Time Series Analysis

MUKESH KUMAR

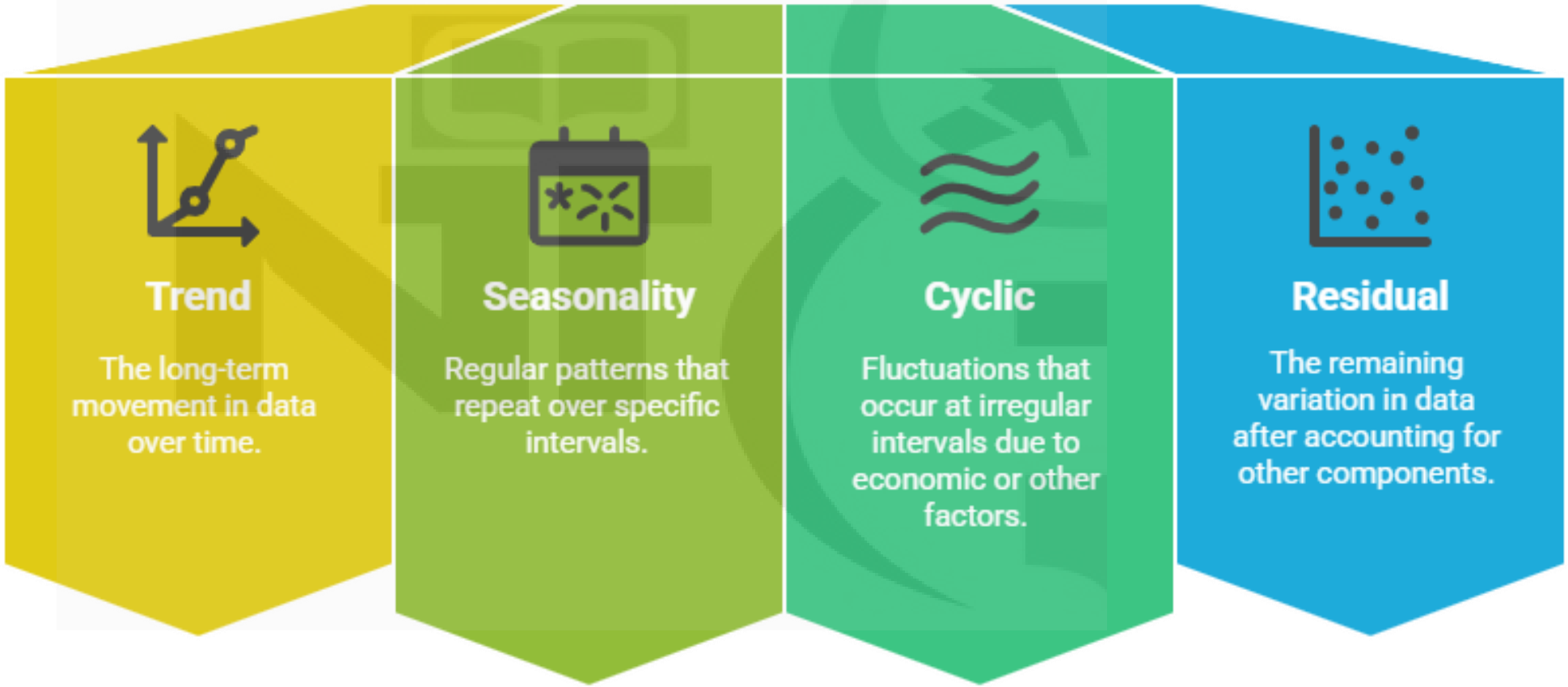
What is a Time Series?

A **time series** is a sequence of data points recorded or measured at successive points in time, usually at uniform intervals (e.g., daily, monthly, yearly).

Examples:

- Daily stock prices of a company
- Monthly rainfall in a city
- Yearly GDP of a country
- Hourly electricity consumption

