FBA | QUANTITATIVE FINANCE RESEARCH GROUP

Financial Machine Learning

Homework 1

Due at 07:00 pm (Korea Standard Time) on Sunday, August 14.

Submit one file: written solutions with executable Python code

Following tasks to get set up for session work and future assignments.

Preparation 1. Miniconda is a free minimal installer for Conda, Python, their dependencies and small collection of packages.

(a) Start by installing Miniconda and Create new environment (python==3.8). (Korean paths can cause errors.)
(b) Install requirements.

(.ven) $ pip install -r requirements.txt

(c) **(Optional**) if you have a TensorFlow-compatible GPU, install GPU driver as well as the appropriate version of CUDA and cuDNN

Preparation 2. Practice *git clone, pull, push, and branch.* Create separate team directories and each assignment. (FML assignment *github* link:)

Problem 1. The following exercise are all based on Text book chapter 1, 2 housing dataset.

(a) Try a Support Vector Machine regressor (sklearn.svm.SVR) with various hyperparameters, such as kernel = 'linear' or kernel = 'rbf' (with various values for a C and gamma hyperparameter). How does the best SVR predictor perform?
(b) Automatically explore some preparation options using GridSearchCV and RandomizedSearchCV.

Problem 2. Given the matrix **X** and the vectors **y** and **z** below:

$$\mathbf{X} = \begin{pmatrix} x_{11} & x_{12} \\ x_{21} & x_{22} \end{pmatrix} \quad \mathbf{y} = \begin{pmatrix} y_1 \\ y_2 \end{pmatrix} \quad \mathbf{z} = \begin{pmatrix} z_1 \\ z_2 \end{pmatrix}$$

(a) Expand $\boldsymbol{X}\boldsymbol{y} + \mathrm{z}$
(b) Expand $y^T\boldsymbol{X}\boldsymbol{y}$

Problem 3. Assume matrix **X** has shape (n x d), and vector **w** has shape (d x 1).

(a) What shape is $\boldsymbol{y} = \boldsymbol{X}\boldsymbol{w}$?
(b) What shape is $(\boldsymbol{X}^T\boldsymbol{X})^{-1}$?
(c) Using **y** from part Problem 2, what shape is $(\boldsymbol{X}^T\boldsymbol{X})^{-1}\boldsymbol{X}^T\boldsymbol{y}$?

Problem 4. Solve the following.

(a) Verify that $Var(aX + b) = a^2 Var(X)$
(b) Suppose that $X_1, \dots, X_n$ are i.i.d., scalar random variables with mean μ and variance σ^2. Let $\bar{x}$ be the mean $\frac{1}{n}\sum_i^n X_i$. Find $E(\bar{X})$ and $Var(\bar{X})$.

Problem 5. Suppose that the below table represented the joint probability mass function of X and Y:

	$Y=1$	$Y=0$
$X=1$	$\frac{10}{100}$	$\frac{5}{100}$
$X=0$	$\frac{15}{100}$	$\frac{70}{100}$

(a) Calculate the marginal probability P(Y = 1). In the context of this problem, what does this probability represent?
(b) Calculate the conditional probability P(Y = 1|X = 1). In the context of this problem, what does this probability represent?
(c) Are X and Y independent? Why or why not? What is the interpretation of this?