TIME SERIES ANALYSIS & FORECASTING

By: Asmaa Mahmoud Saeed

PREREQUISITE

- Python
- Probability and statistics

CONTENT

- Concepts
- Python for time series analysis and forecasting
- Smoothing
- Stationarity
- Decomposition
- ACF-PACF
- AR model
- MA model

- ARMA & ARIMA
- SARIMA
- Box – Jenkins
- ARCH
- GARCH
- Facebook prophet
- Machine learning for time series
- Deep learning for time series

WHAT IS A TIME SERIES?

Time Series is a sequence of numerical data obtained at regular time intervals (equally spaced over time).
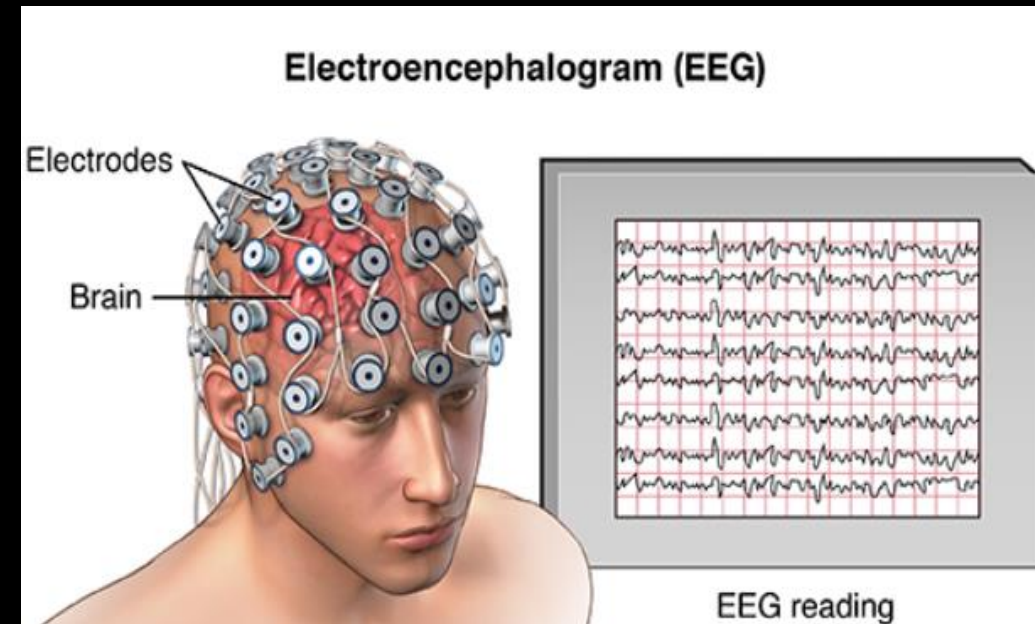

EUR/USD Price

TIME SERIES APPLICATIONS

Time Series Forecasting related to many applications like:

- Medical data like EEG*

- Data collected by sensors
  like internet of things, …etc.

- Energy consumption.

- Demand Forecasting

- Weather.

- Traffic control.

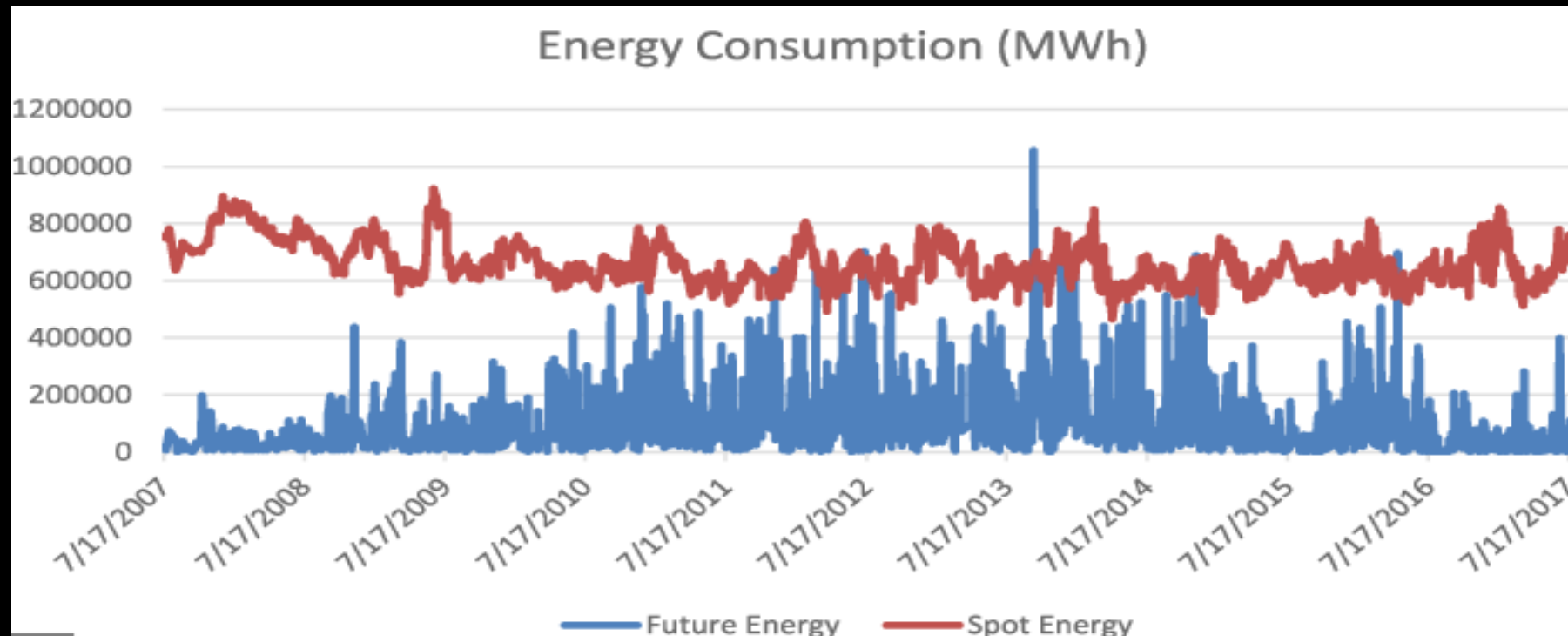- Time Series Financial market (stock-forex)

