The problem: An organ donor must send an organ urgently from BWI airport (Baltimore) to a New York Airport on a Monday so the patient who will receive that organ can have his surgery done that same day with the least delay as possible. To do this the organ can be shipped though OH carrier that reaches JFK airport, or alternatively use RU carrier that reaches Newark airport. We must decide by reducing the chances of fligt delays of each option.

In [1]:
```
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn import preprocessing
from sklearn.naive_bayes import MultinomialNB
from sklearn.metrics import accuracy_score
from sklearn.neighbors import NearestNeighbors,KNeighborsClassifier
import matplotlib.pylab as plt
from dmba import classificationSummary, gainsChart
```

In [11]:
```
delays_df = pd.read_csv('FlightDelays.csv')
```

In [81]:
```
delays_df.head(8)
```

Out[81]:

	CRS_DEP_TIME	CARRIER	DEP_TIME	DEST	DISTANCE	FL_DATE	FL_NUM	ORIGIN	Weather	DAY_WEEK	DAY_OF_MONTH	TAIL_NUM	Flight Status
0	1455	OH	1455	JFK	184	01/01/2004	5935	BWI	0	4	1	N940CA	ontime
1	1640	DH	1640	JFK	213	01/01/2004	6155	DCA	0	4	1	N405FJ	ontime
2	1245	DH	1245	LGA	229	01/01/2004	7208	IAD	0	4	1	N695BR	ontime
3	1715	DH	1709	LGA	229	01/01/2004	7215	IAD	0	4	1	N662BR	ontime
4	1039	DH	1035	LGA	229	01/01/2004	7792	IAD	0	4	1	N698BR	ontime
5	840	DH	839	JFK	228	01/01/2004	7800	IAD	0	4	1	N687BR	ontime
6	1240	DH	1243	JFK	228	01/01/2004	7806	IAD	0	4	1	N321UE	ontime
7	1645	DH	1644	JFK	228	01/01/2004	7810	IAD	0	4	1	N301UE	ontime

In [82]:
```
# Replacing spacing with underscore in all column headers
delays_df.columns = [s.strip().replace(' ','_') for s in delays_df.columns]
```

In [83]:
```
# https://stackoverflow.com/questions/13851535/how-to-delete-rows-from-a-pandas-dataframe-based-on-a-conditional-expression
# Keeping only records with BWI as origin airport
delays_df = delays_df.drop(delays_df[(delays_df.ORIGIN != 'BWI')].index)
```

In [84]:
```
delays_df.shape
```

Out[84]: (145, 13)

In [85]:
```
delays_df.head(2)
```

Out[85]:

	CRS_DEP_TIME	CARRIER	DEP_TIME	DEST	DISTANCE	FL_DATE	FL_NUM	ORIGIN	Weather	DAY_WEEK	DAY_OF_MONTH	TAIL_NUM	Flight_Status
0	1455	OH	1455	JFK	184	01/01/2004	5935	BWI	0	4	1	N940CA	ontime
32	1455	RU	1452	EWR	169	01/01/2004	2403	BWI	0	4	1	N14916	ontime

In [86]:
```
df1 = pd.get_dummies(delays_df['Flight_Status'])
# delays_df = pd.get_dummies(delays_df['Flight_Status'])
```

In [89]:
```
df1
```

Out[89]:

	delayed	ontime
0	0	1
32	0	1
33	0	1
34	0	1
35	0	1
...	...	...
2151	0	1
2184	0	1
2185	0	1
2186	0	1
2187	0	1

145 rows × 2 columns

In [90]:
```
delays_df['delayed'] = df1.delayed
```

In [92]:
```
delays_df['ontime'] = df1.ontime
```

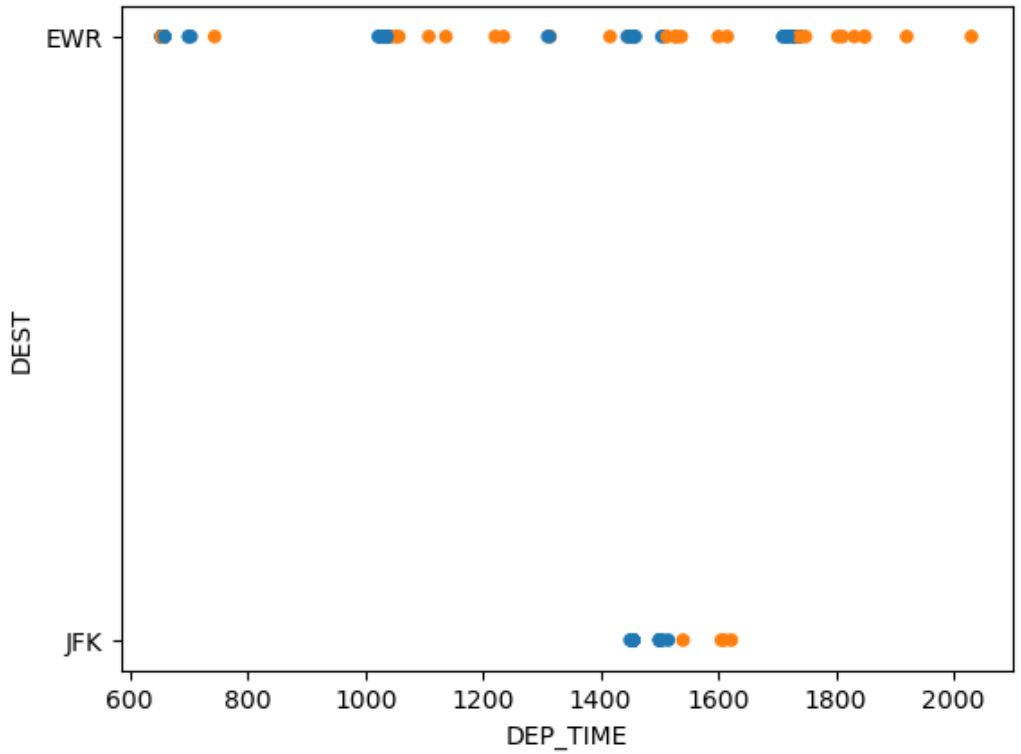
In [100]:
```
delays_df.head(15)
```

Out[100]:

