

BUSI 6905

Advanced Statistical Methods

Winter 2024

Please read this course outline. Unless you, the student, inform the instructor by the first class otherwise, it is assumed that you understand and agree to the terms specified in this course outline.

Instructor: Ernest Kwan
Email: ernest.kwan@carleton.ca
Phone: 613-520-2600 x3007
Office: 6030 Nicol
Office hours: Thu. 7:45-8:45 PM on Zoom, <https://carleton-ca.zoom.us/j/8052504786>
Class meeting: Thu. 11:35-2:25; location TBD, starts Jan. 11

1. Course description

This course examines those situations where simple linear regression is no longer applicable. You, the student, are introduced to more advanced and more powerful methods. Another focus is actual data analysis; 6905 addresses, for example, the following questions that typically arise in data analysis:

- *What if the relationship between the predictor and response is not a straight line?*
- *What if there are missing data?*
- *If there are multiple predictors, how to assess their relative role and importance?*
- *How to find outliers in very large models (i.e., many predictors)?*
- *What if the response is not continuous but discrete (e.g., "yes" vs. "no")?*
- *What are the essential steps of responsible and thorough data analysis?*

6905 relies heavily on statistical graphics, computing primarily makes use of SPSS. 6905 is intended for students striving for a career of research, abstract problem solving, and academic writing. Thus despite being a statistics course, 6905 also emphasizes reasoning and language skills; these are critical skills for academia.

2. Course objectives

Because this is the mandatory statistics course in the Ph.D. program, my (the instructor's) overall goal is to teach you skills you need to excel in your studies. The course objectives are:

1. To learn necessary data analysis steps before and after hypothesis testing (i.e., what else you need to do beyond rejecting or accepting your hypotheses)
2. To recognize data limitations that could impact your analysis
3. To learn some reasoning skills for abstract problem solving

3. Course prerequisite

6905 assumes students to know the topics from BUSI 5981, Statistics for Business Research. Students that are not familiar with those topics (see 25) will struggle at the onset of 6905. 6905 also assumes a working knowledge of SPSS.

4. Class format

Brightspace is used for distribution of material (lecture slides, assignments, etc.). Grades are posted on Brightspace as soon as they become available.

5. Attendance

Students should attend all classes. Topics build on each other on a weekly basis, any missed class is detrimental to understanding new material. If a student cannot attend class, the student is responsible for obtaining any missed information (i.e., contacting colleagues to copy notes). To be fair to other students, no class time or Ernest's office time will be used to re-present the missed information.

6. Communicating with Ernest outside of class

Email is the fastest way of reaching Ernest outside the class. Ernest will do his best to reply within 48 hours. (Also see 24.)

7. Evaluation breakdown

Test 1 50%

Test 2 50%

8. Schedule of events (tentative)

Week

01 (Jan 11) Lecture

02 (Jan 18) Lecture

03 (Jan 25) Lecture

04 (Feb 01) Lecture

05 (Feb 08) Lecture

06 (Feb 15) **Test 1**

Reading week

07 (Feb 29) Lecture

08 (Mar 07) Lecture

09 (Mar 14) Lecture

10 (Mar 21) Lecture

11 (Mar 28) Lecture

12 (Apr 04) **Test 2**

9. List of topics (tentative)

Transformations in regression: Popular functional forms • Transforming the response vs. the predictor • Box-Cox procedure • Data screening • Missing data mechanisms • Stochastic regression imputation • Multiple regression (MR): Mix of continuous and discrete predictors • MR: Several continuous predictors / visualizing the regression plane • MR: Regression coefficients as effect sizes • MR: Relative importance of predictors • MR: Standardized regression coefficients • MR: Marginal vs. partial effects • MR: Interpreting regression coefficients when there is interaction • MR: Simple slopes • Centering with interaction and without interaction • Centering and curvilinear regression • Piece-wise regression • General linear test • Standardized effect sizes for the general linear test • MR: Model diagnostics • Influence indices: Why they are not enough • MR: Leverage • One-way analysis of variance (ANOVA) model • ANOVA: Hypothesis testing • ANOVA: Post hoc comparisons (motivation, traditional perspectives, special techniques) • ANOVA: Contrasts • ANOVA: Model diagnostics • ANOVA: Two-way model • ANOVA: Profile plots / Visualizing interactions • Analysis of covariance • Stepwise regression: Applications and limitations • Adjusted R-square • Maximum likelihood estimation • Binomial distribution • Odds • Odds ratio • Association with a discrete variable • Problems with the linear probability model • Comparison: simple linear regression to logistic regression (LR) • Maximum likelihood estimation of LR • Significance tests in LR • LR: predicted probabilities • LR: predicted memberships • Interpretation of β s from LR • Confidence interval of β s from LR • ϵ s in LR • Pearson residuals • Deviance residuals • Pseudo R^2 s in SPSS

11. Assignments (if applicable)

Although students could discuss assignments, the submitted assignment must be based on individual effort (for group assignments, "individual effort" refers to that of group members within a group). Assignments involve topics from the course (or topics from course prerequisite), students are not expected to use additional resources to do assignments. Penalty for late submission: If an assignment is submitted n calendar days after the deadline, the assignment mark (%) is reduced by $n \times 5\%$.