TIME SERIES APPLICATIONS

Data collected by sensors
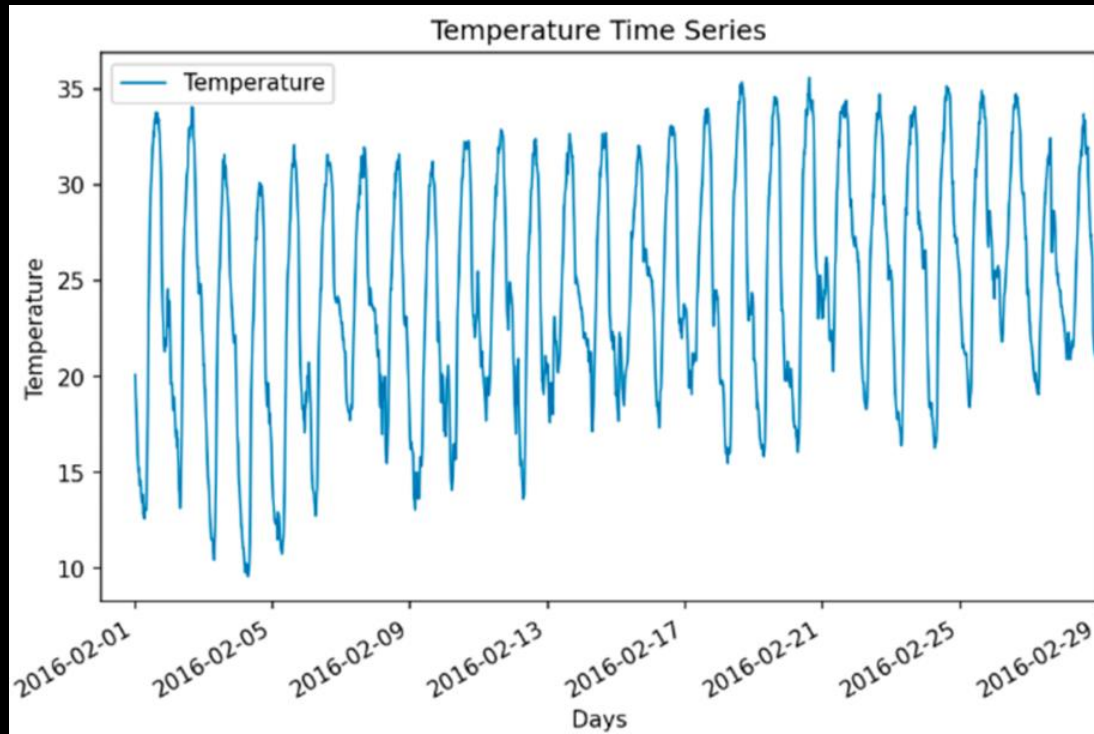like internet of things, …etc.
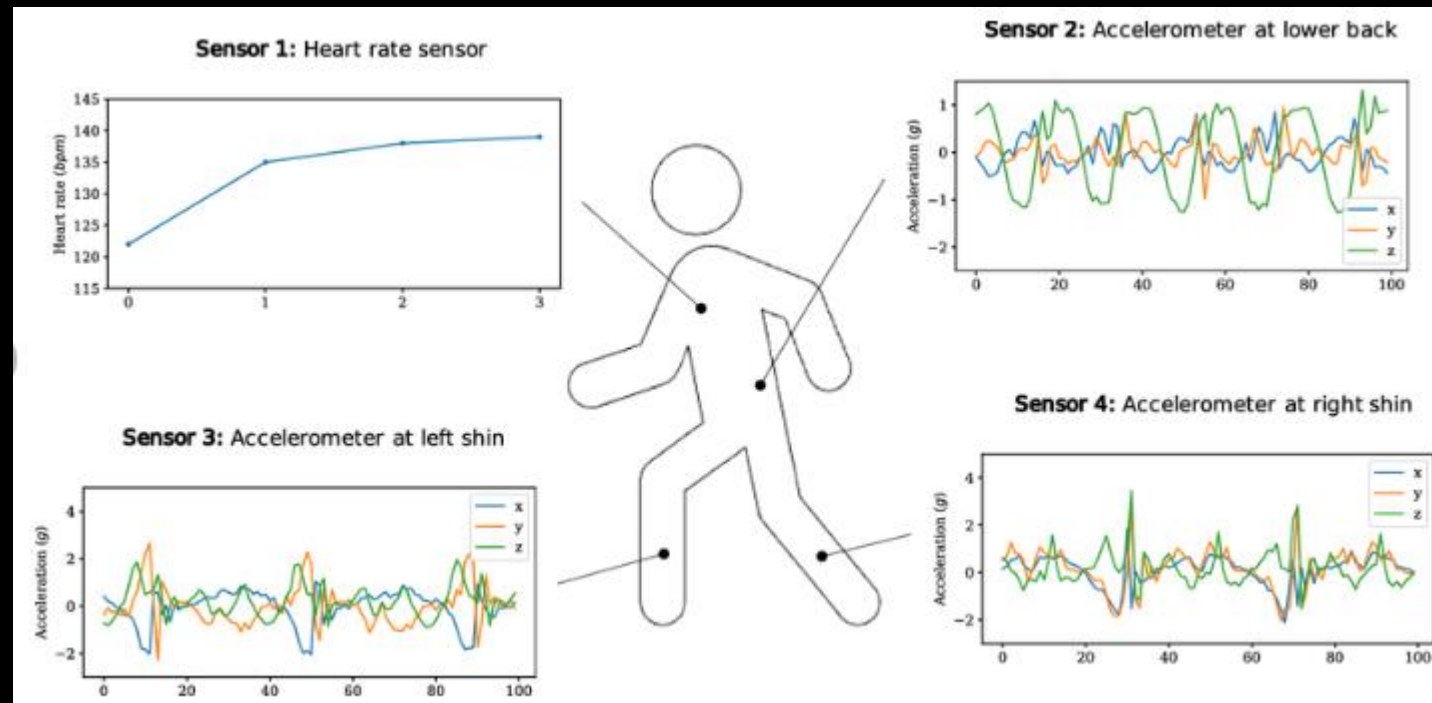
TIME SERIES APPLICATIONS