	CRS_DEP_TIME	CARRIER	DEP_TIME	DEST	DISTANCE	FL_DATE	FL_NUM	ORIGIN	Weather	DAY_WEEK	DAY_OF_MONTH	TAIL_NUM	Flight_Statu
0	1455	OH	1455	JFK	184	01/01/2004	5935	BWI	0	4	1	N940CA	ontim
32	1455	RU	1452	EWR	169	01/01/2004	2403	BWI	0	4	1	N14916	ontim
33	1720	RU	1710	EWR	169	01/01/2004	2675	BWI	0	4	1	N16954	ontim
34	1030	RU	1030	EWR	169	01/01/2004	2303	BWI	0	4	1	N26549	ontim
35	700	RU	656	EWR	169	01/01/2004	2703	BWI	0	4	1	N16954	ontim
50	1455	OH	1455	JFK	184	01/02/2004	5935	BWI	0	5	2	N995CA	ontim
88	1720	RU	1715	EWR	169	01/02/2004	2675	BWI	0	5	2	N19966	ontim
89	1030	RU	1030	EWR	169	01/02/2004	2303	BWI	0	5	2	N12540	ontim
90	700	RU	656	EWR	169	01/02/2004	2703	BWI	0	5	2	N16961	ontim
91	1455	RU	1456	EWR	169	01/02/2004	2403	BWI	0	5	2	N12946	ontim
145	1720	RU	1714	EWR	169	01/03/2004	2675	BWI	0	6	3	N15574	ontim
146	700	RU	655	EWR	169	01/03/2004	2703	BWI	0	6	3	N11536	ontim
147	1030	RU	1026	EWR	169	01/03/2004	2303	BWI	0	6	3	N14907	ontim
148	1455	RU	1448	EWR	169	01/03/2004	2267	BWI	0	6	3	N14974	ontim
163	1455	OH	1605	JFK	184	01/04/2004	5935	BWI	0	7	4	N973CA	delaye

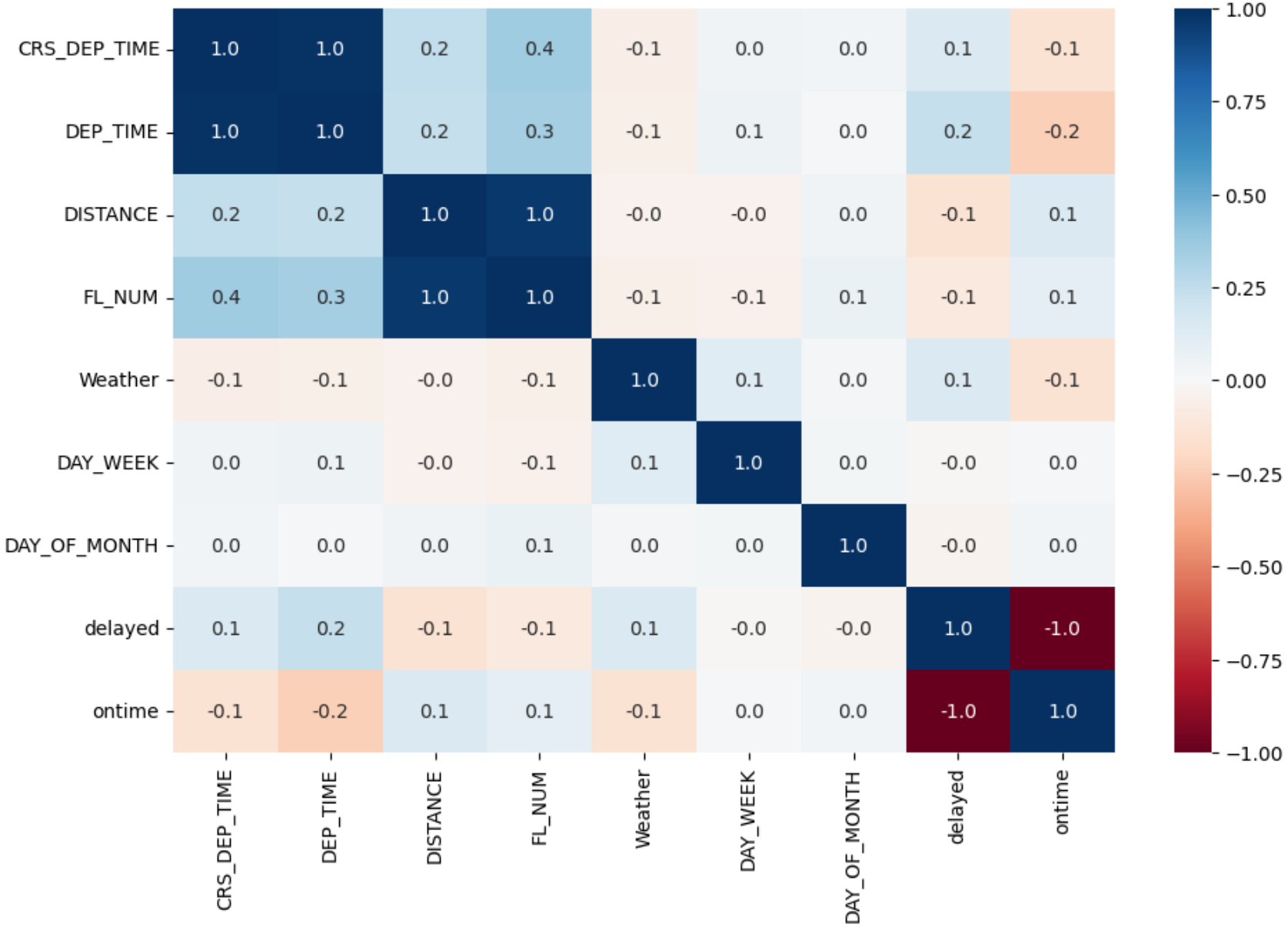
In [94]:
```
# Scatterplot
delays_df.plot.scatter(x='DEP_TIME', y='DEST', c=['C0' if c == 'ontime' else 'C1' for c in delays_df.Flight_Status])
# We can clearly observe the departure time frames towards each ariport and notice that they both have delays in the data set.
```

