Syllabus: JPG1400H Advanced Quantitative Methods

Class Day/Time (ex: Tuesdays, 10AM–1PM)
Online Only

Instructor

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Office Hours: By appointment

Course Description

This course has two overarching foci. The first is Spatial Analysis, which consists of a set of techniques used for statistical modeling and problem solving in Geography, Urban Planning, and other social and physical sciences. As such, it plays an integral role in the detection of spatial processes and the identification of their causal factors. Space, of course, is treated explicitly in spatial analytical techniques, and the goal of many methods is to quantify the substantive impact of location and proximity on human and environmental processes.

The second focus is on reproducible research workflows. Science is a collaborative and collective process, one where theory and methods are built up over time. You may have heard about the 'Replication Crisis' in the social sciences, wherein many scientific studies are difficult or impossible to reproduce. This has led some to argue that science is 'broken' and 'bogus' (link).[1] In response, there is a growing movement towards research that is *reproducible* – allowing researchers to obtain consistent results using the same input data, *replicable* – where researchers using new data obtain similar findings as a previous study, and *open* – where the research is accessible to other scholars, practitioners, and the general public. New technologies are increasingly enabling the production of open, reproducible, and replicable research, and this course will familiarize students with one method through the use of RStudio and R Notebooks that incorporate written text alongside working code.

This course is not meant to serve as an introductory or refresher course in statistics for graduate students, but it is for graduate students who wish to develop their skills in generating reproducible research and using spatial regression techniques in their theses and dissertations. The course is meant to provide advanced training in a range of regression techniques (multivariate regression, generalize linear models, and spatial regression), a foundation in the rigorous and mathematical treatment of regression approaches, and awareness of other commonly utilized quantitative methods in geography. Through this, students will be provided with the ability to continue their acquisition of knowledge of, and practical abilities to perform, quantitative methods that are required by their own research agendas.

Learning Outcomes

By the end of the course, students will be able to:

[1] While there have been arguments that this is contributing to a decrease in public trust in science and scientists, polls show trust in science has largely remained stable (link).

- understand the particular pitfalls and benefits of analyzing spatial data;
- appropriately select, apply, and interpret advanced spatial statistical techniques;
- accurately identify and remediate spatial effects in geographic regression processes;
- confidently use the RStudio environment for spatial statistical computing, modelling, and visualization;
- critically interpret results from a range of advanced quantitative methods used in academic and applied geography and planning research;
- produce reproducible and replicable research workflows (with some degree of openness, topic/data permitting).

Course Organization

Access to Course Materials & Readings

The course is typically offered in a computer lab setting, with a 3-hour weekly session mixed between formal lectures and applied lab-work on the computers. COVID means this is not possible – so we will do our best to facilitate a similar experience in an online collaborative learning environment. Key tools will be Quercus, Zoom for meetings, and Slack for regular communication.

Assignments and Evaluation

Students will be evaluated based on their understanding of the practical and conceptual material offered in this course. Grade allocations are as follows:

Item	Due Date	Weight
Lab 1: Simple Regression	October 5	8%
Lab 2: Multivariate Regression	October 19	8%
Lab 3: Logistic Regression	November 2	8%
Lab 4: Spatial Autocorrelation	November 16	8%
Lab 5: Spatial Econometrics	November 30	8%
Term Project		
Proposal	October 19	10%
Descriptive Analysis	November 2	10%
Final Paper	December 7	40%

Labs Assignments

There will be 5 lab assignments due about every 2 weeks corresponding to the lecture material. Grades will be assigned based on completion, with each lab receiving a half grade (4 out of 8 percentage points) for partial completion and a full grade (8 percentage points) for full completion. To receive the full grade, students must provide thoughtful and complete responses to all questions asked and submit working code (if applicable).

Research Project

The final project is the largest grade component of the course. Deliverables include a project proposal (1 page), descriptive data analysis (500 words excluding tables and figures), and the final paper (2000-3000 words not including figures and tables, 12 pt. font, double spaced). Students will demonstrate their knowledge of the course material through the application of methods in an applied research project. Students will be responsible for acquiring their own

datasets, ensuring their suitability through communication with the instructor, and conducting and reporting on their analyses in the final paper. More details will be provided in class.

