

# Time Series Analysis

## Administration

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**Applied AI Research Lab (AAI)**  
**Informatik**



# About me

Studied computer science at EPFL & ETH

PhD in AI for clinical dermatology at the University of Basel

- AI decision support
- AI challenges & opportunities for dermatology clinics

Dozent at HSLU

- 80% research projects with industry in MedTech & FinTech
- 20% lecturing: Time Series Analysis, Explainable AI, Medical Imaging



**AAI**  
**Research Lab**



# Applied AI Research Lab

# AAI Research Lab



## Applied AI Research Lab (AAI)

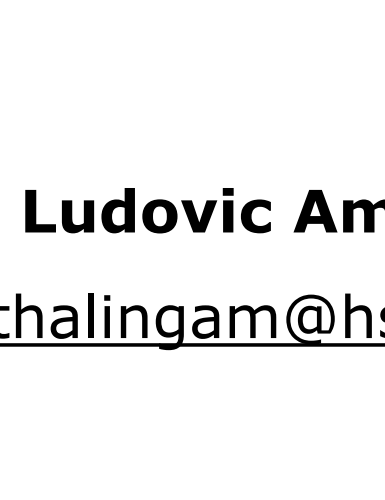
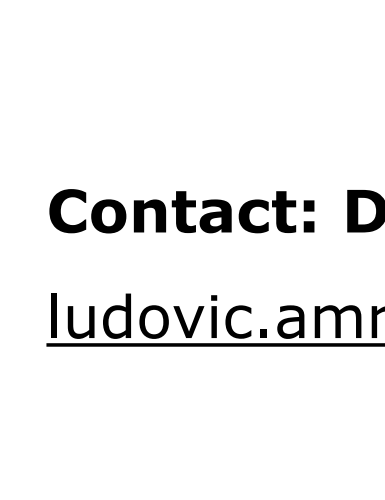
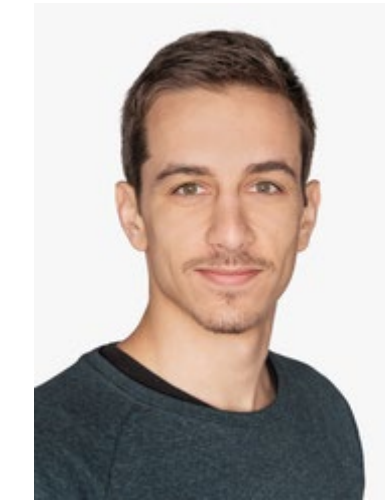
<https://hslu.ch/ai>

Research & Development  
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Part of the HSLU Applied AI Center  
and of the HSLU MedTech Cooperation

HSLU

**HSLU** Hochschule  
Luzern



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# Applied AI Research Lab: Vision & Values



## **Mission: Innovation Transfer**

- Link science with practice
- Use AI to bring value to people, companies, and institutions



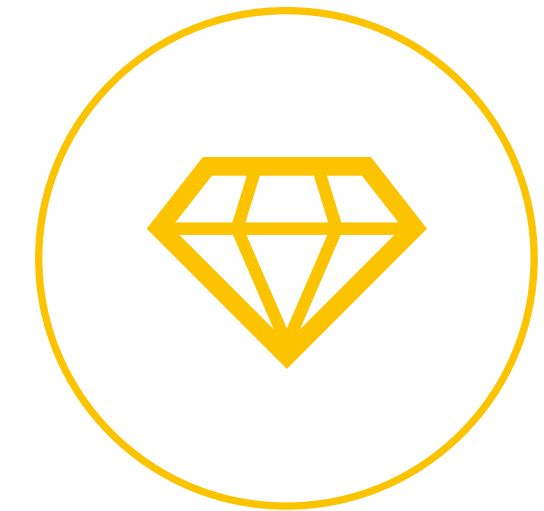
## **Mindset: Problem Solving**

- Identify, build, and evaluate the right technologies
- Embrace partner use-cases, challenges, and capabilities



