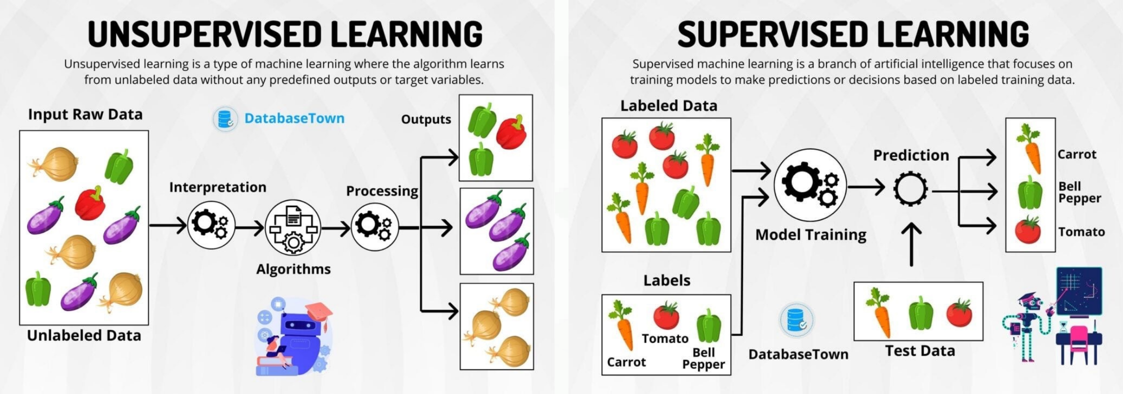
Time Series Analysis

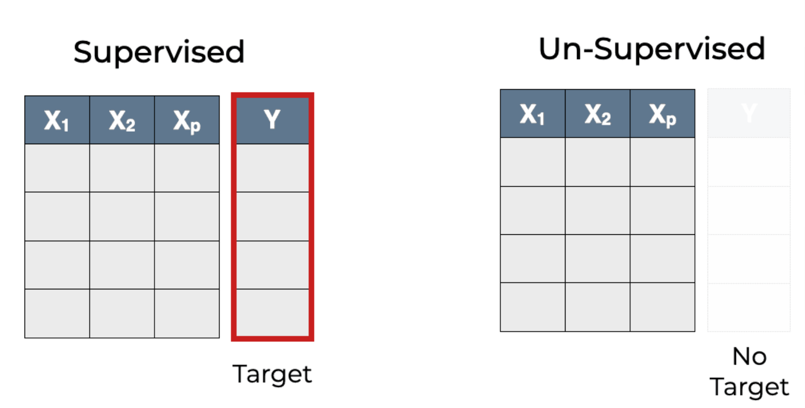
Kalbe Digital University

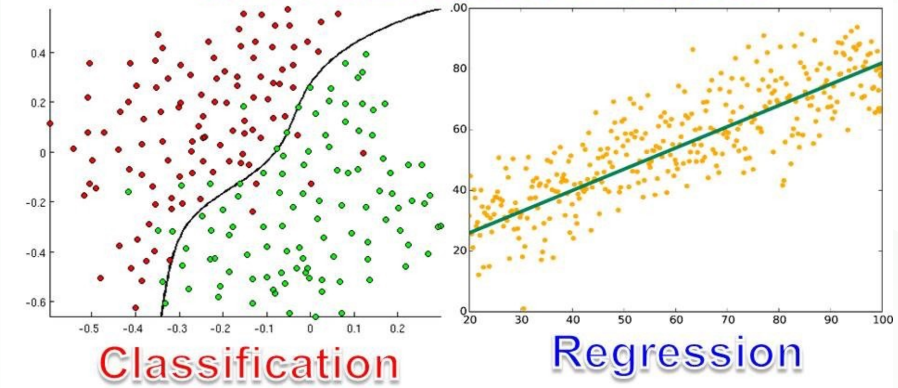
Outline

1. What is Time Series Data
2. Framework and Toolkit
3. Visualization
4. Linear Regression

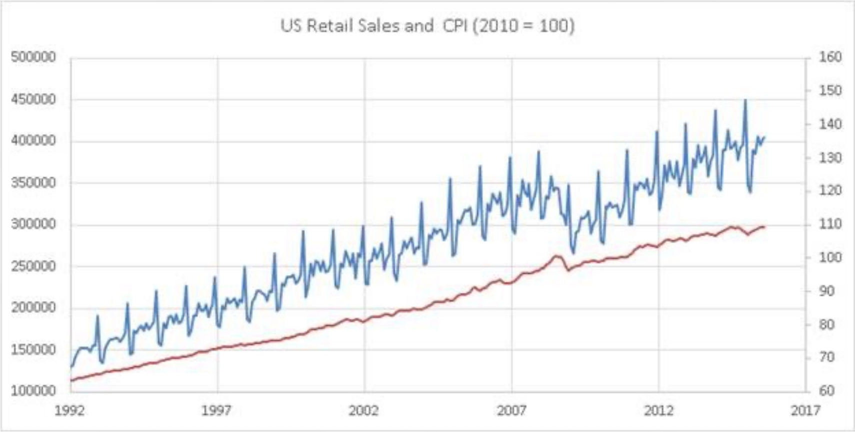
Kinds of Data We learn







No	Tahun	Jumlah Penduduk
1	2000	174706
2	2001	178125
3	2002	191990
4	2003	201263
5	2004	210984
6	2005	219351
7	2006	225249
8	2007	231121
9	2008	240553
10	2009	250367
11	2010	253178
12	2011	259913
13	2012	268022
14	2013	274089
15	2014	280109
16	2015	285967



Time Series

What is Time Series Data

Time series is a sequence of data points collected at successive and uniformly spaced points in time.

Format:

