DELAY ESTIMATION AND SHORTEST FLIGHT PATH ANALYSIS

CME 4416 INTRODUCTION TO DATA MINING

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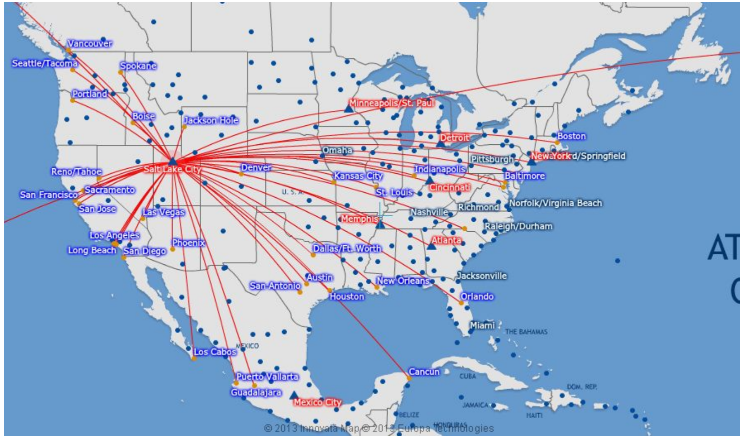
CONTENTS

INTRODUCTION

- Flight information between US cities in October 2014 is used.
- The estimation of delays that may occur in flights was made using many features.
- The shortest flight between the two cities was tried to be found.



LIBRARIES

- Networkx
- Pandas
- Numpy
- Scikit-Learn
- Matplotlib

DATASET

Dataset Name: International Air Transportation Performance

Dataset Source: Kaggle

```
RangeIndex: 49101 entries, 0 to 49100
Data columns (total 50 columns):
 #   Column                 Non-Null Count  Dtype  
---  ------                 --------------  -----  
 0   Year                   49101 non-null  int64  
 1   Quarter                49101 non-null  int64  
 2   Month                  49101 non-null  int64  
 3   DayofMonth             49101 non-null  int64  
 4   DayOfWeek              49101 non-null  int64  
 5   FlightDate             49101 non-null  object 
 6   UniqueCarrier          49101 non-null  object 
 7   TailNum                49042 non-null  object 
 8   FlightNum              49101 non-null  int64  
 9   Origin                 49101 non-null  object 
 10  OriginCityName         49101 non-null  object 
 11  OriginState            49101 non-null  object 
 12  OriginStateFips        49101 non-null  int64  
 13  OriginStateName        49101 non-null  object 
 14  Dest                   49101 non-null  object 
 15  DestCityName           49101 non-null  object 
 16  DestState              49101 non-null  object 
 17  DestStateFips          49101 non-null  int64  
 18  DestStateName          49101 non-null  object 
 19  CRSDepTime             49101 non-null  int64  
 20  DepTime                48599 non-null  float64
 21  DepDelay               48599 non-null  float64
 22  DepDelayMinutes        48599 non-null  float64
 23  DepDel15               48599 non-null  float64
 24  DepartureDelayGroups   48599 non-null  float64
 25  DepTimeBlk             49101 non-null  object 
 26  TaxiOut                48583 non-null  float64
 27  WheelsOff              48583 non-null  float64
 28  WheelsOn               48567 non-null  float64
 29  TaxiIn                 48567 non-null  float64
 30  CRSArrTime             49101 non-null  int64  
 31  ArrTime                48567 non-null  float64
 32  ArrDelay               48495 non-null  float64
 33  ArrDelayMinutes        48495 non-null  float64
 34  ArrDel15               48495 non-null  float64
 35  ArrivalDelayGroups     48495 non-null  float64
 36  ArrTimeBlk             49101 non-null  object 
 37  Cancelled              49101 non-null  int64  
 38  CancellationCode       522 non-null    object 
 39  Diverted               49101 non-null  int64  
 40  CRSElapsedTime         49101 non-null  int64  
 41  Distan                 48495 non-null  float64
 42  AirTime                48495 non-null  float64
 43  Distance               49101 non-null  int64  
 44  DistanceGroup          49101 non-null  int64  
 45  CarrierDelay           9124 non-null   float64
 46  WeatherDelay           9124 non-null   float64
 47  NASDelay               9124 non-null   float64
 48  SecurityDelay          9124 non-null   float64
 49  LateAircraftDelay      9124 non-null   float64
```

PREPROCESSING

- Dropped Columns
- Delay Classification
- Flight Range Calculations
- KNN Imputer for NaN values
- Converted Data Types
- Generated New Columns
- Outlier Detection

CONVERTED DATA TYPES

- The dataset had data types of object, float, and integer. All of them have been converted to numerical form in order to be included in the model. All our features have been converted to integer type.