## **Know-how: Machine Learning**

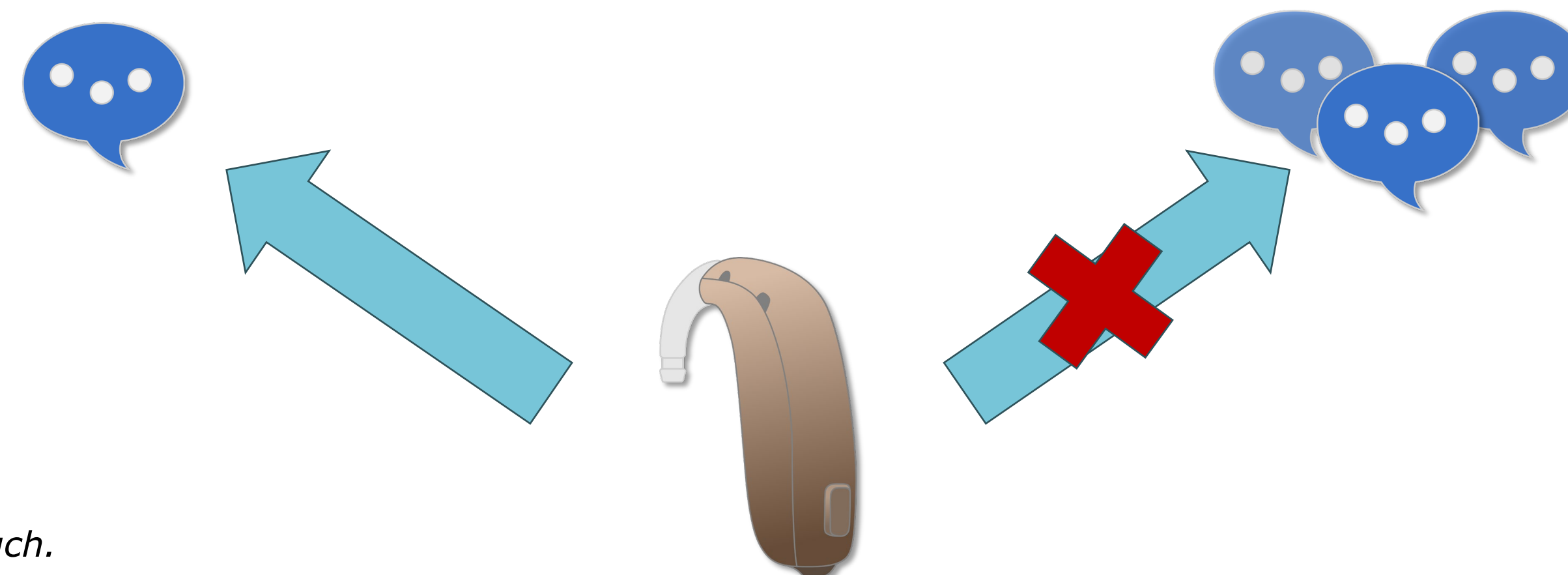
- Follow the field's scientific progress
- Develop and contribute own methods and findings



