# Time series and analysis forecasting

## Prof. Enrico Barbierato

***COURSE AIMS AND INTENDED LEARNING OUTCOMES***

The Time Series Analysis and Forecasting course provides students with the fundamental knowledge to build and apply time series forecasting models in a variety of experimental data contexts using various statistical approaches. At the end of the course, students should be able to choose an appropriate model for a given dataset and fit the model using appropriate software packages, as well as to compute and evaluate the model forecasts.

***COURSE CONTENT***

***PART ONE***

1. *Characteristics of Times Series*: TS statistical models. Autocorrelation and Cross-correlation. Stationary TS. Estimation of correlation
2. *TS regression and exploratory data analysis*: Classical regression in TS context. EDA. Smoothing in the TS context
3. *ARIMA models*: Autoregressive Moving Average Models. Difference Equations. Autocorrelation and Partial autocorelation functions. Forecasting and Estimation. Integrated Models for Nonstationary Data. ARIMA models. Multiplicative Seasonal ARIMA models
4. *Spectral Analysis and Filtering*: Cyclical behavior and Periodicity. Spectral density. Periodogram and Discrete Fourier transorm. Non parametric spectral estimation.

***PART TWO***

1. *Recurrent Neural Networks*. Delay units and backpropagation trough time. Practical applications of RNNs
2. *Long Short-Tern Memory recurrent neural networks*: LSTM paradigm. Practical applications.
3. *Gated Recurrent Unit NNs*. Reset and Update Gate. Examples
4. *Elman NNs*: Role of memory, Practical applications
5. *Jordan NNs*: Practical Applications.

***READING LIST***

Slides provided by the lecturer.

***TEACHING METHOD***

The course will include lectures and class exercises based on traditional teaching and teach-by-example principles. It is strongly advised to attend lectures for working on case studies and examples, and for revising materials.

The course also involves lectures and exercise sessions using the integrated development environment (PyCharm, Jupiter, RStudio, Tensorflow). Active participation, and ongoing personal study are required.

***ASSESSMENT METHOD AND CRITERIA***

The exam consists of the following weighted parts:

* 60% Written test, including open or multiple choice questions, manual exercises, and Python/R coding;
* 30% Individual small project
* 10% Discussion of a paper from the scientific literature in the area of Time Series.

***NOTES AND PREREQUISITES***

It s strongly recommended to take the following exams:

* Probability and Statistics
* IT Coding for Data Science