

EXPERIMENT 9

CO5: To implement and evaluate predictive models, including classification and machine learning models.

1. Aim

To analyze the trend, seasonality, and other components of a time series dataset to understand and predict future values.

Hint: Install the ‘Simple Time Series Analysis’ App.

2. Objective

- To use **Time Series Analysis** to model and forecast a sequence of data points.
- To identify and decompose the components of a time series: **trend**, **seasonality**, and **random fluctuations**.
- To apply **Time Series Analysis** techniques available in **Origin Pro 2024** for forecasting future values.

3. Theory

Time Series Analysis involves statistical methods to analyze data points collected or recorded at specific time intervals. The primary purpose is to understand the underlying patterns and potentially forecast future values. Time series data can be broken down into three primary components:

1. **Trend Component:**
 - Represents the general direction in which the data is moving over time, either upward, downward, or remaining constant.
2. **Seasonal Component:**
 - Refers to the repeating patterns or cycles that occur at regular intervals (e.g., daily, weekly, monthly, yearly).
3. **Random (Irregular) Component:**
 - Represents random variations in the data that are not explained by the trend or seasonality, often due to external factors.

Mathematical Models commonly used in time series analysis include:

- **Moving Averages:** Smoothes out the data to highlight trends by averaging neighboring data points.
- **Exponential Smoothing:** Weights recent observations more heavily, making it sensitive to changes.
- **ARIMA (Auto Regressive Integrated Moving Average):** A more complex model that incorporates autoregression, differencing, and moving averages for more sophisticated forecasting.

4. Procedure

1. Prepare Sample Data

- Set up a table with **10 time-based observations**. For instance, monthly sales data over 10 months.

Month	Sales (\$)	Profit (\$)
January	150	155
February	170	172
March	165	168
April	180	190

Month	Sales (\$)	Profit (\$)
May	200	195
June	195	192
July	205	207
August	220	225
September	215	221
October	225	228

2. Open and Import Data into Origin Pro

- Open **Origin Pro 2024**.
- Import or manually enter the data into the **Worksheet**.

3. Plot the Data

- Highlight the **Sales** column and the **Month** column.
- Create a line plot by selecting **Plot > Basic > Line**. This plot helps visualize the trend in your data over time.

4. Perform Time Series Analysis

- **Moving Average:**
 - Go to **Analysis > Signal Processing > Moving Average**.
 - Specify the window size (e.g., 2 or 3 months).
 - Run the analysis and observe how the moving average smoothens the time series, highlighting the trend.
- **Exponential Smoothing:**
 - Go to **Analysis > Signal Processing > Exponential Smoothing**.
 - Set the smoothing parameter (between 0 and 1; higher values give more weight to recent data).
 - Run the analysis to see how recent values are emphasized.
- **Trend Analysis:**
 - Select the **Analysis > Fitting > Linear Fit** (for linear trends) or **Polynomial Fit** (for non-linear trends).
 - Choose an appropriate model and run the fitting process to determine the underlying trend.

5. Decomposition of Time Series

If your data has more than 10 observations and exhibits seasonality, you could decompose the series:

- Go to **Analysis > Time Series Analysis > Seasonal Decomposition**.
- Choose the type of decomposition (additive or multiplicative) depending on whether seasonal fluctuations are constant or vary with trend.
- Run the decomposition and observe the trend, seasonal, and residual components.

6. Forecasting Future Values (Using ARIMA)

- If the **ARIMA model** option is available, you can go to **Analysis > Time Series Analysis > ARIMA**.
- Configure the parameters for the ARIMA model based on the seasonality and trends observed.
- Use the model to forecast future values and plot them on the graph.

5. Results

- **Trend Analysis:** The trend component of the analysis will show if the **sales** are increasing, decreasing, or remaining stable over time.
- **Moving Average and Exponential Smoothing:** These methods provide a smooth representation of the data, making it easier to detect the overall trend and short-term fluctuations.
- **Seasonal Decomposition** (if applicable): Helps identify repeating patterns, seasonality, and

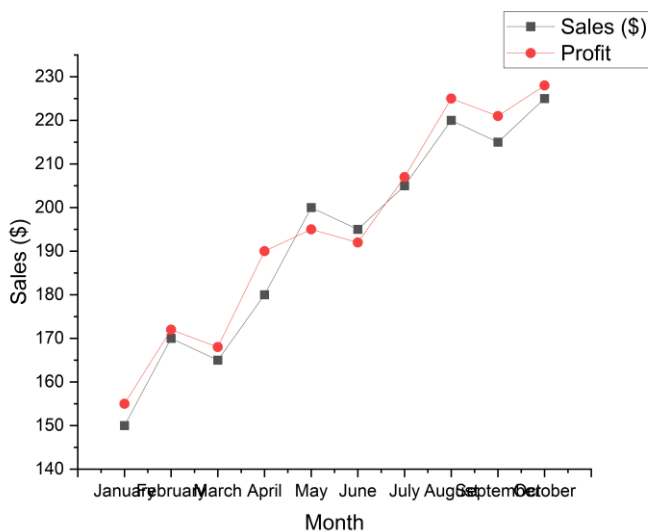
irregular components.

- **ARIMA Forecasting:** If applicable, this will provide forecasted sales values, showing what can be expected in future months based on past trends.

6. Learning Outcomes

- Understand the components of time series data: trend, seasonality, and random variation.
- Learn to apply smoothing techniques like **Moving Average** and **Exponential Smoothing** to highlight data trends.
- Gain hands-on experience with **Origin Pro 2024** to perform time series analysis and interpret the patterns in data.
- Apply decomposition methods to separate out seasonal and trend components of a time series, aiding in better decision-making.
- Use forecasting methods to make informed predictions about future data points, which is essential for planning and strategy.

Screenshots:



Single Exponential Smoothing (16-10-2024 12:37:28)

