```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt

plt.rcParams['figure.figsize'] = (10, 4)
```

```
#Downloading the dataset
!gdown 1-pOuGRd8zuAUKBll-1xkr7_867NwoWHg
```

```
Downloading...
From: https://drive.google.com/uc?id=1-pOuGRd8zuAUKBll-1xkr7_867NwoWHg
To: /content/mobilesales.xlsx
100% 13.7k/13.7k [00:00<00:00, 33.3MB/s]
```

```
mobile_sales = pd.read_excel("mobilesales.xlsx")
```

Start coding or generate with AI.

```
mobile_sales.head()
```

	DATE	Sales
0	2001-01-01	6519.0
1	2001-02-01	6654.0
2	2001-03-01	7332.0
3	2001-04-01	7332.0
4	2001-05-01	8240.0

Next steps: Generate code with mobile_sales View recommended plots

```
mobile_sales.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 217 entries, 0 to 216
Data columns (total 2 columns):
 #   Column  Non-Null Count  Dtype
---  ------  --------------  -----
 0   DATE    217 non-null    datetime64[ns]
 1   Sales   198 non-null    float64
dtypes: datetime64[ns](1), float64(1)
memory usage: 3.5 KB
```

```
#Make the timestamp column index
mobile_sales.set_index("DATE",inplace=True)
mobile_sales.head()
```

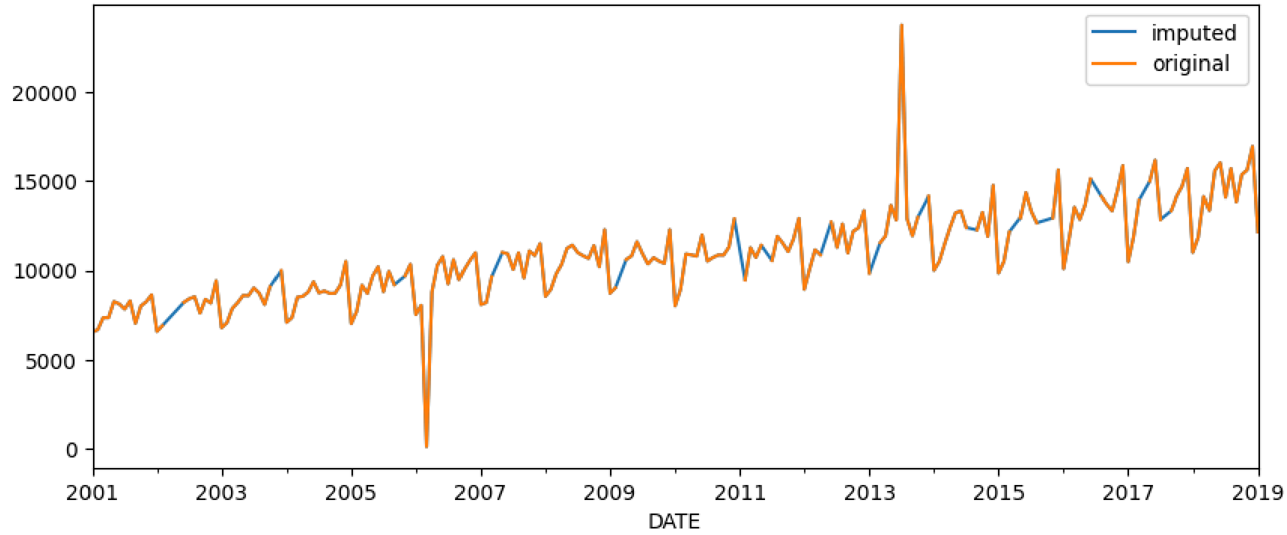
	Sales
DATE	
2001-01-01	6519.0
2001-02-01	6654.0
2001-03-01	7332.0
2001-04-01	7332.0
2001-05-01	8240.0

