GEOGRAPHY AND ENVIRONMENTAL STUDIES
Carleton University

COURSE OUTLINE - Fall 2018

COURSE: **Quantitative Analysis for Geographical Research – GEOG 5002**

INSTRUCTOR: **Derek Mueller**
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OFFICE HOURS: Thursdays 13:30-14:30 or by appointment.

MEETINGS: Wednesdays and Fridays 9:35 – 11:25 Loeb A220

Recommended Textbooks:
There is no required textbook. Recommended reference materials will be introduced at the beginning and throughout the course.

Objectives: This course will cover topics in data management, programming and quantitative geographic analysis using the popular open source software R. The course will begin with an introduction to the R programming language including data structures, syntax, descriptive and inferential statistics, and basic programming techniques. Once these foundations are in place, students will apply advanced quantitative analysis techniques to a wide range of environmental and geographic data sets. Students will develop critical understanding and technical knowledge of the broad field of environmental modelling through readings, workshops and problem sets. The course will culminate in individual research projects focused on a suitable environmental modelling problem, ideally chosen with input from each student's graduate supervisor.

Core topics (these topics will be prioritized):

- Basic programming (variables, functions, flow control, etc)
- Data manipulation and organization
- Descriptive and inferential statistics
- Central Limit Theorem and power analysis
- Multiple regression and partial regression analysis
- ANOVA and repeated measures
- Classification and regression trees
- Random forest machine learning
- Model selection
- Cross-validation
- Bootstrapping confidence intervals
- Vector and raster geomatics with R
- Time series analysis (basic)

Optional topics (these will be selected depending on the progression/interests of the students in the class)

- Clustering/Discrimination analysis
- Ordination and gradient analysis (PCA, nMDA, RDA, CCA)
- Time series (ARIMA and frequency domain)
- Bootstrapping / Monte Carlo
- Spatial autocorrelation and variography
- Logit regression
- Model simulation and optimization

Uncertainty and error
Linear mixed effects regression models (LMER)
General Linear Models, General Additive Models
Bayesian modelling
Data management – metadata
Deterministic numerical modelling
Advanced programming, object-oriented coding, version control, debugging

Program: Workshops as per schedule
Readings as assigned
Problem sets as assigned
Modelling reading assignment
Modelling project proposal and presentation
Online quizzes (self-paced)
Final project presentation
Final project report

Evaluation:

Problem sets	25%
Literature review assignment	10%
Modelling project proposal	10%
Modelling project report	35%
Online statistics quizzes	10%
Presentations (2)	10%
Total	**100%**

Standing in a course is determined by the course instructor subject to the approval of the Faculty Dean. This means that grades submitted by the instructor may be subject to revision. No grades are final until they have been approved by the Dean.

Assignments:
1) Problem sets: You will be assigned several problem sets throughout the semester. These are designed to help you understand apply key concepts and develop hands-on experience solving quantitative research problems with R. They will not be always the same length/level of difficulty and the marks assigned to each one will reflect that. For example, you may be assigned a quick 'show me you can do what you just learned' assignment that might not be a formal problem set – in that case, marks would be given for participation.

2) Modelling in the geographic and environmental sciences: This is a short (~1000-1500 word) synthesis/review of some prescribed readings designed to help you understand the continuum of quantitative methods used in our discipline and to reflect on the type(s) of approach(es) that you expect to be using in your own research.

3) Modelling Project Proposal and Report: The purpose of the modelling project is to develop a more in-depth and working knowledge of statistics, data manipulation and/or modelling with R, with application to a problem of relevance to your research topic. You should focus on either analysis of a dataset using methods learned in class, or on implementation of a new technique not learned in the course. You are expected to discuss the topic of this project with your supervisor and may wish to request a suitable dataset from them. You will write a project proposal at the half-way point in the course, to be submitted for evaluation. The project report should follow the format of a journal article (Introduction with background/literature review, Methods, Results, Discussion, Conclusion, References (with citations throughout following academic norms). Figures and Tables are expected and students will supply their R code in an Appendix, along with supplementary figures, if warranted). This will be the major deliverable of independent work for the course and you are encouraged to progress throughout the term to avoid last minute angst.

3) Presentations: You will deliver two short (~15 minute) oral presentations to the class throughout the semester. The first will provide an overview of your proposed modelling project proposal. In the second presentation during the last week of classes, you will present your findings.

4) Quizzes – a series of short (~10 question) online quizzes must be completed by all students in order to demonstrate that you have a solid grasp of fundamental statistical concepts, as expected at the graduate level in our program. You will be directed towards appropriate readings to help you prepare for and succeed in these quizzes.

5) You will be assigned journal article readings throughout the course and some meetings may be devoted to discussion of key concepts introduced in the course. All students must come prepared to discuss the readings and individuals may be asked to lead discussions without prior notice.

