School of Economics

Academic Year 2024-25
Term 2

DSA303 Spatial Data Analysis - X

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Consultations : Friday 9am (or by appointment)

COURSE DESCRIPTION

This course introduces statistical concepts and basic tools used in modelling and analysing spatial data: data on variables that are correlated in 'space/location' (geo-tagged data). Spatial data are commonly used in regional science and urban economics (related to **property prices, crime, household income**, etc.), epidemiology and public health (such as **disease clusters**, etc.), environmental science (**air pollution, ozone density**, etc.), ecology, biology, geology and other disciplines.

We start by looking at the practical aspects of organising and visualising spatial data where we will discuss methods available to organise and visualise (i) vector data and (ii) raster data using the *R* programming language. These are the two main ways in which spatial data are maintained. We also discuss how to use a coordinate reference system to **give spatial awareness to a dataset** and make meaningful maps including **animated and interactive maps using OpenStreetMap** and others.

We then consider the statistical aspects behind spatial data analysis with a special focus on how to re-align classical statistical methods towards spatial data. An outline is given to the three broad types of spatial data in spatial statistical analysis: (i) geostatistical data, (ii) areal data and (iii) point patterns. Standard spatial regression techniques are used to **build models** to explain attributes that are spatially correlated such as the number of **COVID cases**.

These techniques are fully **implemented using *R*** throughout the course. You may follow the **links** to get a flavour of the applications in this course.

SMU-X

We will partner with a government statutory board to conduct a live project. Students, under the direct supervision of the faculty, will conduct a literature review, formulate research hypotheses, and conduct spatial data analyses to fulfil the main questions posed by the partner. The primary dataset will be provided by the partner. Depending on the formulated hypotheses, students may also need to collect additional data from publicly available sources. As the data provided by the partner will be confidential in nature, students are required to fulfil a confidentiality undertaking before embarking on the project.

We will aim to complete the proposal by week 7. You are expected to present a progress report in week 11 and a final presentation in week 13.

PRE-REQUISITE/CO-REQUISITE/MUTUALLY EXCLUSIVE COURSE(S)

Please use the class search function at OASIS > Study > BOSS > BOSS Bidding (Plan & Bid page > Add to Cart and Perform Course Search) or the course catalogue in OASIS to check the most updated attributes of this course.

LEARNING OBJECTIVES

1. Handling spatial data in *R*: vector data (and raster data, if time permits)
2. Handling geometry operations and coordinate reference systems
3. Making maps, a.k.a. the ancient art of *cartography*
4. Engaging in areal data analysis and modelling spatial relationships
5. Spatial descriptive summary measures and point pattern analysis
6. Engaging in geostatistical analysis

LAPTOP
Students are required to bring a laptop computer to class for programming and data analysis.

ASSESSMENT METHODS
Class Participation : 10%
Assignments : 20%
Group project : 40%
Final Examination : 30%

ASSESSMENT DETAILS

- Class Participation: Regular attendance and active participation are essential for the successful execution of the group project. Any absence must be supported by a valid excuse (e.g., medical certificates).
- Assignments: There will be two assignments of equal weight, designed to provide essential practice for the group project. These will be scheduled after the completion of learning objectives 3 and 4.
- Project Timeline
    - Week 1: The main project details and requirements will be introduced.
    - Week 2: Groups will be formed and tasks allocated. Students will meet with the industry partner to discuss project specifics.
    - Research Phase (Weeks 1-4)
        - Students will work on formulating research hypotheses under instructor supervision.
        - Additional data will be collected from public sources, with necessary data cleaning conducted during this period.
    - Data Analysis (Weeks 5-7)
        - Preliminary Analysis: Students may begin preliminary data analysis as early as week 5.
        - Spatial Regression Models: These will be covered by week 7, allowing students to conduct the main analyses.
    - Interim Report (Week 11): An interim report detailing findings from the initial analysis segment will be presented.
    - Final Presentation: Students can incorporate analyses from weeks 9-11 into the interim presentation or defer them to the final presentation, if applicable.
- Final Exam: Open book. Three hours.

CLASS ARRANGEMENT
Class sessions are of 3-hour duration per week. Zoom recordings of the lectures will be made available after each class.

RECOMMENDED TEXTS
No single textbook covers all the listed topics above. The lecture notes provided will cover all examinable material. Additional readings are listed in each lecture note from the following texts.

For Theory:

- Tonny Oyana (2021), **Spa*tial Analysis with R****,* 2nd edition, CRC Press.
- Guiseppe Arbia (2014) ***A Primer for Spatial Econometrics***, 1st edition, Palgrave Macmillan.

For *R*:

- Robin Lovelace, Jakub Nowosad, Jannes Muenchow (2019), ***Geocomputation with R***, 1st edition, CRC Press. Click here for the updated online version. 2nd edition of this title is forthcoming. Click here for the Python version of the same title.
- Paula Moraga (2023), ***Spatial Statistics for Data Science: Theory and Practice with R,*** 1st edition, CRC Press. Click here for the updated online version.

ACADEMIC INTEGRITY
All acts of academic dishonesty (including, but not limited to, plagiarism, cheating, fabrication, facilitation of acts of academic dishonesty by others, unauthorized possession of exam questions, or tampering with the academic work of other students) are serious offences.

All work (whether oral or written) submitted for purposes of assessment must be the student's own work. Penalties for violation of the policy range from zero marks for the component assessment to expulsion, depending on the nature of the offense.

When in doubt, students should consult the instructors of the course. Details on the SMU Code of Academic Integrity may be accessed at https://smu.sharepoint.com/sites/oasis/SitePages/DOS-WKLSWC/UCSC.aspx.

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ACCESSIBILITY
SMU strives to make learning experiences accessible for all. If students anticipate or experience physical or academic barriers due to disability, please let the instructor know immediately. Students are also welcome to contact the university's student accessibility support team if they have questions or concerns about academic provisions: accessibility@smu.edu.sg. Please be aware that the accessible tables in the seminar room should remain available for students who require them.

DIGITAL READINESS FOR TEACHING AND LEARNING (DRTL)
As part of emergency preparedness, instructors may conduct lessons online via the Zoom platform during the term, to prepare students for online learning. During an actual emergency, students will be notified to access the Zoom platform for their online lessons. The class schedule will mirror the current face-to-face class timetable unless otherwise stated.

WEEKLY LESSON PLAN
The table provides a tentative course schedule which is subject to change.

Week	Topic
1	Handling spatial data in R: vector data handling using simple features
2	Handling geometry operations and coordinate reference systems
3	Making maps with R
4	Engaging in areal data analysis 1
5	Engaging in areal data analysis 2
6	Modelling spatial relationships 1
7	Modelling spatial relationships 2 and project proposals
8	Recess Week
9	Spatial descriptive summary measures
10	Engaging in point pattern analysis 1
11	Engaging in point pattern analysis 2 and group presentations (preliminary)
12	Engaging in geostatistical analysis 1
13	Engaging in geostatistical analysis 2 and group presentations (final)

Updated: 05/10/2024