Shri Vile Parle Kelavani Mandal's
DWARKADAS J. SANGHVI COLLEGE OF ENGINEERING
(Autonomous College Affiliated to the University of Mumbai)
NAAC Accredited with "A" Grade (CGPA : 3.18)

Department of Computer Science and Engineering (Data Science)

Subject: Time Series Analysis

Experiment 1

(Detecting and Detrending trends in Time Series)

D 12
60009210105
Amitesh Sawarkar

Aim: (1) Detecting trends using Hodrick -Prescott Filter.
(2) Detrending a Time Series (Pandas, Signal, HP filter)

Theory:

Trends:

A trend is a pattern that is observed over a period of time and represents the mean rate of change with respect to time. A trend usually shows the tendency of the data to increase/uptrend or decrease/downtrend during the long run. It is not always necessary that the increase or decrease is in the same direction throughout the given period of time. **A trend line is also drawn using candlestick charts.**

For example, you may have heard about an increase or decrease in different market commodities such as gold, silver, stock prices, gas, diesel, etc., or about the rate of interest for banks or home loans increasing or decreasing. These are all commodity market conditions, which may either increase or decrease over time that show a trend in data.

Detecting and Detrending Trends:

1. Detecting Trend Using a Hodrick-Prescott Filter
2. Detrending a Time Series Trend using the following methods:
    a. Pandas differencing
    b. SciPy signal
    c. HP filter

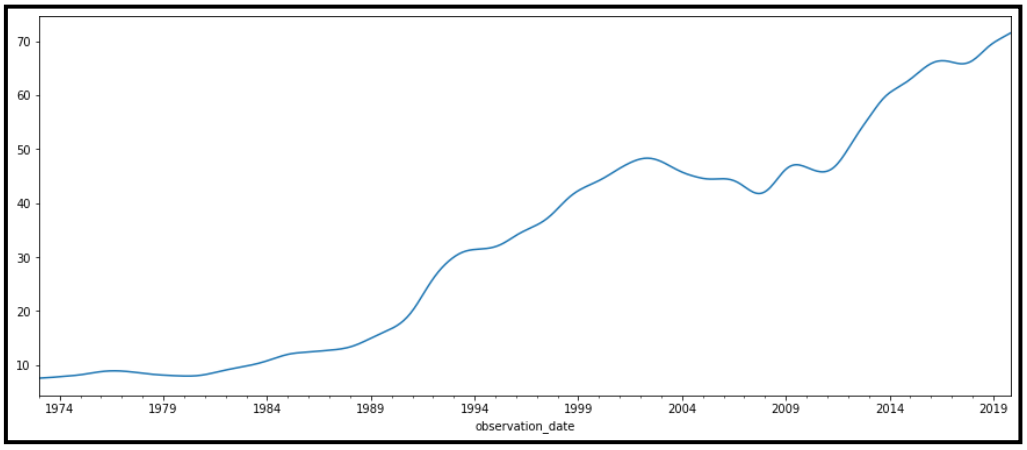
Detecting Trend Using a Hodrick-Prescott Filter:

The Hodrick-Prescott (HP) filter has become a benchmark for getting rid of trend movements in data. This method is broadly employed for econometric methods in applied macroeconomics research. The technique is nonparametric and is used to dissolve a time series into a trend; it is a cyclical component unaided by economic theory or prior trend specification. Like all nonparametric methods, the HP filter is contingent significantly on a tuning parameter that controls the degree of smoothing. This method is broadly employed in applied macroeconomics utilized in central banks, international economics agencies, industry, and government.

