George Tsoukalas

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Education

Rutgers University New Brunswick, New Jersey
Bachelor of Science - Mathematics & Computer Science; GPA: 4.00/4.00 *September 2019 - May 2023*

- **(2021) David Martin Weiss Memorial Award**: Awarded to a sophomore demonstrating excellence as a math major.
- **(2022) Weill Scholarship**: Awarded to full-time students majoring in mathematics based on academic merit.
- **(2022) John Bogart Prize**: For exceptional achievement in mathematics.

Research Experience

Automated Reasoning Lab Rutgers University, New Jersey
Undergraduate Researcher *August 2022 - Present*

- Researching syntax-guided synthesis (SyGuS) of numerical invariants for program verification & synthesis.
- Implementing neurosymbolic programming techniques with dPads and DifferentiableSygus using PyTorch.

Numerical Semigroups REU San Diego State University, California
Undergraduate Researcher *May 2022 - August 2022*

- Researched connections between numerical semigroups and a geometric object called the Kunz Cone.
- Uncovered several key properties regarding symmetries of the Kunz Cone and their action on unimaximal faces.
- Performed probabilistic analysis on Erdős-Rényi type random numerical semigroups towards Wilf's Conjecture.

Matrix Analysis REU College of William & Mary, Virginia
Undergraduate Researcher *May 2021 - September 2021*

- Researched generalized notions of graph adjacency matrices, including questions of eigenvalue assignments and disparity.
- Characterized $k-$NIM trees, extending a characterization of $1-$NIM Trees by mentor Charles R. Johnson.
- Utilized singularity analysis to enumerate these trees according to the newly found characterization.
- **Publication**: (Submitted) k-NIM Trees: Characterization and Enumeration, arXiv:2208.05450, July 2022.

Projects

- **Indie Game Development**: Developed a Roblox game which registered over 23M player visits, including a total of 6.1M unique players. Recorded 100K+ daily active users over multiple months. Appeared within the top 10, of thousands, for average playtime sitewide. Utilized knowledge of client-server architecture. Published bi-weekly updates.
- **Jigsaw Puzzle Solver**: Implemented a deep convolutional network in TensorFlow to find matches among input puzzle pieces, with fairly good accuracy. Additionally implemented a direct approach to compare edges of pieces according to several metrics, including CIE94 and the ℓ^p norm. Used topological sort to find linear extension of resultant piece ordering.
- **Superimposed N-Queen Problem**: Implemented simulated annealing and various probability scheduling algorithms to achieve lower bounds on best-possible configurations for the N superimposed $N-$Queen problem for several unresolved cases $N = 8, 9, 10$ following work by Vasquez (2004).
- **Othello Computer Engine**: Implemented both Othello/Reversi and MiniMax to test heuristics for tree-search towards creating a strong machine opponent - strength was intermediate. Used Python's pygame for visualization. Working towards implementing Deep Reinforcement Learning to improve performance.
- **Directed Reading Program**: Researched cardinal invariants with graduate student. Studied several invariants, including the bounding, dominating, splitting, and reaping numbers. Presented Cichon's Diagram of cardinal characteristic results.

Technical Skills

- **Languages:** Python, Lua, Java, C, C++, OCaml, Javascript
- **Frameworks:** TensorFlow, Keras, Scikit-Learn, PyTorch, NodeJS
- **Math Software:** Lean4, Sage, Maple, MatLab

Relevant Coursework

- Algorithms (Graduate)
- Nonlinear Optimization (Graduate)
- Probability Theory (Graduate)
- Artificial Intelligence
- Machine Learning
- Formal Languages & Automata
- Combinatorics I & II (Graduate)
- Graph Theory (Graduate)
- Game Theory (Graduate)
- Linear Algebra
- Matrix Analysis
- Mathematical Analysis I & II
- Measure Theory (Graduate)
- Ergodic Theory (Graduate)
- Fourier Analysis (Graduate)
- Complex Analysis (Graduate)
- Algebra I (Graduate)
- Point-Set Topology

Presentations

- **Geometric characteristics of symmetric numerical semigroups in the Kunz Cone** - *San Diego State*, August 2022
- **Eigenvalues, Multiplicities, and Graphs** - *College of William & Mary*, July 2021
- **Cardinal characteristics of the Continuum** - *Rutgers University*, May 2021

Service

Department of Mathematics Rutgers University
Undergraduate Grader *August 2020 - May 2021*

- Graded for two sections of Math 311: Intro to Real Analysis, providing timely feedback to both the students and the instructor.

SAS Honors Program Rutgers University
Undergraduate Tutor *September 2020 - Present*

- Tutored peers in Math 300: Introduction to Mathematical Reasoning and Math 411: Mathematical Analysis I.