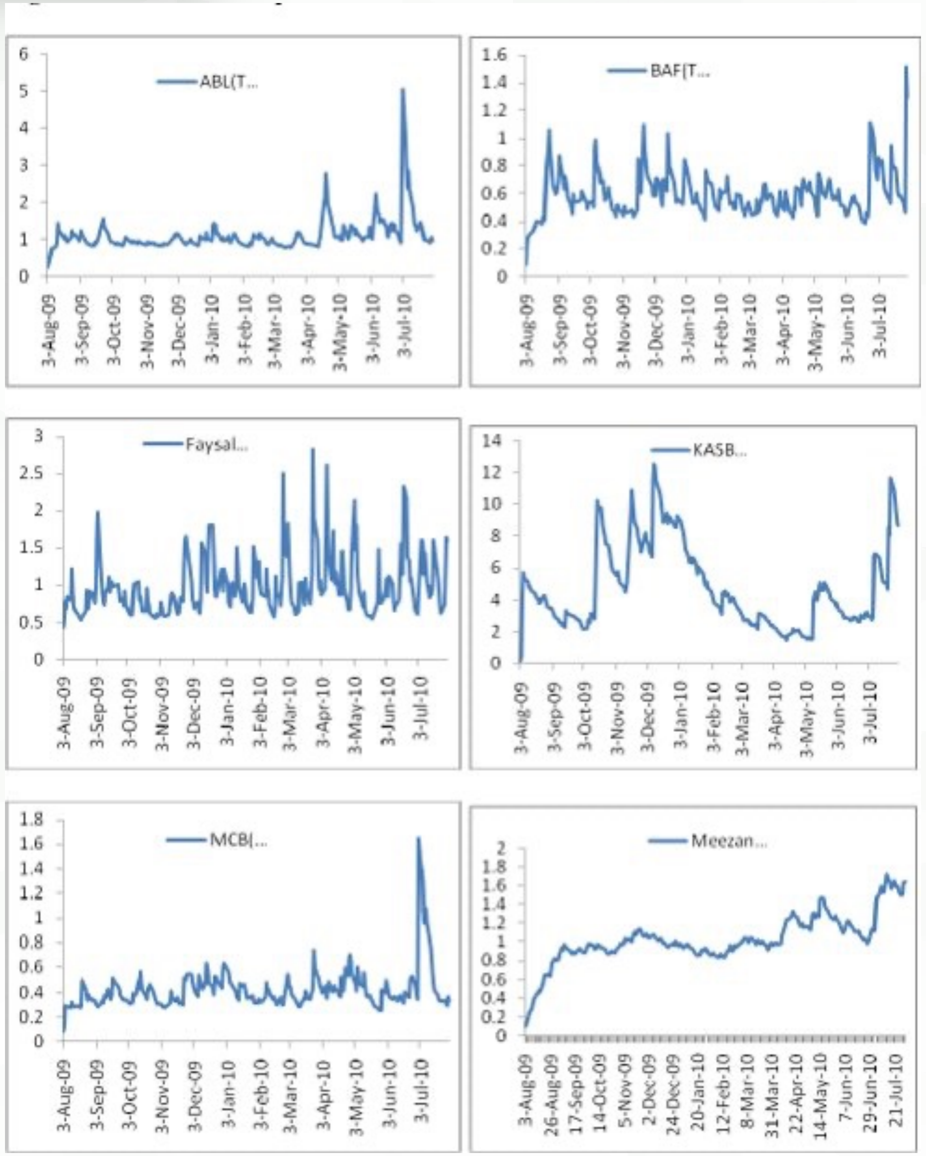
- Daily
- Monthly
- Yearly

Patterns:

- Seasonality
- Cyclic Patterns
- Noise