With the following example code, you can see how the EXINUS stock changes over a period of time:

```
import pandas as pd
%matplotlib inline
from statsmodels.tsa.filters.hp_filter import hpfilter
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)
EXINUS_trend.plot(figsize=(15,6)).autoscale(axis='x',tight=True)
```

Output:



Detrending a Time Series:

Detrending is the process of removing a trend from time-series data, or it mentions a change in the mean over time. It is continuously increasing or decreasing over the duration of time. Identification, modeling, and even removing trend data from time-series datasets can be beneficial. The following are methods to detrend time-series data:

- Pandas differencing
- SciPy signal
- HP filter

Detrending using Pandas Differencing:

The Pandas library has a built-in function to calculate the difference in a dataset. This diff() function is used both for series and for DataFrames. It can provide a period value to shift in order to form the difference. The following code is an example of Pandas differencing.

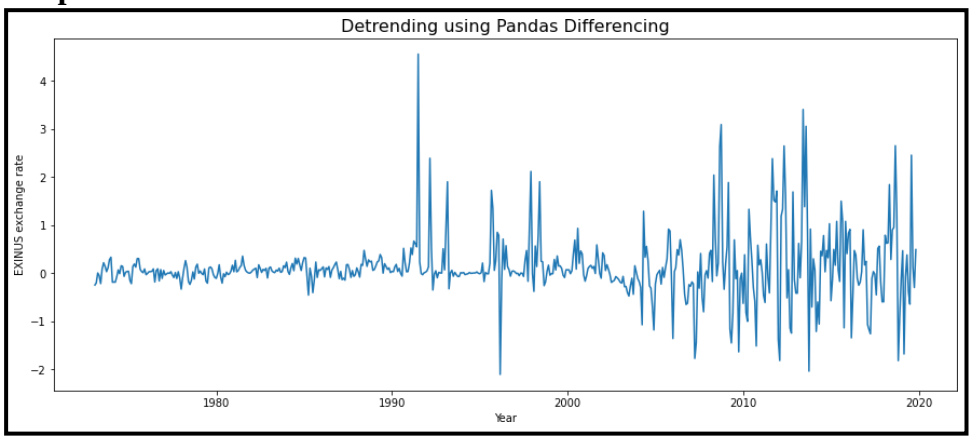
- Warning is a built-in module of Python that handles the warning messages.
- Pyplot is a submodule of Matplotlib that is used to design the graphical representation of the data.

```
import pandas as pd
from pandas import datetime
from matplotlib import pyplot

series = pd.read_excel(r'India_Exchange_Rate_Dataset.xls',
index_col=0,parse_dates=True)
X = series.values
diff = list()
for i in range(1, len(X)):
    value = X[i] - X[i - 1]
    diff.append(value)
plt.figure(figsize=(15,6))
pyplot.plot(diff)
plt.title('Detrending using Pandas Differencing', fontsize=16)
plt.xlabel('Year')
```

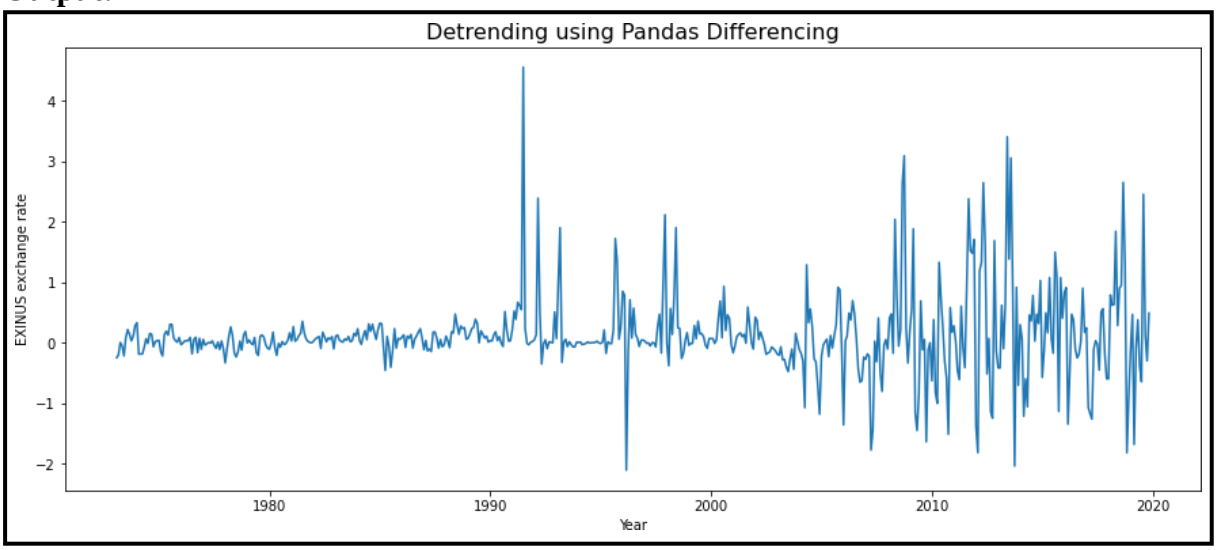
```
plt.ylabel('EXINUS exchange rate')
pyplot.show()
```

