Universitat Autònoma de Barcelona

2023/2024

Temporal Data Analysis

Code: 104413
ECTS Credits: 6

Degree	Type	Year	Semester
2503740 Computational Mathematics and Data Analytics	OT	4	1

Contact

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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

- Calculate and reproduce certain mathematical routines and processes with ease.
- Design, develop, maintain and evaluate software systems that allow large volumes of heterogeneous data to be represented, stored and handled in accordance with the established requirements.
- Formulate hypotheses and think up strategies to confirm or refute them.
- Make effective use of bibliographical resources and electronic resources to obtain information.
- Relate new mathematical objects with other known objects and deduce their properties.
- 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.
- Students must develop the necessary learning skills to undertake further training with a high degree of autonomy.
- Using criteria of quality, critically evaluate the work carried out.
- Work cooperatively in a multidisciplinary context assuming and respecting the role of the different members of the team.

Learning Outcomes

1. Analyse data using the time-series model.
2. Critically analyse distinct models of temporary series.
3. Draft the technical report based on a statistical analysis.
4. Extract relevant conclusions from applied problems through the application of statistical methods.
5. Extract relevant conclusions from applied problems, through the application of advanced statistical methods.
6. Identify the most appropriate modeling for a chronological series.
7. Identify the special methodological characteristics of statistical analysis according to the distinct areas of application.
8. Identify the statistical assumptions associated with each advanced procedure.
9. Identify, use and interpret the criteria for evaluating degree of fulfillment of the requirements needed to apply each advanced statistical procedure.
10. Interpret results with advanced methodologies, and extract conclusions.
11. Make effective use of bibliographical resources and electronic resources to obtain information.
12. Plan studies based on time series for real cases.
13. Recognize the advantages and disadvantages of distinct statistical methodologies when applied to the various disciplines.
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. Students must develop the necessary learning skills to undertake further training with a high degree of autonomy.
18. Understand statistical software for programming functions and advanced procedures.
19. Use statistical software for the study of temporary series.
20. Use temporary-evolution data-summary graphs.
21. Using criteria of quality, critically evaluate the work carried out.
22. Work cooperatively in a multidisciplinary context, taking on and respecting the role of the distinct members in the team.

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.

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 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	24	0.96	
Theoretical sessions	26	1.04	
Type: Autonomous			
Personal work	62	2.48	
Real data analysis	25	1	

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	2, 1, 18, 5, 4, 6, 8, 9, 10, 12, 14, 20
Homework (exercises and computer activities)	0,3	8	0.32	2, 1, 21, 18, 5, 4, 6, 7, 8, 9, 10, 12, 17, 16, 14, 15, 3, 22, 11, 20, 19
Mid-term exam	0,3	2	0.08	2, 1, 18, 5, 6, 7, 8, 9, 10, 13, 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 (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.