Domains:

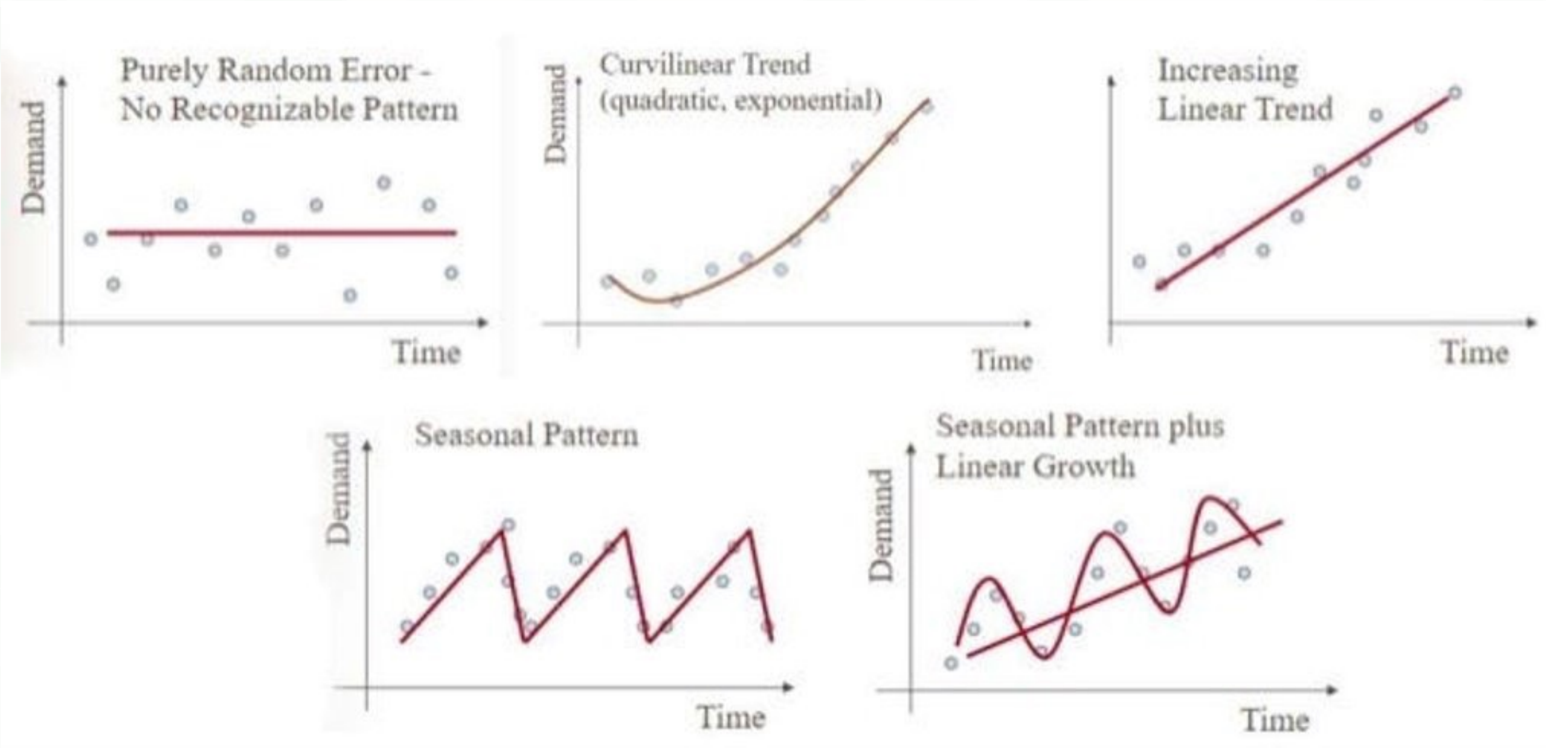
- Economics
- Medicine
- Environment
- Retail and Sales
- Technology



