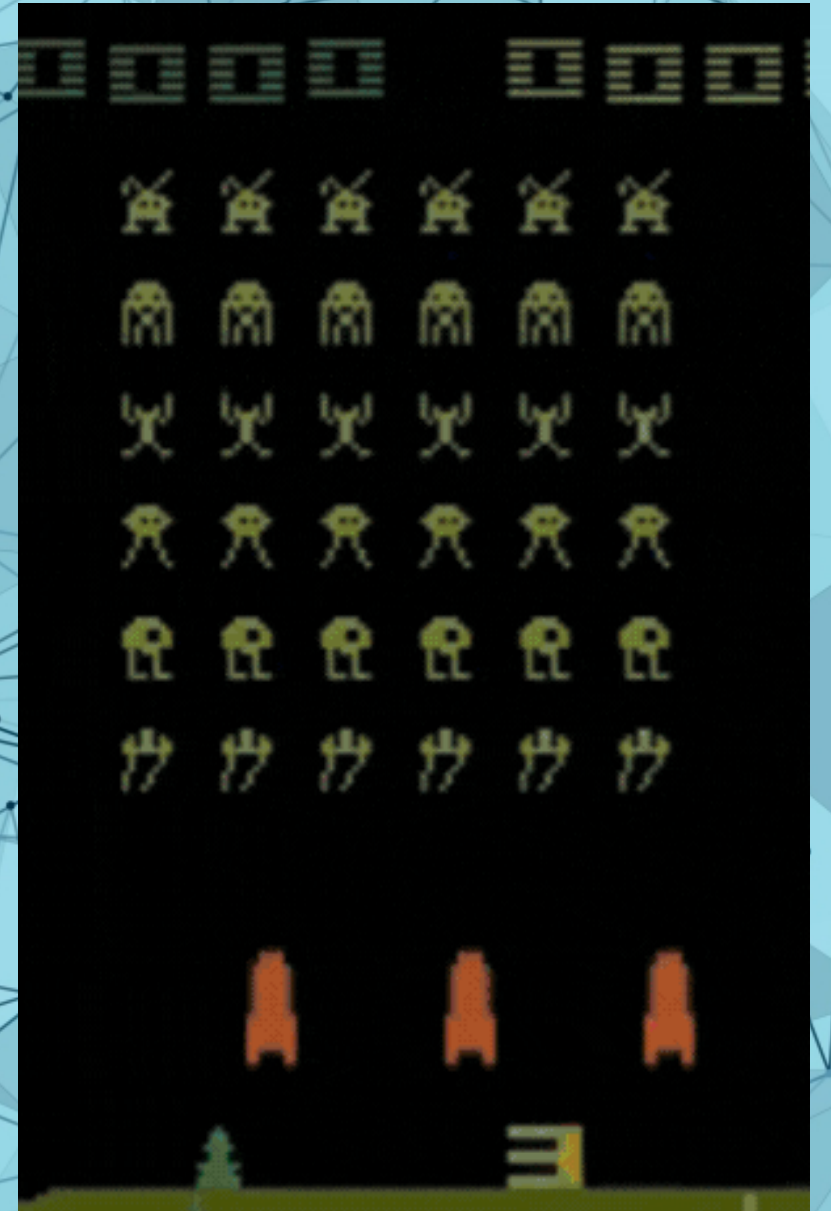


AI as a Gamer: Applying Q-Learning to Space Invaders

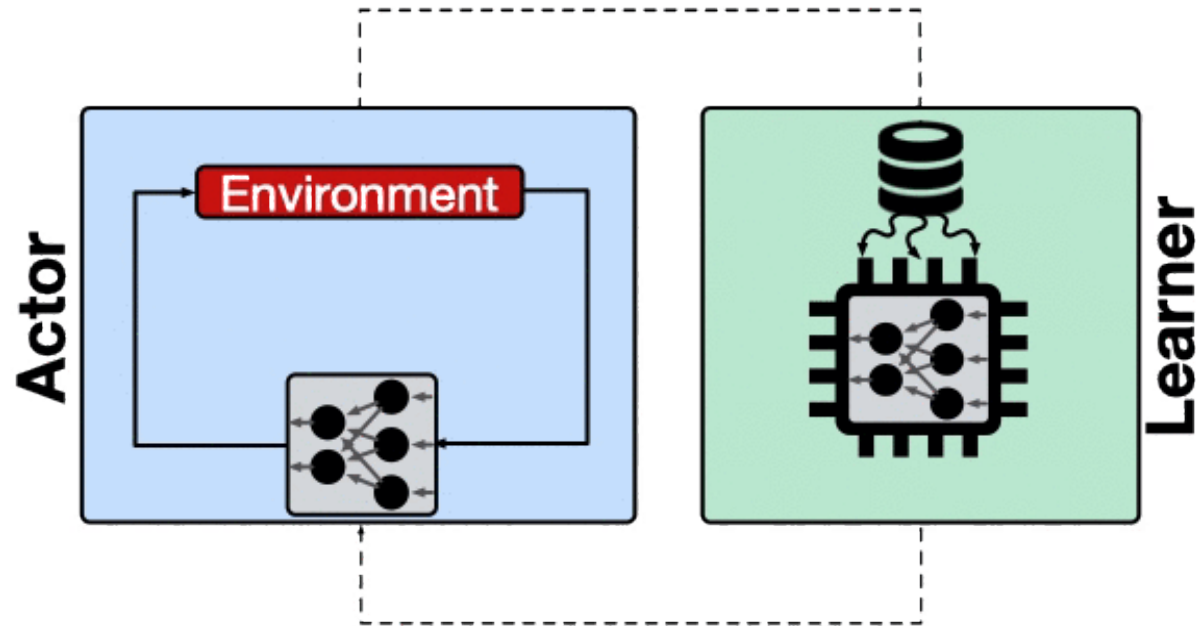
ONKAR PRASANNA KHER

KIRAN PALAVALASA



Reinforcement Learning

Reinforcement learning is one of the most basic machine learning techniques.



