2020
DIMACS Newsletter
Issue 1

DIMACS

this issue

Introducing the DIMACS Newsletter

Welcome to the first DIMACS Newsletter! With all of us working remotely, we are looking for more ways to stay connected, and we thought a short, relatively informal newsletter might be one way to do that. In the spirit of informal communication, the newsletter will not adhere to a particular schedule or format. It will highlight activities, people, and research associated with DIMACS programs with the aim of keeping our community informed & engaged at least until we can be together again.

LET US KNOW

Did a DIMACS workshop or program lead to a new result, collaboration, course, or student project? Did DIMACS help your career, your research, or that of your students? If so, please let us know:

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David Pennock becomes DIMACS Director

With the start of the new year and decade in 2020, DIMACS welcomed David Pennock as its new director. Pennock came to DIMACS from his position as Principal Researcher at Microsoft and founding Assistant Director of Microsoft Research NYC. Associated with DIMACS since his days as a postdoc, Pennock served on the DIMACS Executive Committee since 2012, was a frequent seminar speaker for the DIMACS Research Experiences for Undergraduates program, and was co-organizer of the influential DIMACS Workshop on Markets as Predictive Devices (Information Markets) in 2005.

Pennock's research, which broadly falls under the umbrella of artificial intelligence (AI), is focused on designing intelligent markets to crowdsource forecasts and improve decision making, often combining human and machine intelligence. Pennock describes himself as an AI researcher working at the interface of economics and computation, with a strong appreciation of the importance of CS theory and related areas of mathematics and their applicability in his own research. See page 3 for more on Pennock's research.

Pennock shared some of his thoughts on future directions for DIMACS in a message to the commmunity as he assumed the center's leadership, saying "I plan an increasing emphasis on artificial intelligence, including the theory of machine learning, the intelligent economy, and the ethics of AI, among other topics reflecting trends in computer science, math, statistics, and operations research."

"We are early in the digital age. Technology improves life on average, with some of its largest benefits yet unimagined. As we move forward, it is crucial to ensure that gains spread broadly and fairly. As Director, I plan to promote diversity, prioritize students and early-career scholars, let a thousand projects bloom, and nurture those projects showing promise to improve society or business."

With the pandemic striking in March, Pennock's honeymoon was short, but DIMACS is thriving under his leadership.

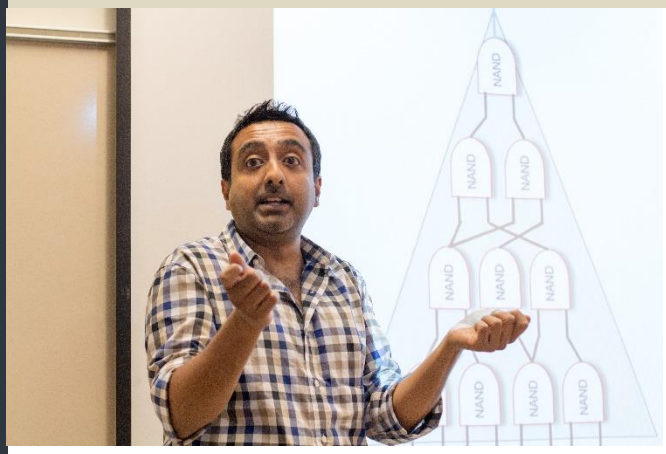
RUTGERS

Visitor Research

Muthu Venkitasubramaniam (right), a computer science professor at the University of Rochester, visited Cornell Tech faculty members Rafael Pass and Elaine Shi in association with the Special Focus on Cryptography.

Research conducted during his visit led to publications on the round-complexity of designing zero-knowledge argument systems based on minimal assumptions and on new multi-party computation protocols that are secure against malicious adaptive corruption. The most recent outcome of the visit is work with Pass exploring the question of whether the average-case hardness of problems in NP implies average-case hardness of search problems in NP that are *guaranteed to be true* (i.e. problems in TFNP). In a paper presented at FOCS 2020, they show that the answer is "yes". In so doing, they also demonstrate that the answer is "yes" to at least one of the following two fundamental open problems in complexity theory:

1. Does a hard-on-average language in NP imply the existence of one-way functions (i.e. functions that are easy to compute but hard to invert)?
2. Does a hard-on-average language in NP imply a hard problem in complexity class TFNP (i.e. the class of total NP search problems)?



