time-series-analysis

December 26, 2023

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

     from statsmodels.tsa.seasonal import seasonal_decompose
```

```
[2]: df = pd.read_csv('/kaggle/input/air-passengers/AirPassengers.csv')
     df.head()
```

```
[2]:      Month  #Passengers
     0  1949-01          112
     1  1949-02          118
     2  1949-03          132
     3  1949-04          129
     4  1949-05          121
```

```
[6]: df.rename(columns={"#Passengers": "Passengers"}, inplace=True)
     df.head()
```

```
[6]:      Month  Passengers
     0  1949-01         112
     1  1949-02         118
     2  1949-03         132
     3  1949-04         129
     4  1949-05         121
```

```
[7]: df.shape
```

```
[7]: (144, 2)
```

```
[9]: df['Month'] = pd.to_datetime(df.Month)
     df = df.set_index(df.Month)
```

```
[10]: df.drop('Month', axis = 1, inplace = True)
      print('Column datatypes= \n',df.dtypes)
```

```
Column datatypes=
 Passengers    int64
dtype: object
```

[11]:

```
df
```

[11]:

```
            Passengers
Month
1949-01-01         112
1949-02-01         118
1949-03-01         132
1949-04-01         129
1949-05-01         121
…                    …
1960-08-01         606
1960-09-01         508
1960-10-01         461
1960-11-01         390
1960-12-01         432

[144 rows x 1 columns]
```

1 Time Series Characteristics

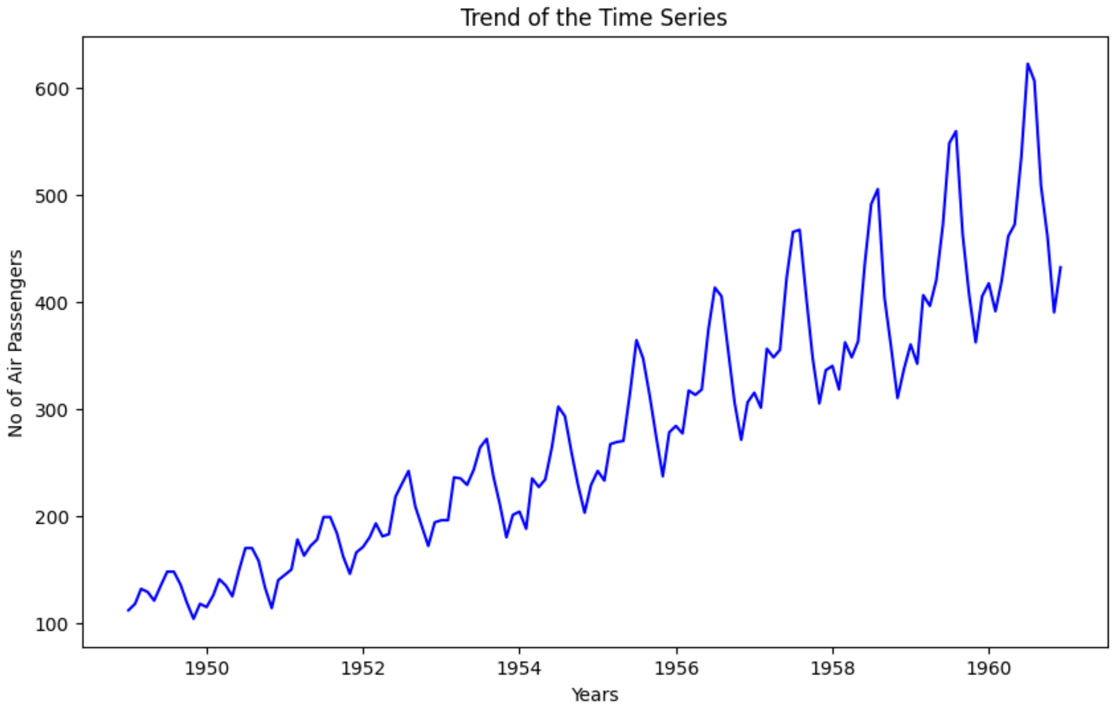
1.1 Trend

[14]:

```
plt.figure(figsize= (10,6))
plt.plot(df, color="blue")
plt.xlabel('Years')
plt.ylabel('No of Air Passengers')
plt.title('Trend of the Time Series')
```

[14]:

```
Text(0.5, 1.0, 'Trend of the Time Series')
```

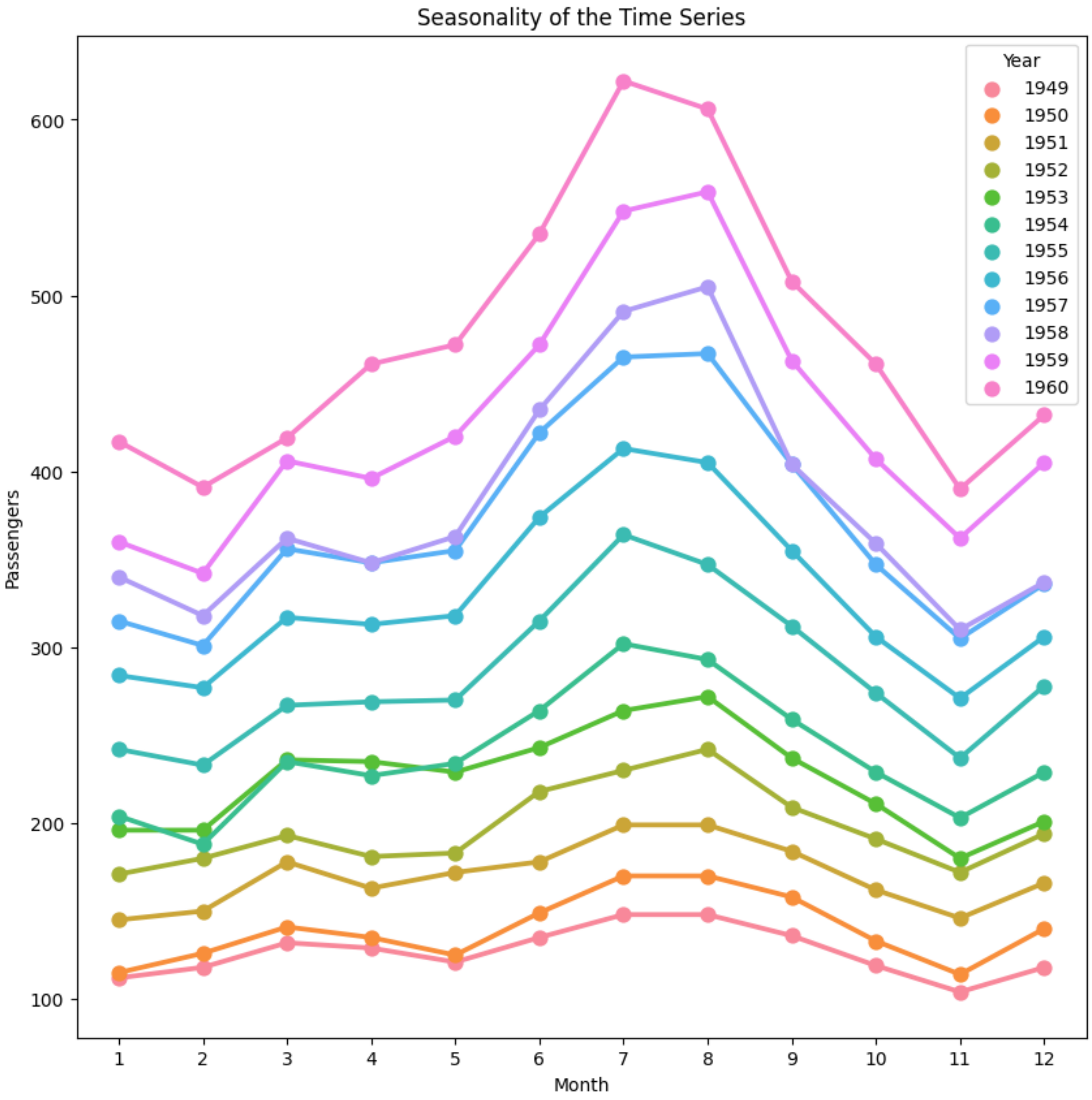


1.2 Seasonality

[15]:
```
# To plot the seasonality we are going to create a temp dataframe and add␣
↪columns for Month and Year values
df_temp = df.copy()
df_temp['Year'] = pd.DatetimeIndex(df_temp.index).year
df_temp['Month'] = pd.DatetimeIndex(df_temp.index).month
```

[16]:
```
# Stacked line plot
plt.figure(figsize=(10,10))
