STAT878
Modern Computational Statistical Methods
S1 Evening 2014

Statistics

Contents

General Information 2
Learning Outcomes 2
Assessment Tasks 3
Delivery and Resources 5
Unit Schedule 6
Policies and Procedures 7
Graduate Capabilities 9

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## General Information

### Unit convenor and teaching staff

**Unit Convenor**  
Jun Ma  
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Contact via jun.ma@mq.edu.au  
E4A511  
TBA

Other Staff  
Maurizio Manuguerra  
[maurizio.manuguerra@mq.edu.au](mailto:maurizio.manuguerra@mq.edu.au)  
Contact via maurizio.manuguerra@mq.edu.au  
E4A 452  
TBA

### Credit points

4

### Prerequisites

Admission to MAppStat or PGDipAppStat or PGCertAppStat

### Corequisites

STAT806 or STAT810

### Co-badged status

No co-badged units

### 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 non-parametric curve estimation. The computing software MATLAB is used.

## Important Academic Dates

Information about important academic dates including deadlines for withdrawing from units are available at [https://students.mq.edu.au/important-dates](https://students.mq.edu.au/important-dates)

## Learning Outcomes

On successful completion of this unit, you will be able to:
Perform maximum likelihood and Bayesian computations
Make inferences using these estimates
Know how to deal with missing data and use the EM algorithm
Compute nonparametric estimators of probability density function and nonparametric curve estimation
Compute nonparametric estimators of regression function and smoothed quantile regression
Understand Monte-Carlo inferential statistics and understand bootstrap bias, variance and CI computations
Program in Matlab (or R)

Assessment Tasks

<table>
<thead>
<tr>
<th>Name</th>
<th>Weighting</th>
<th>Due</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assignment 1</td>
<td>20%</td>
<td>6pm, April 10th</td>
</tr>
<tr>
<td>Assignment 2</td>
<td>20%</td>
<td>6pm, June 5th</td>
</tr>
<tr>
<td>Take home exam 1</td>
<td>30%</td>
<td>10am, April 14th</td>
</tr>
<tr>
<td>Take home exam 2</td>
<td>30%</td>
<td>TBA</td>
</tr>
</tbody>
</table>

Assignment 1

Due: **6pm, April 10th**
Weighting: **20%**

This assignment covers weeks 1 - 6 materials. Assignments comprise a major part of the learning process. Assignments are compulsory. Failure to submit any assignment will be taken as an evidence of non-participation in the course and may lead to exclusion from the course. Late submission without approval will be penalized at the rate of 20% deduction per day. 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.*

On successful completion you will be able to:
- Perform maximum likelihood and Bayesian computations
- Make inferences using these estimates
- Know how to deal with missing data and use the EM algorithm
- Program in Matlab (or R)
Assignment 2
Due: 6pm, June 5th
Weighting: 20%

This assignment covers weeks 7 - 12 materials. For policy on later submission and other issues please see Assignment 1 description.

On successful completion you will be able to:
- Compute nonparametric estimators of probability density function and nonparametric curve estimation
- Compute nonparametric estimators of regression function and smoothed quantile regression
- Understand Monte-Carlo inferential statistics and understand bootstrap bias, variance and CI computations
- Program in Matlab (or R)

Take home exam 1
Due: 10am, April 14th
Weighting: 30%

This first take home eaxm covers the teaching materials from week 1 to week 6 and it will be available from iLearn at 10am on Friday 11 April 2014. Your answers to this test must be submitted electronically to A/Prof Jun Ma by 10am Monday 14 April 2014. Your answers should be word processed. Matlab/R and WinBUGS codes written to answer the exam questions should also be included as an attachment. This take home exam must be submitted on time. Any later submissions without approval will NOT be accepted and no special consideration will be given.

On successful completion you will be able to:
- Perform maximum likelihood and Bayesian computations
- Make inferences using these estimates
- Know how to deal with missing data and use the EM algorithm
- Program in Matlab (or R)

Take home exam 2
Due: TBA
Weighting: 30%

This take home exam will cover the lecture materials from week 7 to week 13. Its date will be
within the university Examination Period. The date of availability and submission will be advised before the end of week 13 of lectures. The solutions should be word processed and submitted electronically to Dr Maurizio Manuguerra. This test will have the same duration and policy on late submission as Take Home Exam 1.