Out[94]: <AxesSubplot:xlabel='DEP_TIME', ylabel='DEST'>



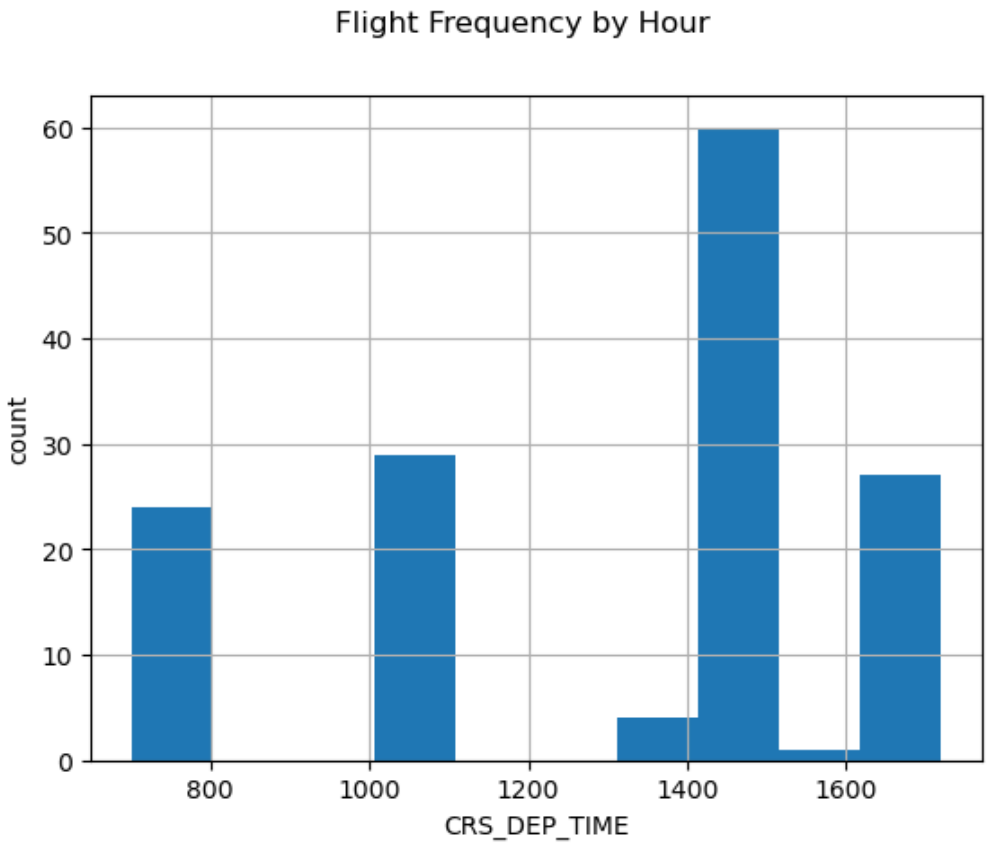
In [95]:
```
import seaborn as sns
corr = delays_df.corr()
fig, ax = plt.subplots()
fig.set_size_inches(11, 7)
sns.heatmap(corr, annot=True, fmt=".1f", cmap="RdBu", center=0, ax=ax)
# CRS_DEP_TIME and DEP_TIME are highly correlated.
# DISTANCE and FL_NUM are highly correlated.
```

Out[95]:
```
<AxesSubplot:>
```


CRS_DEP_TIME 1.0 1.0 0.2 0.4 -0.1 0.0 0.0 0.1 -0.1
DEP_TIME 1.0 1.0 0.2 0.3 -0.1 0.1 0.0 0.2 -0.2
DISTANCE 0.2 0.2 1.0 1.0 -0.0 -0.0 0.0 -0.1 0.1
FL_NUM 0.4 0.3 1.0 1.0 -0.1 -0.1 0.1 -0.1 0.1
Weather -0.1 -0.1 -0.0 -0.1 1.0 0.1 0.0 0.1 -0.1
DAY_WEEK 0.0 0.1 -0.0 -0.1 0.1 1.0 0.0 -0.0 0.0
DAY_OF_MONTH 0.0 0.0 0.0 0.1 0.0 0.0 1.0 -0.0 0.0
delayed 0.1 0.2 -0.1 -0.1 0.1 -0.0 -0.0 1.0 -1.0
ontime -0.1 -0.2 0.1 0.1 -0.1 0.0 0.0 -1.0 1.0
CRS_DEP_TIME
DEP_TIME
DISTANCE
FL_NUM
Weather
DAY_WEEK
DAY_OF_MONTH
delayed
ontime
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00

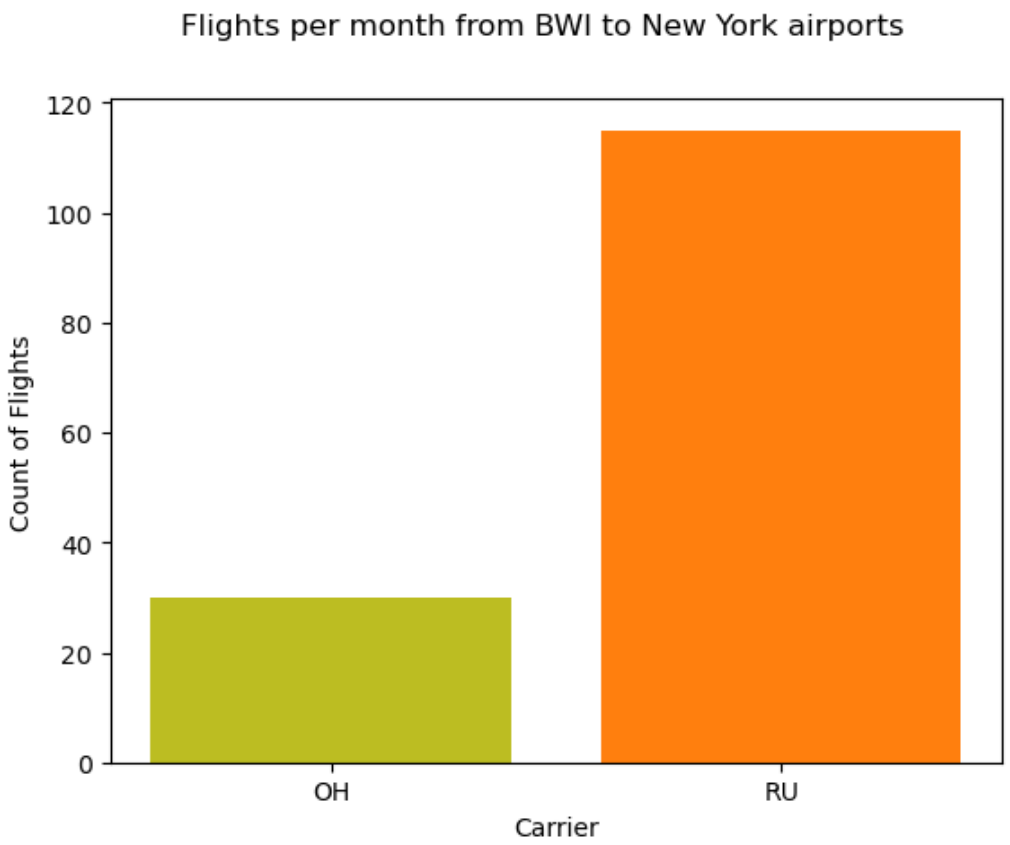
In [96]:
```
#Pandas version - Histrogam Distribution
ax = delays_df.CRS_DEP_TIME.hist()
ax.set_xlabel('CRS_DEP_TIME'); ax.set_ylabel('count');
plt.suptitle('Flight Frequency by Hour')
```