plt.title('Seasonality of the Time Series')
sns.pointplot(x='Month',y='Passengers',hue='Year',data=df_temp)
```

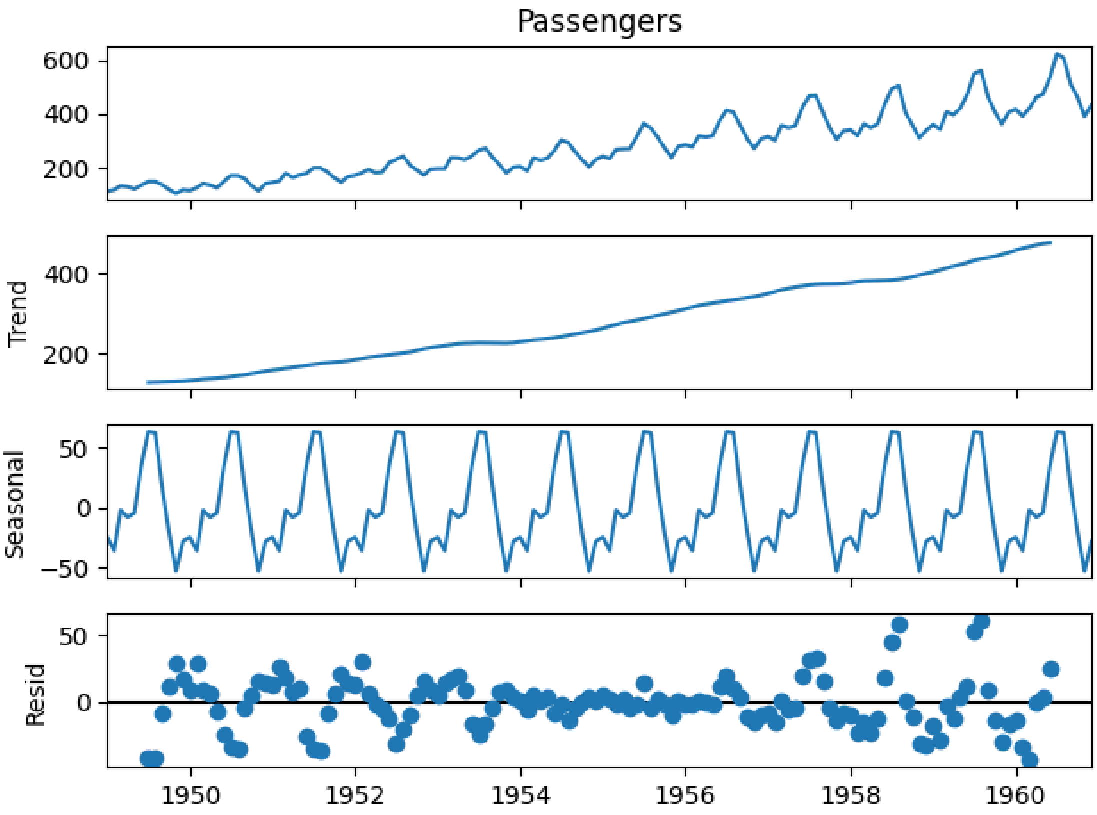
[16]:
```
<Axes: title={'center': 'Seasonality of the Time Series'}, xlabel='Month',
ylabel='Passengers'>
```



1.3 Decomposition of Time Series

[20]:
```
# Decompose the time series into trend, seasonality, and residuals
decomposition = seasonal_decompose(df['Passengers'], model='additive')
```

[21]:
```
fig = decomposition.plot()
```

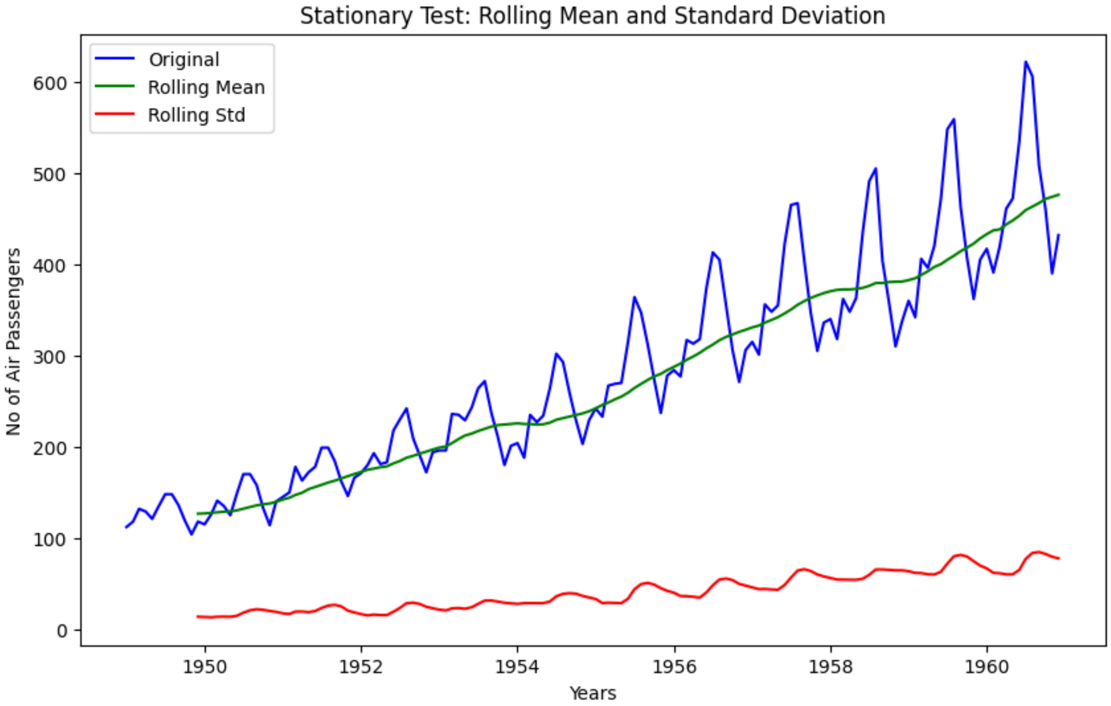


2 Time Series Analysis

2.1 Check for Stationarity

[34]:

```
from statsmodels.tsa.stattools import adfuller
timeseries = df['Passengers']

def stationarity_test(timeseries):
    rolling_mean = timeseries.rolling(window=12).mean()
    rolling_std = timeseries.rolling(window=12).std()

    # Plot rolling statistics
    plt.figure(figsize=(10, 6))
    plt.xlabel('Years')
    plt.ylabel('No of Air Passengers')
    plt.title('Stationary Test: Rolling Mean and Standard Deviation')
    plt.plot(timeseries, color='blue', label='Original')
    plt.plot(rolling_mean, color='green', label='Rolling Mean')
    plt.plot(rolling_std, color='red', label='Rolling Std')
    plt.legend()
    plt.show()

    # Dickey-Fuller test
    print('Results of Dickey-Fuller Test')
    df_test = adfuller(timeseries)
    df_output = pd.Series(df_test[0:4], index=['Test Statistic', 'p-value',␣
 ↪'#Lags Used', 'Number of Observations Used'])
    for key, value in df_test[4].items():
        df_output['Critical Value (%s)' % key] = value
    print(df_output)

    return rolling_mean, rolling_std

# Call the stationarity_test function with your time series
rolling_mean, rolling_std = stationarity_test(timeseries)
```



```
Results of Dickey-Fuller Test
Test Statistic                   0.815369
p-value                          0.991880
#Lags Used                      13.000000
Number of Observations Used    130.000000
Critical Value (1%)             -3.481682
Critical Value (5%)             -2.884042
Critical Value (10%)            -2.578770
```

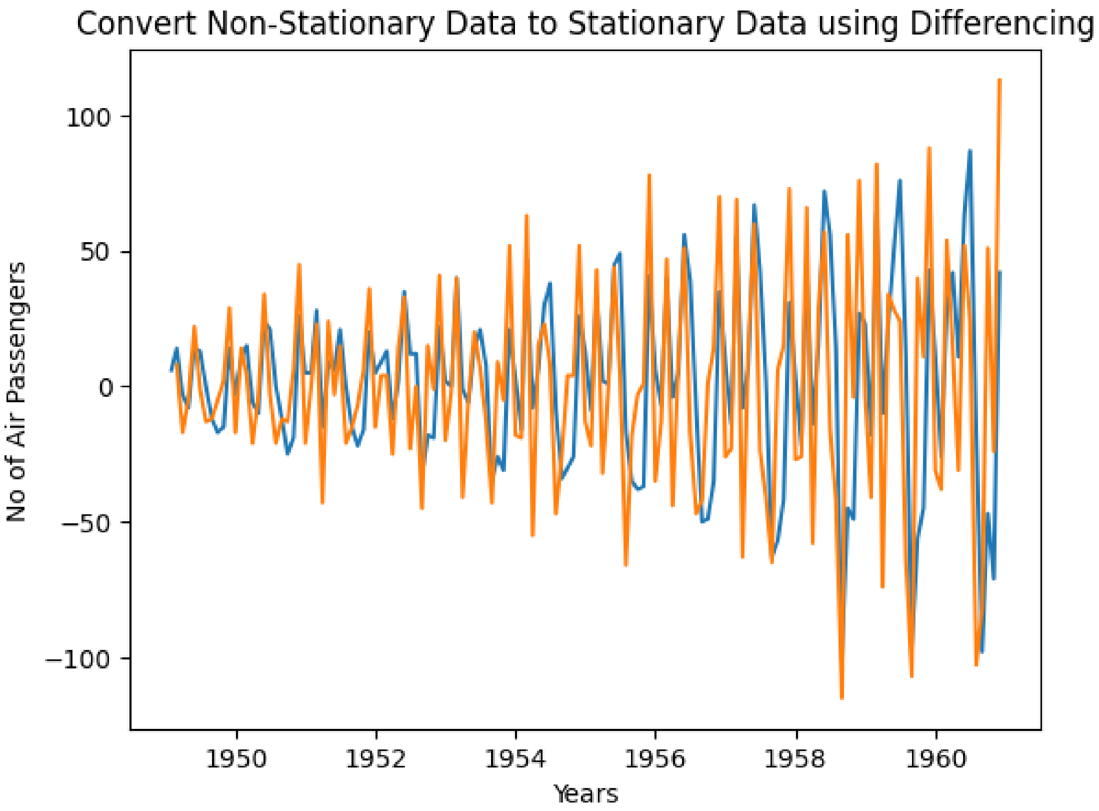
```
dtype: float64
```

3 Convert Non-Stationary Data to Stationary Data

3.1 Differencing

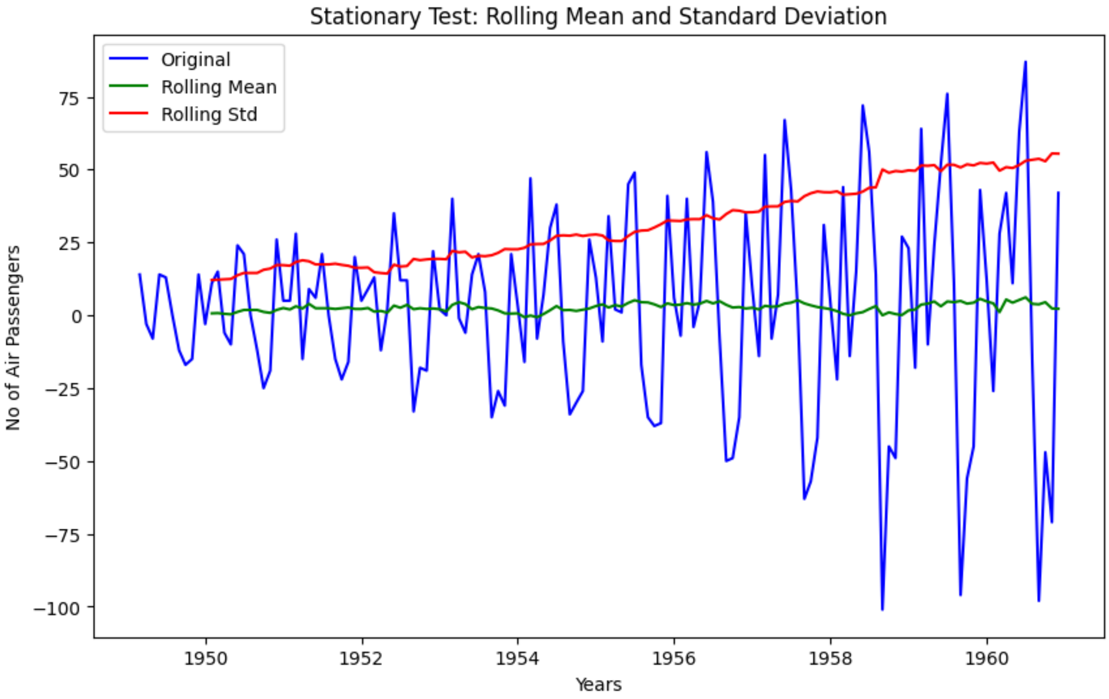
[44]:
```
from statsmodels.tsa.stattools import adfuller

