Econ629 : Economic and Financial Applications of Machine Learning

COURSE AIMS & OBJECTIVES, KEY SKILLS AND LEARNING OUTCOMES

Course Aims & Objectives: The aim of this course is to present several concrete applications of ML techniques in Economics and Finance.

Examples of topics:

- Industry: predictive maintenance and equipment monitoring
- Retail: upselling and cross-channel marketing
- Health and life sciences: diagnosis and risk reduction
- Financial services: risk analysis and regulation, credit risk
- Insurance: Fraud detection
- Energy: demand and supply optimisation
- Asset management: investment opportunities, portfolio optimization

Key Skills: By the end of this course, students should have some knowledge and understanding of:

- Applied Machine Learning Skills: Ability to apply machine learning techniques in practical applications.
- Deployment of Machine Learning Models: Skills to deploy and test machine learning models in real-life projects.
- Practical Application: Hands-on experience in using machine learning for concrete applications.
- Real-life Project Implementation: Applying machine learning skills to real-world projects.
- Machine Learning Model Testing: Ability to rigorously test machine learning models for real-world scenarios.
- Practical Deployment Expertise: Expertise in deploying machine learning models in practical settings.
- Problem-Solving with ML: Addressing real-world problems through the application of machine learning.
- Knowledge of Real-life ML Challenges: Understanding and navigating challenges specific to deploying ML models in real-life projects.

Desired Outcomes: By the end of this course, students should be able to:

- Analyse, appraise and interpret real data effectively;
- Evaluate and interpret data in order to solve advanced complex problems in economics or finance;
- Describe and explain their understanding of ML techniques, demonstrating enhanced knowledge of this area.

COURSE STRUCTURE

Econ 629 is a 10 credits course and therefore students are expected to input approximately 100 hours of study into the course. The total number of contact hours on Econ 629 is 15 hours. This leaves 85 hours for private study. Course Delivery comes in the form of Lectures with 15 hours delivered over the first 3 weeks of the term (10 hours of lectures and 5 hours of tutorials). There will be optional clinics on the last day of the course.

During your private study you should strike a balance between reading the course material (which is the primary source of information) and the recommended textbooks, thinking critically about how these fit in to the body of knowledge on the subject and about how our level of knowledge can be improved, performing exercises, completing coursework and revising for examinations. You can expect to perform well on this course only if you work consistently through the year.

Prior to enrolment on the module, the student must have successfully completed Econ620

COURSE CONVENOR

Prof. Wouter Verbeke

LECTURERS CONTACT INFORMATION (Including Office Hours)

Prof. Wouter Verbeke

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Dr. Guillaume Coqueret

email: coqueret@em-lyon.com

COURSEWORK ASSESSMENT

The CWA mark will be calculated as 100% coursework. The coursework will be assigned at the end of the course.

The coursework will be delivered to students at the end of week 6 of each term and is due for submission at the end of week 10 of the term, allowing students 4 weeks for completion.

Coursework must be submitted electronically through the Moodle site for this course:

FEEDBACK ON COURSEWORK:

The coursework will be marked and returned to students within 4 weeks of the submission deadline. Feedback will consist of marker's notes appended to the pdf of your coursework.

MARKING CRITERIA AND PENALTIES

Marking criteria can be found in the Economics Undergraduate Handbook and the general course information paper. An electronic copy of this can be found via the Current Student page of the university website then follow the Academic Regulations link https://gap.lancs.ac.uk/ASQ/QAE/MARP/Documents/UG-Assess-Regs.pdf

FINAL MARK INFORMATION

This course is assessed 100% by means of coursework. The final mark is the average of the marks obtained in the two pieces of coursework.

COURSE TEXT AND RECOMMENDED READING

ANG A., Asset Management: A Systematic Approach to Factor Investing, Oxford University Press, 2014.

BAESENS B., VAN VLASSELAER V., VERBEKE W., Fraud Analytics Using Descriptive, Predictive, and Social Network Techniques: A Guide to Data Science for Fraud Detection, Wiley, ISBN 1119133122, 2015.

COQUERET G., GUIDA T., Machine Learning for Factor Investing, CRC Chapman Hall, 2020 (or 2022 for the Python version).

SCHEUCH C., VOIGT S., WEISS P., Tidy Finance, CRC Chapman Hall, 2023.

VERBEKE W., BRAVO C., BAESENS B., Profit Driven Business Analytics - A Practitioner's Guide to Transforming Big Data into Added Value, Wiley, 2017.

VAN GESTEL T., BAESENS B., MARTENS D., Predictive Analytics: Techniques and Applications in Credit Risk Modelling , Oxford University Press, forthcoming, 2022.

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COURSE OUTLINE/LECTURE SCHEDULE

The purpose of this course is to introduce and have students apply up to date ML techniques to real economic and financial problems that may differ from year to year. Machine learning and its extensions are used in all business sectors, including industry, commerce, health and life sciences, financial services, energy, commodities and utilities.

More specifically, the course could for instance cover several applications including credit scoring, fraud detection and quantitative investing.

Session 1: Developing a credit scorecard for credit risk management (2h30 lectures, 1h tutorial)

- Introduction to credit scoring and credit risk management
- Introduction to Basel I, II and III regulation, and PD, LGD and EAD modeling
- Data preprocessing for PD modeling
- Building PD models
- Postprocessing PD models
- Developing a credit rating system

Session 2: Developing an insurance fraud detection system (1h00 lecture, 1h tutorial)

- Introduction to fraud detection
- Descriptive analytics for fraud detection
- Predictive analytics for fraud detection
- Social network analytics for fraud detection
- Feature engineering for fraud detection
- Handling the imbalanced class distribution

Session 3: Developing a customer churn and response model for customer relationship management (1h30 lecture, 30m tutorial)

- Predictive analytics for customer churn and response prediction
- Prescriptive analytics for customer response modelling
- Introduction to causal machine learning for treatment effect modelling
- Profit-driven customer churn and response modelling
- Cost-sensitive decision-making

Session 4: Foundations of factor investing (1h15 lecture, 30 min tutorial)

- Historical perspective (Fama-French & the factor zoo)
- Theoretical groundwork (partial equilibrium models)
- Panel models
- Practical application: portfolio sorts
- Tutorial: Fama-MacBeth regressions

Session 5: Data preparation and penalized models (1h15 lecture, 30 min tutorial)

- Missing data and outlier management
- Penalized regressions
- Sparse portfolios (to be coded during the tutorial)

Session 6: Nonlinear models (1h15 lecture, 45min tutorial)

- Tree methods
- Neural networks
- Tutorial: boosted trees with alternative libraries

Session 7: Parameter tuning and backtesting (1h15 lecture, 45min tutorial)

- The variance-bias trade-off & the different flavours of overfitting
- Tuning methods (example: grid search)
- Principles of backtesting
- Tutorial: ML-powered backtest