12. Missed tests

If a student misses a test and would like a make-up test, please follow these steps:

- a. Inform Ernest (by email) of the inability to write the test no later than 24 hours after the missed test is distributed.
- b. In the same email suggest possible dates for a make-up test; note the make-up test must occur within 6 calendar days of the missed test.
- c. Provide Ernest with the appropriate document(s) to support the original absence.

Incompliance to these steps leads to a test mark of 0. A make-up test may be granted when the absence is supported by a medical certificate or appropriate document. A make-up test is not granted for students who have made travel arrangements that conflict with test schedule. It is the responsibility of the student to accommodate the School's availability for a make-up test. Note these procedures apply only to the original test, failure to write a make-up test results in a test mark of 0.

13. Evaluation of submitted work

Given the volume of marking and the need to provide timely feedback, grossly disorganized or illegible work (e.g., assignments) creates unnecessary demands on the grader. The grader has the option to disregard such work and assign a mark of 0, subsequent re-submission will not be accepted and such work does not qualify for reappraisal.

14. Mark reappraisal

If a student would like the grader to reappraise a mark, please inform Ernest by email within 6 calendar days of receiving the mark. This email must explain the disagreement with the original evaluation, this explanation will be given to the grader as part of the reappraisal. Requests that pass the deadline will not be accepted (this deadline ensures timely processing and release of grade-related information, such as the class average). The grader will reappraise the work subject to his/her original commitments. A reappraisal could lead to a downward adjustment (i.e., lowering of original mark) if the submitted explanation demonstrates a misunderstanding of the relevant concepts. Students are thus encouraged to review available solutions prior to requesting a reappraisal.

15. Norms of the course

To achieve a professional relationship that facilitates learning, both students and Ernest must meet the commitments below.

Ernest's commitment	Student's commitment
<ul style="list-style-type: none">• Prepare a learning environment for each class	<ul style="list-style-type: none">• Come to class ready to learn and participate; seek assistance as issues or questions arise
<ul style="list-style-type: none">• Start and finish class on time; provide breaks as necessary	<ul style="list-style-type: none">• Attend the entire class; leave early only for emergencies and with prior notification
<ul style="list-style-type: none">• Solicit and encourage participation	<ul style="list-style-type: none">• Participate constructively; present own ideas; and if it is helpful to the class, constructively critique ideas of others
<ul style="list-style-type: none">• Provide detailed instructions on assignments; provide timely feedback on assignments	<ul style="list-style-type: none">• Follow instructions on assignments; submit assignments on time; learn from feedback
<ul style="list-style-type: none">• Communicate in a professional manner; respond to enquiries in a timely fashion	<ul style="list-style-type: none">• Communicate in a professional and respectful manner
<ul style="list-style-type: none">• Provide office hours	<ul style="list-style-type: none">• Make use of office hours to ask questions or seek elaborations

16. Phones

The use of phones is not permitted in class, students should turn off their phone. If special circumstances require the phone to be on, please inform Ernest.

17. Laptops

Laptop use in class is allowed for activities related to the class only. Students should not use laptop for other purposes (e.g., email). Inappropriate use of laptop in class could affect participation grade.

18. Group work

The Sprott School of Business encourages group assignments in the school for several reasons. They provide you with opportunities to develop and enhance interpersonal, communication, leadership, followership and other group skills. Group assignments are also good for learning integrative skills for putting together a complex task. Ernest may assign one or more group tasks/assignments/projects in this course. *Before embarking on a specific problem as a group, it is your responsibility to ensure that the problem is meant to be a group assignment and not an individual one.*

19. Person with disabilities

Students with disabilities requiring academic accommodations in this course are encouraged to contact a coordinator at the Paul Menton Centre for Students with Disabilities to complete the necessary letters of accommodation. After registering with the PMC, make an appointment to meet and discuss your needs with me at least two weeks prior to the first in-class test or ITV midterm exam. This is necessary to ensure sufficient time to make the necessary arrangements. If a request of accommodation is made after the deadline, it is at my sole discretion to accommodate the request, subject to the resources available to me. Please refer to <http://www.carleton.ca/pmc/> for all PMC information.

