Time Series Analysis

Academic Year: (2023 / 2024)   **Review date: 22-07-2023**

Department assigned to the subject: Statistics Department

Coordinating teacher: MARIN DIAZARAQUE, JUAN MIGUEL

Type: Electives ECTS Credits : 3.0

Year : 1 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Probability
Statistical Inference
Programming in R

OBJECTIVES

The student will acquire the following knowledge:
1) Proficiency of descriptive techniques of univariate time series
2) Modeling of univariate time series using moving averages, exponential smoothing and periodogram methods
3) Modeling of univariate time series using machine learning methods.
4) Stationary time series modeling. AR models. MA models. ARIMA models.
5) Proficiency of model identification techniques. Diagnostics.
6) Modeling of multivariate time series. VAR models. Identification of models. Diagnostics.
7) Proficiency of model identification techniques. Diagnostics.
8) Modeling of financial time series using ARCH and GARCH models.

DESCRIPTION OF CONTENTS: PROGRAMME

1. Basic concepts in Time Series Analysis.
1.1. Random samples and properties of time series.
1.2. Decomposition of a time series: trend, seasonality, cycle and noise.
1.3. Stationary transformations for trend and seasonal.
1.4. Deterministic and stochastic components.

2. Machine learning methods in time series
2.1 Introduction to neural network models
2.2 Applications of neural networks in time series
2.3 Modeling and prediction of time series with machine learning methods

3. Linear Univariate ARIMA models.
3.1. Sationarity and differencing.
3.2. Autocorrelation function and its estimation.
3.3. Autoregressive models AR(p).
3.4. Moving Average models MA (q).
3.5. Non seasonal ARIMA models.
3.6. Estimation and order of selection.
3.7. Forecasting.
3.8. Seasonal ARIMA models.

4. Multivariate time series and financial time series models
4.1. VAR models.
4.2. Cointegration.
4.3. Forecasting properties.
4.4 ARCH models.
4.5 GARCH models.

LEARNING ACTIVITIES AND METHODOLOGY

The classes consist of a mixture of presentations on the fundamental concepts of the subject and the presentation of practical cases through the use of software. The statistical language R is preferably used. Students are expected to bring their own laptops to experiment with the code during the lectures.

* Training activities

  - AF1: Theoretical lesson.
  - AF2: Practical lesson.
  - AF5: Tutorials.
  - AF6: Group work.
  - AF7: Individual work.
  - AF8: On-site evaluation tests.

* Teaching methodologies

  - MD1: Class lectures by the professor with the support of computer and audiovisual media, in which the main concepts of the subject are developed and the bibliography is provided to complement the students' learning.
  - MD2: Critical reading of texts recommended by the professor of the subject: press articles, reports, manuals and/or academic articles, either for later discussion in class, or to expand and consolidate the knowledge of the subject.
  - MD3: Resolution of practical cases, problems, etc. posed by the teacher individually or in groups.
  - MD4: Presentation and discussion in class, under the moderation of the professor of topics related to the content of the subject, as well as case studies.
  - MD5: Preparation of papers and reports individually or in groups.

ASSESSMENT SYSTEM

Group work carried out during the course (100%) consisting of three parts:
- Take a real time series chosen by the students and make a complete descriptive study.
- Apply exponential smoothing models and neural networks.
- Appy ARIMA models.

% end-of-term-examination: 0

% of continuous assessment (assigments, laboratory, practicals…):   100

BASIC BIBLIOGRAPHY

 - Brockwell P.J. and Davis R.A. Introduction to Time Series and Forecasting., Springer., 2002

 - Enders W. Applied Econometric Time Series., Wiley, 2015

 - Hamilton J. Time Series Analysis., Princeton University Press, 1994

 - Krispin, R. Hands-On Time Series Analysis with R: Perform time series analysis and forecasting using R, Packt Publishing, 2019
 - Lazzeri, F Machine Learning for Time Series Forecasting with Python, Wiley, 2020

BASIC ELECTRONIC RESOURCES

 - . Introduction to Time Series Analysis and Forecasting in R:
 https://bookdown.org/singh_pratap_tejendra/intro_time_series_r
 - . Using R for Time Series Analysis: https://a-little-book-of-r-for-time-series.readthedocs.io/en/latest/src/timeseries.html
 - . Time Series Analysis in Python: https://www.machinelearningplus.com/time-series/time-series-analysis-python