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200610 - ST - Time Series

Coordinating unit: 200 - FME - School of Mathematics and Statistics

Teaching unit: 715 - EIO - Department of Statistics and Operations Research

Academic year: 2017

Degree: MASTER'S DEGREE IN STATISTICS AND OPERATIONS RESEARCH (Syllabus 2013). (Teaching unit Optional)

ECTS credits: 5 Teaching languages: Spanish

Teaching staff

Coordinator: JOSEP ANTON SÁNCHEZ ESPIGARES

Others: Segon quadrimestre:
LESLY MARIA ACOSTA ARGUETA - B
JOSEP ANTON SÁNCHEZ ESPIGARES - A, B

Opening hours

Timetable: Office hour by appointment

Prior skills

The course assumes basic levels of statistics similar to those that can be achieved in the first semester of the Master. Students should be familiar with the concepts related with statistical models, like linear models, and hypothesis testing and statistical significance.
Some basic concepts related to the Box-Jenkins methodology for fitting ARIMA models would help to follow the course (see the three first chapters of 'Time Series Analysis and Its Applications. With R examples' 3rd Edition Shumway and Stoffer http://www.stat.pitt.edu/stoffer/tsa3/).
Although many examples come from the econometric field, methodology from the course might be applied in different areas (ecology, epidemiology, engineering,...)
Methods of prediction based on Machine Learning techniques, in particular artificial neural networks (ANNs) will be treated.
The course will introduce techniques related with state-space models and the Kalman filter. Prior basic knowledge of this framework will also help to follow the course, but it is not essential.
A good knowledge of the R programming language can help to get the most out of the course.

Requirements

Knowledge about the linear model will be useful

Degree competences to which the subject contributes

Specific:

3. CE-2. Ability to master the proper terminology in a field that is necessary to apply statistical or operations research models and methods to solve real problems.
4. CE-3. Ability to formulate, analyze and validate models applicable to practical problems. Ability to select the method and / or statistical or operations research technique more appropriate to apply this model to the situation or problem.
5. CE-5. Ability to formulate and solve real problems of decision-making in different application areas being able to choose the statistical method and the optimization algorithm more suitable in every occasion.

Translate to english

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6. CE-6. Ability to use appropriate software to perform the necessary calculations in solving a problem.

Transversal:

1. ENTREPRENEURSHIP AND INNOVATION: Being aware of and understanding how companies are organised and the principles that govern their activity, and being able to understand employment regulations and the relationships between planning, industrial and commercial strategies, quality and profit.
2. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.

Teaching methodology

* Theory:

Sessions (1,5h) with presentation and discussion of the theoretical aspects and case studies from the time series methodology. All matherial will be accessible on the website.

* Laboratory:

Sessions (1,5h) on computer labs with problem solving and case studies and discussion of the results with the teacher

* Practicals:

Off-site study work, completion of exercises and practical case studies.
Group work outside of lecture hours, the students must complete practical case studies, two of which are presented in laboratory sessions.

At the end of the course, each group of students must prepare a written report on actual data.

Learning objectives of the subject

To acquire experience in the methodology for constructing models and obtaining forecasts from true (o millor actual) cases of time series within different fields, especially in econometric and financial applications.

Identification, estimation and validation of a model for making forecasts from available data in a time series. ARIMA and VAR models.

Consolidation of theoretical knowledge and practice in modeling univariate and multivariate time series, as well as evaluation of the impacts of intervention and outliers and calendar effects

Apply and evaluate the predictions obtained through artificial neural networks

Understanding the formulation of state space models and the Kalman filter for explaining the evolution of non-observable variables from others, in relation to them, that indeed we can observe.

Use of structural models in state space formulation in order to identify components that are not directly observable in time series.

Introduction to volatility models for econometric series and of the financial markets.

Skills to be learned

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Understanding of the particularities that are present in time series, in which one singular observation is made each instant of time and it is related to the past, that is to say they are not independent.

Use of R and other statistical packages for analysis and time series forecasts.

Learning to work in a group and the ability to publicly present the results of a study.

