

# **GEOG 316/PLAN 351: Multivariate Statistics**

Fall 2016

## **Instructor**

Dr. Christopher Fletcher

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**Lecture:** Monday 1-2:20pm, PAS-1241

**Labs:** Tuesday 10-11:20am (GROUP 1) or  
11:30am-12:50pm (GROUP2), EV2-1002A

**Office Hours:** Wednesday 1-3:30pm, EV1-230

## **Teaching Assistant**

TBA

**Office Hours:** TBA

**COURSE DESCRIPTION:** Specialists in the environmental sciences (e.g. geography, hydrology, ecology, atmospheric science) have to deal with a wide variety of data. Multivariate statistical techniques are particularly well suited for analysing diverse types of data (variables) simultaneously. This course will provide students with a foundation in the fundamentals of multivariate analysis, and practical experience of applying those techniques to problems in the environmental sciences.

## **COURSE LEARNING OBJECTIVES**

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

- Identify the most appropriate multivariate statistical techniques to use for data analysis in their academic discipline.
- Discriminate between the most common multivariate statistical techniques used in the environmental sciences.
- Apply these techniques to real data using the statistical software package SPSS
- Interpret the output from SPSS and communicate the results of these techniques.
- Have the confidence to explore beyond the techniques explored in this course.

**PREREQUISITES:** ENVS 278 (Advanced Environmental Research Methods). It is assumed that students are comfortable with mathematics and have basic knowledge of introductory statistics.

## **REQUIRED READING:**

Arnold, T., & Tilton, L. (2015). *Humanities Data in R*. Cham: Springer International Publishing. Retrieved from <http://link.springer.com/10.1007/978-3-319-20702-5>

Everitt, B., & Hothorn, T. (2011). *An Introduction to Applied Multivariate Analysis with R*. New York, NY: Springer New York. Retrieved from <http://link.springer.com/10.1007/978-1-4419-9650-3>

**ADDITIONAL READING:**

Sharma, S. (1995). *Applied Multivariate Techniques* (Har/Dskt edition). New York: Wiley.

Peter J. A. Shaw, 2009. *Multivariate Statistics for the Environmental Sciences*, Wiley, ISBN: 978-0-340-80763-7, 248p.

McGarigal, K., Cushman, S., and S. Stafford, 2000. *Multivariate Statistics for Wildlife and Ecology Research*. Springer-Verlag: New York. 283 p.

Meyers, L.S., G. Gamst, and A.J. Guarino, 2006. *Applied Multivariate Research: Design and Interpretation*. Sage: Thousand Oaks. 722 p.

Shaw, P.J.A., 2003. *Multivariate Statistics for Environmental Sciences*. Arnold: London. 233 p.

Griffith, D.A. and Amrhein, C.G. 1997. *Applied Multivariate Statistical Analysis for Geographers*. Upper Saddle River, New Jersey: Prentice Hall, 800p.

**COURSE WEB PAGE:** Students registered in the course can access the course website via UW Learn (<http://www.learn.uwaterloo.ca>). The course website provides access to lecture presentations and selected research papers as well as lab assignments (and associated data). In addition, the course website supports announcements, discussion groups and e-mail. Please use the UW Learn e-mail tool for sending messages related to this course, but please carefully review the policy on email correspondence before sending any email to the instruction team.

**STUDENT ASSESSMENT:**

Assignments (1@ 10%, 2@15%)	40%
Midterm	20%
Final exam	40%

**ASSIGNMENTS:** Assignments will take the form of research reports (5-6 pages, 12pt, single spaced) and must be uploaded to LEARN before the deadline. Each report should contain the following sections: Introduction, Data and methods, Results and Discussion, Conclusion, and References. Students will be provided with most data sources required to complete the assignments, will apply the statistical analysis techniques learned in class to those data, and then to interpret the results in the report.

Access to the computing labs is restricted by code to those enrolled in particular courses including this one. Food and/or drink are NOT permitted in the lab. The lab activities and assignments require using R software, which is available to students

in the computing labs, or it can be downloaded freely from <https://www.r-project.org>. However, I strongly recommend downloading and using RStudio (<https://www.rstudio.com>), instead of the standard R platform, because it is more user-friendly.

**WEEKLY CLASS SCHEDULE:**

Wk	Week commencing	Lecture Topics	Lab	Assignment
1	12-Sep	Course Introduction	Gather reading materials	
2	19-Sep	Review: Linear regression	Intro to R	
3	26-Sep	Logistic regression I		A1: Logistic regression [10%]
4	03-Oct	Logistic regression II		A1: due
5	10-Oct	Thanksgiving and Study Week: NO CLASS ON MONDAY, LAB ON THURSDAY		
6	17-Oct	Midterm exam in class [20%]	No lab	
7	24-Oct	Principal Components Analysis I		A2: PCA [15%]
8	31-Oct	Principal Components Analysis II		A2: due
9	07-Nov	Classification I: discriminant analysis		A3: Classification [15%]
10	14-Nov	Classification II: cluster analysis		A3: due
11	21-Nov	Time-series analysis		
12	28-Nov	Data mining I		
13	05-Dec	Data mining II		
		<b>Final examination</b> (during on-campus exam period)		

**Note:** The instructor reserves the right to change the course content or structure at any time, with or without warning.

**BACKING UP YOUR DATA:** Students are 100% responsible for maintaining backups of any files and data you have modified. In computing the mantra is: *if it's not in two places it doesn't exist*. 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.

