



Department of Computer Science and Engineering (Data Science)

Subject: Time Series Analysis

Experiment 2

(Seasonality)

Aim: Seasonality:

- (1) Multiple Box Plots
- (2) Autocorrelation Plot
- (3) Deseasoning of Time-Series Data
- (4) Seasonal Decomposition (Additive and Multiplicative)
 - i. Trend
 - ii. Seasonal Index
 - iii. Residual
- (5) Detecting Cyclic Variations

Theory:

Seasonality:

Seasonality is a periodical fluctuation where the same pattern occurs at a regular interval of time. It is a characteristic of economics, weather, and stock market time-series data; less often, it's observed in scientific data. In other industries, many phenomena are characterized by periodically recurring seasonal effects.

For example, retail sales tend to increase during Christmas and decrease afterward. The following methods can be used to detect seasonality:

- Multiple box plots
- Autocorrelation plots

Detecting Seasonality using Multiple Box Plots:

A box plot is an essential graph to depict data spread out over a range. It is a standard approach to showing the minimum, first quartile, middle, third quartile, and maximum. The following code shows an example of detecting seasonality with the help of multiple box plots. **Seaborn** is a graphical representation package similar to Matplotlib.

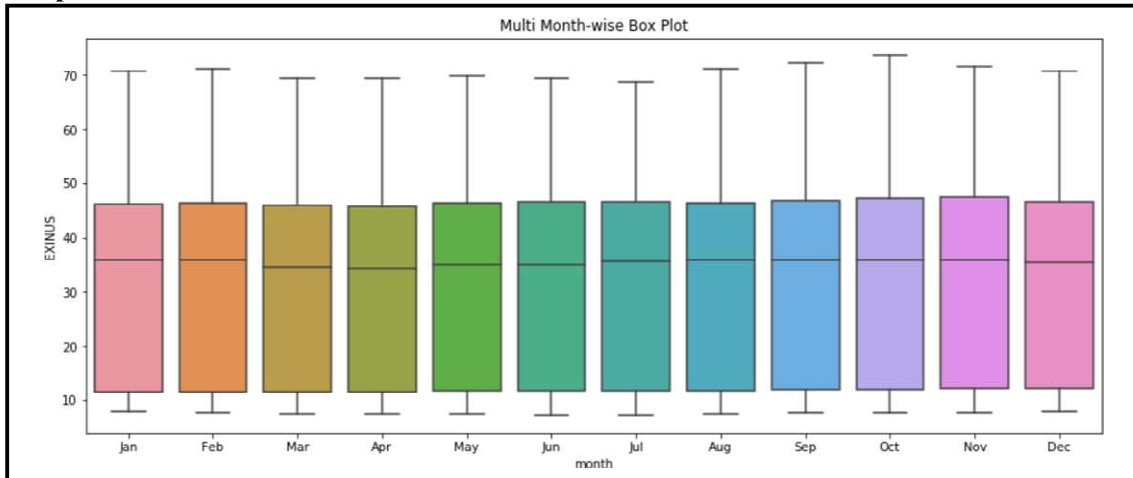
```
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
from statsmodels.tsa.filters.hp_filter import hpfilter
import warnings
warnings.filterwarnings("ignore")
%matplotlib inline
df = pd.read_excel(r'India_Exchange_Rate_Dataset.xls', parse_dates=True)
df['month'] = df['observation_date'].dt.strftime('%b')
df['year'] = [d.year for d in df.observation_date]
df['month'] = [d.strftime('%b') for d in df.observation_date]
years = df['year'].unique()
plt.figure(figsize=(15,6))
```



