Universitat Autònoma de Barcelona

2023/2024

Time Series

Code: 104863
ECTS Credits: 6

Degree	Type	Year	Semester
2503852 Applied Statistics	OB	3	1

Errata

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Teaching groups languages

You can check it through this link. To consult the language you will need to enter the CODE of the subject.
Please note that this information is provisional until 30 November 2023.

Teachers

Anna Lopez Ratera

Prerequisites

It is advisable to have knowledge on probability, statistical inference and linear models.

Objectives and Contextualisation

This course aims to introduce students to time series models and their applications. A time series is a set of observations of a random phenomenon evolving over time (or any other ordered magnitude). Time series appear in many fields of application. Therefore, their analysis and the modelling of the underlying random phenomena are of crucial theoretical and applied importance. The ultimate goal is the modelling of the mechanism that generates the data, performing model diagnostics, and predicting 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. The autocorrelation and partial autocorrelation functions.
4. ARIMA Models. The ARMA(p,q) model. Parameter estimation: method of moments, MLE, unconditional and conditional least squares. The ARIMA(p,d,q) and SARIMA models. The Box-Jenkins method. Segmentation.
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.
7. Count Time Series: The INAR models.

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 real data problems. The programing language used is R.

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

Assessment

The subject will be assessed with assignments (exercise assignments, problem checks and/or practicals) and 2 exams. To obtain the weighted grade of continuous assessment you must have a minimum of 3/10 in each of the parts.
Students who have opted for the single assessment modality will have to complete an assessment that will consist of a theory exam, a problem test and the delivery of the first and last practical reports of the course. Assessment of submissions may require an assessment interview with the teacher. The student's grade will be the weighted average of the three previous activities, where the exam will account for 45% of the grade, the test 45% and the assignments 10%.
If the final grade does not reach 5/10, the student has another opportunity to pass the subject through the remedial exam that will be held on the date set by the degree coordinator. In this test you can recover 70% of the grade corresponding to the theory and the problems. The part of internships is not refundable.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Final Exam	0,4	3	0.12	1, 2, 3, 5, 6, 7, 8, 11, 13, 16, 18, 20
Homework (exercises and computer activities)	0,3	8	0.32	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20

Mid-term exam	0,3	2	0.08	1, 2, 3, 5, 6, 7, 8, 11, 13, 16, 18, 20

Bibliography

1. Bisegard, S. (2011). *Time Series Analysis and Forecasting By Example. John Wiley & Sons, Inc., Hoboken, New Jersey.* https://onlinelibrary-wiley-com.are.uab.cat/doi/pdf/10.1002/9781118056943
2. Brockwell, P.J. and Davis, R.A. (2002). *Introduction to Time Series and Forecasting*. 2nd edit. Springer. https://cataleg.uab.cat/iii/encore/record/C__Rb1671241__Sa%3A%28Brockwell%29%20t%3A%28time%2
3. Cryer, J.D. and Chan, K.S. (2008). *Time Series Analysis with Applications to R*. 2nd. edit. Springer. https://cataleg.uab.cat/iii/encore/record/C__Rb2027637__Sa%3A%28Cryer%29%20t%3A%28time%20ser
4. Peña, R.D. *A course in time series analysis*. https://onlinelibrary-wiley-com.are.uab.cat/doi/book/10.1002/9781118032978
5. Peña, D., Tiao, G.C., and Tsay, R.S. (2001). A Course in Time Series Analysis. John Wiley & Sons, Inc. https://onlinelibrary-wiley-com.are.uab.cat/doi/book/10.1002/9781118032978
6. Shumway, R.H. and Stoffer, D.S. (2011) *Time Series Analysis and its Applications.* 3rd. edit. Springer. https://cataleg.uab.cat/iii/encore/record/C__Rb1784344__Sa%3A%28shumway%29%20t%3A%28time%2
7. Tsay., R.S. (2010). *Analysis of Financial Time Series*, 3rd Edition, Wiley.

Software

R Core Team. 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.