DEPARTMENT OF RENEWABLE RESOURCES

UNIVERSITY OF ALBERTA

RenR 480/580 - Applied Statistics for the Environmental Sciences

Fall 2023 Syllabus

eClass Website – http://tinyurl.com/rr480/eclass

Instructor Andreas Hamann
Telephone: (780) 492-6429
Email: andreas.hamann@ualberta.ca
Office Hours: via Zoom by email appointment, or GSB 733 open door

Assistants Sarah Namiiro
Email: namiiro@ualberta.ca
Office Hours: via Zoom by email appointment

Term Fall 2023 (First class: Tuesday Sep 5, Last class: Thursday Dec 7)

Class times In-person Rm GSB 866: Tues & Thurs 8:00–9:20am & Thurs 12:30–13:50.
On-line: Tues 9:00–9:20, Thurs 12:30–13:50, Tues Dec 5 8:00–9:20am.

Delivery Based on a preference survey of the 2023 participants, the format of this course will be blended on-line/in-person. All lectures will be available as videos on eClass, with optional in-person sessions for some lecture slots. In-person labs will be offered every Thursday afternoon, with the option to attend via Zoom. There are no in-person requirements for this class.

No classes Nov 14 & 16 (Fall Term reading week)

Credits *3 credits

(1) Course Description

The course focuses on problem formulation, method selection, and interpretation of statistical analysis. Covers data management and data visualization, statistical tests for parametric, non-parametric and binomial data, linear and non-linear regression approaches. Participants of the REN R 480 section will gain general statistical literacy and learn how to visualize and analyze data with open-source software packages. Participants in the RENR 580 section will also engage in problem-based learning by analyzing data from their thesis research project. Graduate students without a suitable dataset should enroll in two or more ★1 modules from the REN R 581/582/585/586 options instead. Prerequisite: a minimum of ★60 of university-level courses; ★3 introductory statistics recommended.

(2) Course Delivery

We will use teaching and learning strategies referred to as a “flipped classroom”. The traditional class room lectures will be provided as videos that you can watch any time that suits you. Conversely, synchronous classroom times will be used for Q&A sessions and for working on labs and projects, allowing more time for support and mentoring, and for students to interact and work together in small groups.

Since this course has no in-person presence requirements, we will hold weekly quizzes to help you stay on track with the class material. Subject of the quizzes will be video and lab material of the proceeding days. The quizzes and exam are "open book": you may consult lab handouts and your own course notes or use computers, calculators and any on-line resource you wish. You are, however, not allowed to consult other persons during quizzes or exams.

In addition to video lectures and labs, you will also carry out a course project that involves statistical analysis. RENR 580 participants carry out an individual research project and undergraduate participants of RENR 480 may carry out their projects in groups of up to three persons, but can also carry out an individual project if they wish. Your projects will be presented online as a website and as a 5-minute video (or narrated PowerPoint file). You will receive feedback from me and your peers on a draft version to improve your final presentation and website submissions. See previous year's projects here: http://tinyurl.com/rr480/projects.

(3) Student Learning Outcomes and Competencies

For broad course objectives watch this video: http://tinyurl.com/rr480/videos/intro. The specific course objectives are as follows:

Introductory section:

• Become familiar with the fundamental concepts of statistics and empirical research. Understand how statistics can effectively be used in science.

• By planning an independent student project, practice how to tell a scientific story from beginning to end, aided by statistical analysis and graphical presentation of quantitative data.

• Learn the basics of experimental and sampling designs, and be aware of common design pitfalls and misinterpretations of results.

Data management and exploratory graphical analysis:

• Learn how to collect and organize your data so that it is most useful for subsequent analysis.

• Gain some hands-on experience with data organization, data checking, data preparation through a set of exercises and a student project.

• Be able to thoroughly understand the nature of your data through graphical display of raw data and summary statistics before applying any statistical tests.

• Learn how to generate publication-quality scientific graphs and how to use the correct type of graph for various objectives.

Inferential statistics:

• Get an overview of statistical methods, and learn under what conditions and for what objectives each method is applicable.

• Explore how organizing your data determines what statistical analysis you can do.

• Learn how the type of variables (continuous, discrete-ordinal, discrete-nominal, and binary) determines what statistical method you should use.

• Be aware of conditions that need to be met for particular methods, learn how to test assumptions, carry out data transformation, and deal with missing values.