Patterns Inside Time Series Data

Patterns

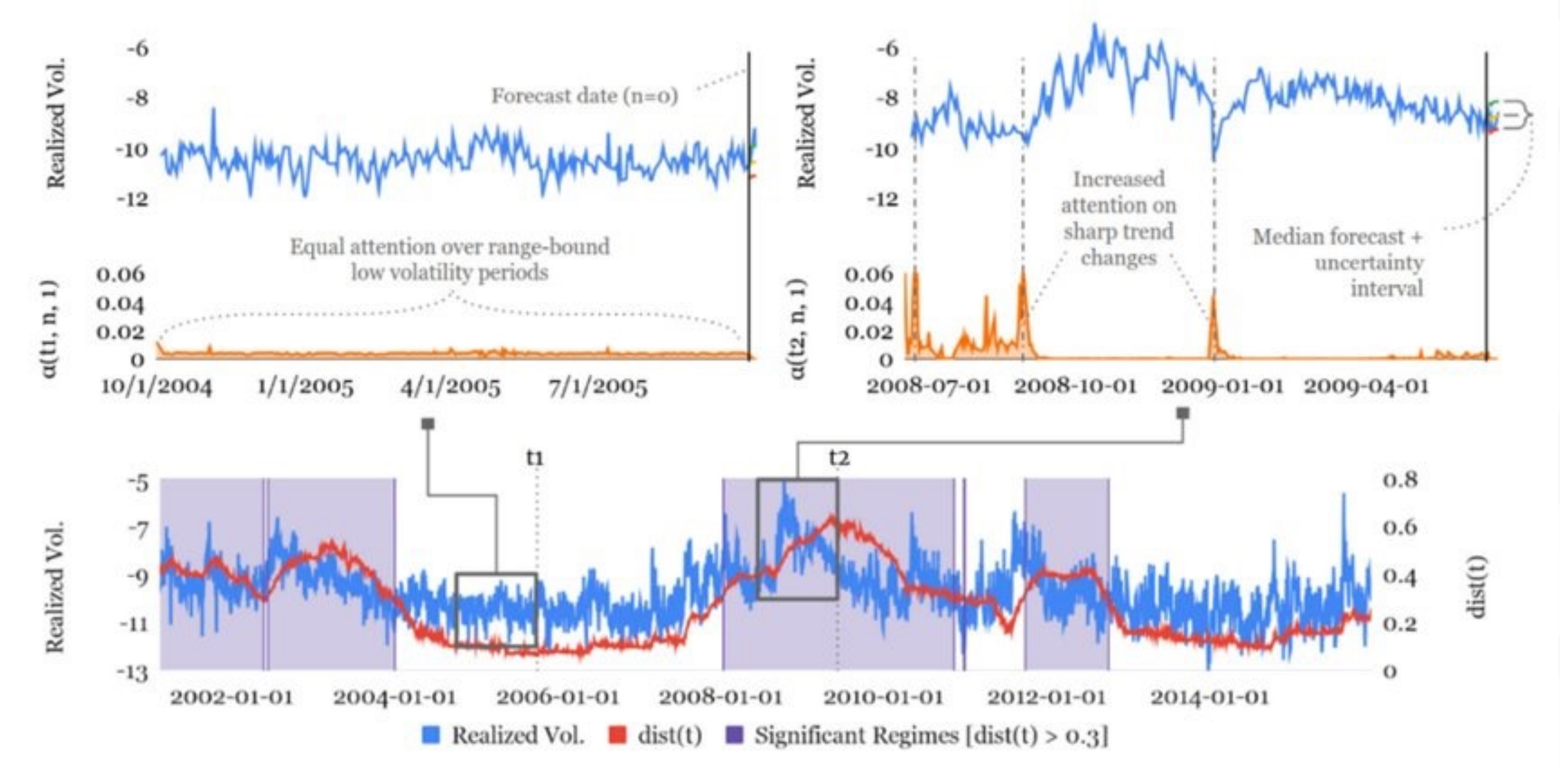
- Trend
- Seasonality
- Cycles
- Noise
- Level
- Structural Breaks
- Autocorrelation
- Stationarity



