Senthil Rajasekaran

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SKILLS

Mathematics: Game Theory, Probability Theory, Integration Theory/Calculus, Topology, Abstract Algebra, Number Theory

Theoretical Computer Science: Logics, Formal Verification, Complexity Theory, Computability, Automata Theory, Graph Theory, Combinatorics, Type Theory, Optimization Theory, Data Structures, Proof Theory

Statistics/Empirical Methods: Curve Fitting, Machine Learning, Qualitative Analysis, Quantitative Modelling, Hypothesis Testing, Bayesian Analysis

Programming: Python, C#, SQL, OCaml, Mathematica, NumPy, Scikit-learn, PyTorch, SMT/ SAT solvers

Special: Mathematical Puzzles, Recreational Mathematics, Logic Puzzles, Programming Puzzles

EDUCATION

PhD in Computer Science, Rice University **Aug 2019 – Aug 2025**
Studied the computational complexity of game-theoretic equilibria concepts in multi-agent systems
Advisor: **Moshe Y. Vardi**, the top figure in the field and a leading figure in computer science in general
Work solved open problems and provided major insights into the bottlenecks that arise in multi-agent architectures
Wide breadth of coursework in theoretical computer science, math, and programming.

MSc in Mathematics and the Foundations of Computer Science, University of Oxford **Sep 2016 – Nov 2017**
Intensive coursework in mathematics and theoretical computer science, culminating in a dissertation advised by Julian Gutierrez, Giuseppe Perelli, and Michael Wooldridge, head of the Oxford CS department, on Strategy Logic

BS in Mathematics and BS in Economics, Tulane University **Aug 2011 – May 2015**
Magna cum laude with departmental honors in mathematics through a thesis in number theory. Advisor: Victor Moll.

Budapest Semesters in Mathematics, Study Abroad **Aug 2014 – Dec 2015**
Intensive mathematics study abroad program, graduated with honors; partially funded by scholarships from Tulane

Math in Moscow, Study Abroad **Aug 2015 – May 2016**
Intensive coursework in mathematics and theoretical computer science, graduated with honors

MAJOR PUBLICATIONS

Nash Equilibria in Finite-Horizon Multiagent Concurrent Games
Senthil Rajasekaran and Moshe Y. Vardi
In Proceedings of the 20th International Conference on Autonomous Agents and Multi-Agent Systems (**AAMAS '21**).
This paper provides a **new PSPACE-complete complexity result** for the problem of finding Nash Equilibria in finite-horizon multiagent games where each agent has a behavioral goal, one that depends on the history of the play, expressed as a deterministic finite automaton. This type of analysis leveraged the automaton representation of the goals in order to provide a **more accurate picture of the overall complexity** compared to the previous literature.

Verification and Realizability in Finite-Horizon Multiagent Systems
Senthil Rajasekaran and Moshe Y. Vardi
In Proceedings of the 19th International Conference on Principles of Knowledge Representation and Reasoning (**KR '22**)
Here, we extend the results of the previous AAMAS paper for new complexity results for both different types of automaton representations of the agent goals and with respect to the problem of checking equilibria. In doing so, **we also solve the previously open problem of determining the complexity of the nondeterministic finite automaton realizability problem, a problem that was actively worked on for around two decades.**

Multi-Agent Systems with Quantitative Satisficing Goals
Senthil Rajasekaran, Suguman Bansal, and Moshe Y. Vardi
In Proceedings of the Thirty-Second International Joint Conference on Artificial Intelligence (**IJCAI '23**)
In this paper we show how to leverage the automata-based techniques developed in the above two papers to **introduce a new way to specify goals in quantitative games with beneficial game-theoretic properties** and show how to develop efficient automata-based algorithms to solve quantitative games in which agents are given these types of goals **providing one of the first algorithms for finding equilibria in concurrent multiagent games with general quantitative goals.**

Verifying Equilibria in Finite-Horizon Probabilistic Concurrent Game Systems
Senthil Rajasekaran and Moshe Y. Vardi
In Submission at Logical Methods in Computer Science (**LMCS Journal**)
This paper considers a probabilistic setting, a generalization that is not usually seen in the formal methods literature. Considering the probabilistic setting motivated the development of **new techniques in numerical analysis** in order to carefully analyze the complexity of dealing with high-precision decimals. Doing so yielded **a highly counterintuitive relationship between the Nash and subgame perfect equilibria, the two most important equilibrium concepts in game theory.**

Multivariate Analysis of Circuit-Based Multiagent Systems
Senthil Rajasekaran and Moshe Y. Vardi
To be submitted at the next relevant opportunity
The complexity-theoretic analysis of multiagent systems has long been hampered by imprecise mathematical models. This not only affects the precision of the theoretical results but also significantly weakens their practical insights. In this paper, we address this issue by introducing a **unified, precisely defined circuit-based multiagent model** that also allows for **fine-grained multivariate analysis**.

EMPLOYMENT

Software Analysis Group Intern, Nokia Bell Labs, NJ **Jun 2022 – Sep 2022**
Created a prototype software tool using OCaml and Python in order to automate the notoriously difficult distributed synthesis problem. The software used a novel approach based on UNITY logic and "refinement" techniques and utilized SAT and SMT solvers as part of its backend.

Full Stack Software Engineer, Digicomm Inc., New Orleans, LA **Mar 2018 – Jun 2019**
Created web applications for customers to analyze and interpret data. We stored this data in SQL databases and used AJAX calls in order to create web applications that could pass user queries into the database. These queries could then be evaluated, and methods for graphical displays and statistical analysis were also implemented for the customers' use.

SELECTED ACHIEVEMENTS AND HONORS

Invited to speak at the Simons Institute – the leading international forum for collaboration in theoretical computer science, and being given a speaker position is a significant honor for even distinguished faculty. Being chosen as a speaker as a PhD student is a very significant honor, and the talk can be found here

Awarded multiple travel scholarships to present my work, including **LICS 2025** (Singapore), **IJCAI 2023** (Macau), **KR/FLoC 2022** (Haifa), and **AAMAS 2021** (London but virtual due to COVID)

Awarded a scholarship for an academic visit to the University of Edinburgh – the two-week visit was part of an effort to develop a stronger collaboration between Rice University and the University of Edinburgh. I was one of the 5 students from both institutions chosen for an academic visit to the other

Feature in Rice CS News – Rice CS News communicates the noteworthy achievements of the Rice CS department to the general public. My work was chosen for one such feature, found here

Numerous Mathematical and Programming Puzzle Challenges. I participate in numerous math and programming puzzle challenges. One achievement I'm particularly proud of is my completion of the legendary fifth level of Google's foo.bar challenge. A write-up of my solution and experience can be found on my old (no longer maintained) blog here. I also enjoy tackling the puzzles put out by the company Jane Street, which are noted for their difficulty, and my name can be found topping some of the unofficial leaderboards that other fans have created.