

Nathan Sheffield

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ABOUT ME

I'm a current junior at MIT studying math and computer science. I'm interested in mathematical logic and combinatorics, and especially their applications to theoretical computer science.

EDUCATION

Belmont High School

Fall 2017 - Spring 2021

MIT

Fall 2021 - Spring 2025

COURSEWORK

Cumulative GPA: 5.0

Current classes: Analysis of Boolean Functions, Advanced Complexity Theory, Geometric Computing, Seminar in Theoretical CS, Software Construction

CS classes taken: Algorithms, Advanced Algorithms, Machine Learning, Fundamentals of Programming, Web Lab, Computation Structures, Theory of Computation, Cryptography, Advanced Topics in Cryptography, Algorithmic Lower Bounds

Math classes taken: Vector Calculus, Linear Algebra, Differential Equations, Real Analysis, Algebra I, Algebra II, Topology, Functional Analysis, Algebraic Combinatorics, Quantum Computation, Quantum Information Science, Ramsey Theory, Mathematical Logic and Set Theory, Graph Theory and Additive Combinatorics

PAPERS

Matching Algorithms in the Sparse Stochastic Block Model

Preprint

A Nearly Quadratic Improvement for Memory Reallocation

In Review

On Base 3/2 and its Sequences[†]

Published in *The Mathematical Intelligencer* 43:2 (2021)

PRIMES STEP plays games[†]

Published in *Math Horizons* 26:2 (2018)

RESEARCH EXPERIENCE

Catalytic Computation

Fall 2023-Present

Currently working on a project on space-bounded computation and communication complexity, supervised by Ryan Williams.

Memory Reallocation

Fall 2023

Developed and analyzed randomized algorithms for dynamically storing items in limited memory with low worst-case expected update cost. Improved upon existing algorithms, and found the first non-trivial lower bounds. Joint with undergrad Alek Westover; supervised by William Kuszmaul and Martin Farach-Colton.

Matching Algorithms

Summer 2023

As part of MIT's SPUR REU program, studied the behaviour of matching algorithms in random graphs generated by the stochastic block model. Found expressions for the matching numbers of a large class of SBM graphs, and analyzed the behaviours of several online matching heuristics. Mentored by grad students Anna Brandenberger and Byron Chin.

Verified Cryptography and Compilers

Summer 2022-Summer 2023

Worked with the Programming Languages and Verification group at MIT on the fiat-crypto (a tool for generating cryptographic primitives along with formal correctness proofs) and bedrock2 (a C-like programming language with formally verified compiler) projects. For fiat-crypto, wrote specifications and proofs in Coq verifying the correctness of looped Montgomery multiplication. For bedrock2, helped add timing traces to the program semantics, and formally proved runtime bounds for several example programs.

PRESENTATIONS

Combinatorics Reading Group

Fall 2023

Met with a reading group led by Guy Moshkovitz. Gave talks on algebraic complexity theory and tensor rank.

Directed Reading Program

Winter 2023

Participated in reading project surveying the role of expander graphs in randomized complexity and PCPs, culminating in a symposium talk with two other students.

SPLASH

Fall 2021

Gave a presentation for high schoolers about an assortment of mathematical impossibility theorems.

WORK EXPERIENCE

CALISTO - Writer

Summer 2021

Worked on a writing team producing a high-school quizbowl (academic trivia) question set. I contributed primarily science, literature, and philosophy questions, although I was involved in editing and difficulty-testing throughout the set.

Cobalt Speech & Language - Engineering Intern

Summer 2018

Developed some internal tools for a speech processing startup. Wrote code to automate meeting scheduling, and built a website used to collect speech audio samples.

EXTRACURRICULARS

MIT Quizbowl Team - VP (23-24), President (22-23)

Fall 2022 - Present

I lead a team of undergrad and grad students to practice for and participate in quizbowl tournaments. I'm also responsible for organizing a number of MIT-hosted competitions, both at the high-school and collegiate level.

17th Shard Puzzlehunt Team - Member

Fall 2020 - Present

I participate in several puzzlehunts throughout the year, and was on the writing team for for Shardhunt.

Last updated March 13, 2024

[†]Old papers from a program in early high school