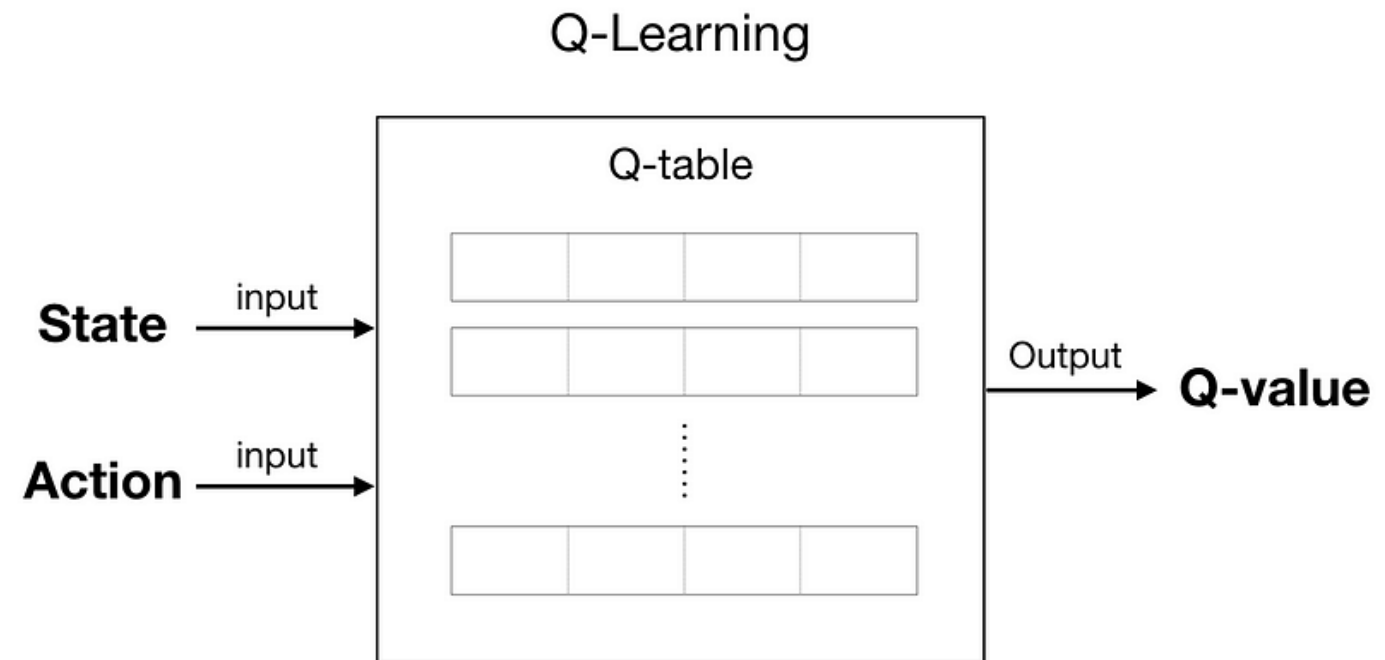
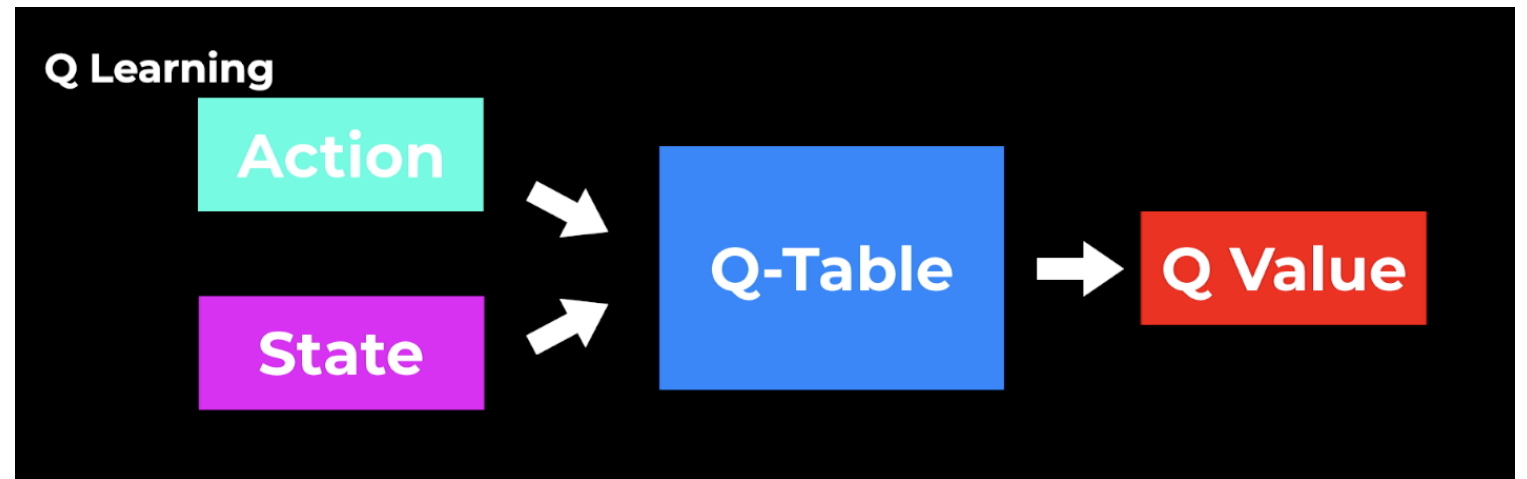
Unlike supervised & unsupervised learning

- It does not require labeled data
- It does not need to directly correct every action

By setting positive & negative rewards, the program can teach itself how to play and perform gaming actions.