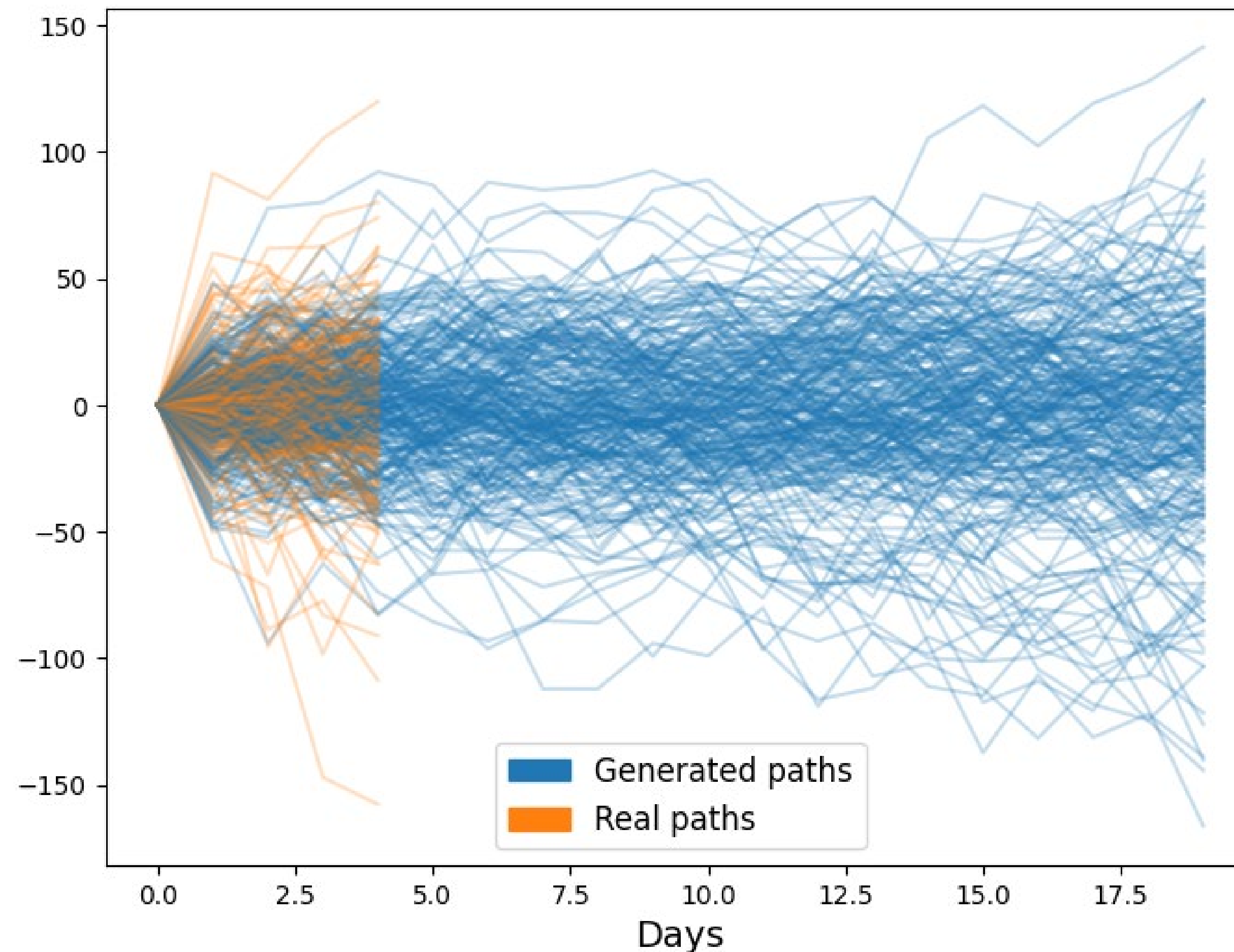
## **Values: Ethical Research**

- Develop technology along ethical principles
- Engage in interdisciplinary research and cooperation

## Hearable steering in complex acoustic scenes



## Benchmarking Synthetic Time Series Quality



# Applied AI Research Lab: Example Projects

- Multimodal Recommender Systems for Betty Bossi
- Recommender Systems for the Event Industry with Eventfrog
- Machine Learning for Financial Advisory with Finpension
- Predictive Maintenance with Roche Diagnostics
- Optimization of the Swiss Upper Airspace with Skyguide
- AI for Hearing Aids with Sonova
- Recommender Systems for Value Added Programs with STU
- Digital Dermatology with University Hospital Basel





# Course objectives

## **Theoretical foundations of time series analysis**

- Time & frequency domain methods
- Machine learning & deep learning approaches

## **Practical applications to real-world data**

- Design and conduct analysis & modeling workflow
- Forecasting, anomaly detection, classification
- Python implementation

