forecasting_0_1

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- Development Env : Jupyter Lab
- Module : Severity Analysis and Forecasting
- Summary : This module will perform Severity Analysis using EDA and finally prepare data for time series forcasting using ARIMA and fbprophet.

[1463]:
```
import os
import warnings
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from pylab import rcParams
import statsmodels.api as sm
from statsmodels.tsa.arima_model import ARIMA
from statsmodels.tsa.statespace.sarimax import SARIMAX

from mpl_toolkits.mplot3d import Axes3D
from pandas.plotting import scatter_matrix
from IPython.display import Image
import pydotplus
from sklearn.linear_model import LinearRegression
from sklearn.model_selection import train_test_split
from sklearn.neighbors import KNeighborsClassifier
from sklearn import preprocessing
from sklearn import svm
from sklearn.naive_bayes import GaussianNB
from sklearn.metrics import confusion_matrix, mean_squared_error
from sklearn.tree import DecisionTreeClassifier
from sklearn import metrics
from sklearn import preprocessing
from sklearn.tree import export_graphviz
from sklearn.cluster import DBSCAN
from sklearn import metrics
from sklearn.datasets import make_blobs
from sklearn.preprocessing import StandardScaler
from sklearn.cluster import KMeans
from sklearn.ensemble import RandomForestRegressor
```

```
from sklearn.neural_network import MLPRegressor
from sklearn.datasets import make_regression
from fbprophet import Prophet
print("Loaded Successfully -- -- -- -- -- -- -- -- -- -- -- -- --")
```

```
Loaded Successfully -- -- -- -- -- -- -- -- -- -- -- -- --
```

Defining input/output directory

[1464]:
```
input_path = "../../data/raw/"
output_path = "../../data/pre_processing/"
image_path = "../../figures/"
```

Load dataset as Dataframe

[1465]:
```
df = pd.read_csv(input_path+"US_Accidents_June20.csv",␣
↪parse_dates=['Start_Time','End_Time'])
df.head()
df.tail()
```

[1465]:
```
                ID Source  TMC  Severity          Start_Time  \
3513612  A-3513776   Bing  NaN         2 2019-08-23 18:03:25
3513613  A-3513777   Bing  NaN         2 2019-08-23 19:11:30
3513614  A-3513778   Bing  NaN         2 2019-08-23 19:00:21
3513615  A-3513779   Bing  NaN         2 2019-08-23 19:00:21
3513616  A-3513780   Bing  NaN         2 2019-08-23 18:52:06

                   End_Time  Start_Lat  Start_Lng   End_Lat    End_Lng  …  \
3513612 2019-08-23 18:32:01   34.00248 -117.37936  33.99888 -117.37094  …
3513613 2019-08-23 19:38:23   32.76696 -117.14806  32.76555 -117.15363  …
3513614 2019-08-23 19:28:49   33.77545 -117.84779  33.77740 -117.85727  …
3513615 2019-08-23 19:29:42   33.99246 -118.40302  33.98311 -118.39565  …
3513616 2019-08-23 19:21:31   34.13393 -117.23092  34.13736 -117.23934  …

         Roundabout Station   Stop Traffic_Calming Traffic_Signal  \
3513612       False   False  False           False          False
3513613       False   False  False           False          False
3513614       False   False  False           False          False
3513615       False   False  False           False          False
3513616       False   False  False           False          False

        Turning_Loop Sunrise_Sunset Civil_Twilight Nautical_Twilight  \
3513612        False            Day            Day               Day
3513613        False            Day            Day               Day
3513614        False            Day            Day               Day
3513615        False            Day            Day               Day
3513616        False            Day            Day               Day
```

```
         Astronomical_Twilight
3513612                    Day
3513613                    Day
3513614                    Day
3513615                    Day
3513616                    Day

[5 rows x 49 columns]
```

0.0.1 Check basic statistics

[1466]:
```
df.describe()
```

[1466]:
```
                TMC      Severity     Start_Lat     Start_Lng       End_Lat  \
count  2.478818e+06  3.513617e+06  3.513617e+06  3.513617e+06  1.034799e+06
mean   2.080226e+02  2.339929e+00  3.654195e+01 -9.579151e+01  3.755758e+01
std    2.076627e+01  5.521935e-01  4.883520e+00  1.736877e+01  4.861215e+00
min    2.000000e+02  1.000000e+00  2.455527e+01 -1.246238e+02  2.457011e+01
25%    2.010000e+02  2.000000e+00  3.363784e+01 -1.174418e+02  3.399477e+01
50%    2.010000e+02  2.000000e+00  3.591687e+01 -9.102601e+01  3.779736e+01
75%    2.010000e+02  3.000000e+00  4.032217e+01 -8.093299e+01  4.105139e+01
max    4.060000e+02  4.000000e+00  4.900220e+01 -6.711317e+01  4.907500e+01

            End_Lng  Distance(mi)        Number  Temperature(F)  \
count  1.034799e+06  3.513617e+06  1.250753e+06    3.447885e+06
mean  -1.004560e+02  2.816167e-01  5.975383e+03    6.193512e+01
std    1.852879e+01  1.550134e+00  1.496624e+04    1.862106e+01
min   -1.244978e+02  0.000000e+00  0.000000e+00   -8.900000e+01
25%   -1.183440e+02  0.000000e+00  8.640000e+02    5.000000e+01
50%   -9.703438e+01  0.000000e+00  2.798000e+03    6.400000e+01
75%   -8.210168e+01  1.000000e-02  7.098000e+03    7.590000e+01
max   -6.710924e+01  3.336300e+02  9.999997e+06    1.706000e+02

       Wind_Chill(F)   Humidity(%)  Pressure(in)  Visibility(mi)  \
count   1.645368e+06  3.443930e+06  3.457735e+06    3.437761e+06
mean    5.355730e+01  6.511427e+01  2.974463e+01    9.122644e+00
std     2.377334e+01  2.275558e+01  8.319758e-01    2.885879e+00
min    -8.900000e+01  1.000000e+00  0.000000e+00    0.000000e+00
25%     3.570000e+01  4.800000e+01  2.973000e+01    1.000000e+01
50%     5.700000e+01  6.700000e+01  2.995000e+01    1.000000e+01
75%     7.200000e+01  8.400000e+01  3.009000e+01    1.000000e+01
max     1.150000e+02  1.000000e+02  5.774000e+01    1.400000e+02

       Wind_Speed(mph)  Precipitation(in)
count     3.059008e+06       1.487743e+06
mean      8.219025e+00       1.598256e-02
std       5.262847e+00       1.928262e-01
```

```
min      0.000000e+00     0.000000e+00
25%      5.000000e+00     0.000000e+00
50%      7.000000e+00     0.000000e+00
75%      1.150000e+01     0.000000e+00
max      9.840000e+02     2.500000e+01
```

0.0.2 Check Datatype of the columns.

[1467]:
```
df.dtypes
```

[1467]:
```
ID                                object
Source                            object
TMC                              float64
Severity                           int64
Start_Time                datetime64[ns]
End_Time                  datetime64[ns]
Start_Lat                        float64
Start_Lng                        float64
End_Lat                          float64
End_Lng                          float64
Distance(mi)                     float64
Description                       object
Number                           float64
Street                            object
Side                              object
City                              object
County                            object
State                             object
Zipcode                           object
Country                           object
Timezone                          object
Airport_Code                      object
Weather_Timestamp                 object
Temperature(F)                   float64
Wind_Chill(F)                    float64
Humidity(%)                      float64
Pressure(in)                     float64
Visibility(mi)                   float64
Wind_Direction                    object
Wind_Speed(mph)                  float64
Precipitation(in)                float64
Weather_Condition                 object
Amenity                             bool
Bump                                bool
Crossing                            bool
Give_Way                            bool
Junction                            bool
```

```
No_Exit                              bool
Railway                              bool
Roundabout                           bool
Station                              bool
Stop                                 bool
Traffic_Calming                      bool
Traffic_Signal                       bool
Turning_Loop                         bool
Sunrise_Sunset                     object
Civil_Twilight                     object
Nautical_Twilight                  object
Astronomical_Twilight              object
dtype: object
```

0.0.3 Check NaN values

[1468]:
```
df.isna().sum()
```

[1468]:
```
ID                             0
Source                         0
TMC                      1034799
Severity                       0
Start_Time                     0
End_Time                       0
Start_Lat                      0
Start_Lng                      0
End_Lat                  2478818
End_Lng                  2478818
Distance(mi)                   0
Description                    1
Number                   2262864
Street                         0
Side                           0
City                         112
County                         0
State                          0
Zipcode                     1069
Country                        0
Timezone                    3880
Airport_Code                6758
Weather_Timestamp          43323
Temperature(F)             65732
Wind_Chill(F)            1868249
Humidity(%)                69687
Pressure(in)               55882
Visibility(mi)             75856
Wind_Direction             58874
```

```
Wind_Speed(mph)           454609
Precipitation(in)        2025874
Weather_Condition          76138
Amenity                        0
Bump                           0
Crossing                       0
Give_Way                       0
Junction                       0
No_Exit                        0
Railway                        0
Roundabout                     0
Station                        0
Stop                           0
Traffic_Calming                0
Traffic_Signal                 0
Turning_Loop                   0
Sunrise_Sunset               115
Civil_Twilight               115
Nautical_Twilight            115
Astronomical_Twilight        115
dtype: int64
```

0.1 Timeseries Forecasting

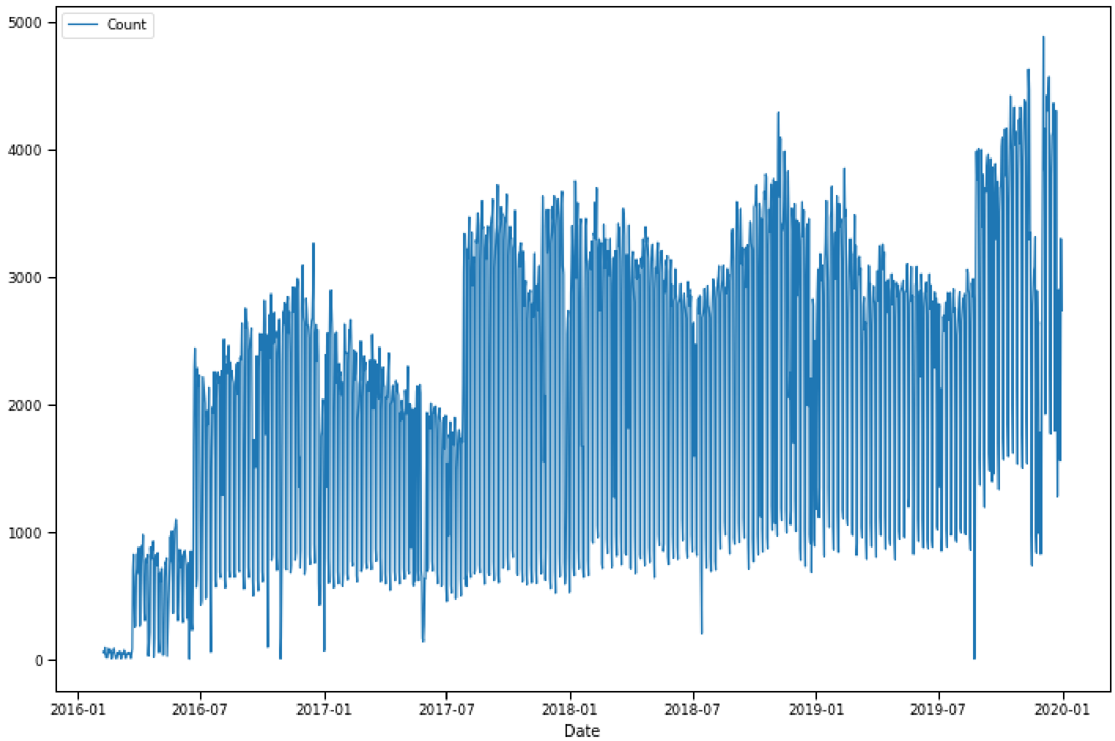
0.1.1 Data Preparation

Data is prepared by taking the count for each day from 2016 to 2019. It will have two columns, date and number of accident.

[1534]:
```python
df_2019 = df[df['Year'] <= 2019]
df_2019['Date'] = df_2019['Start_Time'].dt.date
```

[1535]:
```python
df_ts = df_2019.groupby('Date')['ID'].agg(len).to_frame().reset_index().
 ↪rename(columns = {'ID': 'Count'})
```

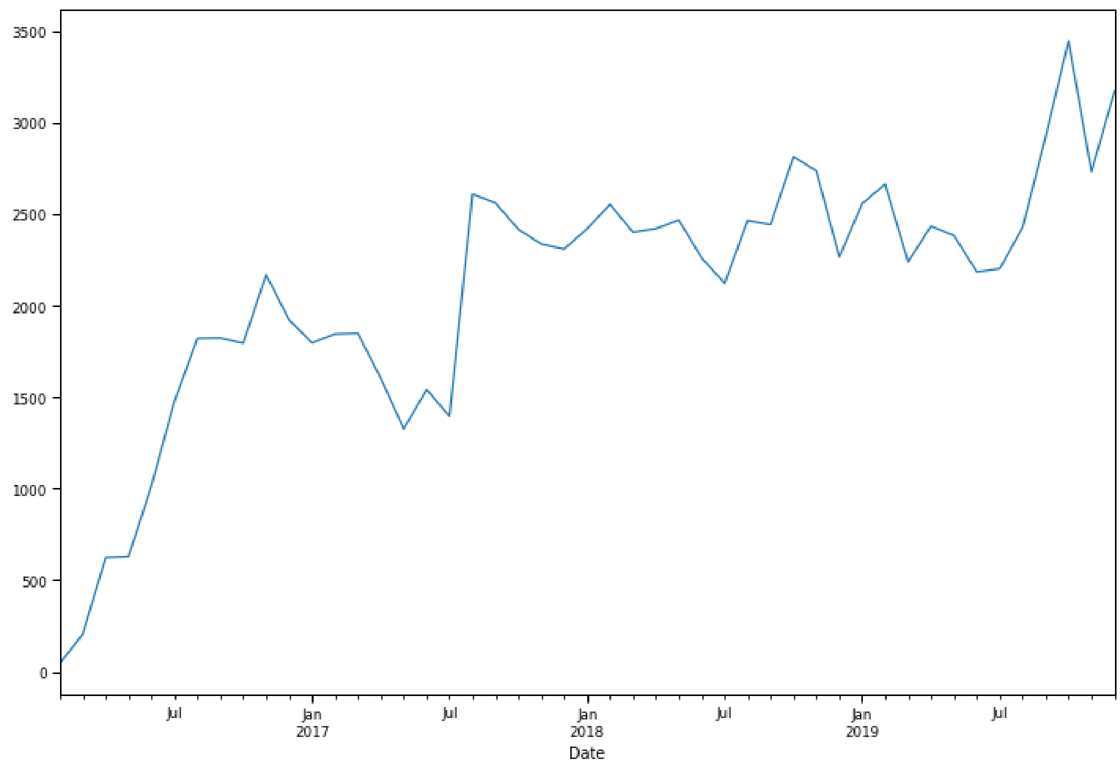
[1536]:
```python
df_ts.set_index('Date', inplace = True)
df_ts.plot(figsize = (12,8)).get_figure().savefig(f'{image_path}ts1.jpeg')
```



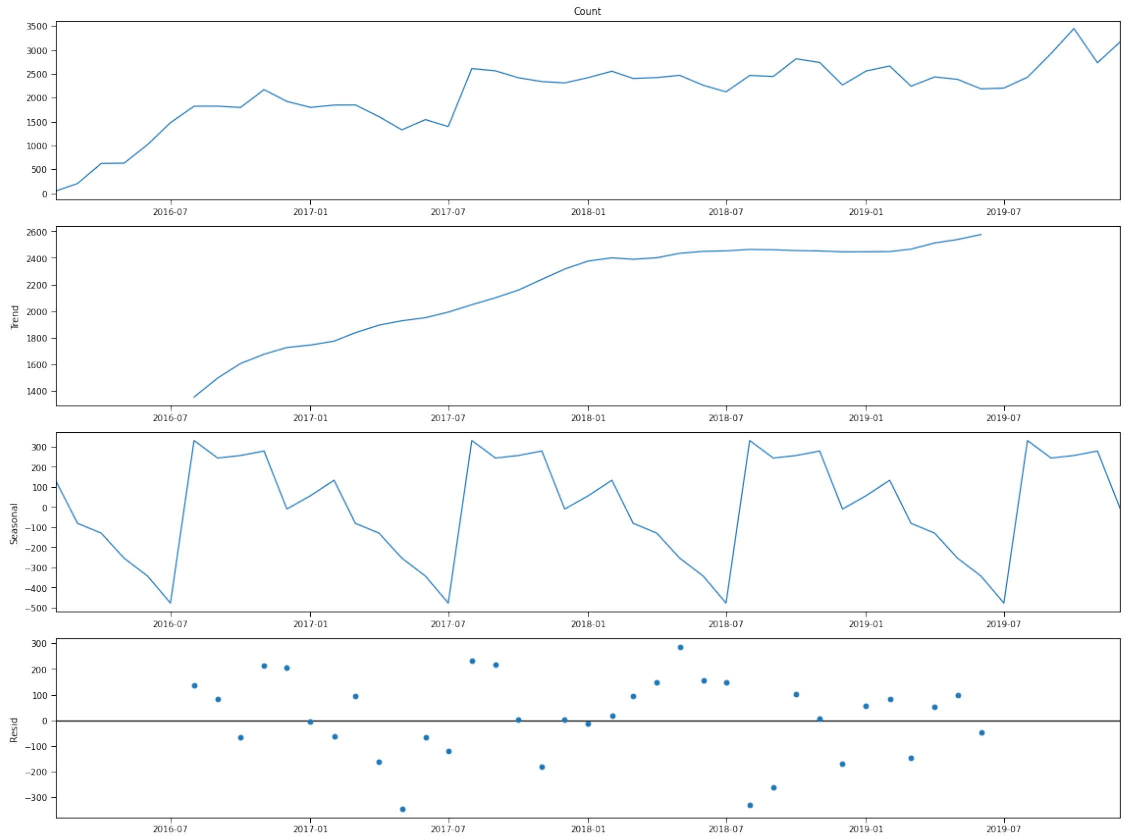
0.1.2 Moving average to visualize the trend

[1537]:
```
df_ts = df_ts.reset_index()
df_ts.Date = pd.to_datetime(df_ts.Date)
df_ts.set_index('Date', inplace = True)
```

[1538]:
```
df_ts = df_ts['Count'].resample('MS').mean()
df_ts.plot(figsize = (12,8)).get_figure().savefig(f'{image_path}ts_ma.jpeg')
```



[1539]:
```
rcParams['figure.figsize'] = 16, 12
decomposition = sm.tsa.seasonal_decompose(df_ts, model='additive')
fig = decomposition.plot()
plt.show()
```



- The trend is increasing.
- The seasonal plot shows that the accident increases sharply in August, and starts decreasing from around Feb till July.

0.2 ARIMA

0.2.1 Evaluate ARIMA Model

I will first split the data set into 70%(first 70%) train and 30% test. Then, train the ARIMA model to compute the error score for the prediction. After creating and evalute model, I will iterate through the value of p,d and q to find the best ARIMA parameters.

[1509]:
```
def evaluate_arima_model(X, arima_order):
    train_size = int(len(X)*0.70)
    train, test = X[0:train_size], X[train_size:len(X)]
    history = [x for x in train]
    predictions = list()
    for i in range(len(test)):
        model = ARIMA(history, order = arima_order)
        model_fit = model.fit(disp = 0)
        pred = model_fit.forecast()[0]
        predictions.append(pred)
```

```
        history.append(test[i])
    error = mean_squared_error(test, predictions)
    print('order: ',arima_order,'error: ', error)
    return error
```

[1510]:
```
def find_ARIMA_params (X, p_orders, d_orders, q_orders):
    best_score, best_conf = float('inf'), None
    for p in p_orders:
        for d in d_orders:
            for q in q_orders:
                order = (p,d,q)
                try:
                    mse = evaluate_arima_model(X, order)
                    if mse < best_score:
                        best_score = mse
                        best_conf = order
                except:
                    continue
    print(f'Best Score: {best_score} best_order: {best_conf}')
    return best_score, best_conf
```

[1511]:
```
p = range(0, 3)
d = range(0, 3)
q = range(0, 3)
warnings.filterwarnings("ignore")
best_score, best_order = find_ARIMA_params (df_ts.values,p,d,q)
```

```
order:  (0, 0, 0) error:  553479.1475567138
order:  (0, 0, 1) error:  287299.5657950613
order:  (0, 0, 2) error:  265690.077543683
order:  (0, 1, 0) error:  134815.07382281928
order:  (0, 1, 1) error:  132315.356899116
order:  (0, 1, 2) error:  136149.6513278566
order:  (0, 2, 0) error:  335723.0891262095
order:  (0, 2, 1) error:  149790.0086389629
order:  (0, 2, 2) error:  151015.87355619873
order:  (1, 0, 0) error:  138725.8273762071
order:  (1, 0, 1) error:  143053.26877239023
order:  (1, 0, 2) error:  256920.85444241826
order:  (1, 1, 0) error:  132772.646110328
order:  (1, 2, 0) error:  243592.58304519558
order:  (1, 2, 1) error:  150716.58533692095
order:  (1, 2, 2) error:  149231.51258205326
order:  (2, 0, 0) error:  143583.07579097585
order:  (2, 0, 1) error:  134286.7070002843
order:  (2, 0, 2) error:  136176.78181608627
order:  (2, 1, 0) error:  135119.841026187
```

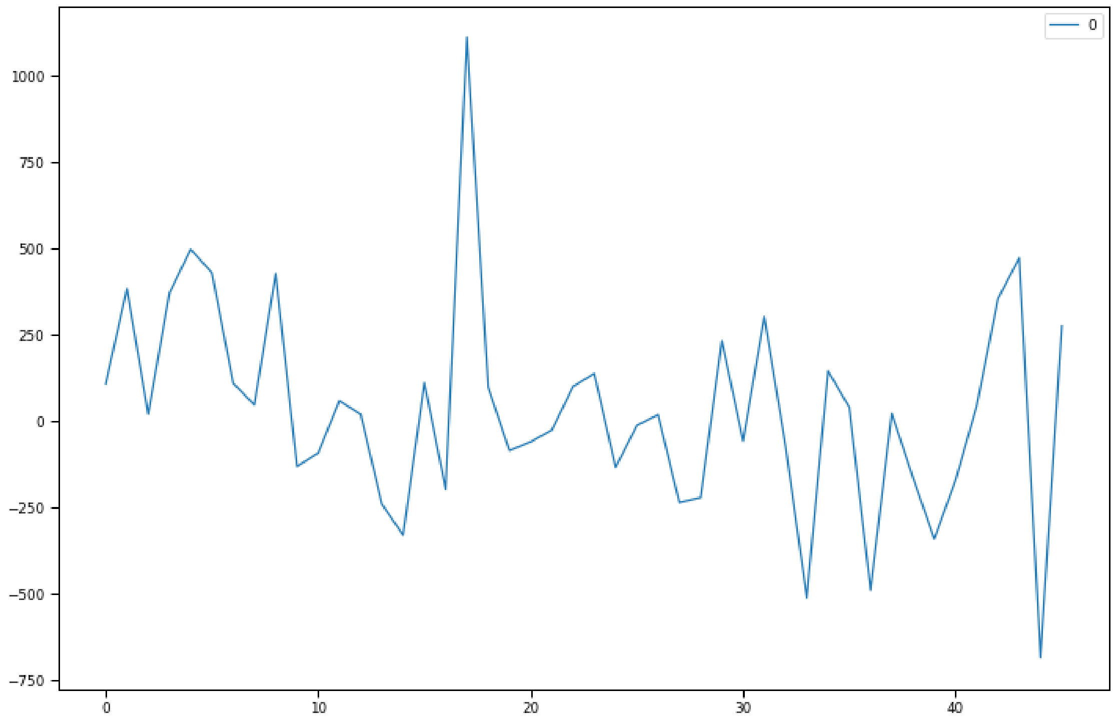
```
order:  (2, 1, 1) error:  132028.58155608416
order:  (2, 2, 0) error:  184135.71071176353
order:  (2, 2, 1) error:  156161.48045713743
order:  (2, 2, 2) error:  152232.5053117024
Best Score: 132028.58155608416 best_order: (2, 1, 1)
```

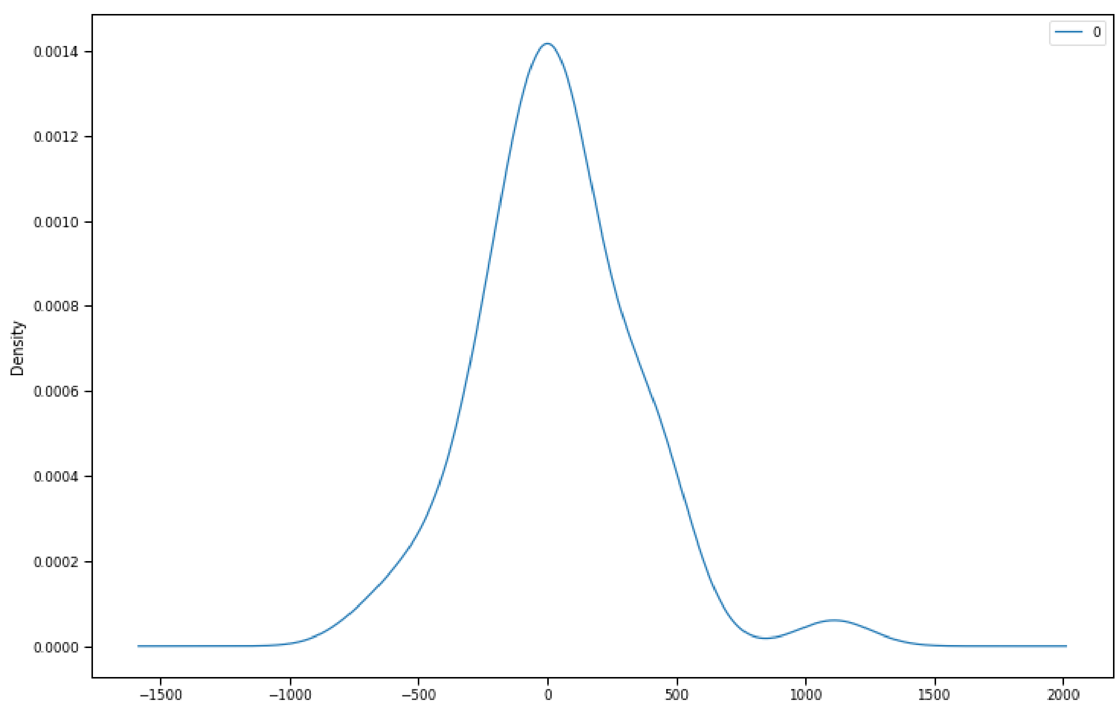
- The best order is (2,1,1). We will use this order to find the result of the model.

[1512]:
```python
model = ARIMA(df_ts.values, order = (2,1,1))
model_fit = model.fit(disp=0)
print(model_fit.summary())
residuals = pd.DataFrame(model_fit.resid)
residuals.plot(figsize = (12,8))
plt.show()
residuals.plot(figsize = (12,8), kind='kde')
plt.show()
print(residuals.describe())
```

```
                              ARIMA Model Results
==============================================================================
Dep. Variable:                    D.y   No. Observations:                   46
Model:                 ARIMA(2, 1, 1)   Log Likelihood                -328.773
Method:                       css-mle   S.D. of innovations            301.797
Date:                Mon, 23 Nov 2020   AIC                            667.546
Time:                        14:53:05   BIC                            676.689
Sample:                             1   HQIC                           670.971

==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
const         52.3009     15.002      3.486      0.000      22.897      81.705
ar.L1.D.y      0.7624      0.151      5.046      0.000       0.466       1.059
ar.L2.D.y      0.0526      0.161      0.325      0.745      -0.264       0.369
ma.L1.D.y     -1.0000      0.068    -14.781      0.000      -1.133      -0.867
                                    Roots
=============================================================================
                  Real          Imaginary           Modulus         Frequency
-----------------------------------------------------------------------------
AR.1            1.2106           +0.0000j            1.2106            0.0000
AR.2          -15.7182           +0.0000j           15.7182            0.5000
MA.1            1.0000           +0.0000j            1.0000            0.0000
-----------------------------------------------------------------------------
```


0
1000
750
500
250
0
−250
−500
−750
0
10
20
30
40


0
Density
0.0014
0.0012
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
−1500
−1000
−500
0
500
1000
1500
2000

0

```
count     46.000000
mean      35.472080
std      308.603005
min     -686.874656
25%     -134.819542
50%       20.236870
75%      142.448477
max     1113.292750
```

- The dense plot shows that the distribution curve is centered near to 0.

1 Rolling forecast ARIMA model

I will be using the order obtained(2,1,1) after iteration to make the prediction and later compare the plot of the expected value and predicted value.

[1513]:
```
train_size = int(len(df_ts) * 0.70)
train, test = df_ts[0:train_size], df_ts[train_size:len(df_ts)]
history = [x for x in train]
predictions = [x for x in test]
for i in range(len(test)):
    model = ARIMA(history, order = (2,1,0))
    model_fit = model.fit(disp = 0)
    pred = model_fit.forecast()[0]
    predictions[i] = pred[0]
    history.append(test[i])
    print(f'expected: {test[i]}, predicted: {pred}')
```

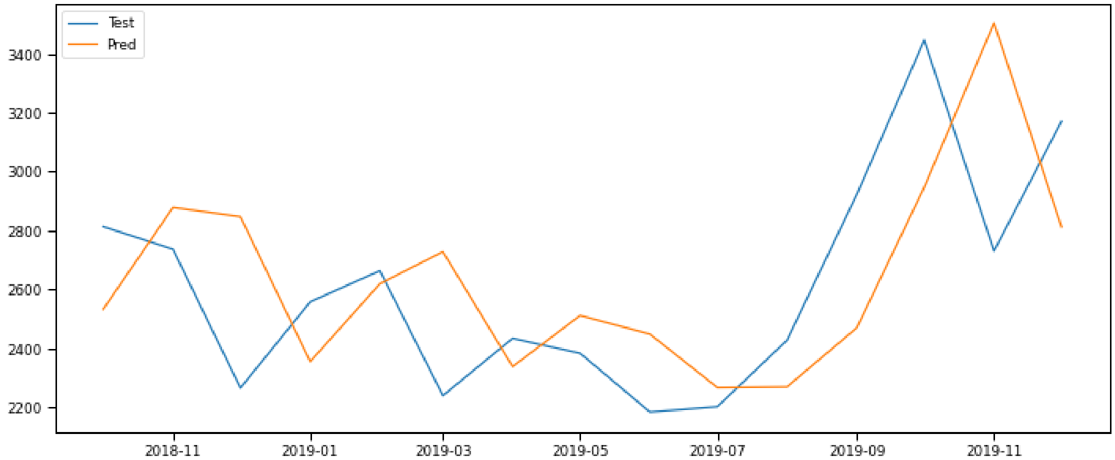
```
expected: 2812.7419354838707, predicted: [2532.12248617]
expected: 2735.9333333333334, predicted: [2877.75079638]
expected: 2264.6774193548385, predicted: [2846.44260013]
expected: 2557.2903225806454, predicted: [2354.34848111]
expected: 2662.8214285714284, predicted: [2618.69644105]
expected: 2238.7419354838707, predicted: [2727.59611266]
expected: 2433.366666666667, predicted: [2337.39987217]
expected: 2382.7096774193546, predicted: [2510.90877816]
expected: 2183.366666666667, predicted: [2447.92375639]
expected: 2201.0967741935483, predicted: [2266.35664353]
expected: 2427.2903225806454, predicted: [2268.79428527]
expected: 2921.9666666666667, predicted: [2469.1994524]
expected: 3445.7096774193546, predicted: [2946.52197494]
expected: 2729.8, predicted: [3503.97485906]
expected: 3170.3548387096776, predicted: [2811.42803367]
```

[1514]:
```
x = test.reset_index()
```

[1515]:
```
rcParams['figure.figsize'] = 12, 5
plt.plot(x.Date, x.Count, label = 'Test')
```

```
plt.plot(x.Date, predictions, label = 'Pred')
plt.legend(loc="upper left")
```

[1515]: <matplotlib.legend.Legend at 0x453f41af0>



- Prediction plot is shifted to the right by one step. This indicates that the forecasted value is close to the current value.

1.0.1 SARIMA Model

The parameters for SARIMA model are found using grid search method with lowest AIC value.

[1540]:
```
import itertools
#set parameter range
p = range(0,3)
q = range(1,3)
d = range(1,2)
s = range(7,8)
aic = float('inf')
n_order = None
s_order = None
# list of all parameter combos
pdq = list(itertools.product(p, d, q))
seasonal_pdq = list(itertools.product(p, d, q, s))
# SARIMA model pipeline
for param in pdq:
    for param_seasonal in seasonal_pdq:
        try:
            mod = sm.tsa.statespace.SARIMAX(train,
                                            order=param,
                                            seasonal_order=param_seasonal)
```

```
            results = mod.fit(max_iter = 50, method = 'powell')
            if(results.aic < aic):
                n_order = param
                s_order = param_seasonal
                aic = results.aic
#              print('SARIMA{},{} - AIC:{}'.format(param, param_seasonal,␣
↪results.aic))
        except:
            continue
print('SARIMA{},{} - AIC:{}'.format(n_order, s_order, results.aic))
```

```
Optimization terminated successfully.
         Current function value: 5.424812
         Iterations: 4
         Function evaluations: 143
Optimization terminated successfully.
         Current function value: 5.363982
         Iterations: 4
         Function evaluations: 187
Optimization terminated successfully.
         Current function value: 5.368904
         Iterations: 7
         Function evaluations: 342
Optimization terminated successfully.
         Current function value: 5.374305
         Iterations: 5
         Function evaluations: 299
Optimization terminated successfully.
         Current function value: 5.364890
         Iterations: 5
         Function evaluations: 290
Optimization terminated successfully.
         Current function value: 5.365724
         Iterations: 5
         Function evaluations: 346
Optimization terminated successfully.
         Current function value: 5.424903
         Iterations: 4
         Function evaluations: 185
Optimization terminated successfully.
         Current function value: 5.360933
         Iterations: 5
         Function evaluations: 298
Optimization terminated successfully.
         Current function value: 5.364184
         Iterations: 9
         Function evaluations: 531
```

```
Optimization terminated successfully.
         Current function value: 5.369146
         Iterations: 5
         Function evaluations: 349
Optimization terminated successfully.
         Current function value: 5.364235
         Iterations: 7
         Function evaluations: 484
Optimization terminated successfully.
         Current function value: 5.363581
         Iterations: 5
         Function evaluations: 404
Optimization terminated successfully.
         Current function value: 5.424839
         Iterations: 4
         Function evaluations: 190
Optimization terminated successfully.
         Current function value: 5.364207
         Iterations: 4
         Function evaluations: 232
Optimization terminated successfully.
         Current function value: 5.371011
         Iterations: 5
         Function evaluations: 297
Optimization terminated successfully.
         Current function value: 5.374264
         Iterations: 5
         Function evaluations: 351
Optimization terminated successfully.
         Current function value: 5.365722
         Iterations: 5
         Function evaluations: 347
Optimization terminated successfully.
         Current function value: 5.366278
         Iterations: 5
         Function evaluations: 403
Optimization terminated successfully.
         Current function value: 5.422667
         Iterations: 4
         Function evaluations: 234
Optimization terminated successfully.
         Current function value: 5.363638
         Iterations: 5
         Function evaluations: 376
Optimization terminated successfully.
         Current function value: 5.367008
         Iterations: 8
         Function evaluations: 634
```

```
Optimization terminated successfully.
         Current function value: 5.373648
         Iterations: 6
         Function evaluations: 484
Optimization terminated successfully.
         Current function value: 5.365516
         Iterations: 6
         Function evaluations: 502
Optimization terminated successfully.
         Current function value: 5.365955
         Iterations: 5
         Function evaluations: 462
Optimization terminated successfully.
         Current function value: 5.424851
         Iterations: 4
         Function evaluations: 233
Optimization terminated successfully.
         Current function value: 5.360330
         Iterations: 5
         Function evaluations: 356
Optimization terminated successfully.
         Current function value: 5.362283
         Iterations: 8
         Function evaluations: 571
Optimization terminated successfully.
         Current function value: 5.367792
         Iterations: 5
         Function evaluations: 408
Optimization terminated successfully.
         Current function value: 5.364774
         Iterations: 6
         Function evaluations: 486
Optimization terminated successfully.
         Current function value: 5.362938
         Iterations: 5
         Function evaluations: 458
Optimization terminated successfully.
         Current function value: 5.397310
         Iterations: 9
         Function evaluations: 677
Optimization terminated successfully.
         Current function value: 5.348601
         Iterations: 6
         Function evaluations: 510
Optimization terminated successfully.
         Current function value: 5.350839
         Iterations: 8
         Function evaluations: 680
```

```
Optimization terminated successfully.
         Current function value: 5.363515
         Iterations: 6
         Function evaluations: 577
Optimization terminated successfully.
         Current function value: 5.352563
         Iterations: 6
         Function evaluations: 584
Optimization terminated successfully.
         Current function value: 5.350900
         Iterations: 6
         Function evaluations: 636
SARIMA(0, 1, 1),(0, 1, 2, 7) - AIC:360.4575702696719
```

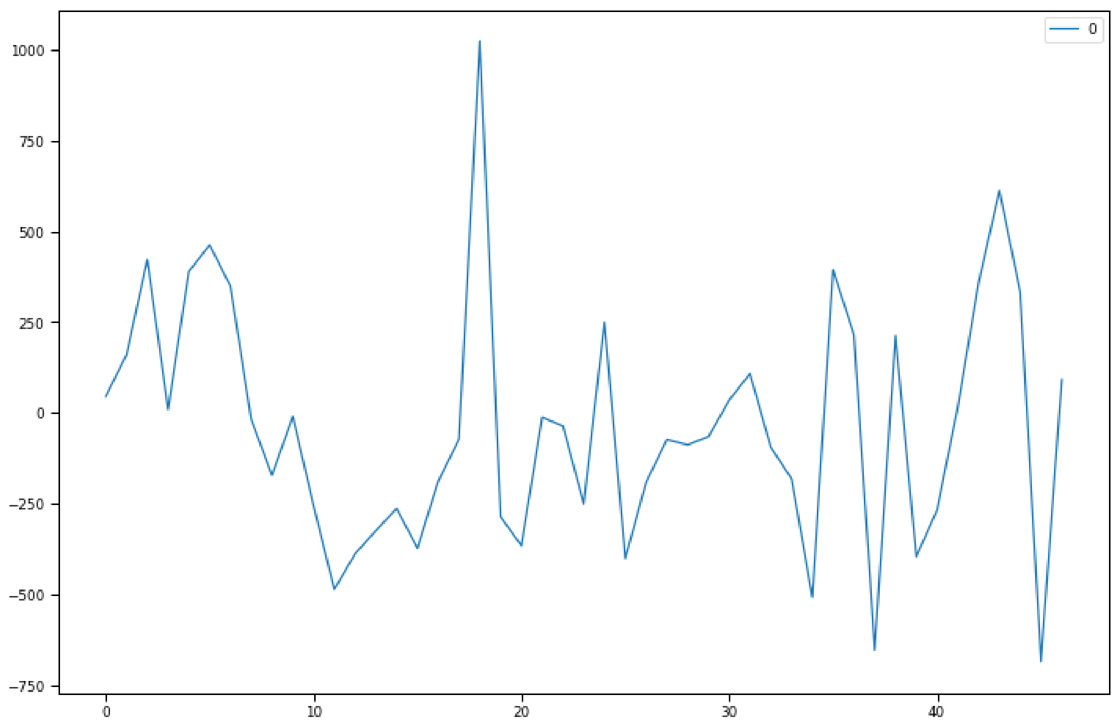
[1541]:

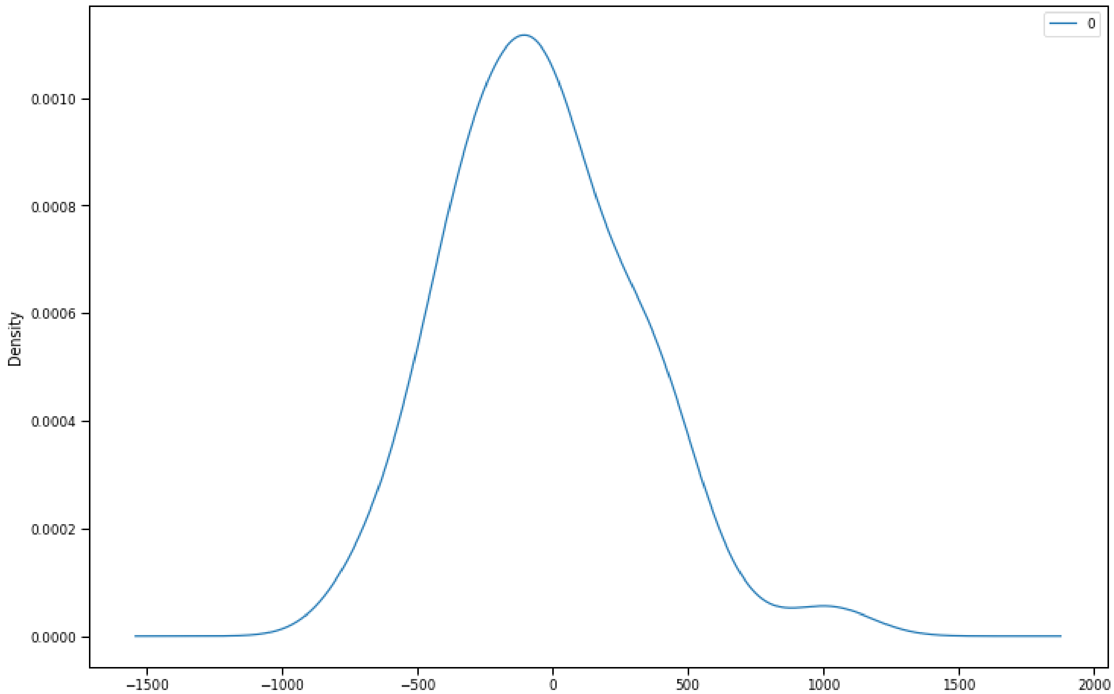
```python
model_sarimax_fit = SARIMAX(df_ts.values, order=(0,1,1),␣
 ↪seasonal_order=(0,1,2,7)).fit(max_iter = 50,method = 'powell')
print(model_sarimax_fit.summary())
residuals_s = pd.DataFrame(model_sarimax_fit.resid)
residuals_s.plot(figsize = (12,8))
plt.show()
residuals_s.plot(figsize = (12,8), kind='kde')
plt.show()
print(residuals_s.describe())
```

```
Optimization terminated successfully.
         Current function value: 6.046264
         Iterations: 3
         Function evaluations: 140
                                          SARIMAX Results
================================================================================
==============
Dep. Variable:                                      y   No. Observations:
47
Model:             SARIMAX(0, 1, 1)x(0, 1, [1, 2], 7)   Log Likelihood
-284.174
Date:                                Mon, 23 Nov 2020   AIC
576.349
Time:                                        15:14:30   BIC
583.003
Sample:                                             0   HQIC
578.736
                                                 - 47
Covariance Type:                                  opg
==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
ma.L1         -0.0531      0.184     -0.289      0.773      -0.414       0.308
ma.S.L7       -0.9604      0.235     -4.082      0.000      -1.421      -0.499
```

```
ma.S.L14        0.2800      0.286      0.981      0.327     -0.280      0.840
sigma2       1.089e+05   2.81e+04      3.875      0.000   5.38e+04   1.64e+05
================================================================================
===
Ljung-Box (L1) (Q):                   0.10   Jarque-Bera (JB):
6.59
Prob(Q):                              0.75   Prob(JB):
0.04
Heteroskedasticity (H):               1.46   Skew:
0.80
Prob(H) (two-sided):                  0.50   Kurtosis:
4.23
================================================================================
===

Warnings:
[1] Covariance matrix calculated using the outer product of gradients (complex-
step).
```






```
                0
count   47.000000
mean   -34.540122
std    341.929694
min   -684.437487
25%   -265.633722
50%    -65.865985
75%    186.319659
max   1023.548850
```

[1542]:

```
train_size = int(len(df_ts)*0.70)
train, test = df_ts[0:train_size], df_ts[train_size:len(df_ts)]
history = [x for x in train]
model_sarimax_fit = SARIMAX(df_ts.values, order=(0,1,2),␣
 ↪seasonal_order=(0,1,2,7)).fit(max_iter = 50,method = 'powell')
predictions_sarima = model_sarimax_fit.get_forecast(steps = len(test))
predictions_sarima.summary_frame()
```

```
Optimization terminated successfully.
         Current function value: 6.034313
         Iterations: 4
         Function evaluations: 234
```

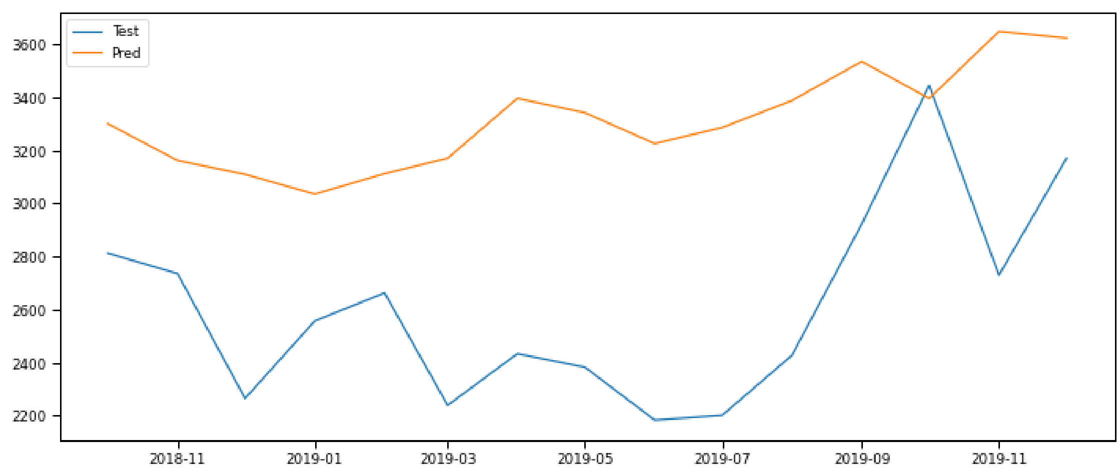
[1542]:

y	mean	mean_se	mean_ci_lower	mean_ci_upper
0	3301.060942	319.413739	2675.021517	3927.100366
1	3162.197368	444.885321	2290.238161	4034.156574
2	3109.953671	509.872488	2110.621957	4109.285384
3	3035.873670	567.347668	1923.892673	4147.854667
4	3112.521821	619.514275	1898.296155	4326.747488
5	3170.573831	667.619177	1862.064289	4479.083374
6	3396.794062	712.484127	2000.350833	4793.237291
7	3342.566624	750.441501	1871.728309	4813.404938
8	3226.156469	786.706987	1684.239107	4768.073831
9	3286.499661	822.098132	1675.216930	4897.782393
10	3388.448723	855.924878	1710.866790	5066.030657
11	3535.548395	888.464969	1794.189055	5276.907736
12	3396.277131	919.855255	1593.393959	5199.160303
13	3648.946685	950.209337	1786.570606	5511.322763
14	3624.198191	1002.476356	1659.380638	5589.015744

[1543]:

```
rcParams['figure.figsize'] = 12, 5
plt.plot(x.Date, x.Count, label = 'Test')
plt.plot(x.Date, predictions_sarima.predicted_mean, label = 'Pred')
plt.legend(loc="upper left")
```

[1543]: <matplotlib.legend.Legend at 0x4a0070790>



- The predicted values are much higher than the expected/original values.

1.1 Facebook Prophet

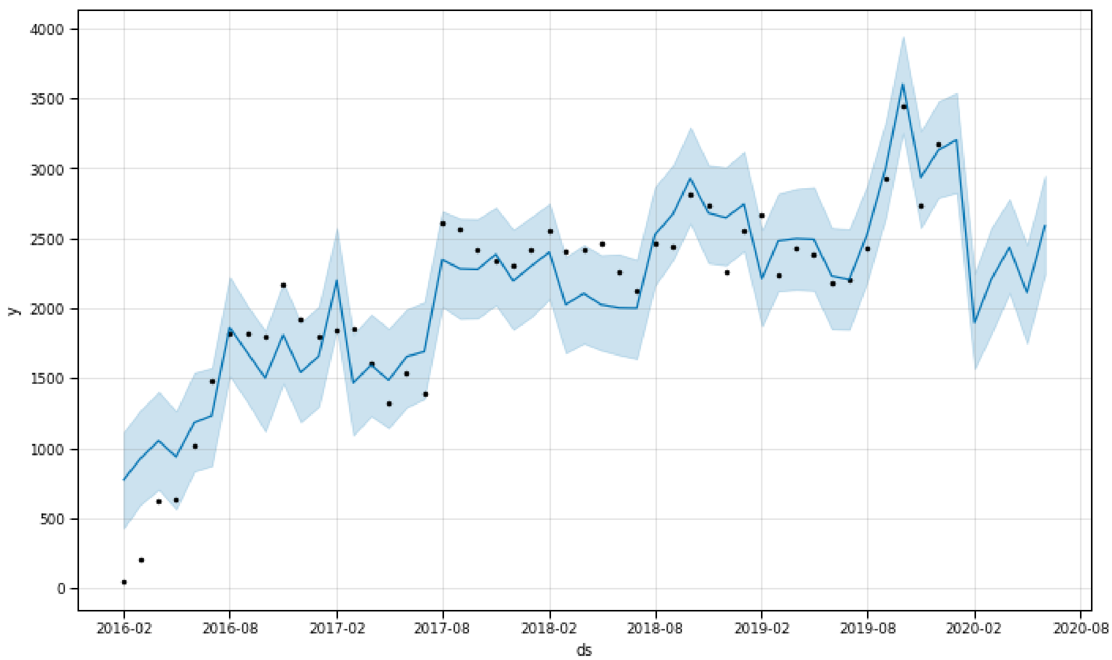
Here, facebook prophet will be used to forecast the accident for 6 month of 2020. Prophet automatically add the yhat(forecast) value for the provided dataframe to.

