STAT878

Modern Computational Statistical Methods

S1 External 2018

Dept of Statistics

Contents

General Information

Unit convenor and teaching staff
Lecturer
David Bulger
david.bulger@mq.edu.au
12 Wally's Walk Room 530
Wednesdays 10–12

Lecturer
Hassan Doosti
hassan.doosti@mq.edu.au
12 Wally's Walk Room 534
Thursdays 10–12

Credit points
4

Prerequisites

Corequisites
((Admission to MAppStat or GradCertAppStat or GradDipAppStat or MActPrac or MDataSc or MSc) and (STAT806 or STAT810)) or (admission to MInfoTech)

Co-badged status
Co-badged with STAT778.

Unit description
This unit offers students the opportunity to study some modern computational methods in statistics. The first half of the unit covers maximum likelihood computations, Bayesian computations using Monte Carlo methods, missing data and the EM algorithm. The second half considers Kernel density estimation, Kernel regression, quantile regression and inferences using Monte-Carlo and bootstrapping methods. The computing software MATLAB, R and WinBUGS are used.

Important Academic Dates

Information about important academic dates including deadlines for withdrawing from units are available at https://www.mq.edu.au/study/calendar-of-dates

Learning Outcomes

On successful completion of this unit, you will be able to:

Ability to compute maximum likelihood and Bayesian estimates

Ability to make inferences using these estimates

Know how to deal with missing data and use the EM algorithm

Compute nonparametric estimators of probability density function

Compute nonparametric estimators of regression function and smoothed quantile regression

Understand Monte-Carlo inferential statistics and understand bootstrappping estimates of bias, variance and CI computations

Gain proficiency in Matlab and R

Assessment Tasks

Name	Weighting	Hurdle	Due
Assignment 1	20%	No	week 6 lecture
Assignment 2	20%	No	week 13 lecture
Take-home exam	30%	No	10am, June 11
Written exam	30%	No	TBA

Assignment 1

Due: **week 6 lecture**
Weighting: **20%**

This assignment covers the material from Weeks 1–5. Assignments comprise a major part of the learning process**.** Assignments must be each student's own work. Discussions are allowed but the final work must be your personal effort. *We prefer that assignments are word-processed.*

In the case of the late submission of an assignment, if no special consideration has been granted, 10% of the earned mark will be deducted for each day that the assignment is late, up to a maximum of 50%. After 5 days, including weekends and public holidays, a mark of 0% will be awarded for the assignment.

On successful completion you will be able to:

- Ability to compute maximum likelihood and Bayesian estimates
- Ability to make inferences using these estimates
- Know how to deal with missing data and use the EM algorithm
- Understand Monte-Carlo inferential statistics and understand bootstrappping estimates of bias, variance and CI computations
- Gain proficiency in Matlab and R

Assignment 2

Due: **week 13 lecture**
Weighting: **20%**

This assignment covers the material from Weeks 7–12. For policy on late submission and other issues please see the Assignment 1 description.

On successful completion you will be able to:

- Compute nonparametric estimators of probability density function
- Compute nonparametric estimators of regression function and smoothed quantile regression
- Understand Monte-Carlo inferential statistics and understand bootstrappping estimates of bias, variance and CI computations
- Gain proficiency in Matlab and R

Take-home exam

Due: **10am, June 11**
Weighting: **30%**

This take-home exam covers the teaching materials from Week 1 to Week 13 and it will be available on iLearn from 10am on Friday 8 June 2018. Your answers to this exam must be submitted electronically (by email) to David Bulger by 10am Monday 11 June 2018. Your answers should be word processed. Any Matlab, R or WinBUGS code written to answer the exam questions should also be included as attachments.

Except in special circumstances, this take-home exam must be submitted on time, and any later submissions will not be accepted. In case of documented illness or unavoidable disruption, you may apply for special consideration via ask.mq.edu.au.

On successful completion you will be able to:

- Ability to compute maximum likelihood and Bayesian estimates
- Ability to make inferences using these estimates
- Know how to deal with missing data and use the EM algorithm
- Compute nonparametric estimators of probability density function
- Compute nonparametric estimators of regression function and smoothed quantile regression
- Understand Monte-Carlo inferential statistics and understand bootstrappping estimates of bias, variance and CI computations
- Gain proficiency in Matlab and R

Written exam

Due: **TBA**
Weighting: **30%**

This is a 2-hour supervised exam and it will cover the lecture materials from Week 1 to Week 13. Its date will be within the University Examination Period.

