

SYLLABUS

QM412E_0101_26

Time Series Analysis

ACADEMIC AREA :	OPERATIONS AND ANALYTICS
PROGRAMME :	MASTER DAIS / PGE / UGTC LEVEL 4 PGE
PERIOD :	SPRING
COORDINATOR :	Dr. Ahmed ATIL
INSTRUCTOR(S) :	Mr. Amine LAHIANI
CONTACT HOURS :	24.0 hours
STUDY TIME :	null hours (Class preparation, homework and assessments)
CREDITS :	4.0 ECTS
AOL :	NO

PRE-REQUISITE MODULES :

Prerequisites

Time Series Analysis (8 Sessions)

Basic Statistics

Solid understanding of core statistical concepts such as mean, variance, correlation, probability distributions, and descriptive analysis, essential for interpreting temporal data and identifying patterns over time.

Probability and Stochastic Thinking

Basic knowledge of probability to understand randomness, uncertainty, and variability in time-dependent data, as well as the foundations of stochastic time series models.

Linear Algebra (Foundations)

Familiarity with vectors and matrices, useful for understanding regression-based models, multivariate time series, and model estimation concepts.

Programming for Time Series Analysis (R or Python)

Ability to use R or Python for data manipulation, visualization, and implementation of time series methods, including smoothing techniques, regression models, and ARIMA-based forecasting.

These prerequisites enable students to progressively engage with time series decomposition, smoothing methods, regression models, autocorrelation analysis, ARIMA modeling, and forecast evaluation, as developed throughout the eight sessions of the course.

MODULE DESCRIPTION :

Module Description

Time series refer to variables observed or measured at successive points in time. This course aims to introduce the statistical and mathematical foundations of time series analysis, with a focus on modeling, forecasting, and interpretation of temporal data.

Students will learn to analyze time-dependent data using methods such as time series decomposition, smoothing techniques, regression models, autocorrelation analysis, and ARIMA models, supported by practical implementations in R

and Python.

These techniques are widely used across multiple application domains, including finance, economics, supply chain management, retail, and operations, where understanding trends, seasonality, and uncertainty is essential for informed decision-making.

CONTRIBUTION TO PROGRAMME LEARNING OBJECTIVES :

- Leverage the economic, ecological, social performance of the firm and its operations to Change Business models #ChangeBusiness

MODULE INTENDED LEARNING OUTCOMES (ILOs) :

Upon successful completion of this module, students will be able to:

Understand the fundamentals of time series analysis in business and management

Explain the key concepts and techniques used to analyze temporal data in business, economics, and management contexts.

Apply time series models for forecasting using R and Python

Use statistical and computational tools in R and/or Python to build, estimate, and interpret time series models for forecasting purposes.

Analyze time series components and data properties

Identify and interpret trend, seasonality, noise, and autocorrelation structures in time-dependent data.

Evaluate and compare forecasting methods

Assess the performance of different forecasting techniques using appropriate accuracy measures and validation strategies.

Interpret and communicate forecasting results

Present and explain forecasting outcomes clearly, highlighting limitations, uncertainty, and managerial implications.

TOPICS COVERED :

Topics Covered

1- Introduction to Time Series Analysis and Visualization (R / Python)

Basic concepts of time series data, exploratory analysis, and visualization techniques using R and Python.

2- Time Series Components and Decomposition

Trend, seasonality, and irregular components; classical and model-based decomposition methods.

Stationarity and Autocorrelation Analysis

Stationarity concepts, differencing, autocorrelation and partial autocorrelation functions.

ARIMA Models for Time Series Analysis

Autoregressive, moving average, and integrated models; model identification, estimation, and diagnostics.

Time Series Regression Models and Advanced Topics

Regression with time-dependent variables, seasonal regression, and an introduction to advanced methods, including machine learning approaches for time series forecasting.

RESEARCH-LED TEACHING :

I have published more than 70 papers in the field of Time Series Analysis including analyzing the complex relationships between time series data, modeling the dynamics of time series data, decomposition of time series data, Box-Jenkins modelling procedure, Forecasting of time series data. These papers were published in top Journals according the CNRS and ABS rankings of journals.

CSR AND SUSTAINABLE DEVELOPMENT GOALS :

My research covered several SDG goals. In particular, I have worked on green and clean energy, renewable energy use and its impact on the air quality, the challenging relationship between economic growth and CO2 emissions, electricity consumption and pollution, energy use and climate change

CSR NB HOURS :

3

SUSTAINABLE DEVELOPMENT GOALS COVERED :

- 03 - Good health and well-being
- 07 - Affordable and clean energy

TEACHING METHODS :

Teaching Methods

Conceptual Lectures

Lectures introduce the fundamental concepts and methods of time series analysis, supported by real-world examples to illustrate their relevance in business, economics, and management contexts.

Applied Case Studies and Practical Exercises

Students work on applied exercises and case studies drawn from finance, marketing, operations, and supply chain contexts, applying time series techniques to analyze data and solve real-world business problems.

E-learning Platform and Continuous Learning

An online learning platform is used for continuous assessment, self-paced exercises, and supplementary learning materials to reinforce theoretical concepts and practical skills throughout the course.