- Energy consumption.
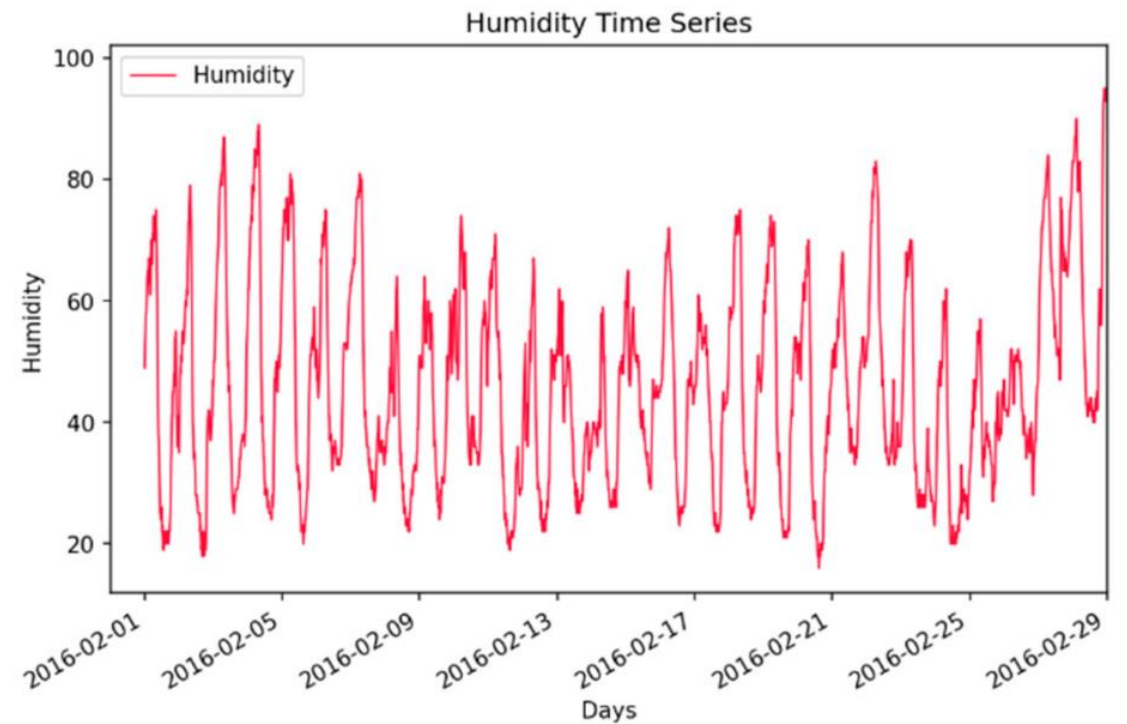

Energy Consumption (MWh)

Future Energy — Spot Energy
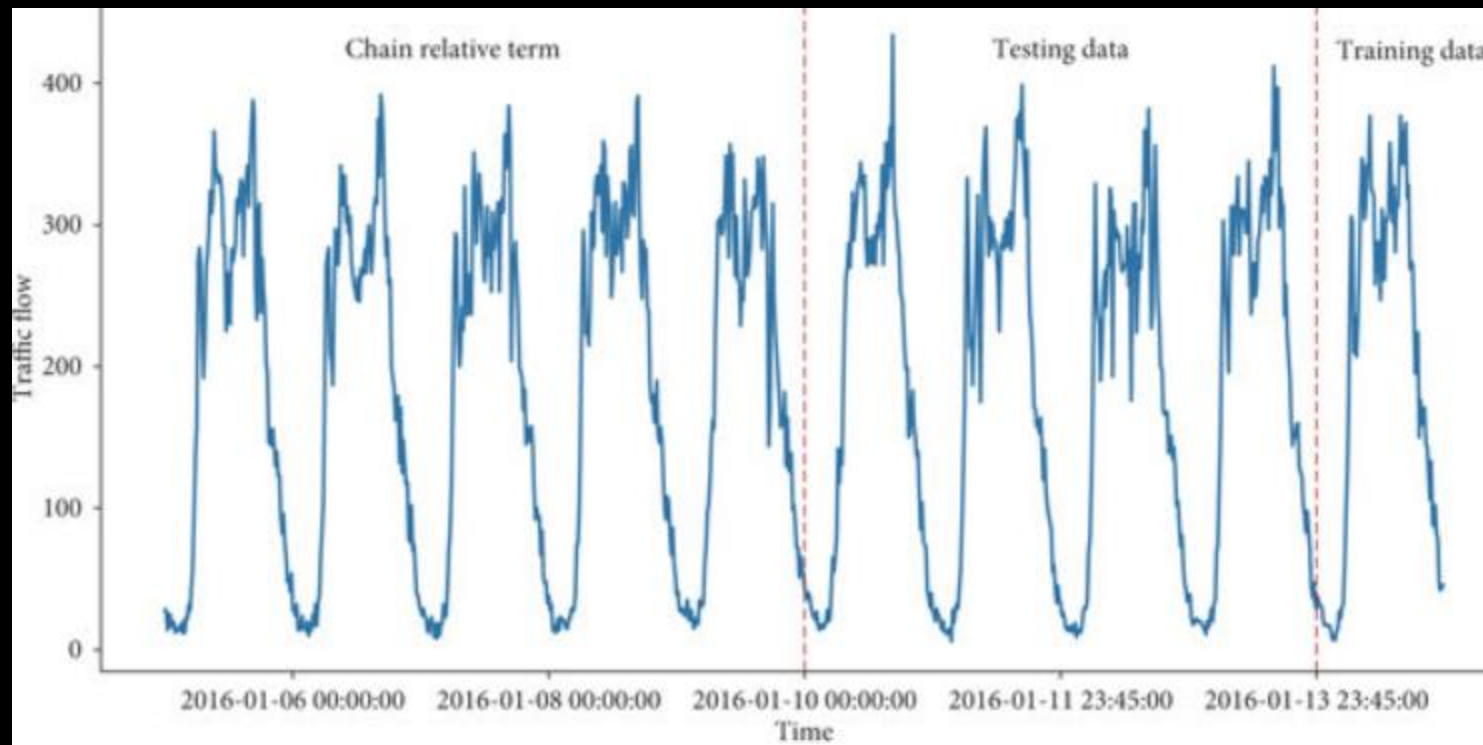
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TIME SERIES APPLICATIONS

