COURSE DESCRIPTION

Spatial Statistics in GIS

Academic year 2025-2026

1. Program details

1.1. Higher education institution	Babeș-Bolyai University
1.2. Faculty	Geography
1.3. Department	Doctoral School of Geography
1.4. Field of study	Geography
1.5. Cycle of studies	Doctorate
1.6. Study program / Qualification	Doctoral School of Geography
1.7. Type of education	

2. Information about the discipline

2.1. Name of the discipline	*Spatial Statistics in GIS*					Subject code	**DG1105**
2.2. Course coordinator	Associate Professor Titus Cristian MAN						
2.3. Seminar coordinator	Associate Professor Titus Cristian MAN						
2.4. Year of study	I	2.5. Semester		2.6. Type of assessment	E	2.7. Course requirements	

3. Total estimated time (hours per semester of teaching activities)

3.1. Number of hours per week	**3**	of which: 3.2. lectures	**2**	3.3. seminar/laboratory/project	**1**
3.4. Total hours in the curriculum	36	of which: 3.5. course	24	3.6 seminar/laboratory	12

Distribution of time for individual study (IS) and self-study activities (SS)	**hours**
Study using textbooks, course materials, bibliography, and notes (AI)	40
Additional documentation in the library, on specialized electronic platforms, and in the field	40
Preparation for seminars/labs/projects, assignments, reports, portfolios, and essays	20
Tutoring (professional counseling)	40
Examinations	2
Other activities	2
3.7. Total hours of individual study (IS) and self-study activities (SS)	**164**
3.8. Total hours per semester	**20**
3.9. Number of credits	**8**

4. Prerequisites (where applicable)

4.1. Curriculum	-
4.2. Competency	-

5. Conditions (where applicable)

5.1. Course delivery	Classroom with computer, projector, and GIS software
5.2. for conducting the seminar/laboratory	Classroom with computer, projector, GIS software, and Internet connection

6.1. Specific skills acquired[1]

Professional/essential skills	• Formulation of spatial research problems • Preparing and integrating geospatial data sets • Applying and interpreting exploratory spatial data analysis (ESDA) • Building, estimating, and comparing advanced spatial statistical models • Implementing reproducible workflows for spatial statistics in GIS
Transversal skills	• Critical thinking and data evaluation • Advanced quantitative analysis and problem-solving skills • Digital skills and programming/scripting for automation • Scientific communication (writing, visualization, presentation) • Interdisciplinary work and team collaboration • Ethics in data use and professional responsibility • Research project management (planning, prioritization, deliverables) • Understanding and communicating uncertainty

6.2. Learning outcomes

Knowledge	The student knows the fundamental concepts of spatial statistics (spatial dependence/autocorrelation, heterogeneity, stationarity). The student knows the principles of exploratory spatial data analysis (ESDA) and the logic of significance testing through permutations/simulations. The student understands the concepts of spatial proximity and weighting and the impact of their choice on the results. The student knows the essential principles of spatial modeling and the rationale for their use. The student knows the effects of scaling and zoning and their consequences on inference and interpretation.
Skills	The student is able to prepare, integrate, and document geospatial datasets for statistical analysis (cleaning, harmonization, projections, metadata). The student is able to perform exploratory spatial data analysis (ESDA) and identify/authenticate spatial clusters and patterns through appropriate tests. The student is able to build, estimate, and interpret spatial regression models in relation to hypotheses and geographical context. The student is able to design and apply spatial validation strategies and quantify the uncertainty of results. The student is able to rigorously communicate the results of spatial statistics through accurate maps and GIS visualizations, explaining limitations, scale sensitivity, and implications for decision-making.
Responsibilities and autonomy	The student has the ability to work independently to formulate and refine spatial research problems, defining hypotheses, scale, units of analysis, and evaluation criteria. The student has the ability to work independently to fully manage geospatial data (collection, cleaning, integration, documentation), assuming standards of quality, ethics, and data protection. The student has the ability to work independently to select, implement, and justify appropriate spatial statistical methods and models, assuming limitations and conditions of applicability. The student has the ability to work independently to validate results, assess uncertainty, and perform sensitivity analyses (neighborhoods, parameters, scale), making reasoned methodological decisions. Students have the ability to work independently to draft and support scientific and technical communications (reports, articles, maps), ensuring transparency, reproducibility, and traceability of the workflow.