Next steps: Generate code with mobile_sales View recommended plots

Imputing Missing Values

```
#Linear Interpolation
mobile_sales.Sales.interpolate(method="linear").plot(label="imputed")
mobile_sales.Sales.plot(label="original")
plt.legend()
```

```
<matplotlib.legend.Legend at 0x7c4a04884580>
```

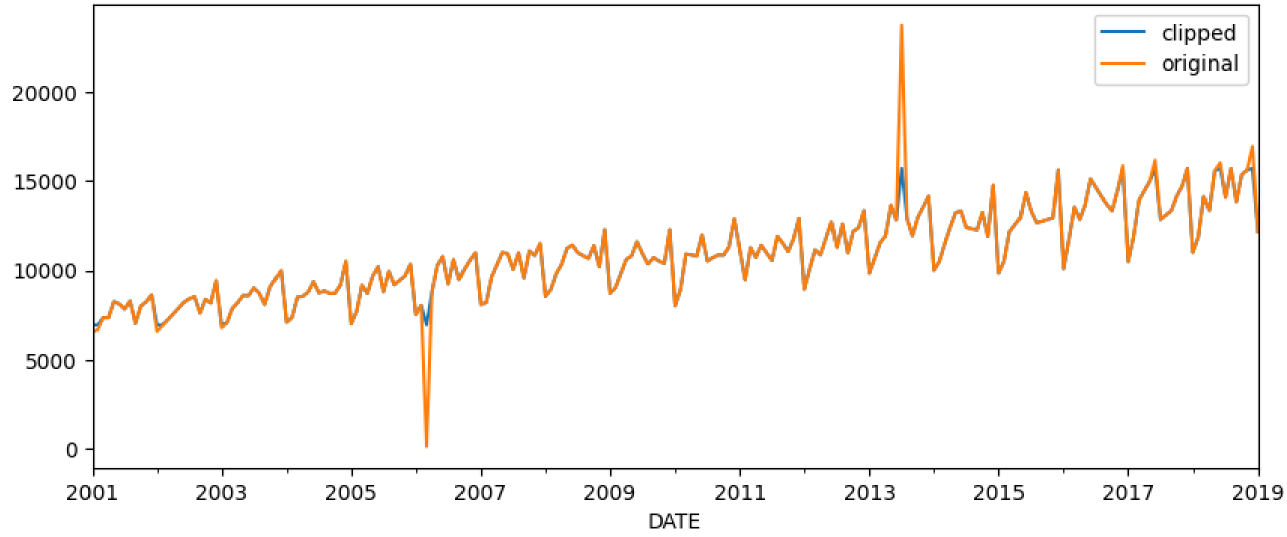


```
mobile_sales.Sales = mobile_sales.Sales.interpolate(method="linear")
```

Handling ANomalies

```
mobile_sales.Sales.clip(lower = mobile_sales.Sales.quantile(0.025),upper = mob
mobile_sales.Sales.plot(label="original")
plt.legend()
```

```
<matplotlib.legend.Legend at 0x7c4a04887700>
```



```
mobile_sales.Sales = mobile_sales.Sales.clip(lower = mobile_sales.Sales.quanti
```

```
mobile_sales.Sales.rolling(window=3).mean()
```

```
DATE
2001-01-01             NaN
2001-02-01             NaN
2001-03-01     7061.866667
2001-04-01     7196.933333
2001-05-01     7634.666667
                  ...
2018-09-01    14538.333333
2018-10-01    14962.000000
2018-11-01    14934.666667
2018-12-01    15555.733333
2019-01-01    14492.066667
Name: Sales, Length: 217, dtype: float64
```

```
#Centered MA
mobile_sales.Sales.rolling(window=3,center=True).mean()
```

```
DATE
2001-01-01             NaN
```

```
2001-02-01     7061.866667
2001-03-01     7196.933333
2001-04-01     7634.666667
2001-05-01     7892.000000
                  ...
2018-09-01    14962.000000
2018-10-01    14934.666667
2018-11-01    15555.733333
2018-12-01    14492.066667
2019-01-01             NaN
Name: Sales, Length: 217, dtype: float64
```

