PROJECT DEVELOPMENT PHASE

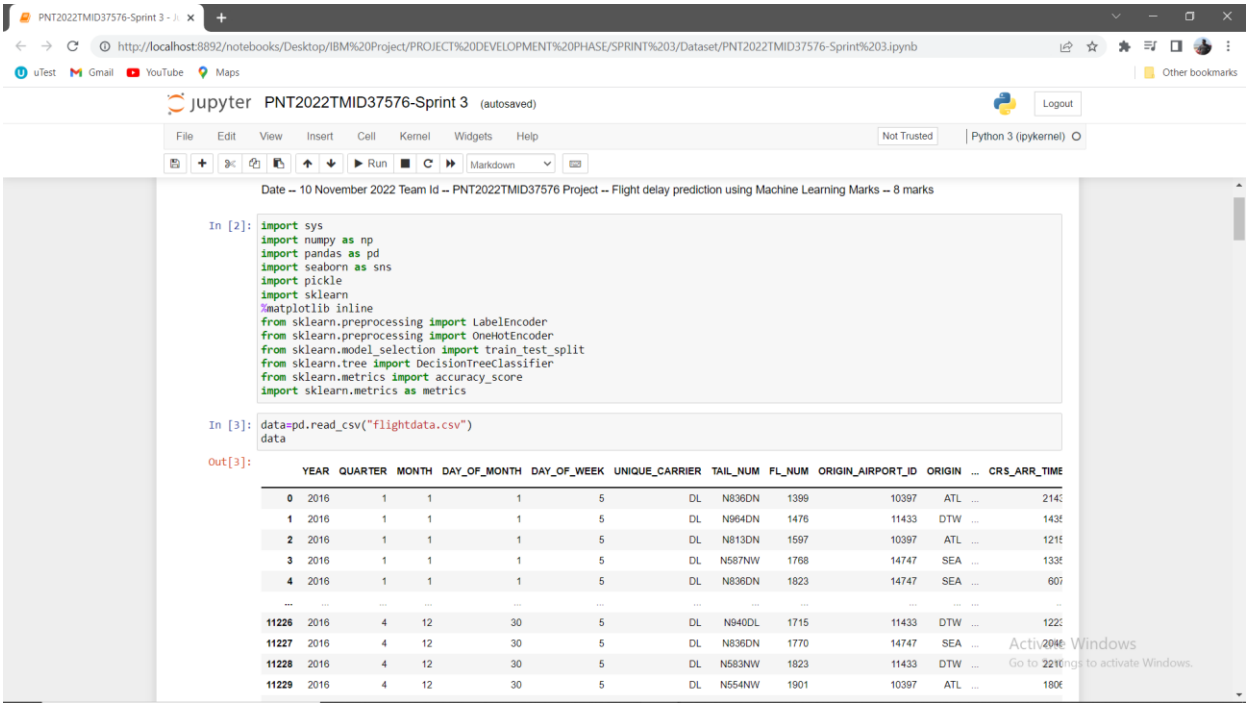
SPRINT 3 – CODE AND TESTCASE

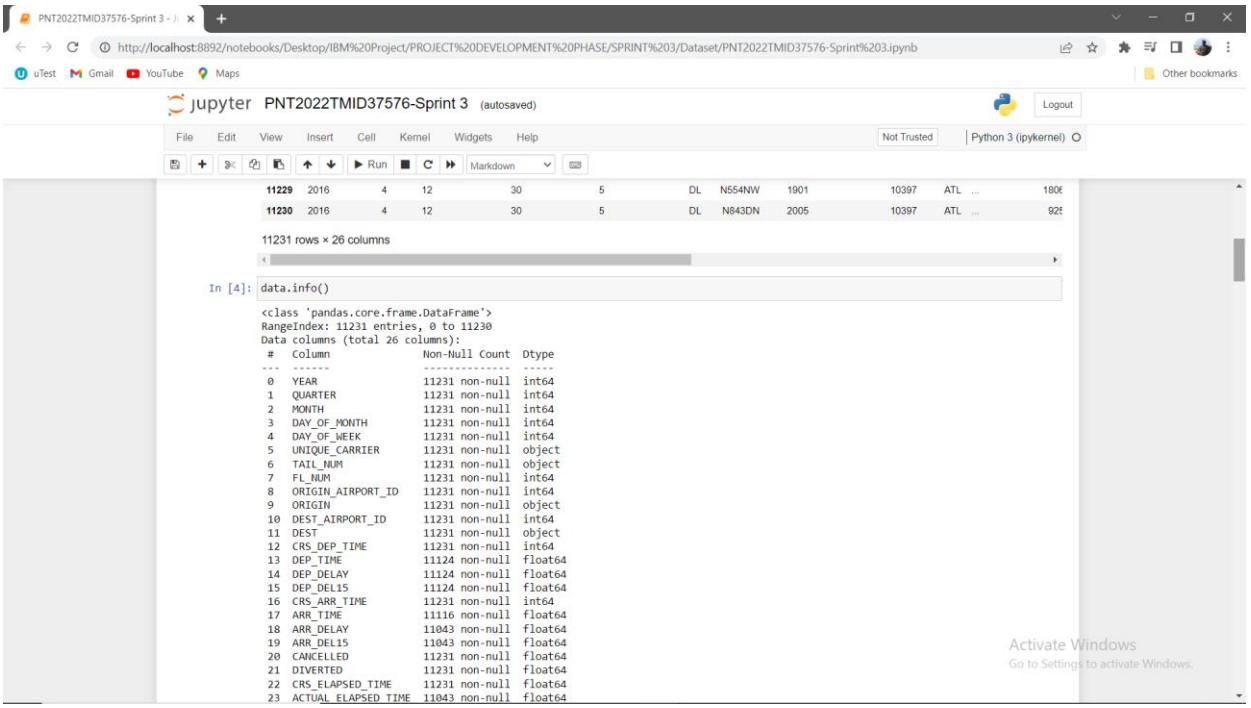
Date	10 November 2022
Team ID	PNT2022TMID37576
Project	Flight delay prediction using Machine learning
Marks	8 Marks