Special Focus on Cryptography

The special focus ended this year, and we look back with a brief recap of the 2015-2020 program.

Earlier this year, the DIMACS Special Focus on Cryptography said goodbye to its final visitor, concluding both the special focus and the larger DIMACS/Simons Collaboration in Cryptography that contained it. Funded by the National Science Foundation (NSF) as a research coordination network (RCN), the DIMACS/Simons Collaboration was the first formal partnership between DIMACS and the Simons Institute for the Theory of Computing.

The Collaboration in Cryptography was devoted to advancing both the foundations and applications of cryptography through activities held at both DIMACS and the Simons Institute. The Collaboration began with an intensive program on cryptography at the Simons Institute during the summer in 2015, and it continued with a multi-year Special Focus on Cryptography at DIMACS. The Simons program involved 96 long-term visitors to the Simons Institute, nearly half of whom received some form of support from the RCN project. The DIMACS special focus began in the fall of 2015 to sustain collaborations begun during the Simons program and expand them to include more people and more topics. The Special Focus sponsored 10 events involving roughly 900 participants, and it hosted 11 visitors. It also sponsored NYC CryptoDay, which marked its tenth anniversary this year.

In the spirit of research coordination, events of the DIMACS special focus reflect coordination with the Columbia Data Science Institute, two SaTC frontier projects—the Center for Encrypted Functionalities led by UCLA and the Modular Approach to Cloud Security project led by Boston University—and association with the Crypto Conference in 2018 and 2019, which began holding affiliated events in 2018.

Participants in RCN activities conducted at both the Simons Institute and DIMACS reported a trove of new results that now appear in over 150 papers. These results include foundational advances in the study of interactive proofs for verifying the correctness of computations delegated to the cloud; progress in understanding the round-complexity of non-malleable cryptography to efficiently enable strong security guarantees in distributed settings; breakthroughs in constructing efficient secure multi-party computation protocols under discrete-log assumptions to break the so-called circuit-size barrier; and exciting progress on simplifying and weakening the objects and assumptions that imply indistinguishability obfuscation (IO) toward the goal of basing the existence of IO on well-studied assumptions. Many of these results enable simpler, more efficient, and ultimately, more practical cryptographic systems.

The 2020 REU program runs online

With 60 students participating, the 2020 REU program was our largest ever. It was also the first to be held entirely online.

In a typical year, the DIMACS REU program brings students participating in several different research programs together at DIMACS in the summer. This combined program includes an NSF-funded REU site, as well as additional students associated with DIMACS projects, projects of DIMACS-affiliated faculty, and programs run by DIMACS partner institutions, such as Charles University in the Czech Republic and the Mathematics Department at Rutgers. In all, we host 35-40 students at DIMACS.

The 2020 program reaped some direct benefits from being online. First, with no travel or housing costs we were able to support more students. Without being tethered to a specific location, we were able to add mentors from outside Rutgers, invite seminar speakers from around the world, and enable students participating in the Barnard College Computer Science Summer Research program to join DIMACS REU acitvities. From a research perspective, communication between students and mentors may have been more frequent and more focused.

That said, the "secret sauce" of the DIMACS REU stems from the comraderie of students being together—sharing ideas, learning from each other, and just having fun. This community is hard to replicate online. As we plan for 2021 and beyond, we look forward to welcoming students back to DIMACS.

Workshop on Co-Development of CS & Law

Held online November 10-12, 2020.

With the prevalence of technology in our daily lives, the interface of computer science and law is becoming an important area of interdisciplinary exploration. Many problems are simultaneously problems in law and problems in computer science, and they would benefit from jointly developed solutions. These include digital intellectual property protection, online content moderation versus rights to free speech, access to encrypted data for surveillance, and fair and ethical use of algorithms.

