Spatial methods for economists using Python

University of Bern

Fall 2025

Prof. Dr. Olivier Schöni

1. General Information

Course Manager

Prof. Dr. Olivier Schöni

Professor of Urban and Real Estate Economics

University of Lausanne

E-mail:olivier.schoni@unil.ch

Time, Venue, Language, and Credits

Time: See course schedule below.

Venue: University of Bern, A222 UniS, Schanzeneckstrasse 1 (TBC), Bern

Language: English

Credits: 3 ECTS MASTER | 6 ECTS PhD

KSL root number: 512282

Teaching Method

12 lectures in presence.

Teaching Material

Lecture notes, data, and code are available prior to the lecture and can be downloaded from a sharing platform, a server of the University of Bern (ILIAS) and/or Dropbox.

Course Objectives and Content

In the last decade, the use of spatial data in empirical analyses has spread to a variety of economic fields, including urban and real estate economics, development and environmental economics, labor and public economics, economic history, and trade. The aim of the course is to provide students and researchers with an effective and systematic workflow allowing them to extract and structure information provided by spatial data. To this end, the course will

primarily focus on the automation of tasks involving spatial data using Python and ArcGIS. Among others, these tasks include importing different formats of spatial data, projecting spatial data to a common reference system, defining a spatial structure, selecting areas according to specific rules, merging data according to their spatial relationship, computing spatial statistics, and exporting the results. Additionally, the course will show how to integrate these tasks into the workflow of standard statistical software, such as R and Stata. The programming part of the lecture is complemented with a discussion of papers published in leading economic journals that exploit spatial data in their econometric analyses.

Expected Learning Outcomes

1. Students can write a script in Python to extract relevant information from GIS data.
2. Students have a good understanding of how spatial data can be exploited in econometric analyses.
3. Students can integrate Python scripting into the code of standard statistical software.
4. Students can use ArcGIS to create maps and investigate spatial dynamics visually.

Evaluation

The final grade will be determined by a group project.

For Master's Students:

Each group of Master's students will complete a series of specific tasks assigned by the instructor. The project requires the preparation of a presentation document, which will be presented in a short video. The final grade will be a weighted average of the grades awarded for the submitted code, the written presentation, and the oral presentation.

For PhD Students:

PhD student groups must either replicate a spatial analysis from an existing academic paper or conduct an original analysis. Each group will submit a concise document of 10-12 pages. The final grade will be a weighted average of the grades awarded for the submitted code and the accompanying short document.

Remarks

The course will be conducted in a PC lab equipped with Windows-based machines and all requisite software, including ArcGIS Pro. Please be advised that ArcGIS Pro is natively supported **only on the Windows** operating system; it is not compatible with macOS or Linux without additional configuration. Students who wish to use their personal laptops must ensure that a functioning Windows environment is available—either via native installation (e.g., dual-boot) or through virtualization/emulation platforms such as Parallels Desktop, VMware, or VirtualBox.

Please note that the setup and maintenance of such virtualization or emulation environments are the sole responsibility of the student; technical support for these configurations will not be provided by the instructor.

2. Syllabus

1. **Introduction to spatial data**
   - 1.1. Motivation and role in empirical analysis
   - 1.2. Goals of the course
   - 1.3. Why Python and ArcGIS?
   - 1.4. Types of spatial data, projections, where to obtain spatial data
   - 1.5. Opening and working with ArcGIS
2. **Introduction to Python and arcpy**
   - 2.1. Python IDEs and setting up a project
   - 2.2. Structure of a python script
   - 2.3. A crash course in Python
   - 2.4. Basics of SQL for data selection
3. **Vector data**
   - 3.1. Where to find help/ information
   - 3.2. Arcpy tools for vector data
4. **Raster data**
   - 4.1. Arcpy tools for raster data
   - 4.2. Focus on elevation data
   - 4.3. Conversion tools
5. **Advanced Python programming and maps**
   - 5.1. Debugging
   - 5.2. Coding tips and tricks, improving execution time
   - 5.3. Writing your own functions
   - 5.4. Creating maps
6. **Integrating Python into Stata and R**
   - 6.1. Importing and preparing spatial data in Stata and R
   - 6.2. Running python scripts from Stata and R
   - 6.3. Overview of packages for handling spatial data in Stata and R