**SUBMITTING WORK:** Unless otherwise noted, all work should be submitted via UW Learn **in PDF format**. Please do not submit work in any format other than PDF (e.g., LibreOffice, Microsoft Word, Excel). Each assignment will have a specified due date and time on UW Learn.

**LATE SUBMISSION:** Any work submitted after the deadline **will not be graded** unless you have a verifiable excuse, for which you can provide official documentation; for example, a certificate of death, or a University Illness verification form.

**STUDENT COLLABORATION:** All assignments and examinations are to be completed individually by each student. These pieces of work are expected to be the student's original work and to reflect her/his own thinking. Student collaboration in classroom exercises and during labs is permitted and encouraged, as long as all submitted work reflects each student's own thinking.

**ACKNOWLEDGEMENT OF SOURCES:** All sources used in the preparation of student work in this course must be acknowledged/cited in an appropriate way. I strongly recommend using free reference management software such as Zotero ([www.zotero.org](http://www.zotero.org)) or Mendeley ([www.mendeley.com](http://www.mendeley.com)).

**READABILITY AND CLARITY:** Students are expected to present well organized and properly written work. The instruction team reserves the right not to grade any work submitted that does not meet commonly recognized standards of readability and clarity.

**ILLNESS DURING TERM:** Please refer to the University of Waterloo Policies regarding documentation and the management of requests for accommodation due to illness during the term. Illness verification forms are required for any student seeking accommodation for any course requirement missed due to an illness. Please refer to [http://www.registrar.uwaterloo.ca/students/accom\\_illness.html](http://www.registrar.uwaterloo.ca/students/accom_illness.html) for more information.

#### **ACCOMMODATIONS DUE TO ILLNESS**

**MISSED DUE DATES AND TERM TESTS:** If an assignment or midterm is missed because of illness, and all of the proper documentation is submitted on time, the weight of the missed assignments will be added to the final exam. Assignment due dates will not be extended under any circumstances and term tests will not be written at a different time.

**FINAL EXAMINATION:** If the final exam is missed for any reason, and all of the proper documentation is submitted on time, where sufficient other assignments and tests have been completed during the term a student's final exam grade may be calculated based on a reweighting of their previous grades. If insufficient work is available to calculate a final exam grade, then the final examination will be written the next time that this course is taught.

#### **POLICY ON REGRADING ASSIGNMENTS:**

If you notice an error in the assessment of your work please follow these steps:

1. Wait 72 hours after the assignment was returned before requesting a regrade
2. All regrade requests must be formally submitted in writing to the instructor, describing the errors you believe were made. **Verbal requests will not be accepted.** Be as specific as possible and list all relevant details, e.g., "*my marks were summed incorrectly for questions 1-5*".
3. If another student's assignment is used as an example or reason for an error in grading, both assignments must be submitted for a regrade.

4. 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.

**ATTENDANCE:** Attendance will not be taken at any lectures or labs. However, it is highly recommended that students attend all scheduled lectures and labs, since [research shows very clearly](#) that students who attend class earn higher grades.

**POLICY ON EMAIL CORRESPONDENCE:** Face-to-face contact time is available through office hours, during and after lectures, and in the tutorials. Discussion forums (for which participation grades are awarded) are available in LEARN for any inquiries that are of general interest (e.g., clarification of assignment instructions, or a concept introduced in class). Students are strongly encouraged to attend office hours to discuss any issues related to the course, and email should only be used when none of these other options is appropriate. 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. The instruction team reserves the right not to respond to emails sent from non-UW accounts.
- All emails should have the following subject line: "GEOG316: <<insert your subject here>>"
- The instructor should be copied on all course-related email communication with the TAs.
- 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 LEARN. The questioner's identifying personal information will be removed from such announcements.

### **UW / Faculty of Environment 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. The University's guiding principles on academic integrity can be found here: <http://uwaterloo.ca/academicintegrity>

ENV students are strongly encouraged to review the material provided by the university's Academic Integrity office specifically for students:

<http://uwaterloo.ca/academicintegrity/Students/index.html>

Students are also expected to know what constitutes academic integrity, to avoid committing academic offenses, and to take responsibility for their actions. Student who are unsure whether an action constitutes an offense, or who need 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. Students may also visit this webpage:

<https://uwaterloo.ca/library/get-assignment-and-research-help/academic-integrity/academic-integrity-tutorial>

**Discipline:** When misconduct has been found to have occurred, disciplinary penalties will be imposed under Policy 71 – Student Discipline. For information on categories of offenses and types of penalties, students should refer to Policy 71 - Student Discipline, <https://uwaterloo.ca/secretariat-general-counsel/policies-procedures-guidelines/policy-71>

**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:** Students who believe that they have been wrongfully or unjustly penalized have the right to grieve; refer to Policy #70, Student Grievance: <https://uwaterloo.ca/secretariat-general-counsel/policies-procedures-guidelines/policy-70>. When in doubt please contact the department's administrative assistant for further assistance.

**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:** Plagiarism detection software (Turnitin) **will not** be used to screen assignments on this course.

**Unclaimed Work:** Unclaimed assignments will be retained for at least one month after term grades become official in quest. After that time, they will be destroyed in compliance with UW's [confidential shredding procedures](#).

**Note for students with disabilities:** 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 AccessAbility Services at the beginning of each academic term.

PROVISIONAL