

Degree programme	Type	Course
Applied Statistics	OB	2

Contact lecturer

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Prerequisites

You are expected to be familiar with:

- Descriptive statistics
- Probability
- Statistical inference

In addition, it is recommended that you are currently enrolled in or have already completed the course Models Lineals 1, and that you have basic knowledge of R.

Objectives

This course introduces the fundamental concepts for the analysis of survival random variables (also known as "time-to-event" variables), including: survival functions, hazard and cumulative hazard functions, concepts of censoring and truncation, likelihood and log-likelihood functions for different types of censored data (right, left, interval) as well as for truncated data. The course covers non-parametric estimators such as the Kaplan-Meier estimator (for the survival function), the Nelson-Aalen estimator (for the cumulative hazard function) and the log-rank test. Additionally, the course provides an introduction to parametric regression models for survival analysis, focusing on proportional hazards (PH) and accelerated failure time (AFT) models, with special emphasis on exponential and Weibull regression models. An introduction to the semi-parametric Cox proportional hazards model is also included. If time permits, more advanced topics in survival analysis will be covered. Although applications will mainly focus on the field of health sciences, examples from other areas such as economics or reliability may also be discussed.

Learning outcomes

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

Contents

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.

Learning activities and methodology

Title	Hours	ECTS	Learning outcomes
Resolution of theory-based problems	25	1	
Resolution of certain laboratory problems and exercises during face-to-face sessions	14	0.56	
Complete all laboratory practice tasks independently	36	1.44	
Lecture sessions	24	0.96	
Self-directed learning to deepen understanding of lecture topics	30	1.2	
Resolution of laboratory problems in class	10	0.4	

Independent learning:

1. **EXTENSION OF CONCEPTS:** Some parts of the course will require independent work using the recommended bibliography, which is available as an online resource through the library.
2. **REALISATION OF HANDS-ON WORK:** Laboratory activities will be carried out to apply the concepts covered in the course and to gain experience with the R software for data analysis and model implementation.
3. **LISTS OF THEORY-RELATED PROBLEMS:** As a general rule, solutions to the problem sets will not be posted on the Moodle course page. Students are encouraged to suggest exercises during the practice sessions for correction, particularly those they have been unable to solve individually. It is expected that

students approach the problem sets autonomously and consult the professor in case of questions 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

Continuous assessment activities

Title	Weight	Hours	ECTS	Learning outcomes
Primer examen (E1)	25%	2	0.08	CM12
Hands-on deliverables (P)	20%	4	0.16	CM12
R practical exam	20%	2	0.08	CM12
Second exam (E2)	35%	3	0.12	CM12

See version in Catalan

Bibliography

- Collett, D. (2015). Modelling Survival Data in Medical Research, 3rd Edition. Chapman & Hall.
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- Hosmer, D., Lemeshow, S. and May, S. (2008). Applied Survival Analysis: Regression Modeling of Time-to-Event Data, 2nd Edition. Wiley.
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- Klein, J. and Moeschberger, M. (2003). Survival Analysis: Techniques for Censored and Truncated Data, 2nd Edition. Springer.
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- Kleinbaum, D. (2012). Survival Analysis: A Self-Learning Text, 3rd Edition. Springer Science.
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- Lee, E.T. and Wang, J.W. (2003). Statistical Methods for Survival Data Analysis, John Wiley & Sons, Inc.
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Software

We will carry R lab sessions

Course groups and languages

The information provided is provisional until November 30. After this date, you will be able to consult the language of each group through this [link](#). To access the information, you will need to enter the course CODE

Type of teaching	Group	Language	Semester	Shift
(TE) Theory	1	Catalan/Spanish	second semester	afternoon
(PLAB) Practical laboratories	1	Catalan/Spanish	second semester	afternoon