

Time Series

Code: 104863
ECTS Credits: 6

Degree	Type	Year	Semester
2503852 Applied Statistics	OB	3	1

Contact

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Use of Languages

Principal working language: spanish (spa)
Some groups entirely in English: No
Some groups entirely in Catalan: No
Some groups entirely in Spanish: No

Other comments on languages

Class material (slides and practical exercises) will be in english and/or spanish

Teachers

Anna López Ratera

Prerequisites

It is advisable to have knowledge on Probability, Statistical Inference and Linear models

Objectives and Contextualisation

This course is devoted to introduce the student to the study of time series models and its applications. A time series is a collection of observations of a random phenomenon evolving over time (or any other ordered magnitude).

Time series appear in almost all fields of application. Hence, its analysis and the modelling of the underlying random phenomenon is of crucial theoretical and applied importance.

The ultimate goal is the modelling of the mechanism that generates the data, perform model diagnostics and predict future values.

Competences

- Analyse data using statistical methods and techniques, working with data of different types.
- Correctly use a wide range of statistical software and programming languages, choosing the best one for each analysis, and adapting it to new necessities.
- Critically and rigorously assess one's own work as well as that of others.
- Design a statistical or operational research study to solve a real problem.
- Formulate statistical hypotheses and develop strategies to confirm or refute them.
- Make efficient use of the literature and digital resources to obtain information.
- Select and apply the most suitable procedures for statistical modelling and analysis of complex data.

- Select statistical models or techniques for application in studies and real-world problems, and know the tools for validating them.
- Students must be capable of applying their knowledge to their work or vocation in a professional way and they should have building arguments and problem resolution skills within their area of study.
- Students must be capable of collecting and interpreting relevant data (usually within their area of study) in order to make statements that reflect social, scientific or ethical relevant issues.
- Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.
- Summarise and discover behaviour patterns in data exploration.
- Use quality criteria to critically assess the work done.

Learning Outcomes

1. Analyse data through inference techniques using statistical software.
2. Analyse data using models of time series.
3. Analyse the residuals of a statistical model.
4. Critically assess the work done on the basis of quality criteria.
5. Establish the experimental hypotheses of modelling.
6. Identify response distributions with the analysis of residuals.
7. Identify the stages in problems of modelling.
8. Identify the statistical assumptions associated with each advanced procedure.
9. Make effective use of references and electronic resources to obtain information.
10. Make slight modifications to existing software if required by the statistical model proposed.
11. Measure the degree of fit of a statistical model.
12. Reappraise one's own ideas and those of others through rigorous, critical reflection.
13. Recognise the need to use models for non-independent errors.
14. Students must be capable of applying their knowledge to their work or vocation in a professional way and they should have building arguments and problem resolution skills within their area of study.
15. Students must be capable of collecting and interpreting relevant data (usually within their area of study) in order to make statements that reflect social, scientific or ethical relevant issues.
16. Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.
17. Use graphics to display the fit and applicability of the model.
18. Use statistical inference as an instrument of prognosis and prediction in time series.
19. Use summary graphs for multivariate data and temporal evolution data.
20. Validate the models used through suitable inference techniques.

Content

1. Introduction. Classical analysis of time series models. Trend and seasonality. Regression Models, Regression with AR(1) errors. Durbin Watson test.
 2. Stationary Processes. On the concept of stationarity Examples. Simulation of time series.
 3. ARIMA Models I. MA(q) and AR(p). Correlograms. Yule-Walker equations. The difference operator. Relationship between MA and AR models ACF and PACF.
 4. ARIMA Models II. ARMA(p,q). Parameter estimation: method of moments, MLE, unconditional least squares, conditional least squares. ARIMA(p,d,q) and SARIMA. Box-Jenkins methodology. Prediction.
 5. Diagnostic checking and Forecasting. AIC and BIC criteria. Analysis of residuals. Confidence intervals for predictions.
 6. Models for non-stationary series: ARCH/GARCH, ARMA with covariates.
- Methodology

Methodology

During the theoretical lessons (2 H/week) the fundamental results will be presented, and computer exercises will be developed.

During the lab hours (with laptop) students will solve by themselves real data problems. The programming language used is R.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Practical sessions	26	1.04	2, 1, 3, 12, 4, 5, 19, 17, 6, 7, 8, 11, 10, 16, 14, 15, 13, 18, 20
Theoretical sessions	26	1.04	2, 1, 3, 5, 19, 17, 6, 7, 8, 11, 14, 15, 13, 9, 18, 20
Type: Autonomous			
Personal work	60	2.4	2, 1, 3, 12, 4, 5, 19, 17, 6, 7, 8, 11, 10, 16, 14, 15, 13, 9, 18, 20
Real data analysis	25	1	2, 1, 3, 12, 4, 5, 19, 17, 6, 7, 8, 11, 10, 16, 14, 15, 13, 9, 18, 20

Assessment

During the course, students must handle computer labs. There will 2 partial exams, with both theoretical and practical questions.

In order to pass the course, a minimum of 3/10 in both practice and theory is required, and an average over 5/10

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Exam	0,4	3	0.12	2, 1, 3, 5, 6, 7, 8, 11, 16, 13, 18, 20
Homework (problems & computer excercises)	0,4	8	0.32	2, 1, 3, 12, 4, 5, 19, 17, 6, 7, 8, 11, 10, 16, 14, 15, 13, 9, 18, 20
Partial 1	0,2	2	0.08	2, 1, 3, 5, 6, 7, 8, 11, 16, 13, 18, 20

Bibliography

P.J. Brockwell and R.A. Davis: *Introduction to Time Series and Forecasting*. 2nd edit. Springer. 2002.

J.D. Cryer and K.S. Chan: *Time Series Analysis with Applications to R*. 2nd. edit. Springer. 2008

R.D. Peña. *Anàlisis de series temporales*. Alianza Editorial. 2005.

R.H. Shumway, and D.S. Stoffer: *Time Series Analysis and its Applications*. 3rd. edit. Springer. 2011.

R. Tsay *Analysis of Financial Time Series*, 3rd Edition, Wiley 2010