

ARC: Vision, Activities, and Future Plans

Mohit Singh

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ARC Director

Current: Mohit Singh (ISyE): 2019-2022.

Past directors:

- Eric Vigoda (CS): 2016-19
- Dana Randall (CS): 2014-16
- Prasad Tetali (Math): 2011-14
- Santosh Vempala (CS): 2006-11

Motivation

- Algorithms and stochastic processes are ubiquitous, notable examples:
 - Optimization.
 - Deep learning.
 - Scheduling, routing.
 - Google's PageRank: directed Markov chain.
 - Markov Chain Monte Carlo (MCMC).
 - Statistical physics phase transitions.

Motivation

- Mission: Bring together researchers in Georgia Tech working on foundational work on Algorithms and Randomness together.
- To serve as a resource for scientists across the campus on applications.
 - Fast optimization
 - Algorithms for sharing economy (Uber, Lyft, etc.)
 - Smart logistics (Amazon)
 - Mechanism design and Algorithms (Google)
 - Stochastic processes: modeling and applications
 - Foundations of Fairness in Machine Learning and AI
 - Foundations of Data Privacy
- Synergy with TRIAD

Activities

- PhD Fellowships
 - 10 joint ARC-TRIAD fellowships
 - 4 from underrepresented groups.
 - Over 35 applicants.
 - Partial support and successful model being replicated.
 - Also received funding from Provost's Fund (PEGS).
- Annual ARC day: Full day event showcasing the year's accomplishment. (February 2019, Planned for April 20, 2020).
- ARC Colloquium series.
- Workshops and Schools: April 2019 and October 2019.
- Postdocs:
 - Current: 2 Joint Funded (Grants+ARC+TRIAD)
- Research visitors.

ARC 12

February 2019

- 12th annual event
- Keynote: [Eva Tardos \(Cornell\)](#)
 - Learning and Efficiency of Outcomes in Games

Local Speakers:

- Tuo Zhao
 - Non-Convex Optimization in Machine Learning.
- Galyna Livshyts
 - Random Matrix Theory.

PhD Fellowships

Spring '2020 ARC-TRIAD fellowships (10 out of 36 applicants)

- **Timothy Duff** (ACO), Challenges in computational algebraic vision.
- **Haoming Jiang** (ML), Nonparametric Regression on Low Dimensional Manifolds using Neural Networks.
- **Aditi Laddha** (ACO), Better Approximation for Uniform Sparsest Cut.
- **Jiaming Liang** (OR), First-Order Methods for Nonconvex Smooth Composite Optimization Problems.
- **Yuliia Lut** (IE) Improving accuracy for dynamic differential privacy with change-point detection.
- **Andrew McRae** (ECE), Exploiting low-dimensional manifold structure with kernel methods.
- **Shengding Sun** (ACO), Sparse positive semidefinite relaxations with $S^{\{n,k\}}$.
- **Mohamed El Tonbari** (OR), On Two-Stage Distributionally Robust Optimization with Binary Variables.
- **Liyan Xie** (IE), Distributionally Robust Nonparametric Hypothesis Testing.
- **Yujie Zhao** (Statistics), Homotopic Methods can Significantly Speed up the Computation of the Non-differential Optimization Problems.

ARC faculty

- Computer Science:
 - J. Abernethy, S. Aluru, A. Boldyreva, M. Furst, Z. Galil, R. Peng, D. Randall, L. Song, S. Vempala, E. Vigoda
- Engineering (ISyE & ECE):
 - R. Cummings, S. Dey, S. Gupta, X. Huo, S. Maguluri, R. Monteiro, D. Mukherjee, G. Nemhauser, A. Nemirovski, J. Romberg, M. Singh, Y. Xie, T. Zhao, E. Zhou
- Mathematics:
 - M. Baker, G. Blekherman, E. Croot, C. Heitsch, V. Koltchinskii, M. Lacey, A. Leykin, P. Tetali, R. Thomas, W. Trotter, X. Yu, L. Warnke, J. Yu, M. Zhilova

World-class team

- CS Theory: #8
- Discrete Math/Combinatorics: #4 (US News)
- ISyE: #1
- Many awards:
 - 2 NAE members
 - Fulkerson and Godel prizes, Guggenheim Fellows
 - Editors in chief of top journals
 - IEEE, AMS, ACM, and SIAM Fellows

ARC Colloquium Series

- Weekly talk by external speaker.
 - Mixture of emerging and established researchers.
 - Well attended: 30-40 people, mix of PhD students and faculty from ISyE, CS, Math, ECE, and CSE.
 - Opportunities for students + faculty to meet with speaker
 - Often joint with TRIAD

Workshops and Schools

- *Lecture series on Sampling and Log-concave polynomials.*
 - N. Anari, Stanford, October 2019.
- *Lecture Series on Traveling Salesman Problems.*
 - bO. Svensson, EPFL, April 2019.
- *Algorithms & Randomness.* May 2018
- *The Power of Randomness in Computation.* March 2015.
- *ARC-RIM industry day.* April 2013.
 - Organizers: P. Tetali and H. Christensen.
- *Network Topology and Economics.* November 2012.
 - Organizers: C. Dvorolis (CS), A. Fabrikant (Google), M. Shapira (Hebrew), and P. Tetali (Math)
- *Computation and Phase Transitions.* June 2012.
 - Organizers: Randall, Tetali, Vigoda
- *Modern Aspects of Submodularity.* March 2012
 - Organizers: S. Ahmed (ISyE), N. Balcan (CS), S. Iwata (Kyoto), and Prasad Tetali (Math)

Think-Tank-Talks

- Talk from faculty in Science and Engineering.
- Talks are expected to include research question where expertise of ARC faculty can help.
- Intent to model, analyze and help solve problems from a rigorous and algorithmic perspective.
- Talks are expected to generate discussion (20 minute talk + 30 minute discussion).
- Going forward, plan to have more Think-Tank-Talks.
 - Daniel Molzahn (ECE) discussing algorithmic problems from power grids (April '20).

Future plans

- *Strengthen ties across CoC and CoS and CoE:*
 - *Think-Tank-Talks and seminar speakers internally.*
 - *Student fellowship.*
- *International visibility:*
 - Colloquium series with prominent (junior & senior) speakers.
 - ARC distinguished lectures.
 - High-profile inter-disciplinary workshops/schools.
 - Workshop on Fairness in Optimization and ML.
- *Industry support:*
 - Microsoft, Google, Facebook.

ARC joint grants

- Georgia Tech, UC, Berkeley (USA) and TIFR, Mumbai, IISc, Bangalore (India), Joint Indo-US Virtual Network Center, 2020-2021.
- Vempala, Vigoda, Stefankovic (Rochester). NSF Medium \$1.2 million, 2016-2020.
- Extremely Energy Efficient Collective Electronics (EXCEL): \$4.4 million. PI: S. Dutta (Notre Dame), GT co-PI's: Arijit Raychowdhury, Justin Romberg (ECE), and Santosh Vempala (CS).
- Dan Goldman and Dana Randall, NSF: A Distributed and Stochastic Algorithmic Framework for Active Matter, 2016-18.
- Tetali: Expedition proposal → 3 EAGER awards (900k total) 2014-17.
- Tetali: Symbotic, 30k, 2013.
- Tetali: Yandex Corporate (Russia), 41k for '12 workshop on computer networking.
- Randall, Tetali, Vempala, Vigoda, Stefankovic (Rochester). NSF Large \$1.08 million 2009-13.
- Many individual NSF grants.