# SUBJECT OUTLINE

## 37457 Advanced Bayesian Methods

**Course area** UTS: Science

**Delivery** Spring 2022; City

**Credit points** 8cp

**Requisite(s)** 36103 Statistical Thinking for Data Science
These requisites may not apply to students in certain courses.
There are also course requisites for this subject. See access conditions.

**Result type** Grade and marks

Attendance: 3 to 4 hours per week

## Subject coordinator

Professor Matt Wand (matt.wand@uts.edu.au)

## Subject description

This subject covers advanced Bayesian methods for statistical data analyses and inference. Principles of the underlying methodology, based on graph theory, is also covered. Models include generalised linear models, linear mixed models and generalised additive models. The 'R', 'JAGS' and 'Stan' computing environments are used for analysis of a wide array of data sets.

## Subject learning objectives (SLOs)

Upon successful completion of this subject students should be able to:

1. Have a thorough understanding of the roles of estimation and prediction in advanced data analysis.
2. Formulate regression models for analysis of a complicated data set. Complications may include data with repeated measures or a categorical response variable. Models include generalised linear models and mixed models.
3. Fit such models and perform subsequent analyses and diagnostics using the computer packages "R", "BUGS" and/or "Stan".
4. Derive expressions used for fitting and inference in generalised linear and mixed models.
5. Write independent code in the R language.
6. Write reports that summarise the results of statistical analyses.
7. Evaluate and analyse recent statistical literature.

## Course intended learning outcomes (CILOs)

This subject also contributes specifically to the development of following course intended learning outcomes:

- Evaluate: Critically analyse, question and evaluate implications of alternative and new models and strategies for financial market trading and risk management. (1.3)
- Analyse: Critically analyse new financial models to address financial trading and risk management issues. (2.1)
- Synthesise: Investigate real-world problems by analysing and critically evaluating different solutions to complex challenges. (2.2)
- Analyse: Convey mathematical, statistical and financial models clearly and fluently, in high quality written form appropriate for their audience. (5.1)

## Contribution to the development of graduate attributes

1. Disciplinary knowledge and its appropriate application.

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The lectures and weekly assignment and laboratory exercises impart skills necessary in a number of mathematical disciplines and demonstrate how to apply these skills to a variety of problems.

2. Research, inquiry and critical thinking.

A major component of the weekly assignment and laboratory exercises is the consideration of how best to both quantitatively and/or qualitatively solve a given question. Statisticians who work in industry are often required to solve problems and this subject imparts the skills necessary to solve both routine and complex problems in any discipline.

5. Communication.

The weekly assignment and laboratory exercises illustrate how to present written solutions to statistical problems using appropriate professional language.

## Teaching and learning strategies

The presentation of this subject consists of 2 hours of lectures, 1 hour of computer laboratory and a 1 hour help session with weekly assignments when necessary.

Face-to-face classes will incorporate a range of teaching and learning strategies including presentations, discussion of readings and solving quantitative exercises on whiteboard and collaborative group work. These will be complemented by independent student reading to prepare for the class where they will use the information to participate in discussions and solve exercises. These discussion sessions are inquiry-led, with students given a question or topic to dissect in more detail through critical questioning and investigation. Since this is a 6cp subject, we expect that students will need to do about 10 hours per week to master the material.

Most students will attend three hours of classes each week and spend about 7 hours per week reading the reference book, solving the exercises handed out in class and reviewing the solutions provided to class exercises. Feedback in the format of partial worked solutions will be provided for these exercises (and the weekly assignments) and there will be opportunities to ask questions about these in class and in labs. The partial solutions are also provided online for flexible access.

## Content (topics)

Graph theory; probabilistic graph theory; Bayesian inference; Bayesian inference engines; generalized linear models; generalized linear mixed models; generalized additive models.