Output:




```
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)
diff = df.EXINUS.diff()
plt.figure(figsize=(15,6))
plt.plot(diff)
plt.title('Detrending using Pandas Differencing', fontsize=16)
plt.xlabel('Year')
plt.ylabel('EXINUS exchange rate')
plt.show()
```

Output:



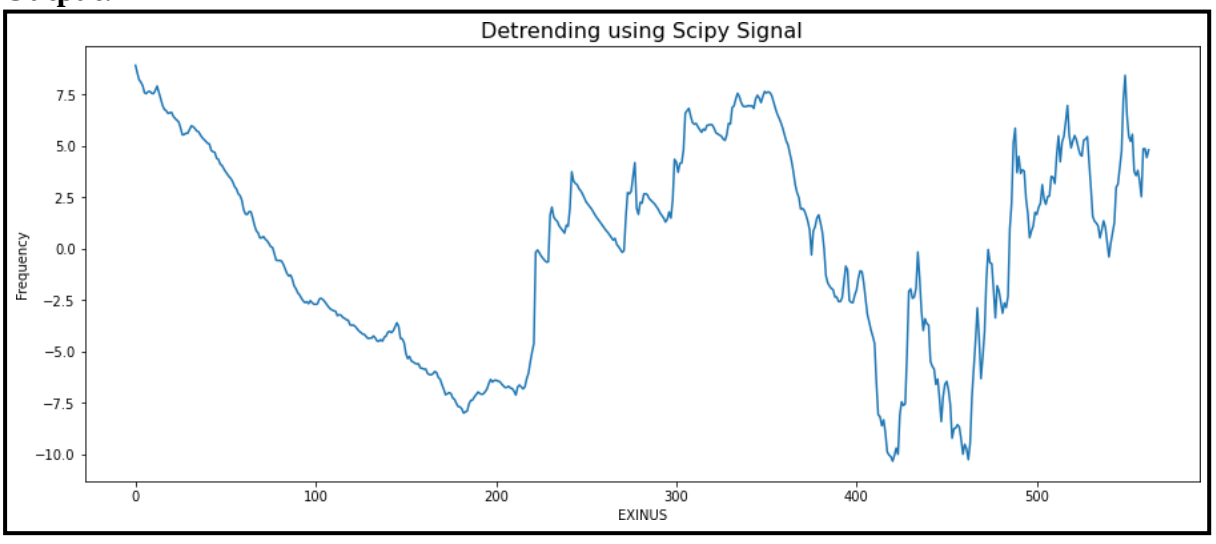
Detrending using SciPy Signal:

A signal is another form of time-series data. Every signal either increases or decreases in a different order. Using the SciPy library, this can be removing the linear trend from the signal data. The following code shows an example of SciPy detrending.