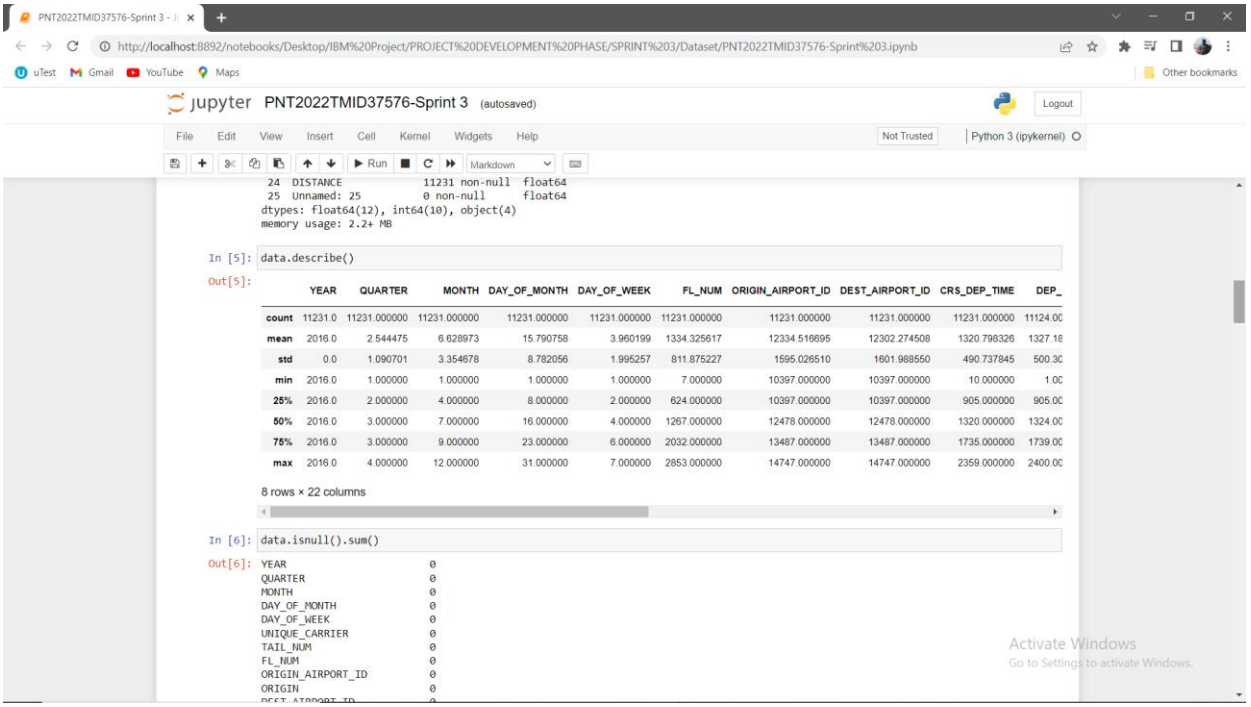
In this Sprint development phase, we have create an model with the help of Pre-processed dataset. We have used Decision Tree Classifier Algorithm for model development. Also we have implement method to check the accuracy of our model and convert the model into pkl file by importing Pickle python library. With the help of pickle model file the prediction is performed by Flask App.

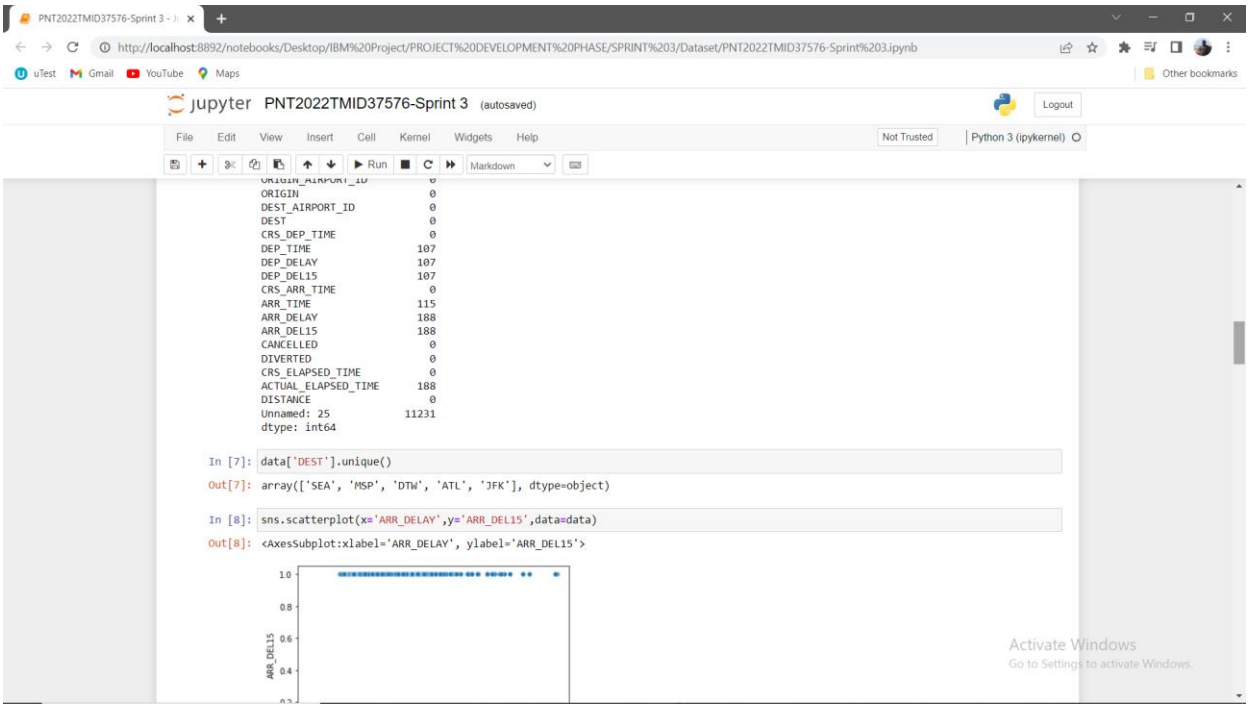
Jupyter notebook :

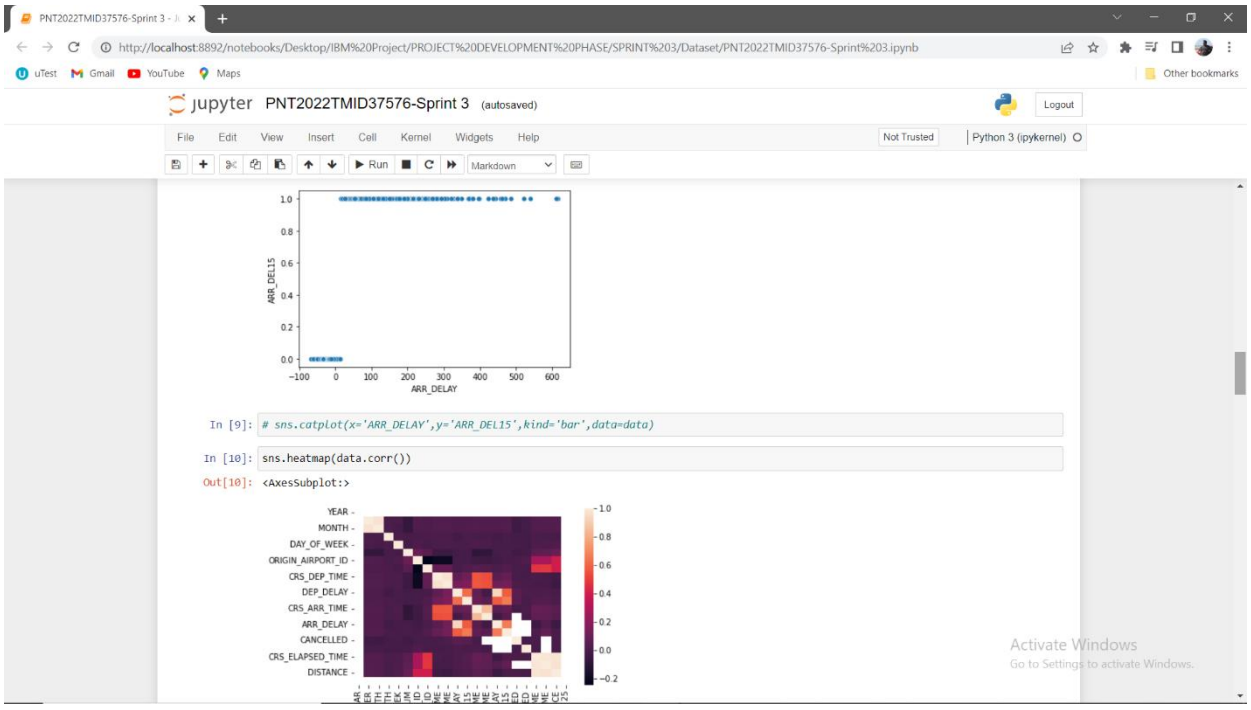
Screenshots :

