**Student Name: Nina Nguyen**

**Date: 11/3/2019**

**Topic: Autonomous Vehicle**

**Article: Autonomous Driving System based on Deep Q Learning**

<https://ieeexplore-ieee-org.proxy.seattleu.edu/document/8494053>

**Citation: K. Arulkumaran, N. Dilokthanakul, M. Shanahan, A. A. Bharath, "Classifying options for deep reinforcement learning", Proc. IJCAI Workshop Deep Reinforcement Learning: Frontiers and Challenges, 2016.**

**Summary of Article:**

The self-driving car industry is on the rise and some automobile manufacturers like Tesla and Uber are close to achieving true self-driving cars. To build a self-driving car is expensive because the advanced technologies required, such as light detection and ranging, global positioning and laser range finder. The authors wanted to take a different route and create a self-driving car solely on single camera vision and artificial intelligence. Joining Deep Learning and Reinforced Learning, Deep Reinforced Learning (DRL) was formed to use with Convolutional Neural Networks to achieve Deep Q Network. The authors trained their models base on this algorithm to achieve steering decisions by the agent.

**Article Purpose:**

The article purpose was to share a different approach to self-driving cars. Instead of using high infrastructure technologies such as LIDAR, GPS, and LRF, the authors use camera images along with artificial intelligence to train the models using Deep Q Network algorithm. Instead of classification from convolutional neural networks, Deep Q Network return Q values (rewards) given to actions resulting from the input states. Learning rates and discount factor were discussed as important attributes in a successful model. Discount factor decides on the importance of future rewards. A discount factor of 0 will make the agent short-sighted in it’s goal and a discount factor of 1 will make the agent strive for long-term high reward.

**Methodology**

An experiment was performed in a simulation using Unity. Unity-Python conversion modules were used for the interaction between the two. In a straight road bounded by footpaths on the sides, 3 obstacles are placed on the road in front of the car, 30 meters apart. The agent approaches the obstacles and using images from the camera, the agent can decide on 3 actions (turn left by 10 degrees, keep straight, or turn right by 10 degrees). If the agent failed at detecting an obstacle, that learning episode is discontinued, and the training starts again. The agent is rewarded for every obstacle it overcomes. In the end, it shows that the at 10 meters/sec the agent can cover about 10,077 meters but the faster it goes, the less distance it can cover. I feel that this could be possible with fine tuning of the models and cameras getting better.

**Conclusion**

Rather than developing self-driving cars using LIDAR, GPS, and LRF; the authors wanted to create a self-driving car that use a single camera images to train the model using Deep Q Network and the agent make decisions based on Q values (rewards). The experiment was done in a simulation and it showed that the agent learning ability decreases with increasing driving speeds.

**Article Strengths:**

The authors explained the algorithm that they used to achieve their goal in a clear and simple way. They explained deep learning, reinforcement learning, convolutional neural networks, and then Deep Q Network. It helped me understand what the agent was trying to achieve during it’s learning process. The authors also highlighted the importance of their algorithm as well (learning rate and discount factor), this will help people with not a lot of artificial intelligence knowledge have some foundation of how an agent learn from some inputs.

**Article Weaknesses:**

The authors only experimented on a straight simulated road, I hoped they would simulate on a curved road to see if the agent can direct a turn versus an obstacle. Other than that, it was a very interesting take on self-driving cars.

**Recommendation:**

In the future, the authors plan to verify the simulation results and enhance the testing by using a Robocar. Robocar is a fully functional driving car, 1/10th the size of standard commercial car. They plan to test the car on the laboratory floor and once that turns successful, they plan to test on the road.

**Checklist:**

Number of Authors: 3

Number of Citations of Article: 20

Number of Citations to other articles: 1

Methodology Explained (Yes/No): Yes

Technology Explained (Yes/No): Yes

Experiments and Data Reviewed (Yes/No): Yes

Conclusion Exist (Yes/No): Yes

Recommendations Exist (Yes/No): Yes