# Personal Statement

Introduced by my father to the world of Go, it was not long before I became fascinated by this unique game. Despite only having several simple rules, it can develop into an entire universe of configurations and moves. Due to its extraordinary complexity, I once believed that a computer could not defeat human grandmasters in Go, as long as it was unable to function as a human brain. Nevertheless, I was proven wrong in 2016, when AlphaGo, the artificial intelligence (AI) created by Google DeepMind, scored 4-1 against the world-class Go player Lee Sedol. My interest in this spellbinding AI program was stimulated. What strategies were employed to devise the program? How did DeepMind train AlphaGo to make it more powerful? With these questions in mind, I commenced studying computer science at McGill University as an undergraduate student.

In summer 2020, supervised by Professor Doina Precup, I worked on my first research project in reinforcement learning (RL) as an undergraduate research assistant in the Reasoning and Learning Lab at McGill University. Because the pandemic led to an unusual situation of working from home, I had considered some underlying problems I would need to overcome, such as remotely accessing the computational resources in the lab and being productive at home. However, an unforeseen issue came up shortly after I started the project.

In addition to being a faculty member of McGill University, Professor Precup is one of the core academic members of Mila, a large and renowned research institute in AI. There were some unexpected upheavals regarding the regulations at Mila starting June 12. The message was emailed to all students including me, but I did not know any details. As a result of the upheavals, Professor Precup had to halt all one-on-one meetings and email communications with students. These activities were not resumed until July. During this one-month period, all I could do was independently solve the problems regarding the research project.

Unable to seek help from my supervisor, I ran into great difficulties in conducting the research. Since I was a complete novice in RL, a sophisticated field of study, I had to teach myself all the important models and formulae. It was inevitable that some confusion arose when I was learning, and I had to figure out the answers without asking my supervisor for clarification. Moreover, I had problems understanding the concept of random projection, a crucial part of my research project, as I aimed at finding methods that are computationally efficient in high-dimensional state spaces. Random projection is actually a technique applied in mathematics and statistics, and it is not commonly mentioned in the literature on RL. Therefore, I had to do some interdisciplinary research to develop my project.

Although I encountered a number of obstacles to my research, I overcame them step by step. First of all, I studied an RL course taught by specialists from DeepMind in cooperation with University College London. I watched all the lecture recordings to grasp the basic concepts of RL and familiarize myself with the important RL methods. Second, I read the famous book *Reinforcement learning: An introduction*.[1] The book not only makes rigorous examinations on major RL topics but also provides plenty of carefully designed exercises. My understanding of RL concepts and models deepened after completing the exercises. Then, I tried to search for readings that provided a clear explanation for random projection. I reviewed theories of

[1] Sutton, R. S., & Barto, A. G. (2018). Reinforcement learning: An introduction. MIT press.

probability and linear algebra, as they were useful background knowledge. After that, I looked into academic articles about issues of dimensionality[2] and random projections.[3] They were direct and to the point, offering theoretical guarantees for me to apply the reduction of dimensionality to the research project. Finally, I scrutinized the documentation of scikit-learn, an open-source machine learning library, and decided to use the Random Projection Transformers in the library while writing the code.

I managed to make steady progress in understanding and applying the theories related to my research. I then discussed with my supervisor how I could further develop the project in July after the meeting schedule resumed. The project underwent several revisions and I performed a series of experiments in RL environments. The project report was supposed to be completed by the end of August, a deadline I met even without the usual constant supervision. This experience over the summer honed my skills of conducting independent research in an unfamiliar discipline, thereby making me more prepared for the M.S. programs at CMU. My long-term plan is to become a research scientist and to work on autonomous vehicles and automated medical diagnosis, two challenging research subjects in RL. I believe that CMU will help me build a firm foundation for my future career goals.

[2] Barman, K., & Borkar, V. S. (2008). A note on linear function approximation using random projections. Systems & control letters, 57(9), 784-786.

[3] Dasgupta, S., & Gupta, A. (2003). An elementary proof of a theorem of Johnson and Lindenstrauss. Random Structures & Algorithms, 22(1), 60-65.