Time Series Components



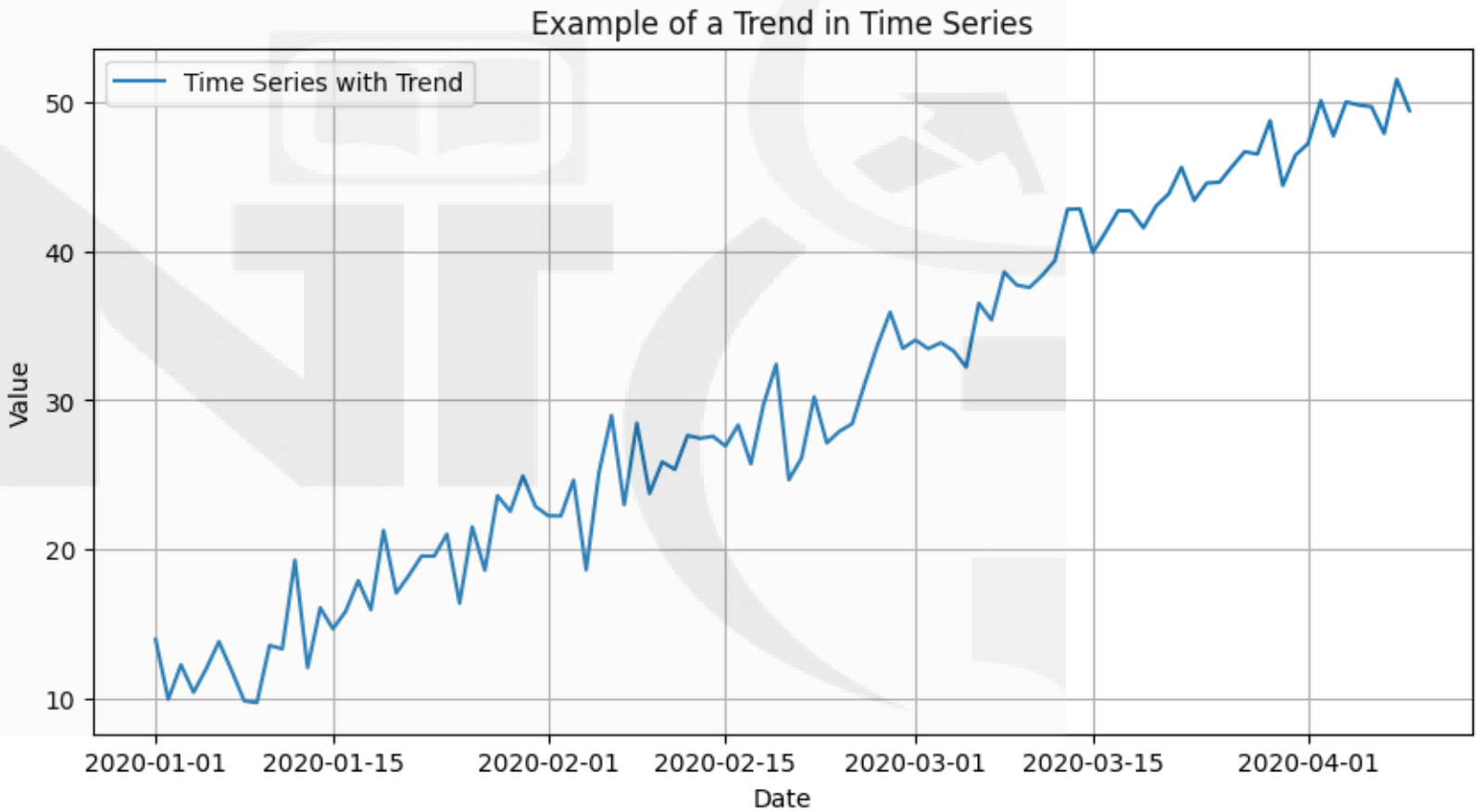
Trend

- The long-term movement or direction in the data.
- It shows the general pattern(like upward, downward, or stable) over a long period of time.
- Example: A company’s revenue increasing steadily over several years.

Key Points about Trend:

