Maneesha Papireddygari

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Research Interests

Algorithmic Economics, Automated Market Makers, Wagering Mechanism, Blockchain Economics, Decentralized Finance, Online Learning Algorithms, Information Elicitation and Aggregation

Education

2020 - 2025* PhD, Theoretical Computer Science, *University of Colorado Boulder*, Boulder.

- Research Advisor : Prof. Bo Waggoner

2018 - 2020 Master of Arts, Economics, Delhi School of Economics, (DSE), Delhi.

- Research Advisor : Prof. Abhijit Banerji

- 2011 2015 Bachelor of Technology Major in Computer Science Engineering, International Institute of Information Technology (IIIT) Hyderabad, India.
 - Project Advisor : Prof. Rajan K.S.

Papers

 $(\alpha - \beta)$ - alphabetic ordering

A Computational Complexity Result and Sampling Algorithm for Pricing Combinatorial Constant Product Market Makers. Maneesha Papireddygari, David Pennock, Bo Waggoner, and Xintong Wang $(\alpha - \beta)$. Working Paper 2024.

A General Theory of Liquidity Provisioning for Automated Market Makers - Adithya Bhaskara, Prof. Rafael Frongillo and Maneesha Papireddygari ($\alpha - \beta$). Pre-print link - https://arxiv.org/abs/2311.08725

An Axiomatic Characterization of CFMMs and Equivalence to Prediction Markets -Prof. Rafael Frongillo, Maneesha Papireddygari and Prof. Bo Waggoner ($\alpha - \beta$). Innovations in Theoretical Computer Science (ITCS) 2024, **Highlights Beyond EC 2024** Link - https://drops.dagstuhl.de/entities/document/10.4230/LIPIcs.ITCS.2024.51

Contracts with Information Acquisition, via Scoring Rules - Maneesha Papireddygari and Bo Waggoner $(\alpha - \beta)$. Economics and Computation (EC) 2022 Link https://dl.acm.org/doi/abs/10.1145/3490486.3538261

Teaching Experience

Fall 2023 CSCI 5444, "Design and Analysis of Algorithms (graduate level)", CU Boulder, Teaching Assistant. My responsibilities included taking office hours to clear conceptual understandings, preparing exam questions and overseeing and guiding graders.

Fall 2021 CSCI 3104, "Algorithms", CU Boulder, Teaching Assistant.

My responsibilities included taking recitation sessions, preparing homework problems and recitation worksheet, holding office hours and grading exams.

Spring CS101, "Data Structures", IIIT - Hyderabad, Teaching Assistant.

2014,2015 My responsibilities included taking recitation sessions, assisting students in lab sessions, holding office hours, grading homeworks and exams.

Fall 2014 **CS102, "Algorithms", IIIT** - **Hyderabad**, Teaching Assistant. My responsibilities included taking recitation sessions, holding office hours, grading homeworks and exams.

Invited Talks

- May 2023 An axiomatic characterization of CFMMs and their equivalence to prediction markets (virtually) at University of Maryland, College Park.
- Dec 2024 An axiomatic characterization of CFMMs and their equivalence to prediction markets at Indian Institute of Technology, Bombay.

Research And Professional Experience

- Nov Dec Visiting Research Student, At Indian Institute of Technology, Bombay. 2024 hosted by Prof. Arpit Agarwal
- June Nov Research Intern, Robust Incentives Group, Ethereum Foundation.
 - 2024 Researching the economic and computational issues in Layer 1 of blockchains like order dependent auctions, multidimensional gas fee, pool staking dynamics etc.
- June Aug Summer Research Intern, Center for Discrete Mathematics and Theoretical Computer Science (DIMACS),
 2023 Rutgers University, Research advisor Prof. David Pennock.
 Research on computational complexity of combinatorial CFMMs and approximation algorithms for estimating price
- May July Research Intern, Indian Statistical Institute(ISI), Kolkata, India.
 - 2019 Theoretical research Did exploratory work on single sided stable matching algorithms, equivalence of these mechanisms(RSD,random TTC etc) under uniform distribution.
- Jan March Research Assistant, University of York, UK.
 - 2019 Applied Worked with Prof. Anindya Bhattacharya on automating data refinement and scraping
- July 2015 Software Developer, Citrix R&D India Pvt. Ltd, Hyderabad, India.
- Nov 2016 Worked on Apache CloudStack an open source software designed to deploy and manage large networks of virtual machines, as a highly available, highly scalable Infrastructure as a Service (IaaS) cloud computing platform.