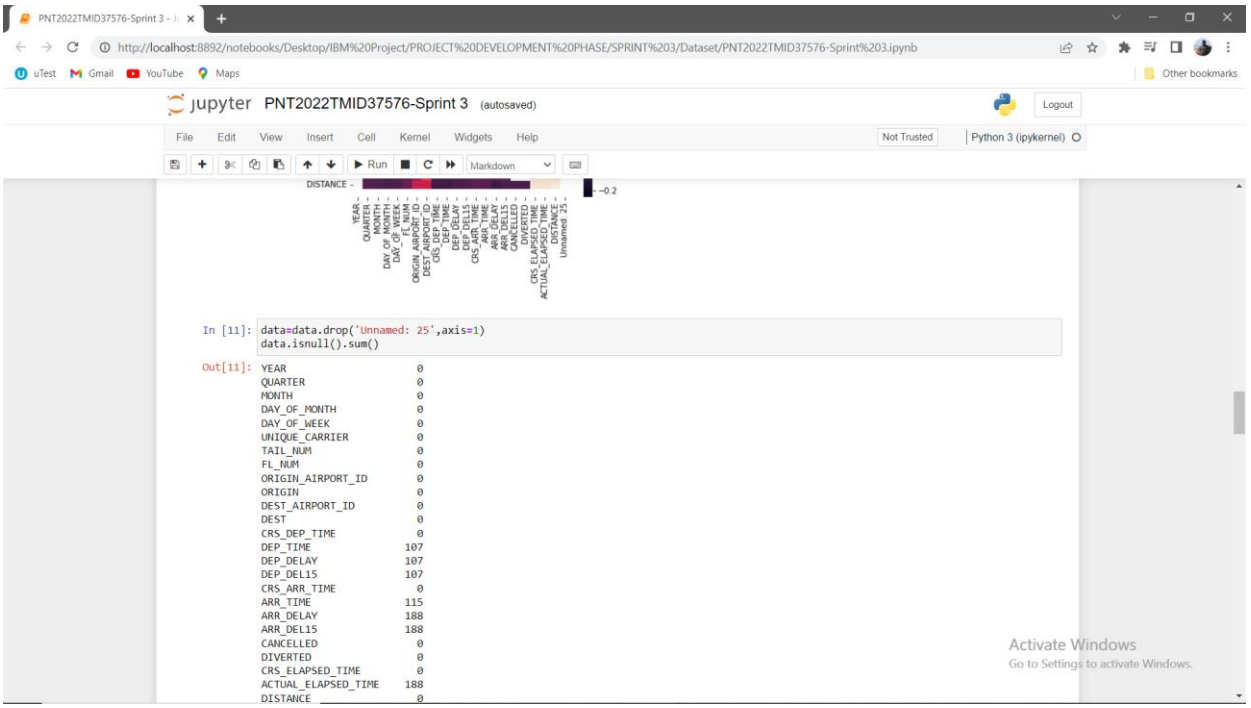


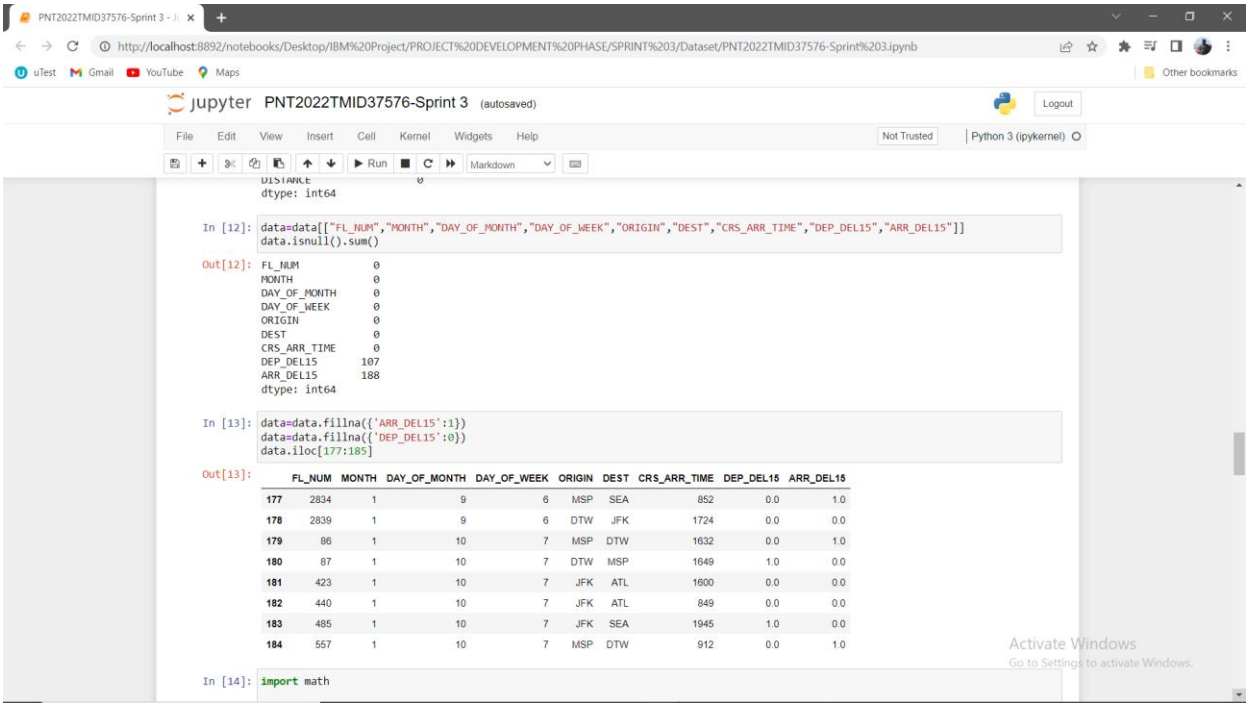

PNT2022TMID37576-Sprint 3 - J
http://localhost:8892/notebooks/Desktop/IBM%20Project/PROJECT%20DEVELOPMENT%20PHASE/SPRINT%203/Dataset/PNT2022TMID37576-Sprint%203.ipynb
uTest
Gmail
YouTube
Maps
Other bookmarks
jupyter PNT2022TMID37576-Sprint 3 (autosaved)
Logout
File Edit View Insert Cell Kernel Widgets Help
Not Trusted
Python 3 (ipykernel)
Run
Markdown
11229 2016 4 12 30 5 DL N554NW 1901 10397 ATL ... 180
11230 2016 4 12 30 5 DL N843DN 2005 10397 ATL ... 92
11231 rows × 26 columns
In [4]: data.info()
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 11231 entries, 0 to 11230
Data columns (total 26 columns):
Column Non-Null Count Dtype
0 YEAR 11231 non-null int64
1 QUARTER 11231 non-null int64
2 MONTH 11231 non-null int64
3 DAY_OF_MONTH 11231 non-null int64
4 DAY_OF_WEEK 11231 non-null int64
5 UNIQUE_CARRIER 11231 non-null object
6 TAIL_NUM 11231 non-null object
7 FL_NUM 11231 non-null int64
8 ORIGIN_AIRPORT_ID 11231 non-null int64
9 ORIGIN 11231 non-null object
10 DEST_AIRPORT_ID 11231 non-null int64
11 DEST 11231 non-null object
12 CRS_DEP_TIME 11231 non-null int64
13 DEP_TIME 11124 non-null float64
14 DEP_DELAY 11124 non-null float64
15 DEP_DEL15 11124 non-null float64
16 CRS_ARR_TIME 11231 non-null int64
17 ARR_TIME 11116 non-null float64
18 ARR_DELAY 11043 non-null float64
19 ARR_DEL15 11043 non-null float64
20 CANCELLED 11231 non-null float64
21 DIVERTED 11231 non-null float64
22 CRS_ELAPSED_TIME 11231 non-null float64
23 ACTUAL_ELAPSED_TIME 11043 non-null float64
Activate Windows
Go to Settings to activate Windows.