7. Course objectives (based on the grid of acquired skills)

[1] You can choose between skills or learning outcomes, or both. If you choose only one option, the table for the other option will be deleted, and the option you keep will be numbered 6.

7.1 General objective of the discipline	• To develop the doctoral student's ability to critically understand and rigorously apply spatial statistics methods and models, integrated into reproducible GIS workflows, for the exploration, inference, prediction, and transparent communication of geographical phenomena, with the assessment of uncertainty and limitations related to scale, zoning, and spatial dependence.
7.2 Specific objectives	• Strengthening the conceptual and critical framework of spatial statistics in GIS and the formulation of research problems (spatial dependence, heterogeneity, scale/MAUP). • Rigorous preparation and analysis of geospatial data through ESDA and advanced spatial modeling (spatial regression, geostatistics, as appropriate), with geographic interpretation. • Validating results and assessing/managing uncertainty through reproducible workflows and appropriate scientific/technical communication.

8. Contents

8.1 Course	Teaching methods	Observations
Introduction to spatial statistics in GIS: concepts, data types, specific problems	Interactive presentation	2 hours
Spatial dependence and heterogeneity: autocorrelation, stationarity, anisotropy	Interactive presentation	4
Scale of analysis and zoning: effects on interpretation	Interactive presentation	2
Neighborhoods and spatial weight matrices	Interactive presentation	2 hours
Exploratory spatial data analysis (ESDA) and visualization: distributions, outliers, patterns	Interactive presentation	4 hours
Global and local autocorrelation: Moran/Geary, LISA, hotspot/coldspot	Interactive presentation	2 hours
Spatial regression	Interactive presentation	4 hours
Geostatistics	Interactive presentation	4 hours

Bibliography

1. Allen, D., W. (2016), GIS Tutorial 2: Spatial Analysis Workbook, ESRI Press
2. Allen, D., W., Coffey, J., M. (2010), GIS Tutorial 3: Advanced Workbook, ESRI Press
3. Bavaud, F., Mager, C. (Eds)(2009), Handbook of Theoretical and Quantitative Geography, UNIL, FGSE Workshop series no 2.
4. Smith, M., J., Goodchild, M., F., Longley, P., A. (2015), Geospatial Analysis. A Comprehensive Guide to Principles, Techniques and Software Tools, The Winchelsea Press, Winchelsea, UK, 750p
5. Docan, Daniela (2016), Learning ArcGIS for Desktop, Packt Publishing, 331p
6. Gomarasca, M., A. (2009), Basics of Geomatics, Springer Netherlands, 656p
7. Gorr, W., L., Kurland, Kristen (2016), GIS Tutorial 1: Basic Workbook, 10.3.x edition, ESRI Press
8. Graser, Anita, Mearns, B., Mandel, A., Ferrero, V., O., Bruy, A. (2017), QGIS. Becoming a GIS Power User, Packt, 727p
9. Kennedy, M., D., Goodchild, M., F., Dangermond, J. (2013), Introducing Geographic Information Systems with ArcGIS: A Workbook Approach to Learning GIS [3rd ed.], Wiley, 672p
10. Liu, J., G., Mason, Philippa (2016), Image Processing and GIS for Remote Sensing: Techniques and Applications [2nd ed.], Wiley Blackwell, 472p
11. Longley, P., A., Goodchild, M., F., Maguire, D., J., Rhind, D., W. (2010), Geographic information systems and science. 3rd ed., J Wiley, Chichester, UK
12. Matthews, J. A. (1981), Quantitative and Statistical Approaches to Geography. A practical manual. Pergamon Press.
13. Mitchell, A. (2001), The ESRI Guide to GIS Analysis, Volume 1: Geographic Patterns and Relationships, ESRI Press
14. Mitchell, A. (2005), The ESRI Guide to GIS Analysis, Volume 2: Spatial Measurements and Statistics, ESRI Press
15. Mitchell, A. (2012), The Esri Guide to GIS Analysis, Volume 3: Modeling Suitability, Movement, and Interaction, ESRI Press
16. Wang, F. (2014), Quantitative Methods and Socio-Economic Applications in GIS [2nd ed.], CRC Press, 333p
17. Walford, N. (2011), Practical Statistics for Geographers and Earth Scientists, Wiley-Blackwell.

