Exploring the data

I wrote a python script to look at the data and clean if necessary. Here are the priliminary check results.

```
Index(['year', ' month', 'carrier', 'carrier_name', 'airport', 'airport_name',
       'arr_flights', 'arr_del15', 'carrier_ct', ' weather_ct', 'nas_ct',
       'security_ct', 'late_aircraft_ct', 'arr_cancelled', 'arr_diverted',
       ' arr_delay', ' carrier_delay', 'weather_delay', 'nas_delay',
       'security_delay', 'late_aircraft_delay', 'Unnamed: 21'],
      dtype='object')
year                : 175915
 month              : 175915
carrier             : 175915
carrier_name        : 175915
airport             : 175915
airport_name        : 175915
arr_flights         : 175663
arr_del15           : 175460
carrier_ct          : 175663
 weather_ct         : 175663
nas_ct              : 175663
security_ct         : 175663
late_aircraft_ct    : 175663
arr_cancelled       : 175663
arr_diverted        : 175663
 arr_delay          : 175663
 carrier_delay      : 175663
weather_delay       : 175663
nas_delay           : 175663
security_delay      : 175663
late_aircraft_delay : 175663
Unnamed: 21         :      0
```

As seen above there were over 200 rows with missing values. For this project, I dropped those rows as it was not significant in the analysis that I was working on. There were over 175663 valid data rows for an effective analysis.

Evaluating the dataset

I used carrier_ct as the prediction factor. I created a new variable to evaluate if there was a carrier delay (1) or not (0) based on the values of carriert_ct. If carrier_cnt was not null and a valid value greater than 0, the carrier delay variable was set to 1 else 0. The numeric variables of interest were arr_del15 (delay over 15 minutes as reported to RITA), weather_ct (delays caused by extreme weather conditions), nas_ct (delays caused by NAS directives), security_ct (delays caused by security issues), late_aircraft_ct (delays caused by the airline carrier)
A simple decision tree classifier is used to train and test the data. Based on the output below we can say the most important feature to determine flight delays is the variable arr_del15. Another variable tht affects flight delay are nas_ct and late_aircraft_ct. Weather and Security do not play a significant part in the delay times. Thus we can conclude that our analysis is on the right track to determine trends with airports and airlines to determine the pain points for a particular carrier. At some airports our selected carrier experienced considerable delays. We will focus our visulaizations on this aspect. If we can pinpoint the delay times and location, we might be able to do further research to eliminate the delays for the airline.

```
training time for all data: 0.425 s
Decision Tree Accuracy on All the data:  1.0
training time: 0.184 s
prediction time: 0.008 s
no. positive predictions:  82060
F1 Score:  0.996
Precision score:  0.996
Recall score:  0.996
Decision Tree Classifier Accuracy:  0.992
output: [0, 1, 2, 3, 4]
importance: of  arr_del15  is  0.716
importance: of   weather_ct  is  0.053
importance: of  nas_ct  is  0.12
importance: of  security_ct  is  0.004
importance: of  late_aircraft_ct  is  0.107
```

PCA Fit

Using the PCA Fit we come to the similar conclusion. Weather and Security are not the leading causes for flght delays. The features we have used are the same as above. The numeric variables of interest were arr_del15 (delay over 15 minutes as reported to RITA), weather_ct (delays caused by extreme weather conditions), nas_ct (delays caused by NAS directives), security_ct (delays caused by security issues), late_aircraft_ct (delays

caused by the airline carrier)
PCA Fit confirms that the Decision Tree Classifier is the best fit for this data set.