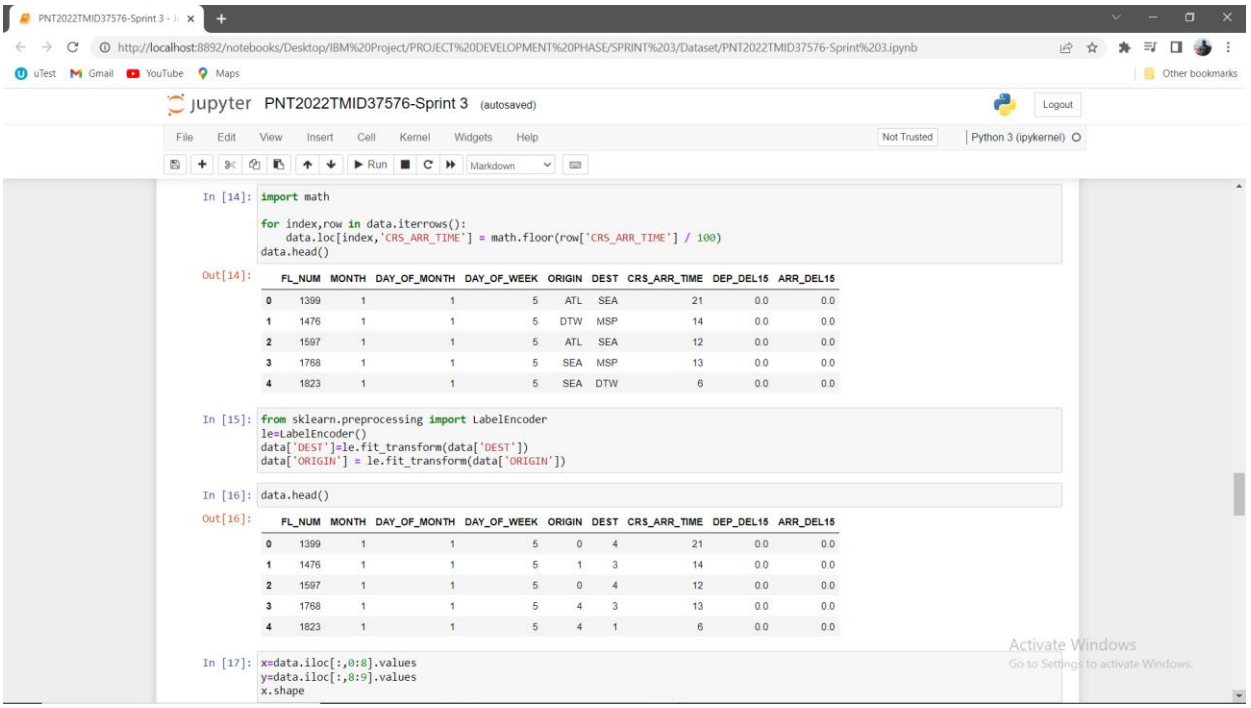

PNT2022TMID37576-Sprint 3 - J
http://localhost:8892/notebooks/Desktop/IBM%20Project/PROJECT%20DEVELOPMENT%20PHASE/SPRINT%203/Dataset/PNT2022TMID37576-Sprint%203.ipynb
uTest
Gmail
YouTube
Maps
Other bookmarks
jupyter PNT2022TMID37576-Sprint 3 (autosaved)
Logout
File Edit View Insert Cell Kernel Widgets Help
Not Trusted
Python 3 (ipykernel)
Run
Markdown
24 DISTANCE 11231 non-null float64
25 Unnamed: 25 0 non-null float64
dtypes: float64(12), int64(10), object(4)
memory usage: 2.2+ MB
In [5]: data.describe()
Out[5]:
YEAR QUARTER MONTH DAY_OF_MONTH DAY_OF_WEEK FL_NUM ORIGIN_AIRPORT_ID DEST_AIRPORT_ID CRS_DEP_TIME DEP_
count 11231.0 11231.000000 11231.000000 11231.000000 11231.000000 11231.000000 11231.000000 11231.000000 11231.000000 11124.00
mean 2016.0 2.544475 6.628973 15.790758 3.960199 1334.325617 12334.516695 12302.274508 1320.798326 1327.18
std 0.0 1.090701 3.354678 8.782056 1.995257 811.875227 1595.026510 1601.988550 490.737845 500.30
min 2016.0 1.000000 1.000000 1.000000 1.000000 7.000000 10397.000000 10397.000000 10.000000 1.00
25% 2016.0 2.000000 4.000000 8.000000 2.000000 624.000000 10397.000000 10397.000000 905.000000 905.00
50% 2016.0 3.000000 7.000000 16.000000 4.000000 1267.000000 12478.000000 12478.000000 1320.000000 1324.00
75% 2016.0 3.000000 9.000000 23.000000 6.000000 2032.000000 13487.000000 13487.000000 1735.000000 1739.00
max 2016.0 4.000000 12.000000 31.000000 7.000000 2853.000000 14747.000000 14747.000000 2359.000000 2400.00
8 rows × 22 columns
In [6]: data.isnull().sum()
Out[6]:
YEAR 0
QUARTER 0
MONTH 0
DAY_OF_MONTH 0
DAY_OF_WEEK 0
UNIQUE_CARRIER 0
TAIL_NUM 0
FL_NUM 0
ORIGIN_AIRPORT_ID 0
ORIGIN 0
Activate Windows
Go to Settings to activate Windows.

