Homework 5

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DS 5220 - Supervised Machine Learning and Learning Theory

November 12, 2018

Due: November 27th, 2018 - 50 points

1. **Feed Forward Neural Network Implementation.** Implement a Feed Forward Neural Network, with an input layer with S_1 units, one hidden layer with S_2 units, and an output layer with S_3 units using the back-propagation algorithm. The network will be trained using data $\{(\mathbf{x_i}, y_i)\}_{i=1}^{N}$ for $\mathbf{x_i} \in \mathbb{R}^{S_1}$ and $y_i \in \mathbb{R}^{S_3}$. The code must allow specifying the following activation functions: sigmoid, hyperbolic tangent and rectifier linear activation **(10 points)**. The code must output all the learned weights and biasses of all layers as well as the activations of the last layer.

   (a) Download the dataset on the course webpage. What should be the value of S_1 and S_3 for this data? **(5 points)**

   (b) Let $S_2 = 2$. Train the neural network on the provided training data for several values of the regularization parameter λ. Report the classification error on the validation dataset for each and report the best that achieves the minimum validation error. For this, report the classification error on the training and also on the test datasets. **(15 points)**

   (c) Repeat part (ii) for $S_2 = 10$. **(15 points)**

   (d) Plot the input training data, so that points in class 1 are denoted by blue circles and points in class 0 are denoted by red squares. Is this dataset linearly separable? Could either of the neural networks in part (ii) or (iii) correctly classify this data? Explain. **(5 points)**