ENVS 278: Applied Statistics for Environmental Research

< ASYNCHRONOUS ONLINE COURSE >

Instructor: Dr. Chris Fletcher (chris.fletcher@uwaterloo.ca)

Lecture: Approximately 1 hour per week, pre-recorded and available on LEARN.

Tutorial: Approximately 30 mins per week, pre-recorded and available on LEARN.

Virtual Office hours: Instant messaging throughout the week on LEARN, or click https://calendly.com/cgf to book an appointment for a voice/video meeting on Microsoft Teams.

Introduction and Course Objectives

Statistics is the art and science of making sense with data; i.e., understanding how our world works through evidence, while accounting for the inherent uncertainties. Statistical methods are critical for quantitative environmental research in every field in the natural and social sciences. This course builds on the knowledge gained in ENVS 178 by examining further techniques for collecting, evaluating, and using data-based evidence in environmental research. The focus in this course is on inferential statistics, including sampling distributions, confidence intervals, parametric and nonparametric hypothesis tests, and linear regression models. Students further develop skills in using statistical software for data analysis and modeling of environmental data, a necessary skill set for further pursuits in academic and professional life.

Prerequisite: ENVS 178

Learning Outcomes

At the end of this course, students will be able to

- Define and understand key statistical terminology and concepts;
- Select and apply suitable statistical tools for a variety of data analysis problems;
- Interpret and critically evaluate the results of statistical analyses;
- Use statistical software to perform selected data analysis tasks.

Learning Activities

This course employs a blend of learning activities and delivery methods: lectures, tutorial, online and individual. Lecture time is used to introduce key concepts, and to work through and discuss examples to illustrate these concepts and ensure students have good foundational understanding. Online quizzes in MyLab provide an opportunity to practice the application of statistical concepts and methods on sample datasets, while tutorials aid in interpreting the output from statistical software. The online learning platform ‘LEARN’ will be used for lectures, tutorials, discussions, informational messages, and virtual office hours. A take-home assessment on linear regression will provide students with the opportunity to apply their statistical analysis skills to a real environmental data set, and to gain further experience using statistical software. The required textbook provides additional material for self-study, for example through in-chapter example problems.

Required Text and Online Learning Resources


- Pearson Education Inc. offers additional online learning resources (MyStatLab); subscription to MyStatLab and Learning Catalytics is required for assessment items in this course.

Last updated: Jan 4, 2021
• NOTE: Other Canadian editions of the text are permitted, but chapter numbering, and some content, is different to the third edition. Students are responsible for finding the appropriate material in their textbook. Use of any United States editions of the text is not recommended.

How to succeed in ENVS 278:
The course is divided up into a series of modules, each covering a different statistical method for a different type of application. For each module:
1. Students are provided with the Professor’s lecture notes for each module, and are expected to have read these notes before watching each week’s lecture.
2. The lecture solidifies foundational understanding of the content for each module, through a series of examples and demonstrations.
3. Once students have read the notes and watched the lecture, they should complete the weekly Homework assignment on MyLab.
4. Once students have achieved a mark of at least 66% on the Homework (unlimited attempts are permitted), the Quiz will be unlocked in MyLab. Only one attempt is permitted on the Quiz, which contributes a small percentage to your final grade, and provides the instructor with an indication of how well the material has been understood.
5. Finally, after completing the Quiz, students will watch a pre-recorded tutorial, and complete a short assessment at the end on interpreting the output from a statistical analysis.

The course content is incremental: one week’s material builds on the previous week’s. This makes it more difficult to catch up after missing a class or two, and so it makes good sense to keep on top of the workload each week (5-7 hours is expected, on average).

This course has a reputation for being “difficult”, but I think that means it forces students out of their comfort zone. History has shown that all students have the potential to do well in this class, regardless of their background in math, if they commit to applying themselves to the material consistently throughout the term. While ENVS278 requires more math than other courses in the Faculty, the math is Grade 9-10 level in Ontario high schools, and the instructor and TAs are here to assist. If you complete all the activities in each module, you will gain confidence by seeing that solving statistical problems is actually not that difficult at all.

