ECON 4305: 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: Jeremy TO Email: ecjeremy@ust.hk Office LSK 6066 Office hours: by appointment	Lecture: Mon & Wed 10:30 - 11:50 Room: Rm 2504, Lift 25-26 Tutorial: Tue 15:00 - 15:50 Room: LSK 1014 Course website: https://canvas.ust.hk

Course Description

This course applies machine learning to solve economic and financial problems, including residential property valuation, GDP and recession forecasting, default risk prediction, credit card fraud detection, portfolio analysis, volatility prediction, market anomaly detection, and stock trading decisions. It maps those problems into relevant supervised, unsupervised, and reinforcement learning tasks, and introduces basic machine learning methods. Students will get hands-on machine learning experience to analyze business problems.

Prerequisites

ECON 3334 or equivalent

School Intended Learning Outcomes (SILOs)

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. (SILO 1, 3).
2. Differentiate machine learning by regression, classification, clustering. (SILO 1).
3. Apply machine learning methods to analyze practical cases related to economics and finance. (SILO 1, 3)
4. Implement machine learning techniques in Python. (SILO 1).
5. Conduct secondary research using machine learning methods (SILO 1, 3).
6. Communicate effectively in oral and written English (SILO 2).

Assessment Scheme

- Term Paper (Group): 56%
- Presentation of Term Paper (Group): 14%
- In-class Quiz (Individual): 30%

Please form a group of 4 members and email your group information (names and student numbers) to me by 15 Sep. We may conduct peer evaluation to assess individual contribution to the group. You can use the term paper to fulfill the requirement of ECON 4670 if you have not taken it before.

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.

Term Paper[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 20 pages**[2] including the cover page, tables, charts, and references.
- Font size 11 or 12, double spacing

Presentation of Term Paper: Each group will make a 15-minute presentation on December 1.

Submission of Term Paper: Please email your term paper together with the code file to me by December 2.

[1] Please refer to the file "Term Paper Guidelines" for more details.
[2] If you would like to use the term paper to fulfil the requirements of ECON 4670, you need to comply with the minimum page requirement: For a group project, each student should write at least 7 pages.

Course Outline (tentative)

1: Machine Learning Landscape (Week 1)

2: Supervised Learning: Regularized Regression Models (Week 2, 3)

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

3: Supervised Learning: Dimensionality Reduction and Feature Selection Methods (Week 3, 4)

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

4: Supervised Learning: Classification Models (Week 4, 5)

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

5: Supervised Learning: Ensemble Methods (Week 5, 6)

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

6: Cost-Sensitive Learning Models (Week 6, 7)

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

7: Unsupervised Learning: Outlier Detection Models (Week 7, 8)

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

8: Unsupervised Learning: Clustering Analysis (Week 8, 9)

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

9: Supervised Learning: Neural Networks (Week 9, 10)

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

10: Unsupervised Learning: Autoencoder (Week 10, 11)

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

11: Reinforcement Learning (Week 11, 12)

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