SML 2025, Winter, Quiz 3, Dur. 1 hr 10 mins. Marks 9.5

Note: Symbols have standard meaning.

Q1. We are given a simple dataset with three data points:

x	y
1	2
2	3
3	4

Build a gradient boosting regression model. Assume the loss to be $L(f(x)) = e^{|y-f(x)|}$. Initial model $F_0(x)$ predicts the mean of all y values. Learning rate is 0.1.

a. Find $h_1(x)$. Evaluate at only two cuts: $x = 1.5$ and $x = 2.5$.[3]

b. Suppose we stop the iteration at $h_1(x)$ itself. What will be the prediction of final model for $x = 2$? [.5]

Q2. Suppose we make a perceptron with following loss function $L(\beta, \beta_0) = e^{(y(\beta^T x+\beta_0))^2} + |\beta_0|$. $|.|$ denotes absolute value. Derive the equations by which we can update the parameters. [3]

Q3. Consider the neural network in Figure 1. The input is 2d: $x = [x_1 \ x_2]^T$. The weights are $\beta = [\beta_1 \ \beta_3 \ \beta_4 \ \beta_5]^T$. There are no activations on hidden nodes. Output node has the following activation: suppose the value before activation at output node is z, then after activation, the output is z^2. Recall that the activation in Rosenblatt' perceptron is *sign* function. $\hat{y}$ denotes the network's prediction. Consider the following loss $L(\beta) = -ylog(\hat{y}) - (1-y)log(1-\hat{y}) + ||\beta||_2^2$. Find the update rule for β_1. [3]

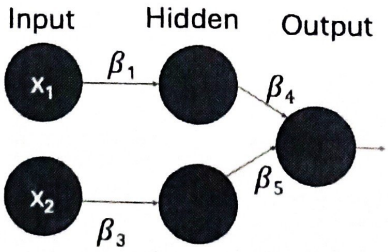

Figure 1: Neural network