

Part I: Contributions to Research and Development

d. Non-peer-reviewed Contributions

Moran-MacDonald, A. & Alajaji, F. (2018). The Rényi Deterministic Information Bottleneck and Geometric Clustering. NSERC summer research project, Queen's University.

Part II: Most Significant Contributions to Research & Development

“The Rényi Deterministic Information Bottleneck and Geometric Clustering” is a technical report about a new information-theoretic tool for clustering datapoints. I wrote this report in its entirety, and I contributed all the theoretical and simulation results (with abundant advice from my supervisor, Fady Alajaji). This report was used by two undergraduate groups at Queen's University for their honours theses in 2019, and it motivated further research in [1].

[1] J.J. Weng, F. Alajaji and T. Linder, *An information bottleneck problem with Rényi's Entropy*, Proceedings of the IEEE International Symposium on Information Theory, Melbourne, Australia, July 2021.

Part III: Applicant's Statement

Research Experience

The following list outlines the scientific and engineering abilities I gained in my research and professional roles.

- **MASc Research, University of Toronto, 2018 – 2021.** In my master's degree, I learned several important research skills: my supervisor taught me to correctly formulate research questions; I learned the tenacity and dedication required to solve a complex problem; I developed my creativity by attacking problems from multiple directions; I learned to read papers, perform a literature review, think critically about the literature, and apply existing results to my research; I improved my time management skills, practiced explaining my work (both orally and in writing), and improved my presentation skills for the thesis defense; and I learned to write research papers and a thesis, which are important tools for communicating my work to the engineering community. I also learned several engineering skills, including advanced control techniques, simulation of physical systems in MATLAB, and implementation of control systems on a physical robot.
- **Radar Developer, University of Toronto, 2018.** In the group project for a graduate course, I worked with three other students to write software which reads data from a radar device. This project improved my project management skills, as I kept our group meetings organized and separated the project tasks in such a way that everyone was challenged appropriately. I learned to read hardware documentation and to wire a device from schematics. I wrote networking code in Python to interface with the device, and validated the hardware's capabilities for myself by creating appropriate test environments. All these skills will be beneficial for my PhD research, where I will collaborate with labmates to build a robotic monkey.
- **Undergraduate Thesis, Queen's University, 2017 – 2018.** For my undergraduate thesis, I worked with my peers to design an image filtering algorithm by applying theoretical results from information theory. During this project I learned to perform a basic literature review, and to manage deadlines with a supervisor. I also learned to write reports in LaTeX, and my group

worked together on code optimization: we learned to convert equations into matrix form to take advantage of hardware optimization; we parallelized our code so our algorithm would run faster through multithreading; we ported MATLAB code to C++ to achieve even faster results; and we created a GUI so we could test our code quickly and easily.

- **Software Developer, Neptec Technologies Corp., 2016 – 2017.** My experience at Neptec was integral to my career because it convinced me to pursue research in robotics. Working at Neptec exposed me to many areas of electrical and computer engineering. I worked on several embedded software projects, my favourite of which was a control systems project. After completing this work, I decided to do a master's (and a PhD) so I could learn as much about control as possible. At Neptec I also learned to work with large codebases, and I became extremely proficient at software development, a skill which has served me well in all aspects of my research.

Relevant Activities

Over the course of my career, I have enjoyed several extracurricular roles which developed my communication, interpersonal, and leadership skills. Here is a brief description of some of these roles.

- **Lionel Massey Fund Co-chair, Massey College, September 2021 – Present.** I am one of six co-chairs for the Lionel Massey Fund, which is the events committee for Massey College (an interdisciplinary college at the University of Toronto). I have already organized 13 events for members of the college, and will continue to organize events throughout the year. This role has taught me the logistics and leadership skills required to manage large events for up to 60 people. I have also learned to make events accessible to everyone, and to communicate with attendees so I can meet their needs.
- **Jiu-Jitsu Instructor, 2019 – Present.** I am an instructor at the University of Toronto Jiu-Jitsu club. I teach martial arts while fostering a safe, friendly atmosphere that encourages learning through action. This role has refined my communication and interpersonal skills: it has taught me to create learning plans for my students; break down difficult concepts into manageable chunks; and to reward students for trying their best, even if they make a mistake.
- **Teaching Assistant, 2017 – Present.** I have been a teaching assistant for 14 engineering courses in the past 5 years. Each course I teach improves my communication skills, and each tutorial gives me the opportunity to make the course material more fun and engaging. I focus most on attaining high levels of student participation by being kind and non-judgemental, which makes students feel comfortable enough to ask more questions.
- **Science Payload Designer, Queens University Satellite Design Team (QSAT), 2017 – 2018.** I took on a mentorship role at QSAT, where I taught C++, Git, and information theory to the team's software developers. I helped them organize the satellite codebase, managed all code reviews, and provided advice for my peers rather than writing software myself.
- **Head Programming Mentor, FRC Team 2809, 2013 – 2015.** In this role, I mentored high school students in Object Oriented programming for robotics software. I taught students to program a robot in under 6 weeks, which earned us 3rd place at the Ontario provincial competition in 2014. In this role I became a better leader by listening to my students' feedback, and I learned to communicate effectively with people from all over the world in high-stress situations.

I take pride in my teaching, communication, and leadership abilities, yet I remain aware that these can always be improved. Obtaining an NSERC scholarship will provide me with the financial liberty to participate in more volunteer roles, where I can improve my skills while giving back to my community.