pda-6-18

March 22, 2025

1 Time Series Analysis

Time series Analysis (TSA) is a method of analysing the data collected over time to identify patterns,trends and seasonal variations.It is used to forecast future values based on the historical data.

importing Libraries

[5]:
```
import pandas as pd
import matplotlib.pyplot as plt
import numpy as np
import seaborn as sns
from statsmodels.tsa.stattools import adfuller
from statsmodels.tsa.seasonal import seasonal_decompose
from statsmodels.tsa.arima.model  import ARIMA
```

Loading and Viewing data

[6]:
```
tm=pd.read_csv(r"C:\Users\Megha I Angadi\Downloads\DailyDelhiClimateTrain.csv")
```

[7]:
```
tm.head()
```

[7]:

	date	meantemp	humidity	wind_speed	meanpressure
0	2013-01-01	10.000000	84.500000	0.000000	1015.666667
1	2013-01-02	7.400000	92.000000	2.980000	1017.800000
2	2013-01-03	7.166667	87.000000	4.633333	1018.666667
3	2013-01-04	8.666667	71.333333	1.233333	1017.166667
4	2013-01-05	6.000000	86.833333	3.700000	1016.500000

info

[8]:
```
tm.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1462 entries, 0 to 1461
Data columns (total 5 columns):
 #   Column        Non-Null Count  Dtype
---  ------        --------------  -----
 0   date          1462 non-null   object
 1   meantemp      1462 non-null   float64
```

```
 2   humidity      1462 non-null   float64
 3   wind_speed    1462 non-null   float64
 4   meanpressure  1462 non-null   float64
dtypes: float64(4), object(1)
memory usage: 57.2+ KB
```

[9]:
```
#Checking null values
```

[10]:
```
print(tm[tm['date'].isna()])
```

```
Empty DataFrame
Columns: [date, meantemp, humidity, wind_speed, meanpressure]
Index: []
```

[11]:
```
tm['date']=pd.to_datetime(tm['date'],errors='coerce')
tm.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1462 entries, 0 to 1461
Data columns (total 5 columns):
 #   Column        Non-Null Count  Dtype
---  ------        --------------  -----
 0   date          1462 non-null   datetime64[ns]
 1   meantemp      1462 non-null   float64
 2   humidity      1462 non-null   float64
 3   wind_speed    1462 non-null   float64
 4   meanpressure  1462 non-null   float64
dtypes: datetime64[ns](1), float64(4)
memory usage: 57.2 KB
```

[12]:
```
tm.set_index('date',inplace=True)
tm.head()
```

[12]:

date	meantemp	humidity	wind_speed	meanpressure
2013-01-01	10.000000	84.500000	0.000000	1015.666667
2013-01-02	7.400000	92.000000	2.980000	1017.800000
2013-01-03	7.166667	87.000000	4.633333	1018.666667
2013-01-04	8.666667	71.333333	1.233333	1017.166667
2013-01-05	6.000000	86.833333	3.700000	1016.500000

