

# **Course Outline STAT\*4340: Winter 2020**

## **General Information**

**Course Title: Statistical Inference**

**Course Description:** This course extends and deepens the theory of estimation and inference introduced in STAT\*3110. Topics including point estimation, interval estimation, hypothesis testing and decision theory will be presented from the frequentist, likelihood and Bayesian perspectives. Foundational issues concerning the frequentist, likelihood and Bayesian paradigms will also be discussed. While this course builds on STAT\*3110, the level is considerably deeper and much new material is introduced.

**Credit Weight: 0.5**

**Academic Department (or campus): Math and Stats**

**Campus: Guelph**

**Semester Offering: Winter 2020**

**Class Schedule and Location: Monday 2:30 to 5:20, ALEX 309**

## **Instructor Information**

**Instructor Name: Tony Desmond**

**Instructor Email: [tdesmond@uoguelph.ca](mailto:tdesmond@uoguelph.ca)**

**Office location and office hours: MCN 523 Friday 4- 5 pm.**

## **Course Content**

### **Specific Learning Outcomes:**

Implement various methods of point estimation for parametric models; likelihood, Bayes and method of moments; understand their strengths and limitations; understand concepts such as bias, variance and mean-squared error.

Utilize various methods of interval estimation: such as, pivotal methods or inversion of tests in the frequentist context, likelihood intervals in the likelihood context, and posterior credible intervals in the Bayesian context. Experiment with simple bootstrap intervals using R.

Understand various approaches to testing hypotheses, whether Neyman-Pearsonian, Fisherian or Bayesian; be able to critique each of these approaches.

Implement the Bayesian approach and compare and contrast with the likelihood and frequency approach for simple models; learn the basics of the decision-theoretic approach.

Use software such as R to implement approaches to statistical inference such as the Bayesian and the bootstrap approach.

Understand basic principles of statistical inference, likelihood, sufficiency and conditionality; ask questions critically about the concept of statistical evidence. Discuss flaws in statistical inference as conventionally applied in subject matter journals.

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### **Lecture Content:**

**1. PRINCIPLES OF DATA REDUCTION: LIKELIHOOD, SUFFICIENCY, CONDITIONALITY.**

**2. POINT ESTIMATION: (A) METHOD OF MOMENTS, MAXIMUM LIKELIHOOD, BAYES ESTIMATION. CRAMER-RAO BOUND. EXPONENTIAL FAMILIES**

**(B) PROPERTIES OF ESTIMATORS: UNBIASEDNESS, MEAN-SQUARED ERROR, CONSISTENCY, SUFFICIENCY, EFFICIENCY, ASYMPTOTICS. NEYMAN-FISHER, RAO- BLACKWELL AND LEHMAN-SCHEFFE THEOREMS.**

**3. HYPOTHESIS TESTING: LIKELIHOOD RATIO, NEYMAN-PEARSON LEMMA, BAYES TESTS, ASYMPTOTICS OF TESTS, KARLIN-RUBIN THEOREM.**

**4. INTERVAL ESTIMATION: PIVOTAL METHOD, INVERSION OF TESTS, BAYESIAN INTERVALS, ASYMPTOTIC LIKELIHOOD INTERVALS, FIDUCIAL INTERVALS, DELTA METHOD, BOOTSTRAP INTERVALS**

**5. DECISION THEORY. RISK FUNCTIONS (BAYESIAN AND FREQUENTIST), MINIMAXITY, ADMISSIBILITY**

**6. OTHER TOPICS. MONTE CARLO METHODS, E.G. BOOTSTRAP AND MCMC.**

### **Course Assignments and Tests:**

**4 or 5 assignments, worth 30%.**

**Midterm Test on Monday, March 2, 2:30-4:30, in class, worth 30%.**

**Final examination date and time: Monday, April 20, 2:30-4:30pm, worth 40%.**

### **Course Resources**

**Required Texts: Statistical Inference. Casella, G. and Berger, R. 2nd Edition. (A copy will be on reserve.)**

**Applied Bayesian Statistics with R and OpenBUGS Examples. Cowles, M.K. (An electronic copy is available in the Library and will be placed on Reserve)**

### **Recommended Texts:**

*All of Statistics: A Concise Course in Statistical Inference. Wasserman, L. Springer. On Reserve and Online.*

*In all Likelihood: Statistical Modelling and Inference Using Likelihood. Pawitan, Yudi. Oxford University Press. On Reserve.*

*Principles of Statistical Inference. Cox, D.R. Cambridge University Press. On Reserve.*

*Statistics on the Table: the History of Statistical Concepts and Methods. Stigler, Stephen. Harvard University Press. On Reserve.*

*Comparative Statistical Inference, 3<sup>rd</sup> Edition. Barnett, Vic. Wiley. On Reserve.*

### **Course Policies**

**Late Assignments will not be accepted except under very exceptional circumstances.**

## **Course Policy on Group Work:**

**Assignment solutions should be your own work, be clear, legible and well organized. You may discuss assignments with other classmates, but the work handed in should be your own.**

## **Course Policy regarding use of electronic devices and recording of lectures**

*Electronic recording of classes is expressly forbidden without consent of the instructor. When recordings are permitted they are solely for the use of the authorized student and may not be reproduced, or transmitted to others, without the express written consent of the instructor.*

## **University Policies**

### **Academic Consideration**

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons, please advise the course instructor in writing, with your name, id#, and e-mail contact. See the academic calendar for information on regulations and procedures for

Academic Consideration:

<http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml>

### **Academic Misconduct**

The University of Guelph is committed to upholding the highest standards of academic integrity and it is the responsibility of all members of the University community, faculty, staff, and students to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring.

University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff and students have the responsibility of supporting an environment that discourages misconduct. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection. Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

The Academic Misconduct Policy is detailed in the Undergraduate Calendar:  
<http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml>

### **Accessibility**

The University of Guelph is committed to creating a barrier-free environment. Providing services for students is a shared responsibility among students, faculty and administrators. This relationship is based on respect of individual rights, the dignity of the individual and the University community's shared commitment to an open and supportive learning environment. Students requiring service or accommodation, whether due to an identified, ongoing disability or a short-term disability should contact the Centre for Students with Disabilities as soon as possible.

For more information, contact CSD at 519-824-4120 ext. 56208 or email [csd@uoguelph.ca](mailto:csd@uoguelph.ca) or see the website: <http://www.uoguelph.ca/csd/>

### **Course Evaluation Information**

Please see <http://www.mathstat.uoguelph.ca/files/TeachevaluationformF10.pdf>

### **Drop date**

The last date to drop one-semester courses, without academic penalty is **Friday, April 3 2020**. For regulations and procedures for Dropping Courses, see the Academic Calendar:  
<http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-drop.shtml>

### **Additional Course Information**

*Additional Course Information will be provided in class.*