## **Review and utilize methods from scientific publications**



# Provisional agenda

SW 1	SW 2	SW 3	SW 4
<b>Introduction</b>  - Course administration - Concepts and definitions - Real-world applications across various domains - Discrete time series and Nyquist sampling	<b>Foundations I</b>  - Decomposition: Understanding trend, seasonality, cyclicalty - Visualization techniques - Introduction to stationarity	<b>Foundations II</b>  - Achieving stationarity: differencing and transformations - Correlation and autocorrelation analysis - Hands-on: Exploratory data analysis on time series	<b>Time Domain Methods I</b>  - Autoregressive (AR) models - Moving Average (MA) models - Combining AR and MA: the ARIMA model
SW 5	SW 6	SW 7	SW 8
<b>Forecasting with Time Domain Methods</b>  - Forecasting future values - Evaluation metrics - Hands-on: Forecasting with ARIMA models	<b>Time Domain Methods II</b>  - Seasonal ARIMA (SARIMA) models - Model selection criteria and diagnostics - Hands-on: Building and selecting SARIMA models	<b>Frequency Domain Methods I</b>  - The Fourier transform and its properties - Discrete Fourier transform (DFT) - Fast Fourier transform (FFT)	<b>Applications of Frequency Domain Methods I</b>  - Visualization of Fourier transforms - Hands-on: Noise reduction in time series data
SW 9	SW 10	SW 11	SW 12
<b>Frequency Domain Methods II</b>  - Spectral analysis - Spectrum, periodogram	<b>Applications of Frequency Domain Methods II</b>  - Power spectral density estimation - Hands-on: Signal decomposition and reconstruction using spectral analysis	<b>Machine Learning for Time Series</b>  - Feature engineering - Regression models in time series - Hands-on: Using regression models for time series forecasting	<b>Deep Learning for Time Series I</b>  - Convolutional Neural Networks (CNNs) for time series - Hands-on: Implementing CNNs for classifying time series patterns
SW 13	SW 14		
<b>Deep Learning for Time Series II</b>  - Recurrent Neural Networks (RNNs) for Time Series - Long Short-Term Memory (LSTM) networks - Hands-on: Building and training LSTM models for forecasting	<b>Wrap-Up</b>  - Dos and don'ts - Exam preparation - Discussion and outlook		