The only excuse for not sitting an examination at the designated time is because of documented illness or unavoidable disruption. In these special circumstances you may apply for special consideration via ask.mq.edu.au.

On successful completion you will be able to:

- Ability to compute maximum likelihood and Bayesian estimates
- Ability to make inferences using these estimates
- Know how to deal with missing data and use the EM algorithm
- Compute nonparametric estimators of probability density function
- Compute nonparametric estimators of regression function and smoothed quantile regression
- Understand Monte-Carlo inferential statistics and understand bootstrappping estimates of bias, variance and CI computations
- Gain proficiency in Matlab and R

Delivery and Resources

Lectures

You are required to attend a 3-hour class each week; the time and room are:

Tuesday 6:00 – 9:00pm 6 Eastern Road Room 214 PC Lab

This class is a combined lecture and practical.

Prescribed texts

Students should obtain the lecture overheads from iLearn prior to the lecture. The lecture overheads are available module by module.

The following are recommended reading books for this unit:

- Computational Statistics Handbook with MATLAB®, W. L. Martinez and A. R. Martinez, Chapman & Hall. (QA276.4.M272)
- Local regression and likelihood, C. Loader, Springer-Verlag, 1999. QA276.8 .L6/1999.
- Quantile Regression, Roger Koenker, Cambridge University Press 2005,

Unit webpage

Unit webpage is located on iLearn at https://ilearn.mq.edu.au.

You can only access the material on iLearn if you are formally enrolled in the unit. All lecturing materials are available at this webpage.

Teaching and Learning Strategy

The unit is taught in both traditional mode and external mode. In traditional mode, students are on campus in standard semesters with weekly lectures. In external mode, students access all teaching material from iLearn and do not attend lectures on campus.

Students are expected to

· attend all the lectures if enrolled internally;

· have read through the material to be covered using the lecture notes provided on iLearn;

· submit assignments due in Weeks 6 and 12 to the appropriate lecturer;

· contact the unit convenor in advance if for any reason, you cannot hand in your assessment tasks on time;

· collect their marked assessment from the lecturer during the lecture if enrolled internally. External students will have their marked assessment sent to them.

Refer to the next section for a week-by-week list of topics to be covered in this unit.

Examinations

If you notify the University of your disruption to studies for your final examination, you must make yourself available during the advertised supplementary examination period. If you are not available at that time, there is no guarantee an additional examination time will be offered. Specific examination dates and times will be determined at a later date.

Software used in teaching

We are using MATLAB, R and WinBUGS in teaching this unit. R and WinBUGS are free software and are widely used nowadays by statisticians. More information about R can be found at http://www.r-project.org/, and WinBUGS at "http://www.mrc-bsu.cam.ac.uk/bugs/". Matlab is commercial software, but is available for Macquarie students and staff: https://web.science.mq.edu.au/it/matlab/.

Unit Schedule

Unit Schedule

Week	Topic	Software	Assignment	
			Out	Due
1	Likelihood and maximum likelihood estimates (MLE)	Matlab		
2	Iterative methods for computing MLE	Matlab		
3	Iterative methods for computing MLE (cont.) Prior and posterior distributions	Matlab		
4	Prior and posterior distributions (cont.) Bayesian estimates Bayesian computation: posterior mean Bayesian computation: posterior mode WinBUGS	Matlab, WinBUGS	**Assg 1**	
5	Asymptotic distribution: MLE Asymptotic distribution: posterior mode	Matlab		
6	Missing data mechanism Complete data and incomplete data Inference based on incomplete data The EM algorithm	Matlab		**Assg 1**
7	Histogram & density estimation	Matlab		
8	Kernel density estimation			
9	Kernel regression			
10 11	Quantile regression Monte-Carlo method for inferential statistics Basic procedure Monte-Carlo hypothesis testing		**Assg 2**	
12	Bootstrap methods Bootstrap method of bias Bootstrap estimate of variance Bootstrap confidence intervals Review			
13				**Assg 2**

Students should read the lecture notes, which will be available at the unit web page, before the lecture.

Policies and Procedures

Macquarie University policies and procedures are accessible from Policy Central (https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-central). Students should be aware of the following policies in particular with regard to Learning and Teaching:

- Academic Appeals Policy
- Academic Integrity Policy
- Academic Progression Policy
- Assessment Policy
- Fitness to Practice Procedure
- Grade Appeal Policy
- Complaint Management Procedure for Students and Members of the Public
- Special Consideration Policy (***Note:*** *The Special Consideration Policy is effective from 4 December 2017 and replaces the Disruption to Studies Policy.)*

Undergraduate students seeking more policy resources can visit the Student Policy Gateway (https://students.mq.edu.au/support/study/student-policy-gateway). It is your one-stop-shop for the key policies you need to know about throughout your undergraduate student journey.

