Individual Capstone Assessment

Throughout a college education, students' abilities are measured frequently, often multiple times per week, through assessments such as homework, tests, quizzes, etc. But these earlier mentioned types of assessments differ greatly from the types of assessments students will face upon finished college. For instance, a student might finish a homework in a day and forget about it. But at work projects rarely takes days to complete and we usually can't forget about assignments once we complete them. At work projects can take years or decades. To offer students an assignment that looks more like something students see outside of work UC requires a senior project. The senior project is a yearlong assessment that students complete as the culmination of classwork, which provides students the opportunity to demonstrate the ability to work on a longer project more similar to what they will see outside of college.

The senior project is open ended and consequently it will be heavy shaped by the interests and earlier class work of students. I think that I learn valuable skills in my classes and outside my classes through self-study, which will help me in my senior project. The area that I have been most interested in for the past few years has been artificial intelligence and specifically deep reinforcement learning. I was first introduced to the area of artificial intelligence through an edX course, which I took after my freshman years titled "6.86x: Machine Learning with Python-From Linear Models to Deep Learning". After taking this edX course I went through online coursework from Berkeley and Stanford during my sophomore and pre-junior year. Namely, I went through Berkeley's material for CS188 (artificial intelligence), CS189 (machine learning), CS182 (deep learning), and EECS127 (convex optimization); and Stanford's material for CS224N (natural language processing). During my junior year, I started taking some of the artificial intelligence class at UC. Namely, I took CS4033 (artificial intelligence), CS5073 (deep learning), and special topics. I had already learned the material in CS4033 and CS5073 through my self-studying of Berkeley's material, but the special topics course was mostly new to me. I took that course with Prof. Atluri and went through the material from Berkeley's CS285 (deep reinforcement learning), which is available online. While I had some experience will deep reinforcement learning prior to taking this course from my co-ops, this was my first experience studying the material formally. I thought that reinforcement learning was, out of all the different learning approaches, the most powerful and the most similar to how learning happens in the real world.

I co-opted at two different companies: Siemens PLM Software and Northrop Grumman. My first two co-ops were at Siemens, where I worked as a software engineer. At Siemens, I learned how to work on a large project with a team of people through my work on Siemens' NX CAD program. I enjoyed my time at Siemens, but after two rotations I decided that I wanted to work on something with a substantial machine learning component. So, I switched to working as a machine learning engineer at Northrop Grumman, where I completed my last three co-ops. At Northrop, worked with a small team on projects focused on using machine learning to support national defense. I major project that I worked on involved using reinforcement learning to autonomously control military assets, i.e., planes, tanks, ships, submarines etc. I hope that the skills I picked up at Northrop and through my studies will serve me well on my senior project.

For my senior project, I will be focusing on using deep reinforcement learning (DRL) to learn to play Mario Kart 8 Deluxe. I find this interesting first because I find DRL interesting. I would like to study DRL in graduate school and eventually make a career working in DRL. So, any project will a DRL aspect to it is interesting to me. But this project is particular interesting to me because it has a number of similarities to how DRL is being used in the real world in self-driving. Right now, Tesla, Audi, BMW, Ford, Google, General Motors, and more are working on self-driving and many are using a DRL approach similar to what I would need to do to train a DRL agent to play Mario Kart 8 Deluxe. Obviously, training an agent to learn to drive in the real world is much more difficult than training an agent to drive in Mario Kart, but the underlying problem and approaches are similar.

Preliminary, I plan to train my Mario Kart agent with a variation of deep q-learning. The agent will take in the pixel values from the game and pass it through a neural network which tries to predict the quality of all of the actions available to it. The best action can then be chosen as the argmax of the action scores. The neural network which predicts action scores is updated using gradient descent and a reward signal telling the agent how well it is doing. One of the difficult parts of this project will be designing the reward function, especially since I might have to do it with only the pixel values to work with. To me success in this project would mean training an agent that performs much better than random. If I could get an agent that preforms as well or better than a skilled play, then I would be very happy.