Examples in Manufacturing

Data Sources
- Production Output Data
- Energy Consumption Data
- Employee Productivity Data

The importance:
- Identification of production trends
- Identification of energy consumption patterns that can provide insights into efficiency and potential energy savings.
- 1Evaluation of employee performance to identify the need for training or skill development.



Time Series Analysis Scopes in EDA

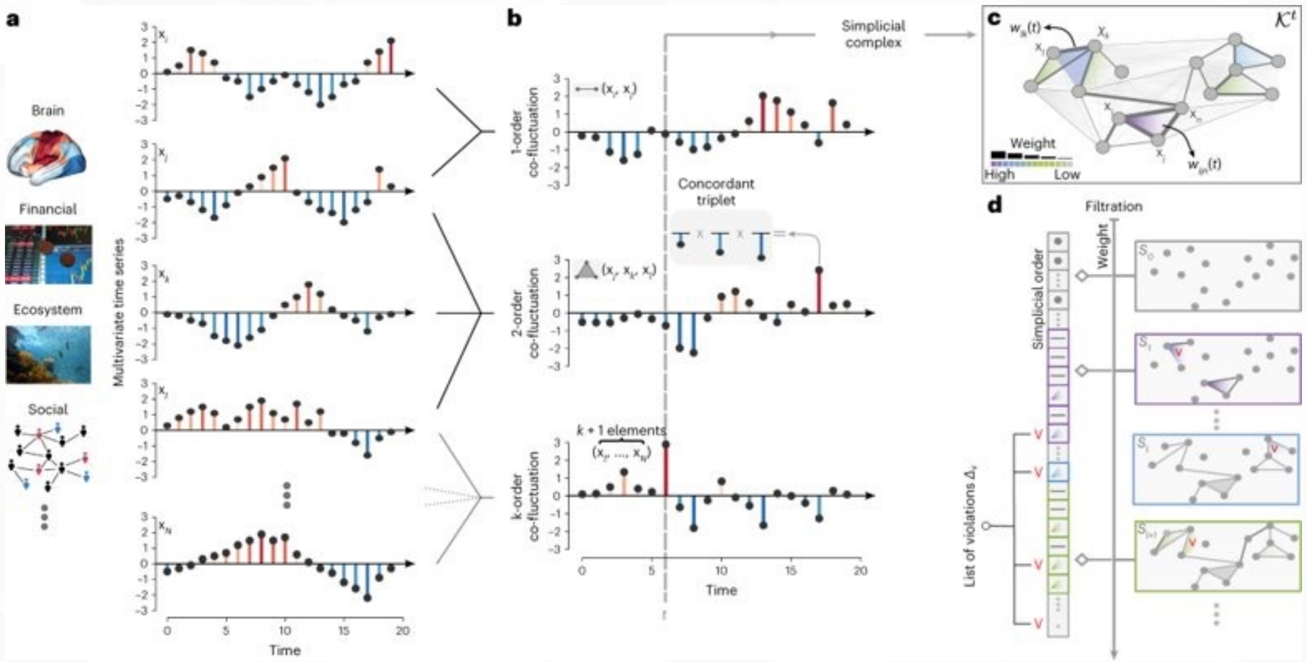
To provide a comprehensive approach to understanding chronological data, ensuring that subsequent analyses or predictions are based on solid foundational knowledge.

