Kevin Shu

kevinshu.me

Present Address
1000 Northside Dr NW Apt 1314
Atlanta, GA 30318
(626) 399-3716
kshu8@gatech.edu

Education

PhD Student, Georgia Institute of Technology, Atlanta, GA
August 2019-Present

- In the Algorithms, Combinatorics, and Optimization program, under the Mathematics department.
- Advised by Grigoriy Blekherman.
- Research interests mostly involve semidefinite programming and applications of sparse semidefinite programming to industrial applications.
- Expected graduation date: May 2024
- 4.0 GPA

B.S. in Mathematics, Computer Science, California Institute of Technology, Pasadena, CA, June 2018
GPA 3.9

Publications

Hidden convexity, optimization, and algorithms on rotation matrices with Akshay Ramachandran, and Alex L. Wang
2023

- Gives geometric results about projections of the set of orthogonal matrices of a given size.
- Applicable to problems in sattelite attitude adjustment.
- Hosted on the arxiv.

Quadratic Programming with Sparsity Constraints via Polynomial Roots
2022

- Introduces a novel method for solving sparse quadratic optimization problems, inspired by classical equations from linear algebra involving the determinant.
- Applicable to data science problems such as sparse linear regression and sparse principal components analysis.
- Gives a fast, practical algorithm for producing good solutions to such sparse quadratic optimization problems.
- Hosted on the arxiv.

Linear Principal Minor Polynomials: Hyperbolic Determinantal Inequalities and Spectral Containment
2022

- Introduces a class of polynomials, which generalize the determinant, and generalizes various theorems from classical linear algebra to a 'sparse' setting.
- Published in **International Mathematics Research Notices** in 2022.

Approximate PSD-Completion for Generalized Chordal Graphs
2021

- Follow up to previous paper.
- Gives quantitative bounds for a certain approximation of a sparse semidefinite program.

- Hosted on the arxiv.

Extreme Nonnegative Quadratics over Stanley Reisner Varieties
2021
- Uses powerful mathematical concepts from algebraic topology and algebraic geometry to study PSD matrix completion.
- Useful for detailed understanding of sparse semidefinite programming.
- Hosted on the arxiv.

Causal Channels
2021
- Describes a connection between causal theory, which is a topic in probability regarding the distinction between correlational and causal data.
- Gives quantitative methods for analysing possible discrepancies in data due to confounding variables.
- Hosted on the arxiv.

Hyperbolic Relaxation of k-Locally Positive Semidefinite Matrices, with Grigoriy Blekherman, Santanu Dey, Shengding Sun
2021
- Describes a relaxation of a collection of matrices where certain block submatrices are PSD, giving exact bounds on their minimum eigenvalues.
- Published in the **SIAM Journal on Optimization** in 2022.

Sums of Squares and Sparse Semidefinite Programming, with Grigoriy Blekherman
2021
- Gives approximations of sparse semidefinite programs using ideas from algebraic geometry and graph theory.
- Published in **SIAM Journal for Applied Algebra and Geometry** in 2021.

Syntactic Structures and Code Parameters, with Matilde Marcolli
2017
- Published in **Mathematics in Computer Science**.
- Describes the connection between the syntactic parameters framework in linguistics with coding theory and theoretical physics.

Talks and Presentations Given

Hyperbolicity Cones and Sparse Optimization, presented at the MIT LIDS seminar
2023
- Talk on sparse quadratic programming.

Symmetrically Hyperbolic Polynomials, presented at the Öberwolfach Meeting on New Directions in Algebraic Geometry
2023
- Talk on symmetric hyperbolic polynomials.

Sparse Quadratic Programs via Polynomial Roots, presented at the Carnegie Mellon University ACO seminar
2023
- Talk on sparse quadratic programming.

Sparse Quadratic Programs via Polynomial Roots, presented at the Centrum Wiskunde and Informatica Networks and Optimization seminar

2022
- Talk on sparse quadratic programming.

Approximating Sparse Semidefinite Programs, presented at the INFORMS conference
2021
- Invited talk on sparsity in semidefinite programming.

Poster on Sparse Semidefinite Programs, presented at the MIP and IPCO conferences
2021
- Describes work on approximating sparse semidefinite programs using a relaxation based on the relationship between nonnegative and sum-of-squares quadratics.
- Won honorable mentions in both poster competitions.

Causal Inference and Optimization, presented at the ACO Student Seminar
2021
- Describes work on connections between causality theory and polynomial optimization.

Lightning Talk on Hyperbolic Relaxations of Locally-PSD Matrices. , presented at the ICERM - Symmetry, Randomness, and Computations in Real Algebraic Geometry.
2020
- Describes work on a relaxation of the positive semidefinite cone where only certain submatrices of a given matrix are required to be positive semidefinite.

Academic Honors

2022 ACO-ARC Fellowship
2022 ARCS Foundation award
2021 Honorable Mention at the MIP Conference Poster Competition
2021 Honorable Mention at the IPCO Conference Poster Competition
2021 David L. Brown Fellowship from the Georgia Tech Math Department
2018 National Science Foundation Graduate Research Fellowship Recipient
2018 Georgia Institute of Technology President's Fellowship Recipient

Research Experience

Visiting Scholar, Max-Planck Institute for Mathematics in the Sciences, Leipzig, Germany
Summer 2022
- Working under the supervision of Rainer Sinn and Bernd Sturmfels.

