Universitat Autònoma de Barcelona

**2018/2019**

# Time Series and Prediction

Code: 103204
ECTS Credits: 6

| Degree | Type | Year | Semester |
|---|---|---|---|
| 2501919 Applied Statistics | OB | 3 | 1 |

## 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

## Prerequisites

It is advisble to have a course on Probability, Statistical Inference and Linear models

## Objectives and Contextualisation

A time series is a collection of observations of a random phenomenon evolving over time. Time series appear in almost all fields of application. Hence, its analysis and modelling of the underlying random phenomenon is of crucial theoretical and applied importance. This course is devoted to introduce the student to the study of basic time series models and its applications. The ultimate goal is the modelling of the mechanism that generates the data, perform model diagnostics and predict future values.

## Skills

- Analyse data using statistical methods and techniques, working with qualitative and quantitative data.
- Correctly use the majority of statistical and research software available, choose the best one for each statistical analysis, and adapt it to the new needs.
- Design a statistical or operational research study to solve a real problem.
- Develop an interest in knowledge and interpretation of quantifiable phenomena.
- Develop critical thinking and reasoning and communicate ideas effectively, both in the mother tongue and in other languages.
- Develop independent learning strategies.
- Display a capacity for logical thinking, structured reasoning and synthesis.
- Display initiative and willingness to stay abreast of new knowledge.
- Express and rigorously apply the knowledge acquired to problem solving
- Identify the best statistical and operative research models for decision-making in each context.
- Identify the usefulness of statistics in different areas of knowledge and apply it correctly in order to obtain relevant conclusions.
- Interpret results, draw conclusions and write up technical reports.
- Recognise the advantages and disadvantages of the procedures studied.

- Recognise the usefulness of statistical inference and operational research, and apply these correctly.
- Summarise and discover behaviour patterns in data exploration.
- Use bibliography or internet tools, specific to statistics or other related disciplines, both in English and in the first language.

## Learning outcomes

1. Analyse critically different time series models.
2. Analyse data through the time series model.
3. Consult bibliography in the field of advanced methods, including English bibliography.
4. Develop an interest in knowledge and interpretation of quantifiable phenomena.
5. Develop critical thinking and reasoning and communicate ideas effectively, both in the mother tongue and in other languages.
6. Develop independent learning strategies.
7. Display a capacity for logical thinking, structured reasoning and synthesis.
8. Display familiarity with specific resources for using and learning about statistical software.
9. Display initiative and willingness to stay abreast of new knowledge.
10. Draw relevant conclusions from applied problems, using advanced statistical methods.
11. Express and rigorously apply the knowledge acquired to problem solving.
12. Identify and use specific resources for applying statistical methodologies.
13. Identify distributions of time and categorical data.
14. Identify special methodological characteristics in statistical analysis according to different areas of application.
15. Identify the most common areas of application of each advanced methodology.
16. Identify the most suitable modelling for a chronological series.
17. Identify the stages in problems that require advanced technologies.
18. Identify the statistical suppositions associated with each advanced procedure.
19. Identify, use and interpret the criteria for assessing compliance with the requirements for applying each advanced procedure.
20. Interpret and apply asymptotic methods correctly.
21. Interpret findings with advanced methodologies and draw conclusions.
22. Know statistical software for programming advanced functions and procedures.
23. Plan studies based on time series for real cases.
24. Recognise the usefulness of maximum-likelihood estimation and apply it correctly.
25. Use graphs summarising multivariate data and time evolution data.
26. Use indices summarising multivariate data, time series and all other advanced techniques.
27. Use residuals to assess the appropriateness of one or another model (logistic regression, series, etc.)
28. Use statistical inference as an instrument for making predictions, specifically in time series and in survival-reliability.
29. Use statistical software for the study of time series.
30. Write a technical report based on an advanced statistical analysis.

## Content

1. **Introduction.** Classical anaysis of time series models. Trend an seasonality. Regression Models, Regression with AR(1) errors. Durbin Watson test.
2. **Filtering and smoothing.** Linear filterong. Local polynomials. Exponential smoothing. Differential filtering.
3. **Stationary Processes.** On the concept of stationarity Examples. Simulation of time series.
4. **ARIMA Models I.** MA(q) and AR(p). Correlograms.Yule-Walker equations. The difference operator. Relationship between MA snd AR models ACF and PACF.
5. **ARIMA** Models II. ARMA(p,q). Parameter estimation: method of moments, MLE, unconditional least squares, conditional least squares. ARIMA(p,d,q) and SARIMA. Box-Jenkins methodology. Predicction.
6. **Diagnostic checking and Forecasting.** AIC and BIC criteira. Analysis of residuals. Confidene intervals for predictions.
7. **Models for non-stationary series:** ARCH/GARCH**,** ARMA with covariants**.**

## Methodology

During the theoretical lessons (2 H/week) the fundamental results will be presented, and computer excercises will be developed.

During the lab hours, students will solve by themselves real data problems. The programing language used is R.

## Activities

| Title | Hours | ECTS | Learning outcomes |
|---|---|---|---|
| **Type: Directed** | | | |
| Theoretical Classes | 30 | 1.2 | 2, 1, 4, 26, 25, 13, 28, 16 |
| **Type: Supervised** | | | |
| Computer Labs | 30 | 1.2 | 2, 1, 26, 25, 13, 28, 16, 23, 29 |
| **Type: Autonomous** | | | |
| Personal work | 76 | 3.04 | 2, 1, 26, 25, 13, 28, 16, 23, 29 |

## Evaluation

**During the course, studenst must handle computer labs. There will be a final examination in the lab and a theoretical exams as well.**

**In order to pass the course, a minumu of 3/10 in both prectice and theory is required, and an average over 5/10**

**Al llarg del curs els alumnes hauran de lliurar regularment treballs de pràctiques d'ordinador. També hi haurà un examen de pràctiques d'ordinador a final de curs. I un examen final.**

## Evaluation activities

| Title | Weighting | Hours | ECTS | Learning outcomes |
|---|---|---|---|---|
| Final Exam | 0,4 | 4 | 0.16 | 2, 1, 9, 7, 6, 4, 5, 26, 25, 11, 13, 28, 16, 17, 18, 19, 20, 21, 23, 24, 27, 29 |
| Problems and computer lab handlings | 0,4 | 8 | 0.32 | 2, 1, 8, 22, 4, 26, 25, 10, 3, 13, 12, 28, 16, 14, 15, 21, 23, 30, 29 |
| problems solved during class | 0,2 | 2 | 0.08 | 2, 1, 26, 28, 16, 23, 29 |

## Bibliography

**References:**

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

J.D. Cryer and K.S. Chan: *Time Series Analysis with Applications to R*. 2nd. edit. Springer, 2008

R.D. Peña. *Anàlisis de series temporales*. Alianza Editorial. 2005.

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

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