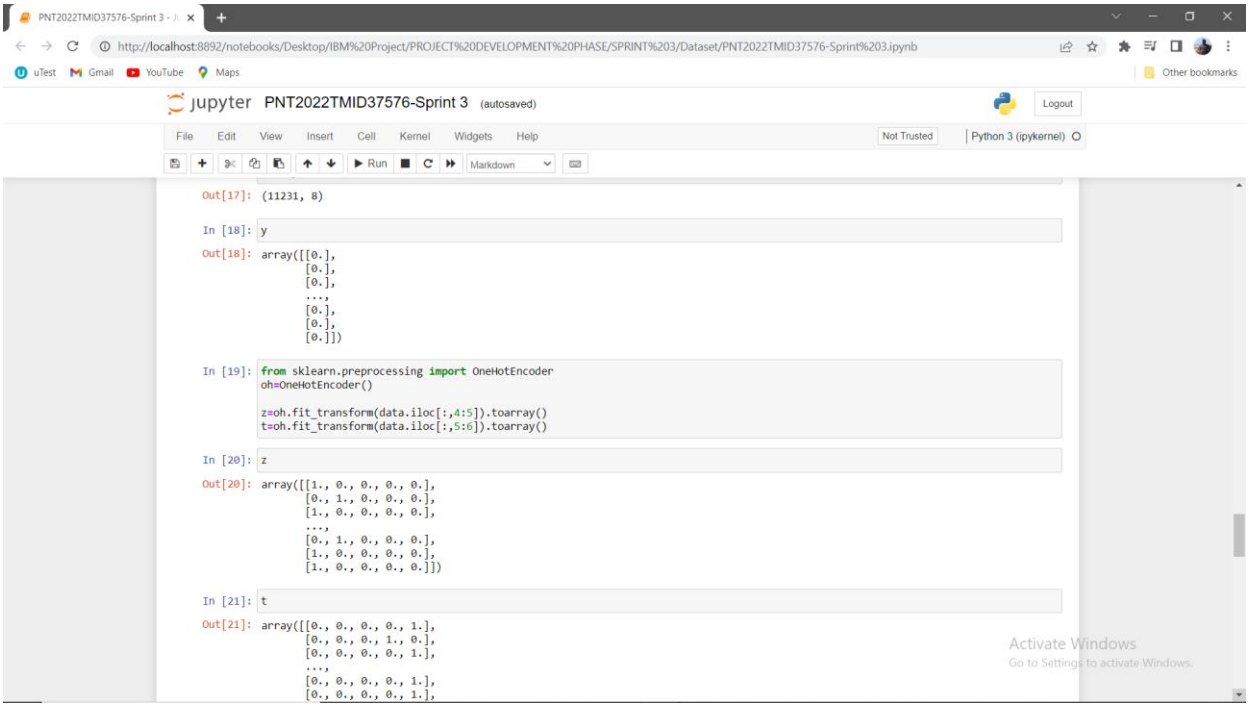

PNT2022TMID37576-Sprint 3 - Jupyter Notebook
http://localhost:8892/notebooks/Desktop/IBM%20Project/PROJECT%20DEVELOPMENT%20PHASE/SPRINT%203/Dataset/PNT2022TMID37576-Sprint%203.ipynb
uTest Gmail YouTube Maps
Other bookmarks
jupyter PNT2022TMID37576-Sprint 3 (autosaved)
Logout
File Edit View Insert Cell Kernel Widgets Help
Not Trusted
Python 3 (ipykernel)
Run
Markdown
ORIGIN_AIRPORT_ID 0
ORIGIN 0
DEST_AIRPORT_ID 0
DEST 0
CRS_DEP_TIME 0
DEP_TIME 107
DEP_DELAY 107
DEP_DEL15 107
CRS_ARR_TIME 0
ARR_TIME 115
ARR_DELAY 188
ARR_DEL15 188
CANCELLED 0
DIVERTED 0
CRS_ELAPSED_TIME 0
ACTUAL_ELAPSED_TIME 188
DISTANCE 0
Unnamed: 25 11231
dtype: int64
In [7]: data['DEST'].unique()
Out[7]: array(['SEA', 'MSP', 'DTW', 'ATL', 'JFK'], dtype=object)
In [8]: sns.scatterplot(x='ARR_DELAY',y='ARR_DEL15',data=data)
Out[8]: <AxesSubplot:xlabel='ARR_DELAY', ylabel='ARR_DEL15'>
ARR_DEL15
1.0
0.8
0.6
0.4
Activate Windows
Go to Settings to activate Windows.

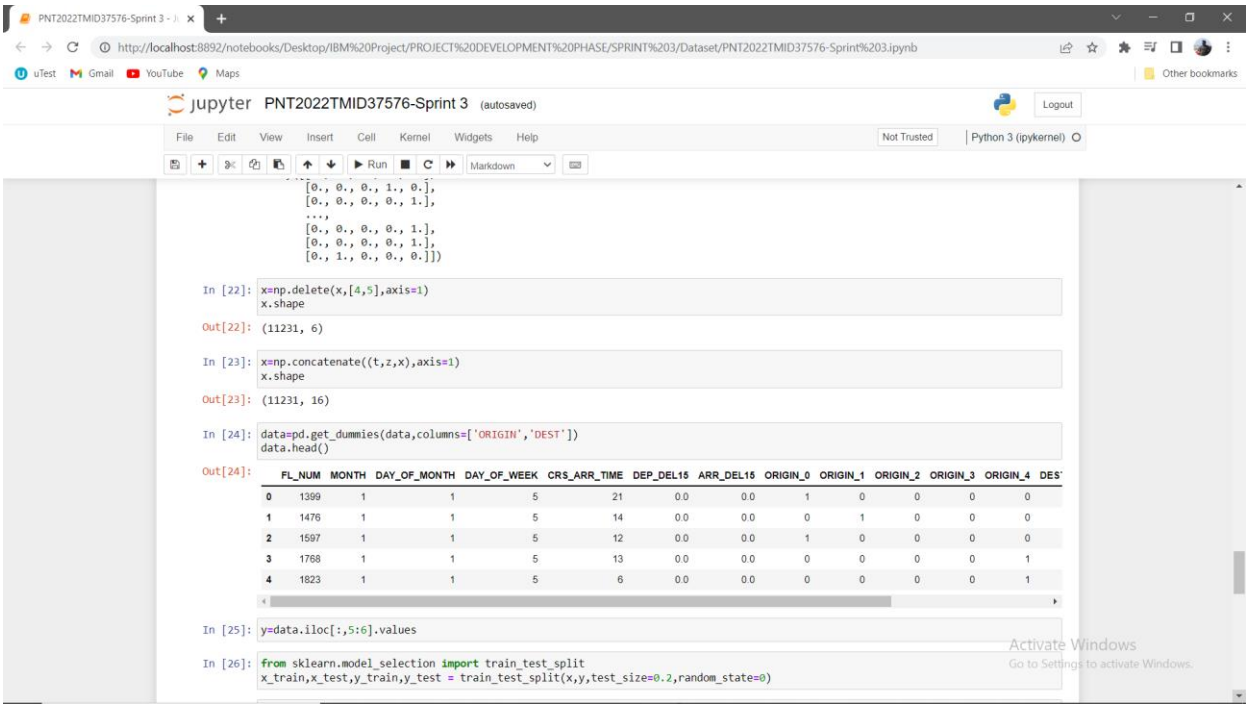

PNT2022TMID37576-Sprint 3 - Jupyter Notebook
http://localhost:8892/notebooks/Desktop/IBM%20Project/PROJECT%20DEVELOPMENT%20PHASE/SPRINT%203/Dataset/PNT2022TMID37576-Sprint%203.ipynb
uTest Gmail YouTube Maps
Other bookmarks
jupyter PNT2022TMID37576-Sprint 3 (autosaved)
Logout
File Edit View Insert Cell Kernel Widgets Help
Not Trusted
Python 3 (ipykernel)
Run
Markdown
ARR_DEL15
1.0
0.8
0.6
0.4
0.2
0.0
−100 0 100 200 300 400 500 600
ARR_DELAY
In [9]: # sns.catplot(x='ARR_DELAY',y='ARR_DEL15',kind='bar',data=data)
In [10]: sns.heatmap(data.corr())
Out[10]: <AxesSubplot:>
YEAR
MONTH
DAY_OF_WEEK
ORIGIN_AIRPORT_ID
CRS_DEP_TIME
DEP_DELAY
CRS_ARR_TIME
ARR_DELAY
CANCELLED
CRS_ELAPSED_TIME
DISTANCE
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
Activate Windows
Go to Settings to activate Windows.

