



ARC 2016 Annual Report

Nov. 9, 2016

Motivation

- Algorithms and stochastic processes are ubiquitous, notable examples:
 - Google's PageRank: directed Markov chain
 - Computation in the brain and deep learning
 - MrBayes: Markov Chain Monte Carlo (MCMC) for phylogenetic reconstruction
 - Statistical physics models: connecting phase transitions with computational complexity
 - Random graphs and probabilistic method
 - SOS: Algebra = Algorithms = Optimization
 - Number theory and cryptography
 - Compressed sensing
 - Optimization

Motivation

- Goals:
 - Understand natural processes (e.g., brain, protein folding, phase transitions, etc.)
 - Analyze algorithms used in scientific fields (e.g., MCMC=Markov Chain Monte Carlo)
 - Design better/faster algorithms
 - Fast optimization
 - Algorithms for sharing economy (Uber, Lyft, etc.)
 - Smart logistics (Amazon)
 - Mechanism design (Google)
 - Machine learning
 - Stochastic processes: modeling and applications
 - Connections between fields

Activities

- PhD Fellowships
 - Joint RA's (funding: 50% ARC + 50% advisor/mentors)
- Research lunches
- Seminar series
- ARC days
- Workshops
- Postdocs
- Research visitors

Research Lunches

- Informal talk to explore connections and possible collaborations.
- Recent talks:
 - May 2016: *Dan Goldman (Physics)*:
 - Active matter in need of algorithms
 - Led to joint project with Dana Randall
 - September 2016: *Chris Rozell (ECE)*:
 - Dimensionality Reduction and Neural Computation
 - Neurocomputing day?
 - December 2016: *Thad Starner (IC)*
 - Dolphin Communication
- Examples of past talks:
 - *Joshua Weitz (Biology)*: Virus dynamics
 - *Jeff Skolnick (Biology)*: Protein folding
- Upcoming talks:
 - *Emmanuel DiLorenzo (EAS)*: Ocean Modeling -- January 26, 2017

ARC faculty

- Computer Science:
 - J. Abernethy, A. Boldyreva, B. Dilkina, L. Fortnow, M. Mihail, R. Lipton, R. Peng, D. Randall, L. Song, V. Vazirani, S. Vempala, E. Vigoda
- Mathematics:
 - *Discrete Mathematics*: Ernie Croot, Ester Ezra, Christine Heitsch, Prasad Tetali, Robin Thomas, William Trotter, Xingxing Yu, Lutz Warnke
 - *Algebra*: Matt Baker, Greg Blekherman, Anton Leykin, Josephine Yu
 - *Probability & Statistics*: Vladimir Koltchinskii, Michael Lacey, Mayya Zhilova
- Engineering (ISyE & ECE):
 - S. Ahmed, S. Dey, A. Dieker, D. Goldberg, R. Monteiro, G. Nemhauser, A. Nemirovski, S. Pokutta, J. Romberg, M. Singh, C. Tovey, Y. Xie, H. Xu

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Recent hires

World-class team

- Discrete Math/Combinatorics: #4 (US News)
- CS Theory: #8
- ISyE: #1
- 2 NAE members
- 3 Fulkerson Prize, 1 Godel prize winners
- 3 Guggenheim fellows
- Editors in chief:
 - SIAM Discrete Math, ACM Computation Theory
- Many IEEE, AMS, ACM, SIAM Fellows

PhD Fellowships

- Joint RA's (funding: 50% ARC + 50% advisor/mentors)
- Selection committee:
 - [Bistra Dilkina](#) (CSE)
 - [David Goldberg](#) (ISyE) chair
 - [Ester Ezra](#) (Math)
 - [Richard Peng](#) (CS)
 - [Huan Xu](#) (ISyE)

