Luck or Skill in the UNO card game: Reinforcment Learning Solutions

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***Abstract*—Casual style card games are often a combination of skill (playing your cards in an order optimized to win the game) and luck (players can be dealt a *good* or *bad* hand). There is a need to create competition based agents that outperform human players. This work not only looks to create an agent that can outperform humans at the game of UNO, but looks to analyze the influence players have on the outcome. This looks to answer the whether the game of UNO is luck or skill. The author is able to create an agent powerful enough to defeat random agents and analyze the chance of winning for specific games of UNO.**

***Key Words*—Reinforcement Learning, Neural Networks.**

I. Introduction

UNO is a card game enjoyed by many different types of people. The game can be frustrating as it often appears to be determined fully on luck. The goal of this study is to analyze the truth behind the game of UNO being luck or skill.

Previous studies have successfully trained agents to play UNO better than random agents [2], [3]

This study uses a UNO environment that allows the creation of Reinforcement Learning Agents [1]. Finding an agent that is able to play UNO well will help provide a baseline that gives information on the nature of the game UNO. This information will help determine the amount of skill UNO requires.

II. Methods

The RL agents trained for this study used a Q learning actor critic method (referred to as the agent).

This study look at data from 3 different parts, pre-training, training, and post-training.

A. Pre-Training

Before any training is done, the agent is initialized and plays 50 games for 100 seeds. That means the agent plays the same game (Starting hand and draw pile all the same) 50 times. The agent win rate for each seed is evaluated and plotted on a distribution graph. This graph shows the distribution of the agent winning each seed over 50 games.

This baseline graph is created with the hope of seeing a positive change in the distribution as the agent learns to play UNO better than when initialized.

Before training the agent also plays 50 games for 100 different seeds and the results are graphed. This is done to later see how well the agent generalizes the information to other unseen games. The agent will never be trained on these 100 seeds.

B. Training

The next step taken is to train the agent on the initial 100 seeds. By playing these games and updating the weights of a neural network, the agent begins to learn strategies that should help the agent beat a random player more often than not.

C. Post-Training

Following training, all efforts to train the model are stopped and the same steps are taken as from the Pre-Training. Distributions are graphed on both the training set of seeds and the other set of seeds. By comparing these distributions, the researchers are able to analyze how well the agent learns, and understand some more of the game UNO.

III. Results

The RL agent is able to learn and shows that UNO is mostly a game of luck. As shown in Figure 1, before learning, the agent was able to win an average of 49.49% of games. This is expected as the initial agent is random and there is 2 agents, each should win roughly half the time.

The trend seen in figure 1 is seen in figure 2 as well. There is a normal distribution centered about

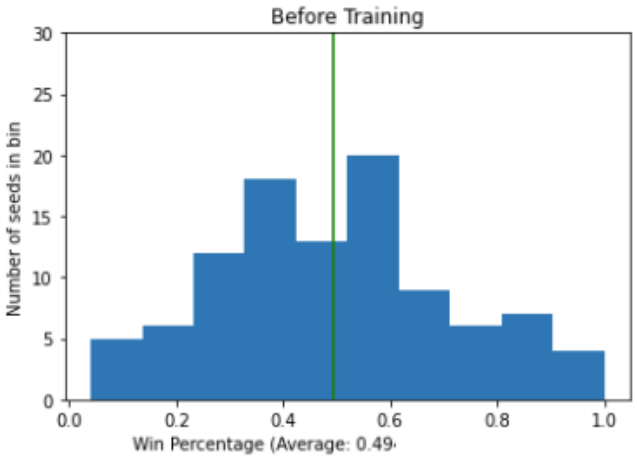

Fig. 1: Win Percentages before training on the seeds. The expected result is half of the games are won, as seen with the average win percentage. The shape of the distribution is normal, roughly centered around 50%

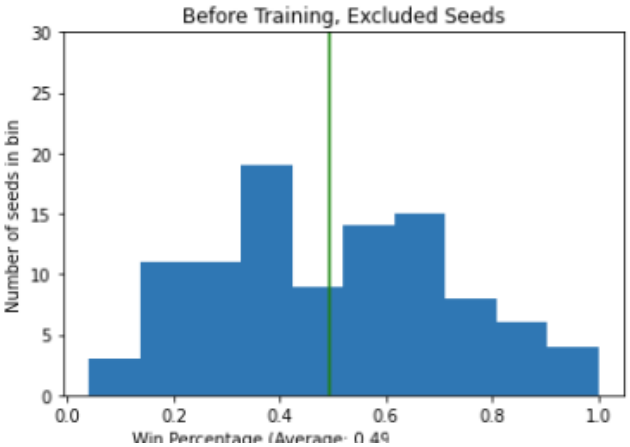

Fig. 2: Pre-Training distribution of seeds that will not be in training simulations. The shape and center of the distribution is the same as the seeds that will be used for training, normal and around 50% center.

