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Computer Science – Theory and Applications

17th International Computer Science Symposium in Russia, CSR 2022
Virtual Event, June 29 – July 1, 2022
Proceedings

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Preface

This volume contains the papers presented at CSR 2022, the 17th International Computer Science Symposium in Russia, held online during June 29 – July 1, 2022. CSR covers a wide range of areas in theoretical computer science and its applications. Initially, CSR 2022 was planned as a satellite event for the International Congress of Mathematicians (ICM) in St. Petersburg, Russia. However, as the Program Committee (PC) was starting its deliberations after completing submission reviews, Russia attacked Ukraine. As a result, ICM and CSR 2022 were moved online. Many PC members expressed dismay at the attack and three PC members resigned. Others chose to continue their work, but many wanted to emphasize that they did not support or condone the actions of the Russian government against Ukrainian people.

We received 51 submissions, and out of these the Program Committee selected 21 papers for presentation at the symposium and for publication in the proceedings. Each submission was reviewed by at least three Program Committee members. Submissions by Program Committee members were reviewed by at least four other members of the Program Committee.

The opening lecture at CSR 2022 was given by Umesh Vazirani (University of California at Berkeley), the closing lecture was given by Mark Braverman (Princeton University). Three invited plenary lectures were given by Irit Dinur (Weizmann Institute of Science), Jelani Nelson (University of California at Berkeley), and Mary Wootters (Stanford University).

Many people and organizations contributed to the smooth running and the success of CSR 2022. In particular, our thanks go to

– all authors who submitted their work to CSR;
– the members of the Program Committee who graciously devoted their time and energy to the evaluation process;
– the expert reviewers who helped us evaluate the papers;
– the invited speakers; and
– the members of the local Organizing Committee who made the conference possible.

May 2022

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Invited Talks

Optimization-Friendly Generic Mechanisms Without Money

Mark Braverman

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Our goal is to develop a generic framework for converting modern gradient-descent based optimization algorithms into mechanisms where inputs come from self-interested agents.

We focus on aggregating preferences from n players in a context without money. Special cases of this setting include voting, allocation of items by lottery, and matching. Our key technical contribution is a new meta-algorithm we call **APEX** (Adaptive Pricing Equalizing Externalities). The framework is sufficiently general to be combined with any optimization algorithm that is based on local search. In the talk we outline the algorithm, and open problem/research directions that it raises, with a particular focus towards mechanism design + machine learning.

We discuss a special case of applying the framework to the problem of one-sided allocation with lotteries. In this case, we obtain a strengthening of the 1979 result by Hylland and Zeckhauser on allocation via a competitive equilibrium from equal incomes (CEEI). The [HZ79] result posits that there is a (fractional) allocation and a set of item prices such that the allocation is a competitive equilibrium given prices. We further show that there is always a reweighing of the players' utility values such that running the standard unit-demand VCG with reweighed utilities leads to a HZ-equilibrium prices. Interestingly, not all HZ competitive equilibria come from VCG prices.

Reference

[HZ79] Hylland, A., Zeckhauser, R.: The efficient allocation of individuals to positions. J. Polit. Econ. **87**(2), 293–314 (1979)

Expanders in Higher Dimensions

Irit Dinur

Weizmann Institute of Science

Expander graphs have been studied in many areas of mathematics and in computer science with versatile applications, including coding theory, networking, computational complexity and geometry.

High-dimensional expanders are a generalization that has been studied in recent years and their promise is beginning to bear fruit. In the talk, I will survey some powerful local to global properties of high-dimensional expanders, and describe several interesting applications, ranging from convergence of random walks to construction of locally testable codes that prove the c^3 conjecture (namely, codes with **c**onstant rate, **c**onstant distance, and **c**onstant locality).

Private Frequency Estimation via Projective Geometry

Jelani Nelson

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We propose a new algorithm ProjectiveGeometryResponse (PGR) for locally differentially private (LDP) frequency estimation. For a universe size of k and with n users, our ε-LDP algorithm has communication cost $\lceil \log_2 k \rceil$ bits in the private coin setting and $\varepsilon \log_2 e + O(1)$ in the public coin setting, and has computation cost $O(n + k \exp(\varepsilon) \log k)$ for the server to approximately reconstruct the frequency histogram, while achieving optimal privacy/utility tradeoff, including optimality of the leading constant factor. Our empirical evaluation shows a speedup of over 50x over PI-RAPPOR [FT21], while using approximately 75x less memory for practically relevant parameter settings. In addition, the running time of our algorithm is within an order of magnitude of HadamardResponse [ASZ19] and RecursiveHadamardResponse [CKO20] which have significantly worse reconstruction error. Our new algorithm is based on using Projective Planes over a finite field to define a small collection of sets that are close to being pairwise independent and a dynamic programming algorithm for approximate histogram reconstruction on the server side. We also give an extension of PGR, which we call HybridProjectiveGeometryResponse, that allows trading off computation time with utility smoothly.

Joint work with Vitaly Feldman (Apple), Huy Le Nguyen (Northeastern), and Kunal Talwar (Apple). This work is to appear in ICML 2022.

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[FT21] Feldman, V., Talwar, K.: Lossless compression of efficient private local randomizers. In: Proceedings of the 38th International Conference on Machine Learning (ICML), pp. 3208–3219 (2021)

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