HOJUNE KIM

Honors Major in Mathematics (B.A.) Major in Engineering (B.S.) Swarthmore College '25

Summary -

Honors candidate pursuing a Bachelor of Arts in Mathematics and a Bachelor of Science in Engineering at Swarthmore College. Passionate about using mathematical rigor to solve real-world challenges. My research focuses on developing scalable, robust algorithms for multi-agent systems to interact effectively under uncertainty, with an emphasis on robotics. I have a solid foundation in mathematical analysis, graph theory, game theory, and stochastic processes. Currently applying to PhD programs, I am seeking opportunities that bridge mathematics and robotics to create impactful solutions.

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Stats and Skills

GPA: 3.93/4.00

Technical Skills:

Python | ROS | C++ | MATLAB | Fusion360 | Git | LaTex | PyTorch

Soft Skills:

Analysis | Mathematical modeling | Mentoring | Problem solving | Prototyping | Team work | Time management

Experience

6/2024 - present

Carnegie Mellon University Robotics Institute

Visiting Scholar

- **Project Overview:** Conducting research with Dr. John Dolan and PhD student Yiwei Lyu to develop a safety-guaranteed navigation algorithm for multi-mobile robot systems, operating in heterogeneous, communication-free environments. This algorithm enables agents to learn the weight parameters of others through observing their movements without prior information on non-ego vehicles.
- **Modeling:** Relaxed the assumption that all agents must know the individual weights of others; they now only need to know the overall weight distribution of the system. Additionally, added an assumption that agents move in proportion to the size of their Voronoi Cell and modeled this system as a multi-agent weight guessing game.
- **Method:** Employed Bayesian Inference to allow agents to learn latent parameters of non-ego vehicles with 90% accuracy under uncertainty, while 100% ensuring collision-free maneuvers by maintaining non-overlapping cell boundaries, supported by mathematical proof.
- **Implementation:** Currently redesigning assumptions to better align with real-world applications. Additionally, working on designing a motion capture system using AprilTag and four cameras to test decentralized Multi-Agent Pathfinding (MAPF) algorithms on multiple TurtleBots as part of my senior capstone project.

10/2022 – present CASPER (Course Schedule Optimizing Startup)

- **Motivation:** Identified inefficiencies in the university course scheduling process, where manual coordination led to frequent course conflicts that could be avoided.
- **Solution Design:** Developed a graph-based optimization model for Swarthmore's scheduling process, introducing a novel metric and bi-level framework that considers faculty preferences while minimizing student course conflicts.
- **Community Collaboration:** Initiated a campaign with the Registrar's Office to gather key input from students, successfully engaging 50% of the total student body.
- **Result:** Implemented the solution using heuristic approaches, such as hill climbing and simulated annealing, reducing student conflicts from 445 (27.86%) to 9 (0.57%) while fully accommodating professors' room and time preferences.
- Leadership/Collaboration: Proposed and successfully pitched a pilot project for the Fall 2024 semester to key stakeholders, including the Registrar's and Provost's Offices. Recruited a student web developer to transform CASPER into an interactive website for professors and administrative staff.
- **Contribution:** Collaborating with the Registrar's Office to partially implement the program for the Fall 2025 semester schedule.

6/2023 – 8/2023 Lawrence Berkeley National Lab

Research Intern

- **Project Overview:** Developed a self-supervised, physics-informed Variational Autoencoder model for Computed Tomography (CT) image reconstruction, achieving more than a 50% reduction in the required number of X-ray shots compared to traditional methods, while preserving reconstruction quality.
- **Contribution:** Benchmarked three types of Generative Artificial Intelligence (GANs, VAEs, and Diffusion Models) on 2D image reconstruction tasks, providing insights for strategic model selection. Implemented a parallel computing pipeline to process a 500 GB+ brain CT dataset, significantly improving the efficiency of the model training workflow.

