CS 559: Machine Learning: Fundamentals and Applications

Due: 3/29/2024 Thursday 11:59 p.m.

- The assignment must be individual work and must not be copied or shared. Any tendency to cheat/copy evidence will lead to a 0 mark for the assignment.
- Students must only use Pandas, NumPy, and Spacy if the coding problem does not specify libraries/packages. Use of other libraries than specified will be penalized.
- All problems must be submitted in a single notebook file. Do not work in the lecture notebook file.

1 Kernel Ridge Regression [45 pts]

a. Load the provided data sets. The train data set will be used to train the model.

b. [10 pts] Train the **NumPy implemented** kernel ridge regression model with the polynomial kernel function, $k = \langle \mathbf{x}, \mathbf{z} \rangle^d$. Find the best model with the lowest MSE value as the degree, d, increases from 2 to 11.

c. [10 pts] Write a code that constructs the kernel matrix with RBF kernel function,

$$k(\mathbf{x}, \mathbf{z}) = \exp\Big\{ -\gamma |\mathbf{x} - \mathbf{z}|^2 \Big\}.$$

The RBF kernel function must be computed using **NumPy**. With 10 different γ parameter values, train the rbf-kernel ridge regression models and find the best model.

d. [15 pts] Construct a kernel function, the product poly-kernel and rbf-kernel functions, and train the kernel ridge regression model. Find the best model with the combinations of d and γ values used in b and c. There must be a total of 100 combinations.

e. [5 pts] Using the best models found in b, c, and d, pick the best model. Explain your choice.

f. [5 pts] Generalize the best train model and predict the target.