Purpose in EDA:

- Understanding Patterns
- Detect Anomalies
- Inform Assumptions
- Data Quality Assessment

Methods and Techniques:

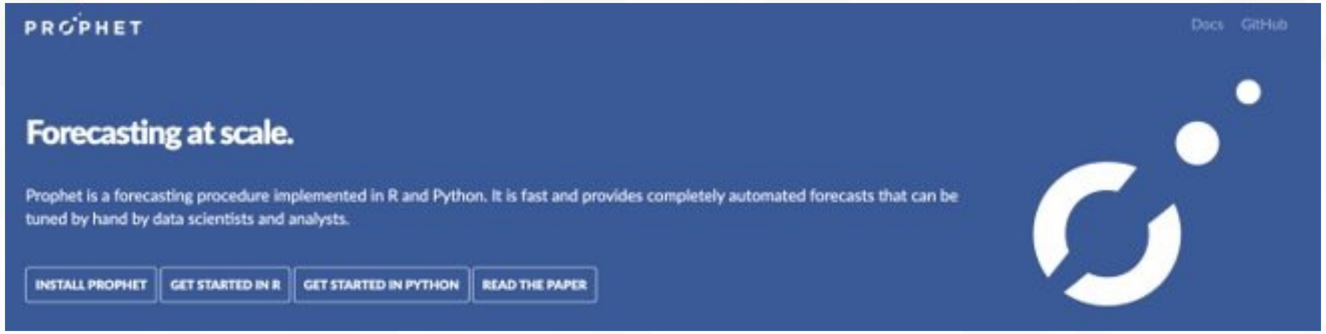
- Visualization: Histogram and Density Plots
- Decomposition
- Autocorrelation
- Partial Autocorrelation
- Rolling Statistics
- Stationarity Testing