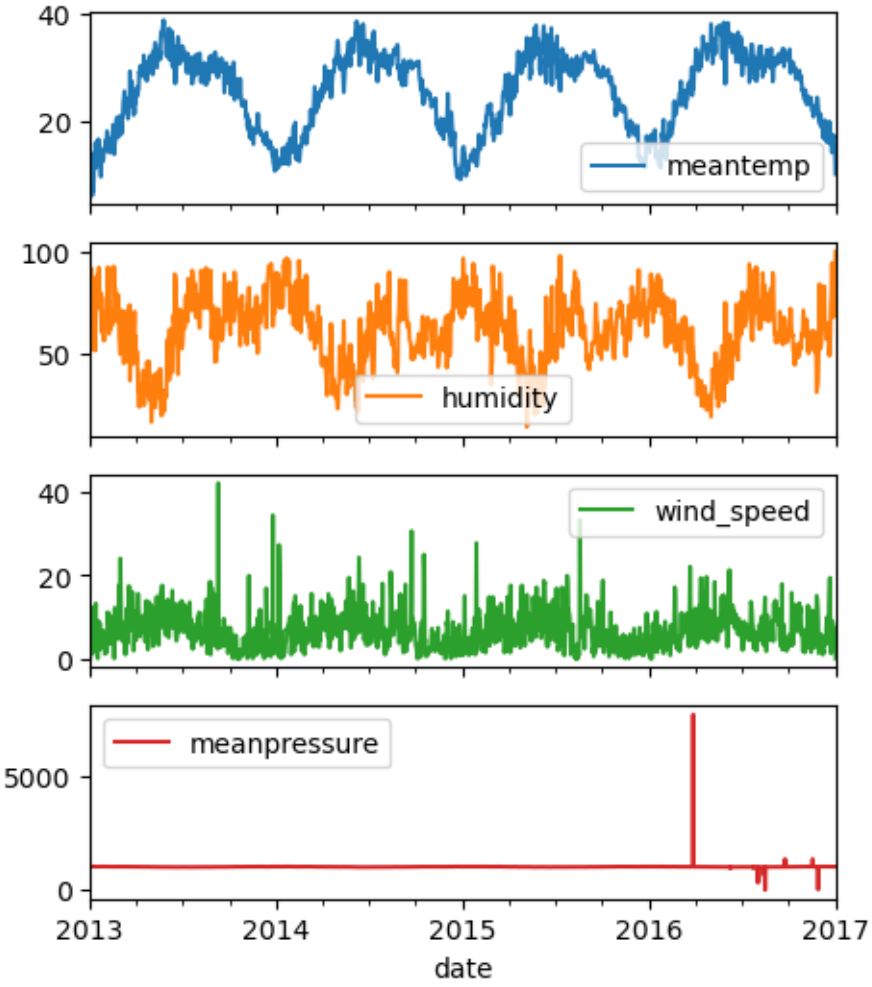
[13]:
```
tm.describe()
```

[13]:

	meantemp	humidity	wind_speed	meanpressure
count	1462.000000	1462.000000	1462.000000	1462.000000
mean	25.495521	60.771702	6.802209	1011.104548
std	7.348103	16.769652	4.561602	180.231668
min	6.000000	13.428571	0.000000	-3.041667

25%	18.857143	50.375000	3.475000	1001.580357
50%	27.714286	62.625000	6.221667	1008.563492
75%	31.305804	72.218750	9.238235	1014.944901
max	38.714286	100.000000	42.220000	7679.333333

[14]:
```
tm.plot(figsize=(5,6),subplots=True)
plt.show()
```



Conclusions: * wind speed:there are 2 spikes between 2013 and 2014,2 spikes between 2014 and 2015,2 spikes between 2015 and 2016 and one spike between 2016 and 2017

2 Stationarity

A time series is stationary if its statistical properties (mean,variance,autocorrelation) remain constant over time.

Hypothises of the ADF Test: * Null Hypothises(H0):The time series has s unit root(i.e,it is non-stationary)). * Alternative Hypothises(H1):The time series does not have a unit root(i.e, it is stationry)

Interpreting ADF Test Results: * If the p-value is less than 0.05,reject the hypothises (The time series is stationary). * If the p-value is greater than 0.05,fail to reject hypothises(The time series is non-stationary).

[15]:
```
ar=adfuller(tm["meantemp"])
ar
```

[15]:
```
(-2.0210690559206728,
 0.27741213723016056,
 10,
 1451,
 {'1%': -3.4348647527922824,
  '5%': -2.863533960720434,
  '10%': -2.567831568508802},
 5423.895746470953)
```

[16]:
```
if ar[1]<0.05:
    print("Stationary.")
else:
    print("Non-stationary.")
```

```
Non-stationary.
```

3 Differencing to Remove Trend:If the series is non_stationary,apply differencing.

differencing is a technique to make nin-stationary time series stationary by removing trends or seasonality.It involves subtracting thye previous abservation from the current abservation.

#example: temperature=[20,21,22,24,25,27,28,27]. Difference=[1,1,2,1,2,1,-1]. The new series fluctuated around zero -2 to 2.