Train Test Split

```
train_x = mobile_sales[mobile_sales.index<mobile_sales.index[-12]]
test_x = mobile_sales[mobile_sales.index>=mobile_sales.index[-12]]
display(train_x.tail(2))
display(test_x.head(2))
```

	Sales
DATE	
2017-12-01	15701.2
2018-01-01	11005.0

	Sales
DATE	
2018-02-01	11852.0
2018-03-01	14123.0

```
from sklearn.metrics import (
    mean_squared_error as mse,
    mean_absolute_error as mae,
    mean_absolute_percentage_error as mape
)

# Creating a function to print values of all these metrics.
def performance(actual, predicted):
    print('MAE :', round(mae(actual, predicted), 3))
    print('RMSE :', round(mse(actual, predicted)**0.5, 3))
    print('MAPE:', round(mape(actual, predicted), 3))
```

Start coding or generate with AI.

Moving Average Forecasting

```
df = mobile_sales.copy()
```

```
df.tail(3)
```

DATE	Sales
2018-11-01	15615.0
2018-12-01	15701.2
2019-01-01	12160.0

```
pd.DataFrame(index = pd.date_range(start=df.index[-1], periods=12,freq='MS'))
```

2019-01-01
2019-02-01
2019-03-01
2019-04-01
2019-05-01
2019-06-01
2019-07-01
2019-08-01
2019-09-01
2019-10-01
2019-11-01
2019-12-01

```
df = pd.concat([df,pd.DataFrame(index = pd.date_range(start=df.index[-1], peri
```

```
print(df.tail(20))
```

```
              Sales
2018-06-01  15701.2
2018-07-01  14080.0
2018-08-01  15697.0
2018-09-01  13838.0
2018-10-01  15351.0
2018-11-01  15615.0
2018-12-01  15701.2
```

```
2019-01-01  12160.0
2019-02-01      NaN
2019-03-01      NaN
2019-04-01      NaN
2019-05-01      NaN
2019-06-01      NaN
2019-07-01      NaN
2019-08-01      NaN
2019-09-01      NaN
2019-10-01      NaN
2019-11-01      NaN
2019-12-01      NaN
2020-01-01      NaN
```

```
pred = df.Sales.dropna().values

for i in range(12):
  pred = np.append(pred, pred[-3:].mean())

pred[-20:]
```

```
array([15701.2       , 14080.        , 15697.        , 13838.        ,
       15351.        , 15615.        , 15701.2       , 12160.        ,
       14492.06666667, 14117.75555556, 13589.94074074, 14066.58765432,
       13924.76131687, 13860.42990398, 13950.59295839, 13911.92805975,
       13907.65030737, 13923.39044184, 13914.32293632, 13915.12122851])
```