- Thus, memory usage is also saved.

DROPPED COLUMNS

- The dataset had 50 features
- Some were dropped because they increased the correlation, didn't work at all, and some were dropped because they were combined to create new meaningful columns.

GENERATED NEW COLUMNS

- The class attribute was obtained by summing the ArrDel15 and DepDel15 columns. The newly created column was named Del15.
- “OriginCityName”, “DestCityName”, “OriginStateName” and “DestStateName” have been converted to numeric. However, when converted to numeric, the numbers in the two columns did not represent the same city or state. This was done in alphabetical order.
- After sorting, new features with numerical values were created. Also, while there were 293 origin cities, there were 292 destination cities.
- This prevented the creation of meaningful rankings.

KNN IMPUTER FOR NAN VALUES

- The number of null values in the data set was quite low (3% or 4%).
- We decided that KNN is the best approach to fill in nulls. We did not want to delete this data directly and filled the blanks with KNN.
- In the KNN approach, we determined the number of neighbors as 4.

DELAY CLASSIFICATION

- Delays may occur in the departure and arrival times of a plane. We classified delays by 15 minutes so that customers are less affected by these delays.

FLIGHT RANGE CALCULATIONS

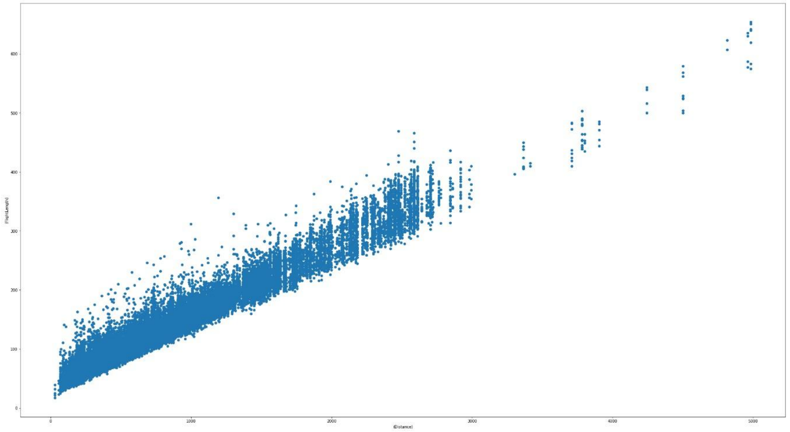
Air Time: Arrival time of the plane from one point to another point
Taxi In & Taxi Out: The time passengers spend on and off the plane

Air Time + Taxi In + Taxi Out= Flight Length

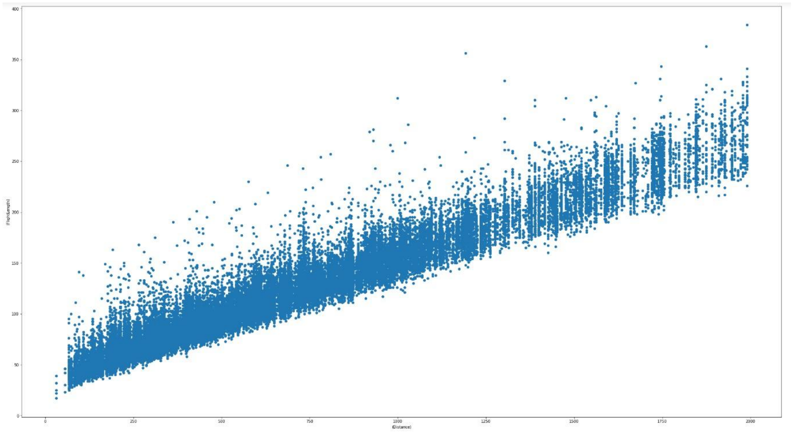
We combined flight information, which is an important detail for a customer, in a single column, resulting in a more understandable result.

