Lehrstuhl für Computational Economics

RWTH AACHEN UNIVERSITY

Deep Learning in Economics

Summer Semester 2026

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Contents

About This Syllabus

This syllabus serves as the central reference document for the master's seminar *Deep Learning in Economics*. It consolidates all relevant information regarding course content, structure, assessment components, and organizational framework of the module.

Important Note on Course Selection: Enrollment in this seminar is limited. Students are explicitly asked to read this syllabus carefully *before selecting the module*. The syllabus does not replace active participation in seminar sessions or independent preparation and follow-up work, but it provides a structured overview of the course requirements and objectives.

Module Description

The seminar *Deep Learning in Economics* provides an introduction to the foundations and applications of deep learning in quantitative economics. At the beginning of the course, key concepts in linear algebra, Python programming, and economic modeling are systematically reviewed to ensure a common methodological starting point. Subsequently, the structure and functioning of neural networks as well as central training and optimization procedures are covered. The methodological content is reinforced through practical exercises in Python, in which models are implemented, trained, and evaluated. In the final stage of the seminar, students independently apply the learned methods to an economic research question and critically reflect on the results as well as on the limitations of the approach compared to classical methods.

Learning Objectives

After successfully completing the seminar, students are able to conceptually understand deep-learning methods and systematically integrate them into economic research questions. They can independently implement, train, and evaluate neural networks in Python, analyze economic datasets using deep-learning models, and critically interpret the results within an economic context. Furthermore, students are capable of conducting their own empirical projects in the field of Deep Learning & Economics, documenting them in a methodologically sound manner, and presenting their findings in an appropriate academic format.

Position within the Study Program

The seminar is aimed at students with an interest in economics, computational methods, and programming. It complements existing courses in economics, econometrics, economic modeling, and applied economic methods by introducing modern deep learning techniques and provides a methodological bridge between economics, data analysis, and computer science.

Prerequisites

There are no formal prerequisites for participation in the seminar. However, basic knowledge of Python, linear algebra, and economic modeling is expected. In addition, students should have an interest in programming, data-driven analysis, and quantitative methods. The expected academic level roughly corresponds to the knowledge typically acquired in the following courses or comparable modules:

- **Economic Foundations**
  - Understanding of microeconomic concepts such as utility functions and optimization under constraints.
  - Ability to interpret and formalize simple economic decision problems.
  - Level comparable to introductory undergraduate courses in economics (e.g., *VWL: Einführung* in the Bachelor's program).
- **Modeling and Optimization**
  - Understanding of optimization problems, objective functions, and constraints.
  - Ability to formally specify and analyze mathematical models.
  - Level comparable to courses such as *Operations Research 1 (OR 1)* in the Master's program or similar modules in mathematical modeling.
- **Linear Algebra**
  - Knowledge of matrices, vectors, and systems of linear equations.
  - Ability to perform basic matrix operations and interpret linear transformations.
  - Level comparable to standard undergraduate mathematics courses (e.g., *Mathematik B* in the Bachelor's program in Business Administration).
- **Programming**
  - Basic experience with Python.
  - Familiarity with variables, loops, functions, and basic data structures.
  - Ability to implement simple numerical or data-driven procedures.
  - Level comparable to *Introduction to Python (fIT course, IT Center RWTH Aachen)* or similar introductory programming courses.

Structure of the Seminar

The seminar consists of three phases:

1. **Refresher Phase:** Review of key foundations in Python, linear algebra, and economic modeling.
2. **Deep Learning Phase:** Introduction to neural networks and their application to economic questions.
3. **Project Phase:** Independent development and presentation of a data-based project.