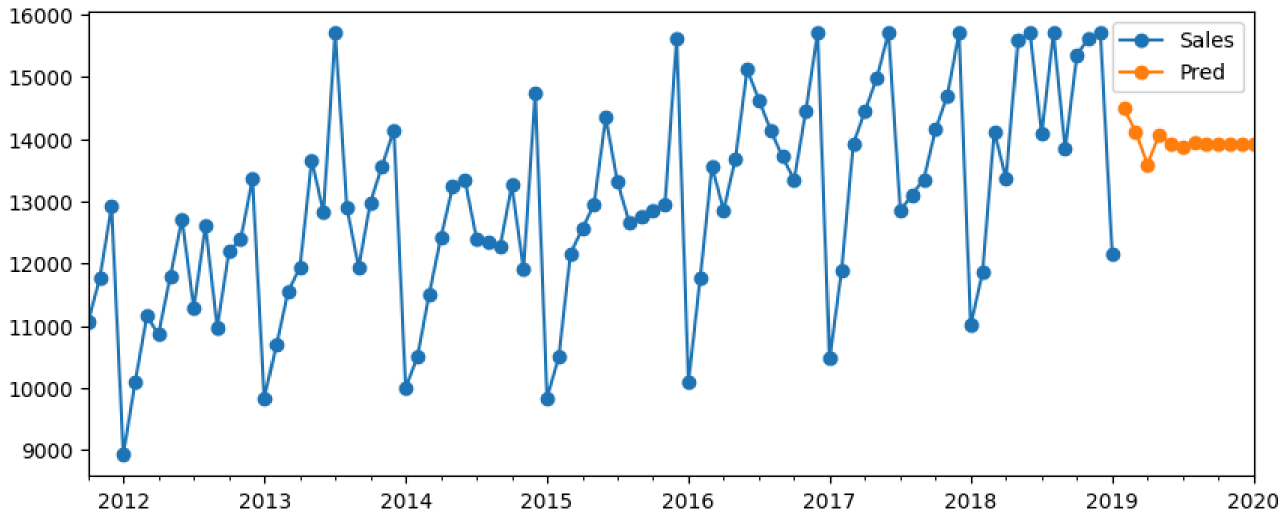
```
df['Pred'] = pred
df.tail(20)
```

```
              Sales          Pred
2018-06-01  15701.2  15701.200000
2018-07-01  14080.0  14080.000000
2018-08-01  15697.0  15697.000000
2018-09-01  13838.0  13838.000000
2018-10-01  15351.0  15351.000000
2018-11-01  15615.0  15615.000000
2018-12-01  15701.2  15701.200000
2019-01-01  12160.0  12160.000000
2019-02-01      NaN  14492.066667
2019-03-01      NaN  14117.755556
2019-04-01      NaN  13589.940741
2019-05-01      NaN  14066.587654
2019-06-01      NaN  13924.761317
2019-07-01      NaN  13860.429904
2019-08-01      NaN  13950.592958
2019-09-01      NaN  13911.928060
2019-10-01      NaN  13907.650307
2019-11-01      NaN  13923.390442
2019-12-01      NaN  13914.322936
2020-01-01      NaN  13915.121229
```

```
df.loc[~df['Sales'].isna(), 'Pred'] = np.nan
df.tail(20)
```

