Increasing Profitability

Airline Carriers

Stakeholders: Airline Carriers

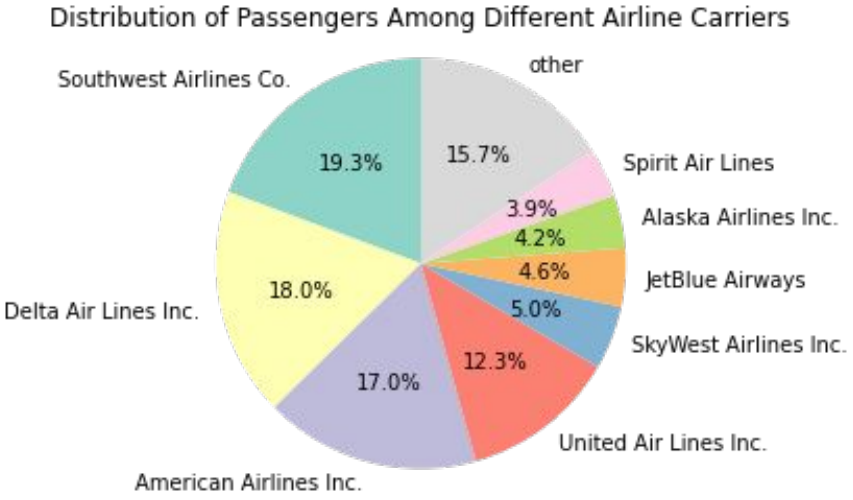
Profitability

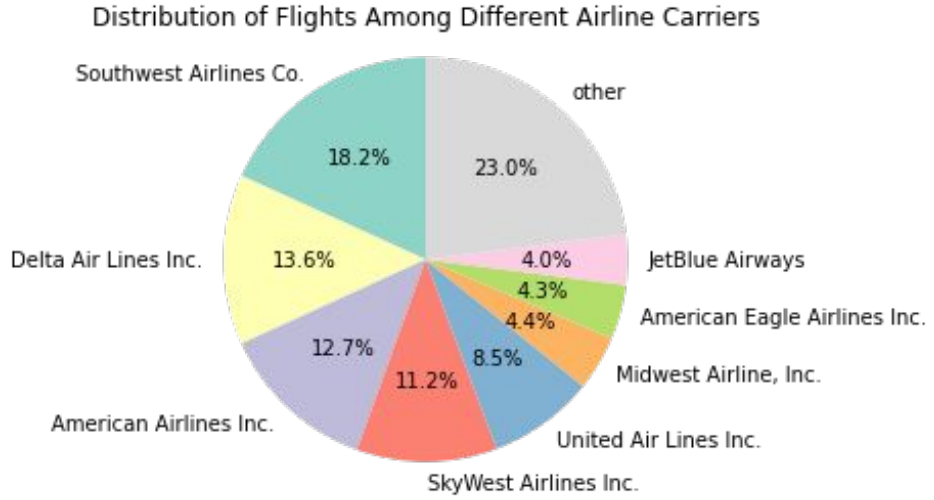
Revenue - Costs

How to increase revenue?

How to decrease costs?

Market Share





Data Set & Motivation

2019 Flights Delays - 6,489,062 rows (slimmed to 1,489,062)

Airports, Airlines, Plane Size and Weather

Strategy

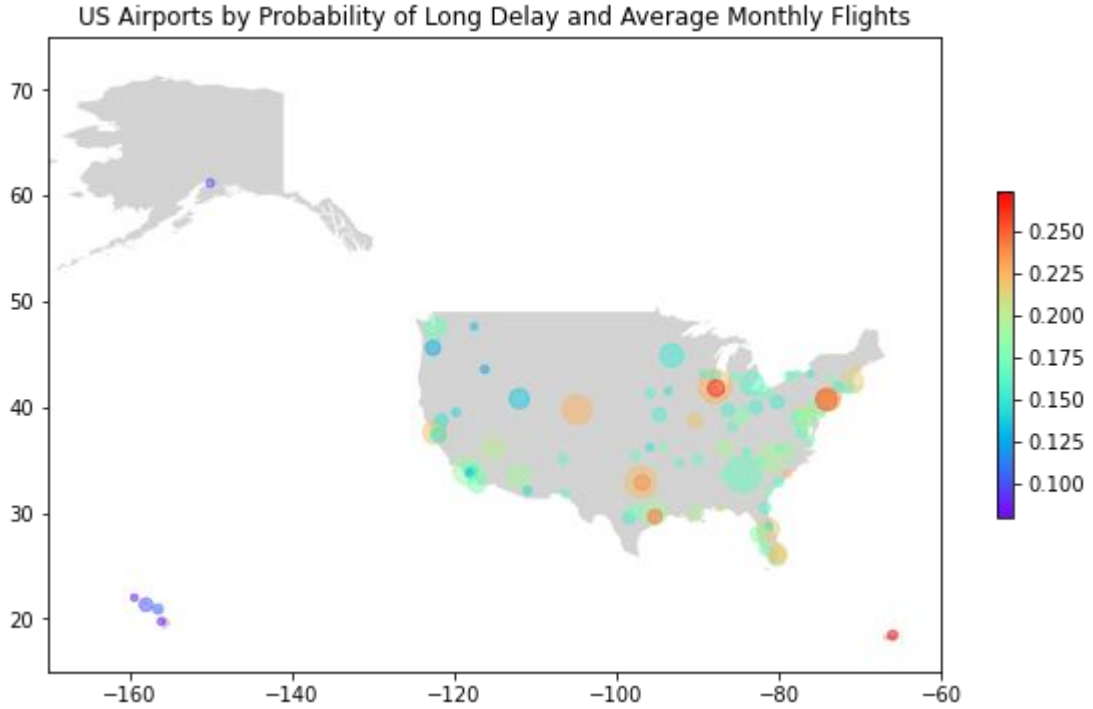
↓ Delays = ↑ Reputation, Loyalty, Market Share = ↑ Revenue

↓ Delays = ↓ Rescheduling, Vouchers = ↓ Costs

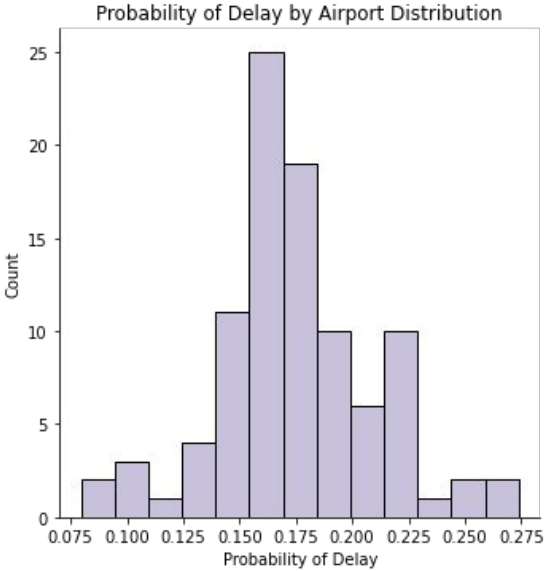
United States Airports

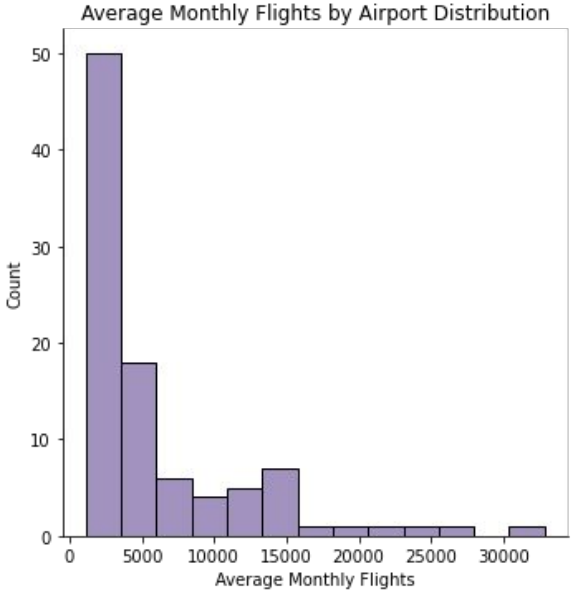
Exploratory Data Analysis

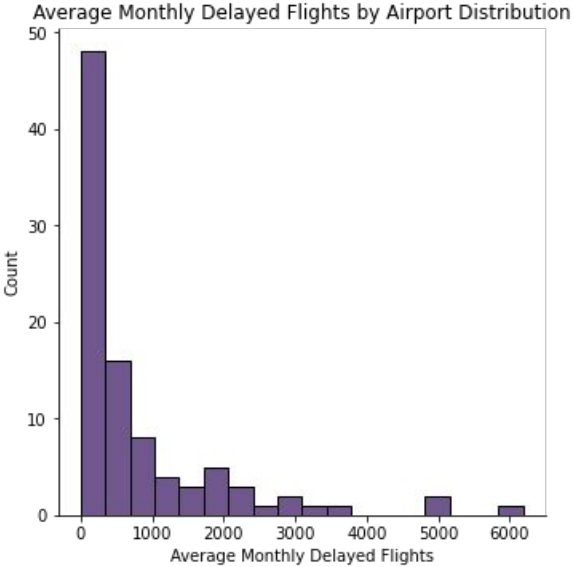
Do airports have different probabilities of delayed flights?



