Personal Statement

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Why CS at Tufts

It was the first programming experience when I used Pascal during my information competition in high school. As I grow up, Computer Science (CS) has become an increasingly important part in my life, which inspires me to learn more about computer and programming. How to discover patterns in massive data? How could AlphaGo program defeat Lee Sedol? What is the use of Nakamoto's Bitcoin? All of these intrigued me to dive into this field. Due to my passion for computers and talents in mathematics, I chose Software Engineering as my undergraduate major in Sun Yat-sen University. During the undergraduate studies, I realized that I still need to accumulate more knowledge and learn to improve my technical skills in graduate program if I aim to achieve high in this promising field. With a prestige faculty and a wide platform, the M.S. in CS at Tufts University can provide me with the opportunities to study in-depth specialization about this subject to achieve my dream, and the alumni network of Tufts would also be a great asset to my development in the future. Thus, I would like to pursue the M.S. in CS at Tufts.

Machine Learning & Reinforcement Learning

During my undergraduate study, I have accumulated a fair amount of knowledge and skills about Machine Learning, especially Data Mining and Computer Vision. In 2019 Mathematical Contest in Modeling, I led my teammates to complete a project about Opioid Crisis. We analyzed the data from National Forensic Laboratory Information System, and found growth pattern of drug reported quantity and important demographic features which are highly relevant to drug abuse. Based on it, we made a breakouts prediction, *i.e.*, when and where a drug epidemic will occur, and recommended administration to strengthen control for some specific groups. Moreover, in my final project in *Introduction to Data Mining* course (scored 99, ranked 1st), I employed various regression methods to predict the NBA players' salary by analyzing the correlation between players' performance and earnings from Basketball Reference records. From these experiences, I become familiar with the process and methods of Data Mining, *e.g.*, data preprocessing, correlation analysis, classification algorithms, *etc.*, which could be of great value to the concentration of Prof. Liu and Prof. Couch in Data Science.

My interest in Machine Learning involves other fields, too. I started to learn about Computer Vision from *Artificial Neural Networks* course (scored 99, ranked 1st). During this course, I employed several neural networks, *e.g.*, VGGNet, ResNet, DenseNet, *etc.*, to recognize objects in images. To further study, I also led a team in a Kaggle competition relevant to cactus identification and achieved a 99.97% accuracy in the test set. Afterwards, I extended my study to dynamic objects captured through my research in China University of Mining & Technology. I used Back Propagation Neural Network and Partial Swarm Optimization to track targets timely, and published a paper *Optimal Analysis of Target Dynamic Tracking Strategy Based on Computer Vision*. I believe aforementioned experiences has prepared me well for Prof. Liu's focus on Deep Neural Networks, and I look forward to joining his Machine Learning Group at Tufts.

Based on my knowledge in Machine Learning, I practiced my knowledge in Reinforcement Learning while interning in the Institute of Automation, Chinese Academy of Sciences. Because 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 satisfactory outcomes, *i.e.*, about 2,100 and 2,600 wins in every 10,000 battles respectively. After communicating with my advisor and colleagues, I enhanced 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. From this internship, I picked up more knowledge in reinforcement learning, including traditional algorithms, training methods, evaluating

criteria, *etc*. Furthermore, I learned more about business cases where Reinforcement Learning methods are being applied, which inspires me to integrate them into other studies in the future. I believe my work in this internship matches well with the research interests of Prof. Allen in Multiagent Reinforcement Learning, which makes it an ideal direction for my further study.

Blockchain Technology & Application

In my sophomore year, I joined Prof. Chen's Inplus Lab to research the contract and application layer of Blockchain technology. Referring to theories in *A Primer in Game Theory* and *Convex Optimization*, I proposed a two-layer Stackelberg Game data trading mechanism in Blockchain-based Internet of Vehicles (IoV) and verified my algorithms in some numerical experiments in Jupyter Notebook beforehand. After months of hard work, I completed a paper *Blockchain-Based Digital Goods Trading Mechanism in Internet of Vehicles: A Stackelberg Game Approach* with my colleagues and submitted it to 2019 International Conference on Service Oriented Computing (ICSOC). Initially, my work did not win the satisfaction of the ICSOC committee and they offered me suggestions for further improvement. Following their advice, I 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 2020 IEEE Cloud this time. During this process, I realized that there was a big gap between idea origination and perfect implementation. We need to take more factors into consideration to ensure the stability and efficiency of operation in the system, such as security and cost of execution and storage, *i.e.*, gas cost. During my research in Inplus Lab, I also participated in *Perishable Digital Goods Trading Mechanism for Blockchain-based Vehicular Network* and published a survey *Application of Blockchain in IoT Data Trust and Information Available Technology*. Currently, I am working on *BCShare: A Decentralized Data Storage and Sharing on Blockchain*, which employs InterPlanetary File System and certificateless cryptography to address the control on user data from the giant companies. The research in Inplus Lab not only helps me to master Blockchain technology, but also deepens my understanding of Trustworthy Systems, Cryptography, Security and Privacy, *etc*.

Networking & Distributed Systems

In my junior year, 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. I interned at Microsoft to work on the *Predictable Remote Direct Memory Access (RDMA) for AI Training* project, which aims 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 teamwork and project integrity, so it is necessary for the team to work closely together to ensure smooth progress. It was a great teamwork experience, which taught me to respect others' roles in the team and to be responsible both at work and in life. This experience is aligned with the research of Networking and Distributed Systems in CS at Tufts, which makes it an ideal choice for my research in the future.

Interests & Goals

The experiences mentioned above clearly demonstrate my strong will, innovative thoughts, and teamwork spirits, which makes me well-qualified for the M.S. in CS. If admitted, I am inclined to work on Data Science, Computer Vision, Reinforcement Learning, and Distributed Systems to make full use of my experiences. Besides, I am also interested in designing technologies for social impact under the instruction of Prof. Dogar as a new field of study.

In the short term, upon obtaining my Master degree, I expect to complete my program with excellent performance to broaden my horizon and consolidate my knowledge. In the next 3-5 year, I aspire to become a reliable researcher by pursuing a Doctor degree. In the long run, I would like 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.