STAT3013
Statistical Inference

Course Description

This course introduces students to the theory underlying the development and assessment of statistical techniques in the areas of point and interval estimation and hypothesis testing.

Topics include: Point estimation methods, including the method of moments and maximum likelihood; Bias and variance; Mean-squared error and the Cramer-Rao inequality; Sufficiency, completeness and exponential families; the Rao-Blackwell theorem and uniformly minimum variance unbiased estimators; Bayesian estimation methods; Resampling estimation methods, including the jackknife and the bootstrap; Confidence interval construction methods, including likelihood-based intervals, inversion methods, intervals based on pivots and simple resampling-based percentile intervals; Highest posterior density and Bayesian credibility regions; Likelihood ratio tests and the Neymann-Pearson lemma; Power calculations and uniformly most powerful tests; Rank-based non-parametric tests, including the sign-test and Wilcoxon tests.

<table>
<thead>
<tr>
<th>Semester and Year</th>
<th>S1 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mode of Delivery</td>
<td>Lectures and tutorials on campus</td>
</tr>
<tr>
<td>Prerequisites</td>
<td>STAT2001 Introductory Mathematical Statistics</td>
</tr>
<tr>
<td>Incompatible Courses</td>
<td>None</td>
</tr>
<tr>
<td>Course Convener</td>
<td>Anton Westveld</td>
</tr>
<tr>
<td>Office Location</td>
<td>CBE 3.03</td>
</tr>
<tr>
<td>Phone:</td>
<td>+61 2 6125 5122</td>
</tr>
<tr>
<td>Email:</td>
<td><a href="mailto:Anton.westveld@anu.edu.au">Anton.westveld@anu.edu.au</a></td>
</tr>
<tr>
<td>Consultation hours:</td>
<td>To be advised or by appointment</td>
</tr>
<tr>
<td>Bio and research interests</td>
<td>Anton Westveld is a Lecturer in RSFAS. His research interests include Bayesian methodology and theory, statistical methods for interaction/relation data (network, game theoretic), statistical applications in social (economics, political science, public policy), environmental, and biological sciences.</td>
</tr>
<tr>
<td>Tutor(s)</td>
<td>There are no tutors for this course.</td>
</tr>
<tr>
<td>Student Administrators</td>
<td>Anna Pickering, Room 4.48, CBE Bldg (26C), +61 2 612 59045, <a href="mailto:anna.pickering@anu.edu.au">anna.pickering@anu.edu.au</a></td>
</tr>
</tbody>
</table>
COURSE OVERVIEW

Course Learning Outcomes
Upon successful completion of the requirements of this course, students should have the knowledge and skills to:

• explain the notion of a parametric model and point estimation of the parameters of those models.
• explain and apply approaches to include a measure of accuracy for estimation procedures and our confidence in them by examining the area of interval estimation.
• assess the plausibility of pre-specified ideas about the parameters of a model by examining the area of hypothesis testing.
• explain and apply the idea of non-parametric statistics, wherein estimation and analysis techniques are developed that are not heavily dependent on the specifications of an underlying parametric model.
• understand the computational issues related to the implementation of various statistical inferential approaches.

Research-Led Teaching
The topic of statistical inference seeks to provide answers to questions of point estimation, interval estimation, and hypothesis testing that are based on observable data. Not surprisingly, through the development of this topic over the past several centuries, there exist diverse approaches to these problems. Examination and application of these diverse approaches will provide insight into the past and potentially future development of statistical science.

Continuous Improvement
We use feedback from students, professional bodies and staff to make regular improvements to the course. In response to this feedback, design improvements from the previous version of the course include:

• There is now a redeemable midterm in addition to a final exam. In previous years there was only a final exam comprising 80% of the total marks.
• We will have a prescribed textbook.

Technology, Software, Equipment
Some examples provided in lectures, tutorials, and some work related to the presentation/project will entail the use of the statistical computer package R, which is freely available at www.r-project.org. The program code used for examples provided in lectures and tutorials will be available on the course Wattle site. Note: students will not be able to use R during the exams.

Additionally, you may find a scientific calculator useful for your exams.

Co-teaching
This course is co-taught with STAT8027 in the same location. STAT8027 students will have slightly different learning outcomes and assessment. They will also be allocated to separate tutorial groups. Tutorial questions may differ between both cohorts.
Student Feedback
All CBE courses are evaluated using Student Experience of Learning and Teaching (SELT) surveys, administered by Planning and Statistical Services at the ANU. These surveys are offered online, and students will be notified via email to their ANU address when surveys are available in each course. Feedback is used for course development so please take the time to respond thoughtfully. Course feedback is anonymous and provides the Colleges, University Education Committee and Academic Board with opportunities to recognise excellent teaching and to improve courses across the university. For more information on student surveys at ANU and reports on feedback provided on ANU courses, visit

http://unistats.anu.edu.au/surveys/selt/students/ and
http://unistats.anu.edu.au/surveys/selt/results/learning/

