FACULTY OF SCIENCE

SCHOOL OF MATHEMATICS
AND STATISTICS

MATH5905

STATISTICAL INFERENCE

Semester 2 2017

MATH5905 – Course Outline

Information about the course

Course Authority: Associate Professor Spiridon Penev

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Room: RC-1038

Consultation: Tuesday 9:30-11:00, Wednesday 9:30-11:00.

Individual times can also be arranged-please use email to arrange an appointment.

Credit, Prerequisites, Exclusions:

This course counts for 6 Units of Credit (6UOC).

MATH2801, MATH2901 or MATH5846 & MATH5856 is assumed minimal knowledge for this course. Once you have been admitted to the postgraduate program of the Department of Statistics, there are no further prerequisites.

Lectures: There will be three hours of lectures per week.

Tuesday	17:00-20:00	OMB230

Lectures will start in week 1 and continue until week 12. (The first lecture is on 25th July).

Tutorials: Tutorials and labs (using MathStatica and `R`) for this course are flexible and will be held in the time slot for the lectures. More precise information will be given during lectures.

Online materials: Further information, skeleton lecture notes, and other materials will be provided via Moodle.

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.

Relation to other statistics courses

The course is a compulsory component of the Mater of Statistics program and is recommended for all the remaining postgraduate coursework programs of the Department of Statistics. It provides theoretical foundation in statistics which many other courses will build on.

Student Learning Outcomes

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

- Learn the fundamental principles of inference: sufficiency, likelihood, ancillarity, equivariance.

- Learn the concepts of finite-sample and asymptotic efficiency of Inference Procedure.

- Master the parametric and non-parametric delta method, asymptotic normality, Edgeworth expansions and saddlepoint method.

- Able to estimate key population parameters of interest, to test hypotheses about them and to construct confidence regions.

- Able to use in practice the parametric, nonparametric, Bayes and robust inference.

- Learn how to use computer packages to generate output for the most common Inference Procedures and for computer-intensive calculations such as bootstrapping and robust estimation.

Relation to graduate attributes

These outcomes are closely related to the graduate attributes "Research, inquiry and analytical thinking abilities", "Communication" and "Information literacy" (through the computing component of the course).

Teaching strategies underpinning the course

Lecture notes provide a brief reference source for this course. At this stage, these are skeleton lecture notes only and sometimes, other materials and textbooks will

be used for deeper understanding. New ideas and skills are first introduced and demonstrated in lectures, then students develop these skills by applying them to specific tasks in tutorials and assessments. Computing skills will be used to some extent but this is not a course in computing; the computing part is mainly used to illustrate the theory/methodology. Some concepts will be illustrated with the *MathStatica* software for symbolic statistical calculations.

Rationale for learning and teaching strategies

We believe that effective learning is best supported by a climate of inquiry, in which students are actively engaged in the learning process. Hence this course is structured with a strong emphasis on problem-solving tasks in tutorials and in assessment tasks, and students are expected to devote the majority of their study time to the solving of such tasks.

Effective learning is achieved when students attend all classes, have prepared effectively for classes by reading through previous lecture notes and by having made a serious attempt at doing for themselves the tutorial problems.

Furthermore, lectures should be viewed by students as an opportunity to learn, rather than just copy down or skim over lecture notes.

Assessment

Knowledge and abilities assessed: All assessment tasks will assess the learning outcomes outlined above.

Assessment

Assessment task	%	Available	Due	Notes
Assignment 1	10	7th August	22nd August	No late assignments!
Mid-session test	20		5th September	Bring own calculator
Assignment 2	10	19th September	10th October	No late assignments!
Final exam	60	N/A	TBA	

In all assessments, marks will be awarded for correct working and appropriate explanations and not just the final answer.

Assignments

Rationale: Assignments will give an opportunity for students to try their hand at more difficult problems requiring more than one line of argument and also introduce them to aspects of the subject which are not explicitly covered in lectures.

Assignments must be YOUR OWN WORK, or severe penalties will be incurred.

