ECON 4999V: Applied Machine Learning for Economic and Financial Analysis

HKUST Department of Economics

2022/23 Fall

Instructor: **C-Y (Eric) NG** Email: ecyng@ust.hk Office: LSK 6016D Office hours: by appointment Teaching Assistant: Email: Office: TBA Office hours: by appointment	Lecture: Mon & Wed 12:00PM - 01:20PM Room: LSK 1033 Tutorial: Tue 11:00AM - 11:50AM Room: LSK 1033 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, and market anomaly detection. It maps those problems into relevant supervised/unsupervised learning tasks and introduces basic machine learning methods. Students will get hands-on experience with machine learning to analyze practical 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, 4).
2. Describe the core differences in machine learning by regression, classification, and clustering. (SILO 1).
3. Apply machine learning methods to analyze practical cases related to economics and finance. (SILO 1, 4)
4. Implement machine learning techniques in Python. (SILO 7).
5. Conduct secondary research using machine learning methods (SILO 4, 7).
6. Communicate effectively in oral and written English (SILO 2).

Teaching Approach

This course is primarily delivered through lectures and a group project.

Teaching & Learning Activities	Roles in the Course	Course Learning Outcomes Addressed
Lectures	Explain machine learning concepts and methods to students.	1, 2, 3, 4
Group Project	Learn to apply machine learning methods to conduct research and present findings.	1, 3, 4, 5, 6

Assessment Scheme

- Term Paper (Group):   50%
- Presentation of Term Paper (Group):   20%
- In-class Quiz: 30%

Please form a group of 3-4 people 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_list" for details. You are highly recommended to bring your laptop when we teach the code examples in the lectures.

Term Paper

Content Requirements:

- Choose one of the given topics or initiate a topic subject to the approval of instructor
- Formulate the 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
- Report the findings

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.
- **Maximum 16 pages** (cover page/tables/charts included) with font size of 11 or 12, double spacing.

Presentation of Term Paper:

- You will make a presentation in Week 13 (28, 30 Nov). Each group will present for 15-20 minutes.
- Please email your presentation slides to me before your presentation.

Submission of Term Paper:

- Please email your term paper together with the code file to me by 30 Nov.

Course Outline

Topic 1: Introduction (Week 1)

- Difference between statistical modeling and machine learning
- The machine learning landscape
- Installation of ML libraries

Topic 2: Supervised Learning: Regression Analysis (Week 2, 3)

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

Topic 3: Supervised Learning: Regression with Dimensionality Reduction and Feature Selection (Week 3, 4)

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

Topic 4: Supervised Learning: Classification Analysis (Week 4, 5)

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

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

- Banking Application: Default Risk Prediction
- Economic Application: Recession forecasting
- Methods: Ensemble Learning (Random Forest, Extra Tree, Gradient Boosting, XGBoost)

Topic 6: Unsupervised Learning: Ensemble and Other Methods (Week 6, 7)

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

Topic 7: Unsupervised Learning: Clustering Analysis (7, 8)

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

Topic 8: Supervised learning: Neural Network (8, 9)

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

Topic 9: Unsupervised Learning: Neural Network (9, 10)

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

*Note that I may fine tune some of the topics above while ensuring the course objectives being achieved.