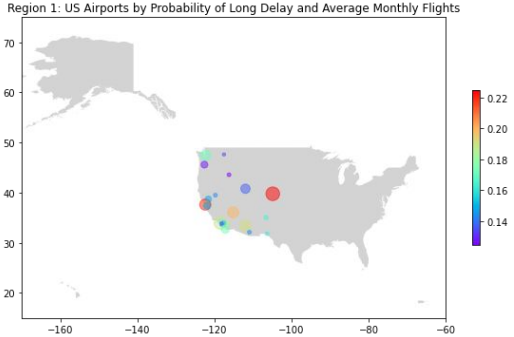
Distributions

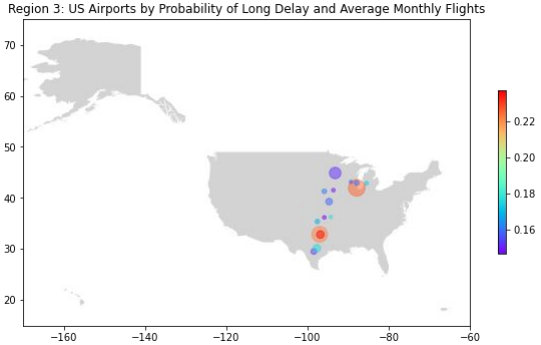


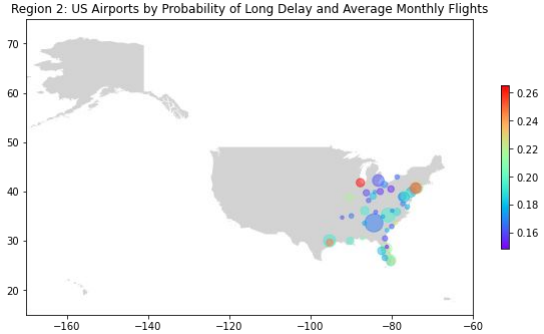


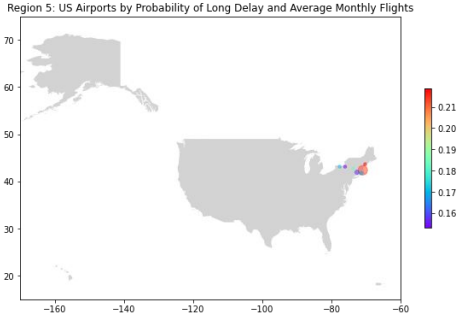


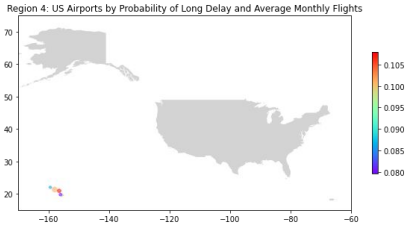
Regions

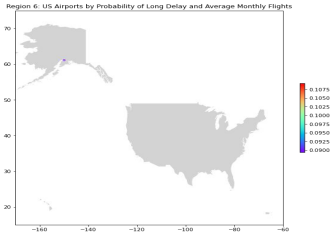

Region 1: US Airports by Probability of Long Delay and Average Monthly Flights

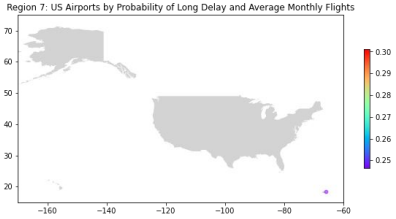

Region 3: US Airports by Probability of Long Delay and Average Monthly Flights


Region 2: US Airports by Probability of Long Delay and Average Monthly Flights


Region 5: US Airports by Probability of Long Delay and Average Monthly Flights


Region 4: US Airports by Probability of Long Delay and Average Monthly Flights

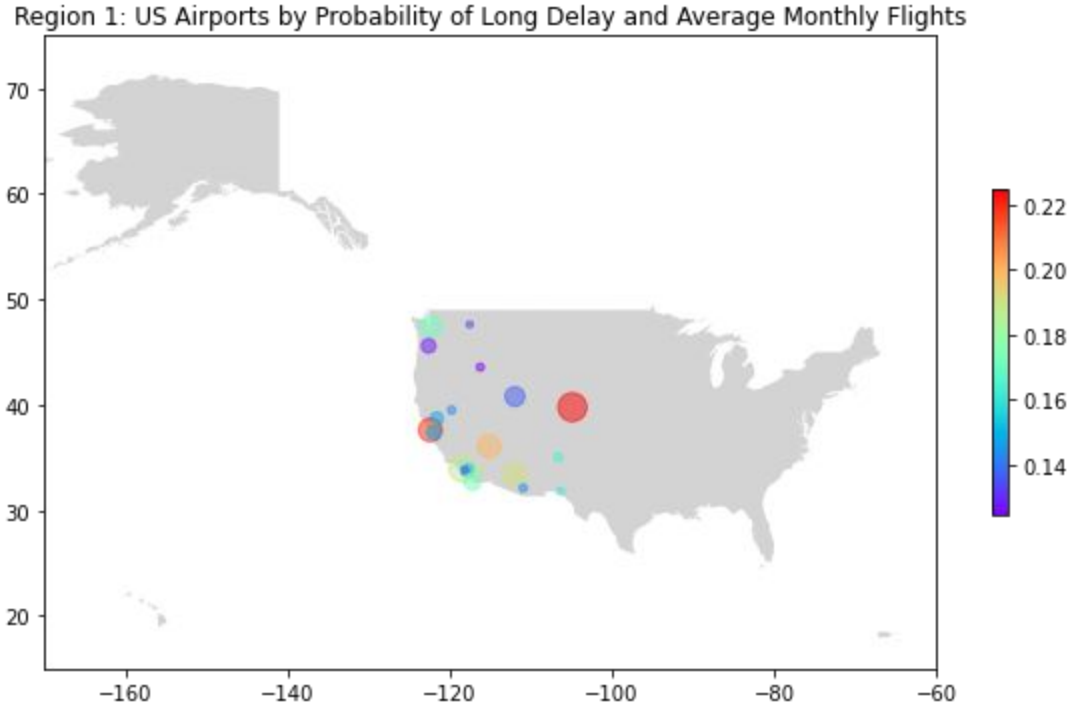

Region 6: US Airports by Probability of Long Delay and Average Monthly Flights


Region 7: US Airports by Probability of Long Delay and Average Monthly Flights

Best Region

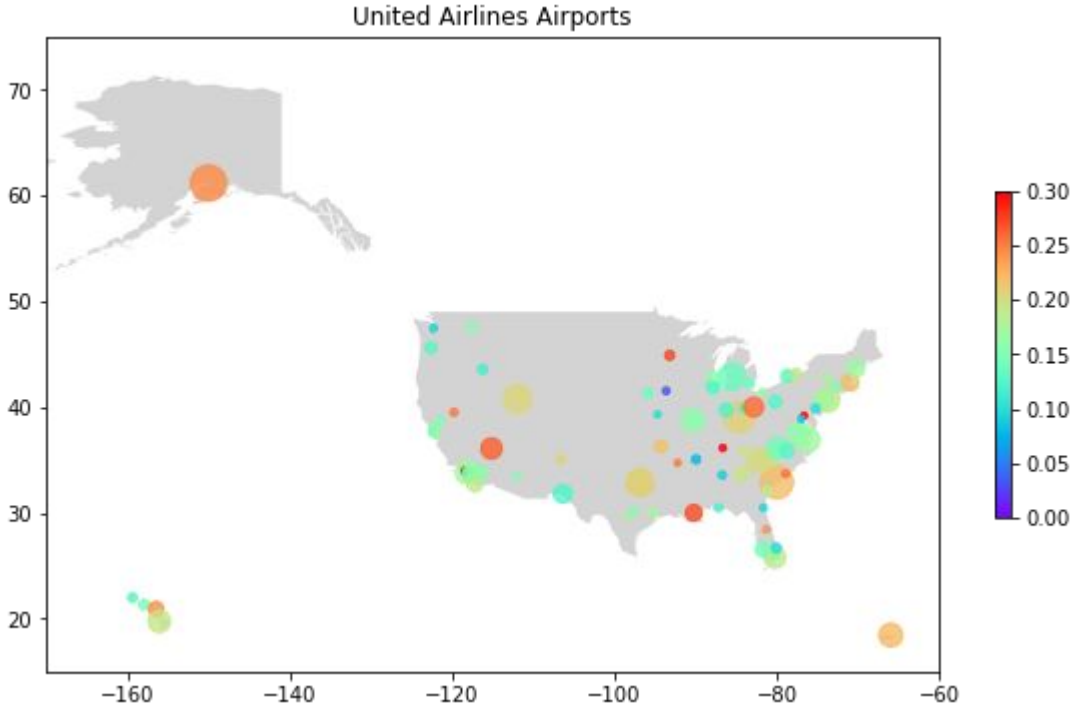
Average probability of delay:16.53%

Average Monthly Flights:6,483



Case Study

How to decrease the number of delayed flights for United Airlines by airport selection?

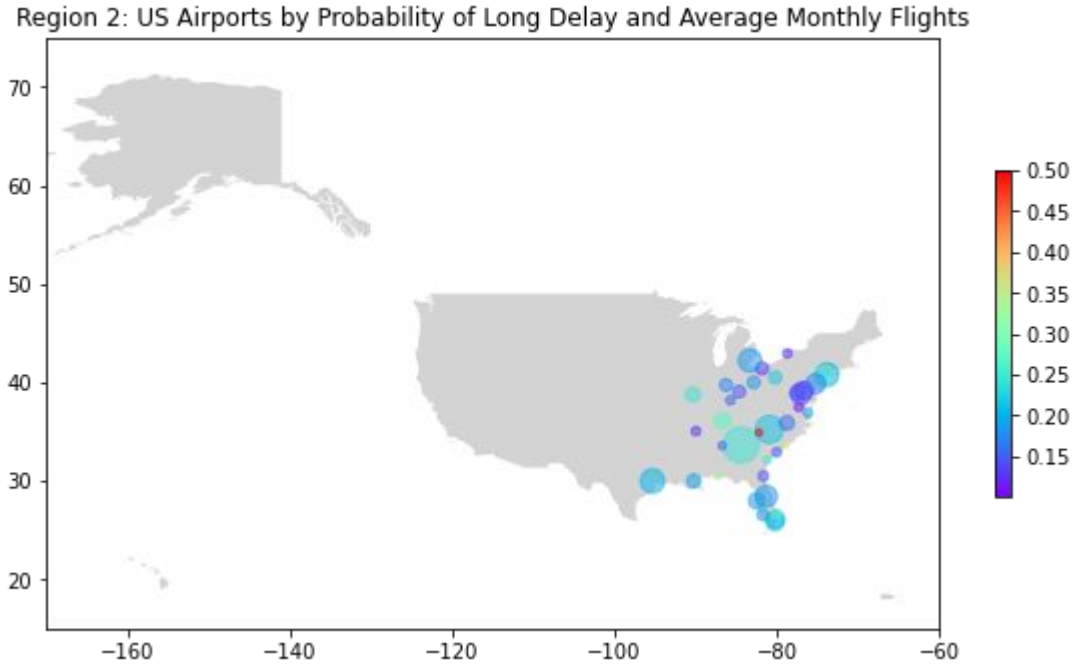


Worst Performing Region

Average Probability of delay:
20.0%

+1.4% Average

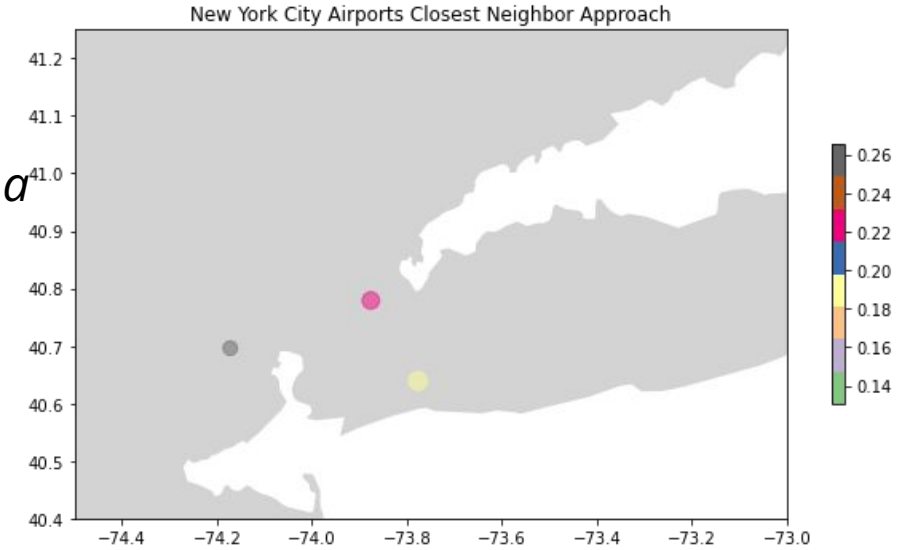
How to lower probability of delays?