Class Schedule (Date column indicates when material will be available in LEARN)

<table>
<thead>
<tr>
<th>Class</th>
<th>Date</th>
<th>Topic</th>
<th>Textbook</th>
<th>Assessment Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEC 1</td>
<td>11-Jan</td>
<td>Review important material from ENVS 178; Course Overview; Statistical Inference for proportions; Confidence intervals</td>
<td>Ch 9, 10. Ch 14, 15.1-15.2</td>
<td>ENVS178 review quiz (on MyLab, ungraded) MyLab + TUT 1 (Due Jan 15th) Course outline Quiz on LEARN (before Jan 15th) Class Data Quiz on LEARN (Due Jan 15th)</td>
</tr>
<tr>
<td>TUT 1</td>
<td>11-Jan</td>
<td>Interpreting a confidence interval</td>
<td>Ch. 15.2</td>
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<tr>
<td>LEC 2</td>
<td>18-Jan</td>
<td>Intro to null hypothesis significance testing</td>
<td>Ch. 15.3-15.4, 16.1-16.3.</td>
<td>MyLab + TUT 2 (Due Jan 22nd)</td>
</tr>
<tr>
<td>TUT 2</td>
<td>18-Jan</td>
<td>Interpreting a one-prop hypothesis test</td>
<td>Ch. 16.3, 16.5</td>
<td></td>
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<tr>
<td>LEC 3</td>
<td>25-Jan</td>
<td>More about hypothesis tests; Comparing Two Proportions</td>
<td>Ch. 17.2, 17.5-17.6; Ch 21</td>
<td>MyLab + TUT 3 (Due Jan 29th)</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Activity</th>
<th>Material/Tools</th>
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</thead>
<tbody>
<tr>
<td>TUT 3</td>
<td>25-Jan</td>
<td>Interpreting a two-prop hypothesis test</td>
<td>Ch. 21.4</td>
</tr>
<tr>
<td>LEC 4</td>
<td>1-Feb</td>
<td>Inference for sample means</td>
<td>Ch. 18.1-18.4 MyLab + TUT 4 (Due Feb 5th)</td>
</tr>
<tr>
<td>TUT 4</td>
<td>1-Feb</td>
<td>Interpreting a CI and hypothesis test for a sample mean</td>
<td>Ch. 18.4</td>
</tr>
<tr>
<td>LEC 5</td>
<td>8-Feb</td>
<td>Comparing means</td>
<td>Ch. 19, Ch. 20 MyLab + TUT 5 (Due Feb 12th)</td>
</tr>
<tr>
<td>TUT 5</td>
<td>8-Feb</td>
<td>Interpreting hypothesis tests for comparing sample means</td>
<td>Ch. 19, Ch. 20</td>
</tr>
<tr>
<td></td>
<td>15-19 Feb</td>
<td>Reading week: No lecture or tutorial content this week</td>
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</tr>
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<td>1-Feb</td>
<td>Interpreting a CI and hypothesis test for a sample mean</td>
<td>Ch. 18.4</td>
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<td>8-Feb</td>
<td>Interpreting hypothesis tests for comparing sample means</td>
<td>Ch. 19, Ch. 20</td>
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<td></td>
<td>15-19 Mar</td>
<td>Winter Pause Days: No lecture or tutorial content this week</td>
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<td></td>
<td>22-Feb</td>
<td>Test 1 (on Modules 1-2: all material up to TUT 5)</td>
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<tr>
<td>LEC 6</td>
<td>23-Feb</td>
<td>Introduction to SPSS software</td>
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<tr>
<td>TUT 6</td>
<td>23-Feb</td>
<td>Comparing Counts</td>
<td>Ch 22 MyLab + TUT 6 (Due Feb 28th)</td>
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<tr>
<td>LEC 7</td>
<td>1-Mar</td>
<td>Nonparametric methods</td>
<td>Ch. 22</td>
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<tr>
<td>TUT 7</td>
<td>1-Mar</td>
<td>Interpreting nonparametric tests</td>
<td>Ch. 22</td>
</tr>
<tr>
<td>LEC 8</td>
<td>8-Mar</td>
<td>Analysis of Variance</td>
<td>Ch. 24, Ch. 25 MyLab + TUT 8 (Due Mar 12th)</td>
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<td>TUT 8</td>
<td>8-Mar</td>
<td>Interpreting ANOVA models</td>
<td>Ch. 24, Ch. 25</td>
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<tr>
<td></td>
<td>15-16 Mar</td>
<td>Winter Pause Days: No lecture or tutorial content this week</td>
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<td></td>
<td>19-Mar</td>
<td>Test 2 (on Modules 3-5: all material since LEC 6)</td>
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<tr>
<td>LEC 9</td>
<td>22-Mar</td>
<td>Multiple Linear Regression</td>
<td>Ch. 26 MyLab + TUT 9 (Due Mar 26th)</td>
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<tr>
<td>TUT 9</td>
<td>22-Mar</td>
<td>Interpreting MLR model output 1</td>
<td>Ch. 26</td>
</tr>
<tr>
<td>LEC 10</td>
<td>29-Mar</td>
<td>Multiple Regression Wisdom</td>
<td>Ch. 27 MyLab + TUT 10 (Due Apr 2)</td>
</tr>
<tr>
<td>TUT 10</td>
<td>29-Mar</td>
<td>Interpreting MLR model output 2</td>
<td>Ch. 27</td>
</tr>
<tr>
<td>LEC 11</td>
<td>5-Apr</td>
<td>Review and test preparation</td>
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<td></td>
<td>12-16 Apr</td>
<td>Test 3 (on Module 6: all material since LEC 9)</td>
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**Assessment**

