STAT778
Modern Computational Statistical Methods
S1 Evening 2015
Dept of Statistics

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## General Information

**Unit convenor and teaching staff**

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Contact via jun.ma@mq.edu.au  
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TBA

**Other Staff**  
David Bulger  
david.bulger@mq.edu.au  
Contact via david.bulger@mq.edu.au  
E4A 538  
TBA

**Credit points**  
4

**Prerequisites**  
Admission to MRes

**Corequisites**  
STAT710

**Co-badged status**

**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://students.mq.edu.au/important-dates](https://students.mq.edu.au/important-dates)

## Learning Outcomes

1. Perform maximum likelihood and Bayesian computations
2. Make inferences using these estimates
3. Know how to deal with missing data and use the EM algorithm
4. Compute nonparametric estimators of probability density function and nonparametric curve estimation
5. Compute nonparametric estimators of regression function and smoothed quantile regression
6. Understand Monte-Carlo inferential statistics and understand bootstrap bias, variance and CI computations
7. 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>15%</td>
<td>week 6 lecture</td>
</tr>
<tr>
<td>Assignment 2</td>
<td>15%</td>
<td>week 13 lecture</td>
</tr>
<tr>
<td>Take home exam</td>
<td>50%</td>
<td>10am, June 8</td>
</tr>
<tr>
<td>Written exam</td>
<td>20%</td>
<td>TBA</td>
</tr>
</tbody>
</table>

Assignment 1

Due: week 6 lecture
Weighting: 15%

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 submissions without approval will be penalized at a 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.

This Assessment Task relates to the following Learning Outcomes:

- Perform maximum likelihood and Bayesian computations
- Make inferences using these estimates
- Know how to deal with missing data and use the EM algorithm
- Understand Monte-Carlo inferential statistics and understand bootstrap bias, variance and CI computations
Assignment 2

Due: week 13 lecture
Weighting: 15%

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

This Assessment Task relates to the following Learning Outcomes:

- 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

Due: 10am, June 8
Weighting: 50%

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 05 June 2015. Your answers to this exam must be submitted electronically to A/Prof Jun Ma by 10am Monday 08 June 2015. 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.

This Assessment Task relates to the following Learning Outcomes:

- 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
Written exam

Due: TBA
Weighting: 20%

This is a supervised exam and it will cover the lecture materials from week 1 to week 13. Its date will be within the university Examination Period.

This Assessment Task relates to the following Learning Outcomes:

- 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)

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.

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>
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<tr>
<td>3</td>
<td>Iterative methods for computing MLE (cont.) Prior and posterior distributions</td>
<td>Matlab</td>
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<tr>
<td>4</td>
<td>Prior and posterior distributions (cont.) Bayesian estimates</td>
<td>Matlab, WinBUGS</td>
<td>Ass 1</td>
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<tr>
<td></td>
<td>Bayesian computation: posterior mean</td>
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<td></td>
<td>Bayesian computation: posterior mode WinBUGS</td>
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<tr>
<td>5</td>
<td>Asymptotic distribution: MLE</td>
<td>Matlab</td>
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<tr>
<td></td>
<td>Asymptotic distribution: posterior mode</td>
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<tr>
<td>6</td>
<td>Missing data mechanism</td>
<td>Matlab</td>
<td>Ass 1</td>
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<td>Complete data and incomplete data</td>
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<td></td>
<td>Inference based on incomplete data</td>
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<td></td>
<td>The EM algorithm</td>
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<tr>
<td>7</td>
<td>Examples of the EM algorithm</td>
<td>Matlab</td>
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<td></td>
<td>Histogram &amp; density estimation</td>
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<td></td>
<td><strong>A TWO-WEEK BREAK</strong></td>
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<tr>
<td>8</td>
<td>Kernel density estimation</td>
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<td>9</td>
<td>Kernel regression</td>
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<td>10</td>
<td>Quantile regression</td>
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<tr>
<td>11</td>
<td>Monte-Carlo method for inferential statistics Basic procedure</td>
<td></td>
<td>Ass 2</td>
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<tr>
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<td>Monte-Carlo hypothesis testing</td>
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<td>Review</td>
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<tr>
<td>12</td>
<td>Bootstrap methods</td>
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<td>Ass 2</td>
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<td>Bootstrap method of bias Bootstrap estimate of variance</td>
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<td>Bootstrap confidence intervals</td>
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<tr>
<td></td>
<td>Review</td>
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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](http://mq.edu.au/policy/docs/). Students should be aware of the following policies in particular with regard to Learning and Teaching:


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

**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](http://mq.edu.au/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/](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**
Graduate Capabilities

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

- 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

- Assignment 1
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

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**

- 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**

- 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**

- Perform maximum likelihood and Bayesian computations
- Make inferences using these estimates
- Know how to deal with missing data and use the EM algorithm
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**Assessment tasks**

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