Weather

(a) (b)

TIME SERIES APPLICATIONS

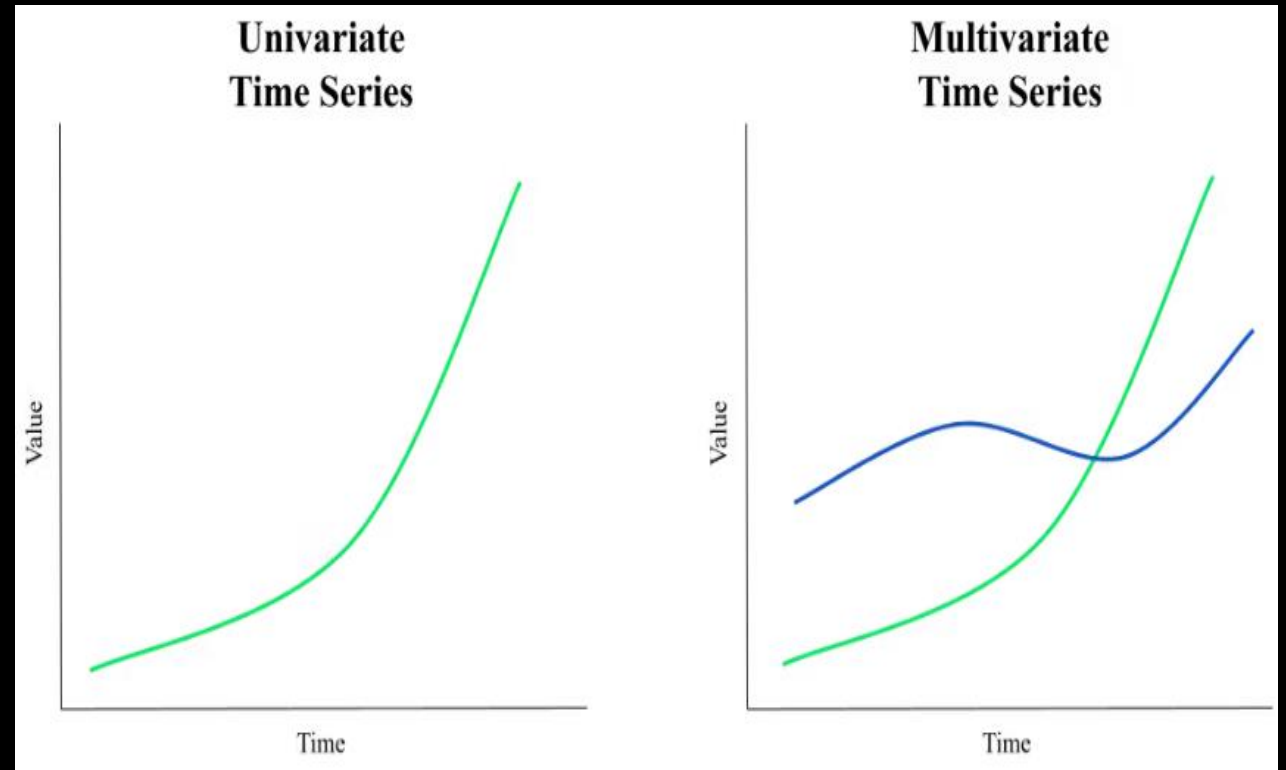Traffic control.

TYPES OF TIME SERIES

Univariate

Univariate time series data follows a single target variable over time.

Multivariate

Multivariate time series data is a collection of observed variables (cross sectional data) that are related to each other.

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TIME SERIES FORECASTING

One-step ahead forecasting where at each step forecast horizon = 1 and window size = w (b)
**Multi-step Ahead** Forecasting:where at each step forecast horizon = h, window size = w, and the window of predictor variables is saturated with forecasted values after w iterations.