Q-Learning

- ❑ The entire Q-learning algorithm depends on an array called Q-Table
- ❑ This Q-Table $n \times m$ dimensions
 - ❑ n is the number of actions possible
 - ❑ m is the number of states possible
- ❑ For every current state & action that led it there, the value of Q-table will change
 - ❑ The value will go up if the reward is positive for that action
 - ❑ The value will go down if the reward is negative
 - ❑ The value could go up or down if there is no reward- this depends on the parameters set.



Parameters

Learning Rate: How much new data overwrites old data [0.25]

- 0 = no learning
- 1 = only new information is retained

Discount Rate: short term or long-term goals[0.75]

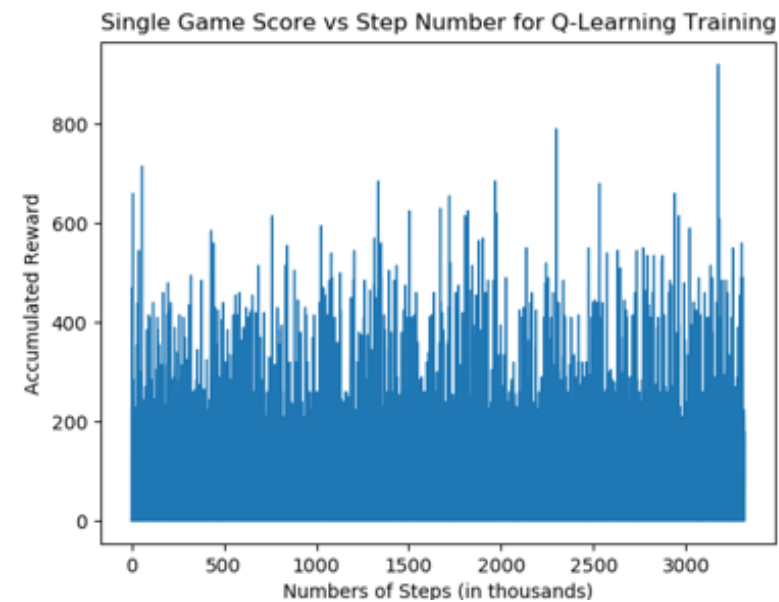
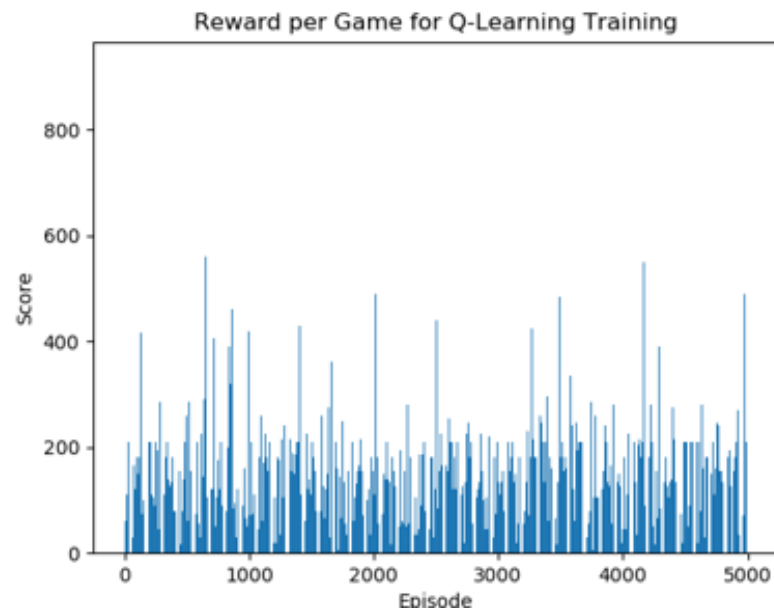
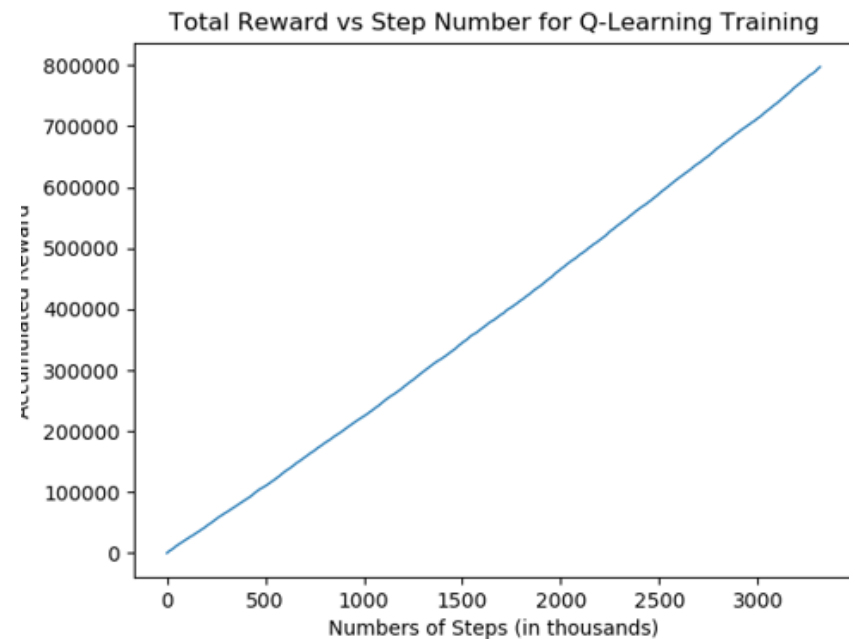
- 0 = short sighted
- 1 = far-sighted

