RAINBOW DQN HYPERPARAMETER OPTIMIZATION USING HYPEROPT FOR CARTPOLE-V1

TECHNICAL REPORT

Jonathan Lamontagne-Kratz
McGill University
jonathan.lamontagnekratz@mail.mcgill.ca

Ezra Huang
McGill University
ezra.huang@mail.mcgill.ca

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ABSTRACT

In this paper, we present a hyperparameter optimization study of the Rainbow DQN algorithm using the Hyperopt library. We use the CartPole-v1 environment from the OpenAI Gym as a benchmark. We show that Hyperopt can be used to find optimal hyperparameters for the Rainbow DQN algorithm. We also show that the Rainbow DQN algorithm can be used to solve the CartPole-v1 environment with a high degree of success. We provide a detailed analysis of the hyperparameters found by Hyperopt and discuss the implications of these results. We also provide a comparison of the performance of the Rainbow DQN algorithm with the performance of other previous DQN algorithms on the CartPole-v1 environment. Finally, we discuss the limitations of our study and suggest directions for future research.

1 Introduction

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2 Background

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2.1 Deep Q-Neworks

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$$\xi_{ij}(t) = P(x_t = i, x_{t+1} = j|y, v, w; \theta) = \frac{\alpha_i(t) a_{ij}^{w_t} \beta_j(t+1) b_j^{v_{t+1}}(y_{t+1})}{\sum_{i=1}^{N} \sum_{j=1}^{N} \alpha_i(t) a_{ij}^{w_t} \beta_j(t+1) b_j^{v_{t+1}}(y_{t+1})} \quad (1)$$

2.2 Double DQN

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2.3 Prioritized Experience Replay

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2.4 Dueling DQN

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2.5 Noisy Nets

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2.6 Categorical DQN

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Table 1: Baseline hyperparameters

Name	Value
Optimizer	Adam
Adam ϵ	1e-08
Learning rate	0.001
Clipnorm	None
Loss function	Categorical crossentropy
Activation	ReLU
Kernel initializer	Orthogonal
Dense layers widths	128
Replay interval	1
Discount factor	0.99
Minibatch size	128
Replay buffer size	5000
Min replay buffer size	128
Target update interval	100
Prioritized experience replay α	0.2
Prioritized experience replay β	0.6
Prioritized experience replay ϵ	1e-06
Value hidden layers widths	128
Advantage hidden layers widths	0
Noisy σ	0.5
N-step	3
Atom size	51

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2.7 Rainbow DQN

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3 Methodology

We used hyperopt with PTE (Parzen Tree Estimator) to optimize the hyperparameters of the Rainbow DQN algorithm. We used the CartPole-v1 environment from the OpenAI Gym as a benchmark. Each agent was trained for 10,000 training steps. Trials took about 10 minutes to complete on a single CPU and GPU. We used hyperparameter search spaces of different sizes in order to determin the effect of search space size on convergence time and performance. The different search spaces can be seen in the appendix. As a baseline we trained an agent using the hyperparameters seen in Table 1. We also compared the performance of the Rainbow DQN algorithm with the performance of other previous DQN algorithms on the CartPole-v1 environment, as well as removed individual components of the Rainbow DQN algorithm to determine their effect on performance, as in [**?**].

4 Results

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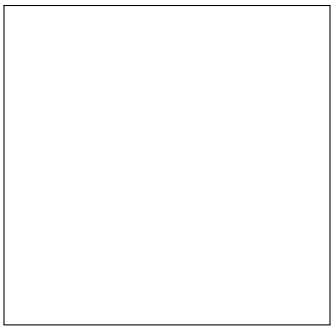

Figure 1: Results of baseline agent.

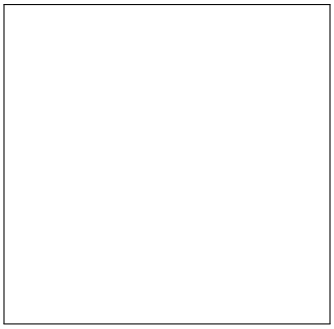

Figure 2: Convergence of hyperopt on search space of size X, Y and Z.

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5 Discussion

All artwork must be neat, clean, and legible. Lines should be dark enough for purposes of reproduction. The figure number and caption always appear after the figure. Place one line space before the figure caption and one line space after the figure. The figure caption should be lower case (except for first word and proper nouns); figures are numbered consecutively.

You may use color figures. However, it is best for the figure captions and the paper body to be legible if the paper is printed in either black/white or in color.

5.1 Lists

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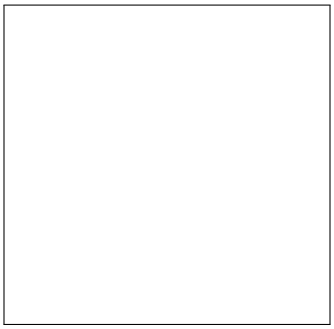

Figure 3: Comparison of performance of Rainbow DQN with other DQN algorithms.

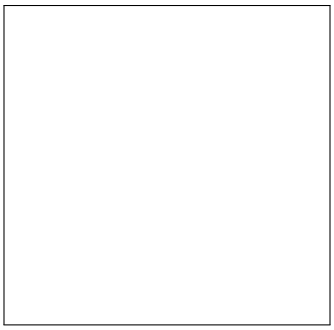

Figure 4: Effect of removing individual components of Rainbow DQN on performance.

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5.2 Math

Note that display math in bare TeX commands will not create correct line numbers for submission. Please use LaTeX (or AMSTeX) commands for unnumbered display math. (You really shouldn't be using $$ anyway; see `https://tex.stackexchange.com/questions/503/why-is-preferable-to` and `https://tex.stackexchange.com/questions/40492/what-are-the-differences-between-align-equation-and-displaymath` for more information.)

5.3 Margins in LaTeX

Most of the margin problems come from figures positioned by hand using `\special` or other commands. We suggest using the command `\includegraphics` from the `graphicx` package. Always specify the figure width as a multiple of the line width as in the example below:

```
\usepackage[pdftex]{graphicx} ...
\includegraphics[width=0.8\linewidth]{myfile.pdf}
```

See Section 4.4 in the graphics bundle documentation (`http://mirrors.ctan.org/macros/latex/required/graphics/grfguide.pdf`)

A number of width problems arise when LaTeX cannot properly hyphenate a line. Please give LaTeX hyphenation hints using the `\-` command when necessary.