SPENCER HILL

spencer.hill@queensu.ca | (705) 768-9219 | https://www.linkedin.com/in/spencer-jc-hill/ | https://github.com/hillspen

RESEARCH INTERESTS

Spencer Hill is a master's student in Applied Mathematics at Queen's University, when he researches machine-learning data compression algorithms. He did his undergraduate degree at Queen's University, where he studied Mathematics and Engineering with a specialization in Computer Engineering. He is broadly interested in questions related to reinforcement learning, deep neural networks, information theory, and stochastic control and optimization.

EDUCATION

Master of Applied Science, Mathematics and Statistics, Queen's University **September 2024 - Present**

- Researching end-to-end compression systems that leverage trainable neural networks and channel simulation algorithms. Supervisors: Dr. Fady Alajaji and Dr. Tamás Linder.
- Coursework GPA of 4.3/4.3.

Bachelor of Applied Science, Mathematics and Engineering (Computing Option), Queen's University **2019 – 2023**

- GPA of 4.27/4.3 (First in Class).
- Thesis project: Data Compression via Nonlinear Transform Coding using Artificial Neural Networks.
- Select Coursework: information theory, stochastic control theory and optimization, modern control theory, stochastic differential equations, probability, complex analysis, systems and signal theory, real analysis, differential equations, computer networks, computer architecture, data structures, and advanced algorithms.

RESEARCH EXPERIENCE

Invasive Species Management Research, Natural Resources Canada **November 2024 – Present**

- Researching optimal control methods for the surveillance of invasive species. Collaborating with Dr. Jue Wang and Dr. Denys Yemshanov.
- Formulating invasive species surveillance as a stochastic control problem (novel) and using methods such as sufficient statistics, deterministic control reformulation, and reinforcement learning to derive numerical and closed-form solutions.

Undergraduate Thesis Project, Queen's University (Supervisor: Dr. Tamás Linder) **September 2022 – April 2023**

- Mathematically formulated and implemented in Python a Nonlinear Transform Coding system that uses artificial neural networks to compress CT scan images.
- Awarded the Keyser Prize for outstanding thesis and oral presentation among Mathematics and Engineering students.
- Thesis: https://github.com/hillspen/mthethesis.

Quantum Machine Learning Research Project Manager, QMIND **May 2021 – April 2022**

- Led a team of undergraduate and graduate students to research Quantum Machine Learning algorithms, specifically the task of image generation with Quantum Generative Adversarial Networks on a simulated Quantum Computer.
- Improved current methods by applying novel data encoding techniques that maintained quantitative performance while dramatically improving qualitative results.
- Conference paper and code: https://github.com/hillspen/qgan.

Machine Learning Researcher, Queen's University (Supervisor: Dr. Tucker Carrington) **May 2021 –August 2021**

- Created a local Gaussian Processes method that reduced the regression complexity from $O(N^3)$ to $O(m^3 + N)$, where N is the number of fitting points (often above 100,000) and m is a local window size less than 400.

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- Applied the novel method to solve previously intractable problems in computational chemistry and published in the Journal of Molecular Spectroscopy, https://doi.org/10.1016/j.jms.2023.111774.

Machine Learning Researcher, QMIND **September 2020 – April 2021**

- Worked in a research team to design and implement a tree-based graph convolutional generative adversarial network capable of generating 3D point clouds.
- Applied this model architecture to novel problems in medical imaging, specifically human body scans.
- Conference paper and code: https://github.com/hillspen/3d-human-generation.

PUBLICATIONS

- N. Yang, **S. Hill**, S. Manzhos, and T. Carrington, "A local Gaussian Processes method for fitting potential surfaces that obviates the need to invert large matrices," *Journal of Molecular Spectroscopy*, vol. 393, pp. 111774–111774, Mar. 2023, doi: https://doi.org/10.1016/j.jms.2023.111774.

CONFERENCE PRESENTATIONS

- "Nonlinear Transform Coding using Artificial Neural Networks," Canadian Undergraduate Conference on AI [Kingston ON], March 4 – 5, 2023.
- "Quantum Generative Adversarial Networks," Canadian Undergraduate Conference on AI [Virtual], April 2 – 3, 2022. *Best Presentation Award.*
- "Local Gaussian process regression for interatomic potentials," 2021 MRS Fall Meeting & Exhibit [Boston MA], November 29 – December 8, 2021.
- "3D Human Body Shape Generation," Canadian Undergraduate Conference on AI [Virtual], March 6 – 7, 2021.