Scholastic Merits/ Awards

- 2025 Departmental Dissertation Completion Award
- 2024 CS Department Annual Research expo winner (published work)
- 2023 CS Department Publication Recognition Award
- 2023 Departmental Conference Support Fellowship
- 2023 Travel funding for MSRI workshop on Mechanism and Market Design, Connections Workshop 2023
- 2023 Travel scholarship for Economics and Computation, EC 2023
- 2022 Recipient of Casey Feldman Memorial Scholarship for volunteer work.
- 2018 Ranked 7th among 250 students (top 3 %) at Delhi School of Economics.
- 2018 Recipient of Smt. Shanti Sharma Memorial Scholarship at Delhi School of Economics.
- 2018 Secured All-India 5th rank in DSE entrance exam, 2018.
- 2012 Recipient of Dean's List of Academic Excellence Award for 2nd semester at IIIT Hyderabad.
- 2011 Ranked All India 84 (top 99.99 %) over a million students in All India Engineering Entrance Exam (AIEEE)
- 2011 Ranked All India 2267 (top 99.56 %) out of about 400k students in IIT Joint Entrance Exam (IIT-JEE)
- 2011 Among the 300 students in India selected for National Physics Olympiad.
- 2011 Among the 300 students in India selected for National Astronomy Olympiad.

Academic Service

PC member	Web and Internet Economics(WINE) 2024.
Co-organizer	Gender Inclusion Workshop(GIW) at Economics and Computation (EC) 2024.
Reviewer	Economics and Computation (EC) 2024.
Co-founder	Inaugural Gender Inclusion Workshop(GIW) at Economics and Computation (EC) 2023.
Reviewer	Symposium on Discrete Algorithms (SODA) 2023.
Sub-reviewer	Symposium on Discrete Algorithms (SODA) 2023, 2024.
Volunteer	Economics and Computation (EC) 2022, Boulder, 12-15 July, 2022.
Volunteer	Conference of Learning Theory (COLT) 2021, Boulder, 15-19 August, 2021.
Volunteer	Winter School 2019 and 2018, Delhi School of Economics, 10-13 December.

Projects

- June 2024 Equilibrium analysis of penalities capping mechanism in Ethereum validator pools, with Barnabe ongoing *Monnot.*
- Sept 2024 Approximate algorithms for restricting the size of mempools in lieu of multi-dimentional gas fee, ongoing with Barnabe Monnot.
- June 2023 On hardness and approximation of combinatorial Constant Product Market Makers (CPMMs), ongoing with Prof. Dave Pennock, Prof. Bo Waggoner and Prof. Xintong Wang.

Chen et.al. 2008 show that pricing combinatorial Logarithmic Market Scoring Rule (LMSR) is #P-hard. With the widespread adaption of Uniswap, we explore complexity questions pertaining to the implementing AMMs using Constant Product rule, which are the generalization of Uniswap to multiple assets/securities. We show that pricing problem in a combinatorial CPMM that is used to trade options/securities that are disjunctions of two events is #P-hard. We also give an approximation algorithm to estimate this price that achieves theoretical optimal guarantees with high probability.

March 2022 - Information aggregation in wagering mechanisms when agents have immutable beliefs, with Prof.

May 2023 Bo Waggoner, Prof. Rafael Frongillo, Robin Bowers, University of Colorado, Boulder. We look into aggregating immutable beliefs of agents in a wagering mechanism when the agents are Bayesian. This model has been previously discussed in Lambert et. al. 2015 but their it doesn't beat the $O(\frac{1}{m})$ worst-case bound for aggregation that just the averaging the truthful reports achieves. In order to achieve perfect aggregation, we look into giving agents a small bonus to overcome no-trade theorem instead of assuming an intrinsic utility to gamble. We propose a mechanism so the agent's best response to wager reveals their confidence in the prediction, which can then be used to aggregate optimally. We also aim to generalize this aggregation mechanism to more information structures.

Aug 2023 - A General Theory of Liquidity Provisioning, with Prof. Rafael Frongillo and Adithya Bhaskara.

Feb 2024 In decentralized finance, it is common for automated market makers to provision liquidity from external parties. The market maker rewards these liquidity providers with a cut of the trading fees, in exchange for the risk they take on. A handful of protocols for liquidity provisioning have been proposed, such as Uniswap V2 and V3, with specific and sometimes complex rules for collecting liquidity deposits, executing trades, and dividing up fees. Beyond these examples, and a broader understanding of liquidity provisioning, and particularly the design space from which one could choose a different protocols, has been out of reach. In this work, we show that one can view liquidity provisioning very broadly as the practice of running several market makers "in parallel": each market maker provides its own liquidity, yet the combined group can operate as a single coherent market. We prove that this general protocol, when restricted to specific forms of the constituent market makers, recovers Uniswap V2 and V3 as special cases. We then go on to propose a new restriction which may have advantages over Uniswap V3. In the context of prediction markets, where computation costs are less constrained, our general protocol gives a maximally flexible way to provision liquidity. We conclude with remarks about the nature of liquidity and fees in markets with more than 2 assets, and several open questions.