All assessment activities are open-book; however, students are expected to complete them independently (**there is no group work in this class**). All participation grades will be posted on LEARN at the end of term (so you won’t see them immediately when you complete the activity).

Students will be evaluated based on:

- **3 Tests (20% each, total 60%)**: hand-written and submitted through Crowdmark.
- **MyLab quizzes (2% each, best 8 of 10, total 16%)**: Weekly multi-choice tests on Pearson MyLab will involve interpretation of statistical output, and/or some short calculations. Further details regarding MyLab activities will be presented during lectures.
- **Tutorial participation (2% each, up to 16%)**: Weekly assessments following each tutorial class. Students need to submit a reasonable attempt at least 8 of 10 tutorial assessments to receive the maximum participation grade. We strongly encourage students to complete all 10 assessments, because they provide practice for the tests and TA feedback.
- **Learning Catalytics participation (0.5% per week, up to 4%)**: Students will earn 0.5 % per week by participating in the Learning Catalytics activity associated with each week’s lecture, accessed

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through MyLab. Students need to complete at least 8 of 10 activities to receive the maximum participation grade.

- **Piazza discussion participation (2%)**: Students can earn a 2 % participation grade by posting a new thread, or editing/replying to an existing thread, on the Piazza discussion platform at any time before 11:59pm on the Monday after the final class of term (1% per post, total of 2 %).
- **Course outline quiz (1%)**: To be completed during the first week of term. Multiple attempts are allowed; course content will be released on LEARN only after students receive a grade of more than 80 %.
- **Class data quiz (1%)**: Students will earn an automatic 1 % participation grade by completing the Class Data Quiz on LEARN during Week 1. These data will be anonymized, and then used for class activities during the term.

**More about the Tests**

Three non-cumulative tests will assess student progress on material covered up to and including the week before the test. The tests will be conducted through the Crowdmark platform, may include calculation and short-answer questions, and will assess student’s ability to interpret the output from statistical analyses.

The tests are completely open book, but they are to be completed independently: this is not group work and students will be required to sign a declaration at the beginning of each test. Some calculations may be required during the tests, and students may use a calculator or software to complete them. The third test will examine students’ knowledge of linear regression, and will require students to perform analysis using the SPSS software that will be used during the term.

**What happens if I miss a Quiz or Test?**

Life happens. Life is important. Sometimes we all need time away from school or work for a multitude of reasons: because we get sick, due to a family bereavement, or perhaps a friend or relative needs our support. I hope your term goes smoothly, and that you don’t need to take any time off. But if you do, for whatever reason, then you shouldn’t need to worry about school – it’s just not as important as those other things.

So, if you need to take time off during term, then please just take it. You don’t need to contact me (unless you want to), and I don’t need to see any doctor’s notes, or other documentation. If you need to miss a quiz, then just miss it: the two lowest quiz grades (including zeros) will be automatically dropped for all students. If you need to miss one test, then just miss it: the weight of each student’s lowest test will automatically be redistributed to the other course assessment items. The same rules apply to all students, regardless of whether you write the test, or not.

Please note that due to the size of the class there are no extensions to quizzes, or alternative (make-up) dates to sit the tests. If you need to miss more than two quizzes, or more than one test, then please make an appointment to meet with the instructor at your earliest convenience to arrange alternative accommodation.

