STAT827
Survival Analysis
S1 External 2015
Dept of Statistics

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General Information

Unit convenor and teaching staff
Unit Convenor
Kenneth Beath
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Contact via ken.beath@mq.edu.au
E4A 526
Wednesday 2-4

Credit points
4

Prerequisites
BCA808 or admission to MAppStat or PGDipAppStat or PGCertAppStat or GradDipAppStat

Corequisites
STAT806 or STAT810 or BCA817

Co-badged status
Unit SVA in the Biostatistics Collaboration Australia (BCA) programme, STAT727

Unit description
This unit explores biostatistical applications of survival analysis. These begin with the Kaplan-Meier curve definition and its extension to the comparison of survival of several groups of subjects. The Cox proportional hazards model is introduced as a method for handling continuous covariates, and parametric accelerated failure-time models are covered. Time-dependent covariates and multiple outcomes are also considered.

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:

- Understand the nature of survival data.
- Summarise and display survival data using nonparametric methods.
- Analyse survival data using the Cox proportional hazards model, including time-dependent covariates.
- Analyse survival data using parametric models.
Analyse data using multi-event models.
Determine sample size for simple survival analysis.
Produce appropriate displays for publication.

### Assessment Tasks

<table>
<thead>
<tr>
<th>Name</th>
<th>Weighting</th>
<th>Due</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exercises</td>
<td>10%</td>
<td>23 March, 27 April</td>
</tr>
<tr>
<td>Assignment 1</td>
<td>26%</td>
<td>13 April</td>
</tr>
<tr>
<td>Assignment 2</td>
<td>36%</td>
<td>11 May</td>
</tr>
<tr>
<td>Assignment 3</td>
<td>28%</td>
<td>9 June</td>
</tr>
</tbody>
</table>

### Exercises

Due: 23 March, 27 April
Weighting: 10%

2 short answer exercises each worth 5%. These will be made available at least 2 weeks before the due date. They will require brief answers and no data analysis.

On successful completion you will be able to:
• Understand the nature of survival data.
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• Analyse survival data using parametric models.
• Analyse data using multi-event models.
• Determine sample size for simple survival analysis.
• Produce appropriate displays for publication.

### Assignment 1

Due: 13 April
Weighting: 26%

Covers Modules 1 and 2

On successful completion you will be able to:
• Understand the nature of survival data.
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• Analyse survival data using the Cox proportional hazards model, including time-dependent covariates.
• Analyse survival data using parametric models.
• Analyse data using multi-event models.
• Determine sample size for simple survival analysis.
• Produce appropriate displays for publication.

Assignment 2
Due: 11 May
Weighting: 36%
Covers mainly Modules 3 and 4,

On successful completion you will be able to:
• Understand the nature of survival data.
• Summarise and display survival data using nonparametric methods.
• Analyse survival data using the Cox proportional hazards model, including time-dependent covariates.
• Analyse survival data using parametric models.
• Analyse data using multi-event models.
• Determine sample size for simple survival analysis.
• Produce appropriate displays for publication.

Assignment 3
Due: 9 June
Weighting: 28%
Covers mainly Modules 5, 6 and 7

On successful completion you will be able to:
• Understand the nature of survival data.
• Summarise and display survival data using nonparametric methods.
• Analyse survival data using the Cox proportional hazards model, including time-dependent covariates.
• Analyse survival data using parametric models.
• Analyse data using multi-event models.
• Determine sample size for simple survival analysis.
• Produce appropriate displays for publication.
Delivery and Resources

The unit is offered only in distance mode. Our means of communication will be via notes which can be obtained from ilearn, e-mail, and forums on ilearn. Our primary communication method is via ilearn and we expect you to log in at least weekly to check for announcements and release of assignments and so on.

