EE 527: Machine Learning Laboratory

Assignment 11

Due date: 2 May 2023

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1. XOR-MLP

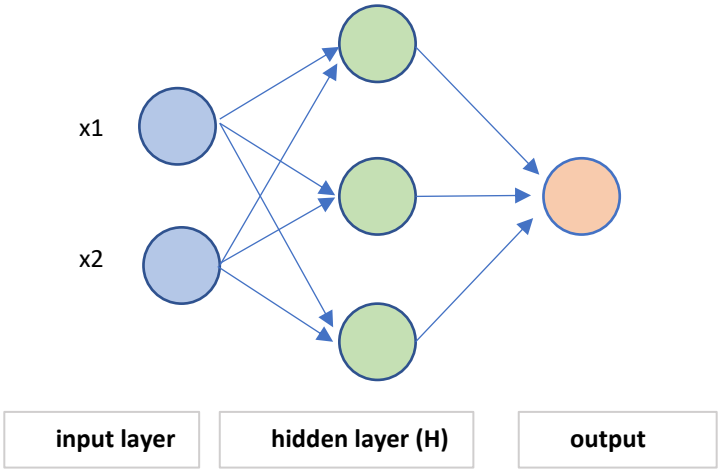
Generate random points $X\,(x_1, x_2)$ on a 2-d plane, with the constraint $x_1 \in [0,1]$ & $x_2 \in [0,1]$. Assign a label z to each of these points using the following criterion:

$$z = 0 \left\{(x_1, x_2) \in [0,\ 0.5) \times [0,\ 0.5) \bigvee (x_1, x_2) \in (0.5,\ 1] \times (0.5,\ 1]\right\}$$

$$z = 1 \left\{(x_1, x_2) \in (0.5,\ 1] \times [0,\ 0.5) \bigvee (x_1, x_2) \in [0,\ 0.5) \times [0.5,\ 1]\right\}$$

Generate N=400 points in such manner for the train set and 100 for the test set. Visualize the train set $X_i\ (i = 1,\ 2,\ \ldots\ N)$. Color the points according to their label (use **BLUE** for z=1 and **RED** for z=0).

Use the above train set to train an MLP with the following architecture. Write the code for forward and backward propagation from scratch (Do not use any inbuilt python packages).



Visualize the Hidden layer activation H in a 3d plot for each of the train samples, following the label-based color coding used previously, and check for linear separability.

2. MNIST-MLP

Consider the **MNIST** Handwritten Digit Recognition dataset used in earlier assignments.

(a) Use the Multilayer Perceptron (MLP) module in Scikit-learn python toolbox to learn the MLP (with a single hidden layer) to perform 10 category classification over the given dataset. Use SoftMax as the activation function for the 10 output nodes. Experiment with the number of nodes in the hidden layer. Report the class-wise F1-scores and the overall accuracy. Report results for different number of nodes in the hidden layer. Report the class-wise F1-scores and the overall accuracy.

(b) Try improving the performance of the MLP by adding more hidden layers. Experiment with the number of nodes in each hidden layer. Report your best performance (in terms of class-wise F1-scores and overall accuracy) on the MNIST dataset.