DETECTED OUTLIERS

BEFORE

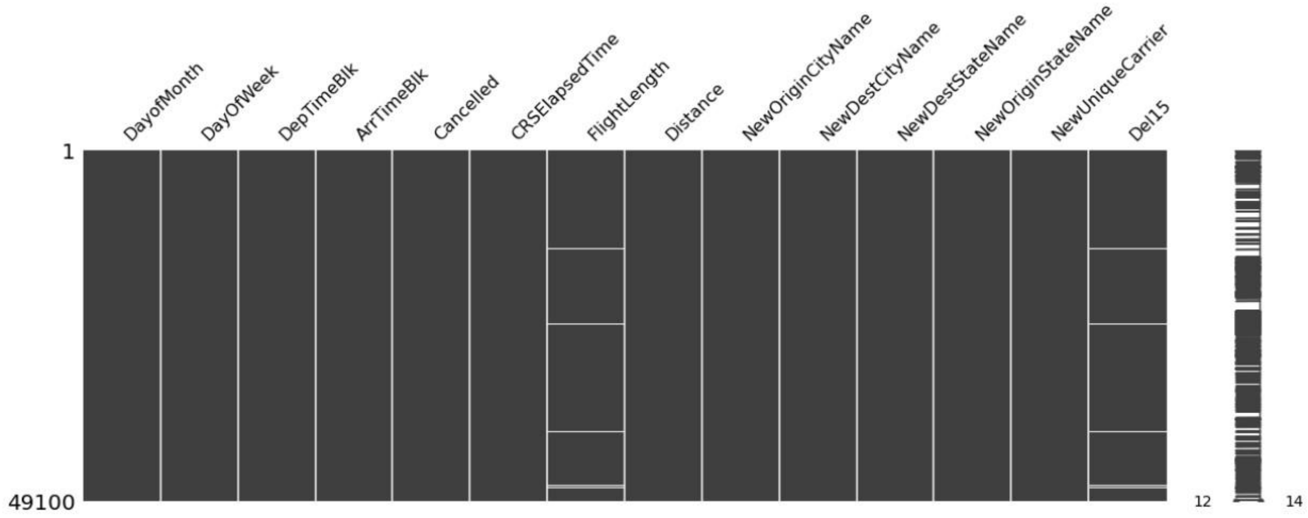


AFTER

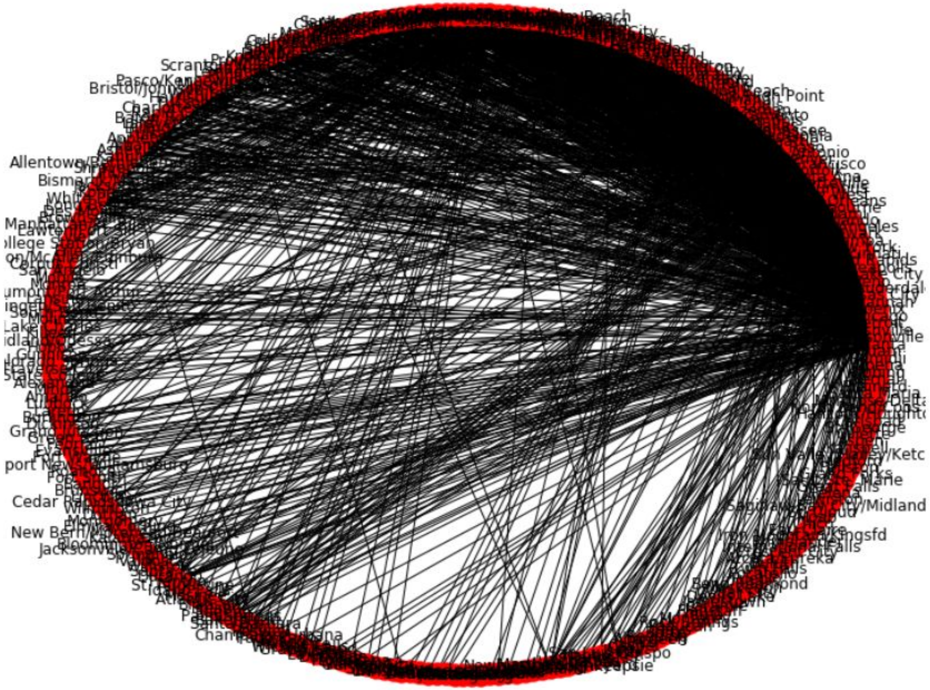


- NaN Values for Mining Dataset

<AxesSubplot:>



Roads between cities with no distance



Datasets after Preprocessing

- Dataset of the Data Mining Side

```
Data columns (total 14 columns):
 #   Column              Non-Null Count  Dtype
---  ------              --------------  -----
 0   DayofMonth          46130 non-null  int32
 1   DayOfWeek           46130 non-null  int32
 2   DepTimeBlk          46130 non-null  int32
 3   ArrTimeBlk          46130 non-null  int32
 4   Cancelled           46130 non-null  int32
 5   CRSElapsedTime      46130 non-null  int32
 6   FlightLength        46130 non-null  int32
 7   Distance            46130 non-null  int32
 8   NewOriginCityName   46130 non-null  int32
 9   NewDestCityName     46130 non-null  int32
 10  NewDestStateName    46130 non-null  int32
 11  NewOriginStateName  46130 non-null  int32
 12  NewUniqueCarrier    46130 non-null  int32
 13  Del15               46130 non-null  int32
dtypes: int32(14)
memory usage: 2.8 MB
```

DATA MINING ALGORITHMS

- **Support Vector Machine**
