# Hshmat Sahak

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## Education

**MASc. in Aerospace Science and Engineering, University of Toronto** — *Sept 2024 - Aug 2026*

*Collaborative Specialization in Robotics*

- Advisors: Tim Barfoot, Nick Rhinehart
- Thesis: Planning and navigation for indoor mobile robots
- GPA: 4.00/4.00, Relevant Courses: State Estimation for Aerospace Vehicles, Imitation Learning for Robotics, AI Applications in Robotics, Mobile Robotics and Perception

**BASc. in Engineering Science, University of Toronto** — *Sept 2019 - April 2024*

*Machine Learning Major, Robotics & Mechatronics Minor*

- Advisor: Tim Barfoot
- Thesis: People Detection from LiDAR point clouds in Cluttered Indoor Environments
- GPA: 3.99/4.00 (95.07%)

## Publications and Preprints

1. James R. Han, Mithun Vanniasinghe, **Hshmat Sahak**, Nicholas Rhinehart, Timothy D. Barfoot. Ratatouille: Imitation Learning Ingredients for Real-world Social Robot Navigation. Submitted to International Conference on Intelligent Robots and Systems (IROS) 2025.

2. **Hshmat Sahak**. Fusing Vision and Language Models to Generate Sequence of Recipe Images from Steps. Published in The Second Tiny Papers Track at International Conference on Learning Representations (ICLR) 2024.

3. Yongchao Zhou, **Hshmat Sahak**, Jimmy Ba. Training on Thin Air: Improve Image Classification with Generated Data. In *Data-centric Machine Learning Research*. Workshop held at International Conference on Machine Learning (ICML), 2023.

4. Yongchao Zhou, **Hshmat Sahak**, Jimmy Ba. Using Synthetic Data for Data Augmentation to Improve Classification Accuracy. In *Challenges of Deploying Generative AI*. Workshop held at International Conference on Machine Learning (ICML), 2023.

5. **Hshmat Sahak**, Daniel Watson, Chitwan Saharia, David Fleet. Denoising Diffusion Probabilistic Models for Robust Image Super-Resolution in the Wild. *arXiv preprint arXiv:2302.07864*, 2023.

6. Stephen Bennett, Stephanie Nevison, **Hshmat Sahak**, Eric Holzapfel, Theresa Aves, Paul Dorian. Treadmill Sress Test Ventilatory Pattern Using A Wearable Device As An Additional Marker For CV Disease. Poster presentation at Canadian Cardiovascular Congress, 2022.

## Work Experience

**Cerebras Systems Inc.** — *May 2024 - Aug 2024*

*Applied ML Intern*

- Expanded the MathVista and MMMU datasets by creating an augmented version with similar samples, which, when used for model training, led to improved performance in multimodal math problem solving and visual reasoning
- Compared the effectiveness of retrieval methods using CLIP, DINO, and I-JEPA embedding spaces with cosine similarity, L1, and L$\infty$ metrics. Proposed dataset improvements led to higher scores across benchmarks such as GQA, MathVista, MMMU, and VQA, with notable gains in visual reasoning and math-solving tasks.
- Developed long-context datasets using clustering techniques to optimize model performance on tasks with extended sequence lengths, enabling more efficient handling of large-scale input data.

**Tesla** — *May 2023 - Aug 2023*

*Software Engineering Intern*

- Developed a script to stream sensor and PLC metrics from InfluxDB and Prometheus, and visualized the data using Grafana. Proposed and explored an unsupervised learning algorithm for real-time anomaly detection.

- Converted E10 tasks for processing machine states from Flux query language to Python, and discovered a more efficient (time and memory) processing pipeline.
- Enhanced back-end reliability by writing Go unit tests for HTTP endpoints and improved the front-end user experience through several React-based UI enhancements.