On successful completion you will be able to:

- Compute nonparametric estimators of probability density function and nonparametric curve estimation
- Compute nonparametric estimators of regression function and smoothed quantile regression
- Understand Monte-Carlo inferential statistics and understand bootstrap bias, variance and CI computations
- Program in Matlab (or R)

**Delivery and Resources**

**Lectures**

You are required to attend a 3-hour lecture (and practice) each week; the time and room are:

- **Thursday** 6.00 – 9.00pm
- **E4B 206 Faculty PC Lab**

**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

- Quantile Regression, Roger Koenker, Cambridge University Press 2005

**Unit Webpage**

Unit webpage is located on Moodle at [https://ilearn.mq.edu.au](https://ilearn.mq.edu.au).

You can only access the material on Moodle if you are 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 end of this handout for a week-by-week list of topics to be covered in this unit.

SOFTWARE USED IN TEACHING

We are using MATLAB (or 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/”.

CHANGES FROM PREVIOUS OFFERINGS

None

Technologies used and required

None

Unit Schedule

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
<th>Software</th>
<th>Assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Likelihood and maximum likelihood estimates (MLE)</td>
<td>Matlab</td>
<td></td>
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<tr>
<td>2</td>
<td>Iterative methods for computing MLE</td>
<td>Matlab</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Iterative methods for computing MLE (cont.) Prior and posterior distributions</td>
<td>Matlab</td>
<td></td>
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</table>
### Policies and Procedures

Macquarie University policies and procedures are accessible from [Policy Central](https://policy.mq.edu.au).

Students should be aware of the following policies in particular with regard to

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**Unit guide** STAT878 Modern Computational Statistical Methods

<table>
<thead>
<tr>
<th>4</th>
<th>Prior and posterior distributions (cont.)</th>
<th>Matlab, WinBUGS</th>
<th>Ass 1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bayesian estimates</td>
<td></td>
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<tr>
<td></td>
<td>Bayesian computation: posterior mean</td>
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<tr>
<td></td>
<td>Bayesian computation: posterior mode</td>
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</tbody>
</table>

| 5 | Asymptotic distribution: MLE             | Matlab          |       |
|   | Asymptotic distribution: posterior mode  |                 |       |

| 6 | Missing data mechanism                   | Matlab          | Ass 1 |
|   | Complete data and incomplete data        |                 |       |
|   | Inference based on incomplete data       |                 |       |
|   | The EM algorithm                         |                 |       |

| 7 | Examples of the EM algorithm             | Matlab          |       |
|   | Histogram & density estimation           |                 |       |

**A TWO-WEEK BREAK**

<table>
<thead>
<tr>
<th>8</th>
<th>Kernel density estimation</th>
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</thead>
<tbody>
<tr>
<td>9</td>
<td>Kernel regression</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>10</th>
<th>Quantile regression</th>
<th></th>
<th>Ass 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Monte-Carlo method for inferential statistics</td>
<td>Basic procedure Monte-Carlo hypothesis testing</td>
<td>Ass 2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>12</th>
<th>Bootstrap methods</th>
<th></th>
<th>Ass 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bootstrap method of bias Bootstrap estimate of variance Bootstrap confidence intervals</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Review</td>
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</tr>
</tbody>
</table>

Students should read the lecture notes, which will be available at the unit web page, before the lecture.
Unit guide STAT878 Modern Computational Statistical Methods

Learning and Teaching:


In addition, a number of other policies can be found in the Learning and Teaching Category of 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/support/student_conduct/](https://students.mq.edu.au/support/student_conduct/)

**Student Support**

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

**Learning Skills**

Learning Skills ([mq.edu.au/learningskills](http://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 Enquiry Service**

For all student enquiries, visit Student Connect at [ask.mq.edu.au](http://ask.mq.edu.au)

**Equity 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.

**IT Help**

For help with University computer systems and technology, visit [http://informatics.mq.edu.au/hel](http://informatics.mq.edu.au/hel)
When using the University's IT, you must adhere to the Acceptable Use 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 outcome**

- Perform maximum likelihood and Bayesian computations

**Assessment tasks**

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

**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:

**Assessment tasks**

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

**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:

Assessment tasks

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

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 1
- Take home exam 2