- Signal.detrend is a submodule of SciPy that is used to remove a linear trend along an axis from data.

```
import pandas as pd
import matplotlib.pyplot as plt
from scipy import  signal
import warnings
warnings.filterwarnings("ignore")
%matplotlib inline
df = pd.read_excel(r'India_Exchange_Rate_Dataset.xls',
index_col=0,parse_dates=True)
detrended = signal.detrend(df.EXINUS.values)
plt.figure(figsize=(15,6))
plt.plot(detrended)
plt.xlabel('EXINUS')
plt.ylabel('Frequency')
plt.title('Detrending using Scipy Signal', fontsize=16)
plt.show()
```

Output:



Detrending using HP Filter:

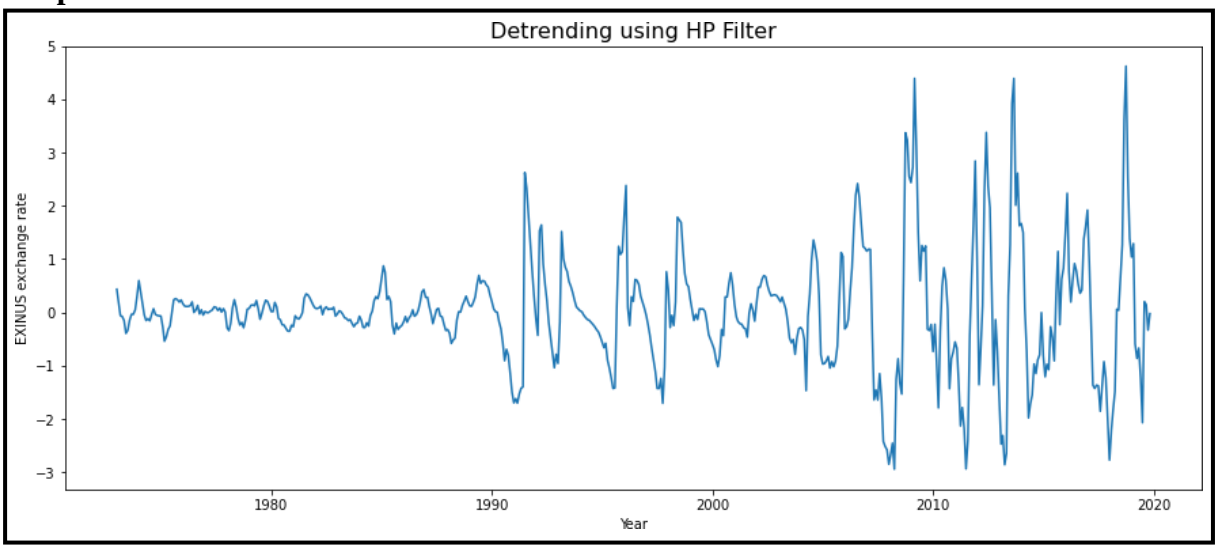
An HP filter is also used to detrend a time series and smooth the data. It's used for removing short-term fluctuations. The following code shows an example of HP filter detrending.

- Hpfilter is a submodule of Statmodels that is used to remove a smooth trend.

```
import pandas as pd
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',index_col=0,parse_dates=True)
EXINUS_cycle,EXINUS_trend = hpfilter(df['EXINUS'], lamb=1600)
df['trend'] = EXINUS_trend
detrended = df.EXINUS - df['trend']
plt.figure(figsize=(15,6))
plt.plot(detrended)
plt.title('Detrending using HP Filter', fontsize=16)
plt.xlabel('Year')
plt.ylabel('EXINUS exchange rate')
plt.show()
```

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: India_Exchange_Rate_Dataset.xls

1. Implement detrending using differencing from scratch.

Dataset 2: shampoo.csv

1. Implement detrending using pandas differencing using diff() function.
2. Implement detrending using SciPy signal using signal.detrend submodule.
3. Implement detrending using HP filter using hp_filter submodule of statsmodels.

Colab File link -
https://colab.research.google.com/drive/15kl6LpdPdnArcZVLpWU9kpmyn2o3KGbj?usp=sharing