UNSW SCIENCE

School of Maths and Statistics

Course outline

MATH5905

Statistical Inference

Term 1, 2021

Cricos Provider Code: 00098G

Staff

Position	Name	Email	Room
Lecturer-in-charge	Dr. Tom Stindl	t.stindl@unsw.edu.au	RC-1037

Please refer to your Timetable on MyUNSW for your Lecture Tut, Lab enrolment days and times.

Administrative Contacts

Please visit the School of Mathematics and Statistics website for a range of information on School Policies, Forms and Help for Students.

For information on Courses, please go to “Current Students” and either Undergraduate and/or Postgraduate”, Course Homepage” for information on all course offerings,

The “Student Notice Board” can be located by going to the “Current Students” page; Notices are posted regularly for your information here. Please familiarise yourself with the information found in these locations. The School web page is: https://www.maths.unsw.edu.au

If you cannot find the answer to your queries on the web you are welcome to contact the Student Services Office directly by phone.

By email Postgraduate pg.mathsstats@unsw.edu.au

By phone: 9385 7053

Should we need to contact you, we will use your official UNSW email address of in the first instance. **It is your responsibility to regularly check your university email account. Please state your student number in all emails.**

Course Aims

The aim of the course is to introduce the main ideas and principles behind the parametric and non-parametric inference procedures. Both frequentist and Bayesian perspective will be discussed. Estimation, confidence set construction and hypothesis testing are discussed within decision-theoretic framework. Both finite sample optimality and asymptotic optimality will be defined and discussed. Computationally intensive methods such as bootstrap are discussed and are compared to asymptotic approximations such as Edgeworth expansions and saddlepoint method. Students will learn how to determine appropriate inference procedure and to draw inferences using the chosen procedure. Time permitting, applications in Statistical Financial Engineering will shortly be discussed.

Course Description

This course presents General interference theory based on maximum likelihood and on Bayes methods is reviewed. Estimation, confidence set construction and hypothesis testing are discussed within decision-theoretic framework. Computationally intensive methods such as bootstrap are discussed and are compared to asymptotic approximations such as saddlepoint and empirical likelihood.

Assessment and Deadlines

Assessment	Week	Weighting %	Due date if applicable
Assignment 1	Week 4	10	Duration 2 weeks, due end of week 4
Mid-session Test	Week 7	20	Duration 120 minutes
Assignment 2	Week 9	10	Duration 2 weeks, due end of week 9
Final Exam	Exam period	60	

Course Schedule

The course will include material taken from some of the following topics. This is should only serve as a guide as it is not an extensive list of the material to be covered and the timings are approximate. The course content is ultimately defined by the material covered in lectures.

Weeks	Topic	Reading (if applicable)
1	Revision. The General Inference Problem as a decision theoretic problem.	Lecture Notes
2	Bayes and minimax decision rules. Principles of data reduction and inference.	Lecture Notes
3	Classical estimation theory. Methods for finding estimators. Information and Likelihood.	Lecture Notes
4	Expected and observed Fisher information matrices. Cramer-Rao Bound. Uniform Minimum Variance Unbiased Estimators.	Lecture Notes
5	Likelihood inference. Estimating statistical functionals. Asymptotic properties of estimators.	Lecture Notes
7	Order Statistics. Hypothesis Testing. Neyman-Pearson theory.	Lecture Notes

8	Generalized Likelihood Ratio Tests. Higher order asymptotics.	Lecture Notes
9	Edgeworth expansions, Saddlepoint approximations, Laplace's method.	Lecture Notes
10	An Introduction to the Bootstrap as a computationally intensive method. Robust M estimators, and L estimators.	Lecture Notes

Text Books

The textbooks are listed below according to their relative importance for this course.

Casella, G. and Berger, R. Statistical Inference. Second Edition, Brooks/Cole(2001). This is the recommended text.

Young, G. and Smith, R., Essentials of Statistical Inference, Cambridge University Press (2005).

A.W. van der Vaart Asymptotic Statistics, Cambridge University Press, (1998).