# Course administration

## **Course (3 ECTS):**

Thursday on-site/streaming

## **Lecture materials (uploaded to ILIAS):**

Lecture slides + theoretical and practical exercises

## **Exam (no Testat)**

Written examination 1.5h, during exam period

Theoretical exercises at end of lectures are in the form of the exam

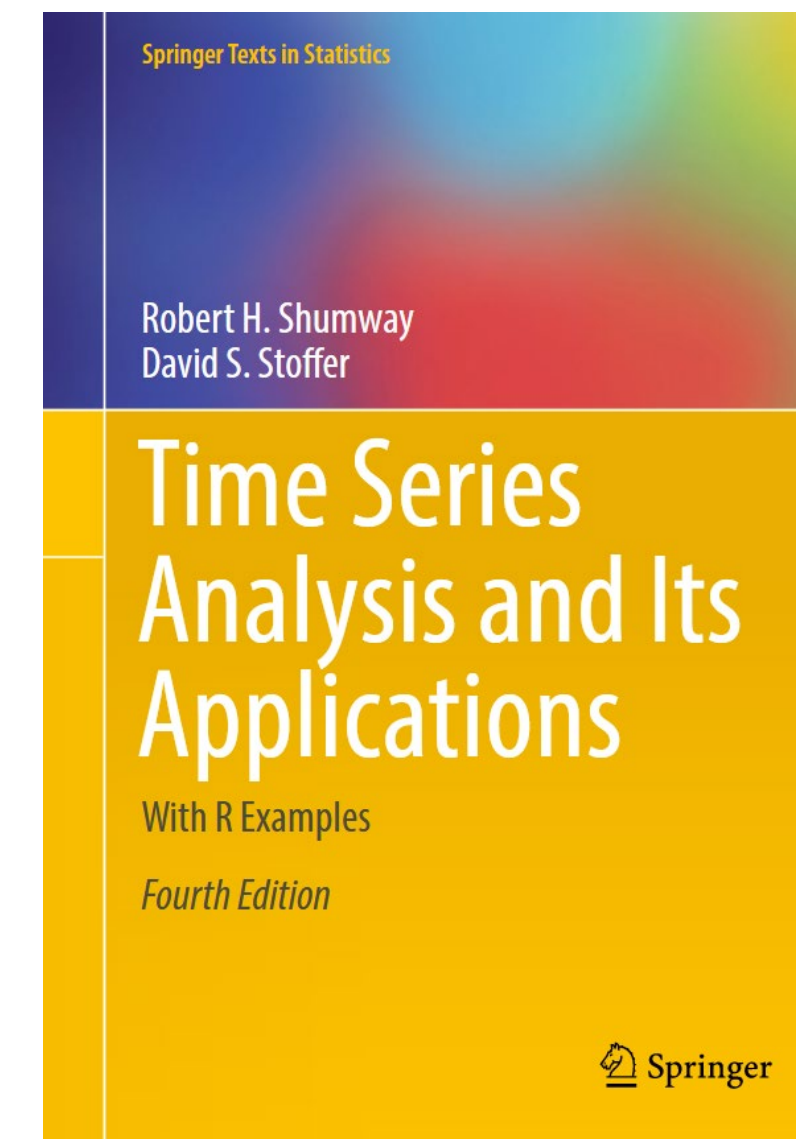
## **Bonus point (extra)**

In groups of 3, finish all lecture practicals no later than the final course session

