



Econometrics IV: Machine Learning (only PhD)

Course instructor:

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Timetable: September 18-22, 2023 (10am to 4pm, room 2544)

Prerequisites: Ideally, Econometrics I and II (TUM) or equivalently 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 (3 ECTS); details below

Registration: Until September 11, 2023, via email.

Course description:

The course is part of a series of econometrics courses at TUM School of Management that also comprises “Econometrics I: Research Design and Estimation Methods” by Prof. Dr. Hanna Hottenrott, “Econometrics II: Causal Inference” by Prof. Dr. Joachim Henkel and “Econometrics III: Advanced Econometrics” by me. Econometrics IV will be a block lecture but conceptualized as a seminar based on 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 likely cover the following topics:

- Regression Shrinkage Methods (Ridge, Lasso, Elastic Net)
- Decision Trees, Random/Causal Forests
- Advanced Identification Strategies (e.g., Double Machine Learning)
- Introduction to Neural Networks

In the morning, we will briefly discuss the econometric methods (including some applications to illustrate them). Students will then apply these methods and will replicate recent research papers in economics. I will also assign a (replication) project to each student. You can also come up with an own application and/or dataset you are interested in.

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 definitely should read:

- 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.
- 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.
- 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.
- Buchner, Wasem and Schillo (2017): Regression Trees Identify Relevant Interactions: Can this Improve the Predictive Performance of Risk Adjustment?, *Health Economics*, 26, 74–85.
- 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.
- Varian (2014): Big Data: New Tricks for Econometrics, *Journal of Economic Perspectives*, 28(2), 3–28.
- Wüthrich and Zhu (2021): Omitted Variable Bias of Lasso-based Inference Methods: A Finite Sample Analysis, *Review of Economics and Statistics*, forthcoming.