In [1]:
```
### FB prophet
```

Prophet

Prophet is open source software released by Facebook's Core Data Science team.
Prophet is a procedure for forecasting time series data based on an additive/multiplicative model where non-linear trends are fit with yearly, weekly, and daily seasonality, plus holiday effects. It works best with time series that have strong seasonal effects and several seasons of historical data. Prophet is robust to missing data and shifts in the trend, and typically handles outliers well.
The Prophet package provides intuitive parameters which are easy to tune.
Prophet example notebooks

Trend parameters

`growth` : 'linear' or 'logistic' to specify a linear or logistic trend `changepoints` : List of dates at which to include potential changepoints (automatic if not specified) `n_changepoints` : If changepoints in not supplied, you may provide the number of changepoints to be automatically included changepoint_prior_scale: Parameter for changing flexibility of automatic changepoint selection Seasonality and Holiday Parameters

`yearly_seasonality` : Fit yearly seasonality
`weekly_seasonality` : Fit weekly seasonality
`daily_seasonality` : Fit daily seasonality
`holidays` : Feed dataframe containing holiday name and date
`seasonality_prior_scale` : Parameter for changing strength of seasonality model
`holiday_prior_scale` : Parameter for changing strength of holiday model
Prophet requires the variable names in the time series to be:

y – Target ds – Datetime

In [2]:
```
###!mkdir ~/.kaggle
```

In [3]:
```
##!cp /kaggle.json ~/.kaggle/
```

In [4]:
```
##!chmod 600 ~/.kaggle/kaggle.json
```

In [5]:
```
###! pip install kaggle
```

In [6]:
```
###!pip install keras-tuner
```

In [7]:
```
###! kaggle datasets download -d bobnau/daily-website-visitors
```

In [8]:
```
###! unzip ./daily-website-visitors.zip
```

In [9]:
```
###! pip install tensorflow
```

In [10]:
```
import pandas as pd
import numpy as np
import tensorflow as tf
from sklearn import preprocessing
import matplotlib.pyplot as plt
tf.random.set_seed(123)
np.random.seed(123)
```

In [11]:
```
import pandas as pd
#import fbprophet
import matplotlib.pyplot as plt
%matplotlib inline
import numpy as np
```

In [12]:
```
df=pd.read_csv('/content/daily-website-visitors.csv', parse_dates=['Date'], index_col ="Date")
df.head(3)
```

Out[12]:

Date	Row	Day	Day.Of.Week	Page.Loads	Unique.Visits	First.Time.Visits	Returning.Visits
2014-09-14	1	Sunday	1	2,146	1,582	1,430	152
2014-09-15	2	Monday	2	3,621	2,528	2,297	231
2014-09-16	3	Tuesday	3	3,698	2,630	2,352	278

In [13]:
```
df.columns
```

Out[13]:
```
Index(['Row', 'Day', 'Day.Of.Week', 'Page.Loads', 'Unique.Visits',
       'First.Time.Visits', 'Returning.Visits'],
      dtype='object')
```

In [14]:
```
df2 = df [['Page.Loads', 'Unique.Visits',
       'First.Time.Visits', 'Returning.Visits']]
```

In [15]:
```
df2['Page.Loads'] = df2['Page.Loads'].str.replace(',', '').astype(int)
```

```
<ipython-input-15-aee0d0387463>:1: 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
  df2['Page.Loads'] = df2['Page.Loads'].str.replace(',', '').astype(int)
```

In [16]:
```
df2['Unique.Visits'] = df2['Unique.Visits'].str.replace(',', '').astype(int)
df2['First.Time.Visits'] = df2['First.Time.Visits'].str.replace(',', '').astype(int)
df2['Returning.Visits'] = df2['Returning.Visits'].str.replace(',', '').astype(int)
```

```
<ipython-input-16-55fee8d7339e>:1: 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
  df2['Unique.Visits'] = df2['Unique.Visits'].str.replace(',', '').astype(int)
<ipython-input-16-55fee8d7339e>: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
  df2['First.Time.Visits'] = df2['First.Time.Visits'].str.replace(',', '').astype(int)
<ipython-input-16-55fee8d7339e>:3: 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
  df2['Returning.Visits'] = df2['Returning.Visits'].str.replace(',', '').astype(int)
```

