UAB
Universitat Autònoma de Barcelona

Survival Analysis

Code: 104867
ECTS Credits: 6

2024/2025

Degree	Type	Year
2503852 Applied Statistics	OB	2

Contact

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Teachers

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Teaching groups languages

You can view this information at the end of this document.

Prerequisites

You should be familiar with:

- Descriptive statistics
- Probability
- Statistical inference

In addition, it is recommended that you are currently taking or have completed the course Models Linears 1 and have a basic knowledge of R.

Objectives and Contextualisation

This course introduces the basic concepts for the analysis of survival random variables (or "time-to-event" random variables) will be introduced: survival functions, hazard and cumulative hazard functions, concepts of censoring and truncation, likelihood and log-likelihood functions for censored data, non-parametric estimators of Kaplan-Meier (survival function) and Nelson-Aalen (cumulative hazard function), an introduction to parametric regression models PH and AFT with special interest in exponential and Weibull regression models, and an introduction to the semi-parametric Cox proportional hazards model. Finally, if there is enough time, some more advanced topics in survival analysis will be introduced. Applications will be mainly in the field of health sciences, but there may be examples from other fields such as economics or reliability.

Learning Outcomes

1. CM12 (Competence) Assess the existence of inequalities on the grounds of gender in databases, to avoid bias in automatic (algorithmic) decision-making.

Content

1. Introduction to survival analysis

- Survival data: Concepts of censoring and truncation, definition of the concepts of study time and patient time, examples, etc.
- Survival function, hazard function, and cumulative hazard function. Mean residual life.
- Classical distributions of survival random variables: Exponential, Weibull, Gompertz, log-logistic, log-normal, etc.

2. Likelihood and log-likelihood functions for survival data

- The Random censoring model and the concept of non-informative censoring.
- Construction of the likelihood and log-likelihood functions under different scenarios of censoring and/or truncation in survival data.

3. Non-parametric inference for right-censored survival data

- Estimation of the survival function (Kaplan-Meier) and the cumulative hazard function (Nelson-Aalen).
- Confidence intervals for survival and hazard functions: Greenwood's formula and log and log-log transformations.
- Point estimates and confidence intervals for the median survival time and other percentiles.
- Comparison of two survival curves: Log-Rank and Wilcoxon tests.

4. Parametric models for survival time: PH and AFT models

- Proportional hazards (PH) models: The exponential regression model.
- Accelerated failure time (AFT) models: The Weibull regression model.

5. The semi-parametric Cox proportional hazards model

- General description of the model.
- Estimation of the Cox regression model: Concept of partial likelihood.
- Confidence intervals, hypothesis testing, and comparison of alternative models.
- Interpretation of parameter estimates in the model.
- Goodness-of-fit techniques in the Cox regression model.

6. Advanced Topics in Survival Analysis

- Extensions of the Cox model.
- Introduction to the Frailty models.

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Problem resolution	14	0.56	
Theory	21	0.84	

Type: Supervised		
Practices	20	0.8
Type: Autonomous		
Complete each practice	30	1.2
More concepts	30	1.2
Problems solutions	10	0.4

Independent learning:

1. EXTENSION OF CONCEPTS: Some parts of the course will need to be completed through personal work using the recommended bibliography (available as an online resource in the library).
2. REALISATION OF HANDS-ON WORK: This will be used to apply the concepts learned as well as to learn implementation with R software.
3. LISTS OF EXERCISES: As a general rule, solutions to problem sets will NOT be posted. Students can propose to the professor in the practice sessions to correct those problem exercises they have not been able to solve individually. Students are expected to have sufficient autonomy to solve the problem sets and to consult the professor in case of doubts or difficulties.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Assessment

Continous Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Hands-on deliverables	30%	20	0.8	
Primer examen (E1)	35%	2.5	0.1	CM12
Second exam (E2)	35%	2.5	0.1	CM12

Continuous evaluation

The continuous evaluation of the course will consist of a first exam in the middle of the course (E1, 35%), a second exam at the end of the course (E2, 35%), and the practical work (P, 30%, not recoverable). In particular, the evaluation of the practical work will consist of a set of problems similar to those solved in class to be graded (P10, 10%) and a final project (P20, 20%). While the set of problems to be graded will be handed out individually, the final project can be done in pairs. Late submission without a valid reason for both the problems and the final project will result in a penalty on that assignment. In addition, plagiarism or copying of practical work will automatically result in a mark of 0 for that assignment. Therefore, the final grade (F) will be calculated as follows:

$F=E1\times0.35+E2\times0.35+P10\times0.1+P20\times0.2$

If a student does not obtain a grade of 5 in the final course qualification, to pass the course, he/she will have to take the resit exam (R), where he/she will be able to retake exams E1 and E2, but not the practical work (P10 and P20). For those students who take the resit exam, the final grade of the course will be:

F=min(R×0.7+P10×0.1+P20×0.2,5)

It is not possible to improve the final grade of the course by taking the resit exam.

Single evaluation:

Students who have chosen the single assessment mode will have to take a final examination consisting of theoretical questions and problems (E). In addition, they will also have to submit the results of a set of exercises and problems (which will not be the same as those submitted in the continuous evaluation but will cover similar content) (P10) and the final project (P20). This examination will be held on the sameday, time, and place as the second exam of the continuous evaluation (E2). The weight of the exam (E) will be 70%, and the evaluation of the practical work of the course will be 30% (not recoverable), where 10% will be a set of problems (P10) and 20% will be the final project (P20). Those who do not attend this exam without justified cause will receive a grade of NOT ASSESSED. Therefore, the final grade (F) will be:

F=E×0.7+P10×0.1+P20×0.2

If a student does not obtain a grade of 5 in the final course qualification (F), to pass the course, he/she will have to take the resit exam (R), where he/she will be able to retake exams E1 and E2, but not the practical work (P10 and P20). For those students who take the resit exam, the final grade of the course will be:

F=min(R×0.7+P10×0.1+P20×0.2,5)

The resit exam will be held on the same day, time, and place as the resit exam for the rest of the students in the course. It is not possible to improve the qualification of the course by taking the resit exam.

Bibliography

- Collett, D. (2015). Modelling Survival Data in Medical Research, 3rd Edition. Chapman & Hall. https://bibcercador.uab.cat/permalink/34CSUC_UAB/1eqfv2p/alma991010839836806709
- Hosmer, D., Lemeshow, S. and May, S. (2008). Applied Survival Analysis: Regression Modeling of Time-to-Event Data, 2nd Edition. Wiley. https://bibcercador.uab.cat/permalink/34CSUC_UAB/1eqfv2p/alma991001026469706709
- Klein, J. and Moeschberger, M. (2003). Survival Analysis: Techniques for Censored and Truncated Data, 2nd Editon. Springer. https://bibcercador.uab.cat/permalink/34CSUC_UAB/1c3utr0/cdi_proquest_miscellaneous_367341
- Kleinbaum, D. (2012). Survival Analysis: A Self-Learning Text, 3rd Edition. Springer Science. https://bibcercador.uab.cat/permalink/34CSUC_UAB/1eqfv2p/alma991010402570806709

Software

We will carry R lab sessions

Language list

Name	Group	Language	Semester	Turn

(PLAB) Practical laboratories	1	Catalan/Spanish	second semester	afternoon
(TE) Theory	1	Catalan/Spanish	second semester	afternoon