a. One-Step Ahead Forecasts

b. Multi-Step Ahead Forecasts

Time

	Actual Data
	Current Forecast
	Previous Forecast
	Future Data
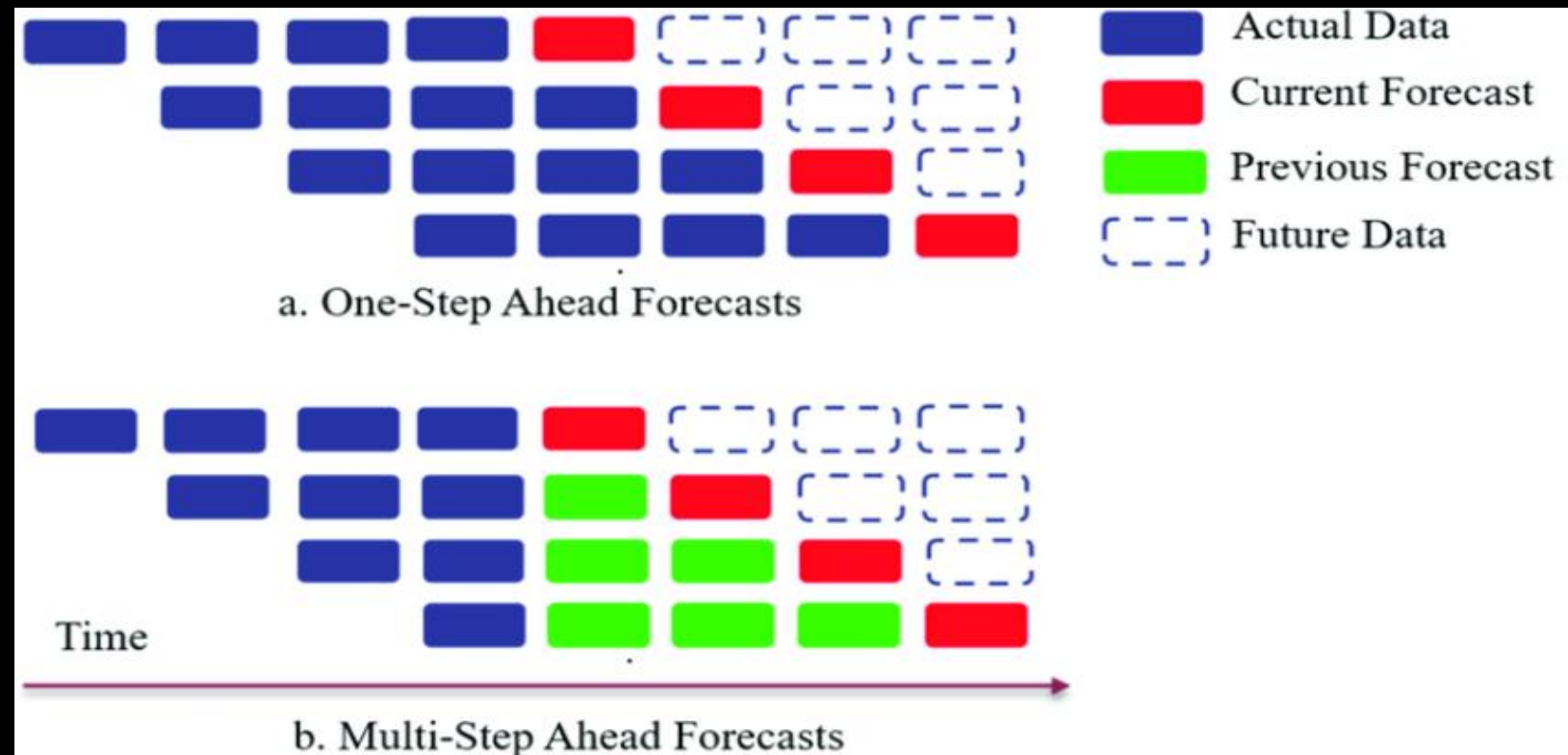
TIME SERIES COMPONENTS

In general, the time series can be decompose into 4 components: **Trend, Seasonal Variation, Cyclical Variation, and Irregular Variation** that can be modelled deterministically with mathematical functions of time .