50%.

Following training the model on 100 seeds, there is a change in the distribution as the games are simulated again. The seeds that received training are successful in not only increasing the mean win percentage, but also moving the center of the normal distribution to above 50%, as shown in figure 3.//

These changes in the distributions show the learning ability of the agent. The difficult time the

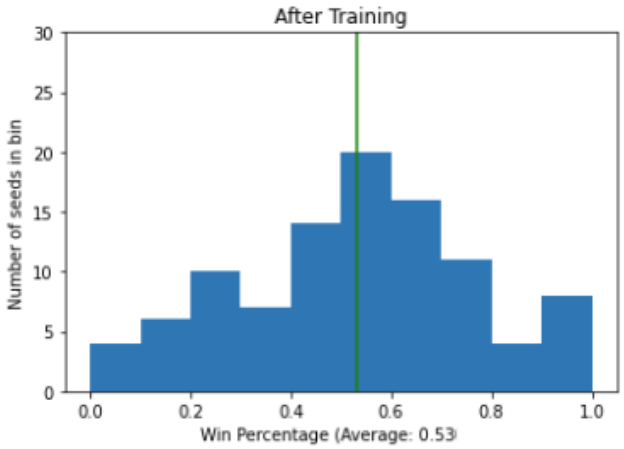

Fig. 3: Distribution of win percentage among seeds after training. The average increased from the same set of seeds to 53%. The normal distribution also moved from to above half. This shows the agent is learning and able to win more games than without training.

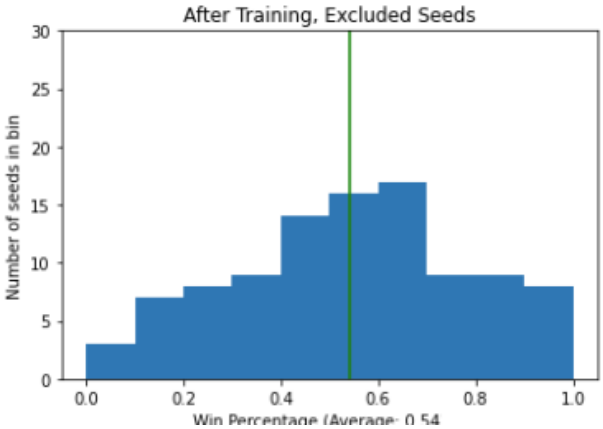

Fig. 4: The distribution of win percentage after training also changed for the seeds that were not seen in training. Similar to figure 3, the distribution center also moved above 50%. This shows that the agent was able to learn and apply strategies to games not seen before.

agent had learning strategies to increase its winning percent above 55% give insights to the game of UNO. There is evidence that UNO is primarily a game of luck as an agent is unable to successfully beat a random agent more that 55% of the time.

IV. Summary

As one of the main questions from this study is about the concept of the game UNO being luck or skill, the researchers support the findings from previous work. UNO is a game of luck. This project was unable to get a win rate above 55% while other studies [2], [3] were only able to get up to 51.5% and 59%. This is in line with this study. Thus UNO can be concluded to be a game of luck.

This project expanded the insights into UNO agents by using a group of fixed games to train and evaluate before introducing a new set of games. The study shows that RL agents are able to learn and apply strategies to games they have not observed. The observation of specific games show there are some games where it is difficult for the agent to win with regard to the situation dealt by the game, and others where it can win most every time.

The distribution of games that are winnable, and difficult to win, is roughly normal around the mean win rate.

V. Conclusion

Teaching an agent to play the game of UNO shows that the game is a game of luck. Practicing UNO to beat your friends will not make you better. When it comes to playing a game, you only need to be the lucky player in the group.

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References

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Gihub URL with Code and Presentation: https://github.com/grbruneel/RLUno