20. Religious observance

Students requesting academic accommodation on the basis of religious observance should make a formal, written request to their instructors for alternate dates and/or means of satisfying academic requirements. Such requests should be made during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist, but no later than two weeks before the compulsory academic event. Accommodation is to be worked out directly and on an individual basis between the student and the instructor(s) involved. Instructors will make accommodations in a way that avoids academic disadvantage to the student. Students or instructors who have questions or want to confirm accommodation eligibility of a religious event or practice may refer to the Equity Services website for a list of holy days and Carleton's Academic Accommodation policies, or may contact an Equity Services Advisor in the Equity Services Department for assistance.

21. Pregnancy

Pregnant students requiring academic accommodations are encouraged to contact an Equity Advisor in Equity Services to complete a *letter of accommodation*. The student must then make an appointment to discuss her needs with the instructor at least two weeks prior to the first academic event in which it is anticipated the accommodation will be required.

22. Academic integrity

Violations of academic integrity are a serious academic offence. Violations of academic integrity – presenting another's ideas, arguments, words or images as your own, using unauthorized material, misrepresentation, fabricating or misrepresenting research data, unauthorized co-operation or collaboration or completing work for another student – weaken the quality of the degree and will not be tolerated. Penalties may include expulsion; suspension from all studies at Carleton; suspension from full-time studies; a refusal of permission to continue or to register in a specific degree program; academic probation; and a grade of Failure in the course, amongst others. Students are expected to familiarize themselves with and follow the Carleton University Student Academic Integrity Policy which is available, along with resources for compliance at <https://carleton.ca/registrar/academic-integrity/>

23. Course sharing websites

Student or professor materials created for this course (including presentations and posted notes, labs, case studies, assignments and exams) remain the intellectual property of the author(s). They are intended for personal use and may not be reproduced or redistributed without prior written consent of the author(s).

24. Further information

- Students must always retain a hard copy of all work that is submitted.
- All final grades are subject to the Dean's approval.
- For us to respond to your emails, we need to see your full name, CU ID, and the email must be written from your valid CARLETON address. Therefore, it would be easier to respond to your inquiries if you would send all email from your Carleton account. If you do not have or have yet to activate this account, you may wish to do so by visiting <http://carleton.ca/ccs/students>

25. Topics that students are expected to know

- Describing a variable: Central tendency, variability, shape
- Plotting a variable: Line-up plot, bar graph, histogram, stem-and-leaf, boxplot
- A normal variable
- Types of distributions: Population distribution vs. sampling distribution
- Central limit theorem
- Transforming a variable - Standardizing a variable
- Pearson correlation
- Fisher z transformation: Confidence interval and significance testing on the Pearson correlation
- Estimation - Confidence intervals
- Null hypothesis significance testing (NHST)
- Factors that influence power
- t distributions
- Independent - dependent groups t test
- Effect sizes
- Binomial distribution
- Hypothesis testing and confidence interval for a proportion
- How to compare two proportions
- NHST: Two fundamental problems, nine misuses and misconceptions
- Formal responses to the NHST controversy: Task Force on Statistical Inference
- Problems in using NHST for theory testing
- Simple linear regression
- F distributions
- Regression: Effect size
- Regression: Significance testing
- Regression: Confidence band vs. prediction interval
- Regression: Three formal assumptions and two implicit claims
- Regression: Lack of fit test
- What are outliers (two definitions) and how to deal with them
- Regression: Influence indices
- Regression: Five types of residuals
- Weighted least squares regression
- Locally weighted least squares regression
- Curvilinear regression

The above topics are covered in Statistics for Business Research, BUSI 5981.

26. Contribution to Learning Goals of the Program

Program Learning Goal	Competencies Not Covered	Competencies Introduced (only)	Competencies Taught But Not Assessed	Competencies Taught and Assessed
	CHECK (X) ONE PER ROW			
PH1 Research Knowledge and Understanding <i>Graduates will have an understanding of research philosophies, designs, methodologies and techniques foundational to conducting advanced academic research.</i>			X	
PH2 Scholarly Research <i>Graduates will be able to conduct scholarly research on complex issues facing organizations.</i>	X			
PH3 Communicate Research Work and Results <i>Graduates can communicate complex ideas, research activities and results to academic, practitioner and student audiences both orally and in writing.</i>	X			
PH4 Professional Activities and Functions <i>Graduates can effectively teach, conduct research and participate in professional organizations and networks in academic and other public and private sector organizations.</i>	X			