MATH 697: Mathematical Statistics (4 credits)

Instructor: Omid Aghababaei Jazi

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Office Hours: Tuesdays and Thursdays, 10:45-12:00

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Lectures: Tuesdays and Thursdays 9:05-10:25 AM, **Room**: BURN 1214

Textbook: Probability and Statistics; The Science of Uncertainty, 2nd Edition, Michael J. Evans and Jeffrey S. Rosenthal. University of Toronto.

Course Description:

The main purpose of this course is to acquire a broad knowledge of some frequently used probability models as we as the principles and techniques in statistical inference. The course essentially compresses the core elements of MATH 323 and 324 as well as Bayesian inference with a strong focus on their application in life sciences, the implementation, and the interpretation of their numerical results. We will therefore introduce computational methods in statistics with the statistical software program R to illustrate the results. Most of the materials for the course will be drawn from the first eight chapters of the textbook. The book, however, does not contain all the materials we intend to cover in this course. Some extra notes will therefore be given on those topics.

Pre-requisites: MATH 141 or equivalent

Grading Scheme

	Formula I	**Formula II**
Assignments (4)	40%	40%
(Project, Take-Home Exam)	15%	-
Participation	5%	5%
Final Exam	40%	55%

Final Mark is the maximum of the marks computed from these two formulas.

Target Syllabus	
Weeks 1-3	Overview • Basic principles of inference through the use of probability and statistics. Probability • Populations, samples, Probability models • Conditional probability, Independence, Bayes Rule • Random variables. Continuous & discrete. Focusing heavily on normal distribution, and maybe binomial. • (Discrete) Probability distributions and cumulative distributions • (Continuous) Probability density functions and cumulative distribution functions • Hands-on examples: simulating from a probability distribution, generating random samples, plotting results. Expectation and variance • Expectation for discrete random variables • Expectation for continuous random variables • Higher order moments • Sampling distributions • Conditional expectation, conditional variance formulas Introduction to R (objects, data structure, basic graphics, useful packages)
Weeks 4-5	• Convergence in probability and distribution; Slutsky's Theorem • Weak law of large numbers • Central Limit Theorem (CLT) Illustrating asymptotic results in R (Law of Large numbers and CLT by graphical tools) Emphasis of these asymptotic concepts should be focused on intuition, rather than detailed mathematical proof.
Weeks 6-8	Point and Interval Estimation • Properties of Estimators (Bias, Variance, Mean-Squared Error) • Sampling distributions and estimation – finite sample • Sampling distributions and estimation – asymptotic • Consistency and efficiency Some Real Examples in R (obtain small and large sample C.I, simulation study to show sensitivity of large and small sample C.I for the mean and normality for the variance of population)
Weeks 9-10	Methods of Estimation • Sufficiency and Factorization Theorem • Maximum Likelihood Estimation (MLE) • Method of moments • Bayesian estimation and inference Using optim function for MLE, Bayesian Analysis in R (graphical tools to illustrate posterior function, Bayesian computation: Newton-Raphson, integral approximation, Monte

	Carlo for estimation, confidence and credible Intervals and prediction, introduction to MCMC)
Weeks 11-13	Hypothesis Testing • Null and alternative hypothesis; Type I and II errors • Large sample hypothesis tests • P-values • Likelihood Ratio Test Hypothesis Testing in R (Small and Large sample hypothesis testing, illustrating power, calculating P-value, etc.)

Take-Home Midterm Exam

Release	Deadline
Monday, October 15th 2018	Thursday, November 30th 2018

ASSIGNMENT TIMELINE

	Release	Deadline	Content
Assignment 1	Friday, Sept 14	Friday, Sept 28	Probability, Expectation
Assignment 2	Friday, Oct 5	Friday, Oct 19	Sampling Distribution, Estimation
Assignment 3	Friday, Oct 26	Friday, Nov 9	Methods of Estimation
Assignment 4	Sunday, Nov 12	Monday, Nov 28	Bayesian Inference, Hypothesis Testing

COURSE MANAGEMENT

a) The course website will be located on myCourses. You should be able to access all online course material through myCourses. It is the student's responsibility to check myCourses regularly. You will need your student ID number and Minerva password to access the materials.
b) Homework assignments will be posted once roughly every two weeks on myCourses. Late assignments will not be accepted for partial credit.

MCGILL POLICY STATEMENTS

The following three statements are included in this course outline, in keeping with various Senate resolutions:

a) McGill University values academic integrity. Therefore, all students must understand the meaning and consequences of cheating, plagiarism and other academic offences under the Code of Student Conduct and Disciplinary Procedures. For more information, see www.mcgill.ca/students/srr/honest/

[Approved by Senate on 29 January 2003]
b) In accord with McGill University's Charter of Students' Rights, students in this course have the right to submit in English or in French any written work that is to be graded. [Approved by Senate on 21 January 2009]

c) Instructors who may adopt the use of text-matching software to verify the originality of students' written course work must register for use of the software with Educational Technologies and must inform their students before the drop/add deadline, in writing, of the use of text- matching software in a course. [Approved by Senate on 1 December 2004]

If you have a disability and need special arrangements, please contact the Office for Students with Disabilities at 514–398–6009.