Late Policies

Except in the case of personal or medical emergencies, work must be submitted on time. Extensions may be permitted on a case-by-case basis through consultation with the instructor. Late assignments, proposals or term papers will be docked 10% per day, including weekends. All assignments will be submitted via the course website.

Required Text

I have tried to ensure that all required readings are available online. We will primarily make use of these sources:

Barrett, T.S. (2019). *R for Researchers: An Introduction*. Available online at https://tysonbarrett.com/Rstats/index.html

Bivand, R. S., Pebesma, E. J., Gómez-Rubio, V., & Pebesma, E. J. (2013). *Applied spatial data analysis with R*. New York: Springer. Available online at http://go.utlib.ca/cat/8978839

Dalpiaz, D. (2020). *Applied Statistics with R*. Available online at http://daviddalpiaz.github.io/appliedstats/

Lovelace, R., Nowosad, J., & Muenchow, J. (2019). *Geocomputation with R*. CRC Press. Available online at https://geocompr.robinlovelace.net

Other Helpful Resources

Here's a collection of some other optional readings and general interest sources that you might find useful:

Brunsdon, C., & Comber, L. (2018). *An introduction to R for spatial analysis and mapping, 2nd Edition*. Sage.

Brudnson, C., & Comber, L. (2019). *Code for An Introduction to Spatial Analysis and Mapping in R, 2nd Edition*. Available online at https://bookdown.org/lexcomber/brunsdoncomber2e/

Chang, W. (2020). *R Graphics Cookbook, 2nd Edition*. Available online at https://r-graphics.org

Comber, L., & Brunsdon, C. (2021). *Geographical Data Science and Spatial Data Analysis: An Introduction in R*. Sage.

Gimond, M. (2020). *Intro to GIS and Spatial Analysis*. Available online at https://mgimond.github.io/Spatial/index.html

Greene, W. (2012). *Econometric Analysis, 7th Edition*. Pearson.

Holtz, Y. (2018). *R Graph Gallery*. https://www.r-graph-gallery.com/index.html

Ismay, C. & Kim, A.Y. (2020). *Statistical Inference via Data Science*. Available online at https://moderndive.com/index.html

LeSage, J. & Pace, R.K. (2009). *Introduction to Spatial Econometrics*. Taylor and Francis.

Navarro, D. (2019). *Learning statistics with R: A tutorial for psychology students and other beginners*. Available online at https://learningstatisticswithr.com/book/

Singleton, A. D., Spielman, S., & Folch, D. (2017). *Urban analytics*. Sage.

Wickham, H., & Grolemund, G. (2016). *R for data science: import, tidy, transform, visualize, and model data*. O'Reilly Media, Inc. Available online at https://r4ds.had.co.nz

Wilke, C.O. (2019). *Fundamentals of Data Visualization*. Available online at https://clauswilke.com/dataviz/

Xie, Y., Allaire, J.J., & Grolemund, G. (2020). *R Markdown: The Definitive Guide*. Available online at https://bookdown.org/yihui/rmarkdown/

Course Schedule

Week 1 – September 14
R and R Notebooks
Readings: Barrett Chapter 1 & 9
Optional: Dalpiaz Chapter 2 & 3

Week 2 – September 21
Describing Data
Readings: Barrett Chapters 2 & 3
Optional: Ismay Chapter 2; Wickham Chapters 3 & 7

Week 3 – September 28
Simple Regression
Readings: Dalpiaz Chapter 7 & 8
Optional: Ismay Chapter 5

Week 4 – October 5
Multivariate Regression
Readings: Dalpiaz Chapter 9
Optional: Ismay Chapter 6
Deliverable: Lab 1

Week 5 – October 12
Regression Diagnostics
Readings: Dalpiaz Chapter 13

Week 6 – October 19
Generalized Linear Models
Readings: Dalpiaz Chapter 17
Optional: Ismay Chapter 5
Deliverables: Lab 2, Project Proposal

Week 7 – October 26
Spatial Data in R
Readings: Lovelace Chapters 2 & 8.1-8.2

Week 8 – November 2
Spatial Autocorrelation
Readings: Bivand Chapter 9.1-9.3
Deliverables: Lab 3, Descriptive Analysis

Week 9 – November 9
Spatial Regression I
Readings: Bivand Chapter 9.4

Week 10 – November 16
Spatial Regression II
Readings: TBD
Deliverable: Lab 4

Week 11 – November 23
Spatial Analysis: Extensions
Readings: TBD

Week 12 – November 30
Projects Week
Deliverable: Lab 5

Policies

The department's full Graduate Course Policies apply to all courses offered.