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```
sns.boxplot(x='month', y='EXINUS', data=df).set_title("Multi Month-wise Box Plot")  
plt.show()
```

Output:

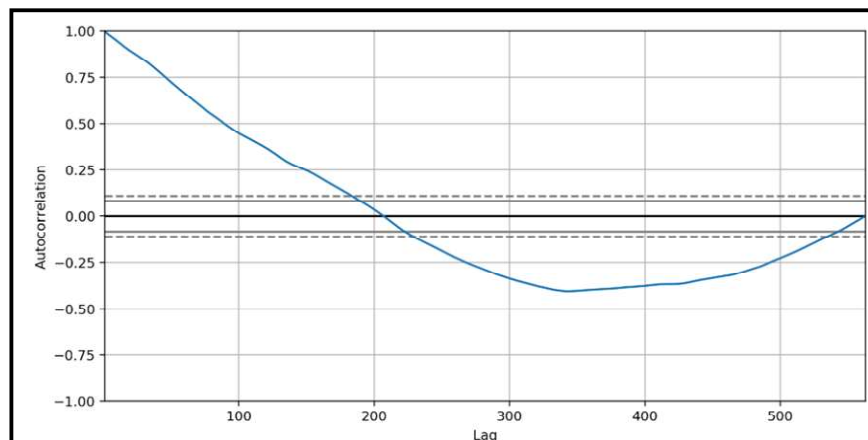


Detecting Seasonality using Autocorrelation Plot:

Autocorrelation is used to check randomness in data. It helps to identify types of data where the period is not known. For instance, for the monthly data, if there is a regular seasonal effect, we would hope to see massive peak lags after every 12 months.

```
from pandas.plotting import autocorrelation_plot  
import pandas as pd  
import matplotlib.pyplot as plt  
%matplotlib inline  
df = pd.read_excel(r'India_Exchange_Rate_Dataset.xls',  
index_col=0, parse_dates=True)  
plt.rcParams.update({'figure.figsize':(15,6)})  
autocorrelation_plot(df.EXINUS.tolist())
```

Output:





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Deseasoning of Time-Series Data:

Deseasoning means to remove seasonality from time-series data. It is stripped of the pattern of seasonal effect to deseasonalize the impact. Time-series data contains four main components.

- **Level** means the average value of the time-series data.
- **Trend** means an increasing or decreasing value in time-series data.
- **Seasonality** means repeating the pattern of a cycle in the time-series data.
- **Noise** means random variance in time-series data.

An additive model is when time-series data combines these four components for linear trend and seasonality, and a multiplicative model is when components are multiplied to gather for nonlinear trends and seasonality.

Seasonal Decomposition:

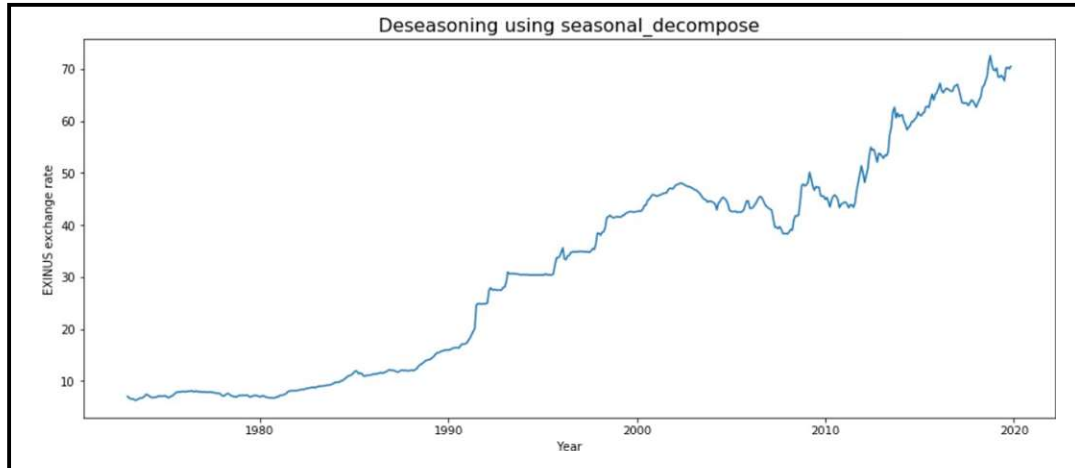
Decomposition is the process of understanding generalizations and problems related to time-series forecasting. We can leverage seasonal decomposition to remove seasonality from data and check the data only with the trend, cyclic, and irregular variations.