4 Differencing

[17]:
```
tm["meantemp_d"]=tm["meantemp"].diff()
tm.head()
```

[17]:

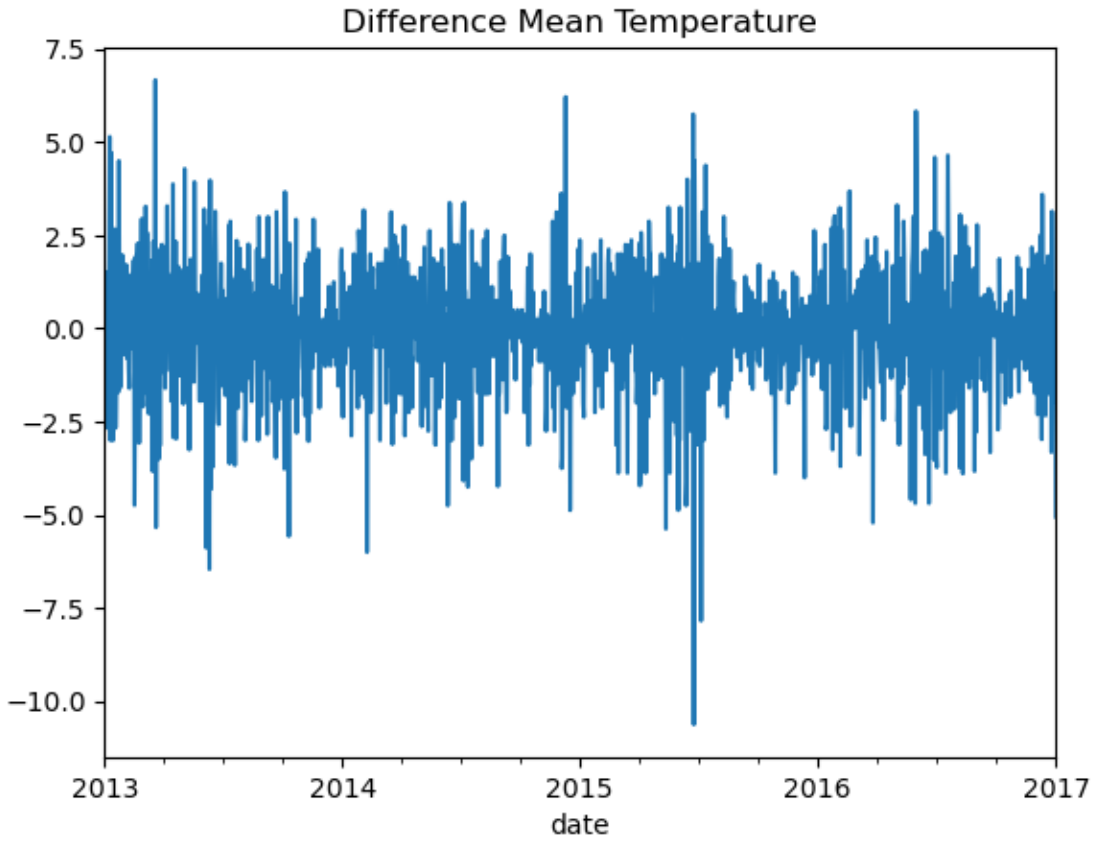
date	meantemp	humidity	wind_speed	meanpressure	meantemp_d
2013-01-01	10.000000	84.500000	0.000000	1015.666667	NaN
2013-01-02	7.400000	92.000000	2.980000	1017.800000	-2.600000
2013-01-03	7.166667	87.000000	4.633333	1018.666667	-0.233333
2013-01-04	8.666667	71.333333	1.233333	1017.166667	1.500000

```
2013-01-05    6.000000  86.833333     3.700000  1016.500000   -2.666667
```

[18]:
```
ard=adfuller(tm["meantemp_d"].dropna())
if ard[1]>0.05:
    print("Non-sationary.")
else:
    print("Sationary.")
```

```
Sationary.
```

[19]:
```
tm["meantemp_d"].plot(title="Difference Mean Temperature")
plt.show()
```



Conclusions: * The mean Temperature is around 0. * There are some positive spikes and some negative spikes suggesting outliers. * between 2015 and 2016 there is an extreme negative spike(lowest temperature). * It is Stationary that means the p-value is less than 0.05.

