PROJECT DEVELOPMENT PHASE

Sprint - II

Date	05-Nov-2022
Team ID	PNT2022TMID49460
Project Name	Developing a Flight Delay Model Using Machine Learning
Maximum Marks	8 Marks

Data Pre-processing

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Importing Libraries

```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
import matplotlib as mpl
import matplotlib.patches as patches
from matplotlib.patches import ConnectionPatch
from collections import OrderedDict
from matplotlib.gridspec import GridSpec
%matplotlib inline

pd.set_option('display.max_columns', None)
pd.set_option('display.max_rows', None)

import os
os.getcwd()
os.chdir("C:/Users/administrator.DOMAIN-01/Documents/GitHub/Abc")
```

Importing the necessary files

```
df = pd.read_csv("Data/flight_data.csv")
planes = pd.read_csv("Data/planes.csv")
airports = pd.read_csv("Data/airports.csv")
carriers = pd.read_csv("Data/carriers.csv")

df.head(15)
```

Checking the dimensions of the 'flight_data' dataset

df.shape

Checking whether the dataset contains the NULL values or not

df.isnull().sum()

Dropping the rows

df = df.dropna()

df.head(10)

df.tail(10)

Dimension after dropping the rows containing NULL values

df.shape

Now again checking whether the dataset till contains any NULL values

df.isnull().sum()

Before type casting of 'dep_time', 'dep_delay', 'arr_time', 'arr_delay'

df.info()

Type casting

```
df['dep_time'] = df['dep_time'].astype('int64')
df['dep_delay'] = df['dep_delay'].astype('int64')
df['arr_time'] = df['arr_time'].astype('int64')
df['arr_delay'] = df['arr_delay'].astype('int64')
```

After type casting of 'dep_time', 'dep_delay', 'arr_time', 'arr_delay'

```
df.info()
```

```
df.head(10)
```

Exploratory Data Analysis

```
plt.figure(figsize = (18, 6))
sns.countplot(df['month'])
plt.title('Month Distribution', size = 25)
plt.xticks(size = 15)
plt.yticks(size = 15)
plt.xlabel("Months", size = 20)
plt.ylabel("Frequency", size = 20)
plt.show()
```

Market share of each Airline(carrier)

```
plt.figure(figsize = (20, 6))
sns.countplot(df['carrier'])
plt.title('Various Carriers in US')
plt.xticks(size = 15)
plt.yticks(size = 15)
plt.xlabel("Carriers", size = 20)
plt.ylabel("Frequency", size = 20)
plt.show()
```

```
df['carrier'].value_counts().to_frame()
```

Extracting statistical parameters from a group by object:

```
def get_stats(group):
    return {'min': group.min(), 'max': group.max(),
            'count': group.count(), 'mean': group.mean()}
```

Creation of a dataframe with statitical infos on each airline:

```
global_stats = df['dep_delay'].groupby(df['carrier']).apply(get_stats).unstack()
global_stats = global_stats.sort_values('count')
global_stats
```

Graphs on flights, airports & delays

```
global_stats1 = global_stats
global_stats = global_stats1.head(14)
codes = global_stats.index.tolist()
carriers1 = carriers[carriers['IATA_CODE'].isin(codes)]
abbr_companies = carriers1.set_index('IATA_CODE')['AIRLINE'].to_dict()

font = {'family' : 'DejaVu Sans', 'weight' : 'bold', 'size' : 15}
mpl.rc('font', **font)
import matplotlib.patches as mpatches
```

Extraction of a subset of columns and redefine the airlines labelling

```
df2 = df.loc[:, ['carrier', 'dep_delay']]
df2['carrier'] = df2['carrier'].replace(abbr_companies)

colors = ['royalblue', 'grey', 'wheat', 'c', 'firebrick', 'seagreen', 'lightskyblue',
          'lightcoral', 'yellowgreen', 'gold', 'tomato', 'violet', 'aquamarine', 'chartreuse']

fig = plt.figure(1, figsize=(22,17))
gs=GridSpec(2,2)
ax1=fig.add_subplot(gs[0,0])
ax2=fig.add_subplot(gs[0,1])
ax3=fig.add_subplot(gs[1,:])
```

