Study Guide

Survival Analysis (SVA)

Semester 1, 2019

Prepared by:

Dr. Ken Beath
Department of Statistics,
Faculty of Science and Engineering
Macquarie University

Contents

Survival Analysis (SVA)

Semester 1, 2018

Instructor contact details

Dr Ken Beath

Room 634
12 Wally's Walk
Department of Statistics
Macquarie University
phone: (02) 9850 8516

e-mail: ken.beath@mq.edu.au

Background

SVA is one of the final subjects in the BCA program. Its focus is on the analysis of survival or time to event data, which is important for analysis in many areas of medicine. Major features of this data are that the observations are often not fully observed and their distribution is not easily described by a parametric model.

Unit summary

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.

Workload requirements

The expected workload for this unit is 10-12 hours per week on average, consisting of guided readings, discussion posts, independent study and completion of assessment tasks.

Prerequisites

Epidemiology (EPI), Mathematical Background for Biostatistics (MBB), Probability and Distribution Theory (PDT), Principles of Statistical Inference (PSI), Linear Models (LMR).

Co-requisites

None.

Learning Outcomes

At the completion of this unit students should be able to:

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

Unit content

The unit is divided into 7 modules, summarised in more detail below. Each module will involve 2 weeks of study, except for Module 7 which is only 1 week) and generally includes the following material:

1. Module notes describing concepts and methods, and possibly including some exercises of a more “theoretical” nature.
2. Selected readings from published articles or textbooks.
3. One or more extended examples illustrating the concepts/methods introduced in the notes and including more practically oriented exercises.

Study materials for all Modules are downloadable from the eLearning unit site. Assignments and supplementary material, such as datasets will be posted to the unit site. Please note that we are not able to post copies of copyright material (journal articles and book extracts)—for these you will have to rely on the hard copy mail-out or resources from your home university’s library.

Recommended approaches to study

Students should work through each module systematically, following the module notes and any readings referred to, and working through the accompanying exercises. *You will learn a lot more efficiently if you tackle the exercises systematically as you work through the notes.* You are encouraged to post any content-related questions to eLearning, whether they relate directly to a given exercise, or are a request for clarification or further explanation of an area in the notes. You should also work through all of the computational examples in the notes for yourself on your own computer.

Outline solutions to the exercises in each module (except those to be submitted for assessment, as described below) will be posted online at the midway point of the allocated time period for the module. This is intended to encourage you to attack the exercises independently (or via the eLearning site), and yet not make you wait too long to see the sketch solutions.

Method of communication with coordinator(s)

Questions about administrative aspects or course content can be emailed to the coordinator, and when doing so please use "SVA:" in the Subject line of your email to assist in keeping track of our email messages. Coordinator/s will be available to answer questions related to the module notes and practical exercises, and to address any other issues that require clarification. However, please note that instructors are not necessarily available every day of the week and you should expect that it may take a day or so to respond to questions (possibly longer over weekends and during breaks!).

We strongly recommend that you post content-related questions to the Discussions tool in the (BCA code) area of BCA's eLearning site. In 2018 we are using the Learning Management system hosted by the University of Sydney. You may be familiar with the system from previous BCA units, and will receive any specific instructions on using the eLearning site this semester from the BCA Coordinating Office. There is also a "Getting Started" document available on the Student Resources page of the BCA website.

Module descriptions

Below is an outline of the study modules, followed by a timetable and assessment description table

Each module is scheduled to begin on a Monday and conclude on the Sunday of the following week. **The due date for submission of the assignments is as shown in the table.**

Module 1:
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.

Module 2:
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.

Module 3:
For the Cox PH model: hypothesis testing on the coefficients, continued; estimation of the baseline functions $S_0(t)$ and $H_0(t)$, and their adjustment for covariate values; the effect of a change in scale and origin of units of measurement of covariates.

Module 4:
Model diagnostics for the Cox PH model; the stratified Cox model.

Module 5:
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.

Module 6:
Correlated survival data; clustered survival data; recurrent events models.

Module 7:
Sample size determination for comparing two response rates and two survival distributions; good practice for the display of survival analysis results in scientific publications.