Accessibility Services

The University of Toronto is committed to accessibility. If you require accommodations because you are disabled, or have any accessibility concerns about the course, the classroom or course materials, please contact Accessibility Services as soon as possible.

Where there is an accommodation recommended by Accessibility Services, the department and/or instructors will be provided with an accommodation letter.

Academic Integrity

Academic misconduct by graduate students is taken very seriously. The University's policy on academic misconduct is found in the Code of Behaviour on Academic Matters (the Code). Students in graduate studies are expected to commit to the highest standards of integrity and to understand the importance of protecting and acknowledging intellectual property. For example, it is assumed that they bring to their graduate studies a clear understanding of how to cite references appropriately, thereby avoiding plagiarism.

Regarding plagiarism, the Code includes the following statements:

> B.i.1. It shall be an offence for a student knowingly:
>
> (d) to represent as one's own idea or expression of an idea or work of another in any academic examination or term test or in connection with any other form of academic work, i.e., to commit plagiarism.

Wherever in the Code an offence is described as depending on "knowing," the offence shall likewise be deemed to have been committed if the person ought reasonably to have known.

Other academic offences include the possession and/or use of unauthorized aids in examinations, submitting the same paper for different courses without the knowledge of the instructors, forgery (whether of academic records or other documents), concocting facts or references to sources, personating someone, and other forms of cheating and academic dishonesty. Please refer to sections B.i.1. and B.i.3. in the Code for detailed descriptions of offences applicable to students.

The SGS Academic Integrity Resources webpage outlines the policy on academic misconduct and the process for handling an allegation of academic misconduct.

Religious Accommodations

Students must alert instructors in a timely fashion to any upcoming religious observances and anticipated absences. Instructors will make every reasonable effort to avoid scheduling tests, exams or other compulsory activities at these times. In the case of an unavoidable conflict with a compulsory activity, every reasonable effort is made to give students the opportunity to make up missed work.

Copyright in Instructional Settings

If a student wishes to record (tape, video, photograph, etc.) any lecture presentations or other similar materials provided by the instructor; the instructor's written consent must be obtained beforehand. Otherwise, all such reproduction is infringement of copyright and prohibited. In the case of private use by students with disabilities, the instructor's consent shall not be unreasonably withheld.

Extension Requests

The authority to grant an extension to submit coursework beyond the sessional grade deadline is with the department and not the instructor of the course. To request a formal extension beyond a grade deadline, students must submit a Coursework Extension Form, completed by both the student and course instructor, to the relevant graduate department prior to the final grade deadline.

In order to ensure fairness in granting extensions, the department must be reasonably certain that:

- The reasons for delay are serious and substantiated.
- The student is not granted unfair advantage over other students in the course.
- The student has a reasonable chance of completing the outstanding work within the time allotted.
- The normal and satisfactory completion of any new coursework is not in jeopardy.

Extension requests for medical reasons (e.g. short-term illness) must be accompanied by a medical note. Extension requests for students with accommodations due to disability must be supported by documentation from Accessibility Services. Extension requests for other reasons must be detailed in the form or a note to the department.

Mental Health Statement

As a student at U of T, you may experience circumstances and challenges that can affect your academic performance and/or reduce your ability to participate fully in daily activities. An important part of the University experience is learning how and when to ask for help. There is no

wrong time to reach out, which is why there are resources available for every situation and every level of stress.

Please take the time to inform yourself of available resources, including:

- Geography & Planning Mental Health Support Website
- Graduate Wellness Services
- Student Mental Health Resources
- Emergency support if you're feeling distressed

An important part of the University experience is learning how and when to ask for help. Please take the time to inform yourself of available resources.

Other Student Services and Support Resources

- Links to Additional Student Services and Support Resources (general services and support for students, international student support, Health & Wellness, financial aid and professional development)