5 Use Seasonal decomposition to analyze trend,seasonality and residuals.

Seasonal decomposition is a technique used to break a time series into components. - Trend-The long-term pattern(increse or decrease over time). - Seasonality-The repeating patterns at fixed intervals(e.g.,monthly sales spike). - Residual(Noise)- The random variations that are not explained by trend or seasonality.

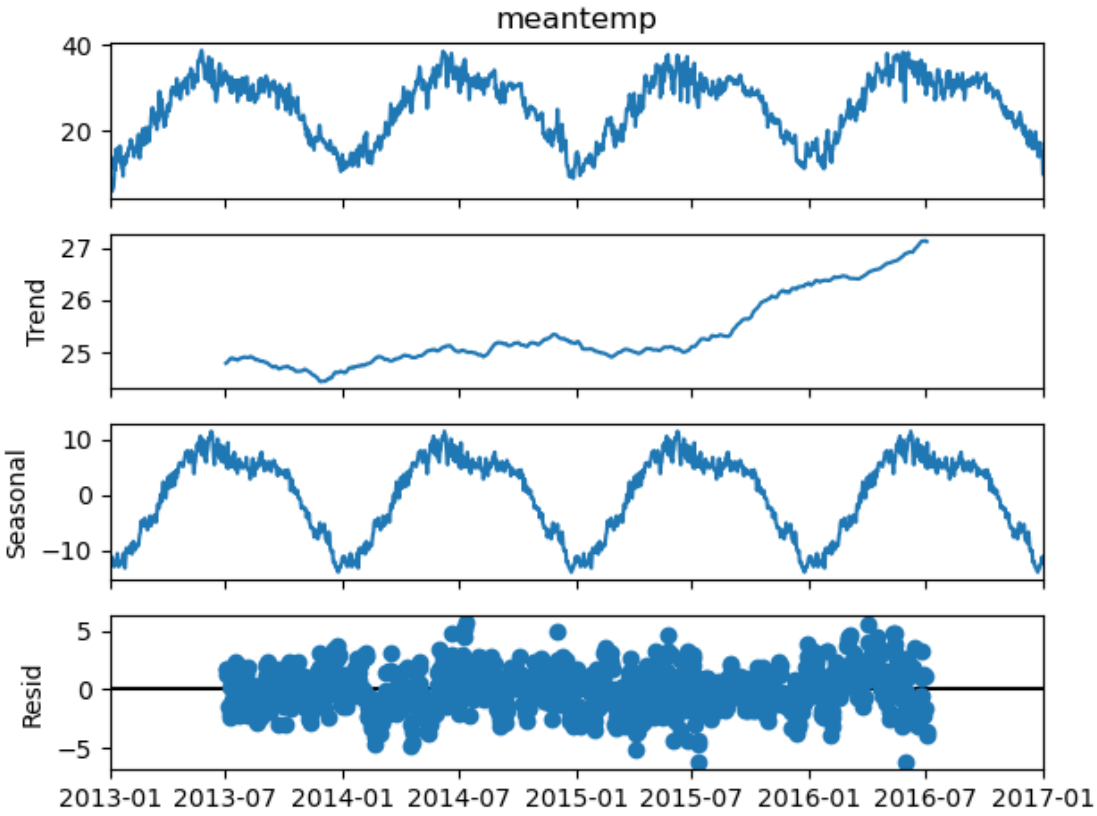
Interpreting the Output: - original series-The raw time series data. - Trend Component-The general direction of the data over time. - Seasonal Component-The repeating patterns(e.g.,higher sales in December). - Residual Component-The remaining part after removing trend and seasonality.

