Module Description

Advanced Spatial Methods

General Information

Module Code

GEO_AdvSpatM

Module Category

Specialization

Lessons

3 lecture and exercise periods per week

Number of ECTS Credits

3

Module Language

Taught in English

Materials in English

Projects (report, writing text section, presentation) can be completed in German or English

Module Description

Doing spatial science and research requires a broad set of methods and technologies. The module "Advanced Spatial Methods" provides an in-depth exploration of advanced geospatial methods using different technologies. Increased performance of small devices and their sensors, positioning, as well as big data, cloud computing, and machine learning, enable new possibilities for spatial analysis and application. For the development of modern mobile geoinformation solutions. However, for their professional use and optimised application, a solid understanding of the underlying concepts and technologies is an important prerequisite. Some necessary topics are taught in this module. Additionally, knowledge about current and future application possibilities will be covered.

The module includes topics from fundamental research methods and spatial analysis such as computational movement analysis, routing and wayfinding to advanced big data geoprocessing techniques, machine learning and location-based services.

- The module equips students with the knowledge and skills to shape their research projects and make them **reproducible**. It discusses advanced topics and **future directions in geospatial methods**, preparing students for further study or professional work in this rapidly evolving field.
- Students will gain a solid understanding of geographic **routing and wayfinding**, as well as **computational movement analysis**. The module introduces the basics of graph theory, providing the foundation for further study on routing and wayfinding.
- The module delves into the realm of **Location-Based Services** (LBS), discussing the technologies, methods, and applications that make these services possible. Students will learn how to apply these concepts to real-world geoinformation solutions.
- Another part of the module focuses on **big data** in the geospatial domain. Students will be introduced to big data geoprocessing with Python, learning how to perform spatial data analysis using big data techniques. They will also explore geospatial visualization of big data and the application of **machine learning** to geospatial big data.

Learning Objectives, Contents, Methods

Learning Objectives and Acquired Competences

- Students know and apply main spatial data science concepts to shape their research projects.
- They know how to make their research reproducible and adhere to sound research principles, reporting the provenance of findings.
- They explain the concepts and methods for modelling and analysing network-like structures and explain basic procedures for route calculation and optimisation.
- They analyse the possible applications of the concepts and methods covered and show suitable approaches for solving and answering specific problems and questions.
- They know and apply the main concepts and methods for the analysis of movement data and can build analysis workflows to build insights from movement data.
- Students can explain the most important concepts and basic technologies for location-based services (LBS) and analyse fields for applications.
- They assess the various possible applications of learned concepts as well as strengths and weaknesses of different methods and technologies in the realisation of mobile geoinformation solutions.

- Students understand the principles and techniques of advanced big data geoprocessing and geospatial visualization and can write Python scripts for basic big data geoprocessing tasks.
- They understand how to apply machine learning techniques to geospatial big data and know the current advanced topics and future directions in big data geoprocessing.

Contents of the Module

- Research Methods
  - Spatial Data Science Concepts
  - Reproducibility
- Geographic routing & wayfinding, computational movement analysis
  - Graph Theory - Introduction and Basics
  - Routing & Wayfinding
  - Computational Movement Analysis
- Location Based Services (LBS)
  - Technologies, Methods and Applications
  - Frameworks and location-aware devices
- Advanced Big Data Geoprocessing
  - Introduction to Big Data Geoprocessing with Python
  - Spatial Data Analysis with Big Data Techniques
  - Big Data Geospatial Visualization
  - Machine Learning for Geospatial Big Data
  - Advanced Topics and Future Directions

Module outline

- Research Methods – 2 weeks
- Geographical Routing & Wayfinding, Computational Movement Analysis - 4 weeks
- Location-based Services, Methods, and Applications - 4 weeks
- Advanced Big Data Geoprocessing – 4 weeks

Teaching and Learning Methods

- Lectures (according to timetable)
- Self-study and discussion
- Exercises and project work

Pre-requisites

Basic knowledge in (spatial) R, including handling of spatial data
Can be acquired through self-study, for example chapters 1-4 of “An Introduction to R for Spatial Analysis and Mapping” (2nd edition) by Chris Brunsdon and LexComber, Sage Publications. The R code covered in the book is available online at https://bookdown.org/lexcomber/brunsdoncomber2e/

Basic knowledge in (Geo-)Python
Can be acquired through self-study, for example YouTube “Python for Beginners” at https://www.youtube.com/watch?v=eWRfhZUzrAc (free, ad-financed) or
Course “Learn Python 3” at https://www.codecademy.com/learn/learn-python-3 (basic access free, paid plans for quizzes etc.)

Assessment

Assessment and Testat Requirements

Final module exam

Final module exam

Exam duration	90 minutes
Permitted aids	Written summaries (max. 4 pages A4, single-sided, handwriting)

Remarks

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