Siming He

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Education

Master of Science in Engineering, Robotics   *Philadelphia, PA*

SCHOOL OF ENGINEERING AND APPLIED SCIENCE, UNIVERSITY OF PENNSYLVANIA, GPA 3.97/4.0   *Aug. 2022 - May. 2025*

Selected Courses: Linear System Theory (ESE 5000), Probability Theory (ESE 5300), Principles of Deep Learning (ESE 5460), Convex Optimization (ESE 6050), Learning in Robotics (ESE 6500), Machine Learning (CIS 5200), Computer Vision (CIS 5810), Game-theoretic Learning (CIS 6200), Uncertainty Quantification (CIS 7000).

Bachelor of Science in Engineering, Computer Science with Math Minor   *Philadelphia, PA*

SCHOOL OF ENGINEERING AND APPLIED SCIENCE, UNIVERSITY OF PENNSYLVANIA, GPA 3.96/4.0   *Aug. 2020 - May. 2025*

Selected Courses: PDE (MATH 2410), Real Analysis (MATH 3600 & 3610), Advanced Linear Algebra (MATH 5140), Discrete Math (CIS 1600), Algorithms (CIS 3200), Operating Systems (CIS 3800), Information Theory (ESE 0099).

Bachelor of Science in Economics, Statistics   *Philadelphia, PA*

WHARTON SCHOOL, UNIVERSITY OF PENNSYLVANIA, GPA 3.86/4.0, STATISTICS-GPA 4.0/4.0   *Aug. 2020 - May. 2025*

Selected Courses: Probability (STAT 4300), Statistical Inference (STAT 4310), Mathematical Statistics (STAT 4320), Bayesian Statistics (STAT 4420), Math Foundation for Reinforcement Learning (STAT 9910).

Research Experience

Active Perception Researcher. Advisor: Dr. Pratik Chaudhari, Dr. Vijay Kumar   *Philadelphia, PA*

THE GENERAL ROBOTICS, AUTOMATION, SENSING AND PERCEPTION (GRASP) LABORATORY, UPENN   *May. 2021 - Current*

- **Researched algorithms** enabling robots to autonomously choose what and how to perceive, from first principles based on information theory, game theory, and neuroscience.
- **Identified the suboptimality** of active perception algorithms due to erroneous predictions of information gain. **Formulated active perception** as a two-player zero-sum game between an active perceiver and an environment. **Devised an online learning algorithm** for improving predictions and relaxing the bad assumption of independent observations. **Developed theoretical guarantees** for the online learning algorithm and active perception performance. **Executed experiments** on two active perception systems both in simulations and on a customized Jackal ground robot. **Wrote the paper** of Publication [4].
- **Identified the need** of active perception algorithms for constructing fine-grained semantic neural radiance field (NeRF). **Formulated active perception** as maximizing the mutual information between past and future observations. **Developed algorithms** for 1) online learning of a bootstrapped ensemble of semantic NeRF for mutual information calculation, 2) sampling-based planner to find dynamically feasible trajectories for mutual information maximization. **Examined the superiority** of our algorithms on reconstructing initially unknown environments and spotting semantic objects. **Wrote the paper** of Publication [3].
- **Engineered a full-stack robotic system** (SLAM, RRT, and PID) on my customized Duckiedrone and developed active perception algorithms on it.

Robotics Perception Researcher. Advisor: Dr. Pratik Chaudhari, Dr. Vijay Kumar   *Philadelphia, PA*

THE GENERAL ROBOTICS, AUTOMATION, SENSING AND PERCEPTION (GRASP) LABORATORY, UPENN   *May. 2023 - Current*

- **Researched geometric, photometric, and semantic maps** as fine-grained scientific measurements, e.g., for forestry and ecology studies.
- **Researched scientific measurements** of tree geometries based solely on images and novel image-based mapping algorithms, e.g., neural radiance field (NeRF).
- **Engineered hardware and algorithms** to enable large-scale and multimodal tree data collection. **Created tree dataset** of urban and forest trees in Philadelphia with LiDAR, RGB cameras, IMU, and GPS.

Research Assistant. Advisor: Dr. Christopher Fang-Yen   *Philadelphia, PA*

DEPARTMENT OF BIOENGINEERING, UPENN   *Sep. 2021 - Jan. 2022*

- Participated in developing a robotic platform capable of conducting and analyzing experiments on C. Elegans, accelerating scientific discovery and freeing researchers from time-consuming, repetitive tasks. See Publication [2].
- Designed an algorithm to decode barcode labels on Petri dishes, allowing the robot to organize experiments and save details based on the labels.
- Created an automatic lens calibration algorithm to ensure the cameras' precise focus on C. Elegans for accurate operations and detection of phenotypes.

Other Projects

Information Theory and Learning Theory *Philadelphia, PA*
DIRECTED READING WITH DR. SANTOSH VENKATESH *Jan. 2023 - May. 2023*
Studied *Elements of Information Theory* by Joy Thomas and Thomas Cover. Investigated axiomatic derivations of information measure, Vapnik–Chervonenkis theory, proofs of theorems including Gaussian channel capacity and Glivenko–Cantelli theorem. Studied recent papers in the field and presented *A sharp concentration inequality with applications*, Boucheron, S., Lugosi, G. and Massart, P. (2000).

