

MASTER THESIS

Jacob Harder

Title: 'On Theoretical Analyses of Deep Q-Learning'

Advisor: Stefan Horst Sommer

LEARNING OBJECTIVES:

- Describe setup, definitions, and theoretical aspects of reinforcement learning and Q-Learning.
- Describe mathematical aspects of Artificial Neural Networks in relation to Q-Learning.
- Describe and analyze the function space foundation in the topics mentioned above.
- Survey existing mathematical results on Q-Learning using deep neural networks, e.g. relating to success and convergence rates
- Analyze assumptions of these results and investigate if they can be changed
- Compare with similar results in the neural network literature
- Perspectivize the theory to empirical results

PROJECT FORMULATION:

Strong empirical results of Artificial Neural Networks (ANN) and Q-Learning (QL) for certain problems, such as image recognition and board game strategies, have appeared during the last 15 years. Mathematical explanation of these results have generally been sparse, however recent attempts aim to remedy this. The project will survey and analyze recent mathematical results on ANN and QL performance, discussing their strength and relevance as well as the possibility of their improvement. In the course of this, the function space foundations of the methods will be described and analyzed in detail. Finally the theoretical results will be put in context of the empirical results that motivated the project.

SCHEDULE:

Beginning: 30. November 2019

Ending: 30. June 2020

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Week 1:

- Describe setup, definitions, and theoretical aspects of reinforcement learning and Q-Learning.

Weeks 2-3:

- Describe mathematical aspects of Artificial Neural Networks in relation to Q-Learning.

Weeks 4-5:

- Describe and analyze the function space foundation in the topics mentioned above.

Weeks 6-8:

- Survey existing mathematical results on Q-Learning using deep neural networks, e.g. relating to success and convergence rates

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Weeks 1-3:

- Analyze assumptions of these results and investigate if they can be changed

Week 4:

- Compare with similar results in the neural network literature

Week 5:

- Perspectivize the theory to empirical results

Weeks 6-8:

- Rereading, error correction and hand-in of project

Weeks 9-10:

- Presentation and defense

The project will be written along side researching, reading and generating the results it discusses.