Study load

Total learning time: 125h	Hours large group:	22h 30m	18.00%
	Hours medium group:	0h	0.00%
	Hours small group:	22h 30m	18.00%
	Guided activities:	0h	0.00%
	Self study:	80h	64.00%

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Content

Analysis and modeling of univariate time series. ARIMA models. ARIMA forecasting models

Learning time: 36h

Theory classes: 6h
Laboratory classes: 6h
Self study : 24h

Description:
- Exploratory study of a time series: trend, seasonality and cycles. Data Transformation
- Dynamic Dependency: autocorrelation and partial autocorrelation
- Stationary stochastic processes. ARMA models. Invertivilitat and stationary model
- Non-stationary stochastic processes. ARIMA and Seasonal ARIMA models.
- Identification, estimation and model validation. Criteria for selecting the best model
- Forecasting with ARIMA models

Outlier, Calendar Effects and Intervention Analysis

Learning time: 16h

Theory classes: 3h
Laboratory classes: 3h
Self study : 10h

Description:
- Techniques and Algorithms for the Automatic outlier detection, Calendar effects analysis (Easter and Trading days) and Intervention analyisis

Machine Learning-based Forecasting methods

Learning time: 7h

Theory classes: 1h 30m
Laboratory classes: 1h 30m
Self study : 4h

Description:
- Forecasting Methods based on Machine Learning: Artificial Neural Networks and Support Vector Regression
- Validation and sensitivity analysis. Measures to compare with statistical models

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Applications of the Kalman Filter	Learning time: 36h Theory classes: 6h Laboratory classes: 6h Self study : 24h

Description:
- Use of the Kalman Filter for filtering and smoothing data and for Estimating Parameters.
- ARMA and ARIMA models representation in State Space and Estimating the Maximum Likelihood of the Parameters in a Univariate and Multivariate Series.
- Missing data treatment by using the Kalman filter

Structural Models in State Space	Learning time: 7h 30m Theory classes: 3h Laboratory classes: 3h Self study : 1h 30m

Description:
Structural Time Series models: estimation and validation.

Introduction to Volatility Models	Learning time: 7h 30m Theory classes: 3h Laboratory classes: 3h Self study : 1h 30m

Description:
- Volatility in an Economic Series and in Financial Markets: ARCH and GARCH Models and Stochastic Volatility.

Qualification system

Exercises and problems presented, cases developed for each group of students, plus partial and final exams.

Final grade will be the result of the following formula:

N=0.2*Np+0.15*Nl+0.15*Nmr+0.5*Nf

Np=Midterm exam
Nl=Two Homeworks from the labs sessions
Nmr= Model from a real case
NF= Final Exam

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Bibliography

Basic:

Shumway, R. H.; Stoffer, D. S. Time series analysis and its applications : with R examples [on line]. 4th ed. New York: Springer, 2017Available on: <http://dx.doi.org/10.1007/0-387-36276-2>. ISBN 9780387293172.

Box, George E. P.; Jenkins, G.M.; Reinsel, G.C. Time series analysis : forecasting and control. 4th ed. Englewood Cliffs: Prentice Hall, 2008.

Peña Sánchez de Rivera, Daniel. Anàlisis de series temporales. Madrid: Alianza Editorial, 2005. ISBN 8420691283.

Brooks, Chris. Introductory econometrics for finance. 2nd ed. Cambridge: University Press, 2008. ISBN 9780521873062.

Harris, Richard I. D.; Sollis R. Applied time series modelling and forecasting. Chichester: John Wiley, 2003. ISBN 0470844434.

Enders, W. Applied econometric time series. 2nd ed. Hoboken, NJ: Wiley, 2004. ISBN 0471230650.

Complementary:

Durbin, J.; Koopman, S.J. Time series analysis by state space methods. New York: Oxford University Press, 2001. ISBN 0198523548.

Brockwell, P.J.; Davis, R.A. Time series: theory and methods. 2nd ed. New York: Springer-Verlag, 1991. ISBN 0387974296.

Peña, D.; Tiao, C.G.; Tsay, R. (eds.). A course in time series analysis. New York: John Wiley, 2001. ISBN 047136164X.

Lütkepohl, Helmut; Krätzig, M. (eds.). Applied time series econometrics. New YORK: Cambridge Univ. Press, 2004. ISBN 052183919X.

Lütkepohl, Helmut. New introduction to multiple time series analysis [on line]. Berlin: Springer, 2006 [Consultation: 23/11/2012]. Available on: <http://www.springerlink.com>. ISBN 9783540262398.

Cryer, Jonathan D. Time series analysis : with applications in R. 2nd ed. New York: Springer Text in Statistics, 2008. ISBN 9780387759586.

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