Schedule

Date (Room)	Time	Content	Assessment
13. April (508*)	14:30–16:00	Kick-off: Organization, Structure, Overview	–
20. April (508)	14:30–16:00	Refresher (Part I): Python Basics	–
27. April (508)	14:30–16:00	Refresher (Part II): Linear Algebra	Quiz I
4. May (508)	14:30–16:00	Refresher (Part III): Economic Modeling	Quiz II
6. May (508)	14:30–16:00	What is a Neural Network?	–
11. May (508)	14:30–16:00	How do Neural Networks Learn?	Quiz III
13. May (508)	14:30–16:00	Building Our First Model	–
21. May (508)	14:30–16:00	Neural Networks for Economic Applications	–
–	–	Project Work Phase: Meetings upon request	–
–	23:59	Jupyter Notebook Submission Deadline	Project
09. July (508)	14:30–16:00	Final Presentations I	Presentation (Part I)
13. July (508)	14:30–16:00	Final Presentations II	Presentation (Part II)

* Sammelbau Templergraben 64, 5th Floor, Room 508.

Refresher Phase

At the beginning of the seminar, key methodological foundations will be revisited to ensure a common starting level and to reduce potential differences in prior knowledge. The refresh sessions are explicitly designed as a refresher; relevant prior knowledge is assumed for all participants.

The refresh phase consists of three thematic blocks:

- Python,
- Linear Algebra,
- Economic Modeling.

The content of these sessions builds on fundamental knowledge required for understanding, applying, and critically evaluating deep learning methods in economic applications. The refresh is conducted in a condensed format and does not serve as a first-time introduction to these topics. Supplementary materials will be provided to support more extensive independent revision.

Important Note: The refresh sessions do not replace introductory courses. Students are expected to possess basic knowledge in the respective areas prior to the start of the seminar. The sessions are designed to move through the material at a brisk pace.

To assess the required foundational knowledge, a short quiz will be administered after each thematic block. The quizzes will take place one week after the corresponding refresh session.

Deep Learning Phase

In the content-focused sessions, the fundamental concepts of neural networks are developed and systematically applied to economic questions. The objective is to build both an intuitive understanding and a formal framework that enables students to critically assess and independently apply deep learning methods.

The course begins by clarifying what a neural network is and how it can be understood as a flexible, nonlinear approximation method. Building on this foundation, the learning process of a network is introduced, including loss functions, optimization via gradient-based methods, and the central role of backpropagation, both conceptually and formally.

Subsequently, a first neural network is constructed step by step. Model architecture, activation functions, the training process, and model evaluation are implemented and analyzed in practice. The focus is not only on technical implementation, but also on interpreting each component from an economic perspective.

Project Phase

In the final phase of the seminar, students apply the methods learned to a specific economic research question. To this end, they develop an independent final project in the form of a Jupyter Notebook. The results of the project are presented and discussed in a concluding presentation session.

The project is intended to demonstrate that students are able to independently apply deep learning methods—especially neural networks—to economic data and to present their results in a methodologically rigorous manner. In addition to the technical implementation, particular emphasis is placed on the economic interpretation of the results as well as on a critical reflection of the strengths and limitations of the methods used.

The specific content of the projects may vary and can, in principle, be freely chosen. Possible topics range from applications in finance and labor economics to decision-making, policy analysis, data analysis, and many other areas. A number of project suggestions will be provided; however, students are strongly encouraged to propose their own topics, provided that a meaningful deep learning approach can be applied.

Assessment and Grading

Assessment Component	**Weight**
Quiz 1 (Python)	10 %
Quiz 2 (Linear Algebra)	10 %
Quiz 3 (Economic Modeling)	10 %
Final Project (Jupyter Notebook)	30 %
Final Presentation	40 %

Participation and Absence Due to Illness

This is a restricted-enrollment master's seminar with mandatory attendance. If you are unable to attend a session, please inform me via email (philipp.olivier@econ.rwth-aachen.de). If you are unable to attend a session that includes an assessed component due to illness, you are required to submit a medical certificate. It is not necessary to send the certificate to the Central Examination Office (ZPA); submitting it directly to me is sufficient.

Organization

Further information regarding dates, rooms, materials, and organizational procedures will be provided via the Moodle learning platform. In addition, a detailed syllabus will be published on the website of the Chair of Computational Economics in the coming days.

Please note that for restricted-enrollment master's seminars, a separate examination registration is mandatory. Registration must be completed via the Curriculum Support section in RWTHonline. The registration period takes place during the first week of lectures.
Please inform the instructor immediately if you do not wish to accept an assigned spot.