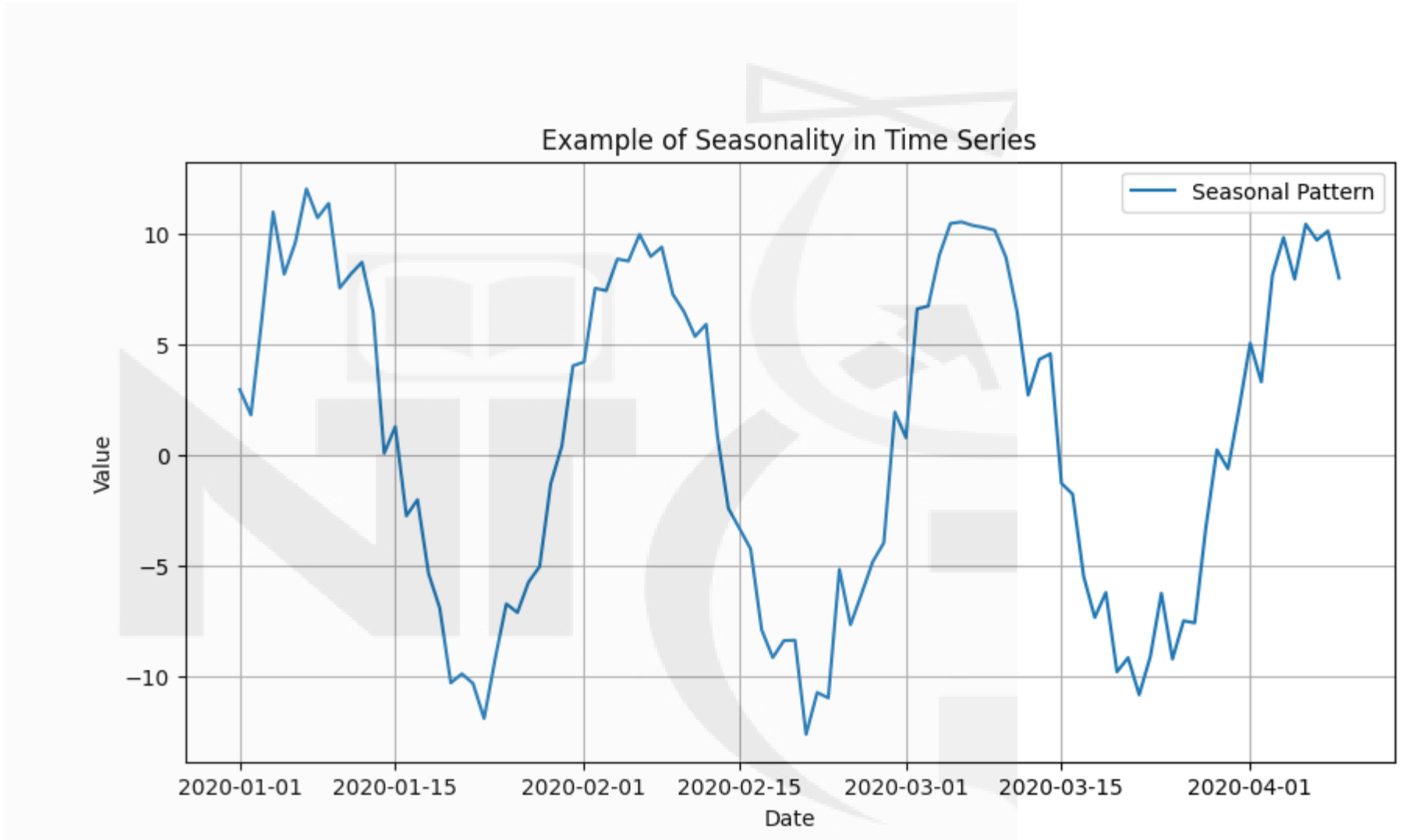
- It can be **upward** (e.g., rising sales over years), **downward** (e.g., declining birth rates), or **stationary** (no clear direction).

- Trends may be **linear** (straight line) or **nonlinear** (curved or exponential).


Example of a Trend in Time Series
Time Series with Trend
Value
Date
10
20
30
40
50
2020-01-01
2020-01-15
2020-02-01
2020-02-15
2020-03-01
2020-03-15
2020-04-01

