MachineLearnAthon - Microlecture Time Series Forecasting

Recorded by Lara Kuhlmann

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A project Co-funded by the Erasmus+ programme of the European Union

Learning outcomes of today

After successfully completing this micro-lecture, you are able to….

- Explain the concept of time series
- Describe the different types of time series patterns and forecast horizons
- Distinguish the terms time series forecasting and regression
- Understand the temporal dependency of time series data
- Explain the procedure of time series cross validation
- Describe uncertainty quantification in forecasting

Agenda for today

- Time Series definition
- Time Series patterns
- Forecast horizons
- Differences between Time Series Forecasting and Regression
- Time series cross validation
- Uncertainty Quantification

Time Series

- Time Series is a type of data, which is collected over time
- Data consists of historical data organized by time
- Example: weekly retail sales, hourly electricity demand, monthly rainfall, etc.

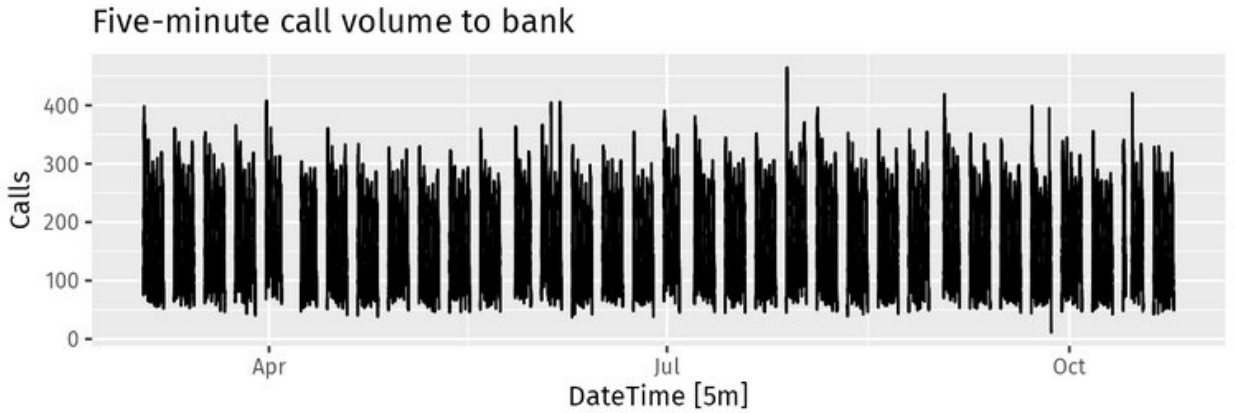

Image source: https://otexts.com/fpp3/complexseasonality.html

Hyndman, R.J., & Athanasopoulos, G. (2021) *Forecasting: principles and practice*, 3rd edition

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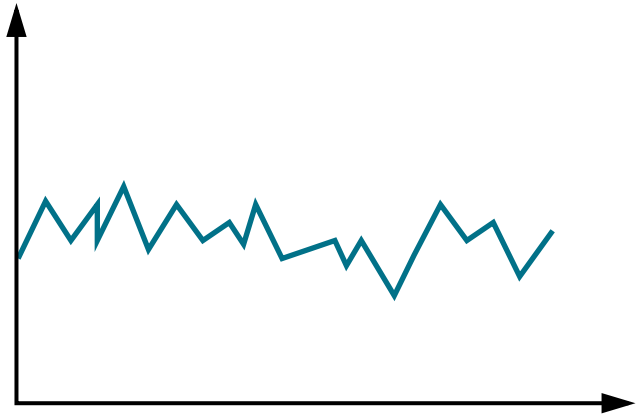
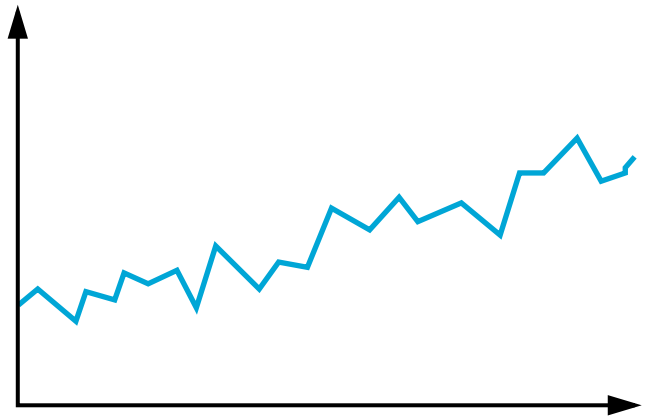
Time series pattern