COURSE SCHEDULE

<table>
<thead>
<tr>
<th>Week (Monday date)</th>
<th>An approximate guideline of topics to be covered</th>
<th>Activity</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (February 9)</td>
<td>Orientation Week</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 (February 16)</td>
<td>Introduction and Properties of a Random Sample</td>
<td>Lectures</td>
<td></td>
</tr>
<tr>
<td>2 (February 23)</td>
<td>Properties of a Random Sample</td>
<td>Lectures, Tutorial</td>
<td></td>
</tr>
<tr>
<td>3 (March 2)</td>
<td>Principles of Data Reduction</td>
<td>Lectures, Tutorial</td>
<td></td>
</tr>
<tr>
<td>4 (March 9)</td>
<td>Principles of Data Reduction</td>
<td>Lectures, Tutorial</td>
<td></td>
</tr>
<tr>
<td>5 (March 16)</td>
<td>Point Estimation</td>
<td>Lectures, Tutorial</td>
<td></td>
</tr>
<tr>
<td>6 (March 23)</td>
<td>Point Estimation</td>
<td>Lectures, Tutorial</td>
<td></td>
</tr>
<tr>
<td>7 (March 30)</td>
<td>Point Estimation</td>
<td>Lectures, Tutorial</td>
<td>Mid-semester exam (possibly)</td>
</tr>
<tr>
<td></td>
<td>Two-week teaching break</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 (April 20)</td>
<td>Interval Estimation</td>
<td>Lectures, Tutorial</td>
<td>Mid-semester exam (possibly)</td>
</tr>
<tr>
<td>9 (April 27)</td>
<td>Interval Estimation</td>
<td>Lectures, Tutorial</td>
<td></td>
</tr>
<tr>
<td>10 (May 4)</td>
<td>Hypothesis Testing</td>
<td>Lectures, Tutorial</td>
<td></td>
</tr>
<tr>
<td>11 (May 11)</td>
<td>Hypothesis Testing</td>
<td>Lectures, Tutorial</td>
<td></td>
</tr>
<tr>
<td>12 (May 18)</td>
<td>Presentations</td>
<td>Lectures, Tutorial</td>
<td>Presentations</td>
</tr>
<tr>
<td>13 (May 25)</td>
<td>Wrap-Up</td>
<td>Lectures, Tutorial</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Examination period</td>
<td></td>
<td>Final exam</td>
</tr>
</tbody>
</table>

* I may have an extra lecture in either Week 12 or 13 to make-up for the Canberra Day holiday (TBD).
COURSE ASSESSMENT

The course primarily consists of chapters 5-10 and portions of chapters 11 and 12 of the prescribed textbook by Casella and Berger. In addition I will draw material from other sources that will be presented through the lectures or tutorials.

It is possible that some material may be presented in class, which is assessable, but not in the textbook or on Wattle.

Assessment Summary

<table>
<thead>
<tr>
<th>Item</th>
<th>Title</th>
<th>Value</th>
<th>Due Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tutorial questions</td>
<td>5%</td>
<td>Submitted online weekly by Thursday morning starting in Week 2 (except for Week 13).</td>
</tr>
<tr>
<td>2</td>
<td>Presentation/Project</td>
<td>15%</td>
<td>In Week 12 of the course (materials should be submitted at the beginning of the week).</td>
</tr>
<tr>
<td>3</td>
<td>Mid-semester examination</td>
<td>20% or 0%, redeemable in favour of the final</td>
<td>In Week 7 or 8 (exact date TBD).</td>
</tr>
<tr>
<td>4</td>
<td>Compulsory final exam</td>
<td>60% or 80%</td>
<td>During the final exam period.</td>
</tr>
</tbody>
</table>

Assessment Task 1: Tutorial Questions

Details of task:
Before each tutorial you should submit your answers to the tutorial questions online via Wattle. These will be graded weekly for `performance` (whether you made a solid attempt on the questions) and not whether you got the answer correct. Each week the `performance` will be graded as 0 or 100. Students may be asked to present their solutions during tutorial.

Assessment Task 2: Presentation/Project

Details of task:
In groups of 2-4, based on your cohort (STAT3013 or STAT8027), you will read and present an academic paper. In addition you will have to consider some type of `extension`. This may be by simplifying the problem and considering another estimator and its properties, extending the inferential method, or even considering other data sets. Each presentation will last 15-20 minutes (TBD) and each member of the group must speak. Every presenter in a group will be given the same grade. Your presentation materials must be submitted on Wattle by the beginning of Week 12 (each member in the group should submit the same material). I will have some possible papers on Wattle or you may choose your own. All paper choices must be approved by me.

Assessment Task 3: Mid-Semester Examination

Details of task:
Reading time: 15 minutes. Writing time: 90 minutes. This exam is redeemable, thus it is worth either 20% of the total assessment, or 0% depending on your final examination score (see Examinations below). This exam will be in either Week 7 or Week 8 based on discussions with the students during. The exact coverage of the exam will be made known at least one week before the examination and will be discussed in lecture as well as posted on Wattle. There will be no special examinations for the mid-semester exam. Instead the weighting will be moved to the final exam.
Assessment Task 4: Final Examination

Details of task:
Reading time: 15 minutes. Writing time: 3 hours.
This exam is worth 60% or 80% of the total assessment. The exam will be in the final examination period. The exact coverage of the exam will be made known at least one week before the examination and will be discussed in lecture as well as posted on Wattle.