Exploration rate – how often the program tries random, new actions[1.0]

- 0 = never
- 1 = always new & random

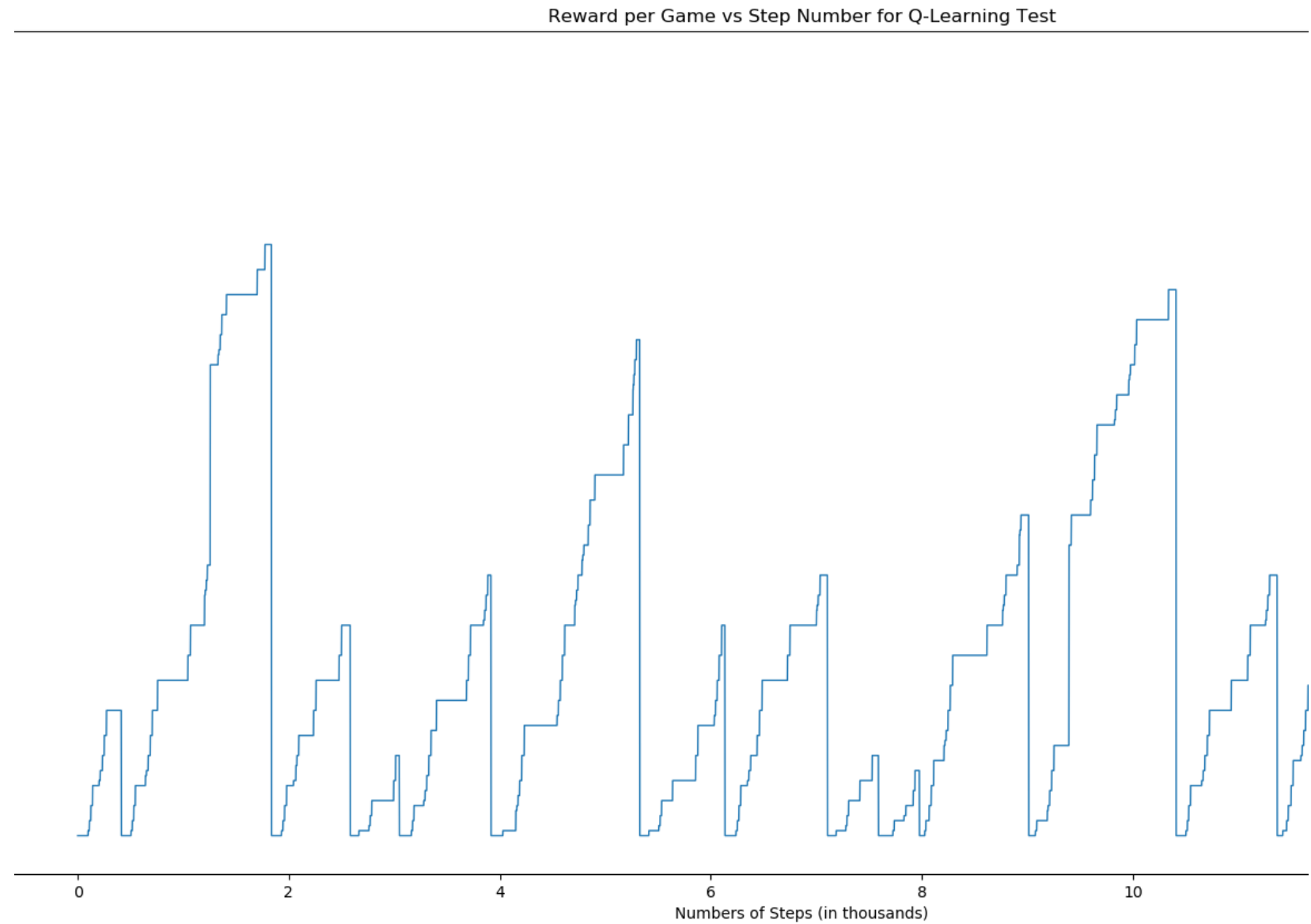
Number of episodes[5000]