METHODS OF ASSESSMENT :

Continuous/Final	Group/Individual	Assessment	Weight	Duration	ILOs assessed
Continuous	Individual	Written assessment at home	60%		2. Know how to use time series techniques to make
Continuous	Group	Participation or task completion	30%		2. Know how to use time series techniques to make
Continuous	Individual	Multimedia production	10%	4 Heures	

Assessment 1 details:

The student will be asked to implement a time series method in R or Python in the form of an article. She/he will be provided with a starting paper and code to build upon.

Description:

Comprehensive final exam covering theoretical and practical applications of data science in business.

Content:

Includes problem-solving, case analysis, and questions on data ethics and CSR considerations.

Objective:

Evaluate the students' ability to apply learned concepts independently, demonstrate critical understanding, and solve complex business problems using data science.

Assessment 2 details:

Group Project Evaluation (30%)

Description:

Collaborative project where students analyze business data, build models, and derive insights for a business case, culminating in a presentation.

Objective:

Develop teamwork skills, apply data science methods in a practical context, and demonstrate understanding of business implications.

Assessment 3 details:

Continuous Assessment via E-learning Platform (10%)

Description:

Students will complete online quizzes, short applied exercises, and interactive activities via the e-learning platform throughout the course. These activities are designed to reinforce key concepts in time series analysis, including data structure, visualization, smoothing techniques, regression models, autocorrelation, and forecasting methods.

Objective:

To continuously assess students' understanding of foundational time series concepts, support progressive learning, and ensure the acquisition of essential analytical skills for modeling, forecasting, and interpreting time-dependent data.

ACADEMIC INTEGRITY :

Academic misconduct encompasses various behaviors or actions that violate the principles of academic integrity, fairness, and honesty, thereby undermining the credibility of academic work, assessments, or research. Examples of academic misconduct include:

- Cheating
- Plagiarism
- Fabrication
- Gaining an unfair advantage
- Assisting others in committing academic misconduct, such as by utilizing generative AI
- Falsification of records or official documents
- Unauthorized access to restricted information or data
- Unauthorized or unethical use of generative AIS

Academic misconduct is a serious offense and can result in consequences such as module failure, research project failure, or even expulsion from the school. To prevent unintentional academic misconduct, it is essential to consult with your instructor to understand the specific rules and instructions pertaining to the use of AI in learning and assessment.

For more comprehensive information on academic integrity rules, principles, and disciplinary procedures, please refer to the Academic Integrity section of the Student Handbook.

BIBLIOGRAPHY :

1. Cryer J. D., Chan K-S (2010). Time Series Analysis: With Applications in R (Springer Texts in Statistics) 2nd Edition
2. Shmueli G., Lichtendahl Jr. K.C. (2024). Practical Time Series Forecasting with R. (3rd edn). Axelrod Schnall Publishers.
3. humway R. H. and Stoffer D. S. (2017). Time Series Analysis and its Applications: With R Examples. (4th edn). Springer. (<http://www.stat.pitt.edu/stoffer/tsa4/>) [eBook <https://bit.ly/3mAyt8u>]

Additional Reading

1. Hyndman, R. J. & Athanasopoulos, G. (2018). Forecasting: Principles and Practice. (2nd edn). Otexts. (Free online version at <https://www.otexts.org/fpp>).
2. Hamilton, J.D. (1994). Time Series Analysis. Princeton University Press. (Advanced Reference)
3. Hayashi, F. (2000). Econometrics. Princeton University Press. (Advanced)
4. Brillinger, D.R. (2001). Time Series: Data Analysis and Theory (2nd edn). Society for Industrial and Applied

MODULE PLAN SESSIONS :

Plan Session 01 :

Session 1 — Introduction to Time Series Analysis

Instructor: Ahmed ATIL

Definition of time series and real-world applications

Business and economic examples of time series

Introduction to tools and course structure

Plan Session 02 :

Session 2 — Time Series Data & Visualization

Instructor: Amin LAHIANI

Time series data collection and structure

Components of time series (trend, seasonality, noise)

Visualization of time series data

Plan Session 03 :

Session 3 — Data Pre-processing and Smoothing Techniques

Instructor: Amin LAHIANI

Data cleaning and transformation for time series

Moving averages and differencing

Introduction to exponential smoothing

Plan Session 04 :

Session 4 — Advanced Smoothing and Holt–Winters Models

Instructor: Amin LAHIANI

Simple vs advanced exponential smoothing

Holt and Holt–Winters models

Interpretation of smoothed series

Plan Session 05 :

Session 5 — Regression Models for Time Series

Instructor: Amin LAHIANI

Trend models and regression-based forecasting

Seasonality in regression models

Introduction to stationarity

Plan Session 06 :

Session 6 — Autocorrelation and ARIMA Models

Instructor: Amin LAHIANI

Lags and serial correlation

Autoregressive and moving average models

ARIMA model identification and estimation

Plan Session 07 :

Session 7 — Forecast Evaluation and Validation

Instructor: Amin LAHIANI

Naive forecasting methods

Forecast accuracy measures

Train/test split and roll-forward validation

Plan Session 08 :

Session 8 — Group Project Presentation

Instructor: Ahmed ATIL

Presentation of group projects

Interpretation and discussion of forecasting results

Feedback and synthesis of key course concepts