PhD Fellowships

- *Spring 2017* fellowships:
 - Marcel Celaya (Math), Advisor: Josephine Yu
 - Alfredo Torrico (ISyE), Advisor: Sebastian Pokutta
 - Di Wu (ISyE), Advisor: Enlu Zhou
 - Samira Samida (CS, joint with IISP, Advisor: Santosh Vempala)
- *Fall 2016* fellowships:
 - David Durfee (ACO PhD, CS)
 - Ezgi Karabulut (OR PhD, ISyE)
 - Kevin Lai (ACO PhD, CS)
 - Tung Mai (ACO PhD, CS)
 - Tianxin Tang (CS PhD, CS) joint with IISP
- *2015-16*:
 - Emma Cohen (ACO PhD, Math)
 - Ben Cousins (ACO PhD, CS)
 - Xie Weijun (OR PhD, ISyE)
 - Sadra Yazdanbod (ACO PhD, CS)
 - Bo Xie (CSE)

PhD Fellowships

- *2014-15:*
 - Burak Kocuk (ISyE)
 - Guido Lagos (ISyE)
 - Ioannis Panageas (ACO)
- *2013-14:*
 - Gustavo Angulo (ISYE)
 - Spencer Backman (Math)
 - Andreas Galanis (CS ACO)
 - Sara Krehbiel (CS ACO)
 - Robert Krone (Math)
 - Andrew Massimino (ECE)
 - Sarah Miracle (CS ACO)

ARC 10: October 24, 2016

- Keynote: [Jon Kleinberg](#) (Cornell)
 - Human Decisions and Machine Predictions
 - NAS, NAE, McArthur Fellow, Nevanlinna Prize
 - Known for: Hubs and Authorities; Small world experiment
- [Josephine Yu](#) (Math)
 - Tropical Geometry in Economics
- [Mohit Singh](#) (ISyE)
 - New Approaches for Constrained Subset Selection Problem
- ARC day: annual event in fall.
- Theory day in spring highlighting exciting new results.
- Distinguished lectures:
 - Oct. '16: [Manuel and Lenore Blum](#)

Fall '16 Seminar Series

- **10 speakers** in weekly seminar
 - well attended: around ~50 people, mix of PhD students and faculty from Math, ISyE, CS, and CSE.
 - Mix of well-known senior lecturers, e.g., David Karger (MIT) and junior stars, e.g., Alina Ene (Boston)
 - Opportunities for students+faculty to meet with speaker

Recent Workshops

- *The Power of Randomness in Computation*. March 2015. (Joint with IMA).
 - Organizers: Randall, Tetali, Vempala, Vigoda
- *Network Topology and Economics*. November 2012.
 - 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)

Future Workshops

- *Algorithms and Randomness*, Spring 2018.
 - Mix of statistical physics phase transitions, Markov Chain Monte Carlo (MCMC), random graphs, and optimization.
- *NeuroComputation Day*, Fall 2017.

Future plans

- *Strengthen ties between CoE, CoS, and CoC:*
 - *Research lunches and seminar speakers*
- *International visibility:*
 - Seminar series with prominent (junior & senior) speakers
 - ARC and theory days with distinguished speakers
 - High-profile inter-disciplinary workshops
- *Internal support:*
 - PhD Fellowships
 - Postdocs

EAGER grants

- EAGER: Convex Optimization Algorithms for 21st Century Challenges
 - PI: [Santosh Vempala](#)
 - Co-PI's: [Vladimir Koltchinskii](#) (Statistical Learning), [Arkadi Nemirovski](#) (Convex Optimization), [Justin Romberg](#) (Signal Processing), [Prasad Tetali](#) (Algorithms, Discrete Mathematics).
- EAGER: Discrete Optimization Algorithms for 21st Century Challenges
 - PI: [George Nemhauser](#)
 - Co-PI sub-team: GT: [Maria-Florina Balcan](#) (Algorithms, Learning), [Santanu S. Dey](#) (Integer Programming), [Santosh Vempala](#) (Algorithms, Optimization); CMU: [Avrim Blum](#) (Algorithms, Learning).
- EAGER: Physical Flow and other Industry Challenges
 - PI: [Prasad Tetali](#)
 - Co-PI's: [Henrik Christensen](#) (Executive Director, Institute for Robotics & Intelligent Machines), [George Nemhauser](#) (IP, Optimization), [Sebastian Pokutta](#) (Complexity, Optimization)

ARC joint grants

- 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.