Closest Neighbor Approach

NYC area airports

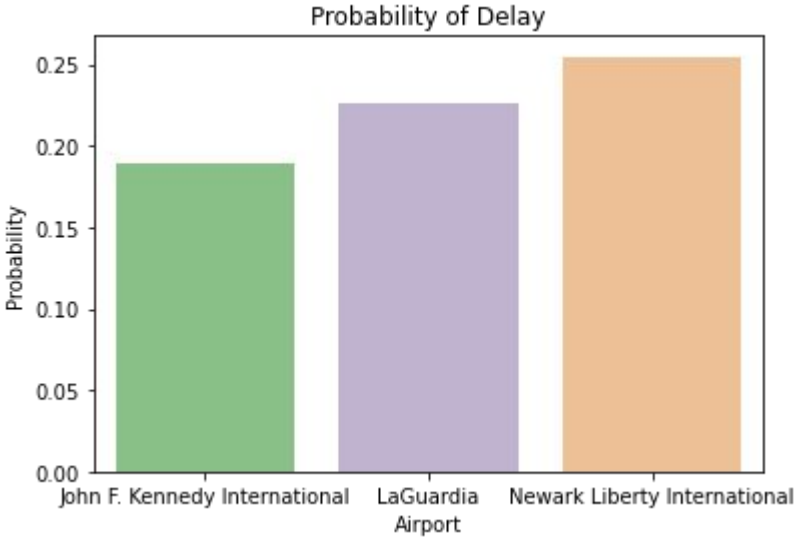
For flights with the same destination, funnel a higher proportion of flights to the airport with a lower probability of delay.



Differences Between Closest Neighbor

Consumers will attribute lower delays with the airline, not the airport

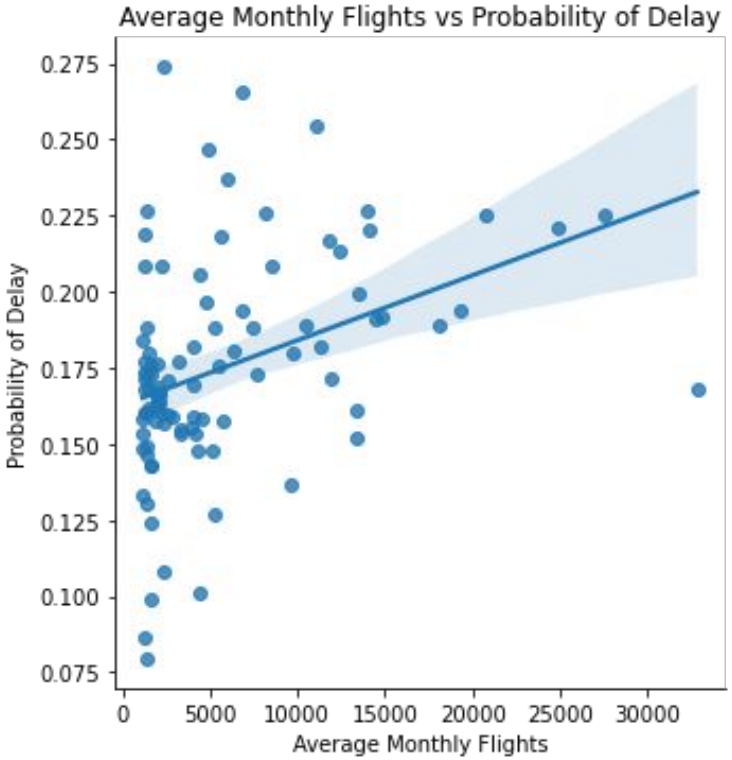
Reputation, Loyalty, Revenue



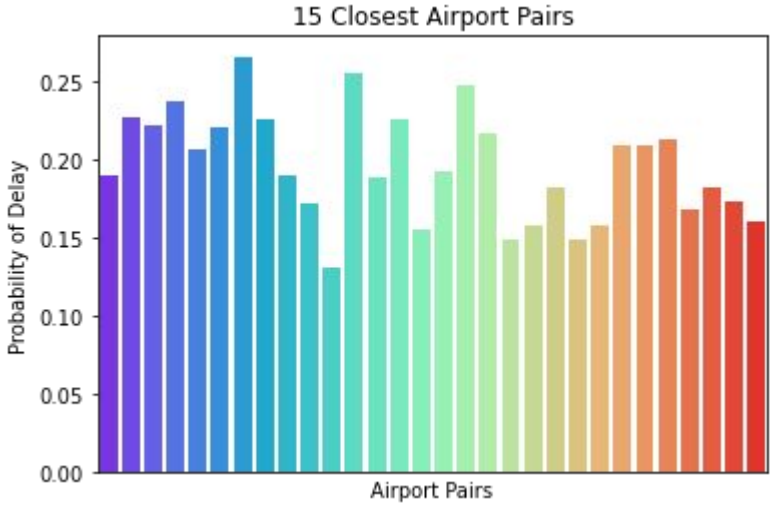
Correlation: Delays & Flights

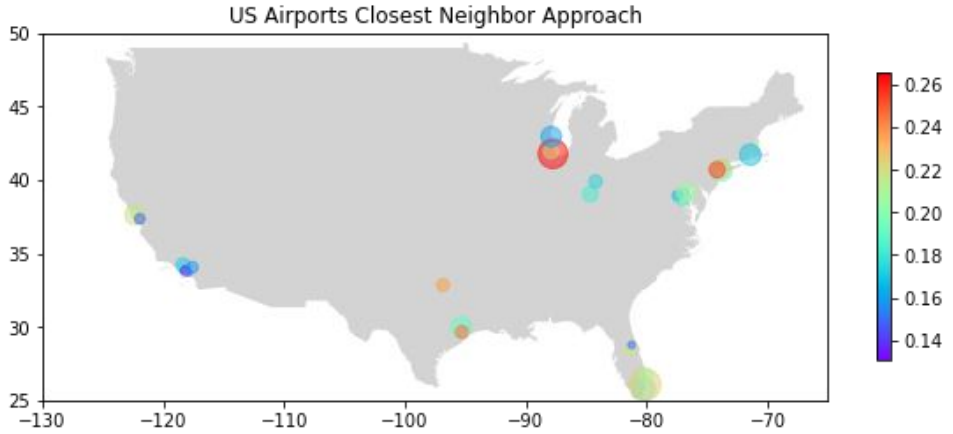
Will increasing the number of flights of an airport increase the probability of delay?

Target smaller airports



Closest Neighbor Approach-30 airports

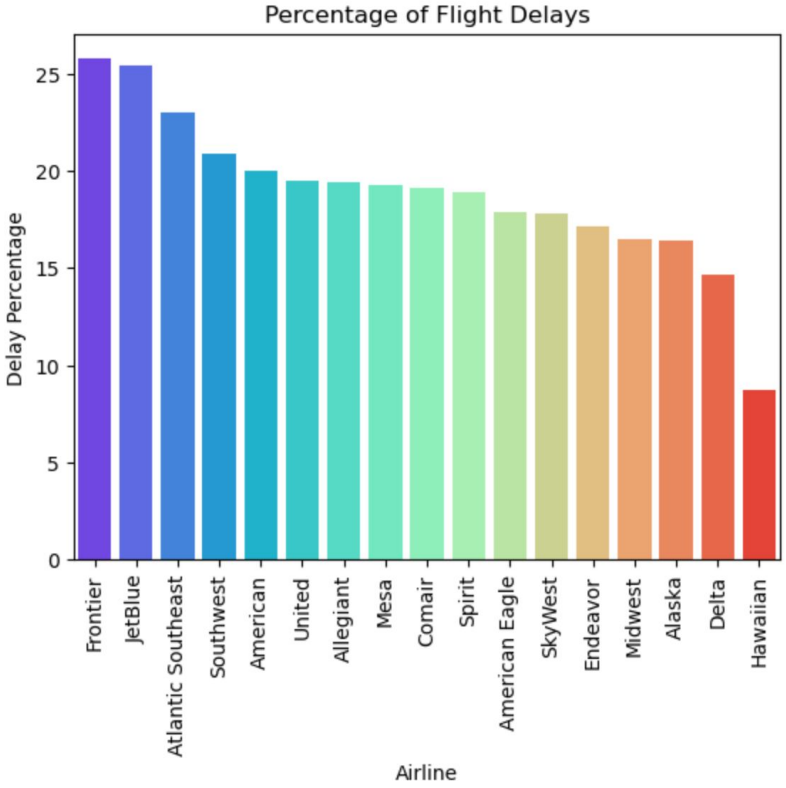




United States Airlines

Exploratory Data Analysis

Which airlines have the most delays and what are their commonalities?



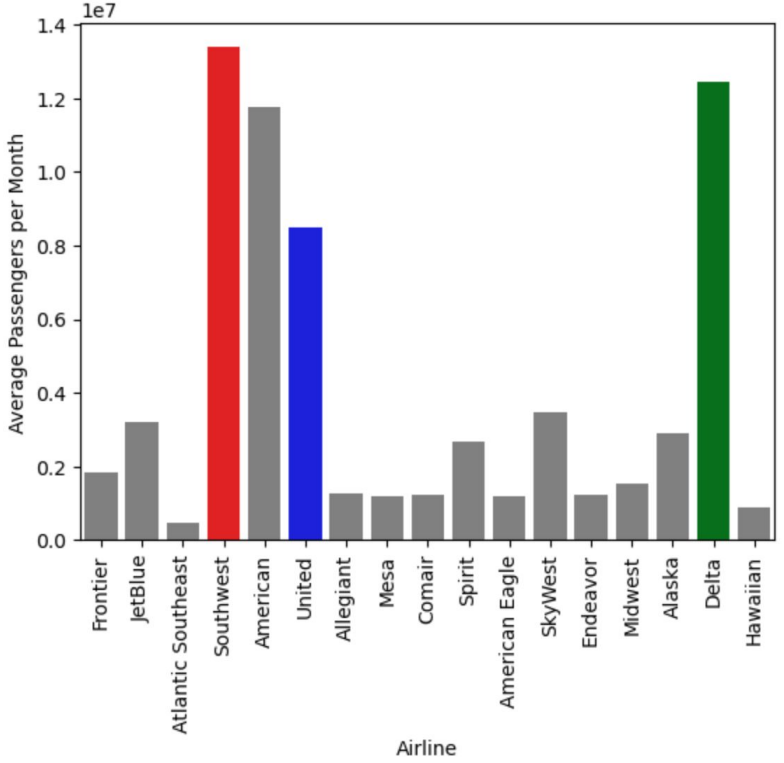
Case Study - Setting Benchmarks

Comparing profit generating variable, passengers:

