Time Series with R

Instructor:	Dhafer Malouche	**Time:**	Thursday 2-5pm
Email:	dhafer.malouche@aucegypt.edu	**Place:**	**online** .

Course Pages: Will be available at http://dhafermalouche.net

Office Hours: To be announced.

Main References: This is a restricted list of various interesting and useful books that will be implemented during the course. You will need to consult them occasionally.

- Robert H. Shumway and David S. Stoffer *Time Series Analysis and Its Applications With R Examples*, Springer, 2016
- Avishek Pal and PKS Prakash, *Practical Time Series Analysis*, Birmingham - Mumbai, 2017.
- Box, G.E.P., G.M. Jenkins and G.C. Reinsel. Time Series Analysis, Forecasting, and Control, 3rd ed. Englewood Cliffs, NJ: Prentice Hall, 1994
- Chan, N.H. (2002). *Time Series: Applications to Finance. New York: Wiley.*
- Fuller, W.A. *Introduction to Statistical Time Series*, 2nd ed. New York: Wiley, 1996.
- Harvey, A.C. *Time Series Models.* Cambridge, MA: MIT Press, 1997.
- P. Brockwell, R. Davis. *Time Series : Theory and Methods.* Springer, 1991.
- J. Cryer, K.-S. Chan. *Time Series Analysis – With Applications in R*, Springer texts in Statistics.
- Param Jeet and Prashant Vats, *Learning Quantitative Finance with R.* Birmingham - Mumbai, 2017.

Objectives: This course aims to give students a clear overview of the basic concepts of time series analysis that are applicable in commonly-found analytical cases in the social sciences, political science, and other fields. Students will learn several important tools to provide trend analytics and forecasting based on past data and time series. Students will be able then to apply the tools and techniques of time series analysis to complex problems to reach effective solutions.

Prerequisites: Familiarity with probability, statistical inference, regression, and model specification or permission from the instructor. The ability to work directly with data (basic proficiency in R).

Course Description: This course is composed of three parts. In the first chapter, I will give examples of time series and how we can manage time series data using R. The next three chapters are more theoretical. I will present the notions of stationary processes, linear filtering, ARMA processes, and linear predictions. In the second part of the course, I will introduce non-stationary processes such as ARIMA and SARIMA processes. I will provide methods for estimating models with real data, with an emphasis on efficient model selection procedures and forecasting. The final third of the class will be devoted to other techniques for times series analysis such as exponential smoothing based methods.

Throughout the class, I will make use of several types of real world data. All of the examples given will be shown how to be performed at the same time in R.

Course Outline: (3h online/week, 13 weeks)

(**Week 1):** (1/20) Introduction to Time Series (lecture 1): First examples, definitions of trends, seasonality and noise

(**Week 2):** (1/27) Introduction to Time Series (lecture 2): Stationary processes, definition and examples. Autocovariance, autocorrelation, and Toeplitz matrices

(**Week 3):** (2/3) Linear Filtering (lecture 1): Definitions and the Theorem of Filtering

(**Week 4):** (10/2) Linear Filtering (lecture 2): Convolutions and compositions, causal processes

(**Week 5):** (17/2) ARMA Processes (lecture 1): The ARMA Equation, Moving Average and Autoregressive processes

(**Week 6):** (24/2) ARMA Processes (lecture 2): Solving the ARMA equation

(**Week 7):** (3/3) ARMA Processes (lecture 3): Applications and Examples

(**Week 8):** (24/3) Linear Prediction (lecture 1): Yule-Walker Equations, Levinson-Durbin Algorithm, Partial autocorrelations

(**Week 9):** (31/3) Non-stationary Processes (lecture 1): ARIMA and SARIMA processes, simulations and examples

(**Week 10):** (7/4) Non-stationary Processes (lecture 2): Model selection and case studies

(**Week 11):** (14/4) Exponential Smoothing Based Methods (lecture 1): Time series smoothing, first and second order smoothing

(**Week 12):** (21/4) Exponential Smoothing Based Methods (lecture 2): Modeling higher-order exponential smoothing

(**Week 13):** (12/5) Revision and Solving problems.

Important Dates:

Midterm #1 To be announced during the week 14/3-19/3
Final Exam To be announced during the week 23/5-28/5

Course Policy:

- I will confirm your enrollment for the course, then you will be able to see the course page.

Class Policy:

- Regular attendance is essential and expected.

Academic Honesty: Lack of knowledge of the academic honesty policy is not a reasonable explanation for a violation.