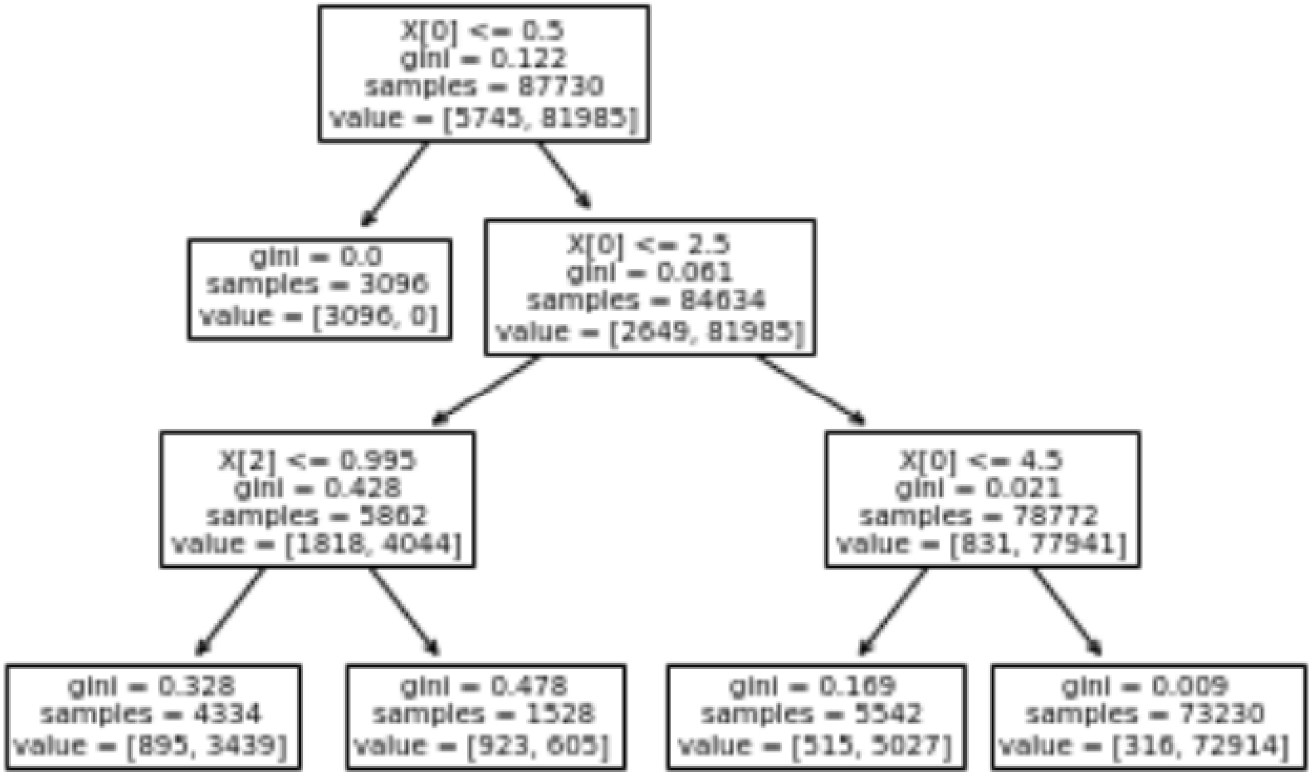
```
Prediction accuracy for the normal test dataset with PCA using the Decision Tree
Classifier
99.01%



Prediction accuracy for the standardized test dataset with PCA using the
Gaussian Naive Bayes Classifier
66.76%



PC 1 without scaling:
 [0.86776321 0.20001608 0.02510475 0.30166796 0.00134976 0.33962471]

PC 1 with scaling:
 [0.45851309 0.44154183 0.39242163 0.42110894 0.26603731 0.43897976]
Carrier Delay:  [0.93628354 0.91977291 0.92658247 ... 0.92730209 1.02254084
0.92235982]
slope: [-0.04989449  0.05111411  0.0497768   0.04979733  0.04961322  0.04960349]
intercept:  0.9199668519849167

##### stats on test dataset #######

r-squared score: 0.015727406648427977

##### stats on training dataset #######

r-squared score: 0.015813212459995896
```

Tuning Decision Tree Parameters

I adjusted the decision tree parameters, in the first run, I let the classifier traverse all the nodes till the tree was completed. In the second case, I limited the depth to 3 levels.

```
In [1]: runfile('C:/Users/maya_/datasets/D195/e
training time for all data: 0.514 s
Decision Tree Accuracy on All the data:  1.0
training time: 0.225 s
prediction time: 0.004 s
no. postive predictions:  82049
F1 Score:  0.996
Precision score:  0.996
Recall score:  0.996
Decision Tree Classifier Accuracy:  0.993
output: [0, 1, 2, 3, 4]
importance: of  arr_del15  is  0.715
importance: of   weather_ct  is  0.053
importance: of  nas_ct  is  0.121
importance: of  security_ct  is  0.004
importance: of  late_aircraft_ct  is  0.106


Figures now render in the Plots pane by default
Plots pane options menu.



In [2]: runfile('C:/Users/maya_/datasets/D195/c
Reloaded modules: readdata, classifyDT

In [3]: runfile('C:/Users/maya_/datasets/D195/e
training time for all data: 0.418 s
Decision Tree Accuracy on All the data:  1.0
training time: 0.079 s
prediction time: 0.006 s
no. postive predictions:  83198
F1 Score:  0.986
Precision score:  0.979
Recall score:  0.993
Decision Tree Classifier Accuracy:  0.973
output: [0, 2]
importance: of  arr_del15  is  0.949
importance: of  nas_ct  is  0.051
```

The tree visualization is given below



Changing the test size to 20% did not yield different results for the F1 score, precision or recall. I chose to leave it at 50%.

The two parameters I tuned were the `max_depth=10` and `min_samples_split=10`. I saw an improvement in the positive predictions with these values.

The features we have used in this project to analyse the flight delays have been verified as appropriate according to the statistics and algorithms seen above.