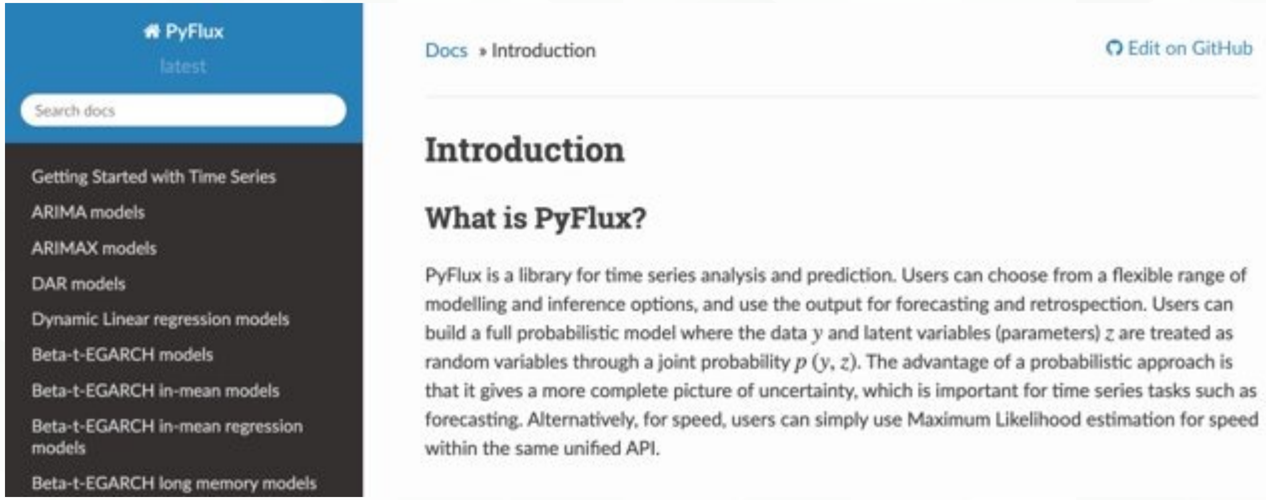


Framework and Toolkit

Methods and Techniques:
- Data Importing (CSV, Database, APIs)
- Handling Missing Values
- Time Zone Handling
- Resampling
- Deduplication
- Outlier Detection

Frameworks and Toolkits:
- Pandas
- StatsModels
- NumPy
- Scikit-Learng
- Prophet
- PyFlux



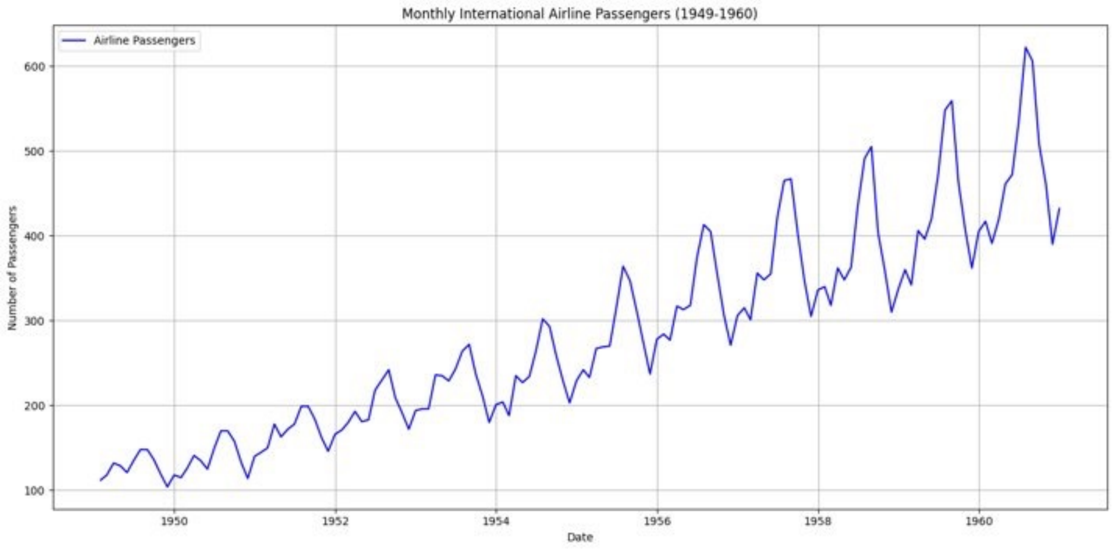


Visualization

Common Visualization

- Line Plots
- Seasonal Plots
- Scatter Plots
- Histogram and Density Plots
- Box and Whisker Plots
- Heat Maps
- Lag Plots
- ACF and PACF
- Decomposition Plots
- Rolling Statistics