6 Decomposing

[20]:
```
from statsmodels.tsa.seasonal import seasonal_decompose
decomposing=seasonal_decompose(tm["meantemp"],model="additive",period=365)
print(decomposing)
```

```
<statsmodels.tsa.seasonal.DecomposeResult object at 0x000002AA40CD3230>
```

[21]:
```
decomposing.plot()
plt.show()
```



Conclusions: Trend: * The lowest temperature is between 2013 and 2014. * The temperaure is constantly increasing between 2015 and 2016. * The hihghest temperature is between 2016/01 and 2016/07.

Seasonal: * No constant temperature is exist. * The lowest temperature is -10 and highest temperature is 10.

Residual: * The mean temperature is around 0. * There is some negative spike and some positive spkies.

7 ARIMA

[22]:
```
#splitting data
len(tm)
```

[22]:
```
1462
```

[23]:
```
print(len(tm)*0.80)
```

```
1169.6000000000001
```

[29]:
```
train=tm.iloc[0:1169]
test=tm.iloc[1169:]
len(test)
```

[29]:
```
293
```

[26]:
```
mm=ARIMA(train["meantemp"],order=(1,1,1))
```

```
C:\Users\Megha I Angadi\anaconda3\Lib\site-
packages\statsmodels\tsa\base\tsa_model.py:473: ValueWarning: No frequency
information was provided, so inferred frequency D will be used.
  self._init_dates(dates, freq)
C:\Users\Megha I Angadi\anaconda3\Lib\site-
packages\statsmodels\tsa\base\tsa_model.py:473: ValueWarning: No frequency
information was provided, so inferred frequency D will be used.
  self._init_dates(dates, freq)
C:\Users\Megha I Angadi\anaconda3\Lib\site-
packages\statsmodels\tsa\base\tsa_model.py:473: ValueWarning: No frequency
information was provided, so inferred frequency D will be used.
  self._init_dates(dates, freq)
```

[27]:
```
mm=mm.fit()
```

[28]:
```
mm
```

[28]:
```
<statsmodels.tsa.arima.model.ARIMAResultsWrapper at 0x2aa40e7bc80>
```

[31]:
```
forecast=mm.forecast(steps=len(test))
print(forecast)
```

```
2016-03-15    22.826205
2016-03-16    23.085687
2016-03-17    23.234913
2016-03-18    23.320731
2016-03-19    23.370084
                 …
2016-12-28    23.436880
2016-12-29    23.436880
2016-12-30    23.436880
2016-12-31    23.436880
2017-01-01    23.436880
Freq: D, Name: predicted_mean, Length: 293, dtype: float64
```

[46]:
```
test.head()
test["forecast"]=forecast
test.head()
```

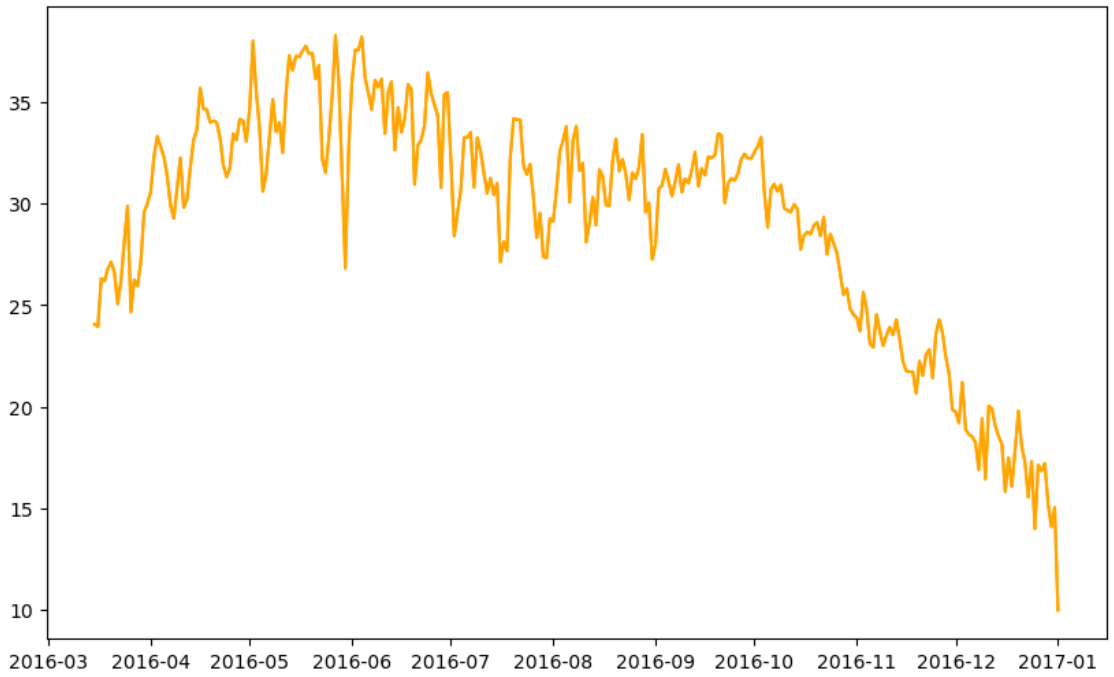
```
C:\Users\Megha I Angadi\AppData\Local\Temp\ipykernel_16204\2784579413.py:2:
SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  test["forecast"]=forecast
```

