

Shanghai Jiao Tong University ECE4530J

Homework 5: Due 2022.7.22

Problem 1

Consider a linear regression model with the hypothetical relation

$$y = \beta^T x.$$

- a) Given one practical example which can be well modeled by such a linear model. Clearly define the predictors and the response. Explain why.
- b) Given one practical example which **cannot** be well modeled by such a linear model. Clearly define the predictors and the response. Explain why not.
- c) Given one practical example which can be **approximately** modeled by such a linear model, with possibly significant error sometimes. Clearly define the predictors and the response. Explain why.

Problem 2

Suppose that we use smart meters to infer the usage of home appliances.

- (a) What data does a smart meter measure?
- (b) Why we need to retrieve “signatures” from the data rather than directly using the original data for the inference?
- (c) Suppose that we use a linear function

$$G_k(x) = \beta^T x - \gamma_k$$

to determine whether appliance k is “on” or “off”. That is, we classify appliance k to be “on” if and only if $G_k(x) > 0$. Use 1-2 sentences to describe how to obtain the coefficients β via linear regression.

- (d) Does the linear regression approach in part (c) always work for general classification problems? Why or why not?

Problem 3

Answer the following questions on neural networks.

- a) What is a deep neural network?
- b) Why this class of machine learning algorithms are called “neural networks”?
- c) What is an activation function?
- d) (bonus) Suppose that you are using a neural network (NN) for an engineering task. How would you determine the structure of the NN?