Analysis of Spatial Data and Images

Winter Term - 3 ECTS

Elective Course

Prerequisites to Enroll (skills)

- Econometrics
- Machine learning (i.e. decision trees, feedforward neural networks)
- Python programming

Overview and Objectives

This course introduces a range of techniques to collect, manipulate and analyse spatial data. In the first part, we provide an introduction to spatial data and study how to represent spatial information using vector and raster data. We explore various prominent examples of empirical economic research that use spatial data to understand its significance in Economics. Then, in the second part, we introduce a range of tools to manipulate spatial data and perform computations. Building on this, the third part of the course focuses on the modelling of spatial processes. This includes selected econometric models to make inference about spatial economics questions. Finally, in the fourth part, we introduce machine learning models for the predictive modelling of spatial and image data. The course provides a hands-on approach to manipulating spatial data using ArcGIS and Python is used extensively to implement computations of spatial data and estimation of the various statistical models.

Course Outline

1. Introduction (4h)
- Vector data
- Raster data
- Projections
- Representing spatial data

2. Spatial computations and tools (4h)
- Vector operations
- Raster operations
- Conversion and projections

3. Spatial modelling – Inference (6h)
- Gravity models
- Spatial Regression Discontinuity Design (RDD)
- Spatial propagation and inference

4. Spatial modelling – Prediction (6h)

- Images as data
- Image processing and segmentation
- Tree-based methods
- Network-based methods

Required Activities

Submission of homework (4 assignments in total), term paper

Evaluation

Examples: term paper (80%), homework (20%)

Competences and Learning Outcomes

To be announced

Materials

General reading

- Breiman, Leo (2001). “Statistical modeling: The two cultures”. Statistical Science, 16 (3), pp. 199–231.
- Burke, Marshall, Anne Driscoll, David Lobell, and Stefano Ermon (2020): “Using Satellite Imagery to Understand and Promote Sustainable Development”, NBER Working Paper No. 27879.
- Dell, Melissa, Benjamin F. Jones, and Benjamin A. Olken. (2014). “What Do We Learn from the Weather? The New Climate-Economy Literature.” Journal of Economic Literature 52 (3): 740–98.
- Donaldson, Dave and Adam Storeygard (2016). “The view from above: Applications of satellite data in economics”. Journal of Economic Perspectives, 30 (4), pp. 171–198.
- LeCun, Yann and Yoshua Bengio and Geoffrey Hinton (2015). “Deep learning”, Nature, 521, pp. 436-444.

- Mullainathan, Sendhil and Jann Spiess (2017). “Machine learning: An applied econometric approach”, Journal of Economic Perspective, 31 (2), pp. 87–106.
- Proost, Stef and Jacques-François Thisse (2019). "What can be learned from spatial economics?", Journal of Economic Literature, 57 (3), 575–643.