- United: 8,501,631
- Southwest: 13,382,999
- Delta: 12,460,183

Performance:

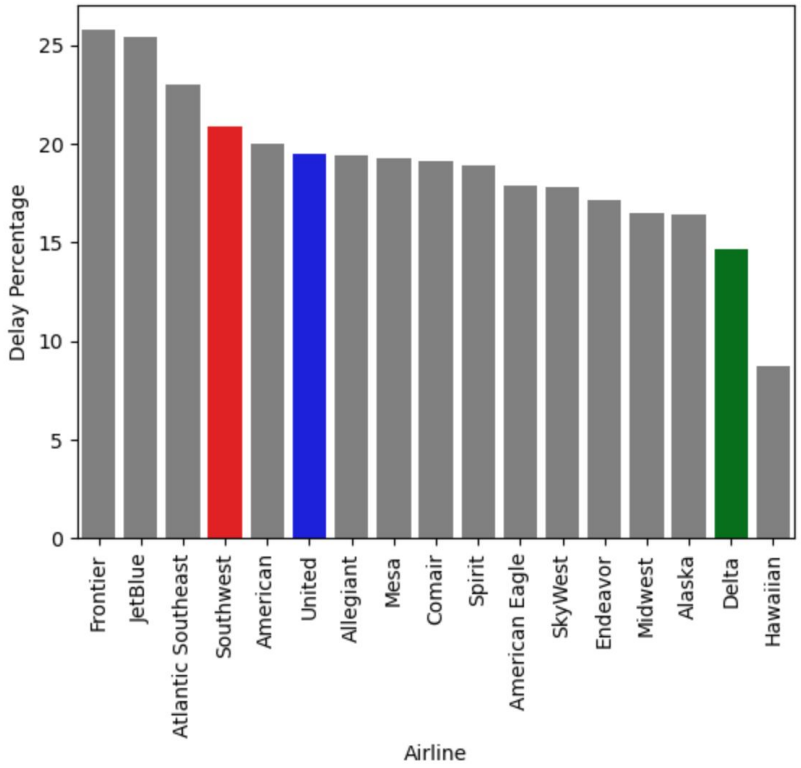
- -4,881,368 less than Southwest
- -3,958,552 less than Delta



Case Study - Delays

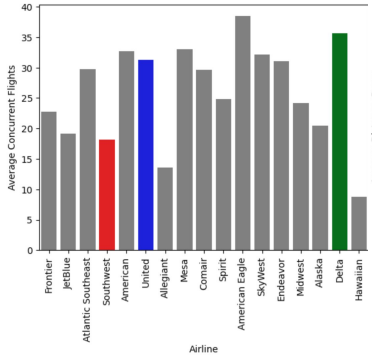
Delay Percentages:
Maximum: 25.75%
United: 19.46%
Southwest: 20.88%
Delta: 14.67%

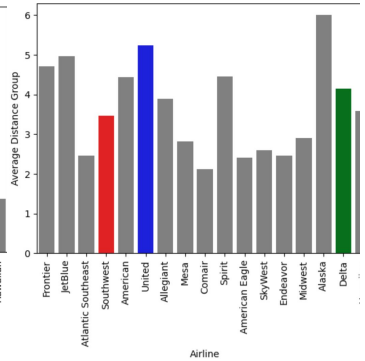
Performance:
- -6.29% on upper bound
- +4.79% on lower bound

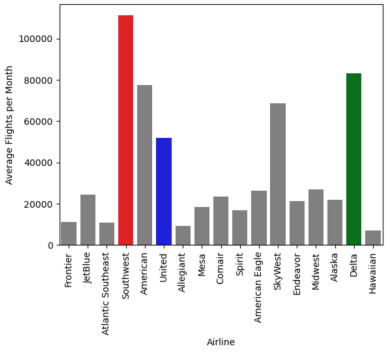


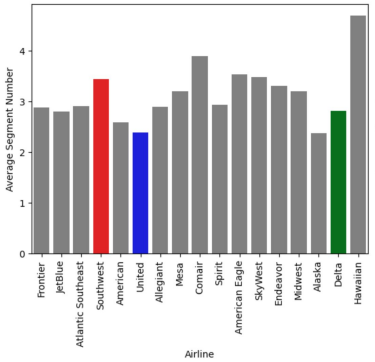
Case Study - Operation Variables

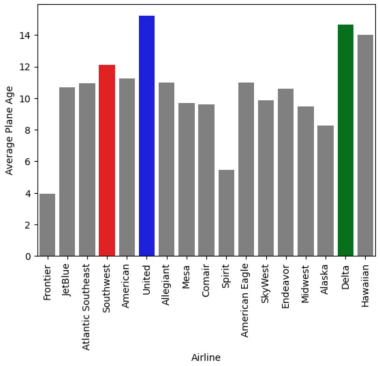
Concurrent Flights | Distance Group | Flights Per Month | Segment Number | Plane Age





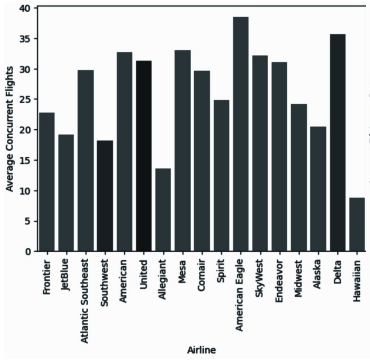


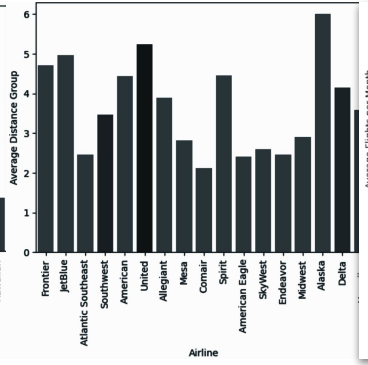


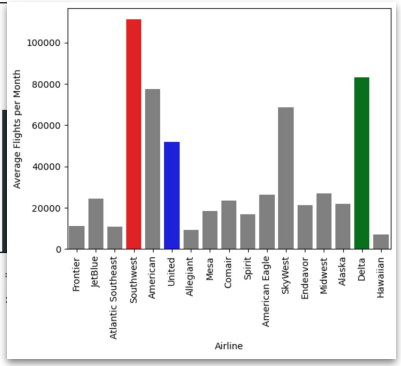


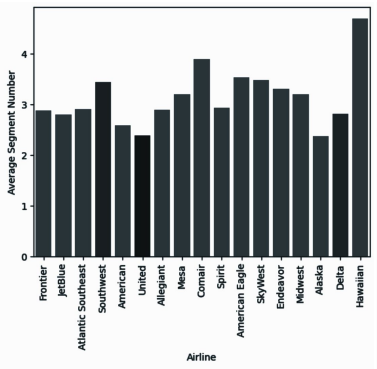
Case Study - Operation Variable of Interest

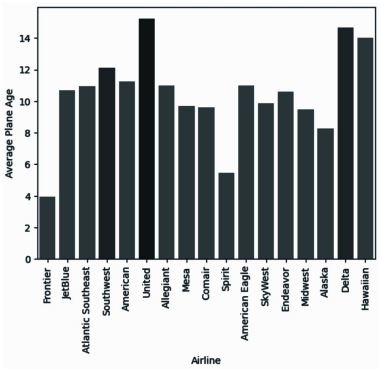
Concurrent Flights | Distance Group | **Flights Per Month** | Segment Number | Plane Age





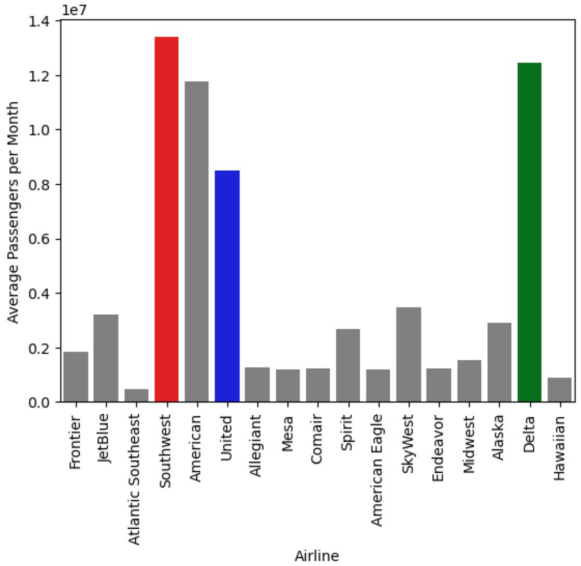


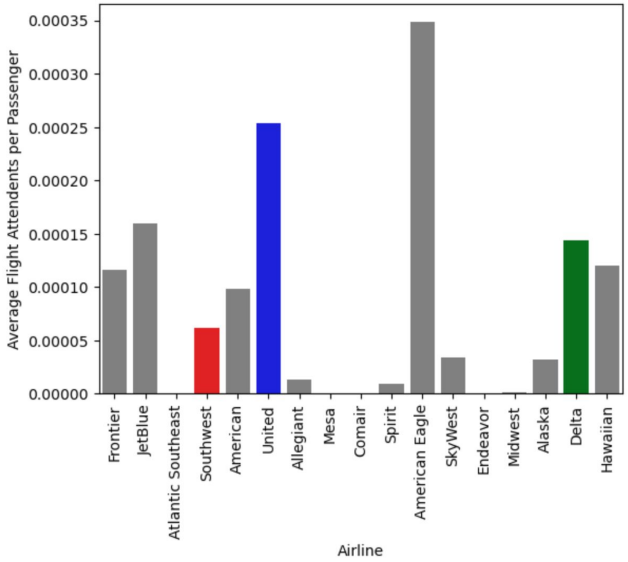


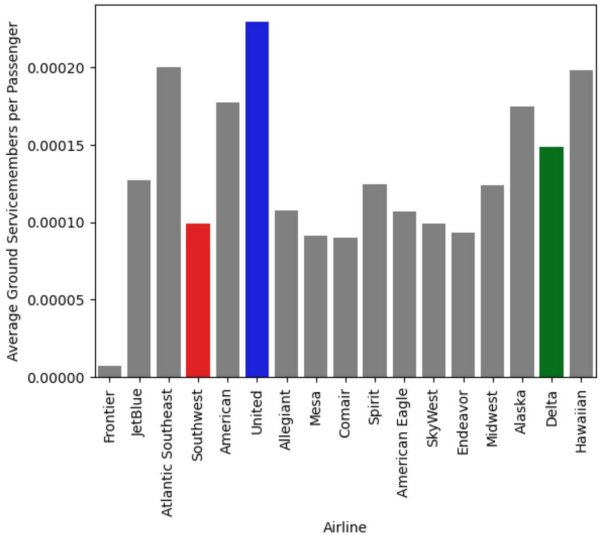


Case Study - Human Resources Variables

Passengers per Month | Flight Attendants per Passenger | Ground Crew per Passenger