You should consult the University web page on plagiarism

Late assignments will not be accepted.

Mid-session Test

Rationale: The Mid-session Test will give students feedback on their progress and mastery of the material.

Both short answer questions and some longer questions requiring clear and logical presentation of correct solutions will be given.

If you are absent from the test, you must provide a medical certificate. No further test will be offered.

Examination

Duration: Two hours.

Rationale: The final examination will assess student mastery of the material covered in the lectures and tutorials.

Further details about the final examination will be available in class closer to the time.

Only calculators on the list of approved calculators may be used in the end of semester exams.

Additional resources and support

Tutorial Exercises

A set of tutorial exercises will be available on Moodle. These problems are for YOU to do to enhance mastery of the course.

SOME of the problems will be done in tutorials, but you will learn a lot more if you try to do them before the tutorial.

Lecture notes

A set of skeleton notes will be provided on Moodle.

Textbooks

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

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

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

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

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

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

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

From the textbooks, the recommended text **CB** would be most useful! The text book **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 texts **YS** and **AvdV** are a bit more advanced but contain important material and will be used for some more specialised topics.

The tex **AD** is an *encyclopedic* book covering both classical and very modern topics of inference. It also covers many examples.

Moodle

Skeleton lecture notes and other useful materails will be available on Moodle. You should check regularly for updates. Some notes and tutorial solutions may be handed out as a hard copy only.

Computer laboratories

Computer laboratories (RC-G012 and RC-M020) are open 9-5 Monday-Friday on teaching days. RC-M020 has extended teaching hours (usually 8:30-9pm Monday-Friday, and 9-5 Monday-Friday on non-teaching weeks).

Course Evaluation and Development

The School of Mathematics and Statistics evaluates each course each time it is run. We carefully consider the student responses and their implications for course development. It is common practice to discuss informally with students how the course and their mastery of it are progressing.

Administrative matters

Additional Assessment

See attached handout.

School Rules and Regulations

Fuller details of the general rules regarding attendence, release of marks, special consideration etc are available via the School of Mathematics and Statistics Web page at
`http://www.maths.unsw.edu.au/currentstudents/assessment-policies`.

Plagiarism and academic honesty

Plagiarism is the presentation of the thoughts or work of another as one's own. Issues you must be aware of regarding plagiarism and the university's policies on academic honesty and plagiarism can be found at
`http://www.maths.unsw.edu.au/currentstudents/assessment-policies`.

Occupational Health and safety

Please refer to the UNSW Occupational Health and Safety policies and expectations:
`http://www.gs.unsw.edu.au/policy/documents/ohspolicy.pdf`.

Equity and diversity

Any equity and diversity issues should be directed to the Student Equity Officers (Disability) in the Student Equity and Diversity Unit (9385-4734). Further information for students with disabilities is available at

`http://www.studentequity.unsw.edu.au/`

Detailed course schedule

It is intended that the following topics will be covered in the given order. Any variation from this will be indicated by the lecturer. Some material may not be possible to cover in details and in such cases, at the discretion of the lecturer, part of some lectures will be used as a Problem Class where instead of new theoretical material, just some examples are shown.

	Topic	Lecture week (approx)
1.	Revision. The General Inference Problem as a decision theoretic problem. Bayes and minimax decision rules.	1-2
2.	Principles of data reduction and inference. Classical estimation theory. Methods for finding estimators.	3
3.	Information and Likelihood. Expected and observed Fisher information matrices. Cramer-Rao Bound. Uniform Minimum Variance Unibiased Estimators.	4
4.	Likelihood inference. Estimating statistical functionals.	5
5.	Asymptotic properties of estimators. Applications to order statistics, robust M estimators, and L estimators. Properties and application.	6-7
6.	Hypothesis Testing. Neyman-Pearson theory. Generalized Likelihood Ratio Tests.	8
7.	Higher order asymptotics. Edgeworth expansions, Saddlepoint approximations, Laplace's method.	9-10
8.	An Introduction to the Bootstrap as a computationally intensive method.	11-12