8.2 Seminar/laboratory	Teaching methods	Comments
Spatial analysis, GIS, software tools	Problem-based learning - geospatial case studies; GIS demonstrations	2 hours

Statistical and spatial analysis: spatial statistics, spatial data infrastructure (SDI)	Problem-based learning - geospatial case studies; GIS demonstrations	2
Spatial analysis I: models and methods for spatial and spatiotemporal data; geometric and related operations; queries, calculations, and density	Problem-based learning - geospatial case studies; GIS demonstrations	2 hours
Data exploration and spatial statistics I: statistical methods and spatial data; exploratory spatial data analysis (ESDA); matrix-based statistics and metrics	Problem-based learning - geospatial case studies; GIS demonstrations	2 hours
Data exploration and spatial statistics II: point sets and distance statistics; spatial autocorrelation; spatial regression	Problem-based learning - geospatial case studies; GIS demonstrations	2
Surface analysis: geostatistical interpolation methods	Problem-based learning - geospatial case studies; GIS demonstrations	2

Bibliography

1. Allen, D., W. (2016), GIS Tutorial 2: Spatial Analysis Workbook, ESRI Press
2. Allen, D., W., Coffey, J., M. (2010), GIS Tutorial 3: Advanced Workbook, ESRI Press
3. Bavaud, F., Mager, C. (Eds)(2009), Handbook of Theoretical and Quantitative Geography, UNIL, FGSE Workshop series no 2.
4. de Smith, M., J., Goodchild, M., F., Longley, P., A. (2015), Geospatial Analysis. A Comprehensive Guide to Principles, Techniques and Software Tools, The Winchelsea Press, Winchelsea, UK, 750p
5. Docan, Daniela (2016), Learning ArcGIS for Desktop, Packt Publishing, 331p
6. Gomarasca, M., A. (2009), Basics of Geomatics, Springer Netherlands, 656p
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13. Mitchell, A. (2001), The ESRI Guide to GIS Analysis, Volume 1: Geographic Patterns and Relationships, ESRI Press
14. Mitchell, A. (2005), The ESRI Guide to GIS Analysis, Volume 2: Spatial Measurements and Statistics, ESRI Press
15. Mitchell, A. (2012), The Esri Guide to GIS Analysis, Volume 3: Modeling Suitability, Movement, and Interaction, ESRI Press
16. Wang, F. (2014), Quantitative Methods and Socio-Economic Applications in GIS [2nd ed.], CRC Press, 333p
17. Walford, N. (2011), Practical Statistics for Geographers and Earth Scientists, Wiley-Blackwell.

9. Corroboration of the course content with the expectations of representatives of the epistemic community, professional associations, and representative employers in the field related to the program

- The course content is correlated with the current requirements of geospatial research and practice, by addressing modern methods of spatial statistics, validation and uncertainty, the use of GIS tools and reproducible workflows, as well as by focusing on applications relevant to institutions and companies that use spatial analysis in decision support

10. Assessment

Type of activity	10.1 Assessment criteria	10.2 Evaluation methods	10.3 Weight in the final grade
10.4 Course	Understanding key concepts	Exam	25
	Justification of method selection	Exam	25
10.5 Seminar/laboratory	Correct application of GIS-spatial statistics workflow	Project	25
	Quality of visualizations	Presentation	25

10.6 Minimum performance standard
• Fulfillment of attendance/activity requirements at the seminar in accordance with the regulations and obtaining a "Pass" grade for each major component (course and seminar/laboratory) • Completion and submission of an applied spatial statistical analysis project in GIS (correctly prepared data, ESDA + at least one appropriate spatial model, basic validation, and cartographic representation), with a technical report and workflow documentation

11. SDG (Sustainable Development Goals) labels[2]

	General label for Sustainable Development

Date:
February 19, 2026

Signature of course coordinator

Seminar coordinator's signature

Date of approval in the department:

Signature of the department director

[2] Keep only the labels that, in accordance with *the Procedure for applying SDG labels in the academic process*, are appropriate for the subject and delete the others, including the general label for *Sustainable Development* - if not applicable. If no label describes the discipline, delete them all and write "*Not applicable.*"