If you would like to see all the policies relevant to Learning and Teaching visit Policy Central (https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-central).

Student Code of Conduct

Macquarie University students have a responsibility to be familiar with the Student Code of Conduct: https://students.mq.edu.au/study/getting-started/student-conduct

Results

Results shown in *iLearn*, or released directly by your Unit Convenor, are not confirmed as they are subject to final approval by the University. Once approved, final results will be sent to your student email address and will be made available in eStudent. For more information visit ask.mq.edu.au.

Student Support

Macquarie University provides a range of support services for students. For details, visit http://students.mq.edu.au/support/

Learning Skills

Learning Skills (mq.edu.au/learningskills) provides academic writing resources and study strategies to improve your marks and take control of your study.

- Workshops
- StudyWise
- Academic Integrity Module for Students
- Ask a Learning Adviser

Student Services and Support

Students with a disability are encouraged to contact the Disability Service who can provide appropriate help with any issues that arise during their studies.

Student Enquiries

For all student enquiries, visit Student Connect at ask.mq.edu.au

IT Help

For help with University computer systems and technology, visit http://www.mq.edu.au/about_us/offices_and_units/information_technology/help/.

When using the University's IT, you must adhere to the Acceptable Use of IT Resources Policy. The policy applies to all who connect to the MQ network including students.

Graduate Capabilities

PG - Discipline Knowledge and Skills

Our postgraduates will be able to demonstrate a significantly enhanced depth and breadth of knowledge, scholarly understanding, and specific subject content knowledge in their chosen fields.

This graduate capability is supported by:

Learning outcomes

- Ability to compute maximum likelihood and Bayesian estimates
- Ability to make inferences using these estimates
- Know how to deal with missing data and use the EM algorithm
- Compute nonparametric estimators of probability density function
- Compute nonparametric estimators of regression function and smoothed quantile regression
- Understand Monte-Carlo inferential statistics and understand bootstrappping estimates of bias, variance and CI computations

- Gain proficiency in Matlab and R

Assessment tasks

- Assignment 1
- Assignment 2
- Take-home exam
- Written exam

PG - Critical, Analytical and Integrative Thinking

Our postgraduates will be capable of utilising and reflecting on prior knowledge and experience, of applying higher level critical thinking skills, and of integrating and synthesising learning and knowledge from a range of sources and environments. A characteristic of this form of thinking is the generation of new, professionally oriented knowledge through personal or group-based critique of practice and theory.

This graduate capability is supported by:

Learning outcomes

- Ability to compute maximum likelihood and Bayesian estimates
- Ability to make inferences using these estimates
- Know how to deal with missing data and use the EM algorithm
- Compute nonparametric estimators of probability density function
- Compute nonparametric estimators of regression function and smoothed quantile regression
- Understand Monte-Carlo inferential statistics and understand bootstrappping estimates of bias, variance and CI computations
- Gain proficiency in Matlab and R

Assessment tasks

- Assignment 1
- Assignment 2
- Take-home exam
- Written exam

PG - Research and Problem Solving Capability

Our postgraduates will be capable of systematic enquiry; able to use research skills to create new knowledge that can be applied to real world issues, or contribute to a field of study or practice to enhance society. They will be capable of creative questioning, problem finding and problem solving.

This graduate capability is supported by:

Learning outcomes

- Ability to compute maximum likelihood and Bayesian estimates
- Ability to make inferences using these estimates
- Know how to deal with missing data and use the EM algorithm
- Compute nonparametric estimators of probability density function
- Compute nonparametric estimators of regression function and smoothed quantile regression
- Understand Monte-Carlo inferential statistics and understand bootstrappping estimates of bias, variance and CI computations
- Gain proficiency in Matlab and R

Assessment tasks

- Assignment 1
- Assignment 2
- Take-home exam
- Written exam

PG - Effective Communication

Our postgraduates will be able to communicate effectively and convey their views to different social, cultural, and professional audiences. They will be able to use a variety of technologically supported media to communicate with empathy using a range of written, spoken or visual formats.

This graduate capability is supported by:

Assessment tasks

- Assignment 1
- Assignment 2
- Take-home exam