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Class policies, requirements and special considerations

• **Backing up your data**: Students are fully responsible for maintaining backups of any files and data you have modified. Suitable options for backups include: networked drives; portable USB flash drives; external hard drives; laptops, or home desktop PCs; online “cloud” storage. **No accommodation will be made** for deadlines missed due to lost or corrupted data.

• **Policy on regrading assignments**: If you notice an error in the assessment of your work please follow these steps:
  - Wait 48 hours after the assignment was returned before contacting a member of the instruction team.
  - All requests for work to be regraded must be submitted to the instructor from your UWaterloo email account, in a message that fully describes the errors you believe were made. Verbal requests for regrades will not be accepted.
  - When writing your request, please follow the policy on student email (see below).
  - Be as specific as possible and list all relevant details, e.g., “my marks were summed incorrectly for questions 1–5”.
  - If another student’s work is used as an example or reason for an error in grading, both assignments will be subject to a regrade.
  - The entire assignment will be regraded, not just the errors indicated in the written request. The resulting grade may increase or decrease depending on the result of the regrading.

• **Policy on student email**: Most information students need is found in this course outline: please review it carefully before contacting the instructor or TAs. Discussion forums (for which participation grades are awarded) are available on Piazza and are the preferred means of answering procedural questions. Virtual office hours are available via instant message in LEARN, face-to-face contact time is available by appointment. Students are strongly encouraged to attend virtual office hours to discuss any issues related to the course, and email should only be used when none of these other options is appropriate. The instructor and the TAs **will not respond** to emails if students have not first attempted to find an answer using these other means.

  **However, if your question or concern cannot wait until the next lecture or office hour** then please remember these policies when sending email to the instructor or TAs:
  - Always send emails from your University of Waterloo email account or from the email tool within UW LEARN.
  - All emails should have the following subject line: “ENVS278: <<insert your subject here>>”
  - The instructor should be copied on all course-related email communication with the TAs (**TAs are under instructions not to respond to emails that do not cc the instructor**).
  - If your email includes an attachment, describe the contents of the attachment in the email.
  - Be polite, respectful and professional.
  - Proofread your email and use correct grammar and punctuation.
  - Always use an appropriate greeting, and sign your full name.
  - Allow the instructor or TA at least **two business days** to respond before sending the request again. Mark all urgent matters “URGENT” in the subject line.
  - The instructor and TAs reserve the right to reply to you along with the entire class, if the question is deemed to be relevant to other students on the course. Alternatively, we may post
the question and response in a discussion forum on Piazza. The questioner’s identifying personal information will be removed from such announcements.

- **Student collaboration**: All assignments and tests are to be completed individually by each student. These elements are expected to be the student’s original work and to reflect her/his own thinking.

- **Readability and clarity**: Students are expected to present well organized and properly written work. The instructor and TAs reserve the right not to grade work that does not conform to normal standards of academic writing and/or organization.

- **Assignment submission**: Quizzes are completed on Pearson MyLab, while the regression assignment is to be submitted as a Word or PDF document to the LEARN drop box. Assignments submitted in a different format or manner than that specified in the assignment instructions will not be graded. Emailed assignments will not be accepted under any circumstances.

- **Late work will not be graded**: all assignments are due on the date set by the instructor. Teaching assistants are NOT allowed to change the due dates. There are no late penalties: any work that is submitted after the stated deadline, without appropriate documentation, will not be graded.

### Academic Policies

- **Academic Integrity**: In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. [www.uwaterloo.ca/academicintegrity/](http://www.uwaterloo.ca/academicintegrity/) Students who are unsure what constitutes an academic offence are requested to visit the on-line tutorial at [http://www.lib.uwaterloo.ca/ait/](http://www.lib.uwaterloo.ca/ait/)

- **Discipline**: A student is expected to know what constitutes academic integrity, to avoid committing academic offence, and to take responsibility for his/her actions. A student who is unsure whether an action constitutes an offense, or who needs help in learning how to avoid offenses (e.g., plagiarism, cheating) or about “rules” for group work/collaboration should seek guidance from the course professor, academic advisor, or the Undergraduate Associate Dean. For information on categories of offences and types of penalties, students should refer to Policy 71, Student Discipline, [www.adm.uwaterloo.ca/infosec/Policies/policy71.htm](http://www.adm.uwaterloo.ca/infosec/Policies/policy71.htm). For typical penalties, check Guidelines for Assessment of Penalties, [www.adm.uwaterloo.ca/infosec/guidelines/penaltyguidelines.htm](http://www.adm.uwaterloo.ca/infosec/guidelines/penaltyguidelines.htm)

