UNIVERSITY OF CAMBRIDGE
Faculty of Economics

D200 - MACHINE LEARNING IN ECONOMICS
COURSE OUTLINE 2024-25

LECTURER: Dr. Stefan Bucher

https://www.econ.cam.ac.uk/people/faculty/sfb41

OFFICE HOURS: Thu 11.30am-12.30pm

FORMAT OF COURSE:

Teaching Hours Overview:

- 18 hours comprising of 9 Lectures during Lent Term.
- 10 hours comprising of 5 x 2-hour Classes

COURSE OVERVIEW:

Course Description:

Machine Learning is in the process of transforming economics as well as the business world. This course aims to provide a graduate-level introduction to machine learning equipping students with a solid and rigorous foundation necessary to understand the key techniques of this fast-evolving field and apply them to economic problems. The curriculum bridges theoretical foundations with practical implementations and strives to remain relevant by teaching a conceptual understanding that transcends the implementation details of current state-of-the art methods.

Course Aims and Objectives:

By the end of this course, students will be equipped with:

- a foundational understanding of the most relevant ML tools and how they are reshaping economic analysis
- the ability to work with ML models using popular software environments such as **PyTorch** and scikit learn, and to adapt them for economic problems
- critical skills in interpreting and explaining sophisticated ML models in economic contexts

Specifics Topics Covered:

The course covers key methods in:

- supervised learning, including regression, classification, and neural networks
- unsupervised learning, including clustering and dimensionality reduction
- reinforcement learning, including bandit problems
- applications to economics.

Contents and Schedule

- Introduction and Foundations - Week 1

Part 1: Supervised Machine Learning

- Prediction and Linear Regression - Week 2
- Classification and Logistic Regression - Week 3
- Artificial Neural Networks and Deep Learning - Week 4

Part 2: Unsupervised Machine Learning

- Unsupervised Learning - Week 5
- Generative AI and Natural Language Processing (NLP) - Week 6

Part 3: Reinforcement Learning

- Reinforcement Learning - Week 7

Part 4: ML and Economics

- Consumer Choice Modelling - Week 8
- ML and Economics - Week 9

Lecture Notes:

Lecture materials will be posted on Moodle.

Computing Environment

The lectures and classes feature examples in Jupyter Notebooks for use on Google Colab. Students with a demonstrated need can request HPC access (e.g. for the project) after consulting with the instructor.

Prerequisites

Linear Algebra, calculus, probability theory and statistics, as well as programming skills (ideally in Python) are required.

RESOURCES AND READING MATERIALS:

Resource:	Description:
Textbook	Prince [2023] which is freely available at https://udlbook.github.io/udlbook/.
Further reading	Christopher M. Bishop. *Pattern recognition and machine learning*. Information science and statistics. Springer, New York, 2006.
Further reading	Trevor Hastie, Robert Tibshirani, and J. H. Friedman. *The elements of statistical learning: data mining, inference, and prediction*. Springer series in statistics. Springer, New York, NY,2nd ed edition, 2009.
Further reading	Ian Goodfellow, Yoshua Bengio, and Aaron Courville. *Deep learning*. Adaptive computation and machine learning. The MIT Press, Cambridge, Massachusetts, 2016.
Further reading	David J. C. MacKay. *Information theory, inference, and learning algorithms*. Cambridge University Press, Cambridge, 22nd printing edition, 2003.
Further reading	Kevin P. Murphy. *Probabilistic machine learning: an introduction*. Adaptive computation and machine learning series. The MIT Press, Cambridge, Massachusetts, 2022.
Further reading	Richard S. Sutton and Andrew G. Barto. *Reinforcement learning: an introduction*. Adaptive computation and machine learning series. The MIT Press, Cambridge, Massachusetts, second edition, 2018.

ASSESSMENT AND EXAMINATION STRUCTURE:

Assessment in the course is based entirely on the completion of a small-scale research project.

The grade is composed of three submissions, due at noon UK time.

• 10% Proposal (due 10th March 2025): 1-page description of the proposed project, clearly articulating the research questions and the methods to be used.

• 30% Draft (due 24th March 2025): Complete draft of the project report.

• 60% Submission (due 7th April 2025): Final project report incorporating feedback received in response to the draft.

The project report should be around 4 single-spaced pages, approximately 2000-2500 words.