March 2022 - An Axiomatic Characterization of CFMMs and Equivalence to Prediction Markets, with Prof. Bo Feb 2023 Waggoner, Prof. Rafael Frongillo.

Constant-function market makers (CFMMs), such as Uniswap, are automated exchanges offering trades among a set of assets. We study their technical relationship to another class of automated market makers, cost-function prediction markets. We first introduce axioms for market makers and show that CFMMs with concave potential functions characterize "good" market makers according to these axioms. We then show that every such CFMM on n assets is equivalent to a cost-function prediction market for events with n outcomes. Our construction directly converts a CFMM into a prediction market and vice versa. Conceptually, our results show that desirable market-making axioms are equivalent to desirable information-elicitation axioms, i.e., markets are good at facilitating trade if and only if they are good at revealing beliefs. For example, we show that every CFMM implicitly defines a *proper scoring rule* for eliciting beliefs; the scoring rule for Uniswap is unusual, but known. From a technical standpoint, our results show how tools for prediction markets and CFMMs can interoperate. We illustrate this interoperability by showing how liquidity strategies from both literatures transfer to the other, yielding new market designs.

May 2020 - Contracts with Information Acquisition, via Scoring Rules, with Prof. Bo Waggoner.

Feb 2022 We consider a principal-agent problem where the agent may privately choose to acquire relevant information prior to taking a hidden action. This model generalizes two special cases: a classic moral hazard setting, and a more recently studied problem of incentivizing information acquisition (IA). We show that all of these problems can be reduced to the design of a proper scoring rule. Under a limited liability condition, we consider the special cases separately and then the general problem. We give novel results for the special case of IA, giving a closed form "pointed polyhedral cone" solution for the general multidimensional problem. We also describe a geometric, scoring-rules based solution to the case of the classic contracts problem.Finally, we give an efficient algorithm for the general problem of Contracts with Information Acquisition.

June-July **On Equivalence of Single-Sided Matching Mechanisms**, *with Prof. Souvik Roy*, Indian Statistical 2019 Institute, Kolkata.

The equivalence of many one-sided matching mechanisms for indivisible objects has been discussed in papers like Pathak(2008), Carroll(2014), Sethuraman & Lee(2011). But the equivalence only holds under the assumption of uniform distribution of priority structures. We looked into the conditions of the distribution for which the equivalence further holds.

2015-2016 Citrix CloudPlatform (powered by Apache CloudStack), Apache CloudStack.

Apache CloudStack is an open source software designed to deploy and manage large networks of virtual machines, as a highly available, highly scalable Infrastructure as a Service (IaaS) cloud computing platform. CloudStack is used by a number of service providers to offer public cloud services, and by many companies to provide an private cloud offering, or as part of a hybrid cloud solution. I had worked on areas scaling across the product like its support for vmware,job monitoring,kubernetes etc..

2014 Distributed Key-Value Store, with Prof. Vasudeva Verma, IIIT Hyderabad.

Built a distributed key value store which provides an interface to store data and efficiently search on primary key and/or multiple secondary keys unlike traditional key-value stores which provides search only on primary variables. The system guarantees strong consistency by trading off little of availability. This System works on two basic concepts of Hyperspace Hashing and Value-dependent Chaining.

2013-2014 Behavioural understanding of Spatial Data, with Prof. K.S.Rajan, IIIT Hyderabad.

Project involved developing a spatial understanding, by accumulating and analyzing big data related to students' movement in campus and outside. Aim is to derive social and behavioral patterns from the data, thus converting useless information into meaningful insights such as effects of road blockages, appropriate change in timings to control traffic in frequently used areas etc.

Computer Skills

Scientific Computing - MatlabProgramming - C, C++, Python, Java.Others - MySQL, Web2py, HTMLOperating Systems - MacOS, Linux (Ubuntu), Windows.

Languages

Telugu (Native) - Fluent, English - Fluent, Hindi - Fluent

Volunteer Work

- Volunteer regularly for local food rescue to serve graduate students with food-insecurities.
- Volunteered for a week (40 hours) at Catalina island conservancy. Participated in conservancy activities like trail building, invasive plant removal, building enclosure etc.
- Volunteer member for resident council which worked to better graduate residents living experience
- Volunteered for a semester with a local non-profit to teach math to underprivileged kids
- Engaged in making baked goods for children in the foster system through the Cakes4kids's North Colorado chapter

Extracurricular Activities, Hobbies and miscellaneous

- * Learning pottery, rock climbing, skiing and piano.
- * Proud summer gardener.
- * Travel and Hiking enthusiast, done several hikes in Colorado, South India and three in the Himalayas.
- * First in women chess and second in carroms at Progress Software.
- * Wildlife photography enthusiast. Clicked 100+ different birds of Indian subcontinent.

For more information visit Maneesha Papireddygari webpage at : Maneesha Webpage