**Nvidia** *May 2021 - Aug 2021*

*Deep Learning Intern*

- Assist team in implementation of deep neural network to improve battery mode dynamic power and performance estimations by considering GPU idle time.
- Suggested data collection and algorithmic improvements for GPU power distribution on Nvidia workstations, resulting in 5-16% power gains over static GPU settings.
- Used Jupyter Notebook to visualize GPU power consumption and performance (frames/second) on compute tasks.
- Controlled the training, inference and deployment of our Deep Learning pipeline using YAML files.

**University of Toronto Aerospace Team** *June 2020 - Sept 2020*

*Orbit Subsystem Member*

- Use NASA GMAT and AGI STK simulation software to simulate orbits and determine pass over Toronto that maximizes imaging time.
- Built script to enable better visualization of contact time periods between a satellite and various ground observers. Designed as part of the Finch Orbit project.

## Research Experience

**University of Toronto, Autonomous Space Robotics Lab** *Sept 2023 - April 2024*

*Undergraduate Thesis Student in Robotics, supervised by Tim Barfoot*

- Implemented people detection from LiDAR point clouds by adding heuristic clustering module on top of pretrained semantic point prediction network.
- Implemented people detection by training neural network to predict bounding boxes outputted by a heuristic clustering algorithm applied on multi session SLAM annotations.
- Compared the two methods of people detection using intersection over union and other metrics to propose a final people detection module and implement it in the Jackal robot.

**Vector Institute for Artificial Intelligence** *Jan 2023 - April 2023*

*Machine Learning Research Intern, supervised by Jimmy Ba*

- Proposed Diffusion Inversion, a method of data augmentation that steers the pre-trained generative model Stable Diffusion in the latent space, generating diverse, high-quality training images by conditioning the generative model on noisy versions of these vectors.
- Identified three key components that allow our generated images to surpass the original dataset in downstream classification, leading to a 2-3x enhancement in sample complexity and a 6.5x decrease in sampling time.
- Submitted to ICML 2023 with mean reviewer rating 6. Published to ICML Workshop on Deployable Generative AI.

**Google Brain** *May 2022 - Dec 2022*

*Student Researcher, supervised by David Fleet and Mohammad Norouzi*

- Train a robust Denoising Diffusion Probabilistic Super-Resolution Model that accepts low-res images of arbitrary dimensions & real-life degradation (e.g., noise, blur, jpeg compression) and outputs corresponding high-res images. Supported higher magnification ratios using Cascaded Diffusion Models.
- Outperform state-of-the-art in blind single-image super-resolution by combining higher-order degradation scheme with noise conditioning augmentation, a technique that adds noise to input at test time and conditions diffusion model on the noise level. Submitted first-author paper to ICML 2023.

**University of Toronto, Data-Driven Decision-Making Lab** *May 2021 - Sep 2021*

*ML and Data Science Undergraduate Researcher, supervised by Scott Sanner*

- Compared COVID statistics in USA with corresponding twitter metrics by region: COVID-related tweet counts and mask/vaccine hesitancy scores. Used Folium library, word clouds and topic modelling to identify spatial & temporal tweet distribution.

- Fine-tuned BERT model using PyTorch to detect mask sentiments, improving mask attitude classification by 41% compared to vanilla VADER sentiment analysis and outperforming existing hashtag & regex-based classifiers. Lay groundwork for future research on sarcasm detection and automatic labelling.

**University of Toronto, Dynamic Systems Lab** *May 2020 - Aug 2020*

*ML and Robotics Undergraduate Researcher, supervised by Angela Schoellig*

- Designed and implemented a scalable, real time trajectory generation algorithm using MATLAB to synchronize the flight of 50 drones with live music from a MIDI keyboard.
- Wrote python script interfacing keyboard with Crazyflie ROS by gathering keyboard input sequences as ROS bags.
- Surveyed 50+ safe-learning papers and categorized them by what is being learned, the definition of safety, control methodology, learning methodology, and type of experiment, to help write a safe-learning survey paper.