Out[96]:
```
Text(0.5, 0.98, 'Flight Frequency by Hour')
```



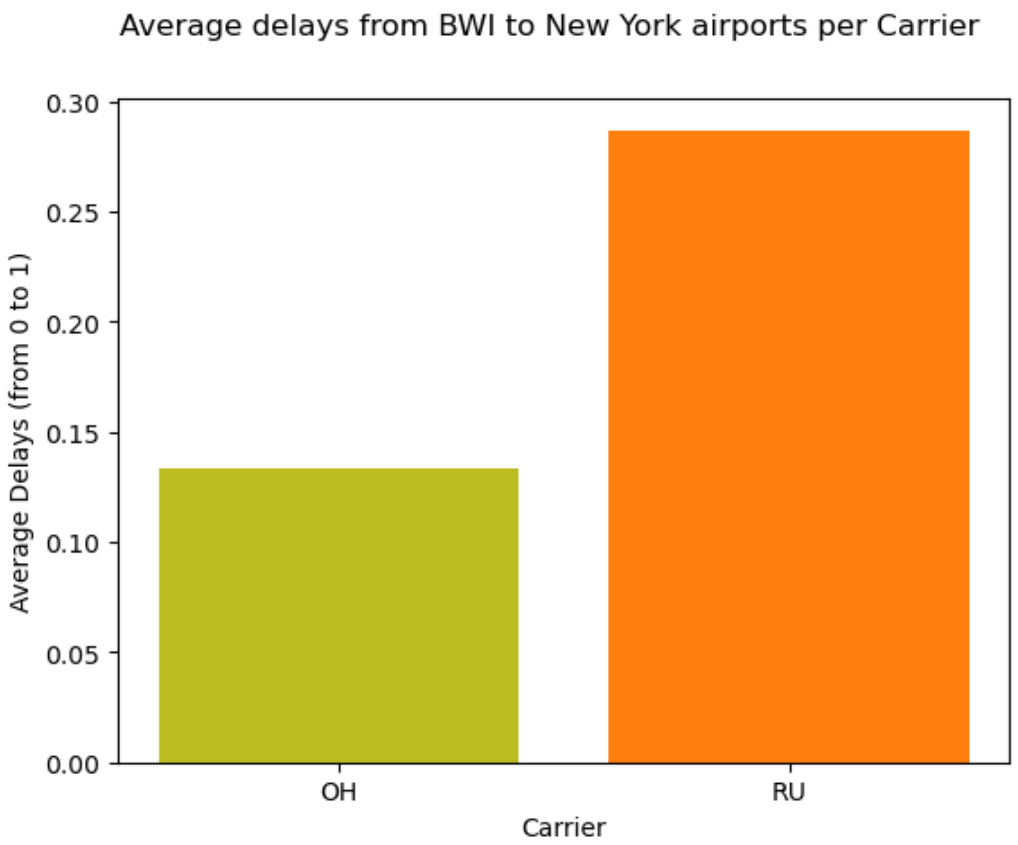
In [106]:
```
#Matplot version - bar chart
dataForPlot = delays_df.groupby('CARRIER').count().Flight_Status
fig, ax = plt.subplots()
ax.bar(dataForPlot.index, dataForPlot, color=['C8','C1'])
ax.set_xlabel('Carrier')
ax.set_ylabel('Count of Flights')
plt.suptitle('Flights per month from BWI to New York airports')
```

Out[106]:
```
Text(0.5, 0.98, 'Flights per month from BWI to New York airports')
```



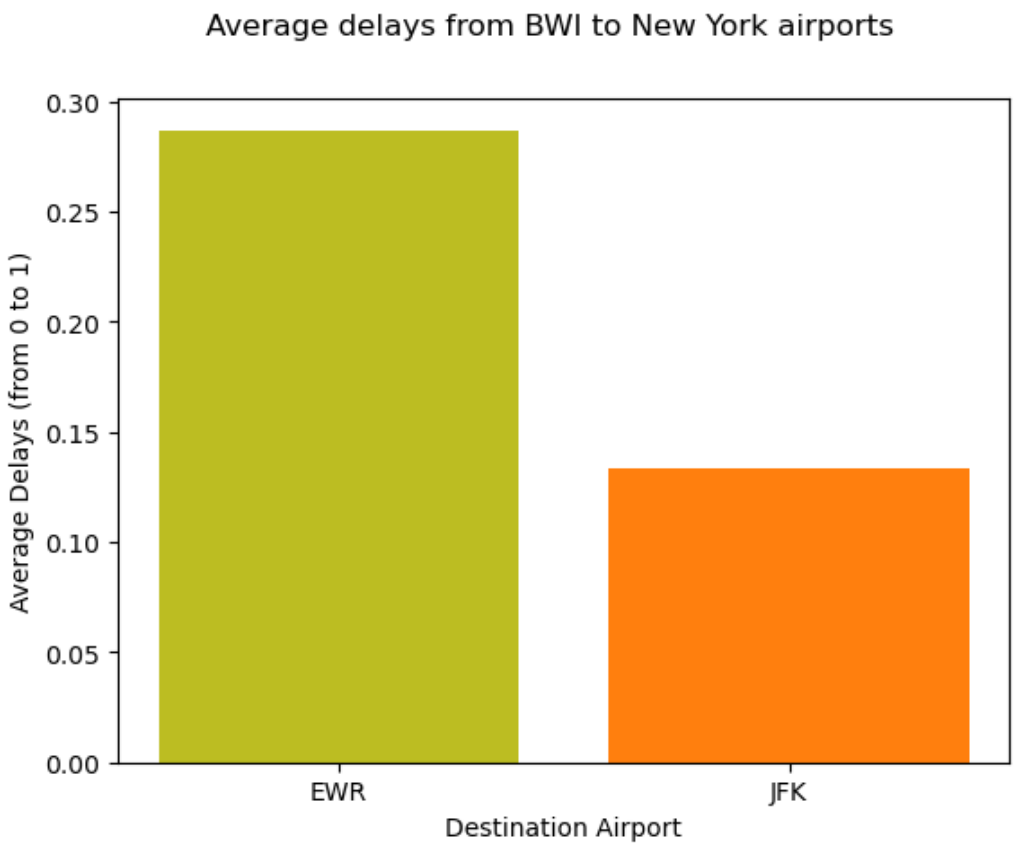
In [110]:
```
#Matplot version - bar chart
dataForPlot = delays_df.groupby('CARRIER').mean().delayed
fig, ax = plt.subplots()
ax.bar(dataForPlot.index, dataForPlot, color=['C8','C1'])
ax.set_xlabel('Carrier')
ax.set_ylabel('Average Delays (from 0 to 1)')
plt.suptitle('Average delays from BWI to New York airports per Carrier')
```

