Time Series Analysis

Yair Mau

Table of contents

about

Welcome to **Time Series Analysis for Environmental Sciences** (71106) at the Hebrew University of Jerusalem. This is Yair Mau, your host for today. I am a senior lecturer at the Institute of Environmental Sciences, at the Faculty of Agriculture, Food and Environment, in Rehovot, Israel.

This website contains (almost) all the material you'll need for the course. If you find any mistakes, or have any comments, please email me.

disclaimer

The material here is not comprehensive and `does not` constitute a stand alone course in Time Series Analysis. This is only the support material for the actual presential course I give.

what, who, when and where?

Course number 71106, 3 academic points
Yair Mau (lecturer), Erez Feuer (TA)
Tuesdays, from 11:15 to 14:00
Computer classroom #18
Office hours: Tuesdays, from 09:45 to 10:45 (you should send an email to let me know you are coming)

syllabus

course description

Data analysis of time series, with practical examples from environmental sciences.

course aims

This course aims at giving the students a broad overview of the main steps involved in the analysis of time series: data management, data wrangling, visualization, analysis, and forecast. The course will provide a hands-on approach, where students will actively engage with real-life datasets from the field of environmental science.

learning outcomes

On successful completion of this module,students should be able to:

- Explore a time-series dataset, while formulating interesting questions.
- Choose the appropriate tools to attack the problem and answer the questions.
- Communicate their findings and the methods they used to achieve them, using graphs, statistics, text, and a well-documented code.

course content

- **Data wrangling:** organization, cleaning, merging, filling gaps, excluding outliers, smoothing, resampling.
- **Visualization:** best practices for graph making using leading python libraries.
- **Analysis:** stationarity, seasonality, (auto)correlations, lags, derivatives, spectral analysis.
- **Forecast:** ARIMA
- **Data management:** how to plan ahead and best organize large quantities of data. If there is enough time, we will build a simple time-series database.

books and other sources

Click here.

course evaluation

There will be assignments during the semester (totaling 50% of the final grade), and one final project (50%).

Evaluation policy

- **Individual Work:** While we support helping your peers, it's important to remember that all assignments must be completed individually. This means that your submissions should be your own unique work and not contain code or text that is identical to someone else's.
- **Zero Plagiarism:** Do not copy text verbatim from any source. Always express ideas in your own words.
- **On-Time Submission:** Assignments must be turned in by the specified deadline. Late submissions will receive a grade of 0. If you require an extension, requests will only be considered if made at least 24 hours before the due date.
- **Non-Compliance Consequence:** Assignments that do not adhere to these guidelines will automatically receive a grade of 0.

2024/2025 Schedule

Week 1, 29 Oct 2024

Introduction

Course overview, setting of expectations, introduction to Jupyter Notebooks, loading data and plotting it.

Assignment 1, due 12 Nov 2024

Week 2, 5 Nov 2024

Resampling

Week 3, 12 Nov 2024

Smoothing

Assignment 2, due 26 Nov 2024

Week 4, 19 Nov 2024

Outliers

Week 5, 26 Nov 2024

Stationarity: random processes, statistics refresher, AR processes

Assignment 3, due 10 Dec 2024

Week 6, 3 Dec 2024

Stationarity: ACF and PACF graphs

Week 7, 10 Dec 2024

Stationarity: Forecasting, ARIMA, SARIMA, SARIMAX

Assignment 4, due 31 Dec 2024

Week 8, 17 Dec 2024

Seasonality

24 Dec 2024

No classes.

Week 9, 31 Dec 2024

Assignment 5, due 14 Jan 2025

Week 10, 7 Jan 2025

Week 11, 14 Jan 2025

Assignment 6, due 28 Jan 2025

Week 12, 21 Jan 2025

Week 13, 28 Jan 2025

Final project, due 4 Mar 2025

who cares?

why "Time Series Analysis?"

Time has two aspects. There is the arrow, the running river, without which there is no change, no progress, or direction, or creation. And there is the circle or the cycle, without which there is chaos, meaningless succession of instants, a world without clocks or seasons or promises.
URSULA K. LE GUIN

You are here because you are interested in how things change, evolve. In this course I want to discuss with you how to make sense of data whose temporal nature is in its very essence. We will talk about randomness, cycles, frequencies, correlations, and more.

why "Environmental Sciences"

This same time series analysis (TSA) course could be called instead "TSA for finance", "TSA for Biology", or any other application. The emphasis in this course is **not** Environmental Sciences, but the concepts and tools of TSA. Because my research is in Environmental Science, and many of the graduate students at HUJI-Rehovot research this, I chose to use examples "close to home". The same toolset should be useful for students of other disciplines.

what is it good for?

In many fields of science we are flooded by data, and it's hard to see the forest for the trees. I hope that the topics we'll discuss in this course can help you find meaningful patterns in your data, formulate interesting hypotheses, and design better experiments.

do I need it?

Maybe. If you are a grad student and you have temporal data to analyze, then probably yes. However, I have very fond memories of courses that I took as a grad student that were completely unrelated to my research. Sometimes "because it's fun" is a perfectly good answer.

what will I actually gain from it?

By the end of this course you will have gained:

- a **hands-on** experience of fundamental time-series analysis tools
- an **intuition** regarding the basic concepts
- **technical** abilities
- a **springboard** for learning more about the subject by yourself

Part I

start here