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Machine Learning in Health Economics
(University of Lucerne)

Course instructor:
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Timetable: 1st part via Zoom: May 20, 2026 (11am to 12am)
2nd part in person: June 8-12, 2026 (9am to 4pm)

Prerequisites: Solid introductory courses in econometrics. Preferably some basic knowledge of R and Python. Participants should bring their own laptop with R and/or Python installed. The target audience are PhD students.

Grading: Successful participation; see separate pdf

Course description:
The course will be a block lecture including tutorials and student presentations. The course covers a selection of state-of-the-art methods in econometrics and machine learning. It aims to provide students with a sound understanding of the methods discussed, such that they are able to do research using modern econometric techniques, as well as critically assess existing studies.

In particular, the course will cover the following topics:

- Lecture 1 & 2: OLS and 2SLS (Recap)
- Lecture 3: Regression Shrinkage Methods, Decision Trees and Random Forests, DML
- Lecture 4: Lasso and Invalid IVs (Application: Mendelian randomization)
- Lecture 5: Causal Forests (Application: Heterogenous Effects of Poverty on Cognition)
- Lecture 6: Deep Learning (Application: Fraud Detection in Claims Management)

Timetable:

	Monday	Tuesday	Wednesday	Thursday	Friday
9-11	Lecture 1 & 2 (Recap)	Lecture 3	Lecture 5	Lecture 6	Presentations
11-13	Lecture 3	Lecture 4	Lecture 5	Lecture 6	Presentations
13-14			**Lunch break**		
14-16	Lecture 3	Project Work	Project Work	Project Work	Presentations

In lecture 1 I will briefly recap the basics in OLS and 2SLS. If you have already heard about these methods, feel free to arrive on Monday at 11am.

Project Work: In these slots you are supposed to work on your application. I will be available for individual questions and discussions.

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1^{st} part of the course (via Zoom):

In the first meeting, we will briefly discuss the econometric methods. In this meeting we will also talk about the (replication) project, which each student has to present at the second part of the course. Students are supposed to work on the replication project before the second part of the course begins.
https://tum-conf.zoom-x.de/j/3812932930 (access code in a separate mail)

2^{nd} part of the course (in person):

The second part of the course will include lectures and tutorials. Moreover, the students will discuss their (replication) projects similar to a reading course. In the morning sessions, we will discuss the econometric methods and/or machine learning techniques (including some applications to illustrate them). Students will then replicate recent research papers in economics and will present their projects in the afternoon sessions. All participants are expected to read the papers before the meetings.

Recommended textbooks:

- Goodfellow Ian, Bengio Yoshua and Courville Aaron. *Deep Learning*, MIT Press, available here
- Bishop Christopher. *Pattern Recognition and Machine Learning*, Springer, available here
- Hansen Bruce. *Econometrics*, available here
- Hastie Trevor, Tibshirani Robert and Friedman Jerome. *The Elements of Statistical Learning*, Springer, available here
- James Gareth, Witten Daniela, Hastie Trevor and Tibshirani Robert. *An Introduction to Statistical Learning with Applications in R*, Springer, available here

Papers you should read (potential project applications):

- Angrist and Frandsen (2022): Machine Labor, *Journal of Labor Economics*, 40(S1), S97–S140.
- Bach *et al.* (2022): DoubleML - An Object-Oriented Implementation of Double Machine Learning in Python, *Journal of Machine Learning Research* 23(53), 1-6.
- Borgschulte and Vogler (2020): Did the ACA Medicaid Expansion Save Lives?, *Journal of Health Economics*, 72, 102333.
- Brot-Goldberg *et al.* (2017): What does a Deductible Do? The Impact of Cost-Sharing on Health Care Prices, Quantities, and Spending Dynamics, *Quarterly Journal of Economics*, 132(3), 1261–1318.
- Buchner, Wasem and Schillo (2017): Regression Trees Identify Relevant Interactions: Can this Improve the Predictive Performance of Risk Adjustment?, *Health Economics*, 26, 74–85.
- Everding and Marcus (2020): The Effect of Unemployment on the Smoking Behavior of Couples, *Health Economics*, 154–170.
- Farbmacher, Guber, Klaassen (2022): Instrument Validity Tests with Causal Forests, *Journal of Business and Economic Statistics*, 40(2), 605–614.
- Farbmacher, Löw, Spindler (2022): An Explainable Attention Network for Fraud Detection in Claims Management, *Journal of Econometrics*, 228(2), 244–258.
- McGuire, Zink and Rose (2021): Improving the Performance of Risk Adjustment Systems, *American Journal of Health Economics*, 7(4).
- Rose (2016): A Machine Learning Framework for Plan Payment Risk Adjustment, *Health Services Research*, 51(6), 2358–2374.
- Rose, Bergquist and Layton (2017): Computational Health Economics for Identification of Unprofitable Health Care Enrollees, *Biostatistics*, 18(4), 682–694.
- Tibshirani (1996): Regression Shrinkage and Selection via the Lasso. *Journal of the Royal Statistical*

Society: Series B (Methodological) 58(1), 267–288.

- Windmeijer, Farbmacher, Davies, Davey Smith (2019): On the Use of the Lasso for Instrumental Variables Estimation with Some Invalid Instruments, *Journal of the American Statistical Association*, 114(527), 1339–1350.
- Zou (2006): The Adaptive Lasso and Its Oracle Properties, *Journal of the American Statistical Association* 101(476), 1418-1429.

Papers you could read if you have plenty of time:

- Athey and Imbens (2019): Machine Learning Methods Economists Should Know About, *Annual Review of Economics*, 11, 685–725.
- Chernozhukov *et al.* (2018): Double/debiased Machine Learning for Treatment and Structural Parameters, *Econometrics Journal*, 21, C1–C68.
- Fu (1998): Penalized Regressions: the Bridge versus the Lasso, *Journal of Computational and Graphical Statistics*, 7, 397–416.
- Giannone, Lenza and Primiceri (2021): Economic Predictions with Big Data: The Illusion of Sparsity, *Econometrica*, 89(5), 2409–2437.
- Mullainathan and Spiess (2017): Machine Learning: An Applied Econometric Approach, *Journal of Economic Perspectives*, 31(2), 87–106.
- Su, Shi and Phillips (2016): Identifying Latent Structures in Panel Data, *Econometrica*, 84(6), 2215–2264.
- Varian (2014): Big Data: New Tricks for Econometrics, *Journal of Economic Perspectives*, 28(2), 3–28.
- Wüthrich and Zhu (2023): Omitted Variable Bias of Lasso-based Inference Methods: A Finite Sample Analysis, *Review of Economics and Statistics*, 105(4), 982–997.