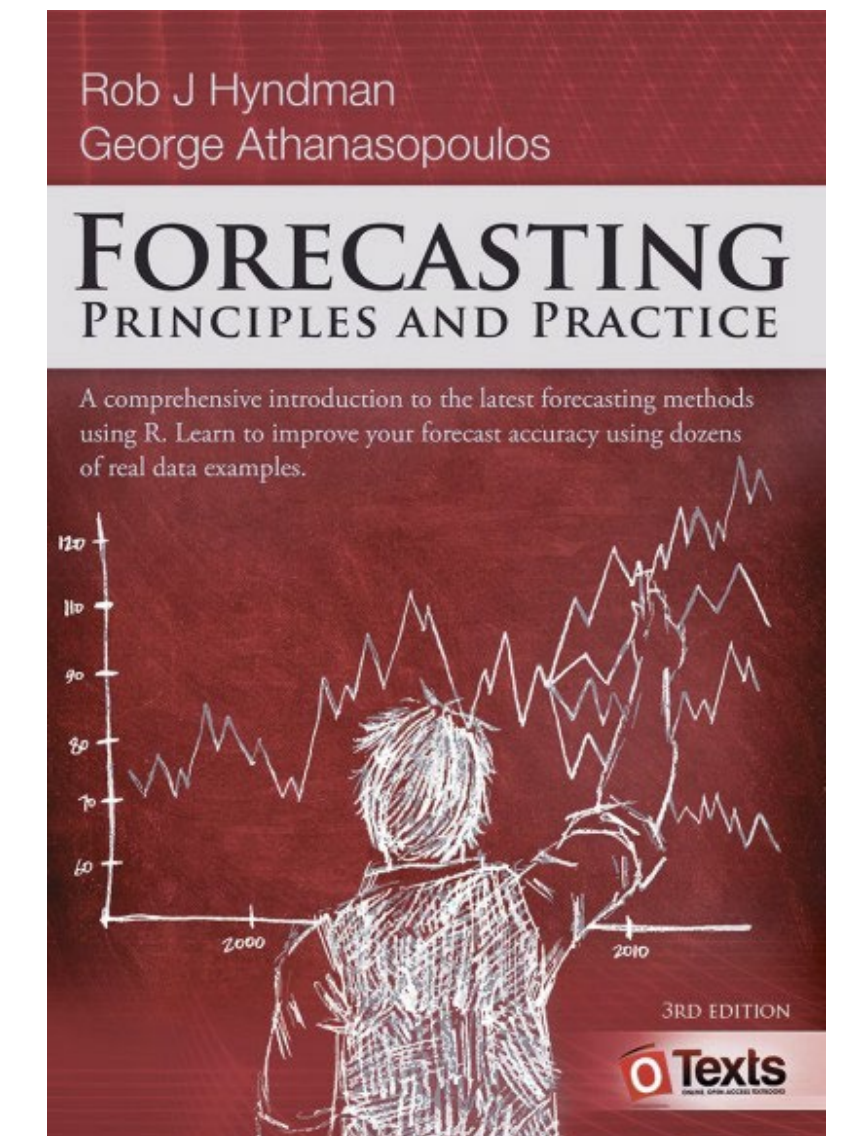


# Literature

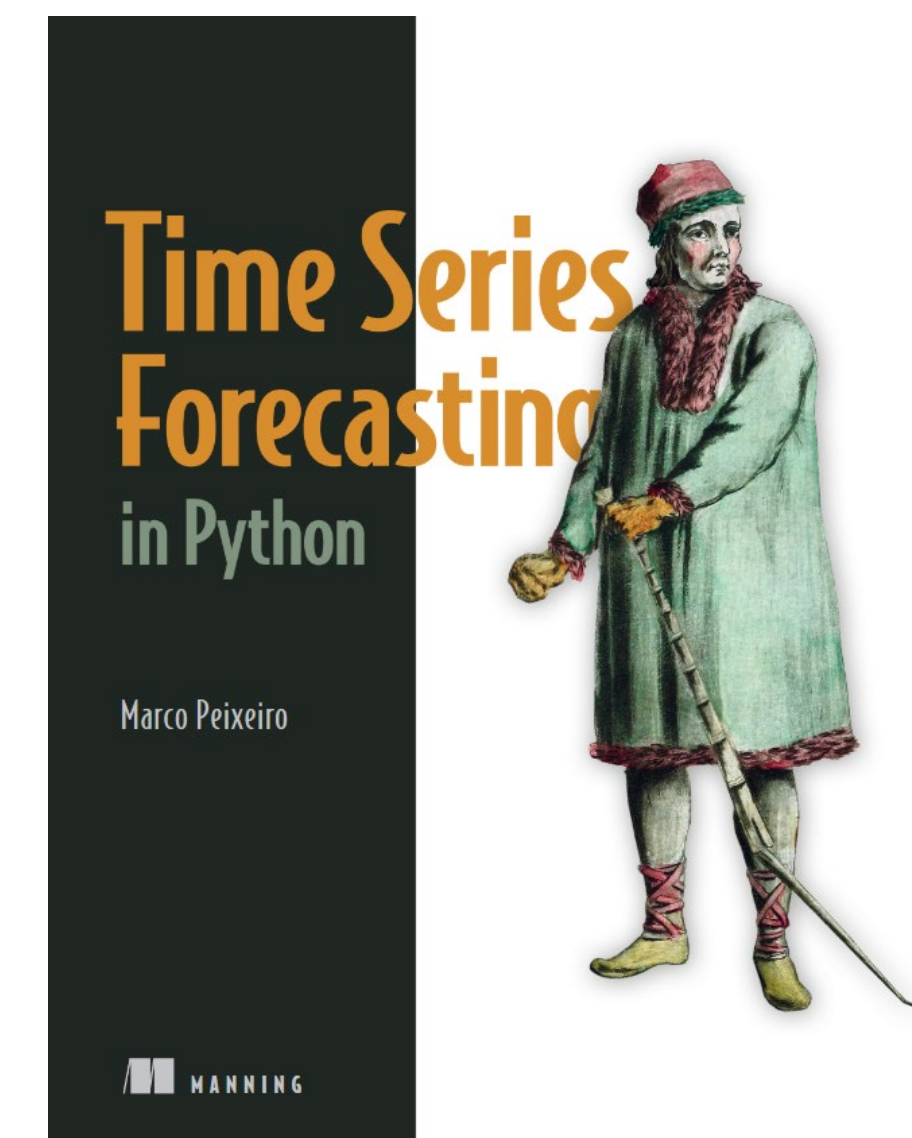
Time Series Analysis and its Applications, Shumway & Stoffer, Springer, 4<sup>th</sup> edition (2017).



Forecasting Principles and Practice, Hyndman & Athanasopoulos, Otexts, 3<sup>rd</sup> edition (2021).



Time Series Forecasting in Python, Peixeiro, Manning, 1<sup>st</sup> edition, (2022).



# Credits

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