Wasserman, L., All of Nonparametric Statistics, Springer (2006).

DasGupta, A., Asymptotic Theory of Statistics and Probability, Springer (2008).

Tani Taniguchi, M., Hirukawa, J. and Tamaki, K. Optimal statistical inference in financial engineering [electronic resource], Chapman & Hall CRC (2008).

From the textbooks, the recommended text by Casella ad Berger (2001) would be most useful! The book by Tani is very useful and contains interesting applications in finance. It is an online textbook available via the UNSW library.

The other references are suitable as additional reading for the interested students. They complement the lecture notes and the recommended text. The books by Young and Smith (2005) and A.W. van der Vaart (1998) are a bit more advanced but contain important material and will be used for some more specialised topics. The textbook DasGupta (2008) is an encyclopaedic book covering both classical and very modern topics of inference. It also covers many examples.

Course Learning Outcomes (CLO)

- Show how Statistical Inference arises from the first principles of Probability Theory.

- Understand the fundamental principles of inference: sufficiency, likelihood, ancillarity, equivariance.
- Comprehend the concepts of finite-sample and asymptotic efficiency of Inference Procedure.
- Demonstrate mastery of the parametric and non-parametric delta method, asymptotic normality, Edgeworth expansions and saddlepoint method.
- Estimate key population parameters of interest, to test hypotheses about them and to construct confidence regions.
- Use in practice the parametric, nonparametric, Bayes and robust inference.
- Use computer packages to generate output for the most common Inference Procedures and for computer-intensive calculations such as bootstrapping and robust estimation.

Moodle

Log in to Moodle to find announcements, general information, notes, lecture slide, classroom tutorial and assessments etc.

https://moodle.telt.unsw.edu.au

Computing lab

The main computing laboratory is Room G012 of the Red Centre. You can get to this lab by entering the building through the main entrance to the School of Mathematics (on the Mezzanine Level) and then going down the stairs to the Ground Level. A second smaller lab is Room M020, on the mezzanine level of the Red Centre.

For more information, including opening hours, see the computing facilities webpage:
https://www.maths.unsw.edu.au/currentstudents/computing-facilities

Remember that there will always be unscheduled periods when the computers are not working because of equipment problems and that this is not a valid excuse for not completing tests on time.

School and UNSW Policies

The School of Mathematics and Statistics has adopted a number of policies relating to enrolment, attendance, assessment, plagiarism, cheating, special consideration etc. These are in addition to the Policies of The University of New South Wales. Individual courses may also adopt other policies in addition to or replacing some of the School ones. These will be clearly notified in the Course Initial Handout and on the Course Home Pages on the Maths Stats web site.

Students in courses run by the School of Mathematics and Statistics should be aware of the School and Course policies by reading the appropriate pages on the Maths Stats web site starting at:

https://www.maths.unsw.edu.au/currentstudents/assessment-policies

The School of Mathematics and Statistics will assume that all its students have read and understood the School policies on the above pages and any individual course policies on the Course Initial Handout and Course Home Page. Lack of knowledge about a policy will not be an excuse for failing to follow the procedure in it.

Academic Integrity and Plagiarism

UNSW has an ongoing commitment to fostering a culture of learning informed by academic integrity. All UNSW staff and students have a responsibility to adhere to this principle of academic integrity. Plagiarism undermines academic integrity and is not tolerated at UNSW. *Plagiarism at UNSW is defined as using the words or ideas of others and passing them off as your own.*

The **UNSW Student Code** provides a framework for the standard of conduct expected of UNSW students with respect to their academic integrity and behaviour. It outlines the primary obligations of students and directs staff and students to the Code and related procedures.

In addition, it is important that students understand that it is not permissible to buy essay/writing services from third parties as the use of such services constitutes plagiarism because it involves using the words or ideas of others and passing them off as your own. Nor is it permissible to sell copies of lecture or tutorial notes as students do not own the rights to this intellectual property.

If a student breaches the Student Code with respect to academic integrity, the University may take disciplinary action under the **Student Misconduct Procedure**.