## Program

| Week/Session | Dates | Description |
|---|---|---|
| | | Introduction. Lecturer releases Assignment 1.<br><br>**Notes:**<br><br>This subject is very assignment and laboratory intensive and less lecture intensive. |
| | | Tutorial for Assignment 1 just before due date. Students submit Assignment 1. Lecturer releases first set of notes and Assignment 2. |
| | | Tutorial for Assigment 2 just before due date. Students submit Assignment 2. Students start Laboratory 1. |
| | | Tutorial for Laboratory 1 just before due date. Students submit Laboratory 1. Lecturer releases Assignment 3. |

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|---|---|
| | Tutorial for Assignment 3 just before due date. Students submit Assignment 3. Lecturer releases Assignment 4. |
| | Tutorial for Assignment 4 just before due date. Students submit Assignment 4. Students start Laboratory 2. |
| | Tutorial for Laboratory 2 just before due date. Students submit Laboratory 2. Lecturer releases further notes and Assignment 5. |
| | Tutorial for Assignment 5 just before due date. Students submit Assigment 5. Lecturer releases Assignment 6. |
| | Tutorial for Assignment 6 just before due date. Students submit Assignment 6. Students start Laboratory 3. |
| | Tutorial for Laboratory 3 just before due date. Students submit Laboratory 3. Lecturer releases Assignment 7. |
| | Tutorial for Assignment 7 just before due date. Students submit Assignment 7. Lecturer releases Assignment 8. |
| | Tutorial for Assignment 8 just before due data. Students submit Assignment 8. Students complete and submit Laboratory 4.<br><br>**Notes:**<br><br>Laboratory 4 is such that a tutorial is not necessary. |

## Assessment

### Assessment task 1: Assignments

**Intent:** This assessment item addresses the following graduate attributes:

1. Disciplinary knowledge

2. Research, inquiry and critical thinking

5. Communication

**Objective(s):** This assessment task addresses subject learning objective(s):

1, 2, 3, 4, 5, 6 and 7

This assessment task contributes to the development of course intended learning outcome(s):

1.3, 2.1, 2.2 and 5.1

**Type:** Exercises

**Groupwork:** Individual

**Weight:** 60%

**Task:** 8 assignment sheets will be completed out of class. It must be handed in during class by the date specified on the assignment. Assignments will be marked and returned during the following class.

**Due:** It must be handed in during class by the date specified on the assignment.

**Criteria:**
1. Correct application of knowledge and procedures of the data analysis;
2. Correct interpretation of questions and terminology;
3. Correct choice of reasoning and proof;
4. Appropriate and correct implementation of solutions using industry standard software;
5. Clear communication using correct statistical terminology.

**Further information:**
- You must show working for each question on the assignment.
- Untidy or illegible work will not be assessed.
- Assignments will not be accepted outside classes or after the due date – unless you are successful in applying for special consideration.
- Faxed or emailed assignments will not be accepted.
- Extensions for assignments will not be granted.
- Late assignments will be penalised at a rate of 10% per day, not including weekends and public holidays.

### Assessment task 2: Exam

**Intent:** This assessment item addresses the following graduate attributes:

1. Disciplinary knowledge
2. Research, inquiry and critical thinking
5. Communication

**Objective(s):** This assessment task addresses subject learning objective(s):

1, 2 and 6

This assessment task contributes to the development of course intended learning outcome(s):

1.3, 2.2 and 5.1

**Type:** Examination

**Groupwork:** Individual

**Weight:** 40%

**Task:** Take-home exam (24 hour assignment).

**Due:** UTS Exam period

**Criteria:** The exam will take the format similar to weekly assignments (i.e. short answers, derivation and data analysis) where students will be assessed on

1. Correct application of knowledge and procedures of the data analysis;
2. Correct interpretation of questions and terminology;
3. Correct choice of reasoning and proof;
4. Clear communication using correct statistical terminology.

## Minimum requirements
Students must obtain a mark of 50 or higher to pass the subject.

## Required texts
All subject materials are provided by the lecturer to the students.

## References
Gelman, A., Carlin, J.B., Stern, H.S., Dunson, D.B., Vehtari, A. and Rubin, D.B. (2014). Bayesian Data Analysis, Third Edition. Boca Raton, Florida: CRC Press.

Faraway, J.J. (2006). Extending the Linear Model with R. Boca Raton, Florida: Chapman & Hall/CRC Press.

Harezlak, J., Ruppert, D. and Wand, M.P. (2018). Semiparametric Regression with R. New York: Springer.

McCulloch, C.E., Searle, S.R and Neuhaus, J.M. (2008). Generalized, Linear, and Mixed Models, Second Edition. New York: Wiley.

## Other resources
The R computing environment and some add-on packages will be used extensively in this subject.

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### Academic liaison officers
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2. consult the plagiarism help site
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