Out[110]: Text(0.5, 0.98, 'Average delays from BWI to New York airports per Carrier')



In [109]:
```
#Matplot version - bar chart
dataForPlot = delays_df.groupby('DEST').mean().delayed
fig, ax = plt.subplots()
ax.bar(dataForPlot.index, dataForPlot, color=['C8','C1'])
ax.set_xlabel('Destination Airport')
ax.set_ylabel('Average Delays (from 0 to 1)')
plt.suptitle('Average delays from BWI to New York airports')
```

Out[109]:
```
Text(0.5, 0.98, 'Average delays from BWI to New York airports')
```



In [111]:
```
delays_df.describe()
```

Out[111]:

	CRS_DEP_TIME	DEP_TIME	DISTANCE	FL_NUM	Weather	DAY_WEEK	DAY_OF_MONTH	delayed	ontime
count	145.000000	145.000000	145.000000	145.000000	145.000000	145.000000	145.000000	145.000000	145.000000
mean	1291.551724	1309.441379	172.103448	3333.344828	0.006897	4.179310	15.710345	0.255172	0.744828
std	344.016067	369.794479	6.097272	1380.654582	0.083045	1.913653	8.892035	0.437469	0.437469
min	700.000000	653.000000	169.000000	2229.000000	0.000000	1.000000	1.000000	0.000000	0.000000
25%	1030.000000	1030.000000	169.000000	2403.000000	0.000000	3.000000	8.000000	0.000000	0.000000
50%	1455.000000	1452.000000	169.000000	2703.000000	0.000000	4.000000	16.000000	0.000000	1.000000
75%	1455.000000	1527.000000	169.000000	3372.000000	0.000000	6.000000	23.000000	1.000000	1.000000
max	1720.000000	2030.000000	184.000000	5935.000000	1.000000	7.000000	31.000000	1.000000	1.000000

In [125]:
```
print('The Mean of delayed flights from BWI to New York airports is: ', str(round(delays_df.delayed.mean(),2)*100) + '%')

print('The number of missing values: ', delays_df.isnull().sum())
```

```
The Mean of delayed flights from BWI to New York airports is:  26.0%
The number of missing values:  CRS_DEP_TIME     0
CARRIER          0
DEP_TIME         0
DEST             0
DISTANCE         0
FL_DATE          0
FL_NUM           0
ORIGIN           0
Weather          0
DAY_WEEK         0
DAY_OF_MONTH     0
TAIL_NUM         0
Flight_Status    0
delayed          0
ontime           0
dtype: int64
```

In [126]:
```
delays_df.groupby(['DEST', 'CARRIER'])['delayed'].mean()
# We can see that RU flies ontly to Newark and OH flies only to JFK.
# We can see that RU has a bigger average delay rate.
```

Out[126]:
```
DEST  CARRIER
EWR   RU         0.286957
JFK   OH         0.133333
Name: delayed, dtype: float64
```

Naives Bayes Classifier

In [139]:
```
delays_df.DAY_WEEK = delays_df.DAY_WEEK.astype('category')
```

In [140]:
```
#Split the data into training (60%) and testing (40%)
predictors = ['DAY_WEEK', 'CRS_DEP_TIME', 'DEST', 'CARRIER']
outcome = 'Flight_Status'
```

In [141]:
```
X = pd.get_dummies(delays_df[predictors])
y = delays_df['Flight_Status']
classes = ['ontime', 'delayed']
```

In [147]:
```
X.head(5)
```

Out[147]:

	CRS_DEP_TIME	DAY_WEEK_1	DAY_WEEK_2	DAY_WEEK_3	DAY_WEEK_4	DAY_WEEK_5	DAY_WEEK_6	DAY_WEEK_7	DEST_EWR	DEST_JFK	CARRI
0	1455	0	0	0	1	0	0	0	0	1	
32	1455	0	0	0	1	0	0	0	1	0	
33	1720	0	0	0	1	0	0	0	1	0	
34	1030	0	0	0	1	0	0	0	1	0	
35	700	0	0	0	1	0	0	0	1	0	

In [143]:
```
# split into training and validation
X_train, X_valid, y_train, y_valid = train_test_split(X, y, test_size=0.40, random_state=1)
```

In [144]:
```
# run naive Bayes
delays_nb = MultinomialNB(alpha=1)
delays_nb.fit(X_train, y_train)
```

Out[144]:
```
MultinomialNB(alpha=1)
```

In [145]:
```
# predict probabilities (Shows the belonging probabilities of each record to which class)
predProb_train = delays_nb.predict_proba(X_train)
predProb_valid = delays_nb.predict_proba(X_valid)
```

In [146]:
```
# predict class membership (shows the class instead of probability by selecting the class with
# highest probability)
y_train_pred = delays_nb.predict(X_train)
y_valid_pred = delays_nb.predict(X_valid)
```