- **Note for students with disabilities**: [AccessAbility services](http://www.uwaterloo.ca/accessability-services/), located in Needles Hall, Room 1401, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with [https://uwaterloo.ca/accessability-services/](https://uwaterloo.ca/accessability-services/) at the beginning of each term.

- **Research Ethics**: The University of Waterloo requires all research conducted by its students, staff, and faculty which involves humans as participants to undergo prior ethics review and clearance through the Director, Office of Human Research and Animal Care (Office). The ethics review and clearance processes are intended to ensure that projects comply with the Office’s Guidelines for Research with Human Participants (Guidelines) as well as those of provincial and federal agencies, and that the safety, rights and welfare of participants are adequately protected. The Guidelines inform researchers about ethical issues and procedures which are of concern when conducting research with humans (e.g. confidentiality, risks and benefits, informed consent process, etc.). If the development of your research proposal consists of research that involves humans as participants, please contact the course instructor for guidance and see [http://iris.uwaterloo.ca/ethics/](http://iris.uwaterloo.ca/ethics/)

- **Religious Observances**: Student needs to inform the instructor at the beginning of term if special accommodation needs to be made for religious observances that are not otherwise accounted for in the scheduling of classes and assignments.

- **Grievance**: A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70 - Student Petitions and Grievances, Section 4, [www.adm.uwaterloo.ca/infosec/Policies/policy70.htm](http://www.adm.uwaterloo.ca/infosec/Policies/policy70.htm). When in doubt please contact your Undergraduate Advisor for details.

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• **Appeals:** A decision made or penalty imposed under Policy 70 - Student Petitions and Grievances (other than a petition) or Policy 71 – (Student Discipline) may be appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to Policy 72 (Student Appeals) [www.adm.uwaterloo.ca/infosec/Policies/policy72.htm](http://www.adm.uwaterloo.ca/infosec/Policies/policy72.htm)

• **Turnitin:** Text matching software (Turnitin) will not be used to screen assignments in this course.

• **LEARN:** Users can login to LEARN via: [http://learn.uwaterloo.ca/](http://learn.uwaterloo.ca/). Use your WatIAM/Quest username and password. Documentation is available at: [http://av.uwaterloo.ca/uwace/training_documentation/index.html](http://av.uwaterloo.ca/uwace/training_documentation/index.html)

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• **Recording lectures:** Use of recording devices during lectures is only allowed with explicit permission of the instructor of the course. If allowed, video recordings may only include images of the instructor and not fellow classmates. Posting of videos or links to the video to any website, including but not limited to social media sites such as: Facebook, twitter, etc., is strictly prohibited.

• **Intellectual Property:** Students should be aware that this course contains the intellectual property of their instructor, TA, and/or the University of Waterloo. Intellectual property includes items such as: Lecture content, spoken and written (and any audio/video recording thereof); Lecture handouts, presentations, and other materials prepared for the course (e.g., PowerPoint slides); Questions or solution sets from various types of assessments (e.g., assignments, quizzes, tests, final exams); and Work protected by copyright (e.g., any work authored by the instructor or TA or used by the instructor or TA with permission of the copyright owner).

  Course materials and the intellectual property contained therein, are used to enhance a student’s educational experience. However, sharing this intellectual property without the intellectual property owner’s permission is a violation of intellectual property rights. For this reason, it is necessary to ask the instructor, TA and/or the University of Waterloo for permission before uploading and sharing the intellectual property of others online (e.g., to an online repository).

  Permission from an instructor, TA or the University is also necessary before sharing the intellectual property of others from completed courses with students taking the same/similar courses in subsequent terms/years. In many cases, instructors might be happy to allow distribution of certain materials. However, doing so without expressed permission is considered a violation of intellectual property rights.

  Please alert the instructor if you become aware of intellectual property belonging to others (past or present) circulating, either through the student body or online. The intellectual property rights owner deserves to know (and may have already given their consent).