Big Data Analysis: Airline performance

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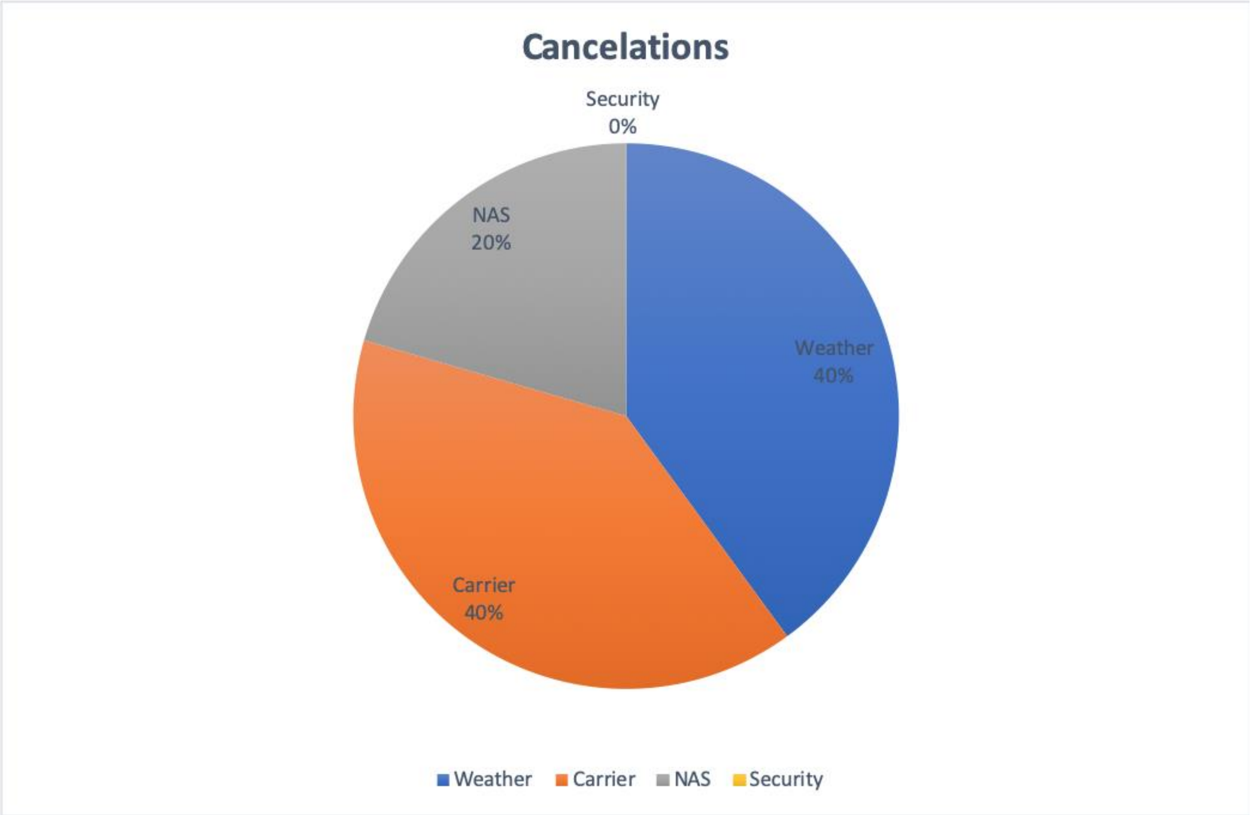
Dataset - Airline on-time performance

- 2008 data
- 7,009,728 flights
- American Statistical Association
  http://stat-computing.org/dataexpo/2009/

Databricks - Spark - Pyspark

What is the most common reason for Cancellation?



What are the routes (Origin, Dest) with more cancellations caused by the Carrier?

- Routes on the top 10:
  - HOU-DAL / DAL-HOU
  - SFO-LAX / LAX-SFO
  - LAS-PHX / PHX-LAS
  - LGA-ORD / ORD-LGA
  - OGG-HNL| / HNL-OGG
- Carriers listing the top 10 Routes:
  - WN (Southwest Airlines Co.)
  - UA (United Air Lines Inc.)
  - HA (Hawaiian Airlines Inc.)
  - US Airways Inc. (US)
  - AA (American Airlines Inc.)