In [17]:
```
df2.head(3)
```

Out[17]:

Date	Page.Loads	Unique.Visits	First.Time.Visits	Returning.Visits
2014-09-14	2146	1582	1430	152
2014-09-15	3621	2528	2297	231
2014-09-16	3698	2630	2352	278

In [18]:
```
# Basic packages
import numpy as np # linear algebra
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)
import random as rd # generating random numbers
import datetime # manipulating date formats
# Viz
import matplotlib.pyplot as plt # basic plotting
import seaborn as sns # for prettier plots
# TIME SERIES
from statsmodels.tsa.arima_model import ARIMA
from statsmodels.tsa.statespace.sarimax import SARIMAX
from pandas.plotting import autocorrelation_plot
from statsmodels.tsa.stattools import adfuller, acf, pacf,arma_order_select_ic
import statsmodels.formula.api as smf
import statsmodels.tsa.api as smt
import statsmodels.api as sm
import scipy.stats as scs
# settings
import warnings
warnings.filterwarnings("ignore")
```

In [19]:
```
monthly_page_loads = df2["Page.Loads"].resample('M').sum()
```

In [20]:
```
monthly_unique_visitors = df2["Unique.Visits"].resample('M').sum()
```

In [21]:
```
monthly_First_Time_Visits = df2["First.Time.Visits"].resample('M').sum()
```

In [22]:
```
monthly_Returning_Visits = df2["Returning.Visits"].resample('M').sum()
```

In [23]:
```
monthly_page_loads.head(3)
```

Out[23]:
```
Date
2014-09-30     56052
2014-10-31    121983
2014-11-30    114190
Freq: M, Name: Page.Loads, dtype: int64
```

In [24]:
```
print(monthly_page_loads.shape)
train=monthly_page_loads.iloc[:-30]
test=monthly_page_loads.iloc[-30:]
print(train.shape,test.shape)
### print(test.iloc[0],test.iloc[-1])
```

```
(72,)
(42,) (30,)
```

In [25]:
```
train = pd.DataFrame(train)
```

In [26]:
```
train.rename(columns={'Page.Loads':'Page_Loads'}, inplace=True)
```

In [27]:
```
test = pd.DataFrame(test)
```

In [28]:
```
test.rename(columns={'Page.Loads':'Page_Loads'}, inplace=True)
```

In [29]:
```
train_prophet = pd.DataFrame()
train_prophet['ds'] = train.index
train_prophet['y'] = train.Page_Loads.values
```

In [30]:
```
train_prophet.head()
```

Out[30]:

	ds	y
0	2014-09-30	56052
1	2014-10-31	121983
2	2014-11-30	114190
3	2014-12-31	105617
4	2015-01-31	96077

In [ ]:
```
###!pip install pystan~=2.14
###!pip install fbprophet
```

In [36]:
```
import fbprophet
```

In [37]:
```
from fbprophet import Prophet

#instantiate Prophet with only yearly seasonality as our data is monthly
model = Prophet( yearly_seasonality=True, seasonality_mode = 'multiplicative')
model.fit(train_prophet) #fit the model with your dataframe
```

```
INFO:fbprophet:Disabling weekly seasonality. Run prophet with weekly_seasonality=True to override this.
INFO:fbprophet:Disabling daily seasonality. Run prophet with daily_seasonality=True to override this.
```

Out[37]:
```
<fbprophet.forecaster.Prophet at 0x7f115f138d00>
```

In [38]:
```
# predict for five months in the furure and MS - month start is the frequency
future = model.make_future_dataframe(periods = 36, freq = 'MS')
future.tail()
```