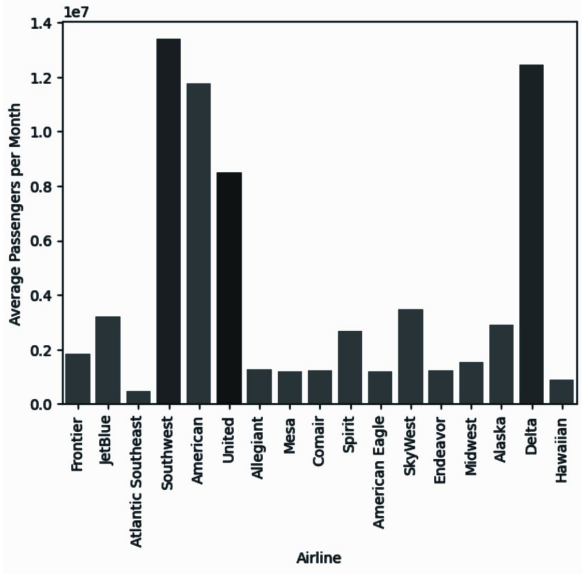


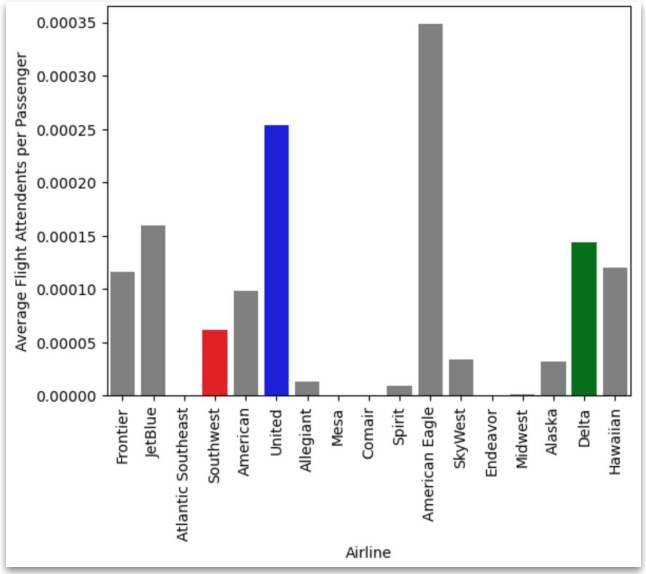


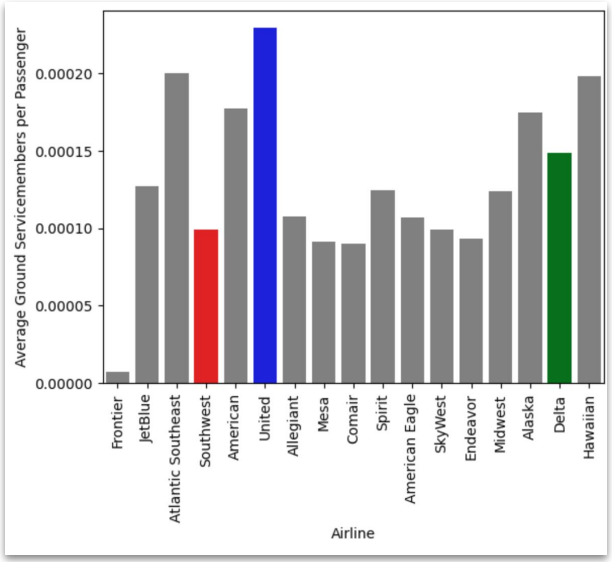


Case Study - Human Resources VOI

Passengers per Month | **Flight Attendants per Passenger** | **Ground Crew per Passenger**







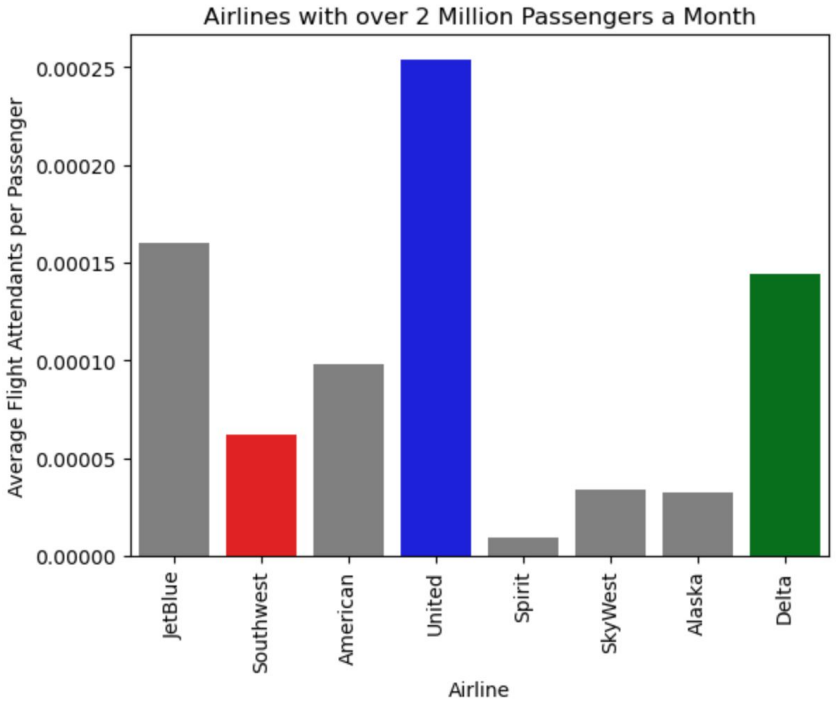
Case Study - Flight Attendants per Passenger

United: ~2.54e-4
Southwest: ~6.2e-5
Delta: ~1.44e-4

Average: ~8.2e-5
Average, similar airlines: ~9.9e-5

United is employing far more flight attendants than all of its competitors, with no discernible difference in delay time

Recommendation: United should slim down its flight attendant crews



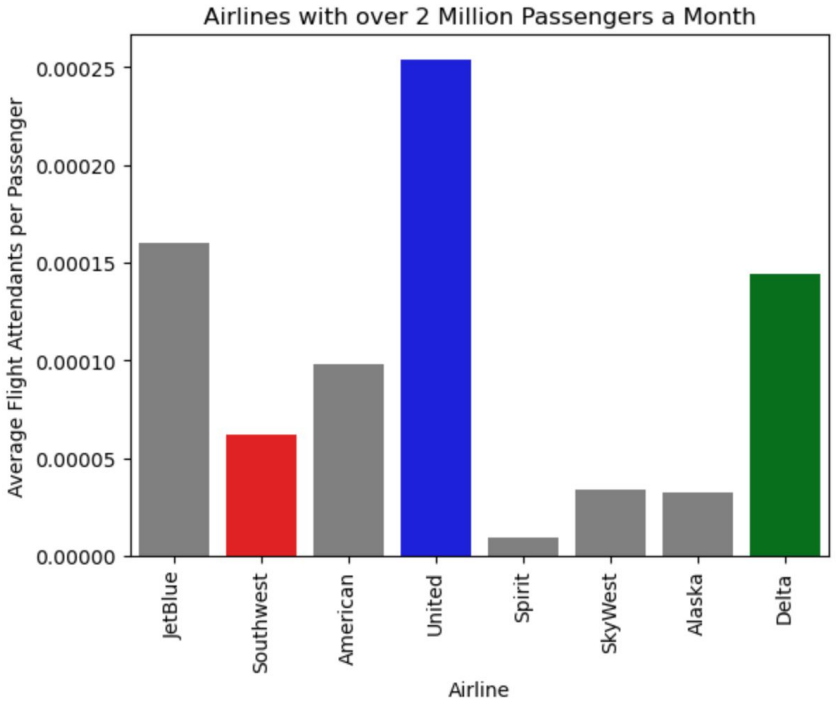
Case Study - Ground Crew per Passenger

United: 2.29e-4
Southwest: ~9.9e-5
Delta: 1.49e-4

Average: ~1.29e-4
Average, similar airlines: ~1.5e-4

Again, United is employing far more ground crew than all of its competitors, with no discernible difference in delay time

Recommendation: United should slim down its ground crews



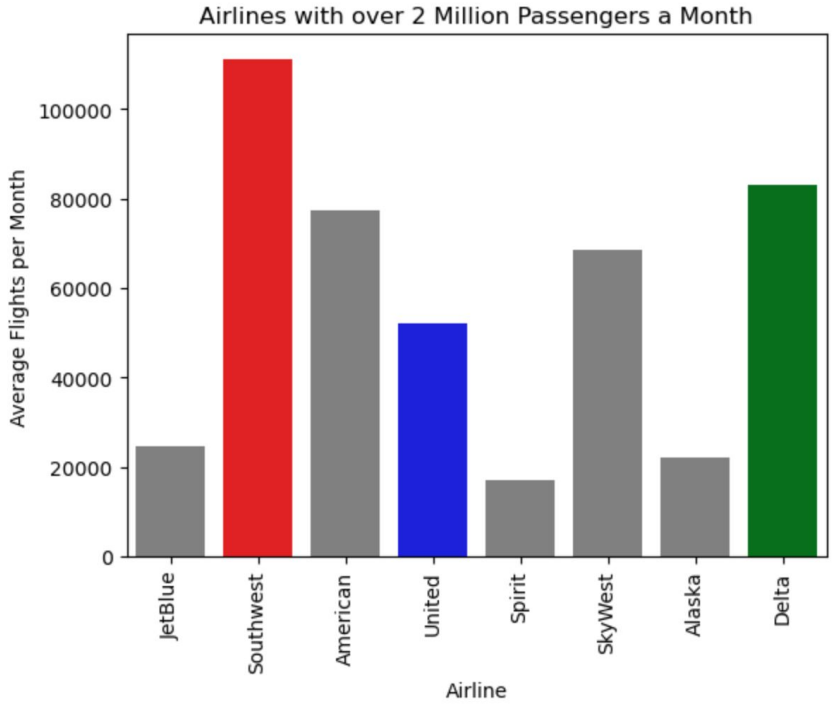
Case Study - Flights per Month

United: ~51,977 w/ 8,501,631 pass. (163.6 per)
Southwest: ~111,171 w/ 13,382,999 pass. (120.4 per)
Delta: ~83,069 w/ 12,460,183 pass. (150.0 per)

Average: ~35,906 w/ 4,070,878 pass. (113.4 per)
Average, similar airlines: ~56,936 w/ 7,290,721 pass. (128.1 per)

United is operating far fewer flights than its competitors, operating with 13.6 more people per flight than delta, and 35.5 more people than similar airlines