Founder

Honors and A	Awards	
2024	Tau Beta Pi Chapter Treasurer Tau Beta P Selected as one of the top five students in Swarthmore's Engineering Department for membership interview. Tau Beta P	
	Tau Beta Pi during junior year, a national honor society recognizing excellence in engineering.	
2023, 2024	Sigma Xi Summer Research Fellow Sigma X Selected to be a member of Sigma Xi, an international honor society of math and science professionals awarded a total of \$11,200 to support research initiatives.	
2023	SwatTank Winner (Startup Competition) Swarthmore College Awarded first place in Swarthmore's annual startup pitch competition, assessed on business feasibility creativity, and pitch quality, receiving a \$3,000 award.	
2022	Stanford University Innovation Fellow Stanford University Selected to be one of four University Innovation Fellows to drive innovation and entrepreneurial initiatives on campus at Swarthmore. Stanford University	
2022	2022 Science and Engineering Summer Research Fellow Swarthmore College Selected from the Engineering Department for outstanding academic and research potential; awarded \$5,500 to pursue an independent summer research project.	
Other Involve	ement	
2024	Swarthmore Robotics Club President Mentored 15 students, led biweekly meetings, and assigned tasks like using a depth camera or imag masking in videos. Currently building an indoor mobile robot to pick up, classify, and dispose garbage	
2023	Swarthmore Academic Assessment Committee Board Representative Advocated for student needs and proposed solutions to enhance academic policies, facilitating a more supportive environment for students to navigate their academic journeys.	
Fall '24	ENGR 028 Mobile Robotics T.A. & Department Tutor	
Spring '24	ENGR 027 Computer Vision T.A.	
Fall '23	ENGR 019 Numerical Methods for Engineering Application T.A.	
	Worked as a department-assigned teaching assistant and private one-on-one tutor; held weekly problem sessions, clarified class materials, and assisted students with homework and lab questions.	

Relevant Coursework -

Courses to be taken in Spring 2025 are starred (*).

Mathematics - Lectures

Linear Algebra	Hefferon Linear Algebra		
Multivariable Calculus with Theory	Colley Vector Calculus		
Discrete Mathematics	Goodaire Discrete Mathematics with Graph Theory		
Real Analysis I	Rosenlicht Introduction to Analysis Kennedy Welcome to Real Analysis		
Abstract Algebra I	Fraleigh A First Course in Abstract Algebra		
Differential Geometry I	Pressley Elementary Differential Geometry		
Ordinary Differential Equations	Edwards Elementary Differential Equations		
Stochastic and Numerical Methods	Holmes Introduction to Scientific Computing and Data Analysis Dobrow Introduction to Stochastic Processes with R		
Probability (*)			
Partial Differential Equations (*)			

Mathematics - Seminars

Graduate-level student-led courses monitored by a professor. Students are expected to present on the text and take exams from the professor.

Real Analysis II (Analysis on Manifold, Measure Theory) Abstract Algebra II (Symmetries, Representation Theory, and Galois Theory) Differential Geometry II (*) (Riemannian Geometry) Munkres | Analysis on Manifolds Stein | Real Analysis III

Artin | Algebra

Engineering/Computer Science

Mechanics	Beer Statics and Mechanics of Materials
Thermo-fluid Mechanics	Gerhart Munson, Young and Okiishi's Fundamentals of Fluid Mechanics
Electrical Circuit Analysis	Nilsson Electric Circuits
Linear Physical System Analysis	Ogata System Dynamics
Embedded Systems	Project-based course – built a 3D LED cube with 125 lights to display programmed patterns.
Data Structures and Algorithms 1	Goodrich Data Structures and Algorithm Analysis in C++
Numerical Methods for Engineering	Kiusalaas Numerical Methods in Engineering with Python 3 $$
Computer-Aided Manufacturing and Proced Design	ural Project-based course (link)
Computer Vision	Szeliski Computer Vision: Algorithms and Applications
Mobile Robotics	Project based course (link)

Other _____

Military Service: Information and Strategy Specialist in Republic of Korea Army (Jul 2020 - Jan 2022)

Languages: English - Bilingual | Korean - Native, Bilingual

Hobby: Cycling (Completed Cross-Nation Trail - Korea) | Bouldering (V5 climber)