Universitat Autònoma de Barcelona

2021/2022

Temporal Data Analysis

Code: 104413
ECTS Credits: 6

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

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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

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 random mechanism that generates the data, perform model diagnostics and predict 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 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	
Theoretical sessions	26	1.04	
Type: Autonomous			
Personal work	60	2.4	
Real data analysis	25	1	

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, 18, 5, 4, 6, 8, 9, 10, 12, 14, 20

Homework (problems & computer excercises)	0,4	8	0.32	2, 1, 21, 18, 5, 4, 6, 7, 8, 9, 10, 12, 17, 16, 14, 15, 3, 22, 11, 20, 19
Partial 1	0,3	2	0.08	2, 1, 18, 5, 6, 7, 8, 9, 10, 13, 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. https://cataleg.uab.cat/iii/encore/record/C__Rb2027637__Sa%3A%28Cryer%29%20t%3A%28time%20series%29

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.