

Personal Statement  
DONG Linsen

Objective

My goal is to pursue a master's degree in computer science. Someday I want to work as a research scientist at a company like Google, DeepMind, or OpenAI, where I'll have the opportunity to solve multi-agent control problems using the deep reinforcement learning (DRL) method. Therefore, I plan to take more courses related to computer science and machine learning in order to lay a solid foundation for my future career.

Motivation

My motivation to solve problems related to reinforcement learning stems from my experiences with research projects and programming contests in high school and college. Under the supervision of Prof. Xu of the Multi-Agent and Robotic System (MARS) Lab, I worked on several research projects related to multi-agent decision systems. I also worked on several research projects related to autonomous driving systems under the supervision of Prof. Guo at the Machine Intelligence Institute (MII) lab. By participating in programming contests such as ACM-ICPC, I became fascinated with algorithms and data structures. All these experiences motivated me to pursue my master's degree and gain more knowledge and techniques related to computer science.

Experience

I had my first experience with scientific research when I became Prof. Xu's research assistant at MARS. The first project which was cooperated with Huawei Technologies Co. Ltd was to solve the mobility load balancing problem in base station control systems using deep learning. Finally, By identifying the Users' movement as a Markov Decision Process(MDP), that inspired the design of my algorithm that using temporal data can lead to a more accurate predication. During this project, I learned how to apply deep learning methods to real-world problems.

My second project involved implementing a prototype multi-agent UAV path planning system based on a swarm intelligence algorithm. Seeing the interests in exploring further on multi-agent problems, Prof. Xu asked me to build a general multi-agent control system based on deep reinforcement learning that incorporates human knowledge. The most common DRL method is using the neural network to approximate a function; so the challenge is that neural network a black-box and can't be explicitly assigned any meaningful weights. After reading several papers and discussing the problem with my professor and the Ph.D students, I realized that this was an opportunity for me to explore a problem that hadn't ever been solved before. In the end, I developed a modified DDPG method that was able to learn from a fuzzy logic rule

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set as an approximation of human knowledge; we used human knowledge to instruct the DRL method in order to give it a warm-start and improve its stability during the training process.

After finishing my research work at MARS which mostly were about implementing prototype of algorithms, I wanted another chance to expose myself to real-world projects. Therefore, I began working on an autonomous driving system under the supervision of Prof. Guo at MII. Instead of building prototypes of algorithms as I had before, I had the chance to participate in the process of designing a complete autonomous driving system. During this process, I learned that a DRL can only perform well when it integrates modules such as high-resolution maps, localization, and human-computer interaction. By the end of the project, I was inspired to learn more about software development and system design.

Spending a total of four years participating in algorithm contests during high school and college, I mastered the knowledge of discrete mathematics, data structures, graph theory, and dynamic programming. During my freshman year, I won a bronze medal in the ACM-ICPC Regional Contest. The most important skill I acquired during this time was the ability to model a problem mathematically. I also gained practical skills such as analyzing algorithms' complexity with big O notations and doing trade-off between space and time. During my sophomore year, I won first prize in the High-Performance Computing Competition at UESTC hosted by NVIDIA. Based on the union-find algorithm, I modified and implemented a CCL algorithm based on the CUDA platform that can run parallel with an NVIDIA graphics card. This solid foundation with algorithms has been a major motivating factor for me to pursue a master's degree in computer science.

### Why This Program?

UMass has top of the line research labs, such as the Autonomous Learning Laboratory (ALL) and the Resource Bounded Reasoning Lab, as well as professors who are experts in reinforcement learning and multi-agent systems. I have read several papers written by these labs that have inspired me very much, such as [1, 2] when I tried to build a multi-agent reinforcement learning algorithm with different level action spaces. Also, the project Decision-Theoretic Foundations for Multi-Agent Planning, led by professor Shlomo Zilberstein, also interests me a lot. I hope I will have the opportunity to work with these brilliant researchers.

By doing projects at MARS, the potential use of deep learning in control industry motivated me to do more research about it. When I was discussing my research at MARS with project partners from other institutes like Huawei, I realized that in the automatic control industry, it is hard to replace traditional control systems with state-of-art deep learning methods because they are uninterpretable and not robust. My goal is to engage in research that will make the current algorithms more accurate and stable so they can be applied to real-world problems. By taking courses like COMPSCI 687, COMPSCI 690M, I will strengthen my theoretical ideas about machine learning, then help me to achieve my goal.

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During my time working on a real-world project with MII, lacking the development experience and knowledge made it hard for me to design a comprehensive code structure. For example, it took a long time for me to re-define the API of a class's constructor due to changes in the design. Therefore, I believe that only by taking more courses related to software development will I gain the ability to apply these algorithms to real-world scenarios and develop products that have robust code. This prompted me to gain more knowledge related to software development and system design, and a course like COMPSCI520 is perfect for my needs.

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Summarizing my own experiences in computer science and considering my career goal, also considering UMass's strong Artificial Intelligence background, this program really fits me and is the best choice for my future.

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[1] Osentoski S. Basis function construction in hierarchical reinforcement learning[J]. 2012.

[2] Ghavamzadeh M. Hierarchical reinforcement learning in continuous state and multi-agent environments[M]. University of Massachusetts Amherst, 2005.