- **General Trend:** The smooth long term direction (upward or downward) of a time series.
- **Seasonal Variation:** Patterns of change in a time series within a year which tend to repeat each year.
- **Cyclical Variation:** The rise and fall of a time series over periods longer than one year.
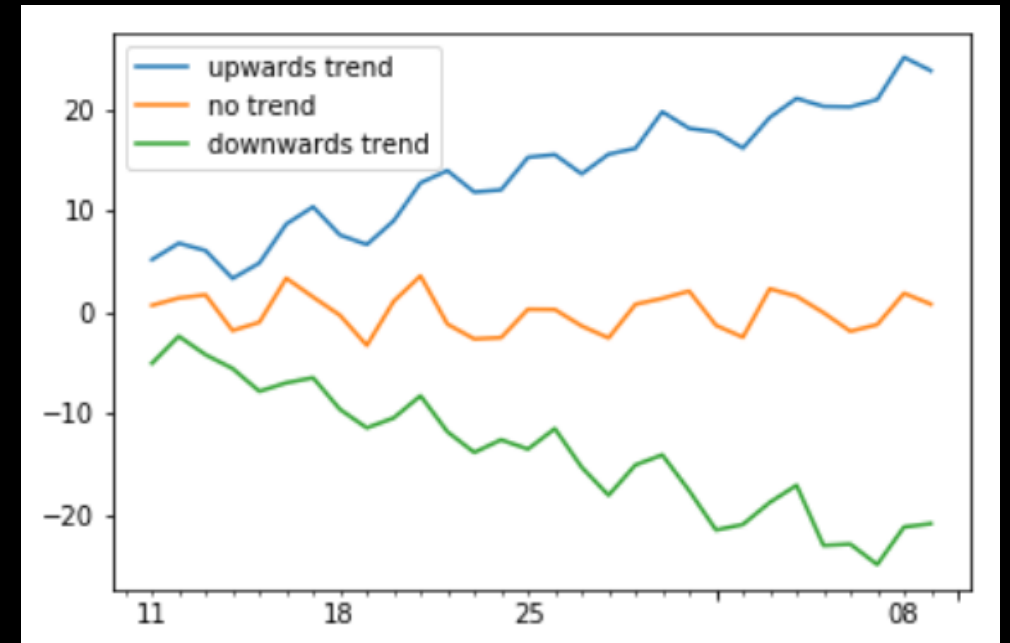- **Irregular Variation:** (error-residuals)Random and follows no regularity in the occurrence pattern
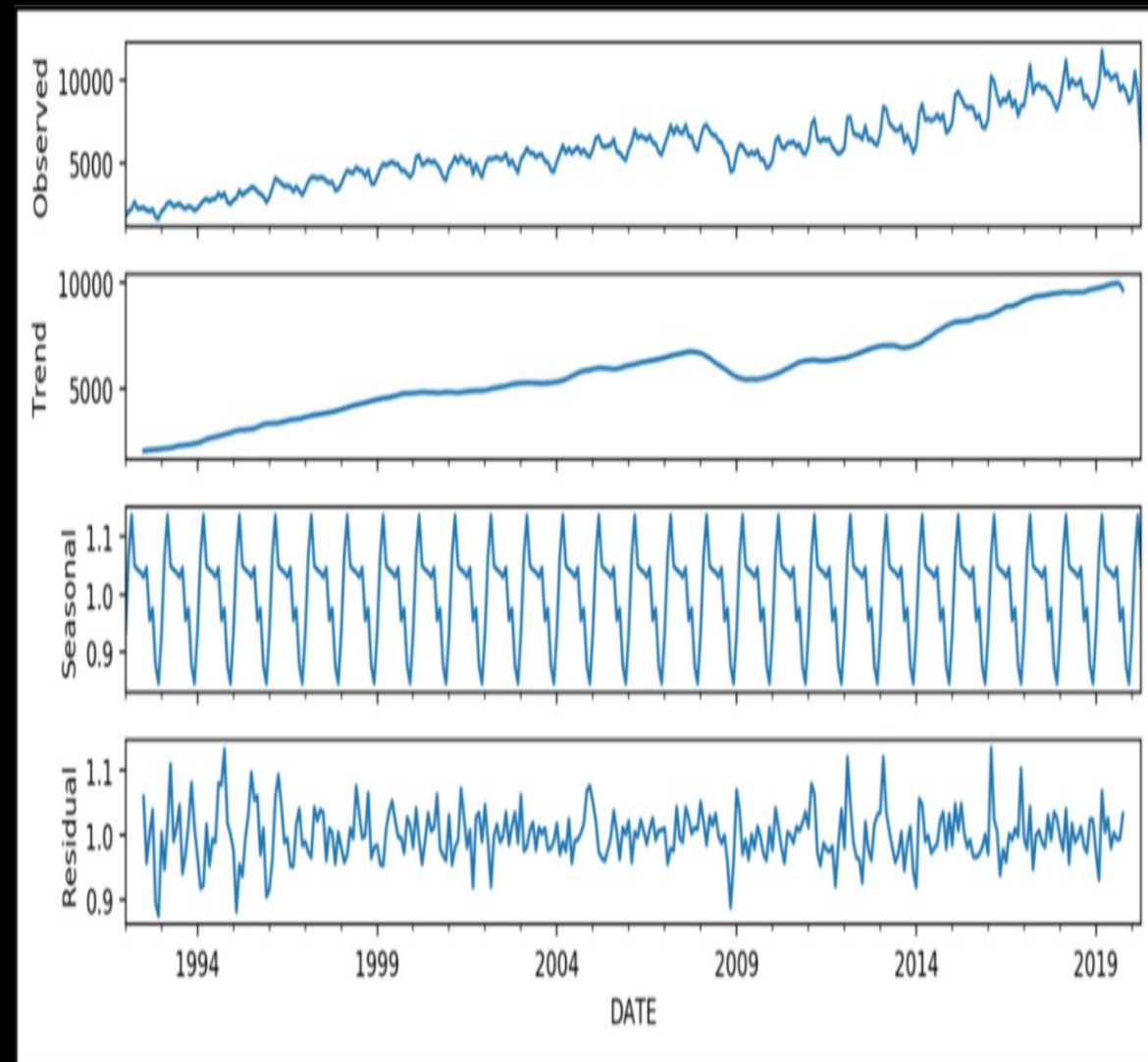
TREND

Trend

Trend captures the general direction of the time series.

▪ Trend can be increasing, decreasing, or constant.

▪ It can increase or decrease in different ways (linearly, exponentially, or in other ways).

TREND TYPES

- **Upward Trend:** A trend that shows a general increase over time, where the values of the data tend to rise over time.

- **Downward Trend:** A trend that shows a general decrease over time, where the values of the data tend to decrease over time.

- **Horizontal Trend:** A trend that shows no significant change over time, where the values of the data remain constant over time.

Trend-types - geeksforgeeks
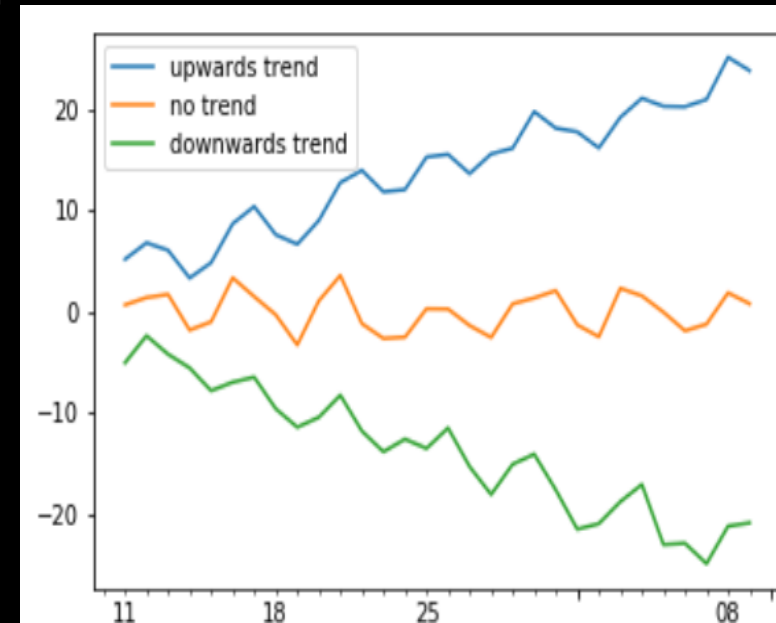
TREND TYPES

- **Non-linear Trend**: A trend that shows a more complex pattern of change over time, including upward or downward trends that change direction or magnitude over time.