In [218]:
```
# Use the model to predict a new data
df = pd.concat([pd.DataFrame({'actual': y_valid, 'predicted': y_valid_pred})], axis=1)
mask = ((X_valid.CARRIER_OH == 1) & (X_valid.DAY_WEEK_1 == 1))
```

In [219]:
```
print(df[mask])
```

```
       actual predicted
759    ontime    ontime
226   delayed    ontime
1800   ontime    ontime
```

In [220]:
```
# Use the model to predict a new data
df = pd.concat([pd.DataFrame({'actual': y_valid, 'predicted': y_valid_pred})], axis=1)
mask2 = ((X_valid.CARRIER_RU == 1) & (X_valid.DAY_WEEK_1 == 1))
```

In [221]:
```
print(df[mask2])
```

```
      actual predicted
818   ontime   delayed
1323  ontime   delayed
1848  ontime   delayed
1324  ontime   delayed
```

In [222]:
```
# According to the predictions, the OH carrier flight on Mondays towards JFK is predicted to be ontime. On the other hand
# the RU carrier flight on Mondays to EWR is predicted to by delayed.
# Therefore, on a Monday it would be better to use the OH carrier towards JFK, instead of the RU carrier that
# that flies to EWR.
# It's important to notice that it's strange to see that RU carrier to EWR is predicted to be delayed when all 4 flights
# were actually ontime. This happens because in the training models, most of the flights covering this route by this airline
# were actually delayed. We can observe this in the steps below.
```

In [223]:
```
# Understainding the training data to explain the strange results from the above ahead. To do this we will run the training da
# instead of the valid data.
df = pd.concat([pd.DataFrame({'actual': y_train, 'predicted': y_train_pred})], axis=1)
mask3 = ((X_train.CARRIER_RU == 1) & (X_train.DAY_WEEK_1 == 1))
```

In [217]:
```
print(df[mask3])
```

```
       actual predicted
820    ontime   delayed
1847  delayed   delayed
819   delayed   delayed
1321   ontime   delayed
283   delayed   delayed
1322   ontime   delayed
821    ontime   delayed
284   delayed   delayed
282   delayed   delayed
```

K-NN

In [ ]:
```
nalyse the flights from BWI to JFK and EWR through the carriers OH and RU on Monday. firstly we look for the flight OH on monda
```

In [18]:
```
import pandas as pd
from sklearn import preprocessing
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score
from sklearn.neighbors import NearestNeighbors,KNeighborsClassifier
import matplotlib.pylab as plt
```

In [19]:
```
delays_df = pd.read_excel("Flightdelays_1.xlsx")
```

In [20]:
```
# Adding index and presenting the first 16 data records.
delays_df['Number'] = delays_df.index + 1
delays_df.head(16)
```

Out[20]:

	CARRIER	DEP_TIME	DAY_WEEK	DAY_OF_MONTH	Flight Status	Number
0	OH	1610	1	5	delayed	1
1	RU	744	1	5	delayed	2
2	RU	1527	1	5	delayed	3
3	RU	1221	1	5	delayed	4
4	OH	1450	1	12	ontime	5
5	RU	656	1	12	ontime	6
6	RU	1509	1	12	delayed	7
7	RU	1720	1	12	ontime	8
8	RU	1040	1	12	ontime	9
9	OH	1455	1	19	ontime	10
10	RU	1710	1	19	ontime	11
11	RU	1028	1	19	ontime	12
12	RU	654	1	19	ontime	13
13	RU	1451	1	19	ontime	14
14	OH	1500	1	26	ontime	15
15	RU	1737	1	26	delayed	16

In [5]:
```
# Rename the column DAY_WEEK to DAY_OF_WEEK for better understanding of the variable.
delays_df.rename(columns = {'DAY_WEEK':'DAY_OF_WEEK'}, inplace = True)
```

In [6]:
```
delays_df = pd.get_dummies(delays_df, columns=['CARRIER'])
```

In [7]:
```
delays_df
```

Out[7]:

	DEP_TIME	DAY_OF_WEEK	DAY_OF_MONTH	Flight Status	Number	CARRIER_OH	CARRIER_RU
0	1610	1	5	delayed	1	1	0
1	744	1	5	delayed	2	0	1
2	1527	1	5	delayed	3	0	1
3	1221	1	5	delayed	4	0	1
4	1450	1	12	ontime	5	1	0
5	656	1	12	ontime	6	0	1
6	1509	1	12	delayed	7	0	1
7	1720	1	12	ontime	8	0	1
8	1040	1	12	ontime	9	0	1
9	1455	1	19	ontime	10	1	0
10	1710	1	19	ontime	11	0	1
11	1028	1	19	ontime	12	0	1
12	654	1	19	ontime	13	0	1
13	1451	1	19	ontime	14	0	1
14	1500	1	26	ontime	15	1	0
15	1737	1	26	delayed	16	0	1
16	1504	1	26	ontime	17	0	1

In [8]:
```
#Splitting the data into training (60%) and validation(40%) sets.
trainData, validData = train_test_split(delays_df,test_size=0.4, random_state=24)
print(trainData.shape, validData.shape)
```

```
(10, 7) (7, 7)
```

In [31]:
```
#Considering a new flight of OH on Monday departing from BWI to JFK on 10th at 1540 hours.
newflight = pd.DataFrame([{'CARRIER_OH':1, 'DEP_TIME': 1540, 'DAY_OF_WEEK':1, 'DAY_OF_MONTH':10}])
newflight
```

Out[31]:

	CARRIER_OH	DEP_TIME	DAY_OF_WEEK	DAY_OF_MONTH
0	1	1540	1	10

In [32]:
```
scaler = preprocessing.StandardScaler()
scaler.fit(trainData[['CARRIER_OH','DEP_TIME', 'DAY_OF_WEEK','DAY_OF_MONTH']])
```

Out[32]:
```
StandardScaler()
```

In [33]:
```
#Transforming the entire dataset by normalizing.
delaysNorm = pd.concat([pd.DataFrame(scaler.transform(delays_df[['CARRIER_OH','DEP_TIME', 'DAY_OF_WEEK','DAY_OF_MONTH']]),colu
trainNorm = delaysNorm.iloc[trainData.index]
validNorm = delaysNorm.iloc[validData.index]
newflightNorm = pd.DataFrame(scaler.transform(newflight), columns=['ZCARRIER_OH','ZDEP_TIME','ZDAY_OF_WEEK','ZDAY_OF_MONTH'])
```