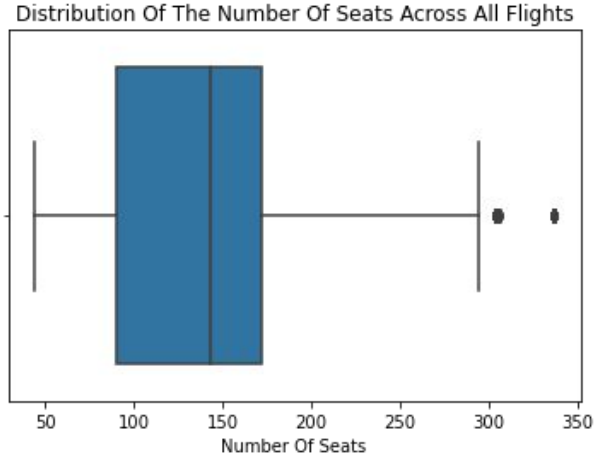
Recommendation: United needs to start decreasing the number of people per flight by increasing the number of flights offered, or changing plane size

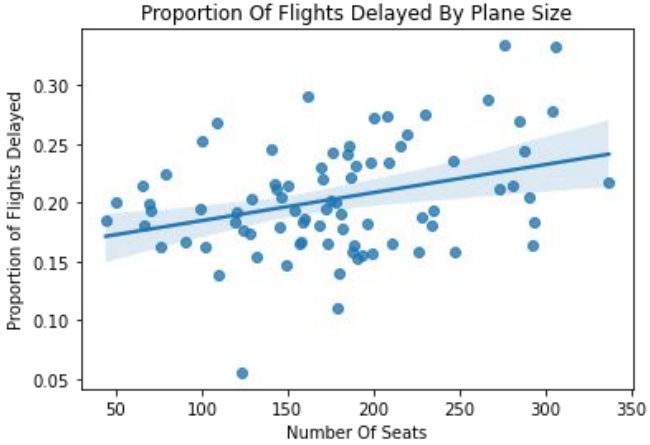


Airplanes

Exploratory Data Analysis

Does the size of the airplane affect how likely it is to be delayed?





Airplanes

Categorizing Plane Size

Small

43 < **Number Of Seats** ≤ 124

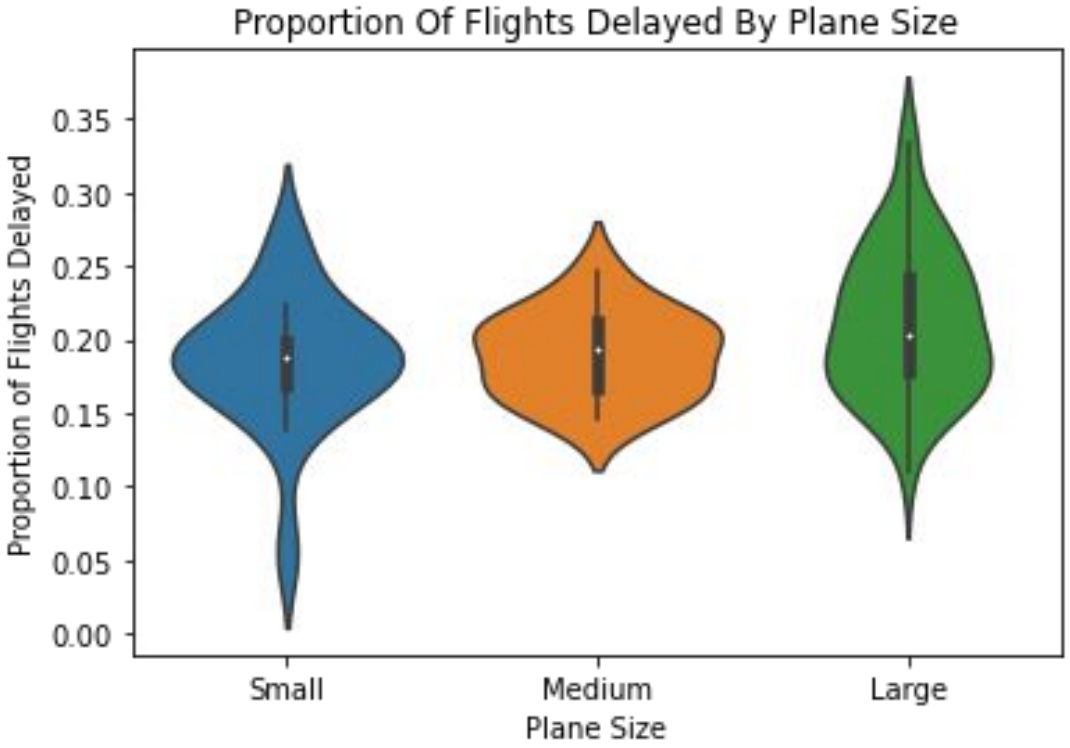
Medium

124 < **Number Of Seats** ≤ 158

Large

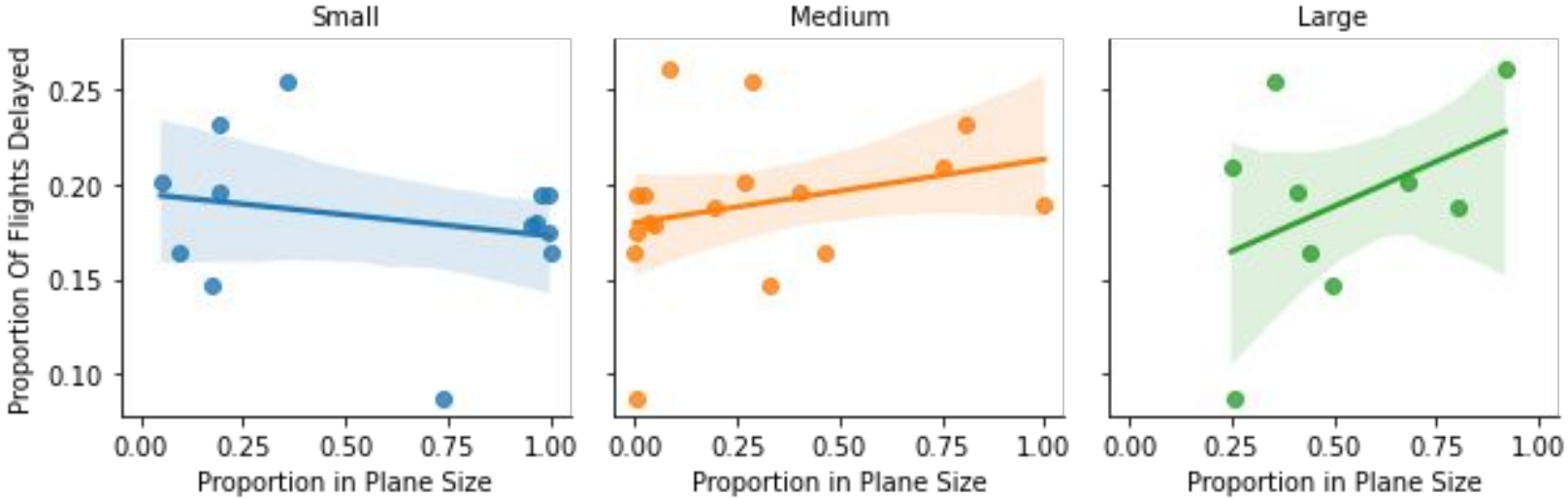
158 < **Number Of Seats** ≤ 337

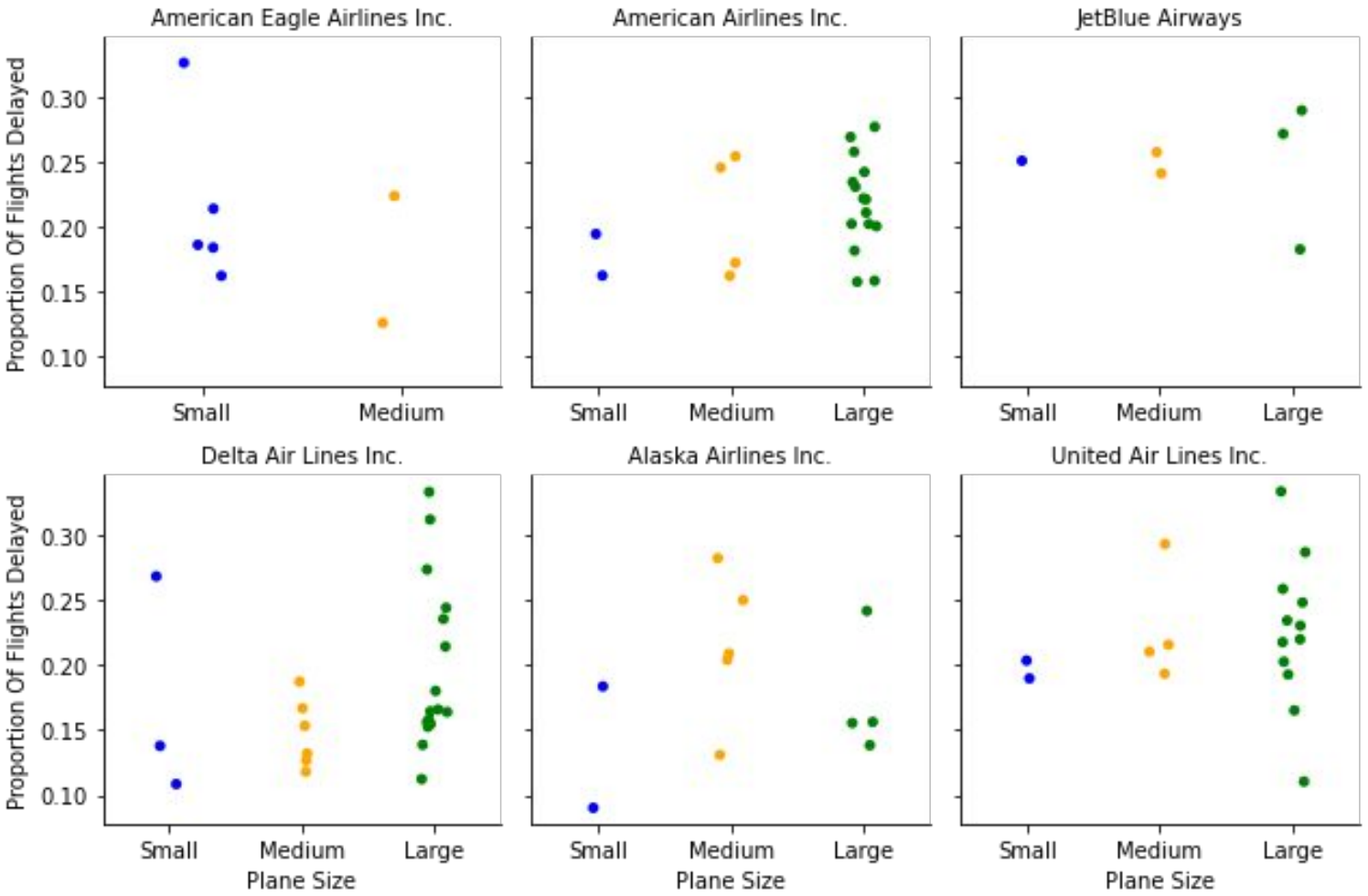
~ Same # of Flights in Each Category



Varying By Carrier

Different plane layouts and boarding procedures likely lead to differences in performance for the same plane size




American Eagle Airlines Inc.
American Airlines Inc.
JetBlue Airways
Delta Air Lines Inc.
Alaska Airlines Inc.
United Air Lines Inc.
Proportion Of Flights Delayed
0.10
0.15
0.20
0.25
0.30
Small
Medium
Large
Plane Size

Plane Size Options

Does having more plane sizes lead to less delays overall?