- **Logistic Regression**
- **k - Nearest Neighbours**

DATA MINING ALGORITHMS

(SUPPORT VECTOR MACHINE)

```python
cv = KFold(n_splits=10, random_state=1, shuffle=True)
# create model
model = svm.SVC(kernel='poly', C=100.0)
# evaluate model
scores = cross_val_score(model, X, y, scoring='accuracy', cv=cv, n_jobs=-1)
# report performance
print('Accuracy: %.3f (%.3f)' % (np.mean(scores), np.std(scores)))
```

```
Accuracy: 0.899 (0.004)
```

	precision	recall	f1-score	support
0	0.89	1.00	0.94	3639
1	1.00	0.54	0.70	974
accuracy			0.90	4613
macro avg	0.95	0.77	0.82	4613
weighted avg	0.91	0.90	0.89	4613

DATA MINING ALGORITHMS

(LOGISTIC REGRESSION)

```
cv = KFold(n_splits=10, random_state=1, shuffle=True)
# create model
model = LogisticRegression()
# evaluate model
scores = cross_val_score(model, X, y, scoring='accuracy', cv=cv, n_jobs=-1)
# report performance
print('Accuracy: %.3f (%.3f)' % (np.mean(scores), np.std(scores)))
```

```
Accuracy: 0.865 (0.014)
```

	precision	recall	f1-score	support
0	0.87	0.94	0.90	3639
1	0.69	0.46	0.55	974
accuracy			0.84	4613
macro avg	0.78	0.70	0.73	4613
weighted avg	0.83	0.84	0.83	4613