What are the routes (Origin, Dest) with more cancellations caused by the Weather?

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- Cities listing the top 10 Routes:
  - Aspen, CO (Mountain location)
  - New York
  - Boston
  - Chicago

What are the routes (Origin, Dest) with more cancellations caused by the National Airspace System (NAS)?

- Airports listing the top 10 Routes:
  - La Guardia in New York
  - Chicago O'Hare International in Chicago

Carriers k-Means Cluster

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- Features:
  - Average Carrier Delay in minutes
  - Average Arrival Delay in minutes
  - Average Departure Delay in minutes
  - Number of Flights (Volume)
  - Percentage of Cancellation (when caused by the Carrier)

- Elbow Analysis => 6 clusters.

Cluster Centers

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```
#Cluster Centers:
#             [AvgCarrierDelay|  AvgArrDelay|   AvgDepDelay|   NumFlights|    PrgtCancellation]
# CLUSTER 0: [14.36              7.97            9.63         461,432.00            2.25%]
# CLUSTER 1: [20.97              2.32            2.95          79,122.50            0.79%]
# CLUSTER 2: [10.28              5.17           10.38       1,201,754.00            1.03%]
# CLUSTER 3: [19.05              9.86           11.04         250,221.00            2.15%]
# CLUSTER 4: [16.50              9.00            8.92         361,081.00            1.75%]
# CLUSTER 5: [16.62              9.60           10.36         586,022.00            2.53%]
```

- Cluster 2: Southwest
- Cluster 0: DELTA, UNITED AIRLINES
- Cluster 4: EXPRESSJET, nwa
- Cluster 5: SkyWest AIRLINES, American Airlines
- Cluster 3: jetBlue, Continental Airlines
- Cluster 1: FRONTIER AIRLINES, Aloha AIRLINES

Analysis of Airlines Dataset to find Insights for Data Driven Decision

To Predict Cancellations

- Descriptive analysis of Cancellation of Flights
    - By Origin, By Airline, By Time period, Cancellation code
- Inferential statistical analysis of Cancellation of Flights
    - Chi-Square test to find variables highly responsible for Cancellation of flight
    - Multi-collinearity test for feature selection for Machine Learning modelling
- Predictive Machine Learning model for Cancellation of flight
    - Support Vector Classifier model to predict Cancellation
    - Model evaluation using Area Under the Curve, Accuracy and F1 Score
- Planned Improvements to the model

Descriptive analysis of Cancellations

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Cancelled	Count of Cancelled
1	137,434

Cancelled	Count of Not Cancelled
0	6,872,294

Origin_airport	Count of Cancellation by Origin Airport
Chicago O'Hare International	15,050
Dallas-Fort Worth International	7,272
William B Hartsfield-Atlanta Intl	5,830

Top 3

Description	Count of Cancellation by Airline
American Eagle Airlines Inc.	18,331
American Airlines Inc.	17,440
Skywest Airlines Inc.	12,436

Top 3

Origin_airport	Description	Count of Cancellation by Origin Airport and Airline
Dallas-Fort Worth International	American Airlines Inc.	4,620
Chicago O'Hare International	American Eagle Airlines Inc.	4,326
Chicago O'Hare International	American Airlines Inc.	2,926

Top 3

CancellationCode	Count by Cancellation code
B	54,904
A	54,330
C	28,188
D	12

Inferential and Predictive Analytics of Cancellations

Description	percent
American Eagle Airlines Inc.	13.34
American Airlines Inc.	12.69
Skywest Airlines Inc.	9.05
Southwest Airlines Co.	9.01
United Air Lines Inc.	7.67

pearson(features)		
1.0	0.06575570036830161	... (8 total)
0.06575570036830161	1.0	...
0.0657252726295638	-0.24011421864393012	...
-0.0026678381935330564	-0.014908711207421689	..
0.0068635648746472626	7.861196209730063E-4	...
-0.040400298332104526	-0.06761987574141898	...
-0.009227404522645217	-0.005782797044295207	...
0.0014049443489825	-4.897018765511002E-4	...

