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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  $L(\beta, \beta_0) = e^{(y(\beta^T x + \beta_0))^2} + |\beta_0|$ .  $|\cdot|$  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's perceptron is  $\text{sign}$  function.  $\hat{y}$  denotes the network's prediction. Consider the following loss  $L(\beta) = -y \log(\hat{y}) - (1 - y) \log(1 - \hat{y}) + \|\beta\|_2^2$ . Find the update rule for  $\beta_1$ . [3]

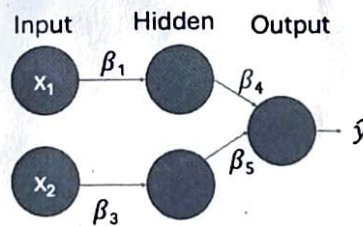


Figure 1: Neural network