df_diff = df.diff(periods=1)  # First-order differencing

# Plot differenced time series
plt.xlabel('Years')
plt.ylabel('No of Air Passengers')
plt.title('Convert Non-Stationary Data to Stationary Data using Differencing')
plt.plot(df_diff)
```

[44]:
```
[<matplotlib.lines.Line2D at 0x7d9301531900>,
 <matplotlib.lines.Line2D at 0x7d93013799f0>]
```



[46]:
```
# Drop NA values
df_diff.dropna(inplace=True)
```

```
# Perform the Dickey-Fuller test on a specific column, e.g., 'Passengers'
column_name = 'Passengers'
stationarity_test(df_diff[column_name])
```



```
Results of Dickey-Fuller Test
Test Statistic                  -2.833426
p-value                          0.053655
#Lags Used                      12.000000
Number of Observations Used    129.000000
Critical Value (1%)             -3.482088
Critical Value (5%)             -2.884219
Critical Value (10%)            -2.578864
dtype: float64
```

[46]:

```
(Month
 1949-03-01          NaN
 1949-04-01          NaN
 1949-05-01          NaN
 1949-06-01          NaN
 1949-07-01          NaN
                  …
 1960-08-01     3.916667
 1960-09-01     3.750000
 1960-10-01    4.500000
 1960-11-01    2.333333
 1960-12-01    2.250000
 Name: Passengers, Length: 142, dtype: float64,
 Month
 1949-03-01          NaN
 1949-04-01          NaN
 1949-05-01          NaN
 1949-06-01          NaN
 1949-07-01          NaN
                 …
 1960-08-01    53.364030
 1960-09-01    53.706483
 1960-10-01    52.852281
 1960-11-01    55.531045
 1960-12-01    55.465182
 Name: Passengers, Length: 142, dtype: float64)
```