```
pValues: [0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0]
degreesOfFreedom: [19, 302, 303, 4, 6, 1440, 11, 30]
statistics: [22182.74291141317,30551.853383112266,29447
1565.8787188880342,4863239.444302091,20553.587598560807
```

```
The area under the curve is 0.5
```

```
The area under the PR curve is 0.01969750732259068
```

```
The accuracy of the model is 0.9803024926774093
```

```
Below is the confusion matrix:
 [[1030493       0]
 [  20706       0]]
```

Following are displayed here

1. % Cancellation by Airline
2. Multi-collinearity (Pearson) results
3. Chi-Square test results (pValues)
4. Predictive model evaluation results (AUC, PR, …)

PLANNED IMPROVEMENT:

- Use more features in the model to increase complexity
- Use Bagging and Ensemble method to improve generalization of the model

Analysis of Airlines Dataset to find Insights

To Predict Duration of Delay

- Descriptive analysis of Delay of Flights
    - By Arrival, More than 10mins, By Month, Number of times per month
- Feature selection for building predictive model on Delay of Flights
    - Multi-collinearity test for feature selection for Machine Learning modelling
- Predictive Machine Learning model for Cancellation of flight
    - Liner Regression model to predict duration of Delay
    - Decision Tree model
    - Model evaluation using Area Under the Curve, Accuracy and F1 Score

Delay analysis

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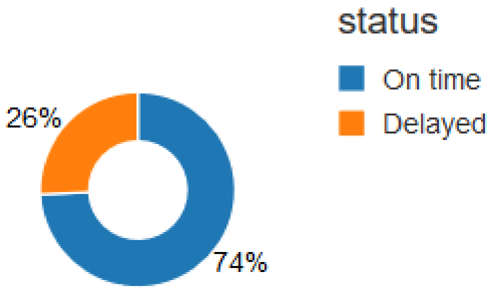

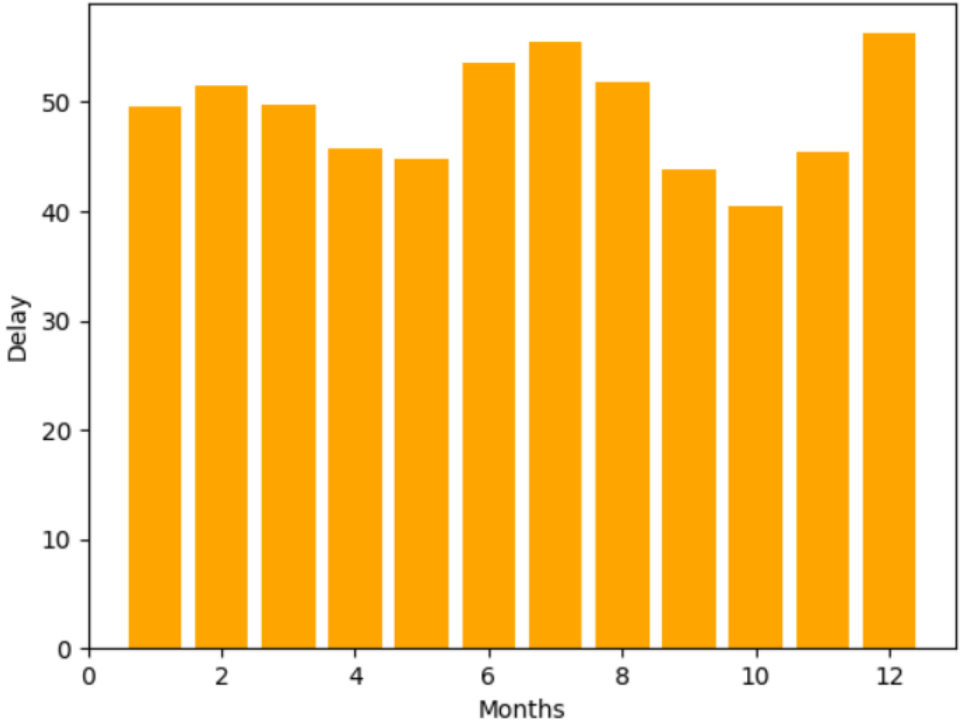

Descriptive Analytics – Delay by Carrier and Day

carrier_name	day_of_the_week
US Airways Inc. (Merged with America West 9/05. Reporting for both starting 10/07.)	friday
Pinnacle Airlines Inc.	friday
Aloha Airlines Inc.	sunday
Skywest Airlines Inc.	monday
American Eagle Airlines Inc.	friday
United Air Lines Inc.	friday
Comair Inc.	friday
Expressjet Airlines Inc.	thursday
Frontier Airlines Inc.	thursday

Predictive Analytics of Flight Delay

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```
predicted.show()
```