**Sunnybrook Research Institute** *Jul 2019 - Aug 2019*

*Focused Ultrasound High School Summer Research Program, supervised by Pegah Aslani*

- Identified and recorded the distribution of sub- and ultra- harmonics present in harmonic motion signals database as observed in 23 pigs and 9 human subjects during experimentation.
- Developed an algorithm to determine the extent of contribution of a given harmonic to the strength of a signal through Boolean values (high/low), and stored lesion observations in SQL database.
- Graphed lesion observations as a pseudo-color MATLAB plot and developed a script to customize color pixel and bit masking representation.

## Awards and Fellowships

**NSERC CGS-M ($27,000)** *2025*

Academic excellence and research potential at the master's level in the natural sciences and engineering.

**Vector Scholarship in AI ($17,500)** *2024*

The Vector Scholarship in Artificial Intelligence is a $17,500 entrance scholarship for pursuing AI master's or related programs in Ontario.

**Yusuf Family Scholarship for Science and Engineering ($5,000)** *2024*

This scholarship aims to recognize an individual that aspires to challenge the status quo and reach new heights in the field of Science and Engineering.

**Rotary Club of Toronto Scholarship ($10,000 x 4)** *2019, 2020, 2021, 2023*

Open to outstanding students graduating from a TDSB or TCDSB secondary school who will be attending a College or University in the Greater Toronto Area. The winners (2/year) had to demonstrate financial need, academic excellence, leadership, school involvement and community service.

**Christina and Logan Martin Scholarship in Engineering ($4,354.80)** *2023*

This award is given to a full-time student proceeding to fourth year of any undergraduate program in the Faculty on the basis of academic merit. Preference is given to students with demonstrated financial need.

**Andrew Alexander Kinghorn Scholarship ($6,868.14)** *2023*

Based on financial need and academic standing.

**The Second Garnet W. Mckee - Lachlan Gilchrist Scholarship In Engineering Science ($1500)** *2021*

This scholarship is awarded to the student who ranks second in second-year Engineering Science and achieves the highest aggregate standing in the first and second years of that course provided the student obtains honours standing in second-year exams.

**The St. George's Society of Toronto Endowment Fund ($5000)** *2021*

Fund is awarded based on financial need and a minimum B average to an undergraduate or graduate student.

**University of Toronto Scholar ($1500)** *2020, 2021*

Given to the 100 most outstanding students in 2020, 2021.

**NSERC Undergraduate Student Research Award ($7500, courteously Declined)** *2021*

Declined to pursue internship at Nvidia.

**Dean's Scholarship of Excellence ($5000)** *2020*

In-course scholarship given after first year for outstanding academic performance.

**Engineering Science Research Opportunity Fellowship (ESROP) ($6000)** *2020*
I was awarded the Engineering Science Research Opportunity Fellowship (ESROP) to pursue summer research with Professor Angela Schoellig at the Dynamic Systems Lab.

**University of Toronto Undergraduate Math Contest** *2020, 2023*
4th place in 2020. 5th place in 2023.

**C. David Naylor University Scholarship ($20,000)** *2019*
Awarded on the basis of academic merit and demonstrated leadership excellence. Up to 10 scholarships are awarded annually.

**MAX Aasima and Pervez Akhter All Star Scholarship Recipient ($3000)** *2019*
The Aasima and Pervez All Star scholarship rewards remarkable, well-rounded students who have excelled in academics and combined this achievement with outstanding contributions to their school and community.

**President's Scholarship of Excellence ($10,000)** *2019*
Given to top incoming students at the University of Toronto.

**Governor General's Academic Medal** *2019*
Awarded the Governor General's Academic Bronze Medal for graduating with the highest average in my high school.

**Ontario Chess Champion** *2019*
Team was ranked 2 second place in Senior Division. Individually, I was awarded for performing 5th best amongst 12th graders at the tournament.

**Canadian Math Olympiad** *2019*
I was one of about 50 students in Canada invited to write the Canadian Mathematical Olympiad, used to determine participants of Math Team Canada at the IMO.

