

MAXWELL FISHELSON

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EDUCATION

Ph.D. in Theoretical Computer Science **Massachusetts Institute of Technology (MIT)**
Supervisor: Prof. Constantinos Daskalakis

B.S. in Mathematics **Massachusetts Institute of Technology (MIT)**
GPA: 4.9/5

RESEARCH

Near-Optimal No-Regret Learning in General Games **NeurIPS 2021**
Oral Presentation

- Established that Optimistic Hedge – a common variant of multiplicative-weights-updates with recency bias – attains $\text{poly}(\log T)$ regret in multi-player general-sum games
- Exponentially improved on the best known regret attainable by no-regret learners in general games
- Introduced many novel techniques for the analysis of the performance of regret minimization algorithms, including Fourier analysis
- A corollary of our bound is that Optimistic Hedge converges to coarse correlated equilibrium in general games at a rate of $\tilde{O}(1/T)$.
- <https://arxiv.org/pdf/2108.06924.pdf>

Near-Optimal No-Regret Learning for Correlated Equilibria **Preprint 2021**
in Multi-Player General-Sum Games

- Constructed algorithmic extensions of Optimistic Hedge attaining $\text{poly}(\log T)$ internal-regret and swap-regret in multi-player general-sum games respectively
- Established a means of simulating the Stoltz-Lugosi Optimistic-Hedge algorithm as an instance of Optimistic Hedge on a combinatorial space, demonstrating that the no-external-regret of Optimistic Hedge implies no-internal-regret for Stoltz-Lugosi
- Introduced novel techniques for the analysis of Taylor expansions of multinomial functions arising from no-regret algorithms, enabling a proof that Blum-Mansour Optimistic Hedge achieves no-swap-regret
- A corollary of our bound is that both Stoltz-Lugosi and Blum-Mansour Optimistic Hedge converge to correlated equilibrium in general games at a rate of $\tilde{O}(1/T)$.
- <https://arxiv.org/pdf/2111.06008.pdf>

Multi-item Non-truthful Auctions Achieve Good Revenue **EC 2020**
(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>

- 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>

Szemerédi-Trotter: Polynomials and Incidences

Mathematical Reflections 2016

- 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

- 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
- Top 150, William Lowell Putnam Math Competition** 2016
- 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

Bombs Away (Rock band): Lyricist, 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