Assignment

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Fractal-3 Assignment
Jan - April 2023
IIT Jodhpur

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Note:

1. Due date: April 29, 2023: 11:55 PM (firm deadline). No extension will be given. 2. Submit a brief report and Github link of your implementation with proper details.

Problem 1: Perceptron [30 points]

Following training samples are given:

x_1	Class
x_2	
1	1 +1
-1	-1
0.5	0 -1
0.5	0.1 -1
0.2	0.2 +1
0.5	0.9 +1

Table 1: Sample data

Assuming weight vector of initial decision boundary $w^T x = 0$ as w=[1, 1], solve the

following: 1. In how many steps perception learning algorithm will converge.

2. What will be the final decision boundary? Show step-wise-step update of weight vector using computation as well as hand-drawn plot.

Problem 2: Learning to implement Neural Network [30 points]

1. Gurmukhi Handwritten Digit Classification: Gurmukhi is one of the popular Indian scripts widely used in Indian state of Punjab. In this part of the assignment, our goal is to develop a neural network solution (a simple NN, not a CNN) for classifying Gurmukhi digits. We provide you Handwritten Gurmukhi digit dataset here:

Dataset link

Modify the code provided in here and a video tutorial here, and develop a robust neural network to classify the Gurmukhi digits. Higher performance on test set will have bonus point. Briefly write your observation and submit your code so that we can evaluate your implementation at our end. (10 points)

Problem 3: Chart Image Classification using CNN [40 points]

Problem statement: You have to develop a CNN-based classification architecture for clas sifying a given chart image to one of five chart classes, namely “Line”,“Dot Line”,“Horizontal Bar”,“Vertical Bar”, and “Pie” chart.
Task 1: Download the dataset from drive link given below.
Dataset link

Use the train and val images for training and validation in an appropriate ratio (e.g., 80% for training and 20 % for validating). The CSV file contains corresponding labels for the images.

Task 2: Implement a two-layer Convolutional Neural Network, and calculate accuracy, and loss and plot the obtained loss. Briefly write your observation and submit your code so that we can4 evaluate your implementation at our end.
Task 3: Finetune a pretrained network (e.g., AlexNet) for this task and report the results.

Problem 4: Gradient Descent and Backprop [10 points]

1. What is the difference between Stochastic Gradient Descent and Mini Batch Gradient Descent? *(2 points)*

2. Consider a 3-layer network shown in Figure 1:
   Given that $f = w^{[3]}_1 a^{[2]}_1 + w^{[3]}_2 a^{[2]}_2$.
   Compute the following derivatives: $\frac{\delta f}{\delta Z^{[2]}}$, $\frac{\delta f}{\delta Z^{[1]}}$, $\frac{\delta f}{\delta z^{[2]}_1}$, $\frac{\delta f}{\delta w_{11}}$. *(8 points)*

Problem 5: Neural network in practice [10 points]

1. What's the risk of tuning hyperparameters using a test dataset? *(2 points)*
2. Give two strategies for addressing the overfitting problem in neural networks. *(2 points)*
3. How do you decide input layer and output layer size for solving a particular problem using a neural network? *(2 points)*
4. Explain the Sigmoid activation function. *(2 points)*

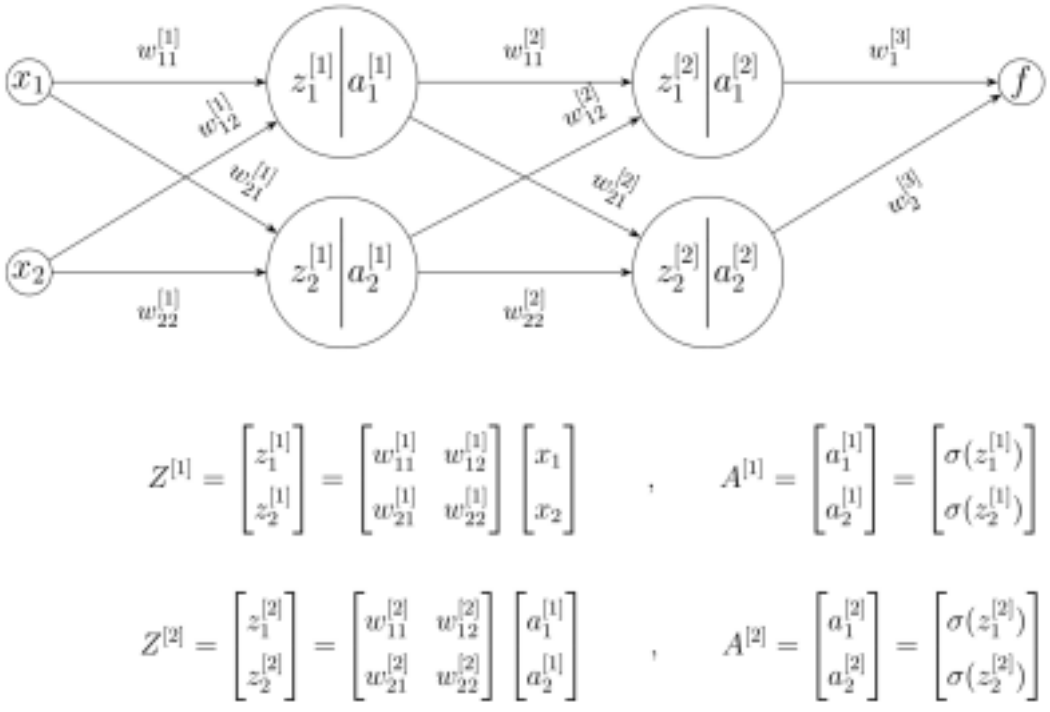

Figure 1: Three Layer Network.

5. In a neural network what is the learning rate? Will the network converge faster, if I have a very large learning rate (say 5.5)? *(2 points)*