STAT827
Survival Analysis
S1 External 2013

Statistics

Contents

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# General Information

<table>
<thead>
<tr>
<th>Unit convenor and teaching staff</th>
<th></th>
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<tbody>
<tr>
<td>Unit Convenor</td>
<td></td>
</tr>
<tr>
<td>Kenneth Beath</td>
<td></td>
</tr>
<tr>
<td><a href="mailto:ken.beath@mq.edu.au">ken.beath@mq.edu.au</a></td>
<td></td>
</tr>
<tr>
<td>Contact via <a href="mailto:ken.beath@mq.edu.au">ken.beath@mq.edu.au</a></td>
<td></td>
</tr>
<tr>
<td>E4A 507</td>
<td></td>
</tr>
<tr>
<td>Friday 2-4</td>
<td></td>
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<table>
<thead>
<tr>
<th>Credit points</th>
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<td>4</td>
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<table>
<thead>
<tr>
<th>Prerequisites</th>
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<tbody>
<tr>
<td>Admission to MAppStat or PGDipAppStat or PGCertAppStat</td>
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<table>
<thead>
<tr>
<th>Corequisites</th>
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<tbody>
<tr>
<td>STAT810 or (BCA808 and BCA817)</td>
<td></td>
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<table>
<thead>
<tr>
<th>Co-badged status</th>
<th></th>
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<tbody>
<tr>
<td>Unit SVA in the Biostatistics Collaboration Australia (BCA) programme.</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Unit description</th>
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<tbody>
<tr>
<td>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.</td>
<td></td>
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</tbody>
</table>

# 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:

- 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>15%</td>
<td>to be described</td>
</tr>
<tr>
<td>Assignment 1</td>
<td>27%</td>
<td>to be decided</td>
</tr>
<tr>
<td>Assignment 2</td>
<td>31%</td>
<td>to be decided</td>
</tr>
<tr>
<td>Assignment 3</td>
<td>27%</td>
<td>to be decided</td>
</tr>
</tbody>
</table>

Exercises

Due: to be described
Weighting: 15%

3 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.
• 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 1

Due: to be decided
Weighting: 27%

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 2**

**Due:** to be decided  
**Weighting:** 31%

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:** to be decided  
**Weighting:** 27%

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 in distance mode. Our means of communication will be via printed notes which will be mailed out, e-mail, and 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.

Study notes will be mailed to you, at the beginning of semester and will also be posted on the iLearn site. If you do not receive these within a few days then please contact Lesley Mooney.

We will be using iLearn for online, posting of course notes, assignments, solutions and data sets, and submission of exercises, assignments and the take-home test. The link is http://ilearn.mq.edu.au/

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 9.2) or later. The current version of Stata is 12, in which some of the code is untested, but this can be remedied by typing the command version 9.2, after which commands will execute as they would in version 9.2. 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. The software is available in the computer laboratories on Macquarie University campus. If you need your own copy of Stata, you will need to purchase it directly from the suppliers. You can place your order via the Survey Design website at http://www.survey-design.com.au. For those that haven't used Stata previously there is much introductory material on the web. A useful starting point is http://www.ats.ucla.edu/stat/stata/advanced_gradplan_intercooled_stata_12_with_perpetual_licence_consisting_of_cd_for_windows_mac_or_linux_including_pdf_of_manu...
There is also a Small Stata option; however, this is limited to around 1,000 observations which will not be sufficient.

Go to the Survey Design website listed above and go to the Grad Plan page (LH column `GradPlan' link). Above the prices is a link to an order form. Follow the instructions and you should order a GradPlan Intercooled package. On the order form you should note that you are enrolled in a BCA course (BCA students) or STAT827 (MU students), your student ID number, the university in which you are enrolled, and the operating system of the computer that you will be using. For GradPlan orders delivery is normally within a few days of payment being cleared.

**Changes from previous Offering**

Removed Take-home Test

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**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</td>
<td>(4 March) 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</td>
<td>(18 March) 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</td>
<td>(8 April) 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</td>
<td>(22 April) Model diagnostics for the Cox PH model; the stratified Cox model</td>
</tr>
<tr>
<td>5</td>
<td>9,10</td>
<td>(6 May) 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</td>
<td>(20 May) Correlated survival data; clustered survival data; recurrent events models; competing-risks models</td>
</tr>
</tbody>
</table>
Sample size determination for comparing two response rates and two survival distributions; good practice for the display of survival analysis results in scientific publications

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:

Academic Honesty Policy http://www.mq.edu.au/policy/docs/academic_honesty/policy.html


Special Consideration Policy http://www.mq.edu.au/policy/docs/special_consideration/policy.html

In addition, a number of other policies can be found in the Learning and Teaching Category of Policy Central.

Student Support

Macquarie University provides a range of Academic Student Support Services. Details of these services can be accessed at: http://students.mq.edu.au/support/

UniWISE provides:

- Online learning resources and academic skills workshops http://www.students.mq.edu.au/support/learning_skills/
- Personal assistance with your learning & study related questions.
- The Learning Help Desk is located in the Library foyer (level 2).
- Online and on-campus orientation events run by Mentors@Macquarie.

Student Enquiry Service

Details of these services can be accessed at http://www.student.mq.edu.au/SES/.

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

If you wish to receive IT help, we would be glad to assist you at http://informatics.mq.edu.au/help/.

When using the university’s IT, you must adhere to the Acceptable Use Policy. The policy applies...
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

- 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.

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 - 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:

**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

**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.
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**Assessment tasks**

• Exercises
• Assignment 1
• Assignment 2
• Assignment 3