

Nathan Sheffield

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EDUCATION

Belmont High School

Fall 2017 - Spring 2021

MIT

Fall 2021 - Spring 2025

COURSEWORK

Cumulative GPA: 5.0/5.0

Current classes: Sum of Squares, Fixed Parameter and Fine Grained Complexity, Probabilistic Method, Discrete Math Seminar, Sublinear Algorithms, Algorithmist's Toolkit

CS classes taken: Advanced Complexity Theory, Geometric Computing, Seminar in TCS, Algorithmic Lower Bounds, Advanced Topics in Cryptography, Cryptography, Advanced Algorithms, Algorithms, Theory of Computation, Software Construction, Fundamentals of Programming, Machine Learning, Web Lab, Computation Structures

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

PAPERS

New Bounds for Induced Turán Problems

In preparation

Catalytic Communication

In review

When to Give Up on a Parallel Implementation

In review

Complexity of Multiple-Hamiltonicity in Graphs of Bounded Degree

In review

A Nearly Quadratic Improvement for Memory Reallocation

In 36th ACM Symposium on Parallelism in Algorithms and Architectures (SPAA '24)

Matching Algorithms in the Sparse Stochastic Block Model

In 35th International Conference on Probabilistic, Combinatorial and Asymptotic Methods for the Analysis of Algorithms (AofA '24)

ABOUT ME

I'm a current senior at MIT, finishing a double major in math (course 18) and CS (course 6). I'm interested broadly in the theory of computation — understanding when tools from combinatorics and graph theory are useful for proving algorithmic upper/lower bounds, and the fundamental limits of these techniques.

RESEARCH EXPERIENCE

Duluth REU

Summer 2024

A combinatorics research program in Minnesota. Worked on a couple problems in extremal and structural graph theory suggested by PIs Joe Gallian and Colin Defant.

Space-Bounded Complexity UROP

Fall 2023-Summer 2024

Considered problems in space-bounded complexity, especially the model of “catalytic computation” in which the machine has some auxiliary space whose initial contents cannot be erased. Supervised by Ryan Williams and Ted Pyne.

“ ϕ club”

Fall 2022-Present

My friend Alek Westover and I (and occasionally other people) meet daily to work on interesting math problems. Sometimes we just solve cute textbook problems, but longer-term projects have produced papers on online algorithms and graph algorithms.

SPUR REU

Summer 2023

As part of MIT's SPUR program, mentored by Anna Brandenberger and Byron Chin, studied the behaviour of matching algorithms in random graphs.

Verified Cryptography and Compilers UROP

Summer 2022-Summer 2023

Worked with the Programming Languages and Verification group at MIT on the fiat-crypto and bedrock2 projects. For fiat-crypto, wrote specifications and proofs in Coq verifying correctness of looped Montgomery multiplication. For bedrock2, helped add timing traces to the program semantics.

TEACHING

Theory of Computation - TA

Fall 2024

Leading a recitation for Mike Sipser's undergrad Theory of Computation class.

SPLASH

Fall 2021

Taught high schoolers about an assortment of mathematical impossibility theorems.

READING

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; Winter 2024

Participated in reading projects: one year surveying the role of expander graphs in randomized complexity and PCPs, the next reading about information theory. In both cases, gave a symposium talk at the conclusion.

EXTRACURRICULARS

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

Fall 2022 - Present

I lead a team of undergrad and grad students to practice for and participate in academic trivia tournaments. I'm also responsible for organizing a number of MIT-hosted competitions, both at the high-school and collegiate level, and have worked as a writer/editor for the math/science categories of a number of question sets.

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.