UniqueCarrier	Dest	Origin	Month	DayOfWeek	ArrTime	Distance	DepDelay	UniqueCarrier_index	Dest_index	Origin_index	features	prediction
9E	ABE	DTW	1	2	2326	424	38	14.0	146.0	9.0	[14.0,146.0,9.0,1...	33.83511183213857
9E	ABE	DTW	1	5	1551	424	23	14.0	146.0	9.0	[14.0,146.0,9.0,1...	35.05761422079986
9E	ALB	DTW	1	4	1234	488	22	14.0	78.0	9.0	[14.0,78.0,9.0,1....	36.1934204436858
9E	ALB	DTW	1	4	1255	488	61	14.0	78.0	9.0	[14.0,78.0,9.0,1....	36.17978984114072
9E	ALB	MSP	1	3	1644	979	11	14.0	78.0	15.0	[14.0,78.0,15.0,1...	35.39062499754558
9E	ALO	MSP	1	3	2325	166	5	14.0	283.0	15.0	[14.0,283.0,15.0,...	32.090768518797596
9E	ALO	MSP	1	4	2331	166	14	14.0	283.0	15.0	[14.0,283.0,15.0,...	32.326696809966414
9E	ATL	HOU	1	1	1302	696	172	14.0	0.0	25.0	[14.0,0.0,25.0,1....	37.24755996497636
9E	ATL	HOU	1	3	1037	696	3	14.0	0.0	25.0	[14.0,0.0,25.0,1....	37.89921068564678
9E	ATL	HOU	1	3	1557	696	5	14.0	0.0	25.0	[14.0,0.0,25.0,1....	37.56169100357804
9E	ATL	HOU	1	4	1645	696	40	14.0	0.0	25.0	[14.0,0.0,25.0,1....	37.74439503718987
9E	ATL	HOU	1	5	1557	696	19	14.0	0.0	25.0	[14.0,0.0,25.0,1....	38.041336501655735
9E	ATL	HOU	1	5	1600	696	17	14.0	0.0	25.0	[14.0,0.0,25.0,1....	38.01342622025389
9E	ATL	HOU	1	6	1350	696	105	14.0	0.0	25.0	[14.0,0.0,25.0,1....	38.4155180472104
9E	ATL	HOU	1	7	1445	696	149	14.0	0.0	25.0	[14.0,0.0,25.0,1....	38.59367854664053
9E	ATL	HOU	1	7	1551	696	3	14.0	0.0	25.0	[14.0,0.0,25.0,1....	38.52487645760345
9E	ATL	IAH	1	1	1752	689	6	14.0	0.0	5.0	[14.0,0.0,5.0,1.0...	36.18672674010886
9E	ATL	IAH	1	2	2140	689	15	14.0	0.0	5.0	[14.0,0.0,5.0,1.0...	36.17470788021949
9E	ATL	IAH	1	4	1803	689	13	14.0	0.0	5.0	[14.0,0.0,5.0,1.0...	36.87309209533019
9E	ATL	IAH	1	4	2127	689	9	14.0	0.0	5.0	[14.0,0.0,5.0,1.0...	36.662791370348906

only showing top 20 rows

RMSE: 35.042989241330005

MSE: 1228.0110949679706

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CHALLENGES FACED	SOLUTION
Identifying a good dataset that qualifies the criteria of having big data size, complexity in number of columns, types of data	Discussed 6 different datasets chosen by each member of team and narrowed down to two. Finally selected one based on opportunity to answers some good business questions
Core dataset had only coded values for airports and airline names	Identified sub-datasets with master data of airports and airlines and joined them to display for ease of understanding the statistics
Airline Delay time identification, whether to consider origin delay or destination delay or average of them or some other way	After some research, used the maximum of origin and destination delay
Model fit process ran for long time (close to 2hrs), so even a small error will force to wait that much time to rerun	Took a sample set to fit the model and then after all steps are successful, ran for full data

Thank you