Universitat Autònoma de Barcelona

2021/2022

Time Series

Code: 104863
ECTS Credits: 6

Degree	Type	Year	Semester
2503852 Applied Statistics	OB	3	1

The proposed teaching and assessment methodology that appear in the guide may be subject to changes as a result of the restrictions to face-to-face class attendance imposed by the health authorities.

Contact

Name: Alejandra Cabaña Nigro
Email: AnaAlejandra.Cabana@uab.cat

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 matrial (slides and practical excercises) 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.
2. Stationary Processes. On the concept of stationarity Examples. Simulation.
3. Linear models. MA(q) and AR(p). Correlograms.Yule-Walker equations. The difference operator. Relationship between MA snd AR models ACF and PACF.
4. ARIMA Models. ARMA(p,q). Parameter estimation: method of moments, MLE, unconditional least squares, conditional least squares. ARIMA(p,d,q) and SARIMA. Box-Jenkins methodology. Segmentation.

5. Diagnostic checking and Forecasting. AIC and BIC criteira. Analysis of residuals. Confidence intervals for predictions.
6. Models for non-stationary series: ARCH/GARCH, ARMA with covariates.

7. Count Time Series, INGARCH models.

Unless the requirements enforced by the health authorities demand a prioritization or reduction of these contents.

Methodology

During the theoretical lessons (2 H/week) the fundamental results will be presented, and computer excercises will be developed.
During the lab hours (with laptop) students will solve by themselves real data problems. The programing language used is R.

The proposed teaching methodology may experience some modifications depending on the restrictions to face-to-face activities enforced by health authorities

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.

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 prectice and theory is required.

Student's assessment may experience some modifications depending on the restrictions to face-to-face activities enforced by health authorities

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Exam	0,3	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	0,3	2	0.08	2, 1, 3, 5, 6, 7, 8, 11, 16, 13, 18, 20

Bibliography

Bisegard, *Time Series Analysis and Forecasting By Example*, https://onlinelibrary-wiley-com.are.uab.cat/doi/pdf/10.1002/9781118056943

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

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J.D. Cryer and K.S. Chan: *Time Series Analysis with Applications to R*. 2nd. edit. Springer. 2008.
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R.D. Peña. *A course in time series analysis*.

https://onlinelibrary-wiley-com.are.uab.cat/doi/book/10.1002/9781118032978

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

https://cataleg.uab.cat/iii/encore/record/C__Rb1784344__Sa%3A%28shumway%29%20t%3A%28time%20series

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

Chan, N.H., *Time Series: Applications to Finance with R and S- Plus(R)* ,https://onlinelibrary-wiley-com.are.uab.cat/doi/pdf/10.1002/9781118032466

Software

R Core Team (2021). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

We shall use several R libraries, including forecast, TSA, TSeries, quantmod, fgarch, tscount.