7. Project assignment and discussion of papers

7.1. Groups' definitions, assignment of projects

7.2. Introduction to using spatial data in econometrics

7.3. Discussion of papers using spatial data as dependent variable, variable of interest, and/or controls.

8. Discussion of papers

8.1. Discussion on spatial data and endogeneity issues – Part 1

8.2. Using spatial data to derive instruments

9. Discussion of papers

9.1. Discussion on spatial data and endogeneity issues – Part 2

9.2. Using spatial data to implement boundary discontinuity designs

9.3. Other topics: level of spatial aggregation and of clustering standard errors

10. Group project

10.1. Questions and answers lecture on group projects

3. Schedule (Provisional – time allocation is indicative only)

Date	*Mode*	*Lecture/Seminar*	*Time*
1 Sept	Presence	**Lecture 1** Introduction to ArcGIS	09:00 – 10:30
		Break	
	Presence	**Lecture 2** Exercises	10:45 – 12:15
		Lunch break	
	Presence	**Lecture 3** Introduction to Python and arcpy	13:30 – 15:00
		Break	
	Presence	**Lecture 4** Exercises	15:15 – 16:45
2 Sept	Presence	**Lecture 5** Vector data	09:00 – 10:30
		Break	
	Presence	**Lecture 6** Exercises	10:45 – 12:15
		Lunch break	
	Presence	**Lecture 7** Raster data	13:30 – 15:00
		Break	
	Presence	**Lecture 8** Exercises	15:15 – 16:45
3 Sept	Presence	**Lecture 9** Advanced Python and integration in Stata and R	09:00 – 10:30
		Break	
	Presence	**Lecture 10** Discussion of papers – Part 1	10:45 – 12:15
		Lunch break	
	Presence	**Lecture 11** Discussion of papers – Part 2	13:30 – 15:00
		Break	
	Presence	**Lecture 12** Discussion of papers – Part 3	15:15 – 16:45
4 Sept	Remote/ presence	Students work autonomously on the project assignment	
5 Sept	Presence	Q&A Project	09:00 – 10:30
		Break	
	Presence	Q&A Project	10:45 – 12:15
		Lunch break	
	Presence	Q&A Project	13:30 – 15:00
		Break	
	Presence	Q&A Project	15:15 – 16:45

4. Reading List

Text Books

The course does not build on a textbook. No existing textbook covers all the topics covered in this course. However, if you are looking for a general introduction to Python scripting for ArcGIS, I can recommend the following:

Silas T. and O'Beirne D., 2017, ArcPy and ArcGIS: Automating ArcGIS for Desktop and ArcGIS Online with Python, Packt Publishing.

Zandbergen, P. A., 2020, Python Scripting for ArcGIS Pro, Esri Press.

Zandbergen, P. A., 2020, Advanced Python Scripting for ArcGIS Pro, Esri Press.

Papers List by Lecture

Lecture 10	
Compulsory readings	Banzhaf, H. S., and Walsh, R. P. 2008. Do People Vote with Their Feet? An Empirical Test of Tiebout, *American Economic Review,* 98 (3): 843-63. Bernstein, A., Gustafson, M.T, Lewis, R. 2019. Disaster on the horizon: The price effect of sea level rise, *Journal of Financial Economics*, 134(2): 253-272. Burchfield, M., Overman, H.G., Puga, D., Turner, M.A. 2006. Causes of Sprawl: A Portrait from Space, *The Quarterly Journal of Economics*, 121(2): 587–633. Eichholtz, P., Nils K., and Quigley, J.M. 2010. Doing Well by Doing Good? Green Office Buildings. *The American Economic Review*, 100(5): 2492-509 Kurlat, P., Stroebel, J. 2015. Testing for Information Asymmetries in Real Estate Markets. *The Review of Financial Studies*, 28(8): 2429–2461.
Lecture 11	
Compulsory readings	Bai, Y. and Jia, R. 2016. Elite Recruitment and Political Stability: The Impact of the Abolition of China's Civil Service Exam, *Econometrica*, 84: 677–733. Bakker, J.D., Maurery, S., Pischkez, J-S., and Rauch, F. 2021. Of Mice and Merchants: Connectedness and the Location of Economic Activity in the Iron Age. *Review of Economics and Statistics* (forthcoming). Volume Title: Agglomeration Economics, Volume Author/Editor: Edward L. Glaeser, (editor). Volume Publisher: The University of Chicago Press, Publication Date: February 2010. Chapter Title: Estimating Agglomeration Economies with History, Geology, and Worker Effects. Chapter Author: Pierre-Philippe C., Duranton, G., Gobillon, L., Roux, S. Michaels, G. 2008. The Effect of Trade on the Demand for Skill: Evidence from the Interstate Highway System, *The Review of Economics and Statistics*, 90(4): 683-701.

	Saiz, A. 2010, The Geographic Determinants of Hosing Supply, *Quarterly Journal of Economics,* 125: 1253–1296.
Lecture 12	
Compulsory readings	Basten, C., von Ehrlich, M. and Lassmann, A. 2017. Income Taxes, Sorting and the Costs of Housing: Evidence from Municipal Boundaries in Switzerland. *Economic Journal*, 127: 653-687. Briant, A., Combes, P.-P. , Lafourcade, M. 2010. Dots to boxes: Do the size and shape of spatial units jeopardize economic geography estimations? *Journal of Urban Economics*, 67(3): 287-302. Lalive, R. 2008. How do extended benefits affect unemployment duration? A regression discontinuity approach, *Journal of Econometrics*, 142(2): 785-806. Michaels, G., Dzhamilya, N., Rauch, F., Regan, T., Baruah, N., Dahlstrand, A. Planning Ahead for Better Neighborhoods: Long Run Evidence from Tanzania, *Journal of Political Economy* (forthcoming).