Universitat Autònoma de Barcelona

2021/2022

Time series

Code: 100124
ECTS Credits: 6

Degree	Type	Year	Semester
2500149 Mathematics	OT	4	0

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

Other comments on languages

Class metrial (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

- Actively demonstrate high concern for quality when defending or presenting the conclusions of ones work.
- Develop critical thinking and reasoning and know how to communicate it effectively, both in ones own languages and in a third language.
- Effectively use bibliographies and electronic resources to obtain information.
- Formulate hypotheses and devise strategies to confirm or reject 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.
- Students must develop the necessary learning skills to undertake further training with a high degree of autonomy.
- Students must have and understand knowledge of an area of study built on the basis of general secondary education, and while it relies on some advanced textbooks it also includes some aspects coming from the forefront of its field of study.
- Take sex- or gender-based inequalities into consideration when operating within one's own area of knowledge.
- Use computer applications for statistical analysis, numeric and symbolic calculus, graphic display, optimisation or other purposes to experiment with Mathematics and solve problems.
- When faced with real situations of a medium level of complexity, request and analyse relevant data and information, propose and validate models using the adequate mathematical tools in order to draw final conclusions

Learning Outcomes

1. Actively demonstrate high concern for quality when defending or presenting the conclusions of ones work.
2. Characterise homogenous groups of individuals by means of multivariate analysis.
3. Data analysis.
4. Design, program and implant statistical packages.
5. Determine the size of the sample and establish a sampling strategy for comparison of means studies.
6. Determine the size of the sample and establish a sampling strategy for proportion comparison studies.
7. Determine the size of the sample and establish a sampling strategy for special comparisons.
8. Develop critical thinking and reasoning and know how to communicate it effectively, both in ones own languages and in a third language.
9. Devise a study on the basis of multivariate and/or data mining methodologies to solve a problem that is contextualised in the experimental reality.
10. Devise predictions and scenarios.
11. Effectively use bibliographies and electronic resources to obtain information.
12. Filter and store information on digital supports.
13. Have the capacity to devise and construct models and validate the same.
14. Identify relationships or associations.
15. Identify the relevant information in order to solve a problem.
16. Identify the stages of problems that require advanced technologies.
17. Interpret results using statistical models.
18. Recognise the different types of sampling.
19. Recognise the need to employ multivariate rather than bivariate methods.
20. Represent data graphically.
21. 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.
22. 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.
23. Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.
24. Students must develop the necessary learning skills to undertake further training with a high degree of autonomy.
25. Students must have and understand knowledge of an area of study built on the basis of general secondary education, and while it relies on some advanced textbooks it also includes some aspects coming from the forefront of its field of study.
26. Take sex- or gender-based inequalities into consideration when operating within one's own area of knowledge.
27. Use graphs to summarise multivariate data and show dynamical pictures.

28. Use multivariate data summary indexes, time series and all other advanced techniques.
29. Use quantitative thinking and reasoning.
30. Use statistical programs for different multivariate analysis methods.
31. Use statistical programs to calculate sample sizes.
32. Use statistical programs to manage databases.
33. Use statistical programs to obtain summarised indexes of study variables.
34. Validate and manage information for statistical treatment.

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	3, 2, 12, 7, 5, 6, 4, 27, 31, 28, 16, 17, 9, 18, 20, 11, 30, 32, 33, 34
Theoretical sessions	26	1.04	26, 3, 13, 2, 1, 8, 7, 5, 6, 16, 14, 29, 9, 18, 19, 20, 11

Type: Autonomous			
Personal work	60	2.4	3, 13, 2, 1, 12, 7, 5, 6, 4, 10, 27, 31, 28, 15, 16, 14, 17, 29, 9, 25, 23, 21, 22, 18, 19, 20, 11, 30, 32, 33, 34
Real data analysis	25	1	26, 3, 2, 12, 7, 5, 6, 27, 31, 28, 15, 16, 14, 17, 29, 9, 18, 19, 20, 30, 32, 33, 34

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	3, 13, 2, 1, 8, 7, 5, 6, 10, 27, 15, 14, 17, 29, 9, 25, 24, 18, 19, 34
Homework (problems & computer excercises)	0,4	8	0.32	26, 3, 13, 2, 1, 12, 8, 7, 5, 6, 4, 27, 31, 28, 16, 14, 17, 9, 24, 23, 21, 22, 18, 19, 20, 11, 30, 32, 33, 34
Partial 1	0,3	2	0.08	26, 3, 13, 2, 1, 8, 7, 5, 6, 15, 14, 17, 29, 9, 25, 24, 21, 22, 18, 19, 11

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.