Number of steps[10000]

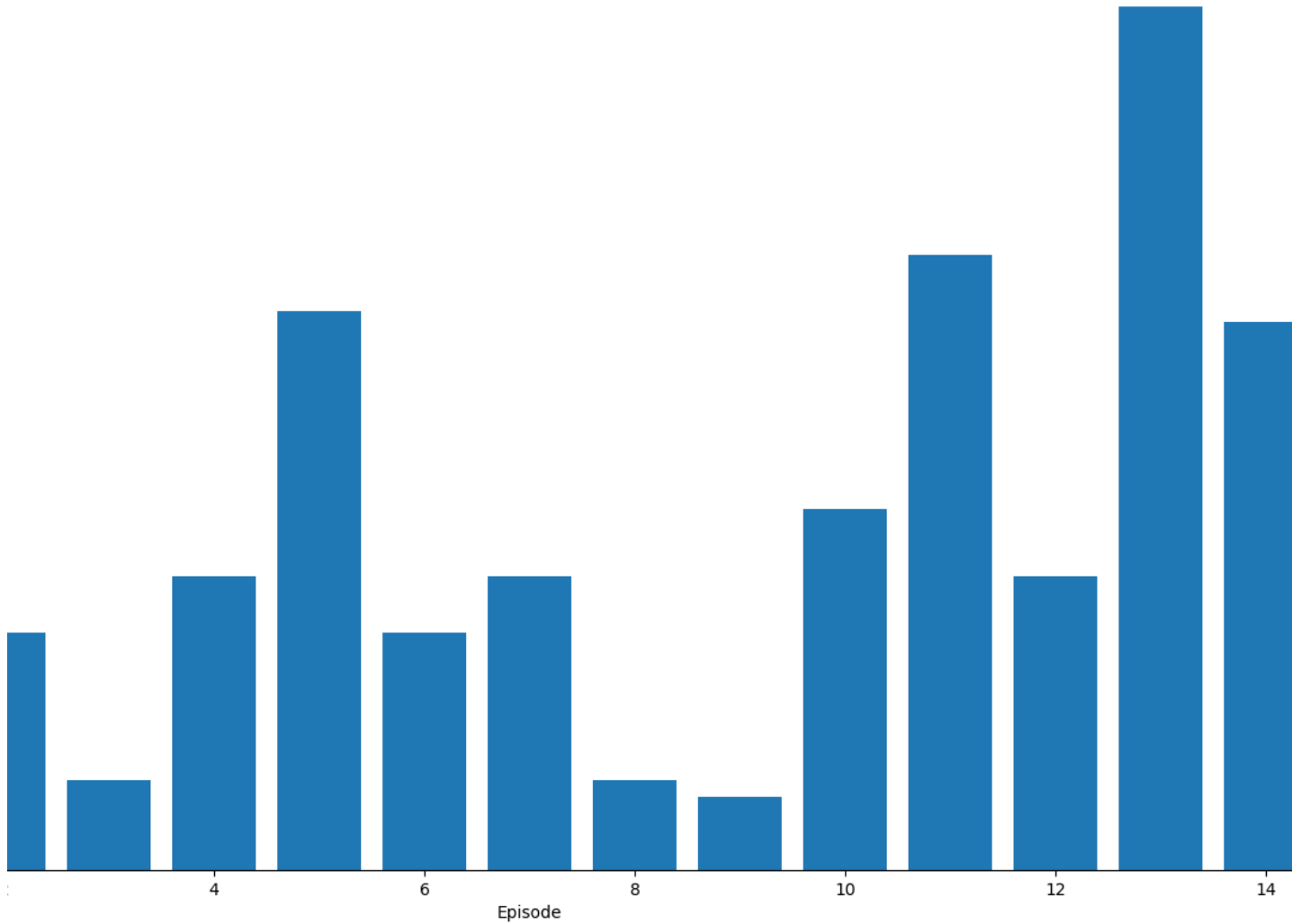


Q- Learning Training Results

Q- Learning Test Results



Reward per Game for Q-Learning Test



Q- Learning Test Results

```
onkar@onkar-OMEN-Laptop-15-en0xxx:
botLearning/Final_Project/SpaceInv
Score 125.0
Score 590.0
Score 210.0
Score 80.0
Score 260.0
Score 495.0
Score 210.0
Score 260.0
Score 80.0
Score 65.0
Score 320.0
Score 545.0
Score 260.0
Score 765.0
Score 485.0
Average Score: 316.6666666666667
onkar@onkar-OMEN-Laptop-15-en0xxx:
```



Test Results

Q-Learning Test scores for 15 episodes

Conclusions

- We have successfully trained an AI model to play Space Invaders using Q-Learning, achieving positive scores. Significant score improvements were noted with extended training and careful hyperparameter tuning.
- The model showed noticeable performance enhancements as the training progressed over a larger number of episodes, indicating effective learning and adaptation.
- To further increase the model's accuracy, implementing a Deep Q-Network (DQN) could be considered. Although DQN offers higher accuracy as it utilizes images directly and employs Convolutional Neural Networks to assess the agent's actions and states, it is computationally more intensive.

References

https://www.freecodecamp.org/news/an-introduction-to-reinforcement-learning-4339519de419/https://simoninithomas.github.io/Deep_reinforcement_learning_Course/

https://www.youtube.com/watch?v=PnHCvfgC_ZA&list=PL7-jPKtc4r78-wCZcQn5lqyuWhBZ8fOxT&index=4

https://www.youtube.com/watch?v=0g4j2k_Ggc4&list=PL7-jPKtc4r78-wCZcQn5lqyuWhBZ8fOxT&index=5

<https://www.youtube.com/watch?v=gCJyVX98KJ4>

https://github.com/deepanshut041/ReinforcementLearning/tree/master/cgames/02_space_invader

THANK YOU