Stereo Visual SLAM with Factor Graph Optimization using Symforce *Philadelphia, PA*
ESE 6500 LEARNING IN ROBOTICS WITH DR. PRATIK CHAUDHARI *2023 Spring*
Implemented a Stereo Visual SLAM (Simultaneous Localization and Mapping) system with feature-based visual odometry.

Conformal Risk Control in Generalist Cellular Segmentation *Philadelphia, PA*
CIS 7000 UNCERTAINTY QUANTIFICATION WITH DR. AARON ROTH *2022 Fall*
Developed conformal risk control of false negative rate in cellular semantic segmentation tasks in collaboration with two classmates.

Preventing the Transfer of Spurious Features in Transfer Learning *Philadelphia, PA*
ESE 5460 PRINCIPLES OF DEEP LEANRING WITH DR. PRATIK CHAUDHARI *2022 Fall*
Identified that the transfer of spurious features can be largely prevented by a transfer algorithm with task interpolation which reduces the transfer distance on the statistical manifold of neural networks, in collaboration with two classmates.

Publications

[4] **He, S.**, Tao, Y., Spasojevic, I., Kumar, V. & Chaudhari, P. *An Active Perception Game for Robust Autonomous Exploration.* arXiv preprint arXiv:2404.00769 (2024)

[3] **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) (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 (2023)

[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 (KDD) (2021)

Presentations

2024 **Robust Active Perception: A Game-theoretic Perspective**, Northeast Systems and Control Workshop (Poster) *Philadelphia, PA*
2024 **Active Perception using Neural Radiance Fields**, Penn Undergraduate Spring Research Symposium (Oral) *Philadelphia, PA*
2024 **Active Perception and Robot Exploration**, GRASP Lab tours to Sawiris Scholars (Oral) *Philadelphia, PA*
2023 **Active Simultaneous Localization and Mapping in Unstructured Environment with a Quadrotor**, Penn Undergraduate Spring Research Symposium (Poster) *Philadelphia, PA*
2021 **Control, Learning, and Perception for an Intelligent Robot**, Penn Undergraduate Fall Research Expo (Poster) *Philadelphia, PA*

Honors & Awards

2024 **Class of 1971 Robert J. Holtz Fund Grant — $1,000**, Penn Center for Undergraduate Research & Fellowships *Philadelphia, PA*
2024 **ETH Robotics Student Fellowship — CHF 4,000**, ETH RobotX *Zürich, Switzerland*
2024 **Honorable Mention, CRA Outstanding Undergraduate Researcher Award**, Computing Research Association *Philadelphia, PA*
2023 **Vagelos Undergraduate Research Grant — $500**, Penn Center for Undergraduate Research & Fellowships *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 & Fellowships *Philadelphia, PA*

Teaching & Community Involvement

Course Development Assistant *Philadelphia, PA*
UNIVERSITY OF PENNSYLVANIA *Mar. 2024 - Current*
• Assisted the development of the course "Mathematical Foundations for Machine Learning" for Penn Engineering Online.

Teaching Assistant   *Philadelphia, PA*

UNIVERSITY OF PENNSYLVANIA   *Sep. 2022 - Current*

- Teaching assistant for graduate-level courses including CIS 5200 Machine Learning 2022 Fall, ESE 5460 Principles of Deep Learning 2023 Fall, ESE 6050 Convex Optimization 2024 Spring, and ESE 5300 Probability Theory 2024 Fall.
- Developed recitation materials on machine learning concepts, information theory, and uncertainty quantification. Held recitations and office hours.

Peer Research Advisor   *Philadelphia, PA*

CENTER FOR UNDERGRADUATE RESEARCH & FELLOWSHIPS, UNIVERSITY OF PENNSYLVANIA   *Sep. 2022 - Current*

- Counseled undergraduate researchers regarding research opportunities, faculty mentors, and grants.
- Mentored 30 1st and 2nd year students interested in doing computer science, robotics, and statistics research.
- Compiled weekly research seminar lists to keep mentees informed about topics in their interested areas.
- Designed and held annual Python Programming for Research Workshops to introduce Python and common Python packages.

Robotics Education for Underrepresented Students   *Philadelphia, PA*

THE GRASP LAB, UNIVERSITY OF PENNSYLVANIA   *Sep. 2023 - Current*

- Taught robotics to over 90 K-12 students in total in Philadelphia public schools who identify as being underrepresented in STEM fields.
- Presented and demonstrated my robotics research to 30 7th grade students.
- Taught Arduino basics to 30 10th grade students
- Taught 30 high school students about mapping and planning in robotics

Resident Advisor   *Philadelphia, PA*

COLLEGE HOUSES & ACADEMIC SERVICES, UNIVERSITY OF PENNSYLVANIA   *Aug. 2023 - May. 2024*

- Resident advisor in a first-year students' dorm.
- Counseled my residents on various aspects of academic and residential life and supporting them through the challenges of first-year college life.
- Hosted lunch and dinner sessions where faculty members join residents for conversations spanning academic, research, and daily life topics.
- Organized information sessions to connect residents with the abundant research resources on campus.

Founder   *St. Catharines, Ontario*

RYKERT AFTER SCHOOL SCIENCE PROGRAM   *Sep. 2018 - May. 2020*

- Organized the program to engage underprivileged middle school students in science experiments in a laboratory environment often beyond their regular access.
- Led the development of intriguing experiments, including building electric wheels, building water rockets, and observing specimens under microscopes.