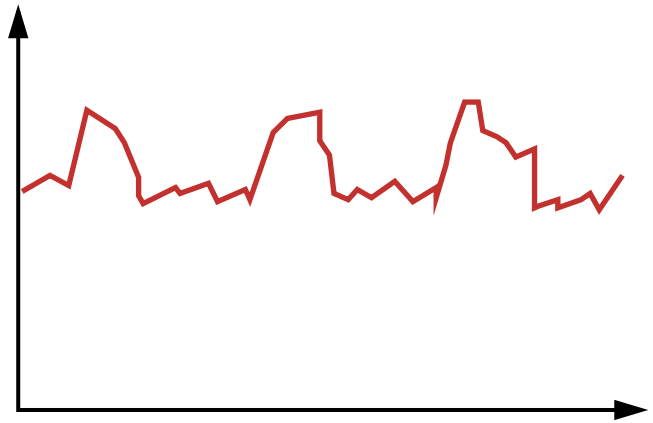
Constant



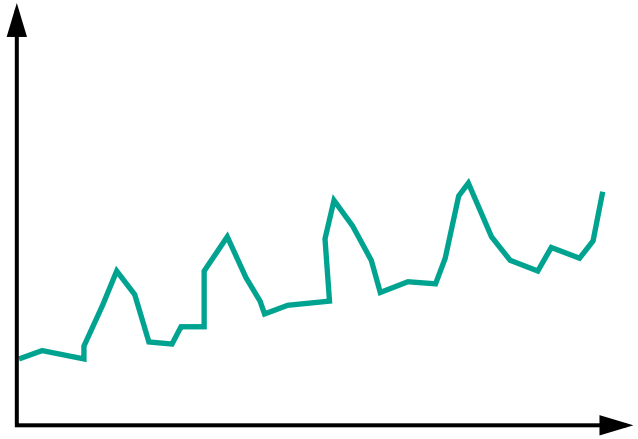
Trend



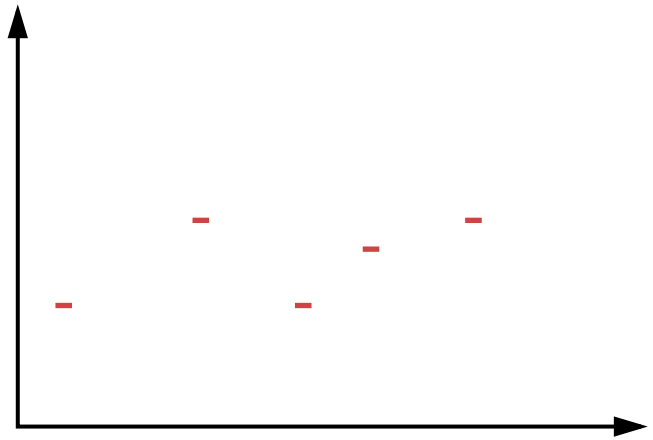
Seasonal



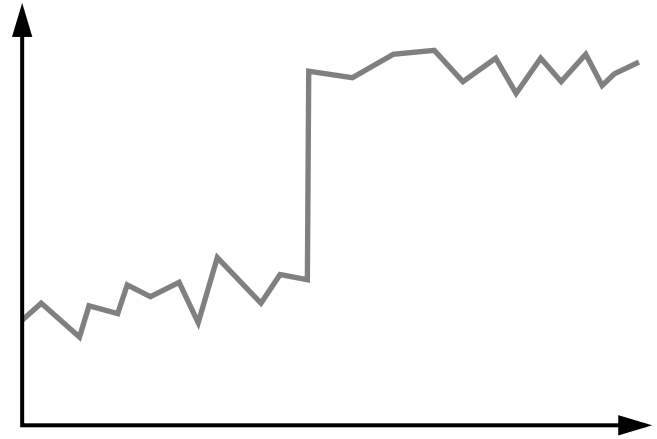
Trend-Seasonal



Sporadic



Structural break



Forecast horizons

- Short-term forecasts
  - Time period: Less than tree months
  - Needed for: Scheduling of production, personal, transportation and demand
- Medium-term forecasts
  - Time period: Three months to one year
  - Needed for: Determine future resource requirements, like hire personal or buy a new machinery
- Long-term forecasts
  - Time period: More than one year
  - Needed for: Strategic planning

Important: Uncertainty increases as the forecast horizon increases

Heizer, J., Munson, C. & Render, B. (2019). *Operations Management*. (13th ed.). Pearson International
Hyndman, R.J., & Athanasopoulos, G. (2021) *Forecasting: principles and practice*, 3rd edition