The unit relies heavily on the prescribed text Hosmer, Lemeshow and May (see below). The study notes provide a guide to readings in this text, as well as sometimes to other readings, which will be provided. They also provide additional explanation where this is needed. In the study notes for each module, tutorial exercises are given, mostly referring to exercises in Hosmer, Lemeshow and May.

We will be using ilearn for online discussions, posting of course notes, assignments, solutions and data sets, and submission of exercises, and assignments.

Textbooks

The prescribed text is Hosmer DW, Lemeshow S and May S (2008). Applied Survival Analysis, John Wiley and Sons, Second Edition. There are numerous texts on survival analysis which you may wish to consult, but the following may be particularly helpful because of its use of Stata:


Other useful texts are:


Software

We will be using Stata (version 13 or later). While Stata has a GUI we will be using the command language. It is still useful to experiment with the GUI, as the corresponding commands are available in the Review pane. You will need your own copy of Stata, and will need to purchase it directly from the suppliers. You can place your order via the Survey Design website at [http://www.surveydesign.com.au/buygradplan.html](http://www.surveydesign.com.au/buygradplan.html). For those that haven't used Stata previously there is much introductory material on the web. A useful starting point is [http://www.stat.com/links/resources-for-learning-stata/](http://www.stat.com/links/resources-for-learning-stata/), and particularly good is [http://www.ats.ucla.edu/stat/stata](http://www.ats.ucla.edu/stat/stata). You should especially learn the use of do files, as these allow for storing a series of commands.

GradPlan Stata IC 13 with perpetual licence (consisting of CD for Windows, Mac or Linux, including PDF of manuals) = $AUD241

GradPlan Stata IC 13 - as above but with a one-year licence = $AUD125

GradPlan Stata IC 13 - as above but with a six month licence = $AUD88 (this will be sufficient time to complete the course)

These prices are for the downloadable version. A DVD can be sent for an additional $AUD61.60.
A valid Australian or NZ university e-mail address is required.

There is also a Small Stata option; however, this is limited to around 1,000 observations which will not be sufficient. Any of the other options have capabilities beyond what is needed for the course.

**Unit Schedule**

The unit timetable is based on the University of Sydney timetable, which starts a week later than Macquarie University, and has only a one week mid-semester break, at a different time.

<table>
<thead>
<tr>
<th>Module</th>
<th>Weeks</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1,2 (2 March)</td>
<td>The nature of survival data, including censoring; the survival (or survivorship) function: definition and estimation via the Kaplan-Meier curve; the stset command in Stata; Kaplan-Meier estimate of the survival (or survivorship) function: confidence intervals and hypothesis testing.</td>
</tr>
<tr>
<td>2</td>
<td>3,4 (16 March)</td>
<td>The density, survival, hazard and cumulative hazard functions; the Nelson-Aalen estimate of the cumulative hazard function; Definition of the proportional hazards model; construction of the partial likelihood for the Cox model; the treatment of tied failure times; hypothesis testing on the coefficients, using Wald and partial likelihood ratio tests.</td>
</tr>
<tr>
<td>3</td>
<td>5,6 (30 March)</td>
<td>For the Cox PH model: hypothesis testing on the coefficients, contd; estimation of the baseline functions S0(t) and H0(t), and their adjustment for covariate values; the effect of a change in scale and origin of units of measurement of covariates.</td>
</tr>
<tr>
<td>4</td>
<td>7,8 (20 April)</td>
<td>Model diagnostics for the Cox PH model; the stratified Cox model.</td>
</tr>
<tr>
<td>5</td>
<td>9,10 (4 May)</td>
<td>Time-dependent covariates in the Cox model; parametric survival time models, in particular the accelerated failure time model, with an exponential and Weibull distribution; discrete-time logistic model.</td>
</tr>
<tr>
<td>6</td>
<td>11,12 (18 May)</td>
<td>Correlated survival data; clustered survival data; recurrent events models; competing-risks models.</td>
</tr>
<tr>
<td>7</td>
<td>13 (1 June)</td>
<td>Sample size determination for comparing two response rates and two survival distributions; good practice for the display of survival analysis results in scientific publications. (Only 1 week)</td>
</tr>
</tbody>
</table>

**Policies and Procedures**

Macquarie University policies and procedures are accessible from **Policy Central**. Students should be aware of the following policies in particular with regard to Learning and Teaching:


Disruption to Studies Policy http://www.mq.edu.au/policy/docs/disruption_studies/policy.html The Disruption to Studies Policy is effective from March 3 2014 and replaces the Special Consideration Policy.