• Practice empirical research, application of statistical methods, and writing reports through the course project

Specific methods:

Learn how to implement basic experimental and sampling designs (CRD, RCB) and analyze data with common statistical methods. The table below provides an overview of techniques covered, with an emphasis in the T-test, single and multifactor ANOVA, multiple comparison methods, effect size statistics, chi-square test, z-test for proportions, nonparametric methods, linear and non-linear regression and correlation analysis. Mixed models and other techniques in parentheses will be covered on demand.

Objective \ Data Type	Parametric	Non-parametric	Binomial
Descriptive Statistices	Mean, Stdev, Variance	Quartiles, quantiles	Proportions
Graphical representations, summaries	Scatter plots, line plots, bar charts, dot plots with SD/SE/CI	Box plots, histograms, parametric charts with transformed scales	Parametric charts with asymetric SE/CI
Compare sample to expectation	1-Sample T-test	Wilcoxon test, (bootstrapping)	1-Sample Z-test for proportions
Compare 2 groups	2-Sample T-Test	Mann–Whitney U test 2-Sample permutational ANOVA	2-Sample Z-test for proportions Fisher's exact test
• How much bigger is A vs B	CI & Effect size statistics (Decision analysis)	⇦ (ignore assumptions)	Asymetric CI & Effect size statistics
Compare paired samples	Paired T-Test	Wilcoxon signed-rank test (bootstrapping on difference)	N/A
Compare >2 groups	Single-factor ANOVA	Kruskal-Walis test, permutational ANOVA	Chi-square test of independence (Chi-square test of goodness of fit)
• How much bigger is A, B vs Ctrl	Contrasts with CI & Effect size statistics (GLHT done right)	⇦ (ignore assumptions)	Pairwise Z-tests with asymetric CI & effect size statistics
Compare >1 factors with >1 groups each	Multi-factor ANOVA (Mixed models, BLUPs & BLUEs)	Friedman's rank test (one factor + block) permutational ANOVA	(Subsets)
Relationships between 2 variables	Pearson correlations	Spearman rank correlations	(Contingency coefficients)
Predict one variable from another	Linear, non-linear regession	(Non-parametric regression)	(Logistic regression)

(4) Required Software, Hardware and Textbooks

This course introduces you to R, a free, open source programming environment for statistical analysis, data management and graphics. The software is available for Windows, Linux or Mac.

For labs we will work with small datasets that can be run on any computer or laptop. However, for your course projects experience has shown that you need a proper workstation with a reasonably sized (or dual) monitor setup. You can use the workstations in GSB 866, or loan a computer for your on-campus office or for home use here: http://tinyurl.com/renr-computers.

No textbooks are required or recommended. The lecture videos and lab handouts will be all you need for this course.

(5) Marking and Grading

Your grade will be determined based on a variety of course rubrics that are weighted differently for graduate and undergraduate students (see tables below). Generally, the workload expectations for this course are higher for graduate students in quantity and quality. The University of Alberta expects the total workload for an undergraduate class to be about 8 hrs/week and for a graduate class about 12 hrs/week. Graduate students are further expected to do more independent, problem-based learning, primarily through individual class projects that receive a higher grading weight. For undergraduate students I generally recommend group projects with 2 or 3 participants (individual projects or groups of 4 require my prior approval).

The final grade determination will be based on a combination of your absolute achievement (total percentage weights out of 100) and your performance relative to the entire class. This will be done separately for RENR 480 and RENR 580 participants. Normally, the class median for RENR 480 sits between a B+ and a B, and the class median for RENR 580 centers around a B+ grade. I will let you know your absolute and relative class standing, with a projected letter grade, after the draft projects have been evaluated.

Grading weights	***RENR 480***	***RENR 580***
Approx. 10 weekly quizzes, worst quiz dropped:	20%	15%
Draft project website and 5-minute presentation:	15%	15%
Your feedback on draft projects by your peers:	10%	15%
Final exam during last week of classes:	30%	20%
Final project website and 5-minute video:	25%	35%

Important dates and deadlines	***Dates to keep in mind***
Weekly quizzes:	Tuesdays 9am
Your ideas and plans for course projects due:	Sep 29, 6pm
Draft project website and 5-minute presentation submission due:	Nov 3, 6pm
Your feedback on draft projects by your peers due:	Nov 10, 6pm
RSVP for attending the optional in-person symposium:	Dec 5, 6pm
Final exam during last week of classes:	Dec 7, 8am
Optional in-person symposium:	Dec 7, 12:30pm
Final project website and 5-minute video submission due:	Dec 15, 6pm