- **Damped Trend**: A trend that shows a gradual decline in the magnitude of change over time, where the rate of change slows down over
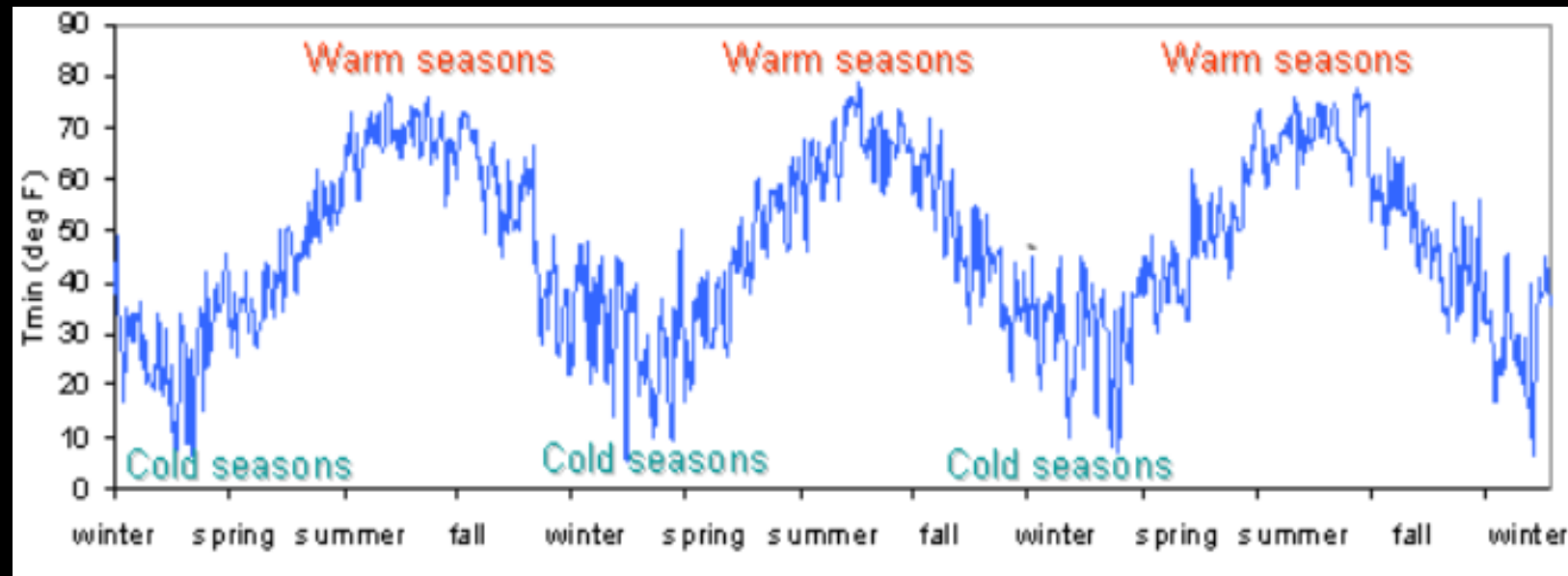
  time
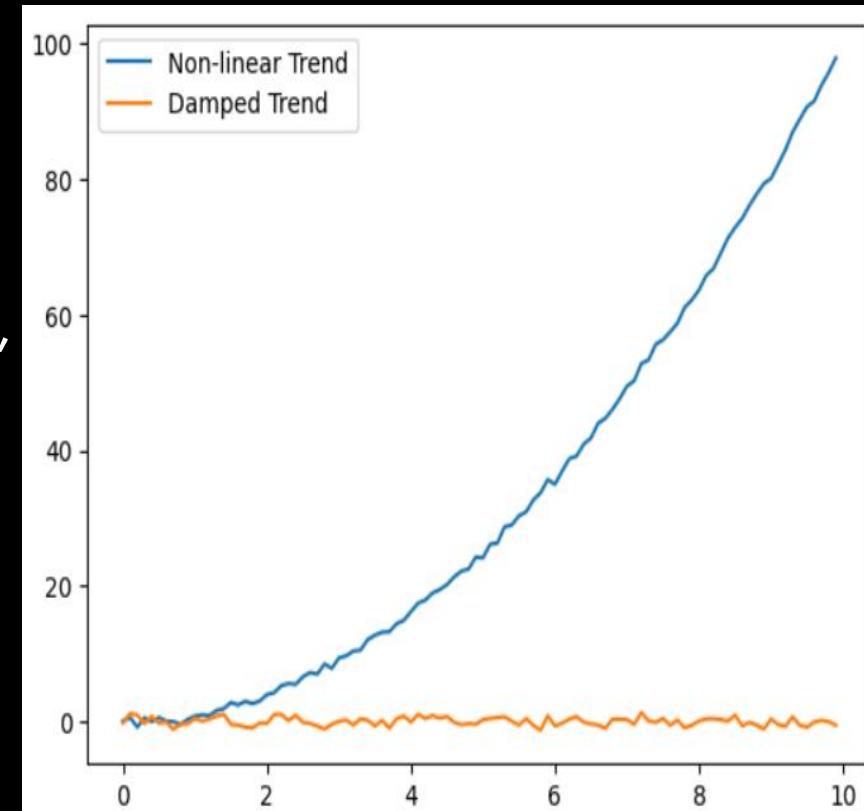
TIME SERIES COMPONENT

Seasonality

Seasonality captures effects that occur with a specific frequency. It can be driven by many factors.

Naturally occurring events, such as weather fluctuations caused by time of year

Business or administrative procedures, such as the start and end of a school year

Social or cultural behavior, such as holidays or religious observances

Intel-source

TIME SERIES COMPONENT

Cycle: A pattern in the data that repeats itself after a specific number of observations, which is not necessarily related to seasonality.