```
import pandas as pd
import matplotlib.pyplot as plt
from statsmodels.tsa.seasonal import seasonal_decompose
import warnings
warnings.filterwarnings("ignore")
%matplotlib inline
df =
pd.read_excel(r'India_Exchange_Rate_Dataset.xls', index_col=0, parse_dates=True)
result_mul = seasonal_decompose(df['EXINUS'], model='multiplicative')
deseason = df['EXINUS'] - result_mul.seasonal
plt.figure(figsize=(15,6))
plt.plot(deseason)
plt.title('Deseasoning using seasonal_decompose', fontsize=16)
plt.xlabel('Year')
plt.ylabel('EXINUS exchange rate')
plt.show()
```

Output:



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Detecting Cyclic Variations:

Cyclical components are fluctuations around a long trend observed every few units of time; this behavior is less frequent compared to seasonality. It is a recurrent process in a time series. In the field of business/economics, the following are three distinct types of cyclic variations examples:

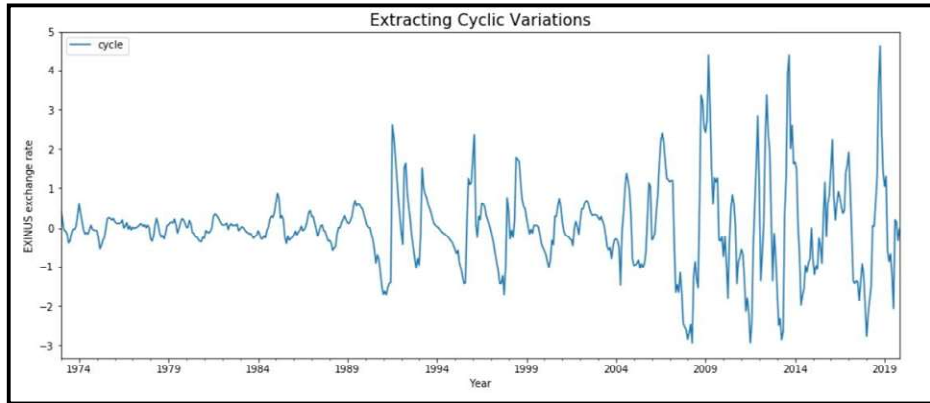
- **Prosperity:** As we know, when organizations prosper, prices go up, but the benefits also increase. On the other hand, prosperity also causes over-development, challenges in transportation, increments in wage rate, insufficiency in labor, high rates of returns, deficiency of cash in the market and price concessions, etc., leading to depression
- **Depression:** As we know, when there is cynicism in exchange and enterprises, processing plants close down, organizations fall flat, joblessness spreads, and the wages and costs are low.
- **Accessibility:** This causes idealness of money, accessibility of cash at a low interest, an increase in demand for goods or money at a low interest rate, an increase in popular merchandise and ventures described by the circumstance of recuperation that at last prompts for prosperity or boom.

```
from statsmodels.tsa.filters.hp_filter import hpfilter
import pandas as pd
import matplotlib.pyplot as plt
import warnings
warnings.filterwarnings("ignore")
%matplotlib inline
df =
pd.read_excel(r'India_Exchange_Rate_Dataset.xls', index_col=0, parse_dates=True)
EXINUS_cycle, EXINUS_trend = hpfilter(df['EXINUS'], lamb=1600)
df['cycle'] = EXINUS_cycle
df['trend'] = EXINUS_trend
df[['cycle']].plot(figsize=(15,6)).autoscale(axis='x', tight=True)
plt.title('Extracting Cyclic Variations', fontsize=16)
plt.xlabel('Year')
plt.ylabel('EXINUS exchange rate')
plt.show()
```



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Output:



Lab Assignments to complete:

Perform the following tasks using the datasets mentioned. Download the datasets from the link given:

Link:

https://drive.google.com/drive/folders/1dbqJuZJULas76_Zzkqs-yRd2DbJReJup?usp=sharing

Dataset 1: Facebook Stock Market Performance

1. Simulate the time series components from scratch.
2. Create the three decomposition models from scratch.
3. Implement seasonality decomposition using the `seasonal_decompose()` method.

Dataset 2: India Exchange Rate Dataset

1. Implement seasonality decomposition on the mentioned dataset (using additive and multiplicative decomposition).

LAB WORK:

<https://colab.research.google.com/drive/1tkSxaNeRJZCvvaMWFbL9H9RG7UIYzNv9?usp=sharing>