EE6380/AI2100/AI5100 Deep Learning, Fall 2023

Indian Institute of Technology Hyderabad

Homework 3, Artificial Neural Networks (ANNs), Assigned 25.09.2023, Due **11:59 pm on 04.10.2023**

Ask the right questions, and nature will open the doors to her secrets. – Sir C. V. Raman

Instructions:

- It is **strongly recommended** that you work on your homework on an *individual* basis. If you have any questions or concerns, feel free to talk to the instructor or the TAs.

- Use `matplotlib` for plotting - `https://matplotlib.org/tutorials/introductory/images.html`.

- Please turn in Python Notebooks with the following notation for the file name: `your-roll-number-hw3.ipynb`.

In this assignment you will implement a simple Artificial Neural Network (ANN) from scratch (i.e., without using built-in functions). Implement the back-propagation algorithm to learn the weights of an ANN with 2 input nodes, 2 hidden nodes and 1 output node. The hidden layer nodes employ a sigmoid nonlinearity. Use squared-error loss. Train your network to learn the following binary operations:

1. XOR (10)

2. AND (10)

3. OR (10)

Since the output is binary (and scalar), choose your $g_k(\cdot)$ appropriately. Your code should make the number of nodes a configurable parameter. To generate the dataset, perturb the input binary digits with a small amount of Gaussian noise. Use 80% of the dataset for training and the rest for testing. Report the following:

1. Training and testing loss over training iterations. Plot these values.

2. Training and testing accuracy over training iterations. Plot these values.

3. Print the training and test loss and accuracy at the end of training.

4. Deterministic gradient descent: Experiment with the number of training samples n and see how its affects performance. In other words, repeat the training and testing for three different choices of n.

5. Stochastic Gradient Descent: Experiment with the batch size m (for a fixed n) and see how its affects performance. In other words, repeat the training and testing for three different choices of m.