Homework Assignment 5

CSE 151A: Introduction to Machine Learning

Due: June 8nd, 2022, 9:30am (Pacific Time)

Instructions: Please answer the questions below, attach your code in the document, and insert figures to create **a single PDF file**.

Grade: ____ out of 100 points

1 Activation functions (40 Points)

1. Which one of these is a valid layer? For this question, `w.shape=(input, output)` with `x.shape=(batch size, input)` and `b.shape=(1, output)`. Note, below that anywhere we use dot, we could have instead used matmul.

   (a) `z = activationFunction(np.dot(x, b) + w)`

   (b) `z = activationFunction(np.dot(x, w)) + b`

   (c) `z = activationFunction(np.dot(x, w) + b)`

2. Name at least two possible activation functions and explain the reason why they are used as activation functions.

3. What will happen if the activation function is a linear function in Multi-layer Perceptron?

2 Overfitting and Regularization (30 Points)

1. What are the common techniques to alleviate overfitting in the neural network training?
2. Can we still apply the L1/L2 regularization in NN? If we can, how; if we cannot, why?

3 Compute output for a Convolutional Neural Network (30 Points)

Consider the image X and filter F given below. Let X be convolved with F using no padding and a stride of 1 to produce an output Y . What is the output Y ?

$$X = \begin{bmatrix} 1 & 0 & -2 & 3 & 4 & 1 \\ 2 & 9 & 5 & 6 & 0 & -1 \\ 0 & -3 & 1 & 3 & 4 & 4 \\ 6 & 5 & 2 & 0 & 6 & 8 \\ -5 & 4 & -3 & 1 & 3 & -2 \\ 4 & 1 & 2 & 8 & 9 & 7 \end{bmatrix}$$

$$F = \begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix}$$

4 (Bonus, 20 points) Experiment with CNN using Keras

In this question, you will experiment with Convolutional Neural Networks using the deep learning framework Keras (https://keras.io/api/). Please download the Jupyter notebook HW5_CNN.ipynb and fill in the blanks and answer the questions. Please attach your **code** and **answers** in Gradescope submission.

Note: Make sure this notebook is launched in an environment with Numpy, Tensorflow, matplotlib and Keras installed. You can refer to: https://www.tutorialspoint.com/keras/keras_installation.htm if you need help with creating a virtual environment with all required dependencies.