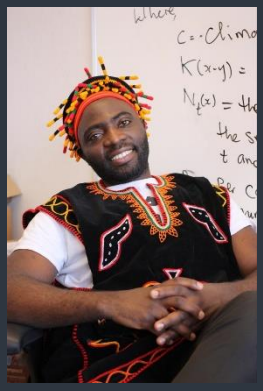
The workshop identified analogies between the two disciplines, as well as challenges that divide them, as it took a step toward building shared understanding, methodology, and vocabulary to improve communication and catalyze research across the two disciplines. Videos of workshop presentations are available on YouTube. An in-person follow-on workshop is in planning for late 2021 or early 2022.

Pennock receives test of time awards

Dave Pennock was recipient of two test of time awards earlier this year. Both awards are for work done in the early to mid-2000's that helped to shape today's online search experience.

Together with Kushal Dave and Steve Lawrence, he received the 2020 Seoul Test of Time Award for the paper, "Mining the Peanut Gallery: Opinion Extraction and Semantic Classification of Product Reviews." This paper, first presented at the World Wide Web Conference in 2003, recognized the value of distilling online product reviews into simple classifications accessible to consumers. It has become foundational research in opinion mining on the web.

With Juan Feng and Hemant Bhargava, he received the INFORMS Journal on Computing Test of Time Award for the paper, "Implementing Sponsored Search in Web Search Engines: Computational Evaluation of Alternative Mechanisms," which appeared in the journal in 2007. Coming at a time when the community puzzled over how free search engines like Google could make money, it was pioneering in its study of mechanisms for the allocation of ads by search engine providers.



Postdoc Profile

Former DIMACS postdoc, Jude Kong, is now making his mark as a faculty member in the Department of Mathematics & Statistics at York University. He was featured in two recent York news articles.

A December 1 story describes his role leading a team of more than 50 researchers from key academic and government institutions in nine African countries and Canada to provide modelling that will help policymakers from across Africa manage the spread of COVID-19 in real time.

An October 22 article highlights his approach to online teaching, which strives to make his classes positive, inclusive, and supportive despite being held remotely.

Research Highlight

- **Guy Moshkovitz**, now a CUNY faculty member, was the 2018-2020 IAS/DIMACS postdoc. During his time at DIMACS, he worked with Rutgers faculty member Swastik Kopparty and then-IAS postdoc Jeroen Zuiddam (now at NYU) to introduce the notion of geometric rank as a new tool in the study of tensors and hypergraphs. Geometric rank is a natural extension of the notion of matrix rank in terms of the dimension of a certain algebraic variety associated with the tensor. In this way, it provides a bridge to the field of algebraic geometry. Using the vast toolbox of algebraic geometry, Moshkovitz and his collaborators proved a number of basic properties and invariances of geometric rank, developed several tools to reason about geometric rank, and showed intimate connections between geometric rank and other important notions of rank for tensors, such as the analytic rank of Gowers and Wolf and the slice rank of Tao. As one application of this work, they answered a long-standing question of Strassen by exactly determining the border subrank of the matrix multiplication tensor. This work appeared at CCC 2020 and has already spurred further study by other researchers.

Upcoming Events

- **Workshop on Forecasting: From Forecasts to Decisions**

  Organizers: Raf Frongillo (U. Colorado), David Pennock (DIMACS), Bo Waggoner (U. Colorado)
  Date: March 17–19, 2021 (online)

- **2021 Research Experiences for Undergraduates Program**

  Date: May 24–July 23, 2021 (to be confirmed)
  Details: The program will be held in 2021 but may be online.

- **Workshop on Meta-Complexity, Barriers, and Derandomization**

  Organizers: Eric Allender (Rutgers), Antonina Kolokolova (Memorial University of Newfoundland), Periklis Papakonstantinou (Rutgers), Rahul Santhanam (University of Oxford)

  Date: Week of August 9–13, 2021

- **12th DIMACS Implementation Challenge on Vehicle Routing Problems**

  Details: The Challenge is considering the following VRP variants: Capacitated VRP, VRP with time windows, VRP with split deliveries, Inventory routing, Stochastic VRP, Capacitiaed arc routing (CARP), and Time-dependent CARP.

  Date: The competition is underway and will conclude with a workshop scheduled for June 14–16, 2021.

COVID-19 continues to impact the scheduling of DIMACS events.

Dates for the above events are tentative and may change to enable holding them in person.

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