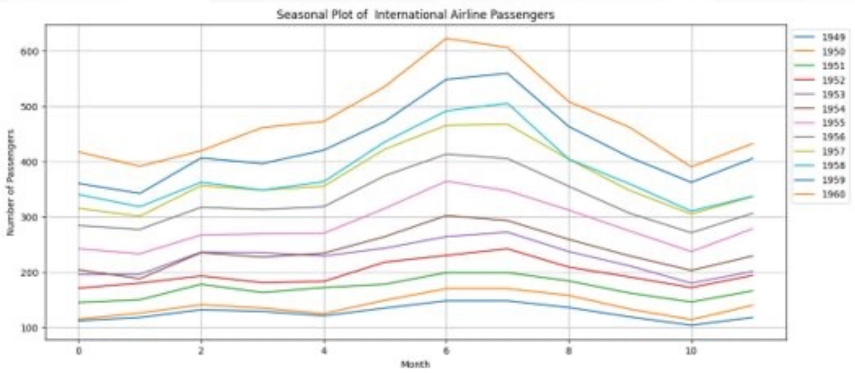
ChatGPT Prompt: Use publicly available Airline Passenger dataset, write Python codes to visualize time series data using Line Plot.

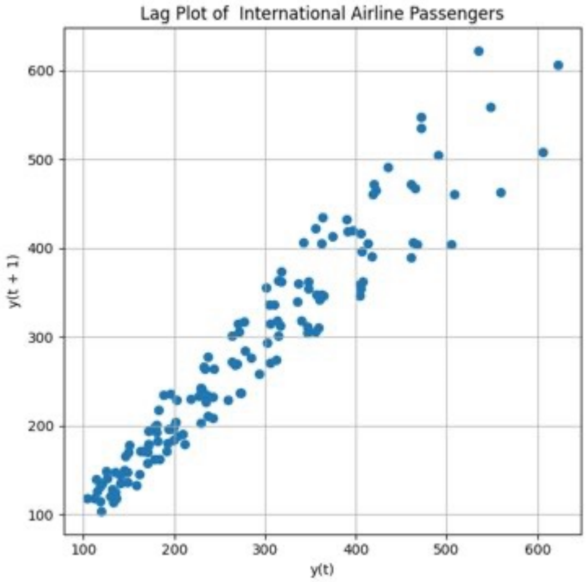


Visualization

ChatGPT Prompt: Use publicly available Airline Passenger dataset, write Python codes to visualize time series data using Scatter, Seasonal, and Lag Plots.

```python
# Import necessary libraries
import pandas as pd
import matplotlib.pyplot as plt
import statsmodels.api as sm
from pandas.plotting import lag_plot

# Load the AirPassengers dataset from statsmodels
dataset = sm.datasets.get_rdataset("AirPassengers").data

# Convert the 'time' column to a datetime format for better visualization
dataset['Date'] = pd.date_range(start="1949-01", periods=len(dataset),freq='M')
dataset.set_index('Date', inplace=True)

# Scatter Plot
plt.figure(figsize=(14, 6))
plt.scatter(dataset.index, dataset['value'], color='blue', facecolors='none')
plt.title('Scatter Plot of International Airline Passengers (1949-1960)')
plt.xlabel('Date')
plt.ylabel('Number of Passengers')
plt.grid(True)
plt.show()

# Seasonal Plot
years = dataset.index.year.unique()
plt.figure(figsize=(14, 6))
for year in years:
    plt.plot(dataset['value'][dataset.index.year == year].values,
             label=str(year))
plt.title('Seasonal Plot of  International Airline Passengers')
plt.xlabel('Month')
plt.ylabel('Number of Passengers')
plt.legend(loc="upper left", bbox_to_anchor=(1,1))
plt.grid(True)
plt.show()

# Lag Plot
plt.figure(figsize=(6, 6))
lag_plot(dataset['value'])
plt.title('Lag Plot of  International Airline Passengers')
plt.grid(True)
plt.tight_layout()
plt.show()
```





Linear Regression

Applications of Linear Regression:

- Trend Estimation
- Seasonal Adjustment
- Forecasting
- Relation to External Factors
- Intervention Analysis
- Error Analysis

Special Concerns:

- Auto Correlation
- Non-Stationarity
- Overfitting

ChatGPT Prompt: Use publicly available Airline Passenger dataset, write Python codes to demonstrate linear regression of time series data and visualize it using line plot.