-linear objective functions and approximation guarantees, and provide a modularized learning algorithm with tight regret analysis. I will then introduce our recent studies including CMAB with probabilistically triggered arms, CMAB with general reward functions, and combinatorial pure exploration, which cover different aspects of combinatorial online learning. Throughout my talk I will illustrate how the framework and the results can be applied to applications such as online advertising, crowd-sourcing, and viral marketing, and discuss many opportunities in further advancing this line of research.

Learning and Data Mining for Combinatorial Optimization: Some Case Studies

Jin-Kao Hao

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Abstract. We present some case studies of using learning and data mining techniques for solving combinatorial optimization: multidimensional scaling and reinforcement learning for graph coloring, opposition-based learning for subset selection with maximum diversity, and frequent patterns for quadratic assignment. We show how learning and data mining techniques techniques can be advantageously combined with an optimization method to obtain high-quality results for difficult combinatorial optimization problems.

Stochastic Combinatorial and Geometric Optimization

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Abstract. The world is full of uncertainty and very often decisions have to be made way before the uncertainty is resolved. Stochastic optimization studies optimization problems with uncertain inputs or parameters, in which the uncertainty is modeled using probability theory. The area was initiated by Danzig in 1950s and has been subject to extensive research in many disciplines including computer science, math, operation research, economics, management science and social science. In this talk, I will talk about some of my recent efforts on stochastic geometric and combinatorial optimization problems. In particular, I will talk about some new results on the stochastic models for several fundamental geometric and combinatorial problems, such as minimum spanning tree, closest pair, minimum enclosing ball, shortest path and knapsack.

Towards Truth: Mechanism Design vs. Data Mining

Qing Li, Minming Li

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Abstract. Eliciting true information from the input is of critical importance for meaningful output. There are two ways to secure true information. One is mechanism design where agents reporting wrong information will not gain them any benefit. The other is data mining where true information is dug out from multi-sourced (and perhaps multi-modal) data upon which cross validation can be carried out.

About mechanism design, we use facility location games as an example to illustrate how the truthfulness can be guaranteed by sacrificing some efficiency. Various models are discussed for this setting of mechanism design without money. Especially for one of the variants, we consider how agents affect each other in their utilities. We assume that the coefficients are already known as input when the mechanism is applied. However, in reality, the way people (agents) affect each other needs to be learned from historical data. Therefore, we also analyze how to learn those coefficients in the underlying social networks. For data mining, we use social event discovery as an example, where multi-sourced social media data is collected, integrated, and fused, upon which clustering and classification algorithms are then applied to discover or detect significant/interested events. In dealing with incomplete or inconsistent data from multiple sources, a multi-dimensional model is devised to facilitate cross checking and validation, thereby achieving the objective of digging out true information.

Interdisciplinary Researches through the Lenses of Theoretical Computer Science

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Abstract. Researches in of Theoretical Computer Science (TCS) cover core problems in computer science such as algorithm and complexity. However, there are also many interdisciplinary researches through the Lenses of TCS such as mathematics, physics, economics and so on. The key concepts, ideas and computational thinking in TCS influence other disciplines deeply. In this talk, I will share a few case studies from my own research.

Towards Understanding Deep Learning: Two Theories of Stochastic Gradient Langevin Dynamics

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Abstract. Deep learning has achieved great success in many applications. However, deep learning is a mystery from a learning theory point of view. In all typical deep learning tasks, the number of free parameters of the networks is at least an order of magnitude larger than the number of training data. This rules out the possibility of using any model complexity-based learning theory (VC dimension, Rademacher complexity etc.) to explain the good generalization ability of deep learning. Indeed, the best paper of ICLR 2017 "Understanding Deep Learning Requires Rethinking Generalization" conducted a series of carefully designed experiments and concluded that all previously well-known learning theories fail to explain the phenomenon of deep learning.

In this talk, I will give two theories characterizing the generalization ability of Stochastic Gradient Langevin Dynamics (SGLD), a variant of the commonly used Stochastic Gradient Decent (SGD) algorithm in deep learning. Building upon tools from stochastic differential equation and partial differential equation, I show that SGLD has strong generalization power. The theory also explains several phenomena observed in deep learning experiments.

The Past, the Present and the Future of Theoretical Computer Science in China

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Abstract. Taking theory of computation and theory of programs as the core, researchers of theoretical computer science in China have made many achievements in the past. Combined with mathematical research, they have also contributed quite a lot on the field of discrete mathematics and numerical computation. In recent years, computing systems characterized by parallel and distributed computing have developed rapidly. The development models of computer software have changed thoroughly. New types of computing represented by quantum computation have received widespread attention. Computing technologies have been widely used in all walks of life. Computer networks have linked the world closely together. Security problem of computing systems, network systems and information systems is getting attention from all sides. Artificial intelligence is leading the application trend of computing technology. Big data and its effective processing is changing the way we research. All these changes have been deeply affecting the researchers of theoretical computer science in China. Although some researchers are still sticking to the positions of theory, more researchers have been pushed to drift around by the tide of technology development and they are free between theory and application. Even if those in the theoretical positions sometimes lack deep understanding about the significance and value of their research, only rest on the state to research for publishing papers. To develop theoretical computer science of China in the long run, it is time to think the following questions calmly. What problems should be researched on theoretical computer science? How to make the research on theoretical computer science both to fit the requirements of technology development and to keep its theoretical characteristics, even to guide the development of technology. Taking history and other countries as a mirror, this report tries to give our experience and thinking about the above questions.

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