

# DS-GA 1003 Final Project Proposal - Group 9

## Comparative Analysis of Reinforcement Learning Algorithms on Atari 2600 Games

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## 1 Introduction

Our team wants to do a comparative study of applying basic reinforcement learning (RL) algorithms for playing (Atari 2600) games, a classic benchmark in RL research. Our foundational understanding of machine learning underpins our analysis, which seeks to address the following research questions:

- How do different basic RL algorithms perform at each step and how do they compare?
- Which challenges are most common for these algorithms and if possible how do we optimize them?

## 2 Work Done So Far:

DQN is able to learn control policies for 7 games directly from screen pixels, outperforming previous methods and human performance. We have also looked into RL applications for games with well-defined reward and environments like Frozen Lake.

## 3 Dataset To Use:

We will use the Arcade Learning Environment (ALE) and the Gymnasium API to develop and test AI agents. These platforms offer a standardized suite of games with varying complexity and are widely recognized in the RL community.

## 4 Evaluation Methods

The primary objective of this research is to conduct a comprehensive investigation into the performance and learning dynamics of various reinforcement learning algorithms applied to Atari 2600 games. In terms of research methods, we intend to focus the step-by-step investigation on the following aspects:

### 4.1 Exploration vs. Exploitation Dynamics

- Evaluate different strategies ( $\epsilon$ -greedy, Softmax) to balance exploration and exploitation.

### 4.2 Policy Updates Mechanisms

- Study the evolution of policy updates in both policy-based and value-based methods.

### 4.3 Reward Signal Analysis

- Examine how different reward structures influence long-term strategy development and learning outcomes.

### 4.4 Impact of Learning Rate and Discount Factor

- Change different learning rates and discount factors to understand their effects on the learning.

## 5 Reference:

Mnih, V., Kavukcuoglu, K., Silver, D., Graves, A., Antonoglou, I., Wierstra, D., & Riedmiller, M. (2013). Playing Atari with Deep Reinforcement Learning. DeepMind Technologies.