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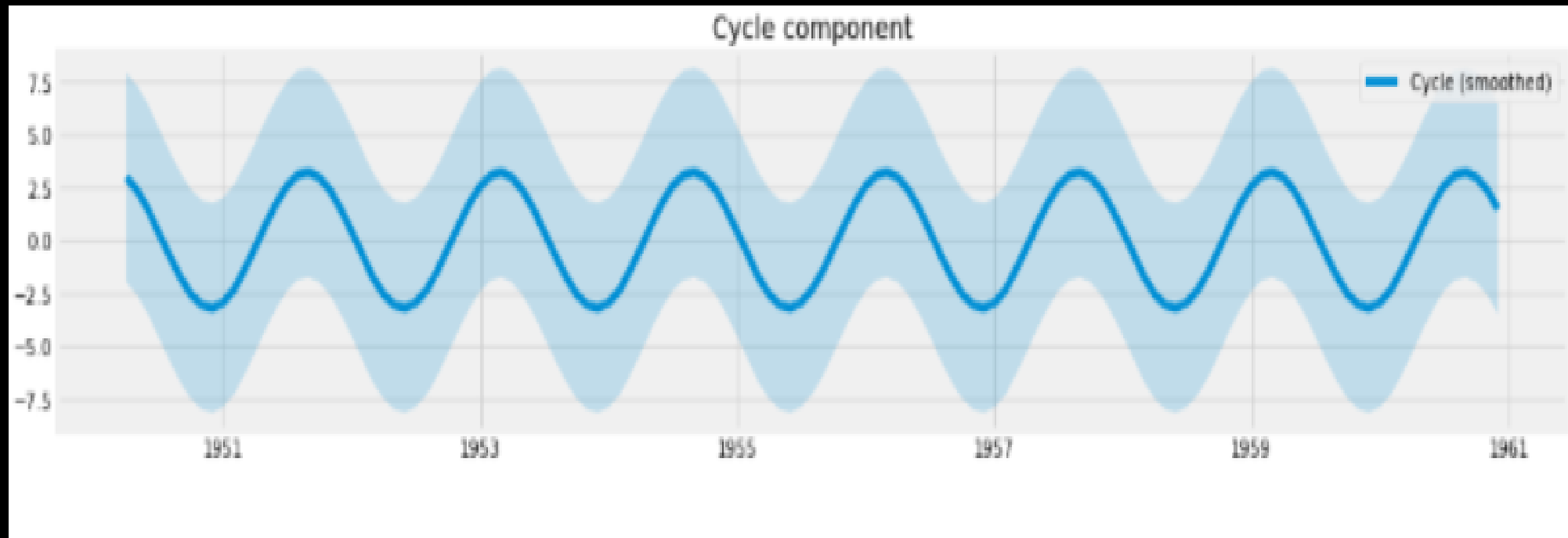
TIME SERIES COMPONENT

Residuals

Residuals are the random fluctuations left over after trend and seasonality are removed.

▪ They are what is left over after trend and seasonality are removed from the original time series.

– You should not see a trend or seasonal pattern in the residual.

▪ They represent short-term fluctuations.

▪ They're either random or a portion of the trend or seasonality components was missed in the decomposition.
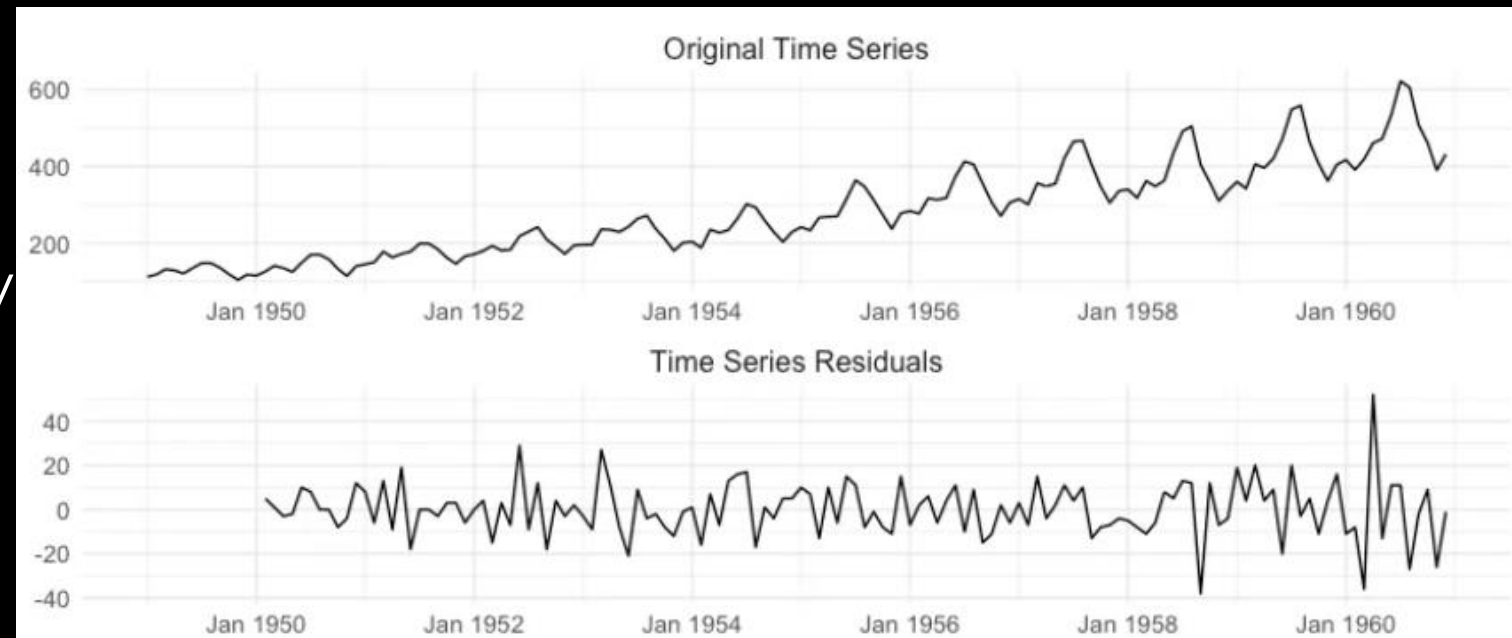
TIME SERIES COMPONENTS

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TIME SERIES COMPONENTS