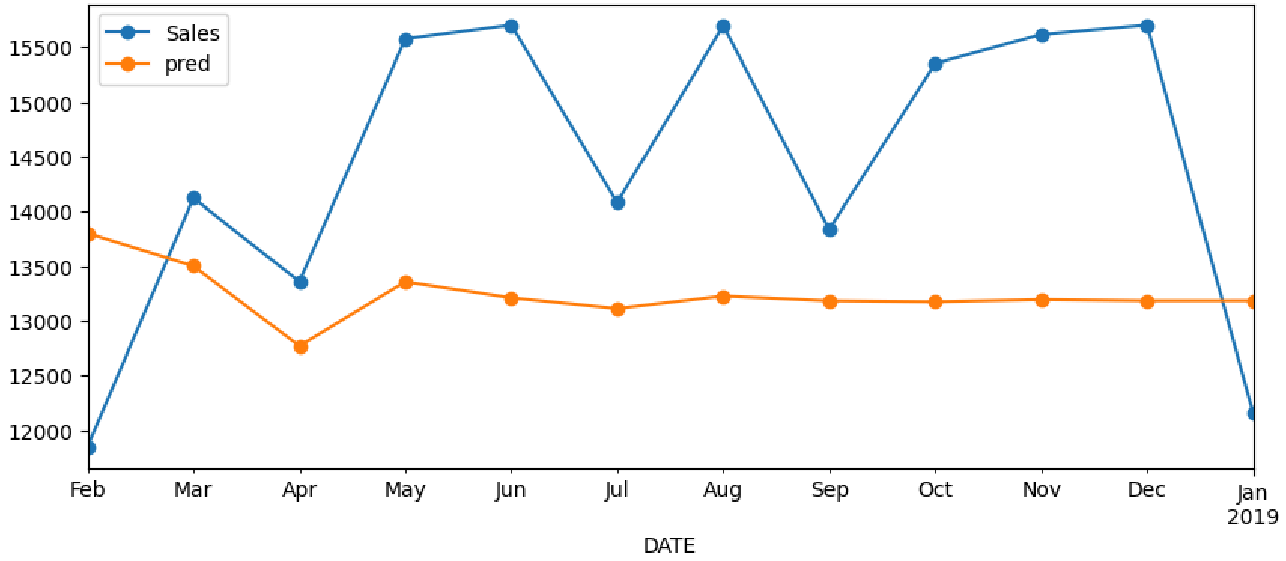
```
              Sales          Pred
2018-06-01  15701.2           NaN
2018-07-01  14080.0           NaN
2018-08-01  15697.0           NaN
2018-09-01  13838.0           NaN
2018-10-01  15351.0           NaN
2018-11-01  15615.0           NaN
2018-12-01  15701.2           NaN
2019-01-01  12160.0           NaN
2019-02-01      NaN  14492.066667
2019-03-01      NaN  14117.755556
2019-04-01      NaN  13589.940741
2019-05-01      NaN  14066.587654
2019-06-01      NaN  13924.761317
2019-07-01      NaN  13860.429904
2019-08-01      NaN  13950.592958
2019-09-01      NaN  13911.928060
2019-10-01      NaN  13907.650307
2019-11-01      NaN  13923.390442
2019-12-01      NaN  13914.322936
2020-01-01      NaN  13915.121229
```

```
df.tail(100).plot(style='-o')
plt.show()
```



```
df = train_x.copy()
df = pd.concat([df,pd.DataFrame(index = pd.date_range(start=df.index[-1], peri

pred = df.Sales.dropna().values

for i in range(12):
  pred = np.append(pred, pred[-3:].mean())

test_x['pred'] = pred[-12:]
test_x.plot(style='-o')
performance(test_x['Sales'], test_x['pred'])
```

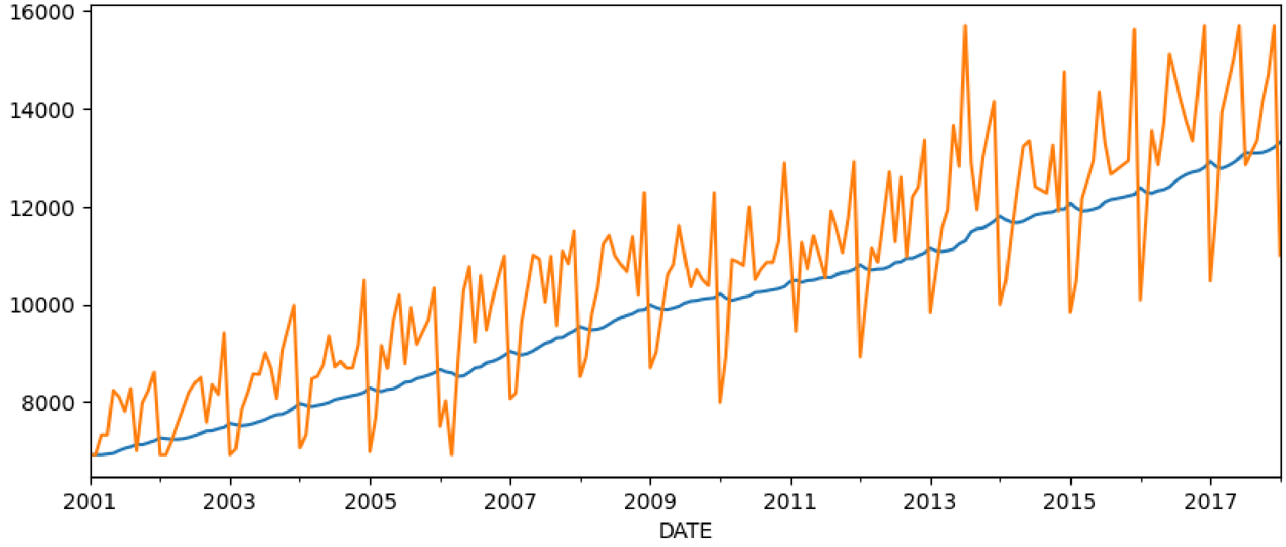
```
<ipython-input-28-b580f0e0be2b>:9: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/us
  test_x['pred'] = pred[-12:]
MAE : 1675.069
RMSE : 1850.877
MAPE: 0.114
```



