ECON 5060: Applied Machine Learning for Economic and Financial Analysis

HKUST Department of Economics

2023/24 Fall

Instructor: **C-Y (Eric) NG** Email: ecyng@ust.hk Office: LSK 6016D Office hours: by appointment Teaching Assistant: Victor Yip Email: victory@ust.hk Office: LSK 6066	Dates: Oct 16 – Oct 16 and Oct 30 – Dec 11 Lecture: Mon 15:00 – 18:20 Room: Rm 1034, LSK Bldg Course website: https://canvas.ust.hk

Course Description

This course introduces the applications of machine learning for economic and financial analysis. It relates different business problems to the relevant supervised, unsupervised, and reinforcement learning tasks. Topics include valuation of property prices, macroeconomic forecasting, credit risk prediction, financial transaction fraud detection, portfolio analysis, volatility prediction, market anomaly detection, and trading decision analysis. Students will learn and apply basic machine learning tools to solve practical economic and financial problems.

Prerequisites

Undergraduate training in introductory econometrics and statistics is expected.

Program Intended Learning Outcomes (PILOs)

Upon successful completion of this course, students will be able to:

1. Identify the appropriate machine learning task for a potential economic and financial application. (PILO 6, 9)
2. Differentiate machine learning by regression, classification, clustering, and strategy optimization. (PILO 6, 9)
3. Apply machine learning methods to analyze practical cases related to economics and finance. (PILO 8, 9, 10, 12)
4. Implement machine learning techniques in Python. (PILO 9, 13)

Assessment Scheme

- Group Project (Dec 15): 70%
- In-class Quiz (Dec 11): 30%

Please form a group of 4 members and email your group information (names and student numbers) to me by 23 Oct. We may conduct peer evaluation to assess individual contribution to the group.

Learning Resources

There is no required textbook. We use lecture slides and code examples for teaching. All teaching files are downloadable from the course CANVAS website (https://canvas.ust.hk).

This course uses Jupyter Notebook to write Python codes. Please download Anaconda Python package online. You also need to install different ML libraries. Please refer to the file "Installation of ML Libraries" for details. You are recommended to bring your laptop when we teach the code examples in the lectures and tutorials.

Group Project[1]

Content Requirements:

- Choose one from the given topics
- Formulate the ML procedures or methodologies in addressing the topic
- Collect, compile, preprocess, and analyze the data
- Apply at least five different ML methods that you learn in this course to solve your ML task
- Summarize the findings, make conclusion and recommendations

Format Requirements:

- Word or PDF
- A cover page with title and group information (group number, student names and numbers).
- The structure includes an introduction (or executive summary), main body, conclusion, and a list of references.
- **A maximum of 16** pages including the cover page, tables, charts, and references
- Font size 11 or 12, double spacing

Submission of Term Paper:

- Please email your term paper together with the code file to me by December 15.

[1] Please refer to the file "Group Project Guidelines" for more details.

Course Outline (tentative)

1: Machine Learning Landscape

2: Supervised Learning: Regularized Regression Models

- Financial Application: Residential Property Valuation
- Methods: Regression with Regularization (Ridge, LASSO, Elastic Net)

3: Supervised Learning: Dimensionality Reduction and Feature Selection Methods

- Economic Application: GDP Forecasting
- Methods: Principal Component Analysis, SelectKBest, Recursive Feature Elimination

4: Supervised Learning: Classification Models

- Banking Application: Default Risk Prediction
- Methods: Logistic Regression, SGD Classifiers, Decision Trees, Support Vector Machines

5: Supervised Learning: Ensemble Methods

- Banking and Economic Applications: Default Risk Prediction, Recession forecasting
- Methods: Random Forest, Extra Tree, Gradient Boosting, XGBoost

6: Cost-Sensitive Learning Models

- Banking Application: Payment Card Fraud Detection
- Methods: Example-Dependent Cost-Sensitive Logistic Regression, Decision Trees, Random Forecast

7: Unsupervised Learning: Outlier Detection Models

- Banking Application: Credit Card Fraud Detection
- Methods: Isolation Forest, Local Outlier Factor, One-Class Support Vector Machine

8: Unsupervised Learning: Clustering Analysis

- Financial Application: Portfolio Construction
- Methods: K-Means, Gaussian Mixture

9: Supervised Learning: Neural Networks

- Financial Application: Volatility Prediction
- Methods: Multilayer Perceptron Neural Network, Recurrent and Long Short-Term Memory Network

10: Unsupervised Learning: Autoencoder

- Financial Application: Stock Market Anomaly Detection
- Method: LSTM Autoencoder

11: Reinforcement Learning

- Financial Application: Stock Trading Decisions
- Methods: Q-Learning, Deep Q-Learning, Policy Gradient methods and its variants