Research Assistantship, Georgia Tech, Atlanta, GA
Summer 2020
- Funded in part by NSF grant DMS-1901950 and the ACO department.
- Advised by Grigoriy Blekherman.

Research in Causality, Caltech, Pasadena, CA
Aug 2018-Jul 2019
- Developed theory of causality and developed bounds on probability distributions.
- Applied geometric and linear programming in search of bounds.
- Advised by Leonard Schulman.

Research in Linguistics, Caltech, Pasadena, CA
Aug 2017-Jul 2018

- Explored connections between linguistics and physical models.
- Used algebraic geometry to compute phylogenetic trees.
- Advised by Matilde Marcolli.

Teaching Experience

Differential Equations Teaching Assistant, Georgia Tech, Atlanta, GA
Aug 2022-Dec 2022
- Graded homework and gave recitations in second year differential equations course.

Differential Equations Teaching Assistant, Georgia Tech, Atlanta, GA
Aug 2021-Dec 2021
- Graded homework and gave recitations in second year differential equations course.

Number Theory Lecture Assistant, Georgia Tech, Atlanta, GA
Jan 2021-May 2021
- Graded homework and gave office hours for an undergraduate number theory course.

Differential Equations Teaching Assistant, Georgia Tech, Atlanta, GA
Jan 2020-May 2020
- Graded homework and gave recitations in second year differential equations course.

Linear Algebra Teaching Assistant, Georgia Tech, Atlanta, GA
Aug 2019-Dec 2019
- Graded homework and gave recitations in first year linear algebra course.
- Covered introductory linear algebra material.

Advanced Algorithms Teaching Assistant, Caltech, Pasadena, CA
Jan 2018-Mar 2018
- Graded homework and gave recitations in graduate level algorithms course.
- Covered multiplicative weights learning, streaming algorithms, spectral graph theory, semidefinite programming.

Linear Algebra Teaching Assistant, Caltech, Pasadena, CA
Sep 2017-Dec 2017
- Graded homework for the applied linear algebra course, including topics like linear algebra, including spectral graph theory, polynomial interpolation, and principal components analysis.
- Gave 1 hour of office hours per week.

Introduction to Algorithms Teaching Assistant, Caltech, Pasadena, CA
Jan 2017-Mar 2017
- Graded homework and gave recitations in undergraduate level algorithms course.
- Covered graph algorithms, greedy algorithms, dynamic programming, matroids.

Other Activities

Organizer for the SIAM AG23 Special Session on Convexity, Georgia Tech, GA
July 2023
- Part of the SIAM AG23 conference on algebraic geometry.
- Organized talks about algebraic methods in convex geometry and optimization.
- Included 10 talks from both professors and students.

Organizer for the AMS Special Session on Algebraic Methods in Algorithms, Georgia Tech, GA

March 2023

- Part of the Spring 2023 Sectional Meeting of the AMS.
- Organized talks in the intersection of algebra and algorithms, involving 10 talks from both professors and students.

Representative for the Diversity, Equity, and Inclusion committee, Georgia Tech, GA
2022-2023

- Organized workshops on inclusive language.
- Organized Math Night, a monthly tutoring session for undergraduates with the aim or promoting community.

Senior Class President, Caltech, Pasadena, CA
2018-2019

- Organized 200 seniors for events such as class trips and senior gifts.
- Implemented a new resource scheduling system based on algorithmic techniques that made a process that used to take several days take only a couple hours.
- Organized rooms, dining, and transportation for over a hundred students for the class trip, including finding funding from a variety of sources in order to ensure the trip was possible.
- Acted as a liason between faculty and students.

Board of Control Secretary, Caltech
2017

- Handled issues relating to academic dishonesty across the school.
- Investigated cases of academic dishonesty .
- Determined, in 20 cases of academic dishonesty, what response was required by the school, in some cases involving student suspensions.
- Organized meetings, gathered evidence, and acted as liason between the faculty and students.

Outreach Activities

First Year Mentor, Georgia Tech, Atlanta, Georgia
2020-2021

- Aided 2 first year graduate students in adjusting to graduate school during pandemic.
- Gave advice about course scheduling, time managagement, which helped students succeed in courses.

Directed Reading Program Mentor, Georgia Tech, Atlanta, Georgia
2020-2021

- Read through lecture notes on game theory with an undergraduate student
- Supervised project involving studying games of imperfect information with chance.

Work Experience

Full-time Software Engineer, Google, Mountain View, CA
August 2018-July 2019

- Full stack web development for a data labelling service (Crowd-Compute)
- Lead an initiative to update authentication/authorization to more modern technologies.
- Added a major feature for tracking work in the system.
- Managed production releases and infrastructure issues.
- Worked with C++, Java.

Software Engineering Intern, Google, Mountain View, CA
Aug 2018-Jul 2019

- Gathered data from online sources by parsing Reddit pages.
- Built a machine learning model to provide movie recommendations.
- Worked with C++, Python.

Computer Skills

Languages:	C++, Java, Python, HTML, Javascript
Software:	Flask server development, LaTeX, vim