SES

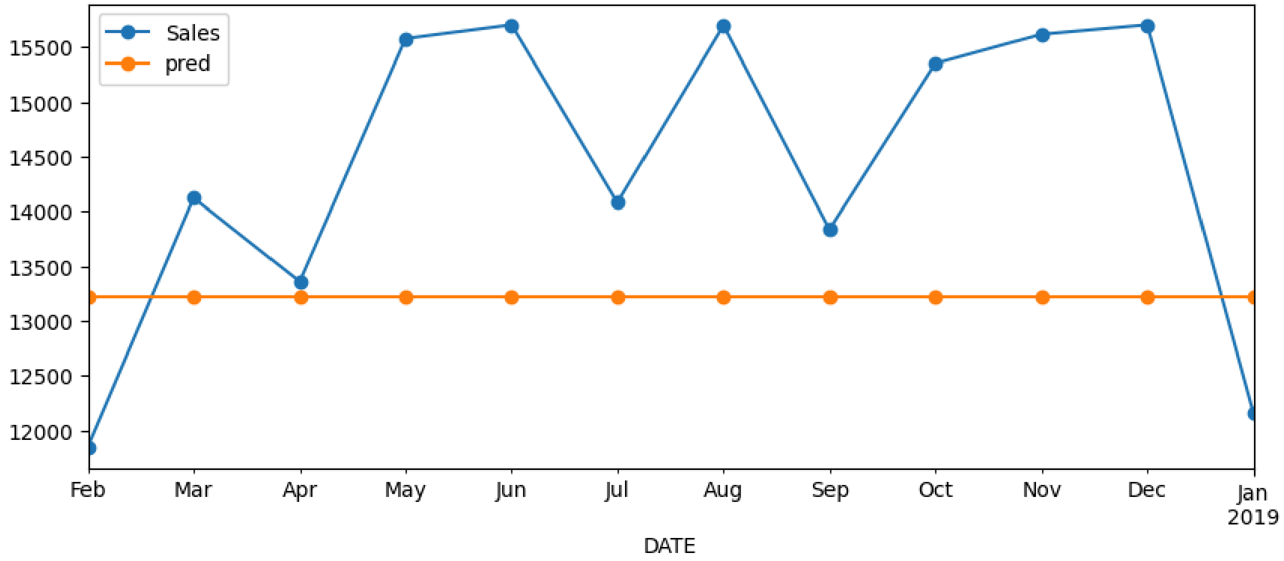
```
import statsmodels.api as sm

#alpha = smoothing level
model = pd.Series(sm.tsa.SimpleExpSmoothing(train_x).fit(smoothing_level=1/(2*

model.plot()
train_x.Sales.plot()
```

```
/usr/local/lib/python3.10/dist-packages/statsmodels/tsa/base/tsa_model.py:473: ValueW
  self._init_dates(dates, freq)
/usr/local/lib/python3.10/dist-packages/pandas/util/_decorators.py:210: EstimationWar
  return func(*args, **kwargs)
<Axes: xlabel='DATE'>
```



```
model = sm.tsa.SimpleExpSmoothing(train_x.Sales).fit(smoothing_level=1/(2*12))
test_x['pred'] = model.forecast(steps = 12)
test_x.plot(style='-o')
performance(test_x['Sales'], test_x['pred'])
```