[46]:

date	meantemp	humidity	wind_speed	meanpressure	meantemp_d	forecast
2016-03-15	24.066667	58.933333	8.646667	1014.866667	1.691667	22.826205
2016-03-16	23.937500	53.750000	10.881250	1012.812500	-0.129167	23.085687
2016-03-17	26.312500	50.312500	6.843750	1010.437500	2.375000	23.234913
2016-03-18	26.187500	61.250000	6.712500	1009.812500	-0.125000	23.320731
2016-03-19	26.785714	61.857143	3.578571	1009.214286	0.598214	23.370084

[69]:
```
plt.figure(figsize=(10,6))
plt.plot(test.index,test["meantemp"],color="orange",label="original")
plt.plot(forecast.index,test["meantemp"],color="orange",label="original")
```

[69]: [<matplotlib.lines.Line2D at 0x2aa58735940>]



ARIMA on Difference values

[59]:
```
len(tm)
print(len(tm)*0.80)
```

```
1169.6000000000001
```

[60]:
```
train1=tm.iloc[0:1169]
test1=tm[1169:]
```

[61]:
```
mm1=ARIMA(train1["meantemp_d"],order=(1,1,1))
```

```
C:\Users\Megha I Angadi\anaconda3\Lib\site-
packages\statsmodels\tsa\base\tsa_model.py:473: ValueWarning: No frequency
information was provided, so inferred frequency D will be used.
  self._init_dates(dates, freq)
C:\Users\Megha I Angadi\anaconda3\Lib\site-
packages\statsmodels\tsa\base\tsa_model.py:473: ValueWarning: No frequency
information was provided, so inferred frequency D will be used.
  self._init_dates(dates, freq)
```

```
C:\Users\Megha I Angadi\anaconda3\Lib\site-
packages\statsmodels\tsa\base\tsa_model.py:473: ValueWarning: No frequency
information was provided, so inferred frequency D will be used.
  self._init_dates(dates, freq)
```

[63]:
```
mm1=mm1.fit()
mm1
```

[63]:
```
<statsmodels.tsa.arima.model.ARIMAResultsWrapper at 0x2aa545e3c80>
```

[64]:
```
forecast_d=mm1.forecast(steps=len(test1))
print(forecast_d)
```

```
2016-03-15    0.322914
2016-03-16   -0.040400
2016-03-17    0.019656
2016-03-18    0.009729
2016-03-19    0.011370
                 …
2016-12-28    0.011137
2016-12-29    0.011137
2016-12-30    0.011137
2016-12-31    0.011137
2017-01-01    0.011137
Freq: D, Name: predicted_mean, Length: 293, dtype: float64
```

[79]:
```
test1.head()
test1["forecast_d"]=tm["meantemp"].diff()
tm.head()
test1.head()
```

```
C:\Users\Megha I Angadi\AppData\Local\Temp\ipykernel_16204\2271608683.py:2:
SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  test1["forecast_d"]=tm["meantemp"].diff()
```

