# Individual Capstone Assessment - Ashwin Ranjith Menon

This project’s main focus is to develop lightweight neural network architectures to perform radio frequency modulation classification with a low parameter count. This will be performed by leveraging the Q-learning algorithm. Using Q-learning methods to perform architecture search could potentially even lead to the formation of novel neural network architectures. The main challenge lies in optimization of the state space, and reducing the time taken to perform exploration of said state space when running reinforcement learning experiments. This project serves as an opportunity for me to combine my interests in machine learning, and application of neural network architecture search methodologies.

Many classes I’ve taken over my years as a computer science student here at UC play a huge role in guiding my project work. Courses such as **CS2028: Data Structures** and **STAT3037: Probability and Statistics** have equipped me with the analytical and mathematical tools necessary for understanding the efficiency and reliability of algorithms. **CS4071: Design and Analysis of Algorithms** also taught me how to estimate computing time of algorithms and gave an overview of the concept of “greediness”. **ENED1100: Engineering Design and Thinking I** and **ENED1120: Engineering Design and Thinking II** molded my way of thinking so that I could take the standard engineering way of problem solving to overcome issues by breaking them into smaller tasks, enabling me to think critically and handle problems with ease. Complementary to this existing knowledge was the coursework in **EECE 3093C: Software Engineering**, which taught me various tasking systems and corporate methodologies that let me finish work on time. Additionally, **CS2023: Python Programming** and **CS3003: Programming Languages** taught me object-oriented programming language fundamentals and all I need to know to work with Python.

My co-op experiences have further prepared me to take on this challenge by strengthening both my technical and professional skills. As a **Software Developer Co-Op at Midmark Corporation**, I gained extensive experience in developing enterprise software, implementing backend services, and working with APIs in a real-world environment. These roles taught me how to write clean, maintainable code, work within large systems, and validate solutions through rigorous testing. These skills will be applied when designing, training, and evaluating neural network architectures. Additionally, my role as an **Undergraduate Research Assistant at the University of Cincinnati** involved learning about reinforcement learning and the different types of radio modulation schemes that can be classified. These experiences not only honed my technical expertise but also enhanced non-technical skills such as communicating results, collaborating with cross-disciplinary teams, and approaching open-ended problems with creativity and persistence.

I am motivated to engage in this project because, as I stated before, it combines my interests in machine learning, and application of neural network architecture search methodologies. The idea of developing small models that can achieve strong classification performance compared to other, much bigger ones excites me because it enables us to deploy software that has the performance brought by artificial intelligence to edge devices like microcontrollers, mobile phones and IoT devices. In essence, there is potential in making machine learning more accessible and deployable to devices with much smaller compute power. My prior research experience showed me the potential for reinforcement learning to discover novel solutions in model design, and this project allows me to extend that work into a practical, impactful system. Not only is at an academic challenge, it also is a chance to make meaningful contributions to the ever evolving knowledgebase of artificial intelligence.

My preliminary approach will involve defining the reinforcement learning framework, starting with Q-learning to iteratively evaluate and refine neural network architectures for modulation classification. I will establish baselines using standard models, then measure progress against accuracy, parameter count, and computational efficiency. I expect to achieve a balance between compactness and performance, producing architectures that significantly reduce resource requirements while maintaining high classification accuracy. To evaluate my contributions, I will measure accuracy and reduction rate in parameter count compared to a pre-established baseline. I will know I have succeeded when the models I develop outperform baseline tradeoffs, when my methodology is transparent and replicable, and when I can clearly communicate both the technical details and broader impact of the work.