Out[38]:

	ds
73	2020-10-01
74	2020-11-01
75	2020-12-01
76	2021-01-01
77	2021-02-01

In [39]:
```
# now lets make the forecasts
forecast = model.predict(future)
forecast[['ds', 'yhat', 'yhat_lower', 'yhat_upper']].tail()
```

Out[39]:

	ds	yhat	yhat_lower	yhat_upper
73	2020-10-01	97434.375753	76491.764352	118166.606330
74	2020-11-01	114107.861797	92885.451948	135082.306734
75	2020-12-01	120773.764779	100271.858879	141803.037628
76	2021-01-01	97546.960429	75950.113460	118983.411930
77	2021-02-01	100127.162651	79735.831315	121414.051636

In [65]:
```
test['ds'] = test.index
test['y'] = test.Page_Loads.values
```

In [66]:
```
# now lets make the forecasts
forecast2 = model.predict(test)
forecast2[['ds', 'yhat', 'yhat_lower', 'yhat_upper']].tail()
```

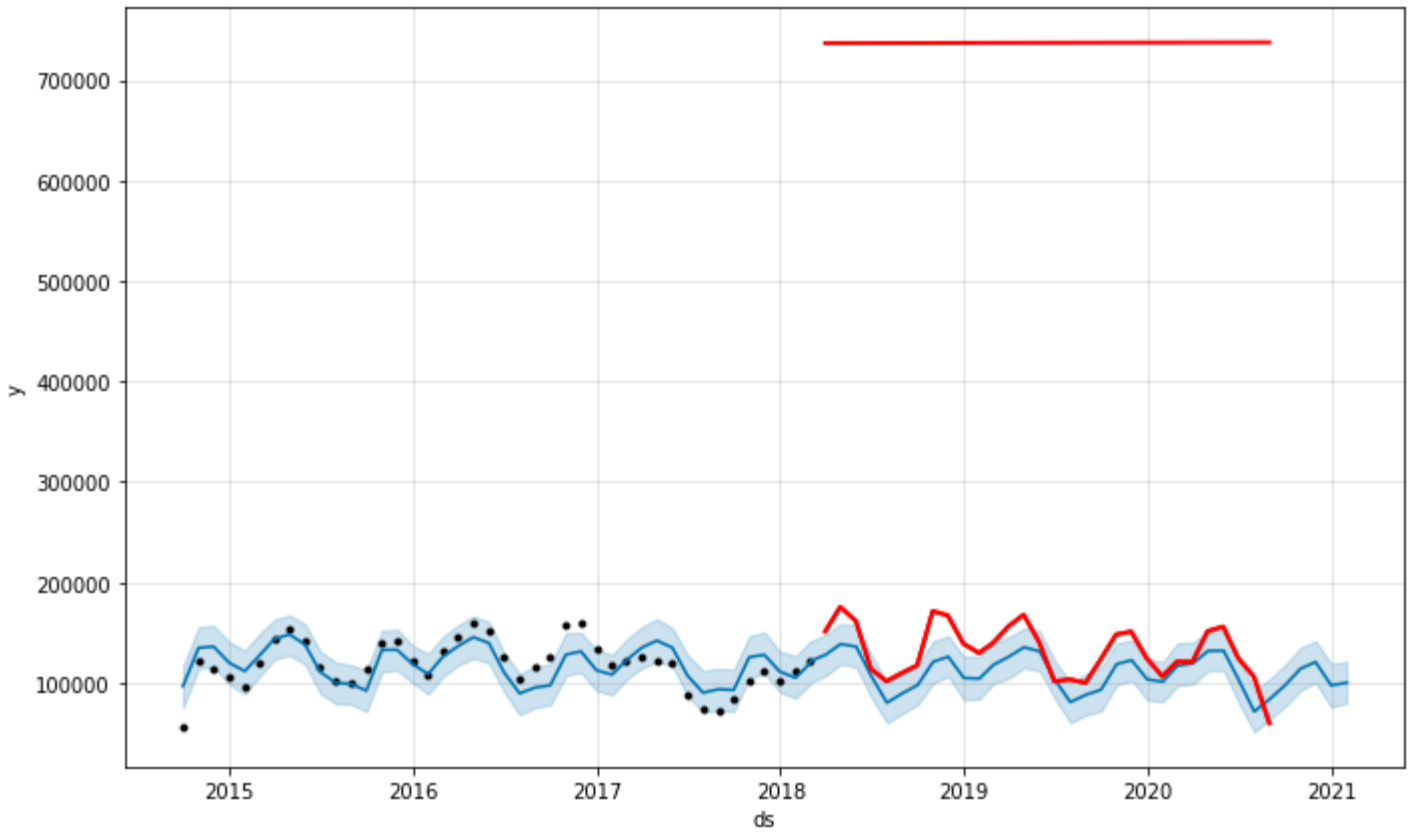
Out[66]:

	ds	yhat	yhat_lower	yhat_upper
25	2020-04-30	132094.928421	112250.570344	152282.880455
26	2020-05-31	126856.466242	106874.802045	146326.122026
27	2020-06-30	100250.201287	78320.808982	120274.633194
28	2020-07-31	81298.076991	59912.562638	101403.303763
29	2020-08-31	86509.035044	66147.033092	106508.391891

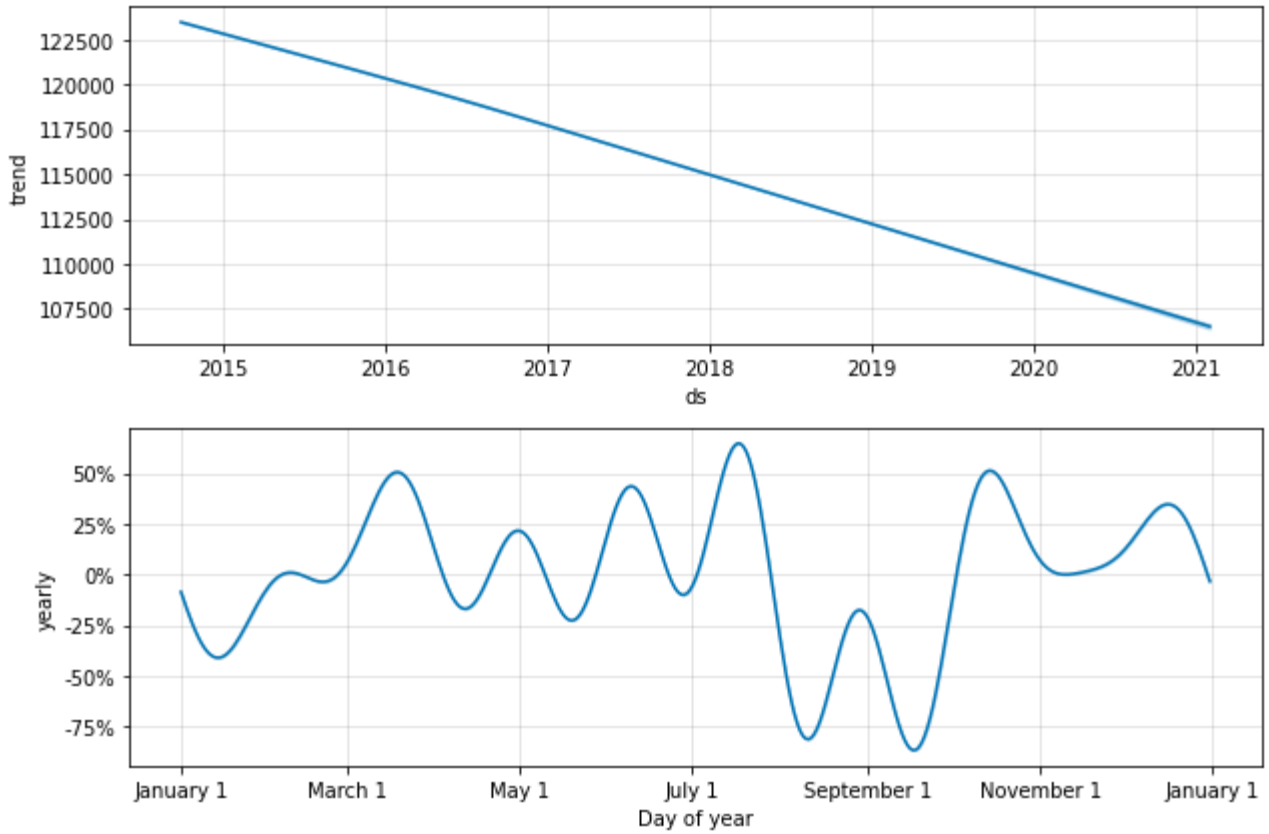
In [68]:
```
fig = model.plot(forecast)
#plot the predictions for validation set

plt.plot(test, label='Test', color = 'red', linewidth = 2)

plt.show()
```