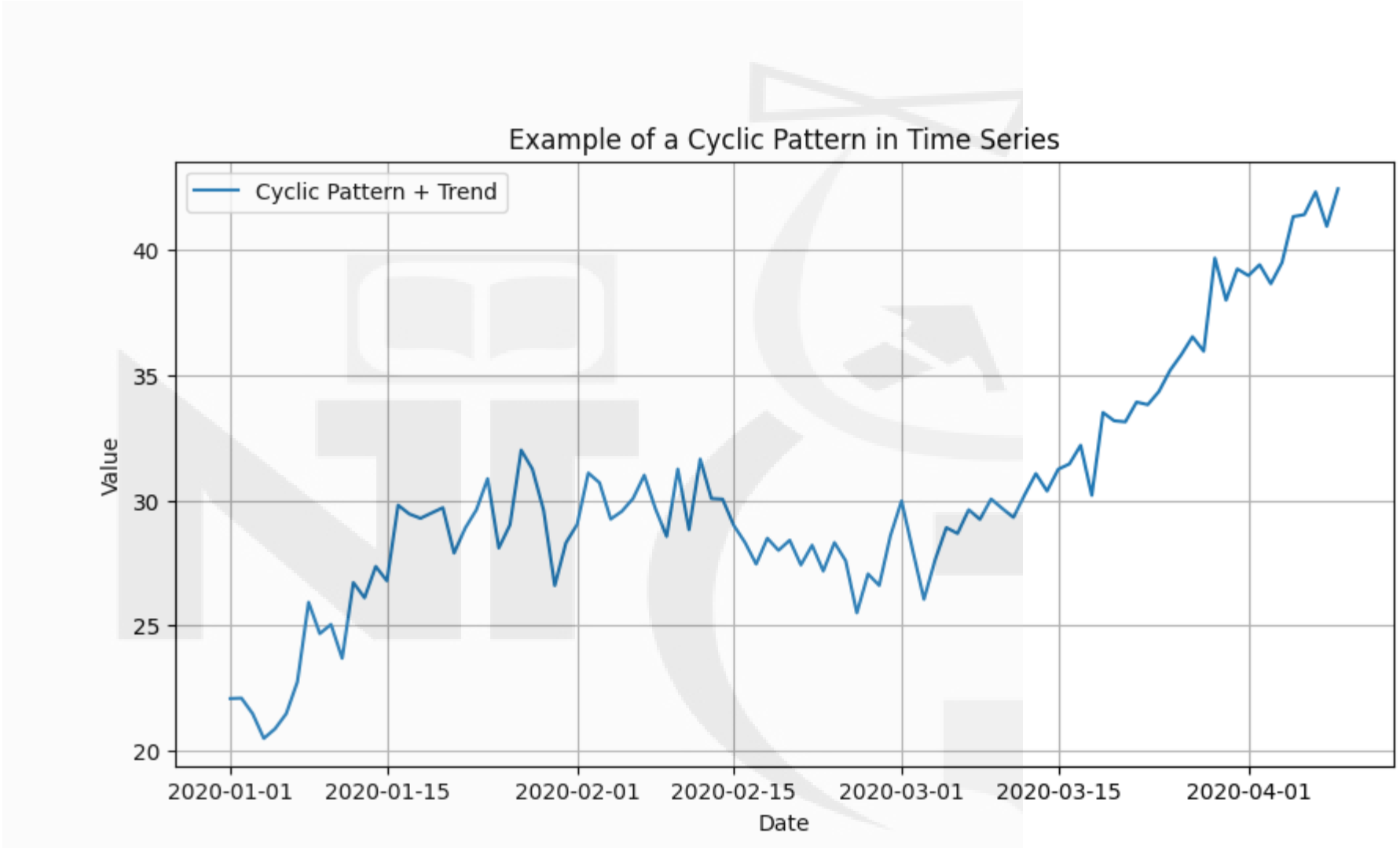
Seasonality

- Repeating short-term cycles or patterns at regular intervals (e.g., days, months, quarters).
- These are usually tied to calendar effects or seasons.
- **Example**: Retail sales peaking every December due to holiday shopping.


Example of Seasonality in Time Series
Seasonal Pattern
10
5
0
−5
−10
Value
2020-01-01
2020-01-15
2020-02-01
2020-02-15
2020-03-01
2020-03-15
2020-04-01
Date

Cyclic

- Fluctuations in the data that occur over longer periods but are not as regular as seasonality.
- Often related to economic or business cycles (like recession or boom).
- Example: Housing market cycles that span several years.


Example of a Cyclic Pattern in Time Series
Cyclic Pattern + Trend
Value
40
35
30
25
20
2020-01-01
2020-01-15
2020-02-01
2020-02-15
2020-03-01
2020-03-15
2020-04-01
Date

Irregular (or Residual or Random) Component

- Random or unpredictable variations that cannot be explained by the other components.
- Often caused by things like strikes, natural disasters, system errors, or one-time promotions.
- **Example**: A sudden drop in tourism due to a natural disaster.

- If your time series =
  Trend + Seasonality + Cyclic + Residual,

- then residual = **Actual data – (Trend + Seasonality + Cyclic)**

Additive and Multiplicative Time Series

- Jupyter notebook: Additive&MultiplicativeTimeSeries.ipynb

How to Determine if a Time Series is Additive or Multiplicative:

- Visual Inspection
- Decomposition
- Statistical Tests