**Canadian Math Kangaroo Contest** *2018*
Grade 11: Perfect Score and National First Place.
Grade 10: National Gold Medal, Regional Third Place.

**Toronto District School Board (TDSB) Top Scholar** *2019*
I was recognized for obtaining a 100% average in my final year of high school. At the time of issue, I was the first student in over a decade to have done so.

## Skills

**Programming Languages**: Python, C/C++, Java, GoLang, MATLAB, R, SQL, Verilog/VHDL, Assembly, HTML/CSS/JavaScript, Node.js, React, LaTeX
**Robotics Tools**: ROS (Robot Operating System), Gazebo, RViz, OpenCV, TensorFlow, PyTorch, JAX, Tesseract
**DevOps & Cloud**: Docker, Kubernetes, Git/GitHub, Unix Shell, VS Code, IntelliJ IDEA, AWS, Azure
**Libraries & Frameworks**: Pandas, scikit-learn, Keras, Flask, FastAPI, React, Node.js, Material-UI, OpenCV, JUnit

## Teaching Experience

**MAT185 (Linear Algebra) TA** *Winter 2026*
Will give weekly tutorials plus grading duties.

**MAT188 (Linear Algebra) TA** *Fall 2025*
Conducted weekly tutorials and quizzes for 4 lecture sections, graded quizzes and midterms.

**MIE250 (Fundamentals of Object Oriented Programming) TA** *Fall 2025*
Conducted weekly practicals and office hours for 2 lecture sections, graded midterms.

**ECE286 (Probability and Statistics) TA** *Winter 2025, 2026*
Conducted weekly tutorials and quizzes, graded quizzes and midterms for 3 lecture sections.

**MIE429 (Machine Intelligence Capstone) TA** *Fall 2024*
Advised and assessed students' final year culminating design project.

**ESC194 (Calculus I) TA** *Fall 2024, 2025*
Conducted weekly tutorials and quizzes, graded quizzes and midterms for 2 lecture sections.

## Volunteer Experiences

**Note-Taker** | ***Volunteer*** *Sept 2023 - Present*

- Take notes for course of more than 1000 students and post to University's note-taking portal.
- Notes are used by students whose disability affects their ability to take notes.

**NSight, Engineering Science Mentorship Program** | ***Executive*** *Sept 2020 - April 2023*

- Provided academic, social and personal support for first- and second-year students in Engineering Science by pairing them with a mentor to guide them through first-year.
- Plan and organize mentor-mentee mixer events to connect first-year students with upper-year mentors.

**Marc Garneau CI Mentorship Program** | ***Co-President*** *Sept 2017 - June 2019*

- Tutored Applied classes and assisted newcomers struggling with English, Mathematics, and Science.
- Assisted teachers in delivering the curriculum and facilitating classroom environment with respect to the cultural and intellectual environment as well as education level.

**Tutor Me Please** | ***Tutor*** *Sept 2017 - June 2019*

- Tutored underprivileged kids (mostly newcomers) in my community for free and helped them with homework.

**Beyond 3:30** | ***Volunteer*** *Sept 2017 - June 2019*

- Organized sports and physical fitness activities for middle school students whose parents worked past dismissal time.
- Prepared nutritious meals for students and provided extensive homework help to the students; teaching them important study habits and skills.

## References

**Tim Barfoot**
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University of Toronto
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Prof.Barfoot is my advisor for both undergraduate and graduate thesis.

**Nick Rhinehart**
Professor
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Prof.Rhinehart is a co-advisor for my graduate thesis.

**Jimmy Ba**
Professor
University of Toronto
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Prof.Ba was my supervisor during my time at the Vector Institute.

**David Fleet**
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Google DeepMind
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Prof.Fleet was my supervisor during my time at Google Brain.

**Scott Sanner**
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Prof.Sanner was my supervisor during my time at the Data-Driven Decision-Making Lab, as well as my course instructor for MIE451.

**Angela Schoellig**
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Prof.Schoellig was my supervisor during my time at the Dynamic Systems Lab.