ARC: Vision, Activities, and Future Plans

Mohit Singh
March 2020
 ARC Director


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

• 12\textsuperscript{th} 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.
- **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 Tonbali** (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:

• Engineering (ISyE & ECE):

• Mathematics:
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.

• Algorithms & Randomness. May 2018
• The Power of Randomness in Computation. March 2015.
• ARC-RIM industry day. April 2013.
  — Organizers: C. Dovrolis (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.
- 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).
- 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.
- Many individual NSF grants.