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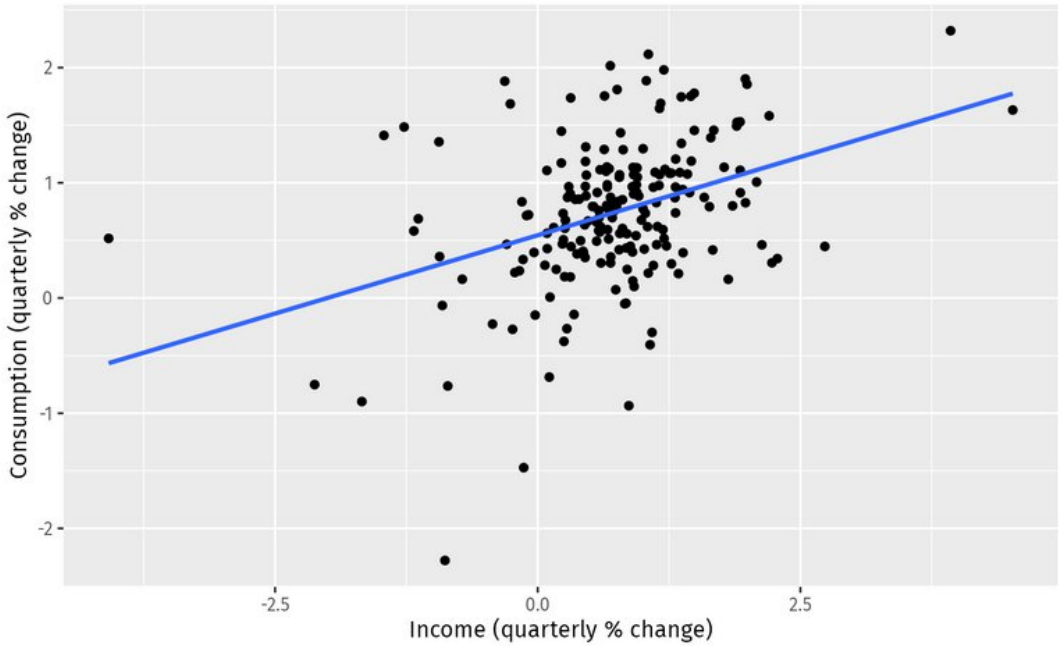
Regression

- Regression is a supervised learning technique
- The target variable is a numeric value
- Target variable: Variable to be predicted
- Explanatory variables: help predict the target variable
- Goal: Identify relationships between the different variables



https://otexts.com/fpp3/regression-intro.html

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Differences

Time Series Forecasting

- Goal: Predict future values based on historical data
- Consideration of the temporal dependency of the data

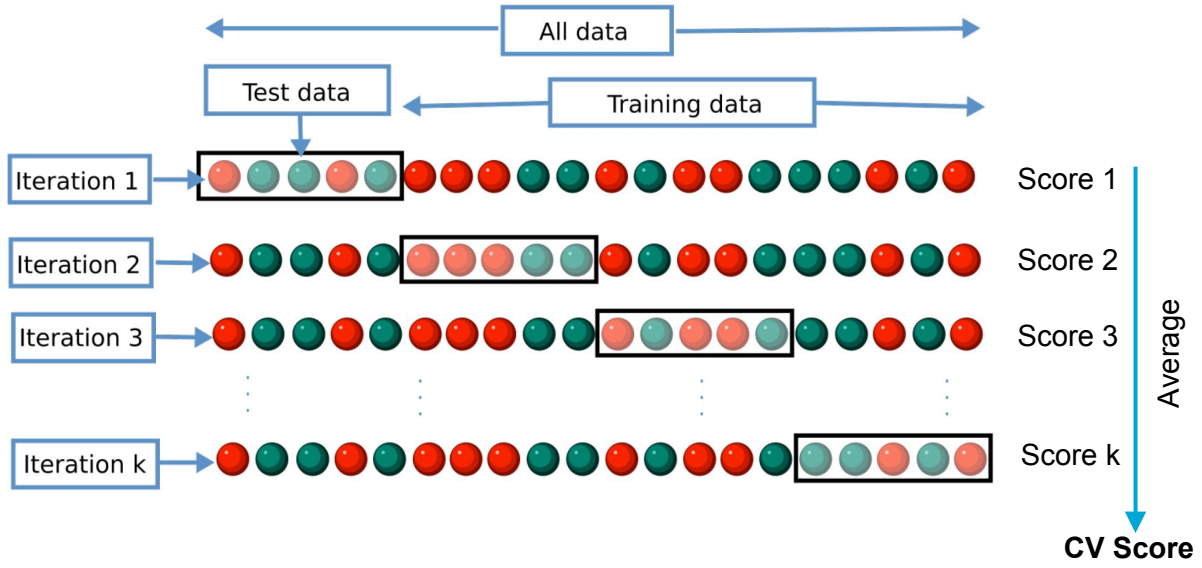
Regression

- Goal: Identify relationships between the different variables
- No consideration of the temporal dependency of the data