In [34]:
```
# Use k nearest neighbor against the normalized training data with K=3
knn = NearestNeighbors(n_neighbors=3)
knn.fit(trainNorm[['ZCARRIER_OH','ZDEP_TIME', 'ZDAY_OF_WEEK','ZDAY_OF_MONTH']])
distances, indices = knn.kneighbors(newflightNorm)
print(trainNorm.iloc[indices[0], :])
```

```
   ZCARRIER_OH  ZDEP_TIME  ZDAY_OF_WEEK  ZDAY_OF_MONTH Flight Status  Number
4     1.527525   0.473808           0.0       0.000000        ontime       5
0     1.527525   0.936060           0.0      -1.118034       delayed       1
9     1.527525   0.488253           0.0       1.118034        ontime      10
```

In [35]:
```
train_X = trainNorm[['ZCARRIER_OH','ZDEP_TIME', 'ZDAY_OF_WEEK','ZDAY_OF_MONTH']]
train_y = trainNorm['Flight Status']
valid_X = validNorm[['ZCARRIER_OH','ZDEP_TIME', 'ZDAY_OF_WEEK','ZDAY_OF_MONTH']]
valid_y = validNorm['Flight Status']
```

In [36]:
```
# Train the classifier for different values of k
results = []
for k in range(1, 11):
    knn = KNeighborsClassifier(n_neighbors=k).fit(train_X, train_y)
    results.append({'k': k,'accuracy': accuracy_score(valid_y, knn.predict(valid_X))
                    })
results = pd.DataFrame(results)
print(results)
```

```
    k  accuracy
0   1  0.714286
1   2  0.571429
2   3  0.571429
3   4  0.571429
4   5  0.714286
5   6  0.428571
6   7  0.714286
7   8  0.714286
8   9  0.714286
9  10  0.714286
```

```
C:\Users\anjan\anaconda3\lib\site-packages\sklearn\neighbors\_classification.py:228: FutureWarning: Unlike other reduction fu
nctions (e.g. `skew`, `kurtosis`), the default behavior of `mode` typically preserves the axis it acts along. In SciPy 1.11.
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will be eliminated, and the value None will no longer be accepted. Set `keepdims` to True or False to avoid this warning.
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will be eliminated, and the value None will no longer be accepted. Set `keepdims` to True or False to avoid this warning.
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C:\Users\anjan\anaconda3\lib\site-packages\sklearn\neighbors\_classification.py:228: FutureWarning: Unlike other reduction fu
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C:\Users\anjan\anaconda3\lib\site-packages\sklearn\neighbors\_classification.py:228: FutureWarning: Unlike other reduction fu
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0, this behavior will change: the default value of `keepdims` will become False, the `axis` over which the statistic is taken
will be eliminated, and the value None will no longer be accepted. Set `keepdims` to True or False to avoid this warning.
  mode, _ = stats.mode(_y[neigh_ind, k], axis=1)
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0, this behavior will change: the default value of `keepdims` will become False, the `axis` over which the statistic is taken
will be eliminated, and the value None will no longer be accepted. Set `keepdims` to True or False to avoid this warning.
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C:\Users\anjan\anaconda3\lib\site-packages\sklearn\neighbors\_classification.py:228: FutureWarning: Unlike other reduction fu
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0, this behavior will change: the default value of `keepdims` will become False, the `axis` over which the statistic is taken
will be eliminated, and the value None will no longer be accepted. Set `keepdims` to True or False to avoid this warning.
  mode, _ = stats.mode(_y[neigh_ind, k], axis=1)
C:\Users\anjan\anaconda3\lib\site-packages\sklearn\neighbors\_classification.py:228: FutureWarning: Unlike other reduction fu
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0, this behavior will change: the default value of `keepdims` will become False, the `axis` over which the statistic is taken
```

```
will be eliminated, and the value None will no longer be accepted. Set `keepdims` to True or False to avoid this warning.
  mode, _ = stats.mode(_y[neigh_ind, k], axis=1)
```

In [37]:
```
# Retrain with full dataset
delays_X = delaysNorm[['ZCARRIER_OH','ZDEP_TIME', 'ZDAY_OF_WEEK','ZDAY_OF_MONTH']]
delays_y = delaysNorm['Flight Status']
knn = KNeighborsClassifier(n_neighbors=5).fit(delays_X, delays_y)
distances, indices = knn.kneighbors(newflightNorm)
print(knn.predict(newflightNorm))
print('Distances',distances)
print('Indices', indices)
print(delaysNorm.iloc[indices[0], :])
```

```
['ontime']
Distances [[0.41188523 0.82380468 1.45829755 2.20725322 2.26591705]]
Indices [[4 0 9 6 7]]
   ZCARRIER_OH  ZDEP_TIME  ZDAY_OF_WEEK  ZDAY_OF_MONTH Flight Status  Number
4     1.527525   0.473808           0.0       0.000000        ontime       5
0     1.527525   0.936060           0.0      -1.118034       delayed       1
9     1.527525   0.488253           0.0       1.118034        ontime      10
6    -0.654654   0.644263           0.0       0.000000       delayed       7
7    -0.654654   1.253858           0.0       0.000000        ontime       8

C:\Users\anjan\anaconda3\lib\site-packages\sklearn\neighbors\_classification.py:228: FutureWarning: Unlike other reduction fu
nctions (e.g. `skew`, `kurtosis`), the default behavior of `mode` typically preserves the axis it acts along. In SciPy 1.11.
0, this behavior will change: the default value of `keepdims` will become False, the `axis` over which the statistic is taken
will be eliminated, and the value None will no longer be accepted. Set `keepdims` to True or False to avoid this warning.
  mode, _ = stats.mode(_y[neigh_ind, k], axis=1)
```

In [9]:
```
# Now we take the RU carrier and predicting whether it will be ontime or delayed on the same day and same time.
newflight = pd.DataFrame([{'CARRIER_RU':1, 'DEP_TIME': 1540, 'DAY_OF_WEEK':1, 'DAY_OF_MONTH':10}])
newflight
```