Unit schedule

Semester 1, 2018 starts on Monday 26 Feb

Week	Week commencing	Module	Topic	Assessment
1	4 Mar	Module 1		Assignment 1 available
2	11 Mar	Module 1 (cont)		
3	18 Mar	Module 2		
4	25 Mar	Module 2 (cont)		
5	1 Apr	Module 3		Assignment 1 due Monday 1 April and Assignment 2 available
6	8 Apr	Module 3 (cont)		
7	15 Apr	Module 4		
	22 Apr		Mid semester break	
8	29 Apr	Module 4 (cont)		
9	6 May	Module 5		Assignment 2 due Monday 6 May and Assignment 3 available
10	13 May	Module 5 (cont)		
11	20 May	Module 6		
12	27 May	Module 6 (cont)		
13	3 Jun	Module 7		Assignment 3 due Monday 3 Jun

Assessment

Assessment will be 3 written assignments worth 30%, 40% and 30% each, to be made available after the first week of the modules to be covered, and to be completed

within approximately 4 weeks. These assignments will be posted on the eLearning site together with an online Announcement broadcasting their availability. Note that I have given one week beyond the end of the material to complete Assignments 1 and 2, so there should be no reason for extensions other than for unexpected events.

Assessment name	Assessment type	Coverage	Learning objectives	Weight
Assignment 1	Assignment	Modules 1-2	1,2,3	30%
Assignment 2	Assignment	Modules 3-4	1,2,3	40%
Assignment 3	Assignment	Modules 5-7	3,5,7	30%

In general you are required to submit your work typed in Word or similar (e.g. using Microsoft's Equation Editor for algebraic work) and we strongly recommend that you become familiar with equation typesetting software such as this. If extensive algebraic work is involved you may submit neatly handwritten work, however please note that marks will potentially be lost if the solution cannot be understood by the markers due to unclear or illegible writing. This handwritten work should be scanned and collated into a single pdf file and submitted via the eLearning site. See the BCA Assessment Guide document for specific guidelines on acceptable standards for assessable work.

The instructors will generally avoid answering questions relating directly to the assessable material until after it has been submitted, but we encourage students to discuss the relevant parts of the notes among themselves, via eLearning. However **explicit solutions to assessable exercises should not be posted for others to use**, and each student's submitted work must be clearly their own, with anything derived from other students' discussion contributions clearly attributed to the source.

Submission of assessments and academic honesty policy

You should submit all your assessment material via eLearning unless otherwise advised. The use of Turnitin for submitting assessment items has been instigated within unit sites. For more detail please see pages 3-5 the BCA Student Assessment Guide.

The BCA pays great attention to academic honesty procedures. Please be sure to familiarise yourself with these procedures and policies at your university of enrolment. Links to these are available in the BCA Student Assessment Guide. When submitting assessments using Turnitin you will need to indicate your compliance with the plagiarism guidelines and policy at your university of enrolment before making the submission.

Late submission of assessments and extension procedure

We adhere to standard BCA policy for late penalties for submitted work, i.e. a 5% deduction from the earned mark for each day the assessment is late, up to a maximum of 50%. After 10 days the assessed mark will be reduced to 0%. Extensions are possible, but these need to be applied for (by email) as early as possible. The Unit

Coordinator is not able to approve extensions beyond three days; for extensions beyond three days you need to apply to your home university, using their standard procedures.

Learning resources

Compulsory Text:
Hosmer DW, Lemeshow S and May S (2008). Applied Survival Analysis, John Wiley and Sons, Second Edition.

Recommended Text:
Cleves MA, Gould WW, Gutierrez RG and Marchenko Y (2010). An Introduction to Survival Analysis using Stata, Third Edition, Stata Press.

Other useful texts are:
Klein JP and Moeschberger ML (2003). Survival analysis : techniques for censored and truncated data, Springer.

Kleinbaum DG (2012). Survival analysis: a self-learning text, Springer-Verlag.

Moore, DF (2010). Applied Survival Analysis using R, Springer. (for those using R)

Therneau, TM and Grambsch, PM (2001). Modeling Survival Data: Extending the Cox Model, Springer. (more advanced treatment with code for SAS and R)

Software

It is expected that you will be using Stata 13-15, the latest of which was released in June 2017. We are not aware of any major differences between Stata versions that affect the material, but minor issues will be pointed out in Blackboard postings. Importantly, whichever version you are using, please ensure that you have performed the online update to the latest update of that version. (Use the command update query.)

Feedback

Our feedback to you:

The types of feedback you can expect to receive in this unit are:

- Formal individual feedback on submitted assignments
- Responses to questions posted on Blackboard

Your feedback to us:

One of the formal ways students have to provide feedback on teaching and their learning experience is through the BCA student evaluations at the end of each unit. The feedback is anonymous and provides the BCA with evidence of aspects that students are satisfied with and areas for improvement.

Required mathematical background

Simple differentiation and integration.

Changes to SVA since last delivery, including changes in response to student evaluation

SVA was last delivered in Semester 1 2018. Added appendix to Module 4 describing all the steps required for an analysis.