Academic Accommodation:
You may need special arrangements to meet your academic obligations during the term. For an accommodation request the processes are as follows:

Pregnancy obligation: write to me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details see the Student Guide

Religious obligation: write to me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details see the Student Guide

Academic Accommodations for Students with Disabilities: The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or pmc@carleton.ca for a formal evaluation. If you are already registered with the PMC, contact your PMC coordinator to send me your Letter of Accommodation at the beginning of the term, and no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). After requesting accommodation from PMC, meet with me to ensure accommodation arrangements are made. Please consult the PMC website for the deadline to request accommodations for the formally-scheduled exam (if applicable).

Student Conduct:
The University has adopted a policy to deal with allegations of academic misconduct. This policy is expressed in the document Carleton University Academic Integrity Policy, effective July 1, 2006. The policy describes in detail its scope of application, principles, definitions, rights and responsibilities, academic integrity standards, procedures, sanctions, transcript notations, appeal process, and records implications.
The complete policy is available at: http://www2.carleton.ca/studentaffairs/student-rights-and-responsibilities/

Plagiarism:
Plagiarism is presenting, whether intentional or not, the ideas, expression of ideas or work of others as one's own. Plagiarism includes reproducing or paraphrasing portions of someone else's published or unpublished material, regardless of the source, and presenting these as one's own without proper citation or reference to the original source. Examples of sources from which the ideas, expressions of ideas or works of others may be drawn from include but are not limited to: books, articles, papers, literary compositions and phrases, performance compositions, chemical compounds, art works, laboratory reports, research results, calculations and the results of calculations, diagrams, constructions, computer reports, computer code/software, and material on

the Internet.

The University Senate defines plagiarism as "*presenting, whether intentionally or not, the ideas, expression of ideas or work of others as one's own.*" This can include:

- reproducing or paraphrasing portions of someone else's published or unpublished material, regardless of the source, and presenting these as one's own without proper citation or reference to the original source;
- submitting a take-home examination, essay, laboratory report or other assignment written, in whole or in part, by someone else;
- using ideas or direct, verbatim quotations, or paraphrased material, concepts, or ideas without appropriate acknowledgment in any academic assignment;
- using another's data or research findings;
- failing to acknowledge sources through the use of proper citations when using another's works and/or failing to use quotation marks;
- handing in "substantially the same piece of work for academic credit more than once without prior written permission of the course instructor in which the submission occurs."

Plagiarism is a serious offence that cannot be resolved directly by the course's instructor. The Associate Dean of the Faculty conducts a rigorous investigation, including an interview with the student, when an instructor suspects a piece of work has been plagiarized. Penalties are not trivial. They can include a final grade of "F" for the course.
(see: http://www2.carleton.ca/studentaffairs/academic-integrity and http://www.library.carleton.ca/help/avoid-plagiarism)

Other Important Locations on Campus:
Paul Menton Centre (501 University Centre) for students needing accommodation
Writing Services https://carleton.ca/csas/writing-services/ (4th Floor, Library)
Centre for Student Academic Support https://carleton.ca/csas/ (CSAS, 4th Floor, Library)

CLASS SCHEDULE, TOPICS AND READINGS
(Subject to modification!!)

Date	Topics	Deadlines (due the night before the date indicated)
Sep 5	Course overview / Introduction to topics	
Sep 7	Introduction to R and RStudio Basic programming (variables, functions, flow control, etc)	
Sep 12	Central limit theorem	
Sep 14	Inferential statistics	Problem Set
Sep 19	Power analysis	Quiz
Sep 21	Correlation and regression; Data manipulation and organization	Problem Set
Sep 26	Multiple linear regression	Describe project dataset; Quiz
Sep 28	Regression diagnostics, model selection	Model Readings Assignment
Oct 3	Variance Partitioning, cross-validation	Discuss your project with Derek
Oct 10	ANOVA; ANOVA with repeated measures	Problem Set; Quiz
Oct 12	Classification and Regression Trees (CART)	Proposal due
Oct 17	Random Forest	
Oct 19	READING WEEK – No Class	
Oct 22-26	Project Proposal Presentations	
Oct 31	Project Proposal Presentations	
Nov 2	Bootstrapping confidence intervals; More cross-validation	
Nov 7	Principal Component Analysis	
Nov 9	Basic time series analysis	Problem Set
Nov 14	Vector and raster geomatics with R	Quiz
Nov 16	TBD (see optional topics)	
Nov 21	TBD	
Nov 23	TBD	
Nov 28	TBD	
Nov 30	Final Project Presentations	
Dec 5	Final Project Presentations	
Dec 7	NO CLASS (follows a Monday schedule)	Project report due