AWARDS AND SCHOLARSHIPS

- **Natural Sciences and Engineering Research Council of Canada (NSERC) Canada Graduate Scholarships – Master's ($27 000), 2024.** Criteria: Federal funding awarded to 22 high-caliber scholars at Queen's University based on academic excellence, research potential, and personal characteristics and interpersonal skills.
- **Queen's University Medal in Mathematics and Engineering, June 2023.** Criteria: Highest GPA in the Mathematics and Engineering program over the final two years of study.
- **Keyser Project Prize ($1000), Spring 2023.** Criteria: Outstanding performance in the final year thesis project.
- **H. Arnold Cowan Scholarship ($3500), Fall 2022.** Criteria: Academic excellence upon entering the third or fourth year of any Engineering program.
- **Nellie and Ralph Jeffery Award in Mathematics ($1225), Fall 2022**. Criteria: Highest average in the first three years of the Mathematics and Engineering program.
- **Ontario Professional Engineers Foundation Scholarship ($1500), Fall 2022.** Criteria: Academic excellence, demonstrated leadership, and participation in extra-curricular activities of an Ontario Engineering student.
- **Frank B. Lee Memorial Scholarship in Engineering ($13 000), Fall 2021**. Criteria: Academic achievement, creative and original thinking, proven leadership skills, and involvement in school activities of one second-year student.
- **Cyril W. Knight Scholarship ($2100), Fall 2021**. Criteria: Highest cumulative average after the second year of engineering**.**
- **Les Gulko Award ($750), Fall 2021.** Criteria: Academic performance in the second year of Mathematics and Engineering.

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- **The Eric R. and Lorraine Davis Memorial Award ($1400), Fall 2021.** Criteria: Academic performance of a student entering the second, third, or fourth year of engineering.
- **Andrew McMahon Standards of Excellence Award ($3600), Fall 2020**. Criteria**:** Academic achievement, strong interpersonal skills, and a commitment to excel in all aspects of university life of a single first-year student.
- **William and Beatrice Alder Scholarship ($700), Fall 2020.** Criteria: Academic performance of a student entering second year of the Mathematics and Engineering or Engineering Physics program.
- **James H. Rattray Memorial Scholarship in Applied Science ($3300), Fall 2020.** Criteria: Academic performance of a student entering their second, third, or fourth year of engineering.
- **Royal Conservatory of Music Grade Eight Piano Certificate, 2015.**

PROFESSIONAL EXPERIENCE

Senior Associate Consultant, Stroud International **September 2023 – August 2024**

- Leading client teams to drive rapid, significant, and lasting improvements in manufacturing processes. Select client results include:
  - Saved $1.1MM in annual labor cost for a personal care production facility through a 10% improvement in plant wide UPLH in 6 weeks.
  - Increased throughput of an aerosol line by 50% in 12 weeks with no capital expenditure, worth $600K in annual efficiency savings.
  - Reduced compounding waste in a production facility by 45% in 8 weeks, worth $480K in annual raw material savings.

APSC 174 Linear Algebra Teaching Assistant, Queen's University **January 2023 – May 2023**

- Planned and executed weekly tutorial sessions for over 100 first-year engineering students in an introductory Linear Algebra course.

Managing Director of Design, QMIND **May 2022 – April 2023**

- Principal of Canada's largest undergraduate machine learning organization, consisting of over 250 students and 40 machine learning projects (including 10 client-facing pro-bono consulting projects).
- Allocated spending of over $100,000 while securing a net profit through sponsorships and events.
- Organized a national undergraduate machine learning conference with 400+ attendees and was chief editor for the conference proceedings.

Family Program Senior, Red Pine Camp **May – June 2022, 2023**

- Ran the daily activities and programming of a 300-person family camp with over 2400 campers each summer.
- Contributed to the strategic direction and planning of the camp for years to come.
- Directly managed 55 Junior Staff, including training, mentorship, and staff evaluations.

APSC 100 Engineering Design Project Manager, Queen's University **September 2021 – May 2022**

- Managed and supervised 8 teams of first-year students through the Queen's first-year Engineering Design Project of handwritten digit classification.
- Mentored and educated students on machine learning, programming, and engineering design.

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EXTRACURRICULAR EXPERIENCE

FREC Committee Pre-Week Coordinator, Queen's Engineering Society **November 2020 – October 2021**

- Planned and executed training for over 250 Engineering Orientation Week leaders.
- One of 5 people responsible for the logistics of Orientation Week, which involved a budget of over $100,000 and more than 1100 incoming students.
- Balanced maintaining Queen's Engineering traditions and safety through the uncertainty of the pandemic.

Bronze Medal at the Canadian Engineering Competition **January 2021**

- Placed 3rd in the Junior Design category at the 2021 Canadian Engineering Competition.
- Qualified by winning the Queen's Engineering Competition (8 teams) and placing 2nd at the Ontario Engineering Competition (30 teams).