

# Siming He

University of Pennsylvania, 3601 Market St, Philadelphia, PA 19104

✉ siminghe@seas.upenn.edu | 🏠 siming-he.github.io/

## Education

### Master of Science in Engineering, Major: Robotics

Philadelphia, PA

SCHOOL OF ENGINEERING AND APPLIED SCIENCE, UNIVERSITY OF PENNSYLVANIA, GPA 3.97/4.0

Aug. 2021 - Dec. 2023

Selected Graduate Courses: Probability Theory, Convex Optimization, Advanced Linear Algebra, Game Theory, Conformal Prediction, Deep Learning, Learning in Robotics, Machine Learning, Linear System Theory, Computer Vision, Math of RL.

### Bachelor of Science in Engineering, Major: Computer Science, Minor: Mathematics

Philadelphia, PA

SCHOOL OF ENGINEERING AND APPLIED SCIENCE, UNIVERSITY OF PENNSYLVANIA, GPA 3.96/4.0

Aug. 2020 - May 2025

Selected Courses: Algorithms, Discrete Math, PDE, Real Analysis, Computer Organization & Design, Operating Systems.

### Bachelor of Science in Economics, Major: Statistics

Philadelphia, PA

WHARTON SCHOOL, UNIVERSITY OF PENNSYLVANIA, GPA 3.77/4.0, STATISTICS-GPA 4.0/4.0

Aug. 2020 - May 2025

Selected Courses: Statistical Inference, Stochastic Process, Mathematical Statistics, Bayesian Statistics, Data Analytics.

## Research Experience

### A Mathematical Theory of the Semantics of Scenes

Philadelphia, PA

ADVISOR: PROF. PRATIK CHAUDHARI | UPENN GRASP LAB

Jun. 2024 - Present

- Formalizing scene semantics based on category theory and probability theory in my **statistics thesis**. Developing a minimal yet sufficient representation of semantics within a scene for diverse tasks.

### Large-scale Forest Mapping and Analysis

Philadelphia, PA

ADVISOR: PROF. PRATIK CHAUDHARI, DEAN VIJAY KUMAR | UPENN GRASP LAB

Jan. 2023 - Present

- Spearheading a project using a monocular camera and IMU to extract geometry and semantics in unstructured environments such as forests. Advancing forestry research by reducing equipment costs 100x compared to LiDAR methods.
- Engineered hardware and software** for multimodal data collection. Developing simultaneous localization and mapping (**SLAM**) and neural radiance field (**NeRF**) methods for accurate and large-scale forest reconstruction.
- Developed a NeRF algorithm presented at a **workshop in 2024 Conference on Computer Vision and Pattern Recognition**.

### Active Perception through Information Theory and Game Theory

Philadelphia, PA

ADVISOR: PROF. PRATIK CHAUDHARI, DEAN VIJAY KUMAR | UPENN GRASP LAB

May 2021 - Sep. 2024

- Designed an **information-theoretic algorithm** for an autonomous quadrotor to reconstruct detailed **semantic NeRFs** from initially unknown environments. First-authored a publication at the **American Control Conference 2024**.
- Analyzed the suboptimality of active perception algorithms through a novel game-theoretic formulation. Developed an on-line optimization algorithm with **theoretical guarantees**. Performed **real robot** experiments using a Jackal ground robot. First-authored a paper under review for the **International Conference on Robotics and Automation 2025**.

### Bio-inspired Navigation and Semantic Gaussian Splatting

Zürich, Switzerland

ADVISOR: PROF. ANDREA CENSI, PROF. EMILIO FRAZZOLI | ETH ZÜRICH

Jul. 2024 - Sep. 2024

- Designed a novel **bio-inspired navigation** algorithm with guarantees based on **differential geometry** and **control theory**.
- Developed an online estimator for **hierarchical 3D object segmentation in Gaussian splatting** with finite sample bound.
- Studied **category theory** and **sheaf theory** by reading 1 book and 5 math research papers.

### Mathematics Directed Reading

Philadelphia, PA

ADVISOR: PROF. SANTOSH VENKATESH | ELECTRICAL AND SYSTEMS ENGINEERING, UPENN

Jan. 2023 - Jul. 2023

- Conducted guided reading and solved problems from 2 books on **information theory and learning theory**. Studied 6 math research papers and presented proofs on concentration inequalities, neural network generalization, and channel capacity.

### A Robotic Platform for Automated Experiments on C. Elegans

Philadelphia, PA

ADVISOR: PROF. CHRISTOPHER FANG-YEN | BIOENGINEERING, UPENN

Sep. 2021 - Jan. 2022

- Participated in developing a robotic platform that autonomously processes C. Elegans, accelerating scientific discovery.
- Designed vision algorithms to decode barcodes in challenging lighting conditions, allowing robots to organize experiments. Developed an automatic lens calibration algorithm to ensure camera focus on C. Elegans for accurate operation.
- Co-authored a paper published in the **National Academy of Sciences (PNAS) nexus**.

## Publications & Preprints

- [5] **He, S.**, Tao, Y., Spasojevic, I., Kumar, V. & Chaudhari, P. *An Active Perception Game for Robust Autonomous Exploration*. arXiv preprint arXiv:2404.00769. Under review at the International Conference on Robotics and Automation 2025.
- [4] **He, S.**, Hsu, C. D., Ong, D., Shao, Y. S. & Chaudhari, P. *Active Perception Using Neural Radiance Fields*. In Proc. of **American Control Conference (ACC)**. IEEE (2024).