Cross Validation

- Problems for time series models:
  - Splits are random
  - Order of a time series may not be maintained
- Solution: Time Series Cross-Validation

k-Fold Cross-validation

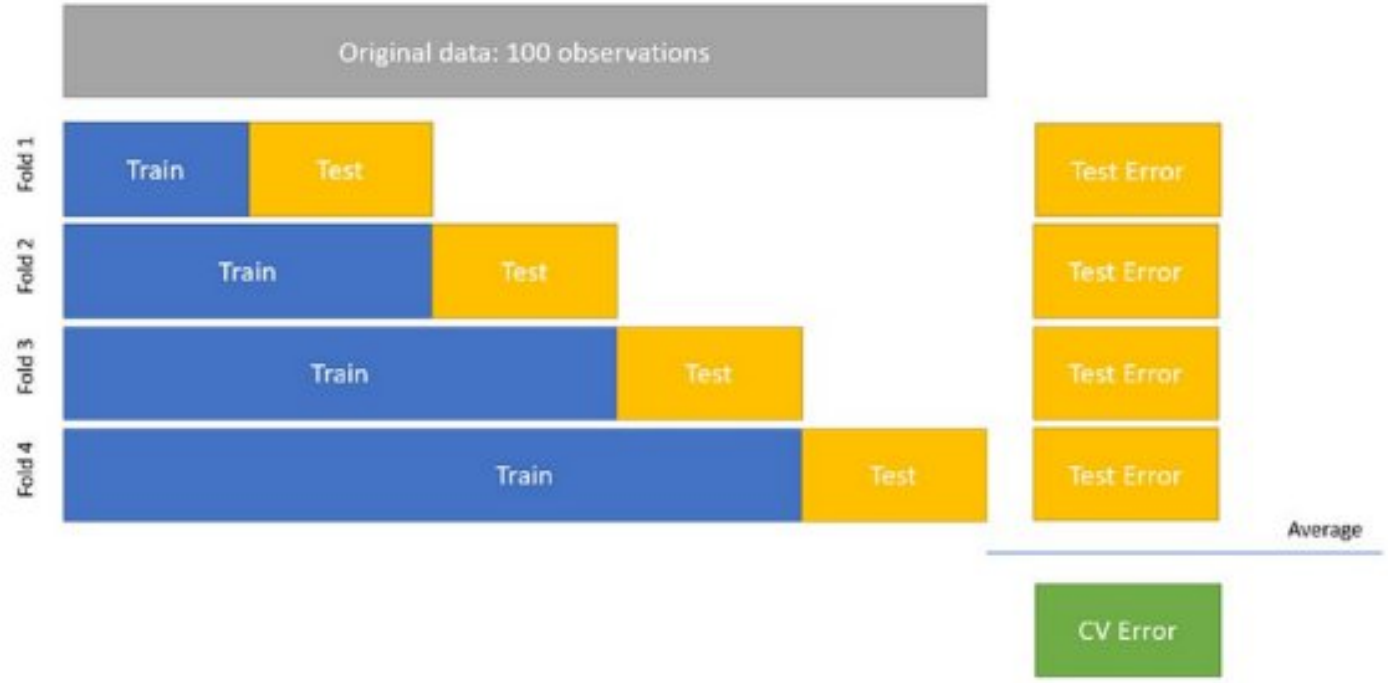


https://en.wikipedia.org/wiki/Cross-validation_(statistics)#/media/File:K-fold_cross_validation_EN.svg

Korstanje, J. (2021): Advanced Forecasting with Python

Time Series Cross Validation

- Training data only includes data prior the test period
- No future observations are possible
- Result: average of all tests



Korstanje, J. (2021): Advanced Forecasting with Python, p. 37

Uncertainty Quantification

- Basis for many critical decisions
- Is needed for trustworthy predictions
- Provides information on the reliability of complex machine learning models
- Predictive distributions: Probability distribution for future events
- Prediction intervals: specify range of values within which a future observation will lie with a certain probability

Anastasios N. Angelopoulos and Stephen Bates (2022): A Gentle Introduction to Conformal Prediction and Distribution-Free Uncertainty Quantification

Recap this lecture

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This material was created with the assistance of an AI language model.

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