Pie chart nº1: nb of flights

```
labels = [s for s in global_stats.index]
sizes  = global_stats['count'].values
explode = [0.3 if sizes[i] < 20000 else 0.0 for i in range(len(abbr_companies))]
patches, texts, autotexts = ax1.pie(sizes, explode = explode,
                                    labels=labels, colors = colors, autopct='%1.0f%%',
                                    shadow=False, startangle=0)
for i in range(len(abbr_companies)):
    texts[i].set_fontsize(14)
ax1.axis('equal')
```

```
ax1.set_title('% of flights per company', bbox={'facecolor':'midnightblue', 'pad':5},
            color = 'w',fontsize=18
```

Setting the legend: abreviation -> airline name

```
comp_handler = []
for i in range(len(abbr_companies)):
    comp_handler.append(mpatches.Patch(color=colors[i],
          label = global_stats.index[i] + ': ' + abbr_companies[global_stats.index[i]]))
ax1.legend(handles=comp_handler, bbox_to_anchor=(0.2, 0.9),
          fontsize = 13, bbox_transform=plt.gcf().transFigure)
```

Pie chart nº2: mean delay at departure

```
sizes = global_stats['mean'].values
sizes  = [max(s,0) for s in sizes]
explode = [0.0 if sizes[i] < 20000 else 0.01 for i in range(len(abbr_companies))]
patches, texts, autotexts = ax2.pie(sizes, explode = explode, labels = labels,
                          colors = colors, shadow=False, startangle=0,
                          autopct = lambda p : '{:.0f}'.format(p * sum(sizes) / 100))
for i in range(len(abbr_companies)):
    texts[i].set_fontsize(14)
ax2.axis('equal')
ax2.set_title('Mean delay at origin', bbox={'facecolor':'midnightblue', 'pad':5},
            color='w', fontsize=18)
```

Redefine the colors for correspondance with the pie charts

```
codes = global_stats1.index.tolist()
carriers1 = carriers[carriers['IATA_CODE'].isin(codes)]
abbr_companies = carriers1.set_index('IATA_CODE')['AIRLINE'].to_dict()

colors = ['firebrick', 'gold', 'lightcoral', 'aquamarine', 'c', 'yellowgreen', 'grey',
          'seagreen', 'tomato', 'violet', 'wheat', 'chartreuse', 'lightskyblue', 'royalblue',
          'black', 'grey', 'white', 'silver', 'black', 'pink']

ax3 = sns.stripplot(y="carrier", x="dep_delay", size = 4, palette = colors,
                    data=df2, linewidth = 0.5,  jitter=True)
plt.setp(ax3.get_xticklabels(), fontsize=14)
plt.setp(ax3.get_yticklabels(), fontsize=14)
ax3.set_xticklabels(['{:2.0f}h{:2.0f}m'.format(*[int(y) for y in divmod(x,60)])
                     for x in ax3.get_xticks()])
plt.xlabel('Departure delay', fontsize=18, bbox={'facecolor':'midnightblue', 'pad':5},
           color='w', labelpad=20)
ax3.yaxis.label.set_visible(False)
```

```
plt.tight_layout(w_pad=3)
```

Plot Mean Delay of various Airline(carrier)

```
carrier_code=carriers.set_index('IATA_CODE')['AIRLINE'].to_dict()

mpl.rc('patch', edgecolor = 'dimgray', linewidth = 1)

mpl.rcParams.update(mpl.rcParamsDefault)

mpl.rcParams['hatch.linewidth'] = 2.0


fig = plt.figure(1, figsize = (11, 6))

ax = sns.barplot(x = 'dep_delay', y = 'carrier', data = df, color = 'lightskyblue', ci = None)

ax = sns.barplot(x = 'arr_delay', y = 'carrier', data = df, color = 'r', hatch = '///', alpha = 0.0, ci = None)

labels = [carrier_code[item.get_text()] for item in ax.get_yticklabels()]

ax.set_yticklabels(labels)

ax.yaxis.label.set_visible(False)

plt.xlabel("Mean delay [min] (@departure: blue, @arrival: hatch lines)", fontsize = 15, weight = 'bold', labelpad = 10)


mpl.rc('patch', edgecolor = 'dimgray', linewidth = 1)

mpl.rcParams.update(mpl.rcParamsDefault)

mpl.rcParams['hatch.linewidth'] = 2.0


fig = plt.figure(1, figsize = (10, 6))
```