Out[9]:

	CARRIER_RU	DEP_TIME	DAY_OF_WEEK	DAY_OF_MONTH
0	1	1540	1	10

In [10]:
```
scaler = preprocessing.StandardScaler()
scaler.fit(trainData[['CARRIER_RU','DEP_TIME', 'DAY_OF_WEEK','DAY_OF_MONTH']])
```

Out[10]:
```
StandardScaler()
```

In [11]:
```
#Transform the full dataset by normalizing.
delaysNorm = pd.concat([pd.DataFrame(scaler.transform(delays_df[['CARRIER_RU','DEP_TIME', 'DAY_OF_WEEK','DAY_OF_MONTH']]),colu
trainNorm = delaysNorm.iloc[trainData.index]
validNorm = delaysNorm.iloc[validData.index]
newflightNorm = pd.DataFrame(scaler.transform(newflight), columns=['ZCARRIER_RU','ZDEP_TIME','ZDAY_OF_WEEK','ZDAY_OF_MONTH'])
```

In [12]:
```
##Use k nearest neighbor against the normalized training data with K=3
knn = NearestNeighbors(n_neighbors=3)
knn.fit(trainNorm[['ZCARRIER_RU','ZDEP_TIME', 'ZDAY_OF_WEEK','ZDAY_OF_MONTH']])
distances, indices = knn.kneighbors(newflightNorm)
print(trainNorm.iloc[indices[0], :])
```

	ZCARRIER_RU	ZDEP_TIME	ZDAY_OF_WEEK	ZDAY_OF_MONTH	Flight Status	Number
7	0.654654	1.253858	0.0	0.000000	ontime	8
2	0.654654	0.696267	0.0	-1.118034	delayed	3
3	0.654654	-0.187790	0.0	-1.118034	delayed	4

In [13]:
```
train_X = trainNorm[['ZCARRIER_RU','ZDEP_TIME', 'ZDAY_OF_WEEK','ZDAY_OF_MONTH']]
train_y = trainNorm['Flight Status']
valid_X = validNorm[['ZCARRIER_RU','ZDEP_TIME', 'ZDAY_OF_WEEK','ZDAY_OF_MONTH']]
valid_y = validNorm['Flight Status']
```

In [14]:
```
# Train the classifier for different values of k
results = []
for k in range(1, 11):
    knn = KNeighborsClassifier(n_neighbors=k).fit(train_X, train_y)
    results.append({'k': k,'accuracy': accuracy_score(valid_y, knn.predict(valid_X))
                    })
results = pd.DataFrame(results)
print(results)
```

```
    k  accuracy
0   1  0.714286
1   2  0.571429
2   3  0.571429
3   4  0.571429
4   5  0.714286
5   6  0.428571
6   7  0.714286
7   8  0.714286
8   9  0.714286
9  10  0.714286
```

```
C:\Users\anjan\anaconda3\lib\site-packages\sklearn\neighbors\_classification.py:228: FutureWarning: Unlike other reduction fu
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0, this behavior will change: the default value of `keepdims` will become False, the `axis` over which the statistic is taken
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  mode, _ = stats.mode(_y[neigh_ind, k], axis=1)
C:\Users\anjan\anaconda3\lib\site-packages\sklearn\neighbors\_classification.py:228: FutureWarning: Unlike other reduction fu
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0, this behavior will change: the default value of `keepdims` will become False, the `axis` over which the statistic is taken
will be eliminated, and the value None will no longer be accepted. Set `keepdims` to True or False to avoid this warning.
  mode, _ = stats.mode(_y[neigh_ind, k], axis=1)
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C:\Users\anjan\anaconda3\lib\site-packages\sklearn\neighbors\_classification.py:228: FutureWarning: Unlike other reduction fu
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will be eliminated, and the value None will no longer be accepted. Set `keepdims` to True or False to avoid this warning.
  mode, _ = stats.mode(_y[neigh_ind, k], axis=1)
C:\Users\anjan\anaconda3\lib\site-packages\sklearn\neighbors\_classification.py:228: FutureWarning: Unlike other reduction fu
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0, this behavior will change: the default value of `keepdims` will become False, the `axis` over which the statistic is taken
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0, this behavior will change: the default value of `keepdims` will become False, the `axis` over which the statistic is taken
```

```
will be eliminated, and the value None will no longer be accepted. Set `keepdims` to True or False to avoid this warning.
  mode, _ = stats.mode(_y[neigh_ind, k], axis=1)
```

In [15]:
```
# Retrain with full dataset
delays_X = delaysNorm[['ZCARRIER_RU','ZDEP_TIME', 'ZDAY_OF_WEEK','ZDAY_OF_MONTH']]
delays_y = delaysNorm['Flight Status']
knn = KNeighborsClassifier(n_neighbors=5).fit(delays_X, delays_y)
distances, indices = knn.kneighbors(newflightNorm)
print(knn.predict(newflightNorm))
print('Distances',distances)
print('Indices', indices)
print(delaysNorm.iloc[indices[0], :])
```

```
['delayed']
Distances [[0.33175599 0.61030756 0.79947839 1.21947862 1.46028802]]
Indices [[ 6  7  2  3 13]]
    ZCARRIER_RU  ZDEP_TIME  ZDAY_OF_WEEK  ZDAY_OF_MONTH Flight Status  Number
6      0.654654   0.644263           0.0       0.000000       delayed       7
7      0.654654   1.253858           0.0       0.000000        ontime       8
2      0.654654   0.696267           0.0      -1.118034       delayed       3
3      0.654654  -0.187790           0.0      -1.118034       delayed       4
13     0.654654   0.476697           0.0       1.118034        ontime      14

C:\Users\anjan\anaconda3\lib\site-packages\sklearn\neighbors\_classification.py:228: FutureWarning: Unlike other reduction fu
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0, this behavior will change: the default value of `keepdims` will become False, the `axis` over which the statistic is taken
will be eliminated, and the value None will no longer be accepted. Set `keepdims` to True or False to avoid this warning.
  mode, _ = stats.mode(_y[neigh_ind, k], axis=1)
```

In [ ]:
```
#Now we can conclude from KNN that it is better to take OH carrier from BWI TO JFK as it predicted to be ontime
#while the RU carrier from BWI to EWR is predicted to be delayed on monday day 10 at 1540 hours.
```