

MODULE SPECIFICATION • CORE

Advanced Machine Learning and Deep Learning Techniques for Business and Economics

This course takes a look at modern machine learning techniques. It takes participants through recent advances in supervised and unsupervised methods and algorithms with a focus on complex business applications. Practical implementations include the use of modern recommendation systems packages, XGBoost, CatBoost, LightGBM, transparent inference, SHAP value analysis, mixture of expert architectures and more. It also provides an introduction to deep learning techniques — reviewing the use of deep neural networks, deep reinforcement learning, recurrent nets and convolutional neural networks among others.

20 CREDITS	25h CONTACT HOURS	175h PRIVATE STUDY	200h TOTAL STUDY
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COURSE CONVENOR

NAME Prof. Badih Ghatthas

OFFICE By appointment — please email to arrange a convenient time

COURSE STRUCTURE

Econ 7920 is a 20-credit course and students are expected to input approximately 200 hours of study. The total number of contact hours is 25 hours, leaving 175 hours for private study. Delivery is by lectures — 25 hours across the first five weeks of term, comprising 20 hours of lectures and 5 hours of tutorials. Optional clinics run on the last day of the course.

During private study, balance the course material (the primary source) against the recommended textbooks: think critically about how these fit into the body of knowledge, perform the exercises, complete coursework and revise. You can expect to perform well only by working consistently through the year.

Prerequisite. Must have successfully completed ECON 7901, ECON 619 and ECON 7921.

MODULE PROGRAMME

LECT.	TOPIC	SESSION CONTENT
01	Introduction to Advanced Machine Learning Techniques	— The role of advanced techniques in solving complex problems — Overview of popular advanced techniques, including deep learning, reinforcement learning and generative models
02	Ensembles	— The basics of model ensembles — Random forests — Gradient Boosting, XGBoost, CatBoost
03	Deep Learning	— What is deep learning and how does it work? — Successes and limitations of deep learning approaches — Implementing deep learning models using popular libraries and frameworks — Convolutional networks, pooling and dropout — Natural language processing and recurrent neural networks — Applications of deep learning in computer vision and natural language processing
04	Reinforcement Learning	— The basics of reinforcement learning and its applications — Implementing reinforcement learning algorithms using popular libraries and frameworks — Examples of reinforcement learning in real-world applications

KEY SKILLS

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

- **Problem-solving with ML.** Ability to address real-world challenges using machine learning.
 - **Comprehensive ML knowledge.** Broad understanding of diverse machine learning topics.
 - **Deep learning.** Mastery of advanced techniques in deep learning.
 - **Generative models.** Understanding and application of generative models.
- **Natural language processing.** Skills in leveraging NLP for complex problem-solving.
 - **Advanced AI techniques.** Exploration and application of cutting-edge AI techniques.
 - **Reinforcement learning.** Proficiency in applying reinforcement learning methodologies.
 - **Complex problem tackling.** Application of skills to address intricate real-world problems.

DESIRED OUTCOMES

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

- Demonstrate a sound knowledge of supervised and unsupervised learning techniques
 - Present, interpret and analyse information in numerical form and use econometric and other packages effectively
 - Understand the relevance of different econometric approaches to specific applications in economics
- Be able to select relevant information from large amounts of data
 - Master the advanced tools of machine learning and deep learning
 - Communicate and present complex arguments with clarity and succinctness
 - Plan and manage time effectively



ASSESSMENT

WEIGHTING	100% coursework
ISSUED	End of week 6
DUE	End of week 10 — four weeks for completion
SUBMISSION	Electronically via the Moodle site for this course
FEEDBACK	Returned within 4 weeks of the deadline, as marker's notes appended to the PDF of your coursework

Marking criteria and penalties are set out in the Economics Undergraduate Handbook and the general course information paper, available via the Current Student page of the university website under Academic Regulations.

COURSE TEXT & RECOMMENDED READING

Lecture notes and lecture slides are made available on the course web pages, together with additional material and course announcements.

- Python Data Science Handbook: Essential Tools for Working with Data. O'Reilly
- Kane, F. Hands-On Data Science and Python Machine Learning. Packt Publishing
- Kauermann, G., Küchenhoff, H. and Heumann, C. Statistical Foundations, Reasoning and Inference: For Science and Data Science. Springer Nature
- Skansi, S. Introduction to Deep Learning: From Logical Calculus to Artificial Intelligence. Springer
- Chollet, F. Deep Learning with Python. Simon and Schuster