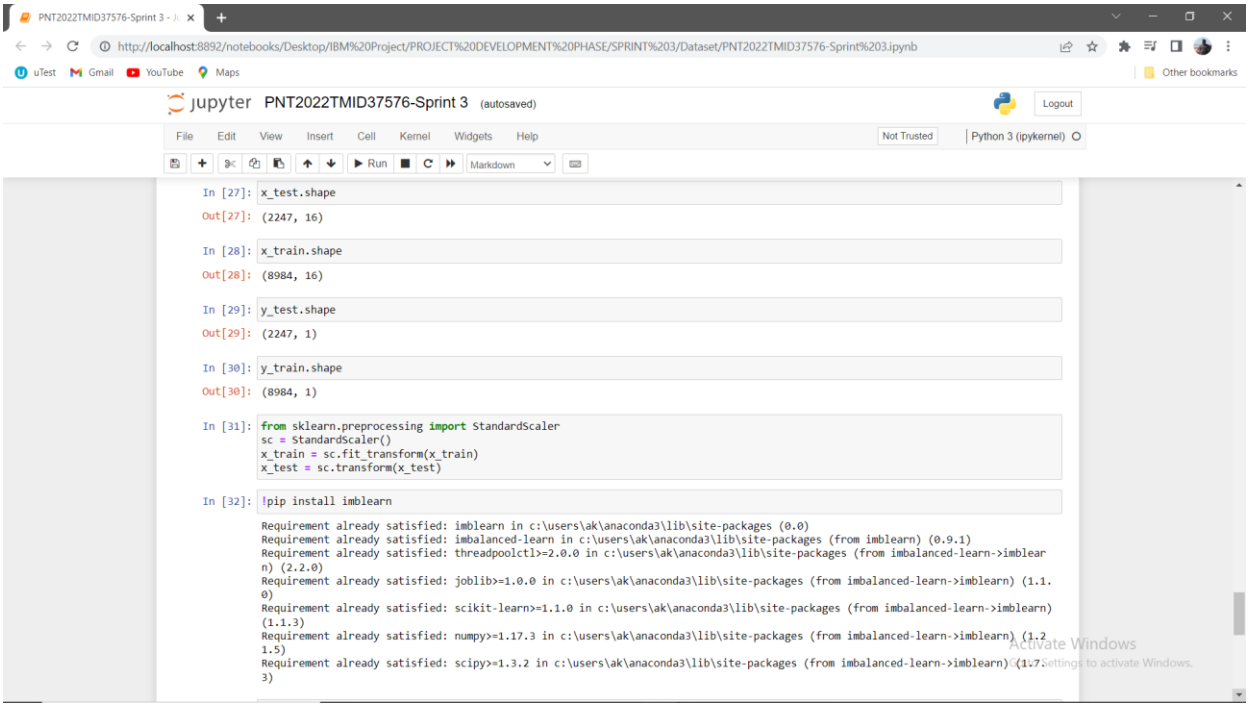

PNT2022TMID37576-Sprint 3 - Jupyter Notebook
http://localhost:8892/notebooks/Desktop/IBM%20Project/PROJECT%20DEVELOPMENT%20PHASE/SPRINT%203/Dataset/PNT2022TMID37576-Sprint%203.ipynb
uTest Gmail YouTube Maps
Other bookmarks
jupyter PNT2022TMID37576-Sprint 3 (autosaved)
Logout
File Edit View Insert Cell Kernel Widgets Help
Not Trusted
Python 3 (ipykernel)
Run
Markdown
DISTANCE
YEAR
QUARTER
MONTH
DAY_OF_MONTH
DAY_OF_WEEK
FL_NUM
ORIGIN_AIRPORT_ID
DEST_AIRPORT_ID
CRS_DEP_TIME
DEP_TIME
DEP_DELAY
DEP_DEL15
CRS_ARR_TIME
ARR_TIME
ARR_DELAY
ARR_DEL15
CANCELLED
DIVERTED
CRS_ELAPSED_TIME
ACTUAL_ELAPSED_TIME
DISTANCE
Unnamed: 25
1.0
0.8
0.6
0.4
0.2
In [11]:
data=data.drop('Unnamed: 25',axis=1)
data.isnull().sum()
Out[11]:
YEAR 0
QUARTER 0
MONTH 0
DAY_OF_MONTH 0
DAY_OF_WEEK 0
UNIQUE_CARRIER 0
TAIL_NUM 0
FL_NUM 0
ORIGIN_AIRPORT_ID 0
ORIGIN 0
DEST_AIRPORT_ID 0
DEST 0
CRS_DEP_TIME 0
DEP_TIME 107
DEP_DELAY 107
DEP_DEL15 107
CRS_ARR_TIME 0
ARR_TIME 115
ARR_DELAY 188
ARR_DEL15 188
CANCELLED 0
DIVERTED 0
CRS_ELAPSED_TIME 0
ACTUAL_ELAPSED_TIME 188
DISTANCE 0
Activate Windows
Go to Settings to activate Windows.

