Lab_CAT

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Name	Tufan Kundu
Reg No.	24MDT0184
Course Name	Regression Analysis and Predictive Models Lab
Course Code	PMDS504P
Set	B
Assessment	Digital Assessment 4

1 QUESTION 1: Data Understanding & Visualization

1.1 AIM: To understand the behavior of monthly sunspot activity data and visualize it. Perform exploratory data analysis and required pre processing steps on the data.

1.1.1 Loading the necessary libraries

[90]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
```

1.2 Data Preprocessing

1.2.1 Loading the dataset

[91]:
```
df = pd.read_csv("Sunspot.csv")
df.head() # displaying the first few rows of the dataset
```

[91]:

	Month	Sunspots
0	1749-01	58.0
1	1749-02	62.6
2	1749-03	70.0
3	1749-04	55.7
4	1749-05	85.0

[92]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2820 entries, 0 to 2819
```

```
Data columns (total 2 columns):
 #   Column    Non-Null Count  Dtype  
---  ------    --------------  -----  
 0   Month     2820 non-null   object 
 1   Sunspots  2820 non-null   float64
dtypes: float64(1), object(1)
memory usage: 44.2+ KB
```

1.2.2 Renaming month column as Time-Stamp

[93]:
```
df.rename(columns={'Month': 'Time-Stamp'}, inplace=True)
```

[94]:
```
df.head()
```

[94]:
```
  Time-Stamp  Sunspots
0    1749-01      58.0
1    1749-02      62.6
2    1749-03      70.0
3    1749-04      55.7
4    1749-05      85.0
```

1.2.3 Converting the Month column to datetime and setting as index.

[95]:
```
df['Time-Stamp'] = pd.to_datetime(df['Time-Stamp'])
df.set_index('Time-Stamp', inplace = True)
```

[96]:
```
df.head()
```

[96]:
```
            Sunspots
Time-Stamp          
1749-01-01      58.0
1749-02-01      62.6
1749-03-01      70.0
1749-04-01      55.7
1749-05-01      85.0
```

1.2.4 Handling missing values

[97]:
```
df.isnull().sum()
```

[97]:
```
Sunspots    0
dtype: int64
```

- the dataset has no missing values

1.3 Exploratory Data Analysis

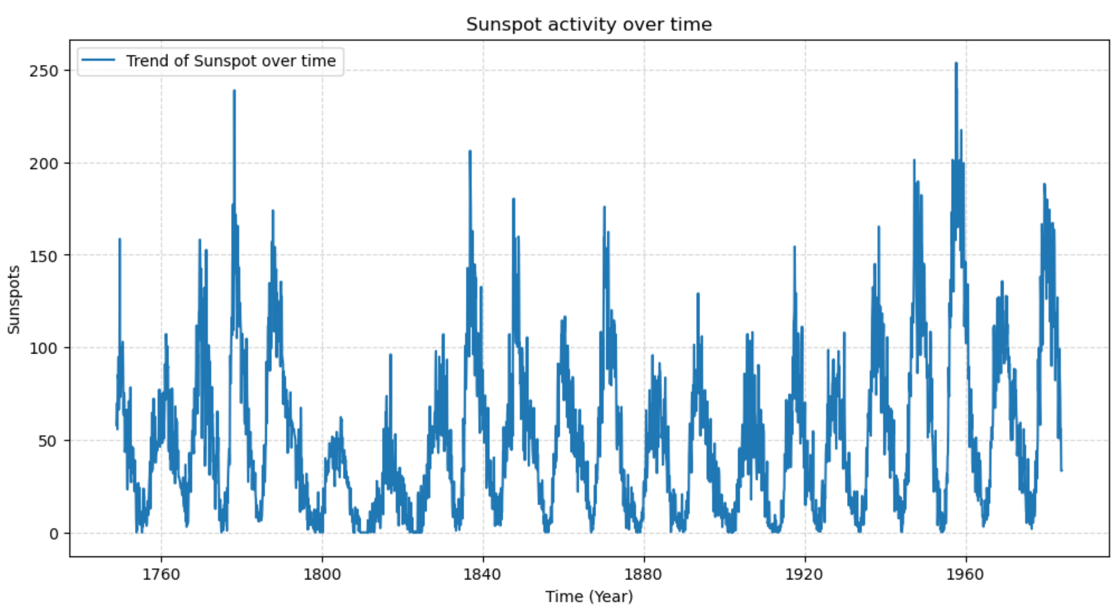
1.3.1 Display summary statistics (count, mean, std, min, max, etc.).

