ML Applications in Finance
Coursework PART I

M.Sc. in Financial Markets
Master Level M2 - Academic Year 2021-22
Professor: Dr. D. O'Kane

Deadline:

Midday Monday 7th March 2022

Read the following instructions carefully

- This coursework forms 30% of your overall course grade.
- Groups must be of 3 persons.
- Send your work to me by email in a zip file with the title ML_IN_FINANCE_COURSEWORK_XXXXX_YYYYY_ZZZZZ where the XXXXX, YYYYY and ZZZZZ are the student ID's of the students in the group.
- The zip file should contain a large notebook containing all of the answers. Make sure it is clearly divided into each question. Make it very clear to understand and ensure that you comment on what you did and why. The entire sheet must calculate.
- Each team must email the notebook to me at dominic.okane@edhec.edu
- All student numbers of the group members must be at the top of each notebook.
- The penalty for copying is to get zero.

1. This question is about comparing MLP to other regression models. Look at notebook **Coursework_Q1_StockPricePrediction**. This contains the trade strategy notebook we examined in Lecture 1. At the end you will see a section where you are to add an analysis of multilayer neural networks using Tensorflow.

(a) Perform the analysis by varying the number of hidden layers trying values 1,2 and 3. Also vary the number of neurons per layer to include [10, 50, 100]. Calculate the training and test error of each of these $3 \times 3 = 9$ combinations.

(b) Compare the multilayer ANN compare to the other ML models, comparing their training and test accuracy scores.

2. This question is about using ANN's as function fitting tools.

(a) Starting with the code from Lecture 2, amend the code to use Tensorflow to build the multilayer neural network. However do not use the volatility smile. Assume that volatility is a free parameter and can take any value between 10% and 50%. This is a more challenging task for a neural network as you have 3 free parameters.

(b) Consider the impact of different neural network architectures on the quality of the fit. Specifically consider the number of hidden layers being [1,2,3,4] and the number of neurons per layer equal to [10, 20, 50, 100]. Calculate the test error for each of these 16 combinations.

(c) For both of the training and test examples, use the Black-Scholes equation to calculate the corresponding option delta. Compare this to the delta implied by the trained neural network - calculate this by increasing the stock price by 0.01 and calculating the new price P' using the model predict function. Calculate $\Delta = (P' - P)/0.01$. Compare a plot of the delta as a function of moneyness, and also of volatility for each of the different architectures in (b).

3. This question is about NLP. In this coursework we use part of the **Amazon_Unlocked_Mobile.csv** dataset published by Kaggle. The dataset contains the following information:

- Product Name
- Brand Name
- Price
- Rating
- Reviews
- Review Votes

We are mainly interested in the 'Reviews' (X) and in the 'Rating' (y). The objective is to try to predict the 'Rating' after reading the 'Reviews'. I've prepared for you the train and test sets.

(a) Please first open the Coursework_Q4 notebook. Follow the sequence of questions in the notebook and answer them carefully.

4. This question is about RNNs.

(a) The one-day prediction LSTM model in the Notebook that predicts the Retail Sales index from FRED looks very good, almost too good. Check the code and make sure it is correct. I am not saying it is wrong. However you should verify this.

(b) Extend this model to a sequence-to-sequence model to predict n periods into the future - as we discussed in class. Examine to see if it performs well and do so for $n = 1, 2, 3, 4, 5$. Perform the usual tests using the test set and plot the reduction of the training and validation error over the training cycle.

(c) Repeat (b) exercise using GRU neurons instead of LSTM neurons. Compare the results.