The UNSW Student Code and the Student Misconduct Procedure can be found at: https://student.unsw.edu.au/plagiarism

An online Module "Working with Academic Integrity" (https://student.unsw.edu.au/aim) is a six-lesson interactive self-paced Moodle module exploring and explaining all of these terms and placing them into your learning context. It will be the best one-hour investment you've ever made.

Plagiarism

Plagiarism is presenting another person's work or ideas as your own. Plagiarism is a serious breach of ethics at UNSW and is not taken lightly. So how do you avoid it? A one-minute video for an overview of how you can avoid plagiarism can be found https://student.unsw.edu.au/plagiarism.

Additional Support

ELISE (Enabling Library and Information Skills for Everyone)

ELISE is designed to introduce new students to studying at UNSW.

Completing the ELISE tutorial and quiz will enable you to:

- analyse topics, plan responses and organise research for academic writing and other assessment tasks
- effectively and efficiently find appropriate information sources and evaluate relevance to your needs
- use and manage information effectively to accomplish a specific purpose
- better manage your time
- understand your rights and responsibilities as a student at UNSW
- be aware of plagiarism, copyright, UNSW Student Code of Conduct and Acceptable Use of UNSW ICT Resources Policy
- be aware of the standards of behaviour expected of everyone in the UNSW community
- locate services and information about UNSW and UNSW Library

Some of these areas will be familiar to you, others will be new. Gaining a solid understanding of all the related aspects of ELISE will help you make the most of your studies at UNSW.

The *ELISE* training webpages:
https://subjectguides.library.unsw.edu.au/elise/aboutelise

Equitable Learning Services (ELS) If you suffer from a chronic or ongoing illness that has, or is likely to, put you at a serious disadvantage, then you should contact the Equitable Learning Services (previously known as SEADU) who provide confidential support and advice.

They assist students:

- living with disabilities
- with long- or short-term health concerns and/or mental health issues
- who are primary carers
- from low SES backgrounds
- of diverse genders, sexes and sexualities
- from refugee and refugee-like backgrounds
- from rural and remote backgrounds
- who are the first in their family to undertake a bachelor-level degree.

Their web site is: https://student.unsw.edu.au/els/services

Equitable Learning Services (ELS) may determine that your condition requires special arrangements for assessment tasks. Once the School has been notified of these, we will make every effort to meet the arrangements specified by ELS.

Additionally, if you have suffered significant misadventure that affects your ability to complete the course, please contact your Lecturer-in-charge in the first instance.

Academic Skills Support and the Learning Centre

The Learning Centre offers academic support programs to all students at UNSW Australia. We assist students to develop approaches to learning that will enable them to succeed in their academic study. For further information on these programs please go to:

http://www.lc.unsw.edu.au/services-programs

Applications for Special Consideration for Missed Assessment

Please adhere to the Special Consideration Policy and Procedures provided on the web page below when applying for special consideration.

https://student.unsw.edu.au/special-consideration

Please note that the application is not considered by the Course Authority, it is considered by a centralised team of staff at the Nucleus Student Hub.

The School will contact you (via student email account) after special consideration has been granted to reschedule your missed assessment, for a *lab test or paper-based test* only.

For applications for special consideration for *assignment extensions*, please note that the new submission date and/or outcome will be communicated through the special consideration web site only, no communication will be received from the School.

For Dates on Final Term Exams and Supplementary Exams please check the “Key Dates for Exams” ahead of time to avoid booking holidays or work obligations.

https://student.unsw.edu.au/exam-dates

If you believe your application for Special Consideration has not been processed, you should email specialconsideration@unsw.edu.au immediately for advice.

Course Evaluation and Development (MyExperience)

Student feedback is very important to continual course improvement. This is demonstrated within the School of Mathematics and Statistics by the implementation of the UNSW online student survey *myExperience*, which allows students to evaluate their learning experiences in an anonymous way. *myExperience* survey reports are produced for each survey. They are released to staff after all student assessment results are finalised and released to students. Course convenor will use the feedback to make ongoing improvements to the course.