Assignment Submission
Assignment materials for submission consist of 1.) weekly tutorial solutions (except Weeks 1 and 13) and 2.) presentation materials. Both the tutorial solutions and presentation materials are to be submitted online using the course Wattle site. The tutorial solutions do not need a cover sheet, however the presentation materials must include a cover sheet, which will be provided on Wattle.

Extensions and Penalties
No extensions will be given unless arranged before the due date and accompanied by a medical certificate. Late assignments without an extension will be marked zero.

Returning Assignments
Assignment will be returned online.

Resubmission of Assignments
It will not be possible for tutorial solutions and the presentation to be resubmitted.

Examinations
The permitted material for the mid-semester and final exams will be:

- A4 pages (Two sheets) with notes on both sides
- Paper-based dictionary, no approval required (must be clear of ALL annotations)
- Calculator (Any - programmable or not)

The mid-semester exam is redeemable, meaning that you will get the better of the two breakdowns 20%+60% and 0%+80%. That is, if you do better in the final exam than in the mid-semester exam, your mid-semester exam will not count and your final exam will count for 80%. If you do not sit the mid-semester exam, your final exam will count for 80%.

Although the mid-semester exam is redeemable and optional, it is advised that students do it if possible. No special provision will be made for students who cannot sit the mid-semester exam.

Scaling
Your final mark for the course will be based on the raw marks allocated for each assignment or examination. However, your final mark may not be the same number as produced by that formula, as marks may be scaled. Any scaling applied will preserve the rank order of raw marks (i.e. if your raw mark exceeds that of another student, then your scaled mark will exceed or equal the scaled mark of that student), and may be either up or down.

Referencing Requirements
Appropriate referencing will be necessary for the presentations.
READING LISTS

Prescribed Texts
G. Casella and R. Berger
Statistical Inference (second edition)
Brooks/Cole Cengage Learning

Recommended Reading
P. Garthwaite, I. Jolliffe and B. Jones
Statistical Inference (second edition)
Oxford University Press

G. Givens and J. Hoeting
Computational Statistics (second edition)
Wiley

J. Kadane
Principles of Uncertainty
CRC Press

G. Parmigiani and L. Inoue
Decision Theory: Principles and Approaches
Wiley

COMMUNICATION

The lecturer can be contacted by email or in person (before or after lectures and tutorials).

Email
If necessary, the lecturers and tutors for this course will contact students on their official ANU student email address. Information about your enrolment and fees from the Registrar and Student Services' office will also be sent to this email address.

Announcements
Students are expected to check the Wattle site for announcements about this course, e.g. changes to timetables or notifications of cancellations. Notifications of emergency cancellations of lectures or tutorials will be posted on the door of the relevant room.

Course URLs
More information about this course may be found on:

• Programs and Courses (http://programsandcourses.anu.edu.au/2015/Catalogue )

• the College of Business and Economics website (http://cbe.anu.edu/courses) and

• Wattle (https://wattle.anu.edu.au), the University's online learning environment. Log on to Wattle using your student number and your ISIS password.
**TUTORIAL AND /OR SEMINAR REGISTRATION**

Enrolment in tutorials will be completed online using the CBE Electronic Teaching Assistant (ETA). To enrol, follow these instructions:

1. Go to http://eta.fec.anu.edu.au
2. You will see the Student Login page. To log into the system, enter your University ID (your student number) and password (your ISIS password) in the appropriate fields and hit the Login button.
3. Read any news items or announcements.
4. Select "Sign Up!" from the left-hand navigation bar.
5. Select your courses from the list. To select multiple courses, hold down the control key. On PCs, this is the Ctrl key; on Macs, it is the ⌘ key. Hold this key down while selecting courses with the mouse. Once courses are selected, hit the SUBMIT button.
6. A confirmation of class enrolments will be displayed. In addition, an email confirmation of class enrolments will be sent to your student account.
7. For security purposes, please ensure that you click the LOGOUT link on the confirmation page, or close the browser window when you have finished your selections.
8. If you experience any difficulties, please contact the School Office (see page 1 for contact details).
9. Students will have until 5pm Wednesday 25 February to finalise their enrolment in tutorials. After this time, students will be unable to change their tutorial enrolment.

**POLICIES**

The University offers a number of support services for students. Information on these is available online from http://students.anu.edu.au/studentlife/

ANU has educational policies, procedures and guidelines, which are designed to ensure that staff and students are aware of the University's academic standards, and implement them. You can find the University's education policies and an explanatory glossary at: http://policies.anu.edu.au/

Students are expected to have read the Student Academic Integrity Policy before the commencement of their course.

Other key policies include:

- Student Assessment (Coursework)
- Student Surveys and Evaluations