Delta Air Lines Inc.	25
American Airlines Inc.	21
United Air Lines Inc.	18
Alaska Airlines Inc.	11
American Eagle Airlines Inc.	7
JetBlue Airways	6
SkyWest Airlines Inc.	6
Mesa Airlines Inc.	6
Midwest Airline, Inc.	5
Endeavor Air Inc.	5
Comair Inc.	5
Hawaiian Airlines Inc.	5
Spirit Air Lines	5
Atlantic Southeast Airlines	4
Southwest Airlines Co.	4
Frontier Airlines Inc.	4
Allegiant Air	2

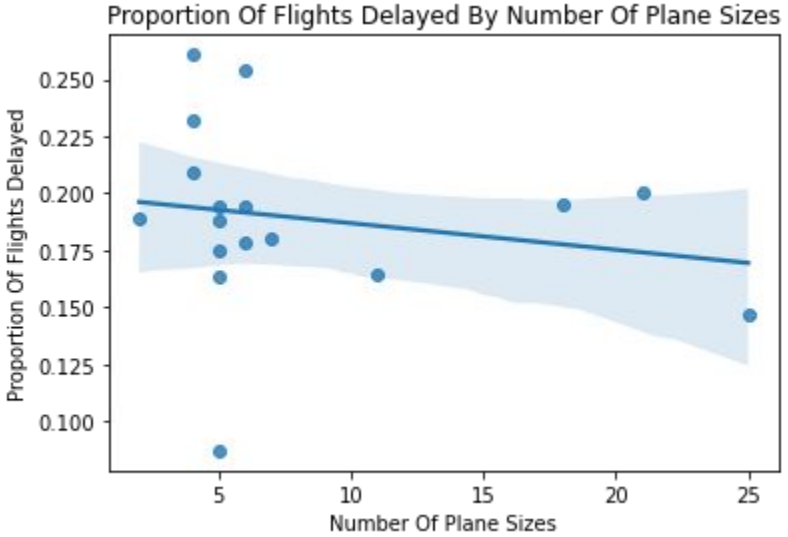
Plane Size Options

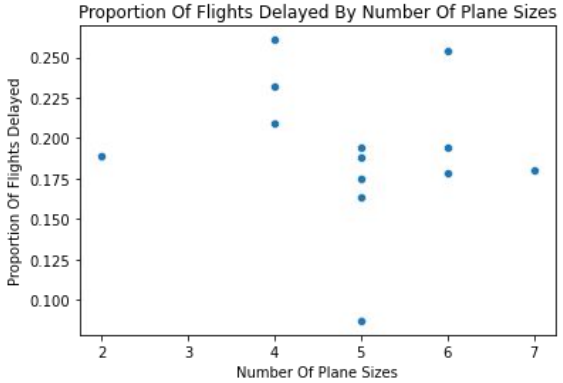
Does having more plane sizes lead to less delays overall?

Correlation is very low

r^2 = 0.037269

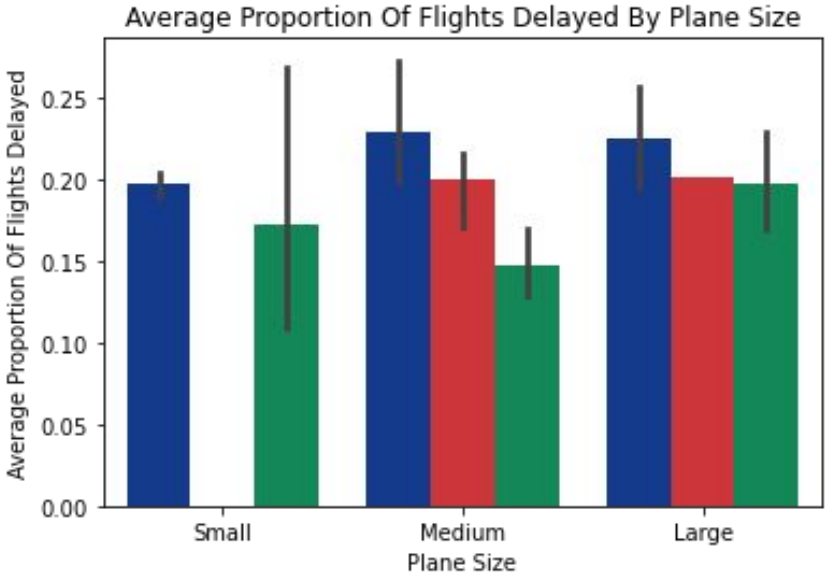
No significant trend when outliers removed

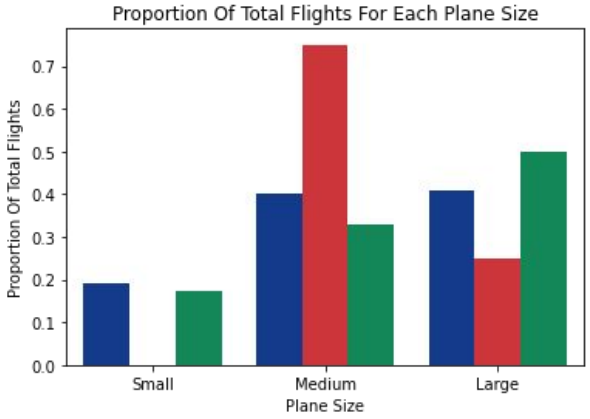




Focusing On United

What airplanes should United Airlines purchase to decrease future delays?





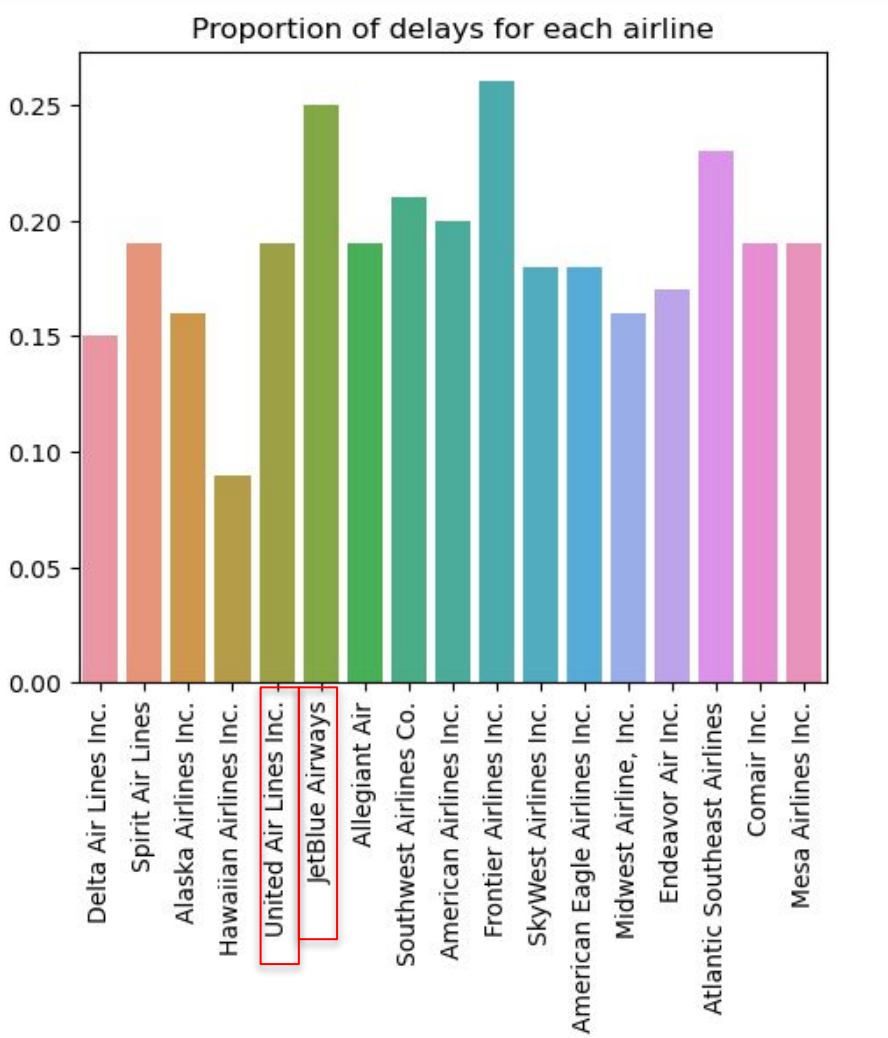
4th EDA: United and weather

is the way United operates in different weather conditions responsible for a bigger probability of delay?

1) United is the 6th most likely airline to be delayed. How much of that is due to “bad” weather?
2) Compared to other airlines, is it the case that United flies more in bad weather?
3) If yes, what factors of “bad” weather are most likely to affect its
4) Case study of airline of biggest probability of delays and airline of lowest prob of dealy : how does their weather indicator look like

Proportion of delays for airlines

- Biggest probability of being delayed the most: **Frontier Airlines, JetBlue**
- Lowest probability of being delayed: **Hawaiian Airlines Inc**



Creating the weather indicator

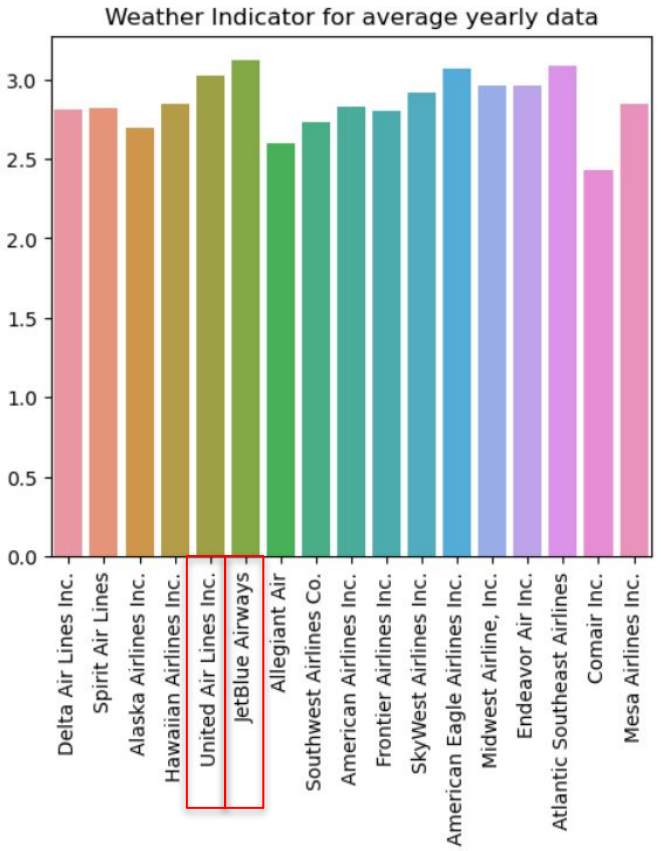
Weather indicator = (snow + rain + wind) /3

United = **4th position**

- Flying more frequently so more flights happen in bad weather - ***9%*** of all flights in dataset are for United

Notice: Comair Inc <**United**< JetBlue Airways

Conclusion 1: United has a high weather indicator which could be causing the delays



Does weather cause delays?