[98]:
```
## Summary Statistics
print("\nSummary Statistics:\n", df.describe())
```

```
Summary Statistics:
            Sunspots
count  2820.000000
mean     51.265957
std      43.448971
min       0.000000
25%      15.700000
50%      42.000000
75%      74.925000
max     253.800000
```

1.3.2 Plot a line chart showing sunspot activity over time.

[99]:
```
plt.figure(figsize = (12,6))
plt.plot(df.index,df['Sunspots'],label='Trend of Sunspot over time')
plt.title("Sunspot activity over time")
plt.xlabel("Time (Year)")
plt.ylabel("Sunspots")
plt.grid(True, linestyle='--', alpha = 0.5)
plt.legend()
plt.show()
```



- The plot shows sunspot activity trends across time.
- There is a regular cyclic pattern, but the intensity of peaks varies across cycles, indicating periodic but varying sunspot activity

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2 QUESTION 2: Stationarity Check & Autocorrelation Analysis

2.1 AIM: To check Stationarity and perform Autocorrelation Analysis on the monthly sunspot activity dataset.

2.2 Stationarity Check

2.2.1 Apply the Augmented Dickey-Fuller (ADF) test

[100]:
```
from statsmodels.tsa.stattools import adfuller
from statsmodels.graphics.tsaplots import plot_acf
```

[101]:
```
# Applying (ADF) Test
adf_result = adfuller(df['Sunspots'])

# Printing the  results
print("\n--- ADF Test Results ---")
print(f"ADF Statistic        : {adf_result[0]:.4f}")
print(f"p-value              : {adf_result[1]:.4f}")
print(f"Number of lags used  : {adf_result[2]}")
print(f"Number of observations used: {adf_result[3]}")
print("Critical Values      :")
for key, value in adf_result[4].items():
    print(f"   {key}: {value:.4f}")

# Interpretation
if adf_result[1] < 0.05:
    print("\nConclusion: The series is stationary, so we reject the null␣
 ↪hypothesis.")
else:
    print("\nConclusion: The series is not stationary, so we fail to reject the␣
 ↪null hypothesis.")
```

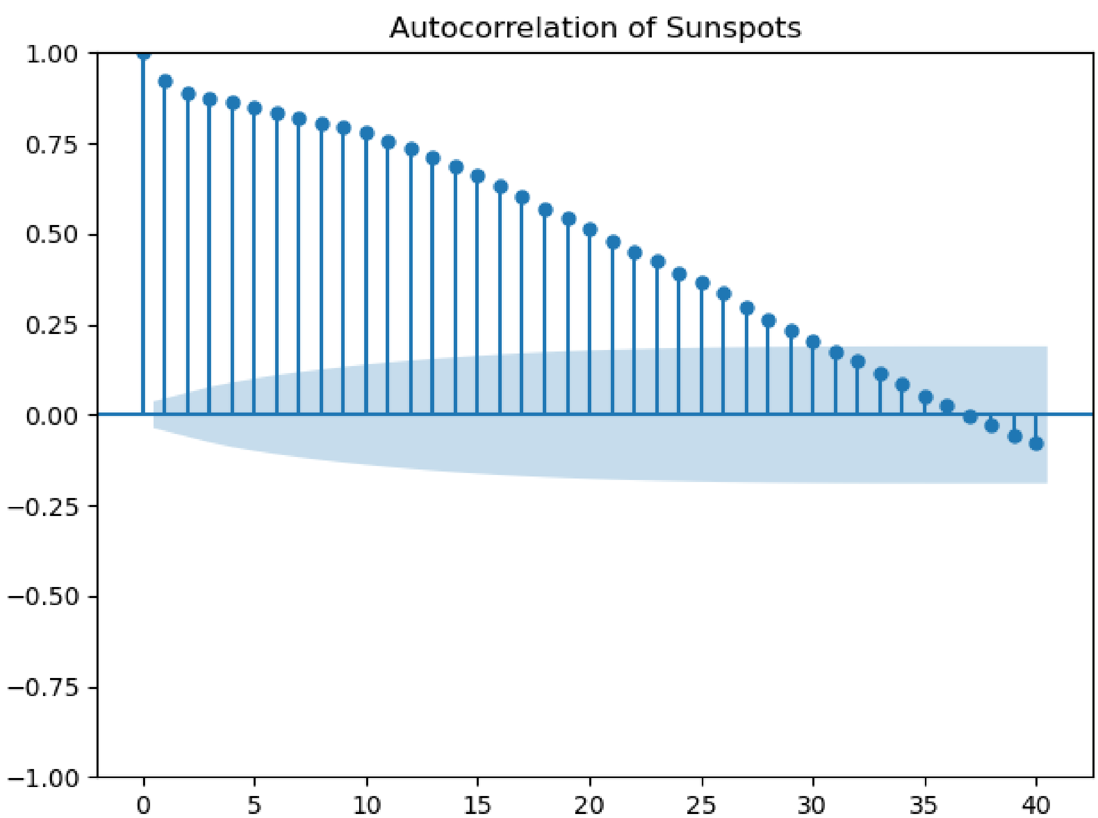
```
--- ADF Test Results ---
```

```
ADF Statistic          : -9.5677
p-value                : 0.0000
Number of lags used    : 27
Number of observations used: 2792
Critical Values        :
   1%: -3.4327
   5%: -2.8626
   10%: -2.5673

Conclusion: The series is stationary, so we reject the null hypothesis.
```

2.3 b) Autocorrelation Analysis

[103]:
```python
### Plotting the autocorrelation function

plt.figure(figsize=(10, 4))
plot_acf(df['Sunspots'], lags=40)
plt.title('Autocorrelation of Sunspots')
plt.tight_layout()
plt.show()
```

```
<Figure size 1000x400 with 0 Axes>
```



2.4 Interpretation

- The first lag has a high autocorrelation, which is expected as a time series is always correlated with itself at lag 0.
- The autocorrelation slowly decreases and remains significantly positive for many lags.
- The autocorrelation slowly decreases and remains significantly positive for many lags