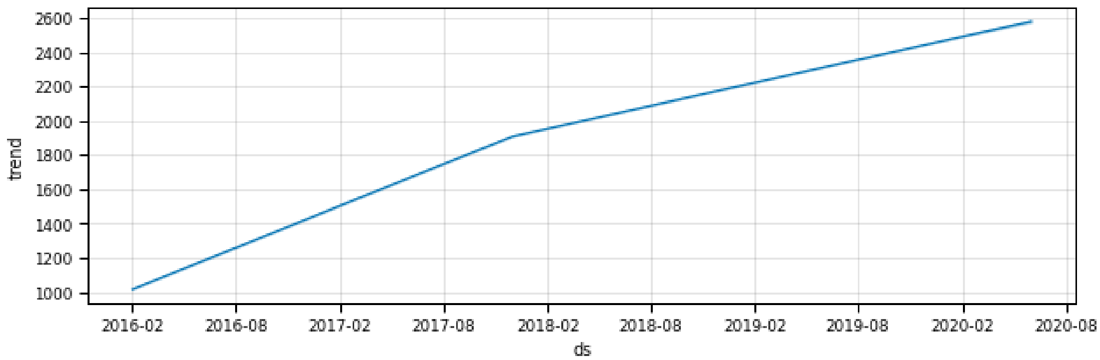
[1520]:
```
df_ts = df_ts.reset_index()
```

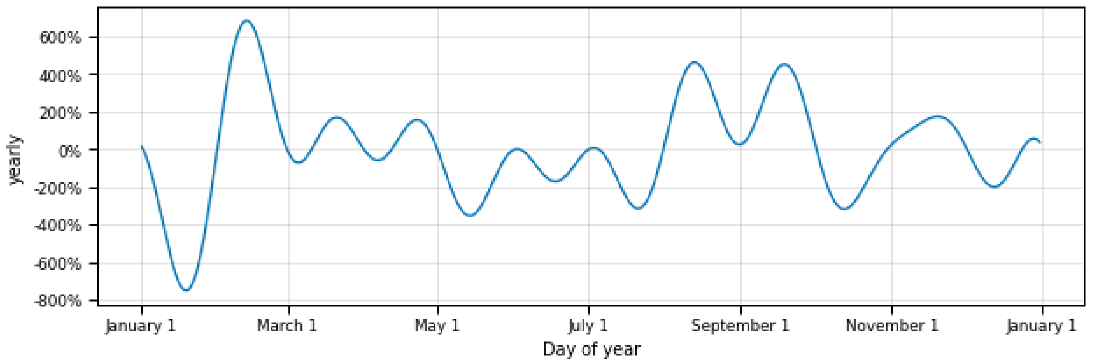
[1521]:
```
df_ts.rename(columns = {'Date': 'ds', 'Count': 'y'}, inplace = True)
```

[1522]:
```
model = Prophet(seasonality_mode='multiplicative')
model.fit(df_ts)
future = model.make_future_dataframe(periods=6, freq='MS')
fcst = model.predict(future)
fig = model.plot(fcst)
fig2 = model.plot_components(fcst)
```

```
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.
```







[1523]:
```
df['Date'] = df.Start_Time.dt.date
```

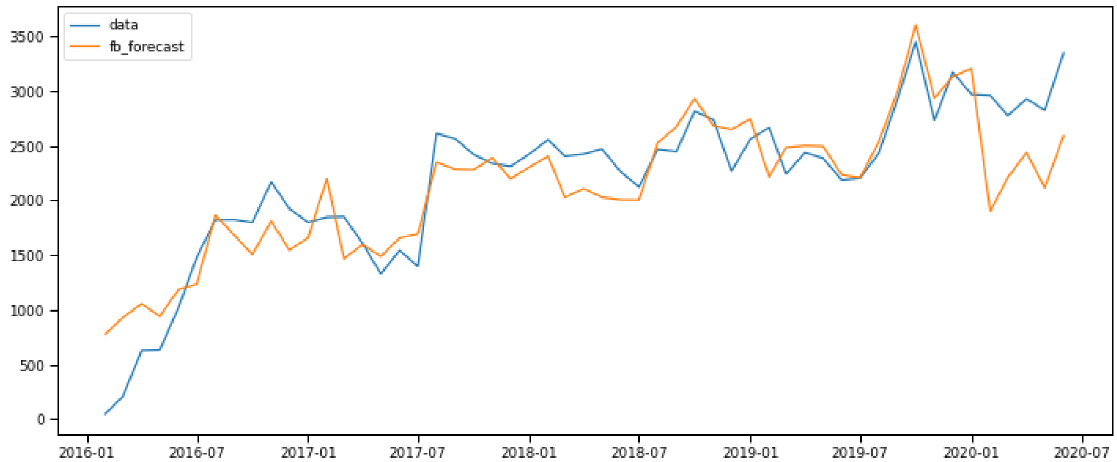
[1524]:
```
df_fb_ts = df.groupby('Date')['ID'].agg(len).to_frame().reset_index().
↪rename(columns = {'ID': 'Count'})
```

[1525]:
```
df_fb_ts.Date = pd.to_datetime(df_fb_ts.Date)
df_fb_ts.set_index('Date', inplace = True)
```

[1526]:
```
df_fb_ts = df_fb_ts['Count'].resample('MS').mean()
```

[1527]:
```
fcst_ts = fcst.yhat
rcParams['figure.figsize'] = 12, 5
x_2020 = df_fb_ts.reset_index()
plt.plot(x_2020.Date, x_2020.Count, label = 'data')
plt.plot(x_2020.Date,fcst_ts, label = 'fb_forecast')
plt.legend(loc="upper left")
```

[1527]: <matplotlib.legend.Legend at 0x434692f10>



- The plot shows that the forcasted value follows the train data
- For the six month of 2020(not used in train data), it is much more less than that of the test values.

1.2 Conclusion:

Although the values predicted by prophet is less than the actual values, it seems to follow the pattern. ARIMA model has shifted the predicted value by one step/month, so some performance tuning might help it make better and SARIMAX model has predicted value which is higher that the expected value preserving some pattern of the test plot. So, for this dataset it seems fbprophet seems to work better.