- [3] **He, S.**, Osman, Z. & Chaudhari, P. *From NeRFs to Gaussian Splats, and Back*. **Embodied AI Workshop, CVPR 2024**.
- [2] Li, Z., Fouad, D.A., Bowlin, D.P., Fan, Y., **He, S.**, Chang, M., Du, A., Teng, C., Kassouni, A., Ji, H., Raizen, M.D., & Fang-Yen, C. *A robotic system for automated genetic manipulation and analysis of Caenorhabditis elegans*. In Proc. of **the National Academy of Sciences (PNAS) nexus** 2.7 (2023): pgad197.
- [1] Lv, Q., Ding, M., Liu, Q., Chen, Y., Feng, W., **He, S.**, Zhou, C., Jiang, J., Dong, Y., & Tang, J.. *Are we really making much progress? revisiting, benchmarking and refining heterogeneous graph neural networks*. In Proc. of **the 27th ACM SIGKDD Conference on Knowledge Discovery & Data Mining** (2021).

## Presentations

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2024	Active Perception using Neural Radiance Fields, American Control Conference (Oral)	Toronto, ON
2024	Forest Mapping Using a 360 Camera, Internet of Things for Precision Agriculture NSF Site Visit (Poster)	Philadelphia, PA
2024	Active Perception using Neural Radiance Fields, GRASP Outreach Student Talks (Oral)	Philadelphia, PA
2024	Leveraging Robotics for Forest Environment Monitoring, Penn Climate Week 2024 (Poster)	Philadelphia, PA
2024	Active Perception using Neural Radiance Fields, Penn Undergraduate Research Symposium (Oral)	Philadelphia, PA
2023	Active SLAM with a Quadrotor, Penn Undergraduate Spring Research Symposium (Poster)	Philadelphia, PA

## Honors & Awards

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2024	Honorable Mention, Outstanding Undergraduate Researcher, Computing Research Association	Philadelphia, PA
2024	Wharton Student Research Subsidy — \$750, Wharton School	Philadelphia, PA
2024	Class of 1971 Robert J. Holtz Fund Grant — \$1,000, Penn Center for Undergraduate Research	Philadelphia, PA
2024	ETH Robotics Student Fellowship — CHF 4,000, ETH RobotX	Zürich, CH
2023	Vagelos Undergraduate Research Grant — \$500, Penn Center for Undergraduate Research	Philadelphia, PA
2023	Wharton Summer Program for Undergraduate Research — \$6,000, Wharton School	Philadelphia, PA
2022	Wharton Summer Program for Undergraduate Research — \$6,000, Wharton School	Philadelphia, PA
2021	Penn Research Mentoring Program — \$4,500, Penn Center for Undergraduate Research	Philadelphia, PA

## Teaching & Community Involvement

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**COURSE DEVELOPER FOR *Mathematical Foundations for Machine Learning (EAS 5160)*** *Mar. 2024 - Present*  
 Developing weekly content, recitation, and homework for graduate-level courses in probability theory and linear algebra.

**TEACHING ASSISTANT FOR GRADUATE COURSES** *Sep. 2022 - Present*  
 Developed 60 pages of recitation materials for graduate courses in probability theory (ESE 5300 by Santosh Venkatesh), machine learning (CIS 5200 by Lyle Ungar), deep learning (ESE 5460 by Pratik Chaudhari), and convex optimization (ESE 6050 by Nikolai Matni). Led 18 sessions for a total of 50 students. Held office hours. Creating and grading homework and exams.

**ROBOTICS EDUCATION OUTREACH FOR UNDERREPRESENTED STUDENTS** *Sep. 2023 - Present*  
 Teaching Arduino and robotics fundamentals to a total of 90 middle and high school students from the local community in Philadelphia, many of whom typically lack access to robotics education opportunities.

**UPENN UNDERGRADUATE PEER RESEARCH ADVISOR** *Sep. 2022 - Present*  
 Advising 40 undergraduates from diverse backgrounds on finding research opportunities and grants. Curating weekly lists of research seminars aligned with advisees' interests, encouraging them to explore diverse topics. Designing and leading annual *Python Programming for Research* workshops, fostering an inclusive environment for students across all research fields.

**RESIDENT ADVISOR OF A FIRST-YEAR STUDENTS' DORM** *Aug. 2023 - May 2024*  
 Organized cultural weeks promoting diversity and inclusion through interactive showcases of global cultures. Hosted faculty-student sessions on academic and research topics. Awarded the Excellence in Academic & Intellectual Life.

**FOUNDER OF RYKERT AFTER SCHOOL SCIENCE OUTREACH PROGRAM** *Sep. 2018 - May 2020*  
 Designed and led 11 hands-on experiments, including water rockets and microscope observations, for 30 primary school students from underrepresented communities, offering them laboratory experiences beyond their regular school access.

## Selected Course Projects

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**ESE 6500 LEARNING IN ROBOTICS WITH PROF. PRATIK CHAUDHARI** *Jan. 2023 - May 2023*  
 Developed a stereo visual SLAM system incorporating feature-based visual odometry and Symforce backend optimization.

**CIS 7000 UNCERTAINTY QUANTIFICATION WITH PROF. AARON ROTH** *Sep. 2022 - Dec. 2022*  
 Developed conformal risk control algorithm to manage false negative rates in cellular semantic segmentation tasks.

**ESE 5460 PRINCIPLES OF DEEP LEARNING WITH PROF. PRATIK CHAUDHARI** *Sep. 2022 - Dec. 2022*  
 Identified a way to reduce spurious features in transfer learning based on information geometry.