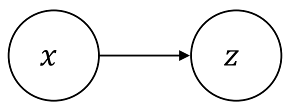
ECE 365 (Fall 2020) **Instructor:** S. Bose

Part 2. Quiz 1

Oct 20 Total points = 40

Instructions: You have 40 minutes to complete the exam and submit within the next 10 minutes via Gradescope. No clarifications from the instructors will be provided. Make suitable assumptions and proceed. No collaboration is allowed. You can access your notes (not an electronic device, however).

Question 1. **[8+4+6 = 18 points]**



Consider a neural network whose input is $x \in \mathbb{R}$ and its output is

$$z := wx + b,$$

where $w \in \mathbb{R}$ and $b \in \mathbb{R}$ define the weight and the bias, respectively. Your training data is given by

$$(x_1, t_1) = (1, 2), \qquad (x_2, t_2) = (2, 3), \qquad (x_3, t_3) = (4, 5),$$

where t's are target outputs. You seek to minimize the following error function

$$E(w, b) := \sum_{i=1}^{3} \frac{1}{2}(t_i - z_i)^2.$$

a) At the start of your training process, suppose that your weight is $w = 0$ and bias is $b = 0$. Compute the derivatives $\frac{dE}{dw}$, $\frac{dE}{db}$.

b) Compute the updated weights and bias if the update rule is given by

$$w \leftarrow w - \eta \frac{dE}{dw}, \quad b \leftarrow b - \eta \frac{dE}{db}$$

with $\eta = 0.1$.

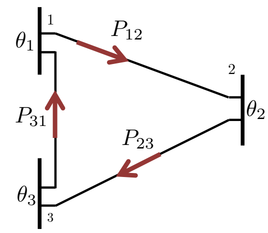
c) Compute the optimal weight w^* and bias b^* that minimizes the error? ***Hint:*** *Plot the points* $(x_i, t_i), i = 1, 2, 3$.

Question 2. **[3 points]**

In power system operation, why is it important to predict the hourly demand for electricity with a lead time, e.g., a day in advance?

Question 3. [4+4+4 = 12 points]

Consider the following 3-bus power network. Recall from lecture that after a sequence of approximations,



the power from bus i to bus j in a power system is given by $P_{ij} = (\theta_i - \theta_j)/X_{ij}$, where θ's are voltage phase angles, and X's are transmission line reactances.

a) Suppose $X_{12} = 1$, $X_{23} = 2$, $X_{31} = 1/2$. If $\theta_1 = 0$ rad, $\theta_2 = 0.3$ rad, and $\theta_3 = 0.2$ rad, compute the power P_2 injected at bus 2. ***Hint:*** *Power injected at bus k equals the sum of powers flowing from bus k to any bus connected to it.*

b) What is the sum of the powers injected at all three buses, i.e., $P_1 + P_2 + P_3$, where P_i is the power injected at bus i? ***Hint:*** *Our approximation to arrive at the dependency of power flow to voltage phase angles is such that the power network is treated as lossless.*

c) Suppose that you are given a dataset with measurements of (P_1, P_2, P_3) from a three bus power system. If data entries can be corrupted with unbiased (zero-mean) numbers, do you expect linear support vector machines to perform well to distinguish between good and bad data?

Question 4. [3 points]

Consider a classification problem that seeks to distinguish two kinds of data points marked with triangles and circles in Figure 1. What kind of support vector machine (SVM) will you choose for this classification task? Write a sentence to explain your choice.

(a) Linear SVM with hard margin

(b) Linear SVM with soft margin

(c) SVM with radial basis function as the kernel with hard margin

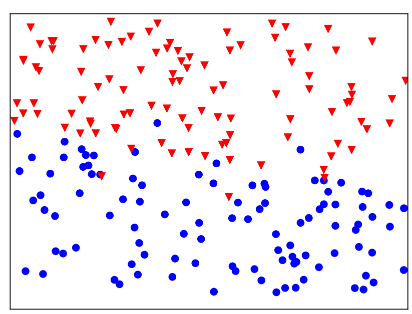


Figure 1: Example data set.

Question 5. [4 points]

Briefly describe the pros and cons of model-driven and data-driven methods for detection of bad data in a dataset.