

MAXWELL FISHELSON

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EDUCATION

Ph.D. in Computer Science

Supervisor: Prof. Constantinos Daskalakis

Massachusetts Institute of Technology (MIT)

B.S. in Mathematics

GPA: 4.9/5

Massachusetts Institute of Technology (MIT)

RESEARCH

Multi-item Non-truthful Auctions Achieve Good Revenue

EC20

(a.k.a. **Simple, Credible, and Approximately Optimal Multi-item Auctions**)

- Established that first-price-type auctions can achieve a constant factor of the optimal revenue in the multi-item auction setting, resolving an open question
- Established the first credible and static multi-item auction that is approximately revenue optimal
- Obtained approximately-revenue-optimal multi-item mechanisms with fixed entry fees that are amenable to tuning via online learning techniques
- Proved a geometric lemma that enabled analysis of the utility of a first price auction, showing that welfare loss in a first price auction is at most 4 times the revenue of the posted price mechanism
- <https://arxiv.org/pdf/2002.06702.pdf>

Generalized Pattern Avoidance via Hypergraph Containers

**Journal of Engineering
and Applied Sciences**

- Achieved a generalization of the Stanley-Wilf theorem, bounding the number of n -permutations avoiding a fixed sub-permutation at indices corresponding to the edges of a hypergraph
- Achieved bounds for both random and deterministic avoidance hypergraphs
- In deterministic case, devised a hypergraph formulation of pattern-avoidance, enabling the use of the hypergraph containers method
- <https://arxiv.org/pdf/1906.09659.pdf>

Packing Perfect Matchings in Random Graphs at the Optimal Threshold **UROP+ 2019**

- Goal of research to close the gap on threshold p value for which random hypergraph H_p^k can be decomposed into perfect matchings
- Discovered room for improvement in Ferber and Vu's online sprinkling upper bound argument, "Packing Perfect Matchings in Random Hypergraphs" (arXiv:0803.3406)
- Investigated a conjectural local resilience version of the Johansson-Kahn-Vu result: existence thresholds for factors in random graphs
- Refining the Ferber-Vu analysis, we show that, given this resilience result, we achieve matching upper and lower bounds on threshold
- <http://math.mit.edu/research/undergraduate/urop-plus/documents/2019/Fishelson.pdf>

Safety Verification for Autonomous Driving

MIT CSAIL (UROP) 2017

- Goal of research team to establish safety guarantees for autonomous vehicles in the form of a safety verification framework built on compositional and contract-based ideas to overcome scalability and computational issues.
- Worked on code optimization, simplifying car trajectory computations represented by convex sets and a dynamic motion model
- Extended verification framework to a broad variety of road elements and more complex road networks like Cambridge and Manhattan
- Research involved reachability analysis, computational geometry, control theory, formal methods for verification, and set theory

Szemerédi-Trotter: Polynomials and Incidences

Mathematical Reflections

- For a set of reals A , proved a lower bound on the magnitude of either the set $A + A = \{x + y | x, y \in A\}$ or the set $f(A) + g(A) = \{f(x) + g(y) | x, y \in A\}$
- Initially a submission to the Intel Science Talent Search, published as an abridged version later
- One of seven math research papers awarded semifinalist in Intel STS
- <https://bit.ly/2rlmeUF>

WORK EXPERIENCE

EconCS Research Extern

Microsoft Research, New England 2020

- Goal of research to devise ways of compressing the information in matching problems via agent classifications while maintaining welfare guarantees for the derived matchings
- Position intended for graduate students; was employed during undergrad; only 1 opening

Tutor

MIT Math Learning Center 2019

- Help undergraduates with coursework from classes spanning MIT's mathematics curriculum
- Provide individual attention to students struggling on a specific topic, helping them gain intuition
- Offer generalized lectures to groups of students in the same classes

Quantitative Research and Trading Intern

Optiver US LLC 2018

- Created a machine learning model to predict volatility of the S&P500 following a day with abnormally high realized volatility
- Invented a strategy to adjust predicted volatility in response to a market input using unbiased historical data
- Traded S&P futures and options in a simulated environment using real market data
- Coded automated trading algorithms to compete against fellow interns in market making games

Teaching Assistant

Awesome Math Summer Program 2015-16

- 4 three-week sessions at Cornell U. (twice), UC Berkeley, and Univ. of Puget Sound, WA
- Worked alongside instructor explaining high-level olympiad math contest techniques from geometry, combinatorics, and number theory
- Worked with 50 students each camp (ages 12-16) helping them work through problems and gain problem solving intuition during classes and office hours

AWARDS AND HONORS

Top 150, William Lowell Putnam Math Competition	2016
Honorable Mention, USA Junior Math Olympiad (#12 nationally; 1 point from winning)	2014
Honorable Mention, USA Junior Math Olympiad (#15 nationally; 2 points from winning)	2013
INTEL National Semi-finalist, Math Research	2016
#1 Team, PClassic Computer Programming Competition (University of Pennsylvania)	2015
Harvard-MIT Math Tournament HMMT individual round (#19 internationally)	2015
2-time USAMO Qualifier + AIME score of 11 and 12	2015-16
AIME Qualifier (five times)	2012-16
AMC perfect score (150) 3-time AMC Distinguished Honor Roll	2012-16
#1 Individual Scorer, NY State Math Tournament (Curt Boddie Award)	2014
#1 Individual Scorer, NYC Math Tournament (NYCIML), 3 years in a row	2014-16

EXTRACURRICULAR

Roadkill Buffet: MIT's improv comedy troupe, Publicity and Social Chair	2018-present
Bombs Away (Rock band): Lead vocalist and rhythm guitar	2019-present
In the Jungle of Cities: MIT Theater Arts production, Male lead	2019
World of Wires: MIT Theater Arts production, Male lead	2018
Burton Conner i3 Chair: Writer, Director, Editor of dorm tour video	2019
MIT Dance Troupe, Member	2016-2020