

Personal Statement for M.Sc. in Computer Science, McGill University

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The first time I used computer was during an information competition in the primary school when I tried to program in Pascal under the guidance of my computer teacher. As I grew up, I found the black boxes of Computer Science (CS) so common that they have dramatically changed our lives. How could AlphaGo program defeat Lee Sedol? What is the use of Nakamoto's Bitcoin? How do computers store and process massive data? All of these aroused my interests to dive into this field. I realized that I need a broader CS base to further understand these advanced technologies. Due to my passion in computer and talents in mathematics, I chose Software Engineering as my undergraduate major in Sun Yat-sen University to accumulate more knowledge and technical skills, and to give further play to my capability and creativity in this promising field.

As an undergraduate student, I managed to accumulate a fair amount of technical knowledge and improve my programming skills. In the first two years of my study, my coursework (100- and 200-level courses) mainly focused on the basics of mathematics and programming. I studied elementary methods to consolidate mathematical basics, and solved many rudimentary puzzles in different languages to hone my programming skills. My scores were ranked top in *Probability and Statistics*, *Data Structures and Algorithms*, *Computer Programming II* (C++), *Java and Object-oriented Design* (Java), and etc. As I've laid solid groundwork for the fundamentals, I was able to achieve high in more advanced courses afterwards. My scores were ranked the first in *Numerical Methods* (MATLAB), *Principles of Artificial Neural Networks* (Python), *Introduction to Data Mining* (Python), and etc. With these courses as the foundation, I think I am well-prepared for further study in School of Computer Science, McGill University.

In sophomore year, I joined the Smart Internet of Things (IoT) and Edge Computing group in Professor Chen's Inplus Lab to gain more research experiences. Based on theories in *A Primer in Game Theory* and *Convex Optimization*, my colleagues and I proposed a two-layer Stackelberg Game data trading mechanism in Blockchain-based Internet of Vehicles (IoV) and verified our methods in some numerical experiments in Jupyter Notebook beforehand. After months of hard work, we completed a paper named *Blockchain-Based Digital Goods Trading Mechanism in Internet of Vehicles: A Stackelberg Game Approach* and submitted it to the International Conference on Service Oriented Computing (ICSOC). However, our work did not win the satisfaction of the ICSOC committee. They offered me suggestions for further improvement. With their advice, we evaluated the robustness and efficiency of my algorithms by implementing several smart contracts on Rinkeby, a test net of Ethereum. With specific scenarios to support this protocol system, I confidently submitted this paper to the IEEE Cloud this time. During this process, I realized that there was a big gap between idea origination and implementation. To ensure the stability and efficiency of operations in the system, we need to take more factors into consideration, such as security and cost of execution and storage, *i.e.*, gas cost. Currently I am working with the Blockchain Technology and Application group on the Decentralized Data Storage and Sharing on Blockchain (BCShare) project. BCShare employs InterPlanetary File System and certificateless cryptography to address a major challenge in social communication, *i.e.*, the control on user data from the giant companies. This project helps to promote decentralization to the social applications and enable users to manage their social linked data. The research in Inplus Lab is definitely one of the most unforgettable and beneficial experiences in my academic life, as it helps to improve my mastery of decentralized systems, smart contract design, Blockchain technology and its application. I think this research experience matches well to the research interests of Professor Adrian Vetta, Bruce Shepherd, and Yang Cai in Algorithmic Game Theory, and I am willing to explore this area under their instruction.

I firmly believe that only when applied to real-world scenarios can theory and research bring out better results. Thus, in the summer of 2018, I started my first internship in the Institute of Automation, Chinese Academy of Science (CASIA). Out of my interests in Game AI, I participated in StarCraft team to build StarCraft II Learning Environment with Tensorflow. Initially, I trained the soldiers with Advantage-Actor-Critic and Deep Deterministic Policy Gradient (DDPG) algorithms, but neither brought any satisfactory outcome, *i.e.*, about 2,100 and 2,600 wins in every 10,000 battles respectively. After communicating with my advisor and colleagues, I tried to enhance my DDPG-based work by allowing the soldiers to cooperate. By referring to *Multi-Agent Actor-Critic for Mixed Cooperative-Competitive Environments*, I applied the novel Multi-Agents Deep Deterministic Policy Gradient (MADDPG) algorithm to this scenario and took more factors into consideration in the rewards. Derived from DDPG, the MADDPG critic not only inputs its own state and action, but also includes others' information to make a global optimization. Due to this revision, the average winning rate of soldiers was improved from 26% to 43% with only 120 training epochs. As the soldiers and reapers were laid close to each other in the battles, I believe a sparser scenario will further demonstrate the effectiveness of the advanced MADDPG algorithm. From this internship, I picked up more knowledge in reinforcement learning, including traditional algorithms, training methods, evaluating criteria, and etc. Furthermore, I learned more about the business cases where reinforce learning methods are being applied, which inspires me to integrate them in other studies in the future.

After this internship, I was attracted to Computer Networks, which aroused my interests to explore other application scenarios as I realized how powerful and scalable this technology could be. After many rounds of interviews, I was offered the chance to intern at Microsoft to work on the Predictable Remote Direct Memory Access (RDMA) for AI Training project. We were aimed at guaranteeing bandwidth for Data Manipulation Language training tasks in RDMA networks. In this project, I managed to implement the central logic controller and the adaptive data backup mechanism, *i.e.*, adaptively specifying the traffic classes of VM-pairs to guarantee the bandwidth of users. Unlike the previous internship, corporate assignments place more emphasis on cooperation and integrity of projects, so it is necessary for the team to work closely together to ensure smooth progress. It's a great teamwork experience, which taught me to respect others' roles in the team and to be a responsible person both at work and in life.

Aforementioned experiences clearly demonstrate my firm will, innovative thoughts and teamwork spirits, which makes me well-qualified for your program. With a prestige faculty and a wide platform, the CS, M.Sc. in McGill University provides me with the opportunity to study in-depth specialization about this subject to achieve my dream. In addition, I think my past experience matches well to the concentration of Algorithmic Game Theory and Computer Games in your department. If admitted, I am inclined to work on Algorithmic Game Theory due to my research experiences in Inplus Lab. I am also willing to concentrate on Applied Machine Learning studied by Professor Paul Kry, Yue Li, Xue Liu, and Benjamin Fung, because of my undergraduate studies, mastery in artificial neural networks, and internship in CASIA.

In the short term, upon obtaining my master degree, I expect to complete my project plan with excellent performance to broaden my horizon and consolidate the knowledge I have gained. In the next 3 to 5 years, I aspire to become a reliable researcher by pursuing a doctor degree. In the long run, I hope to work as a professor to educate future students and to promote promising technologies to better our lives. The road ahead is destined to be a bumpy ride, but I am strong-willed enough to overcome whatever challenges lying ahead to accomplish my dream.