DATA MINING ALGORITHMS

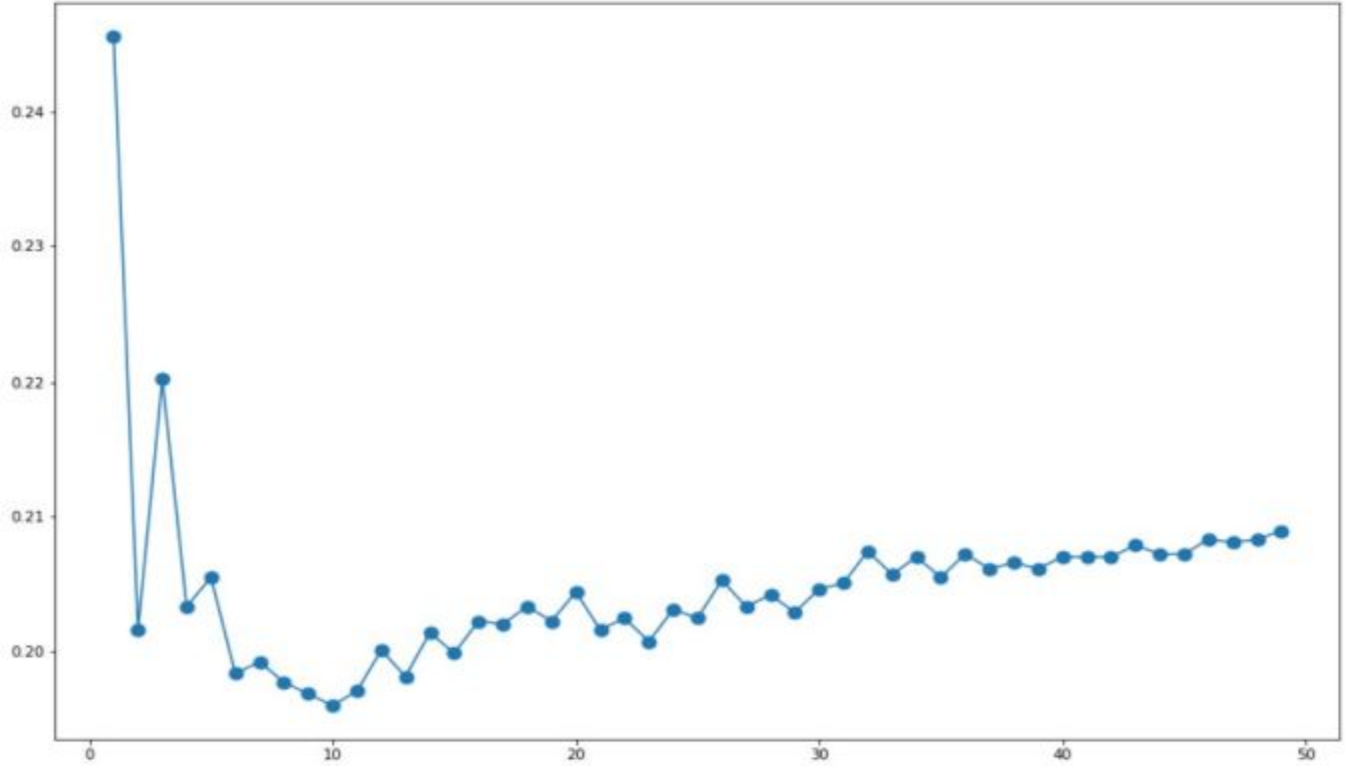
(K - NEAREST NEIGHBOURS)

```
cv = KFold(n_splits=10, random_state=1, shuffle=True)
# create model
model = KNeighborsClassifier(n_neighbors = 10)
# evaluate model
scores = cross_val_score(model, X, y, scoring='accuracy', cv=cv, n_jobs=-1)
# report performance
print('Accuracy: %.3f (%.3f)' % (np.mean(scores), np.std(scores)))
```

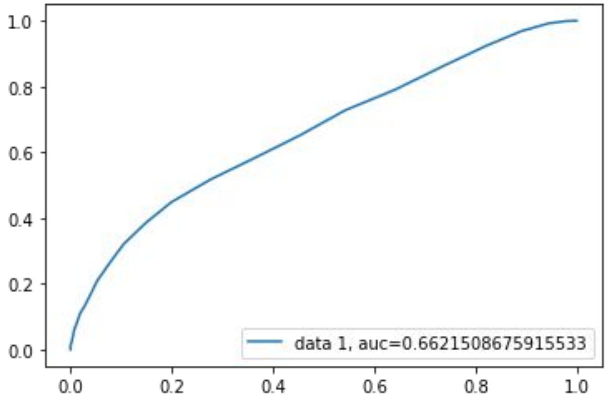
```
Accuracy: 0.798 (0.006)
```

	precision	recall	f1-score	support
0	0.82	0.95	0.88	3639
1	0.54	0.24	0.33	974
accuracy			0.80	4613
macro avg	0.68	0.59	0.60	4613
weighted avg	0.76	0.80	0.76	4613

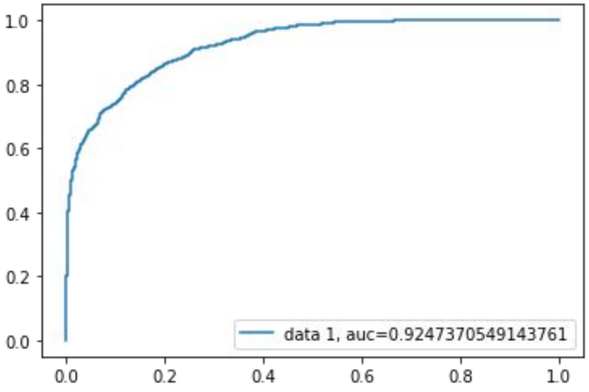
Finding Best Fit K Value



ROC CURVES



KNeighbors



LogReg

THANKS FOR LISTENING!