→ Split data into subsets to notice monthly trends

- Calculate delays per month and indicator per month

→ Find correlation between delays and weather indicator

Weather indicator only:

Comair Inc <**United**< **JetBlue Airways**

Weather indicator + correlation:

JetBlue Airways <**United**< **Comair Inc**

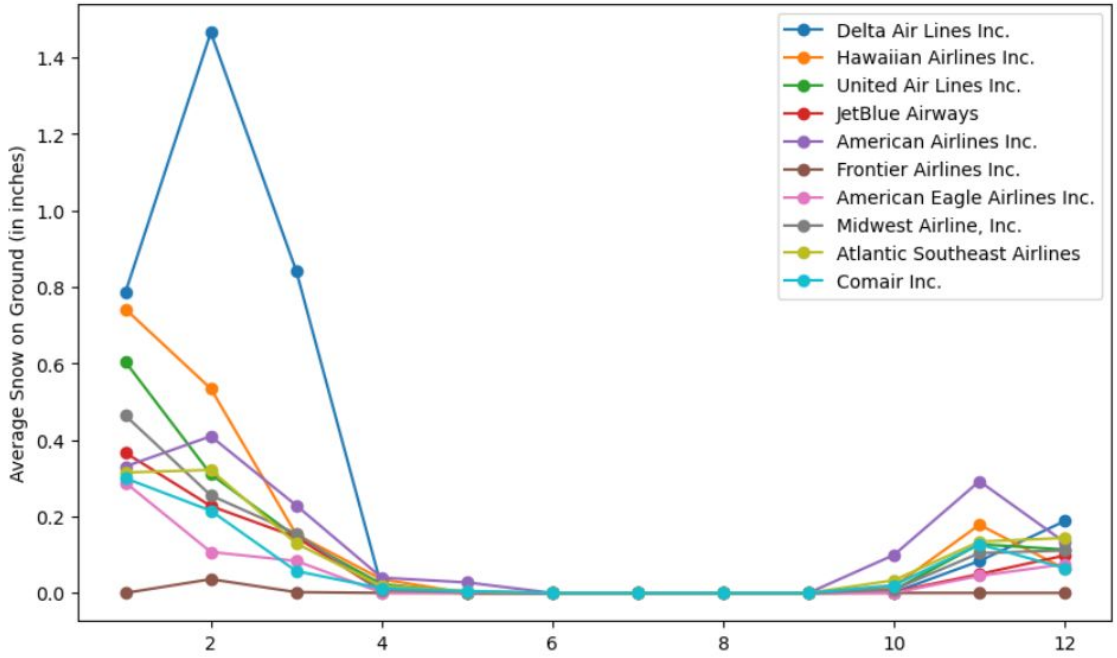
Conclusion 2: United's delays are likely not to be due to bad weather

```
Endeavor Air Inc.                0.401403
Atlantic Southeast Airlines      0.396127
Comair Inc.                     -0.324852
American Airlines Inc.          -0.300407
United Air Lines Inc.           -0.165776
Allegiant Air                   -0.139086
Southwest Airlines Co.           0.134725
American Eagle Airlines Inc.    -0.125721
JetBlue Airways                 -0.124465
SkyWest Airlines Inc.           -0.124411
Delta Air Lines Inc.             0.121742
Spirit Air Lines                -0.075680
Mesa Airlines Inc.              -0.071582
Frontier Airlines Inc.          -0.070815
Alaska Airlines Inc.             0.046326
Hawaiian Airlines Inc.           0.030387
Midwest Airline, Inc.            0.009300
dtype: float64
```

Snow: Potential for weather recommendations?

No, United flying in an average amount of **snow**

Comair Inc =United=JetBlue Airways

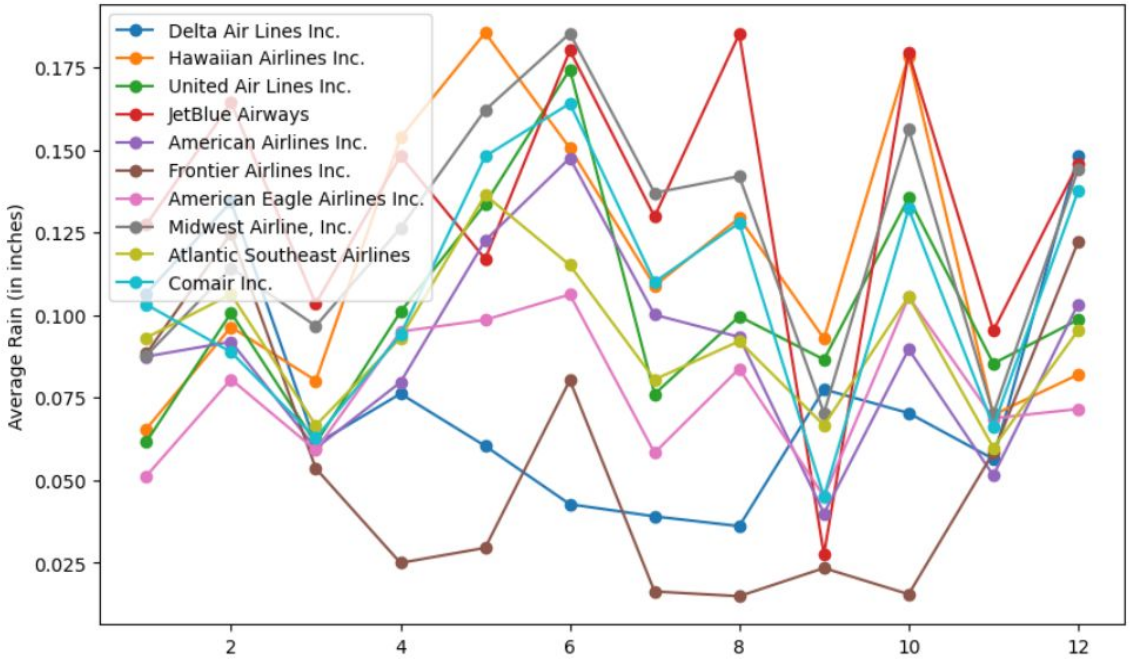


Rain: Potential for weather recommendations?

United vs other airlines:

Yes, rain might be a weather factor that is weighing more heavily or the weather indicator

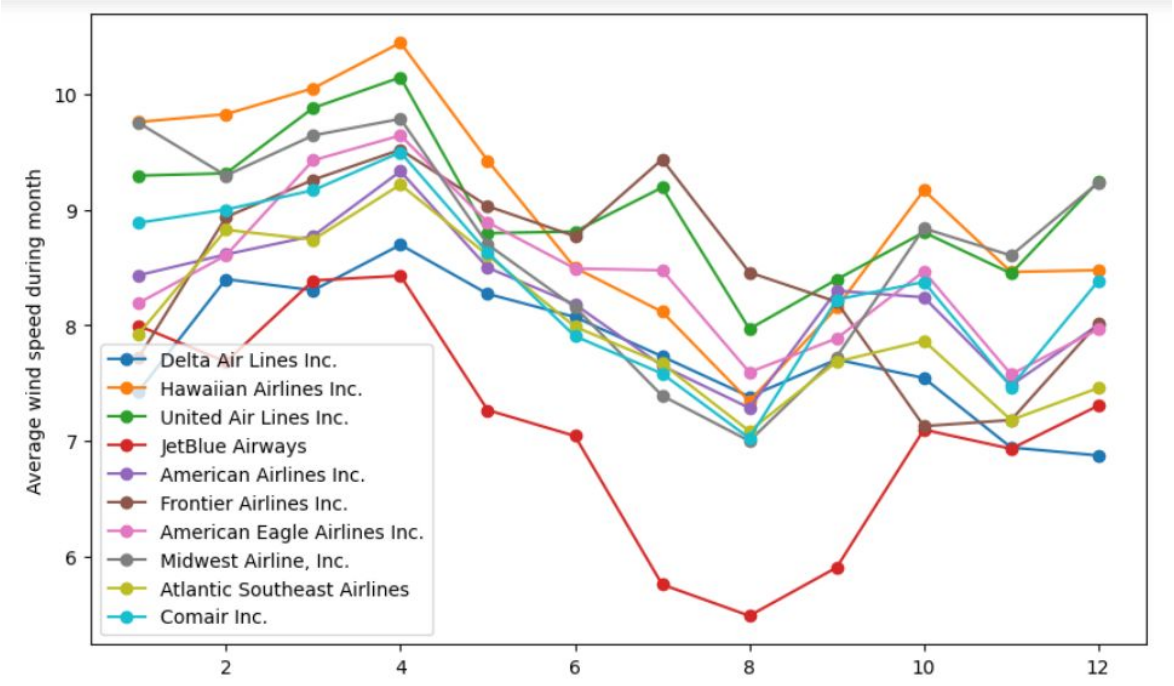
Comair Inc =United<<JetBlue Airways



Wind: Potential for weather recommendations?

Yes, United is flying in highest wind speed compared to other airlines

JetBlue Airways <Comair Inc<<United



Weather takeaways

Good things:

- It's good that United's weather indicator correlation with delays is low - it shows the robust systems in place that take care of random events (minimizing randomness is good)
- United can take advantage of its relatively better performance when it comes to delays by using the correlations found in its advertisement campaigns

Area for growth:

- United can still maintain its average/good delays performance while it operates more flights in the winter/during bad weather – we learn from JetBlue that the weather indicator can be the highest, yet weather is even less of a reason that there are flight delays

Summary

1. Closest Neighbor Approach
   a. Select airports with a lower probability of delay
2. Emulate the Winners, Avoid the Losers
   a. Fly More
   b. Less Employees
3. Weather the Storm or Don't
   a. Delays not due to weather - could do better with handling rain, potentially snow
4. Bigger Bang for your Buck
   a. Purchase Smaller Planes