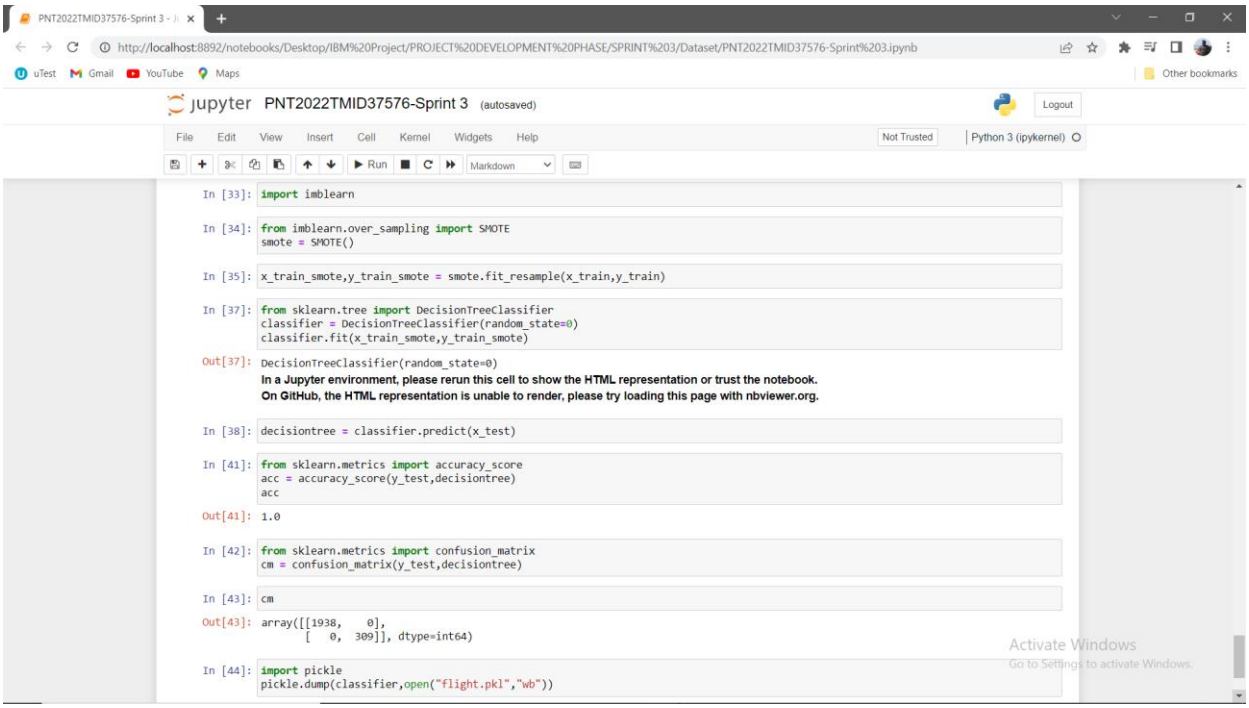

PNT2022TMID37576-Sprint 3 - Jupyter Notebook
http://localhost:8892/notebooks/Desktop/IBM%20Project/PROJECT%20DEVELOPMENT%20PHASE/SPRINT%203/Dataset/PNT2022TMID37576-Sprint%203.ipynb
uTest Gmail YouTube Maps
Other bookmarks
jupyter PNT2022TMID37576-Sprint 3 (autosaved)
Logout
File Edit View Insert Cell Kernel Widgets Help
Not Trusted
Python 3 (ipykernel)
Run
Markdown
DISTANCE 0
dtype: int64
In [12]:
data=data[["FL_NUM","MONTH","DAY_OF_MONTH","DAY_OF_WEEK","ORIGIN","DEST","CRS_ARR_TIME","DEP_DEL15","ARR_DEL15"]]
data.isnull().sum()
Out[12]:
FL_NUM 0
MONTH 0
DAY_OF_MONTH 0
DAY_OF_WEEK 0
ORIGIN 0
DEST 0
CRS_ARR_TIME 0
DEP_DEL15 107
ARR_DEL15 188
dtype: int64
In [13]:
data=data.fillna({'ARR_DEL15':1})
data=data.fillna({'DEP_DEL15':0})
data.iloc[177:185]
Out[13]:
FL_NUM MONTH DAY_OF_MONTH DAY_OF_WEEK ORIGIN DEST CRS_ARR_TIME DEP_DEL15 ARR_DEL15
177 2834 1 9 6 MSP SEA 852 0.0 1.0
178 2839 1 9 6 DTW JFK 1724 0.0 0.0
179 86 1 10 7 MSP DTW 1632 0.0 1.0
180 87 1 10 7 DTW MSP 1649 1.0 0.0
181 423 1 10 7 JFK ATL 1600 0.0 0.0
182 440 1 10 7 JFK ATL 849 0.0 0.0
183 485 1 10 7 JFK SEA 1945 1.0 0.0
184 557 1 10 7 MSP DTW 912 0.0 1.0
Activate Windows
Go to Settings to activate Windows.
In [14]:
import math


PNT2022TMID37576-Sprint 3 - Jupyter Notebook
http://localhost:8892/notebooks/Desktop/IBM%20Project/PROJECT%20DEVELOPMENT%20PHASE/SPRINT%203/Dataset/PNT2022TMID37576-Sprint%203.ipynb
uTest Gmail YouTube Maps
Other bookmarks
jupyter PNT2022TMID37576-Sprint 3 (autosaved)
Logout
File Edit View Insert Cell Kernel Widgets Help
Not Trusted
Python 3 (ipykernel)
Run
Markdown
In [14]:
import math
for index,row in data.iterrows():
data.loc[index,'CRS_ARR_TIME'] = math.floor(row['CRS_ARR_TIME'] / 100)
data.head()
Out[14]:
FL_NUM MONTH DAY_OF_MONTH DAY_OF_WEEK ORIGIN DEST CRS_ARR_TIME DEP_DEL15 ARR_DEL15
0 1399 1 1 5 ATL SEA 21 0.0 0.0
1 1476 1 1 5 DTW MSP 14 0.0 0.0
2 1597 1 1 5 ATL SEA 12 0.0 0.0
3 1768 1 1 5 SEA MSP 13 0.0 0.0
4 1823 1 1 5 SEA DTW 6 0.0 0.0
In [15]:
from sklearn.preprocessing import LabelEncoder
le=LabelEncoder()
data['DEST']=le.fit_transform(data['DEST'])
data['ORIGIN'] = le.fit_transform(data['ORIGIN'])
In [16]:
data.head()
Out[16]:
FL_NUM MONTH DAY_OF_MONTH DAY_OF_WEEK ORIGIN DEST CRS_ARR_TIME DEP_DEL15 ARR_DEL15
0 1399 1 1 5 0 4 21 0.0 0.0
1 1476 1 1 5 1 3 14 0.0 0.0
2 1597 1 1 5 0 4 12 0.0 0.0
3 1768 1 1 5 4 3 13 0.0 0.0
4 1823 1 1 5 4 1 6 0.0 0.0
In [17]:
x=data.iloc[:,0:8].values
y=data.iloc[:,8:9].values
x.shape
Activate Windows
Go to Settings to activate Windows.


PNT2022TMID37576-Sprint 3 - Jupyter Notebook
http://localhost:8892/notebooks/Desktop/IBM%20Project/PROJECT%20DEVELOPMENT%20PHASE/SPRINT%203/Dataset/PNT2022TMID37576-Sprint%203.ipynb
uTest Gmail YouTube Maps
Other bookmarks
jupyter PNT2022TMID37576-Sprint 3 (autosaved)
Logout
File Edit View Insert Cell Kernel Widgets Help
Not Trusted
Python 3 (ipykernel)
Run
Markdown
Out[17]:
(11231, 8)
In [18]:
y
Out[18]:
array([[0.],
[0.],
[0.],
...,
[0.],
[0.],
[0.]])
In [19]:
from sklearn.preprocessing import OneHotEncoder
oh=OneHotEncoder()
z=oh.fit_transform(data.iloc[:,4:5]).toarray()
t=oh.fit_transform(data.iloc[:,5:6]).toarray()
In [20]:
z
Out[20]:
array([[1., 0., 0., 0., 0.],
[0., 1., 0., 0., 0.],
[1., 0., 0., 0., 0.],
...,
[0., 1., 0., 0., 0.],
[1., 0., 0., 0., 0.],
[1., 0., 0., 0., 0.]])
In [21]:
t
Out[21]:
array([[0., 0., 0., 0., 1.],
[0., 0., 0., 1., 0.],
[0., 0., 0., 0., 1.],
...,
[0., 0., 0., 0., 1.],
[0., 0., 0., 0., 1.],
Activate Windows
Go to Settings to activate Windows.


