

Homework Assignment 4

601.464/664 Artificial Intelligence Spring 2020

Due: May 2, 2020

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Deep Learning and Reinforcement Learning

In this part of the assignment, you will implement chess-playing agent with deep reinforcement learning and answer theoretical questions.

Question 1. Open the following google colaboratory notebook.

<https://colab.research.google.com/drive/1Kir-xWX8piHPf6pDu-jbWmGz-eNQkJyy>

Follow all the steps specified in it. Include link to your solved notebook in your submission. Some parts of the notebook are optional and will not be graded.

<https://colab.research.google.com/drive/1X3wgxVDQR8lcCdo5tgElsiSm3kq8o2fT?usp=sharing>

Question 2. Explain the difference between fully connected layer and a convolutional layer.

In a fully connected layer each neuron is connected to every neuron in the previous layer, and each connection has its own weight. Its purpose is to extract global features.

In contrast, in a convolutional layer each neuron is only connected to a few nearby. Its purpose it to extracts local features.

Question 3. What is a softmax function and where is it used in neural networks?

The softmax function is a function that takes as input a vector of K real numbers, and normalizes it into a probability distribution consisting of K probabilities proportional to the exponentials of the input numbers.

The standard softmax function $\sigma : \mathbb{R}^K \rightarrow \mathbb{R}^K$ looks like

$$\sigma(\mathbf{z})_i = \frac{e^{z_i}}{\sum_{j=1}^K e^{z_j}} \text{ for } i = 1, \dots, K \text{ and } \mathbf{z} = (z_1, \dots, z_K) \in \mathbb{R}^K$$

The softmax function is often used in the final layer of a neural network-based classifier. We use it as a normalization to determine the classification.

Question 4. Give an example of non-linearities used in neural networks. Why is it necessary to have it in networks?

Non-linearity are used in neural network mainly as activation functions, including sigmoid function, Relu function, and tangent function.

It is necessary because if you don't use non-linearities between the layers, you can only construct linear functions. For some problem like XOR problem, you can't separate it properly only with linear functions. You can only separate them using an MLP where the hidden layer has non-linear activation functions.

Question 5. What are the loss functions used for regression and classification?

There are many loss functions for regression and classification. For regression the most famous loss functions are Mean Square Error(L2 Loss) and Mean Absolute Error(L1 loss). For classification the most famous loss functions are Cross Entropy Loss and hinge loss.

Question 6. Using what algorithm gradients are usually efficiently computed in neural networks?

Backpropagation Algorithm. One famous algorithm here is stochastic gradient descent(GD) algorithm.

Question 7. What is the discount factor γ and how is it used when computing the reward in reinforcement learning?

The discount factor γ is a factor we need to consider when calculating the reward of actions in reinforcement learning. Discount factor factors are associated with time horizons. The discount factor essentially determines how much the reinforcement learning agents cares about rewards in the distant future relative to those in the immediate future.

The way to use it can be the following equation.

$$R_t = \sum_{k=0}^{\infty} \gamma^k r_{t+k}$$