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/

**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://informatics.mq.edu.au/help/.
Graduate Capabilities

PG - Capable of Professional and Personal Judgment and Initiative

Our postgraduates will demonstrate a high standard of discernment and common sense in their professional and personal judgment. They will have the ability to make informed choices and decisions that reflect both the nature of their professional work and their personal perspectives.

This graduate capability is supported by:

Learning outcomes

- Understand the nature of survival data.
- Summarise and display survival data using nonparametric methods.
- Analyse survival data using the Cox proportional hazards model, including time-dependent covariates.
- Analyse survival data using parametric models.
- Analyse data using multi-event models.
- Determine sample size for simple survival analysis.
- Produce appropriate displays for publication.

Assessment tasks

- Exercises
- Assignment 1
- Assignment 2
- Assignment 3

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

- Understand the nature of survival data.
- Summarise and display survival data using nonparametric methods.
- Analyse survival data using the Cox proportional hazards model, including time-dependent covariates.
- Analyse survival data using parametric models.
• Analyse data using multi-event models.
• Determine sample size for simple survival analysis.
• Produce appropriate displays for publication.

**Assessment tasks**

• Exercises
• Assignment 1
• Assignment 2
• Assignment 3

**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**

• Understand the nature of survival data.
• Summarise and display survival data using nonparametric methods.
• Analyse survival data using the Cox proportional hazards model, including time-dependent covariates.
• Analyse survival data using parametric models.
• Analyse data using multi-event models.
• Determine sample size for simple survival analysis.
• Produce appropriate displays for publication.

**Assessment tasks**

• Exercises
• Assignment 1
• Assignment 2
• Assignment 3

**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.
Learning outcomes

- Understand the nature of survival data.
- Summarise and display survival data using nonparametric methods.
- Analyse survival data using the Cox proportional hazards model, including time-dependent covariates.
- Analyse survival data using parametric models.
- Analyse data using multi-event models.
- Determine sample size for simple survival analysis.
- Produce appropriate displays for publication.

Assessment tasks

- Exercises
- Assignment 1
- Assignment 2
- Assignment 3

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.

Learning outcomes

- Summarise and display survival data using nonparametric methods.
- Produce appropriate displays for publication.

Assessment tasks

- Exercises
- Assignment 1
- Assignment 2
- Assignment 3

PG - Engaged and Responsible, Active and Ethical Citizens

Our postgraduates will be ethically aware and capable of confident transformative action in relation to their professional responsibilities and the wider community. They will have a sense of connectedness with others and country and have a sense of mutual obligation. They will be able to appreciate the impact of their professional roles for social justice and inclusion related to
national and global issues

This graduate capability is supported by:

**Assessment tasks**

- Exercises
- Assignment 1
- Assignment 2
- Assignment 3

**Late Submission**

Requests for an extension of the due date for an assignment must be made in advance of the due date for that assessment. These requests must be made directly to the unit coordinator by email. The unit coordinator will reply by email with the decision as to whether an extension has been granted and the new due date.

The penalty for late submission, where permission has not been granted, is as follows: 5% (of earned mark) will be deducted for each day that an assignment is late, up to a maximum of 50%, and that the final mark for the subject cannot be reduced to a fail.

**Note:** I have made the submission dates a week after the end of the material, so there should be sufficient time to complete the assessments allowing for routine work demands etc. Extensions will only be granted for unexpected events.