Subset 4 major airlines

```
ax = sns.barplot(x = 'dep_delay', y = 'carrier', data = df, order = ['AA', 'DL', 'F9', 'HA', 'B6'], color = 'lightskyblue', ci = None)

ax = sns.barplot(x = 'arr_delay', y = 'carrier', data = df, order = ['AA', 'DL', 'F9', 'HA', 'B6'], color = 'r', hatch = '///', alpha = 0.0, ci = None)

labels = [carrier_code[item.get_text()] for item in ax.get_yticklabels()]
```

```
ax.set_yticklabels(labels)

ax.yaxis.label.set_visible(False)

plt.xlabel("5 Major Carrier's Mean Delay [min] (@departure: blue, @arrival: hatch lines)",

fontsize = 12, weight = 'bold', labelpad = 10)
```

Plotting the Market Share of the Airports(origin) of New York

```
df['origin'].value_counts().to_frame()

plt.pie(
    df['origin'].value_counts(),
    labels = df['origin'].value_counts().index,
    explode = (0.1, 0, 0),
    startangle = 90,
    autopct = '%1.1f%%',
    colors = ['#52D017', '#F62217', '#43C6DB']
)

plt.tight_layout()
plt.title("New York City Airport Market share")
plt.show()

fig = plt.figure(1, figsize = (12, 6))
df[df['origin'] == 'EWR']['month'].value_counts().sort_index().plot(kind = 'line', color =
'#52D017')
df[df['origin'] == 'JFK']['month'].value_counts().sort_index().plot(kind = 'line', color =
'#F62217')
df[df['origin'] == 'LGA']['month'].value_counts().sort_index().plot(kind = 'line', color =
'#43C6DB')

plt.title("Flights in New York City Area", size = 15)
plt.xticks(range(1, 13), size = 12)
plt.yticks(size = 12)
plt.xlabel("Month", size = 17)
plt.ylabel("Frequency", size = 17)
plt.legend(['EWR', 'JFK', 'LGA'])
```

Modelling

```
def map_labels(delays):

    if delays > 15:

        return 1

    else:
```

```
    return 0


df['delayed'] = ((df['dep_delay'].map(map_labels) + df['arr_delay'].map(map_labels)) !=
0).astype(int)

df['delayed'].value_counts(normalize = True)


df.head(20)


df.tail(5)
```

Feature Omission

```
columns_to_remove = ['dep_time', 'sched_dep_time', 'dep_delay', 'arr_time', 'sched_arr_time',
'arr_delay', 'flight', 'tailnum', 'air_time', 'distance', 'hour', 'minute', 'time_hour']
df.drop(columns_to_remove, axis = 1, inplace = True)

df.head()

df['delayed'].value_counts().to_frame()

df['dest'].value_counts().to_frame()

df_filtered =
df[df['dest'].isin(["LEX","TVC","MYR","CHO","BZN","JAC","PSP","EYW","HDN","MTJ",
"SBN","ANC"])]

print(df_filtered.head(15))

print(df_filtered.shape)

df.drop(df[df['dest'].isin(["LEX","TVC","MYR","CHO","BZN","JAC","PSP","EYW","HDN
","MTJ","SBN","ANC"])].index, inplace = True , axis = 0)

print(df.shape)

df['delayed'].value_counts().to_frame()

saving_data = df.to_csv("Data/Processed_data15.csv", index = False)
```