(6) Course policies

Course policy for late submissions: possibly some deduction at my discretion, depending on your circumstances. However, there is a hard deadline for me to submit course grades, and therefore there is a hard deadline for late submissions of any kind from you as well:

Hard deadline for late submissions of any kind: **Dec 17, 6pm**

Course policy for missed quizzes and exams: If you miss a quiz, it should not be a big disaster as each individual quiz will only account for approximately 2% of the grade. Furthermore, the quiz with your worst quiz grade (e.g., 0% for a missed quiz) will be dropped from the grading. If you miss the final exam, you must send me this form within two days to be eligible for a deferred exam application: http://tinyurl.com/rr480/absence.

Illness/Covid/Emergency policy: If you don't feel well, there is no reason and no pressure to attend in-person. In fact, as a courtesy to your peers, you are encouraged to attend on-line. For

longer absences, **I do not need** a Doctor's note or supporting documentation for any other reason. However, let me know as soon as possible what's up (using the absence form: http://tinyurl.com/rr480/absence or informally by email containing the same information), so I can advise you what your best options are to successfully complete the course.

Course policy for technical issues: Participation in this course requires a stable internet and an adequate workstation to participate in quizzes, labs, and carry out your projects. If there are unexpected, widespread technical problems with eClass, I may remove or reschedule a meeting, quiz, or assignment for every participant at my discretion.

Individual accommodations: if you are registered with University of Alberta Accessibility Resources for a disability or health condition, please let me know at your earliest convenience so that I can implement the recommended individual accommodations for quizzes and exams.

Use of AI-based tools: You are welcome to use Artificial Intelligence (AI) to help you with creating your course project, get an alternative explanation for a difficult concept, or even try to improve your quiz and exam score in this course. (Note, however, that my course policy may be different from those of other instructors). In my judgment, it will be a key life skill to take full advantage of generative AI that underlies ChatGPT, Quillbot, Grammarly, etc. When prompted correctly, and guided with follow-up suggestions and critique, AI can come up with pretty good material to write a convincing rationale for your research project, and may even be able to state good scientific objectives or hypothesis. ChatGPT in particular is also a champ in generating code for graphics and statistical analysis and explore new methods with sample datasets.

(7) General policies of the University of Alberta

Disabilities and health conditions: The University of Alberta is committed to creating work and learning communities that inspire and enable all people to reach their full potential. Accessibility Resources promotes an accessible, inclusive, and universally designed environment. For general information to register for services visit the University of Alberta Accessibility Resources webpage.

Recording of lectures: Audio or video recording, digital or otherwise, of lectures, labs, seminars or any other teaching environment by students is allowed only with the prior written consent of the instructor or as a part of an approved accommodation plan. Student or instructor content, digital or otherwise, created and/or used within the context of the course is to be used solely for personal study, and is not to be used or distributed for any other purpose without prior written consent from the content author(s).

Plagiarism and cheating**:** The University of Alberta is committed to the highest standards of academic integrity and honesty. Students are expected to be familiar with these standards regarding academic honesty and to uphold the policies of the University in this respect. Students are particularly urged to familiarize themselves with the provisions of the Code of Student Behaviour (online at www.governance.ualberta. ca) and avoid any behaviour which could potentially result in suspicions of cheating, plagiarism, misrepresentation of facts and/or participation in an offence. Academic dishonesty is a serious offence and can result in suspension or expulsion from the University.

All students at the University of Alberta are subject to the Code of Student Behaviour, as outlined at: University Governance > Code of Student Behaviour. Please familiarize yourself with it and ensure that you do not participate in any inappropriate behavior as defined by the Code. Key components of the code include the following statements: 30.3.2(1) No Student shall submit the words, ideas, images or data of another person as the Student's own in any academic writing, essay, thesis, project, assignment, presentation or poster in a course or program of study. 30.3.2(2)c. No Student shall represent another's substantial editorial or compositional assistance on an assignment as the Student's own work."
Students should speak with the course instructor about any questions or concerns about the code. Students should be particularly aware of the code as it pertains to internet and library research, use of previous class notes, reclamation plans of former students and interviews or discussions with others.

Policy about course outlines**:** Policies about course outlines can be found in Course Requirements, Evaluation Procedures and Grading of the University Calendar.