In [69]:
```
model.plot_components(forecast);
```



In [70]:
```
test.columns
```

Out[70]:
```
Index(['Page_Loads', 'ds', 'y'], dtype='object')
```

In [71]:
```
y_prophet = pd.DataFrame()
y_prophet['ds'] = test.index
y_prophet['y'] = test["Page_Loads"].values
```

In [72]:
```
y_prophet = y_prophet.set_index('ds')
forecast_prophet = forecast.set_index('ds')
```

In [73]:
```
from sklearn.metrics import mean_squared_error, r2_score, mean_absolute_error, median_absolute_error, mean_squared_lo
```

In [74]:
```
def evaluate_forecast(y,pred):
    results = pd.DataFrame({'r2_score':r2_score(y, pred),
                            }, index=[0])
    results['mean_absolute_error'] = mean_absolute_error(y, pred)
    results['median_absolute_error'] = median_absolute_error(y, pred)
    results['mse'] = mean_squared_error(y, pred)
    results['msle'] = mean_squared_log_error(y, pred)
    results['mape'] = mean_absolute_percentage_error(y, pred)
    results['rmse'] = np.sqrt(results['mse'])
    return results
```

In [75]:
```
forecast_prophet.columns
```

Out[75]:
```
Index(['trend', 'yhat_lower', 'yhat_upper', 'trend_lower', 'trend_upper',
       'multiplicative_terms', 'multiplicative_terms_lower',
       'multiplicative_terms_upper', 'yearly', 'yearly_lower', 'yearly_upper',
       'additive_terms', 'additive_terms_lower', 'additive_terms_upper',
       'yhat'],
      dtype='object')
```

In [76]:
```
y_prophet.columns
```

Out[76]:
```
Index(['y'], dtype='object')
```

In [77]:
```
start_index = test.index.min()
end_index = test.index.max()
```

In [79]:
```
print(y_prophet.shape, forecast2.shape)
```

```
(30, 1) (30, 16)
```

In [61]:
```
y_prophet.head(3)
```

Out[61]:

	y
ds	
2018-03-31	151204
2018-04-30	175572
2018-05-31	161708

In [82]:
```
#y_prophet = y_prophet.set_index('ds')
forecast_prophet2 = forecast2.set_index('ds')
```

In [83]:
```
evaluate_forecast(y_prophet.y[start_index:end_index], forecast_prophet2.yhat_lower[start_index:end_index])
```

Out[83]:

	r2_score	mean_absolute_error	median_absolute_error	mse	msle	mape	rmse
0	-1.67438	41298.766001	44951.959059	1.893995e+09	0.153678	0.308813	43520.054896

Improving Time Series Forecast models

Hyperparamter Optimization: Finding the optimal parameters of ARIMA/Prophet models.

Exogenous variables (SARIMAX): Including external variables like campaigns, holidays, events, natural calamities etc.

Combining models for advanced time series predictions

Long Short Term Memory Network (LSTM)

In [ ]:
```

```