PNT2022TMID37576-Sprint 3 - Jupyter Notebook
http://localhost:8892/notebooks/Desktop/IBM%20Project/PROJECT%20DEVELOPMENT%20PHASE/SPRINT%203/Dataset/PNT2022TMID37576-Sprint%203.ipynb
uTest Gmail YouTube Maps
Other bookmarks
jupyter PNT2022TMID37576-Sprint 3 (autosaved)
Logout
File Edit View Insert Cell Kernel Widgets Help
Not Trusted
Python 3 (ipykernel)
Run
Markdown
[0., 0., 0., 1., 0.],
[0., 0., 0., 0., 1.],
...,
[0., 0., 0., 0., 1.],
[0., 0., 0., 0., 1.],
[0., 1., 0., 0., 0.]])
In [22]:
x=np.delete(x,[4,5],axis=1)
x.shape
Out[22]:
(11231, 6)
In [23]:
x=np.concatenate((t,z,x),axis=1)
x.shape
Out[23]:
(11231, 16)
In [24]:
data=pd.get_dummies(data,columns=['ORIGIN','DEST'])
data.head()
Out[24]:
FL_NUM MONTH DAY_OF_MONTH DAY_OF_WEEK CRS_ARR_TIME DEP_DEL15 ARR_DEL15 ORIGIN_0 ORIGIN_1 ORIGIN_2 ORIGIN_3 ORIGIN_4 DES
0 1399 1 1 5 21 0.0 0.0 1 0 0 0 0
1 1476 1 1 5 14 0.0 0.0 0 1 0 0 0
2 1597 1 1 5 12 0.0 0.0 1 0 0 0 0
3 1768 1 1 5 13 0.0 0.0 0 0 0 0 1
4 1823 1 1 5 6 0.0 0.0 0 0 0 0 1
In [25]:
y=data.iloc[:,5:6].values
In [26]:
from sklearn.model_selection import train_test_split
x_train,x_test,y_train,y_test = train_test_split(x,y,test_size=0.2,random_state=0)
Activate Windows
Go to Settings to activate Windows.


PNT2022TMID37576-Sprint 3 - Jupyter Notebook
http://localhost:8892/notebooks/Desktop/IBM%20Project/PROJECT%20DEVELOPMENT%20PHASE/SPRINT%203/Dataset/PNT2022TMID37576-Sprint%203.ipynb
uTest Gmail YouTube Maps
Other bookmarks
jupyter PNT2022TMID37576-Sprint 3 (autosaved)
Logout
File Edit View Insert Cell Kernel Widgets Help
Not Trusted
Python 3 (ipykernel)
Run
Markdown
In [27]:
x_test.shape
Out[27]:
(2247, 16)
In [28]:
x_train.shape
Out[28]:
(8984, 16)
In [29]:
y_test.shape
Out[29]:
(2247, 1)
In [30]:
y_train.shape
Out[30]:
(8984, 1)
In [31]:
from sklearn.preprocessing import StandardScaler
sc = StandardScaler()
x_train = sc.fit_transform(x_train)
x_test = sc.transform(x_test)
In [32]:
!pip install imblearn
Requirement already satisfied: imblearn in c:\users\ak\anaconda3\lib\site-packages (0.0)
Requirement already satisfied: imbalanced-learn in c:\users\ak\anaconda3\lib\site-packages (from imblearn) (0.9.1)
Requirement already satisfied: threadpoolctl>=2.0.0 in c:\users\ak\anaconda3\lib\site-packages (from imbalanced-learn->imblearn) (2.2.0)
Requirement already satisfied: joblib>=1.0.0 in c:\users\ak\anaconda3\lib\site-packages (from imbalanced-learn->imblearn) (1.1.0)
Requirement already satisfied: scikit-learn>=1.1.0 in c:\users\ak\anaconda3\lib\site-packages (from imbalanced-learn->imblearn) (1.1.3)
Requirement already satisfied: numpy>=1.17.3 in c:\users\ak\anaconda3\lib\site-packages (from imbalanced-learn->imblearn) (1.21.5)
Requirement already satisfied: scipy>=1.3.2 in c:\users\ak\anaconda3\lib\site-packages (from imbalanced-learn->imblearn) (1.7.3)
Activate Windows
Go to Settings to activate Windows.


PNT2022TMID37576-Sprint 3 - J
http://localhost:8892/notebooks/Desktop/IBM%20Project/PROJECT%20DEVELOPMENT%20PHASE/SPRINT%203/Dataset/PNT2022TMID37576-Sprint%203.ipynb
uTest
Gmail
YouTube
Maps
Other bookmarks
jupyter PNT2022TMID37576-Sprint 3 (autosaved)
Logout
File Edit View Insert Cell Kernel Widgets Help
Not Trusted
Python 3 (ipykernel)
Run
Markdown
In [33]: import imblearn
In [34]: from imblearn.over_sampling import SMOTE
smote = SMOTE()
In [35]: x_train_smote,y_train_smote = smote.fit_resample(x_train,y_train)
In [37]: from sklearn.tree import DecisionTreeClassifier
classifier = DecisionTreeClassifier(random_state=0)
classifier.fit(x_train_smote,y_train_smote)
Out[37]: DecisionTreeClassifier(random_state=0)
In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.
In [38]: decisiontree = classifier.predict(x_test)
In [41]: from sklearn.metrics import accuracy_score
acc = accuracy_score(y_test,decisiontree)
acc
Out[41]: 1.0
In [42]: from sklearn.metrics import confusion_matrix
cm = confusion_matrix(y_test,decisiontree)
In [43]: cm
Out[43]: array([[1938, 0],
[0, 309]], dtype=int64)
In [44]: import pickle
pickle.dump(classifier,open("flight.pkl","wb"))
Activate Windows
Go to Settings to activate Windows.

With the help of the ‘flight.pkl’ file, we have developed the Web pages by using ‘app.py’ flask app to integrate with the our processed model which is pickle file.

App.py(Flask);

With the help of Flask app, the Machine learning model will get the predicted output and integrated with web page and display the Output to the User.

```
from flask import Flask,request, render_template
import numpy as np
import pandas as pd
import pickle
import os

model=pickle.load(open('flight.pkl','rb'))
app=Flask(__name__)

@app.route('/')
def home():
    return render_template('index2.html')

@app.route('/predicts', methods=['POST','GET'])
```

```
def predict():
    name=request.form['name']
    month=request.form['month']
    dayofmonth=request.form['dayofmonth']
    dayofweek=request.form['dayofweek']
    origin=request.form['origin']
    if(origin=="msp"):
        origin1,origin2,origin3,origin4,origin5=0,0,0,0,1
    if(origin=="dtw"):
        origin1,origin2,origin3,origin4,origin5=1,0,0,0,0
    if(origin=="jfk"):
        origin1,origin2,origin3,origin4,origin5=0,0,1,0,0
    if(origin=="sea"):
        origin1,origin2,origin3,origin4,origin5=0,1,0,0,0
    if(origin=="alt"):
        origin1,origin2,origin3,origin4,origin5=0,0,0,1,0


    destination=request.form['destination']
    if(destination=="msp"):
        destination1,destination2,destination3,destination4,destination5=0,0,0
,0,1
    if(destination=="dtw"):
        destination1,destination2,destination3,destination4,destination5=1,0,0
,0,0
    if(destination=="jfk"):
        destination1,destination2,destination3,destination4,destination5=0,0,1
,0,0
    if(destination=="sea"):
        destination1,destination2,destination3,destination4,destination5=0,1,0
,0,0
    if(destination=="atl"):
        destination1,destination2,destination3,destination4,destination5=0,0,0
,1,0

    dept=request.form['dept']
    arrtime=request.form['arrtime']
    actdept=request.form['actdept']
    dept15 = int(dept) - int(actdept)
    total=[[name,month,dayofmonth,dayofweek,origin1,origin2,origin3,origin4,or
igin5,destination1,destination2,destination3,destination4,destination5,dept,ar
rtime]]
    y_pred=model.predict(total)
    print(y_pred)

    if(y_pred == [0.]):
        ans="The Flight will be on time"
    else:
        ans="The Flight will be Delayed"
```

```
    return render_template("predict.html",showcase=ans)


if__name__=='__main__':
    app.run(debug = True)
```