[79]:

date	meantemp	humidity	wind_speed	meanpressure	meantemp_d
2016-03-15	24.066667	58.933333	8.646667	1014.866667	1.691667
2016-03-16	23.937500	53.750000	10.881250	1012.812500	-0.129167
2016-03-17	26.312500	50.312500	6.843750	1010.437500	2.375000
2016-03-18	26.187500	61.250000	6.712500	1009.812500	-0.125000
2016-03-19	26.785714	61.857143	3.578571	1009.214286	0.598214

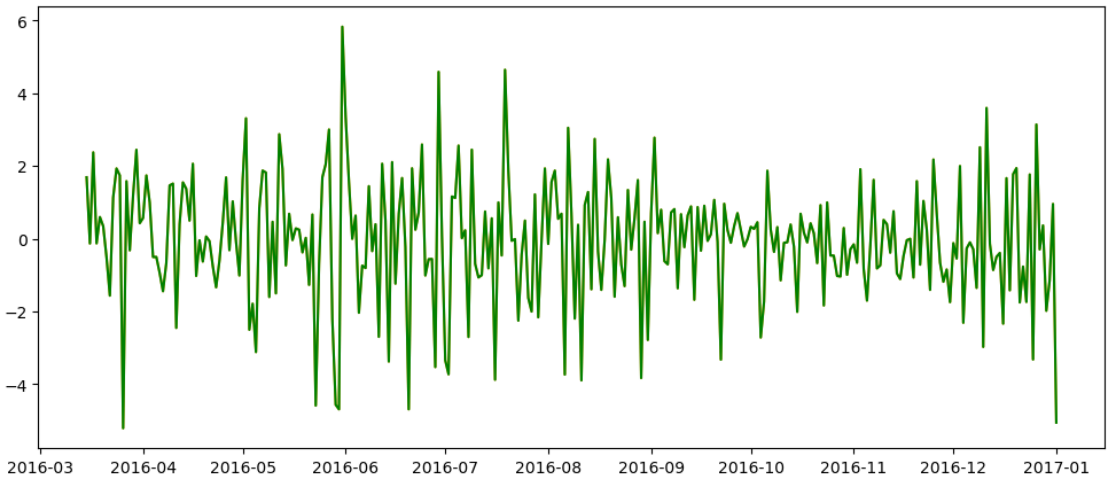
```
            forecast_d   forecast
date
2016-03-15    1.691667  22.826205
2016-03-16   -0.129167  23.085687
2016-03-17    2.375000  23.234913
2016-03-18   -0.125000  23.320731
2016-03-19    0.598214  23.370084
```

[80]:
```
test1.head()
test1["forecast"]=forecast
test1.head()
```

```
C:\Users\Megha I Angadi\AppData\Local\Temp\ipykernel_16204\3701077959.py:2:
SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  test1["forecast"]=forecast
```

[80]:
```
             meantemp   humidity  wind_speed  meanpressure  meantemp_d  \
date
2016-03-15  24.066667  58.933333    8.646667   1014.866667    1.691667
2016-03-16  23.937500  53.750000   10.881250   1012.812500   -0.129167
2016-03-17  26.312500  50.312500    6.843750   1010.437500    2.375000
2016-03-18  26.187500  61.250000    6.712500   1009.812500   -0.125000
2016-03-19  26.785714  61.857143    3.578571   1009.214286    0.598214

            forecast_d   forecast
date
2016-03-15    1.691667  22.826205
2016-03-16   -0.129167  23.085687
2016-03-17    2.375000  23.234913
2016-03-18   -0.125000  23.320731
2016-03-19    0.598214  23.370084
```

[84]:
```
plt.figure(figsize=(12,5))
plt.plot(test1.index,test1["meantemp_d"],color="orange",label="original")
plt.plot(test1.index,test1["forecast_d"],color="green",label="original")
plt.title("")
plt.show()
```



Conclusion: On 15th March,original value=24.0,model says there is change on the next day 24.066667-0.040038=24.02(The predicted)~23.9(original)

[ ]: