Cameron Jakub

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About Me

I am a mathematician and recent graduate from the University of Guelph, currently working as a quantitative analyst for the Canada Revenue Agency. My Master's research involved studying the theoretical behaviour of deep neural networks using mathematical and statistical tools. I have a broad range of experience working with AI, mathematical analysis, calculus, statistical regression, data visualization, bioinformatics, and more. Through my courses and past employment, I have experience coding in Python, R, SQL, C, Fortran, and MATLAB languages.

Education

2021 - 2023 M.Sc. Applied Mathematics with Collaborative Specialization in AI
University of Guelph
Advisor: Dr. Mihai Nica
94.6% average GPA over 2.75 credits completed

2016 - 2020 B.Sc. Mathematical Science
University of Guelph
Area of Emphasis in Bioinformatics
92.0% average GPA over 20.5 credits completed

Research Articles

Journal Article: *Depth Degeneracy in Neural Networks: Vanishing Angles in Fully Connected ReLU Networks on Initialization* (**link**). Accepted to the *Journal of Machine Learning Research* (JMLR) 2024.

Technical skills used: Python, TensorFlow, Matplotlib, Sympy. **Link to sample code.**

Peer-reviewed Workshop Article: *Network Degeneracy as an Indicator of Training Performance: Comparing Finite and Infinite Width Angle Predictions* (**link**). Accepted to the High Dimensional Learning Dynamics workshop at the *International Conference on Machine Learning* (ICML) 2023.

Technical skills used: Python, TensorFlow, Matplotlib. **Link to sample code.**

Master's Thesis: *The Angle Degeneracy Phenomenon in Deep Neural Networks: Analysis and Relation to Training Dynamics* (**link**).

My research investigates the "large depth degeneracy" phenomenon in deep neural networks, where very deep networks have a hard time distinguishing between inputs on initialization. This degeneracy occurs because inputs tend to get more correlated layer-by-layer as they travel through the network, so networks with many layers may send all inputs to effectively the same output. My thesis develops an accurate method to predict the distribution of the angle between two inputs at any layer of an initialized network. We then use our predictions to demonstrate how this type of degeneracy can negatively affect the training performance of the network. Along the way, we develop an explicit formula for the joint moments of the ReLU function applied to correlated Gaussian variables.

Research & Work Experience

2023-Present Intermediate Quantitative Analyst, Canada Revenue Agency

Responsible for analyzing large amounts of data across multiple databases to detect and assess external fraud risks. Other responsibilities include integrating data across databases, and preparing strategy documents and budget proposals to guide the future of data and analytics at the CRA.

Technical skills used: SQL, Databricks, Microsoft Office

2021-2023 Master's Student, University of Guelph

Worked under the supervision of Dr. Mihai Nica (Associate Professor, Mathematics) to explore theoretical issues regarding deep neural networks. See Research Articles.

Technical skills used: Python, Matplotlib, Sympy. **Link to sample code.**

Summer 2020 Research Assistant, University of Guelph

Worked under the supervision of Dr. Rajesh Pereira (Associate Professor, Mathematics) to explore open problems in Banach space theory.

Technical skills used: MATLAB.

Summer 2019 Research Assistant, University of Guelph

Worked under the supervision of Dr. Ayesha Ali (Associate Professor, Statistics) to run and evaluate new regression methods for the prediction of milk composition based on near-infrared spectroscopy data. Full report can be found at **this link**.

Technical skills used: R, MATLAB, Microsoft Excel. **Link to sample code.**

Teaching Experience

2021-2023 Teaching Assistant, First-Year Calculus, University of Guelph. Responsible for teaching in person lab sessions of 200-400+ students, running office hours, grading, and invigilating exams. Labs involved instructing students through challenging problems and concepts in a comfortable and collaborative environment.

Winter 2023 Tutor, Math & Stats Learning Centre, University of Guelph. My role is to provide drop-in help to students in a variety of first-year mathematics courses.

Winter 2022 Teaching Assistant, Numerical Methods, University of Guelph. Responsible for running virtual lab tutorials in MATLAB, instructing students how to implement various numerical methods.

2020-2021 Math & Sciences Tutor, Paper Co. My role involved helping elementary and high school students through homework problems in a text-based environment.

2020 First-Year Calculus & Linear Algebra Tutor, Self-Employed. Provided one-on-one tutoring to first-year University of Guelph students in calculus and linear algebra.

Scholarships & Academic Awards

2024 Nominee, Governor General's Gold Academic Medal, University of Guelph. Considered the most prestigious award that students in Canadian schools can receive. Awarded to students with the highest academic standing at the graduate level at their respective university.

2022-2023 Ontario Graduate Scholarship: University of Guelph, recognizes academic excellence in graduate studies.

2021-2022 Vector Scholarship in Artificial Intelligence: Vector Institute, merit-based award which recognizes exceptional candidates pursuing a Master's program recognized by the Vector Institute.

2021-2022 Queen Elizabeth II Graduate Scholarship in Science & Technology: University of Guelph, designed to encourage excellence in graduate studies in science and technology.

2022 University of Guelph Mathematics Graduate Scholarship: University of Guelph, awarded to the student with the highest average across any 3 departmental graduate courses.

2020 Dean's Scholarship in the College of Engineering & Physical Sciences: University of Guelph, awards students who achieved the highest academic standing in the college and received Dean's Honours List in the previous academic year.

2020 Arvind Ravi Memorial Scholarship for Excellence in Mathematics: University of Guelph, awarded to a student in the department of Mathematics & Statistics with a high cumulative average and an outstanding performance in a number of mathematics courses.

2019 R.C. Moffat Memorial Scholarship in Mathematical Science: University of Guelph, selection based on highest cumulative average out of students majoring in the Department of Mathematics & Statistics who have completed 9-19.5 credits.

2018 Wally Fraser Mathematical Science Scholarship: University of Guelph, recipient selected on the basis of the highest average in the Mathematics & Statistics department on a minimum of 4.0 credits from semesters 3 and 4, for students who have completed 9-14.5 credits.

2017 T.D. Newton Memorial Scholarship: University of Guelph, selection is based on the highest average in the Mathematics & Statistics department for a minimum of 4.0 credits, for students who have completed 4-8.5 credits.

Other Awards

Mar 2023 Teaching Assistant of the Year, University of Guelph. This award was voted on by engineering students and awarded by the Guelph Engineering Society, which recognizes an outstanding TA who has positively impacted the students.

Other Research Projects

Fall 2020 MATH*4600 Advanced Research Project in Math, University of Guelph

Worked under the supervision of Dr. Rajesh Pereira (Associate Professor, Mathematics) to study applications of the quotient ℓ^∞ norm and its connection to Hilbert's projective metric. Full report can be found at **this link**.

Research Presentations

Feb 2023 Depth Degeneracy in Neural Networks: Vanishing Angles in Fully-Connected ReLU Networks on Initialization, presented to the Machine Learning Research Group at the University of Guelph.

Dec 2022 The Angle Process in Deep Neural Networks and the Bessel Numbers of the Second Kind, Canadian Mathematical Society 2022 Winter Meeting, Toronto. In the session *Stochastic Systems, Probability, and Other Mathematical Aspects of Data Science.*

Certifications

Apr 2024 Databricks Certified Data Engineer Associate.

Assesses an individual's ability to use the Databricks Lakehouse Platform to perform data engineering tasks in Python and Spark SQL.

Technical Skills

Python, R, SQL, MATLAB, LaTeX, Databricks, Fortran, C, Microsoft Office.