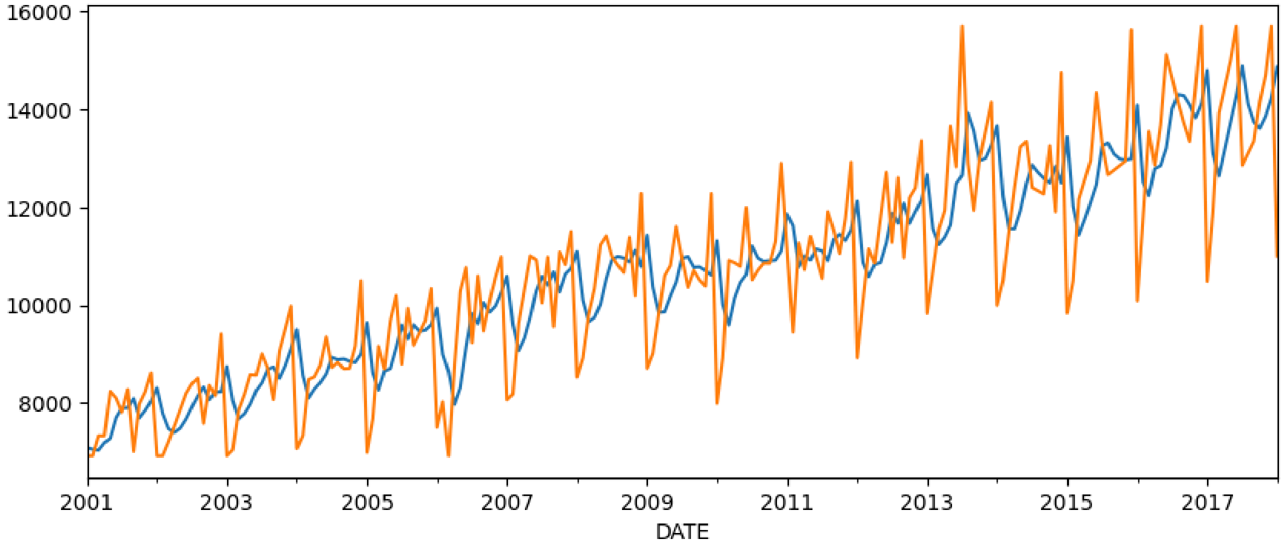
```
/usr/local/lib/python3.10/dist-packages/statsmodels/tsa/base/tsa_model.py:473: ValueW
  self._init_dates(dates, freq)
/usr/local/lib/python3.10/dist-packages/pandas/util/_decorators.py:210: EstimationWar
  return func(*args, **kwargs)
<ipython-input-32-e38fdb9bb653>:2: SettingWithCopyWarning:
A value 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/us
  test_x['pred'] = model.forecast(steps = 12)
MAE : 1607.766
RMSE : 1809.926
MAPE: 0.108
```



Holt's Method (DES)

```
#alpha = smoothing level
model = pd.Series(sm.tsa.ExponentialSmoothing(train_x,trend="add").fit(smoothi

model.plot()
train_x.Sales.plot()
```

```
/usr/local/lib/python3.10/dist-packages/statsmodels/tsa/base/tsa_model.py:473: ValueW
  self._init_dates(dates, freq)
/usr/local/lib/python3.10/dist-packages/statsmodels/tsa/holtwinters/model.py:918: Cor
  warnings.warn(
<Axes: xlabel='DATE'>
```



```
model = sm.tsa.ExponentialSmoothing(train_x.Sales, trend='add').fit(smoothing_
test_x['pred'] = model.forecast(steps = 12)
test_x.plot(style='-o')
performance(test_x['Sales'], test_x['pred'])
```

```
/usr/local/lib/python3.10/dist-packages/statsmodels/tsa/base/tsa_model.py:473: ValueW
  self._init_dates(dates, freq)
```