

Airline Route Optimization

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Background

Airlines companies often wonder what flights are most popular, what flights are most profitable. We wanted to explore which how an airline could target flight routes that have significant room for profit optimization. We explored factors such as revenue, traffic, and frequency of the route (in quarters) to answer this question

Data

We primarily used fare information for 2017. The fare dataset provides information about routes, distance and purchase pattern by quarter. By aggregating the data, we were also able to get passenger counts, flight counts and revenue information by quarter

Model

We chose to look at route optimization by looking at discrepancies in profit and total tickets sold between routes that have inverse start/end points and ones that have similar distances. In this analysis, we define a route as both of the paths that can run from a given point A and B (ex: SFO to LA and LA to SFO combined are 1 route and each of those is a path)

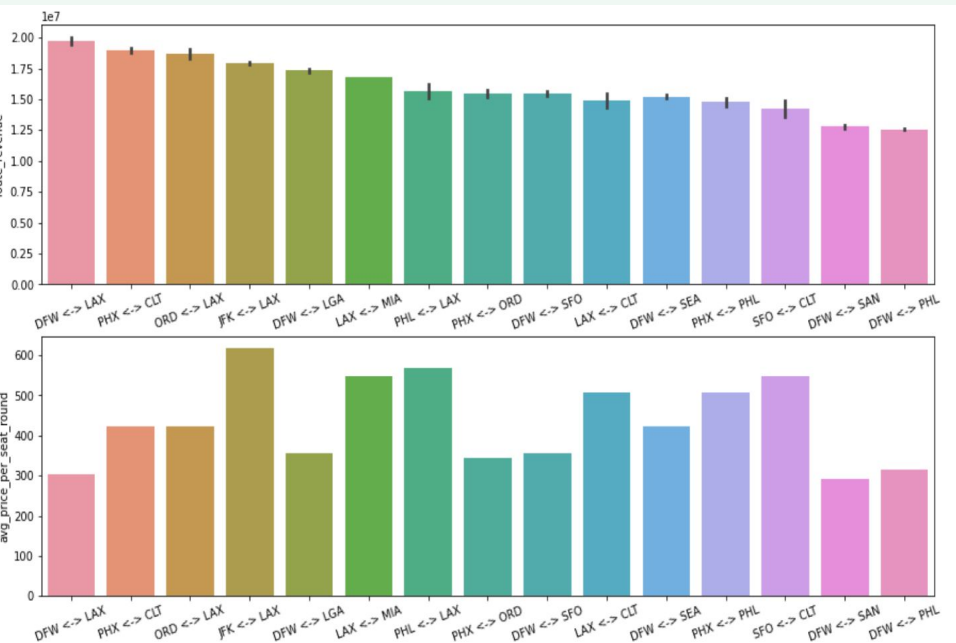
Overview

- By conducting some general visualizations we saw that revenue is positively correlated with flight counts and the number of popular routes .
- This association seems to differ among airlines. Therefore, we further explored four US airlines: American Airline (AA), United Airline (UA), Delta (DN), and Southwest (WN).
- Revenue vs. Distance scatterplot indicates that distance might not have a strong positive correlation with revenue.
- General visualizations are shown on the right.

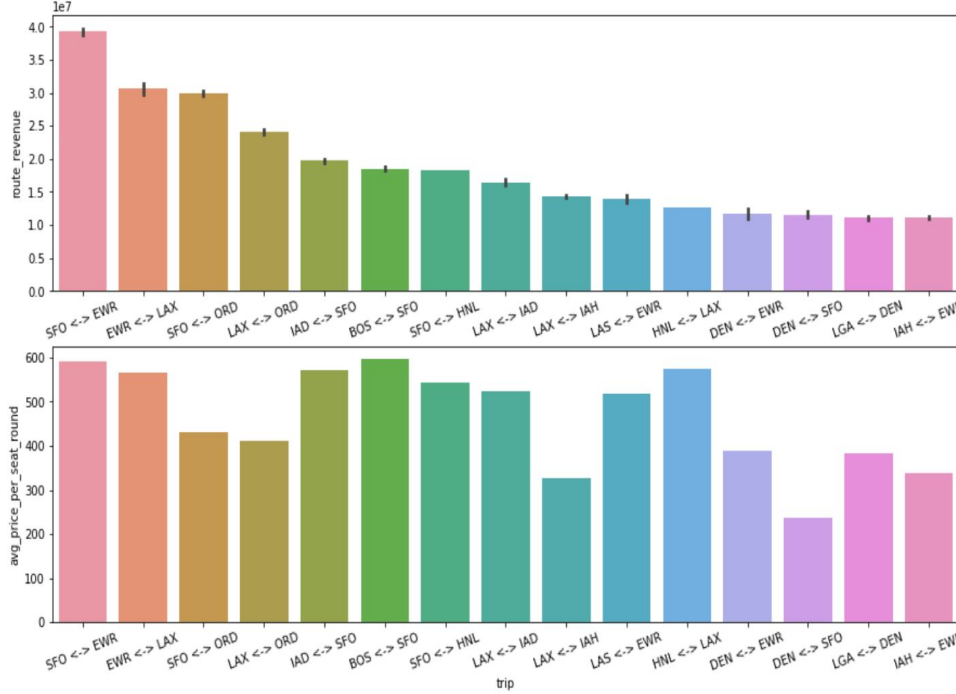
Highlights

- Trips with **high profits and low frequency** or ones with **high traffic and low revenue** are optimizable
- People’s purchasing behavior varies by quarter, as the demand for traveling surges mostly in **Q2**.
- The most **profitable** flights tend to span **longer distance** across the country, whereas the most **popular** ones are **short distance** flight.
- Trips with more **expensive** ticket price **do not** necessarily correspond to trips with **higher revenue**. This can be caused by other factors such as flight counts, flight sizes, and number of passengers who buy the tickets.

Average Price/Seat vs. Revenue

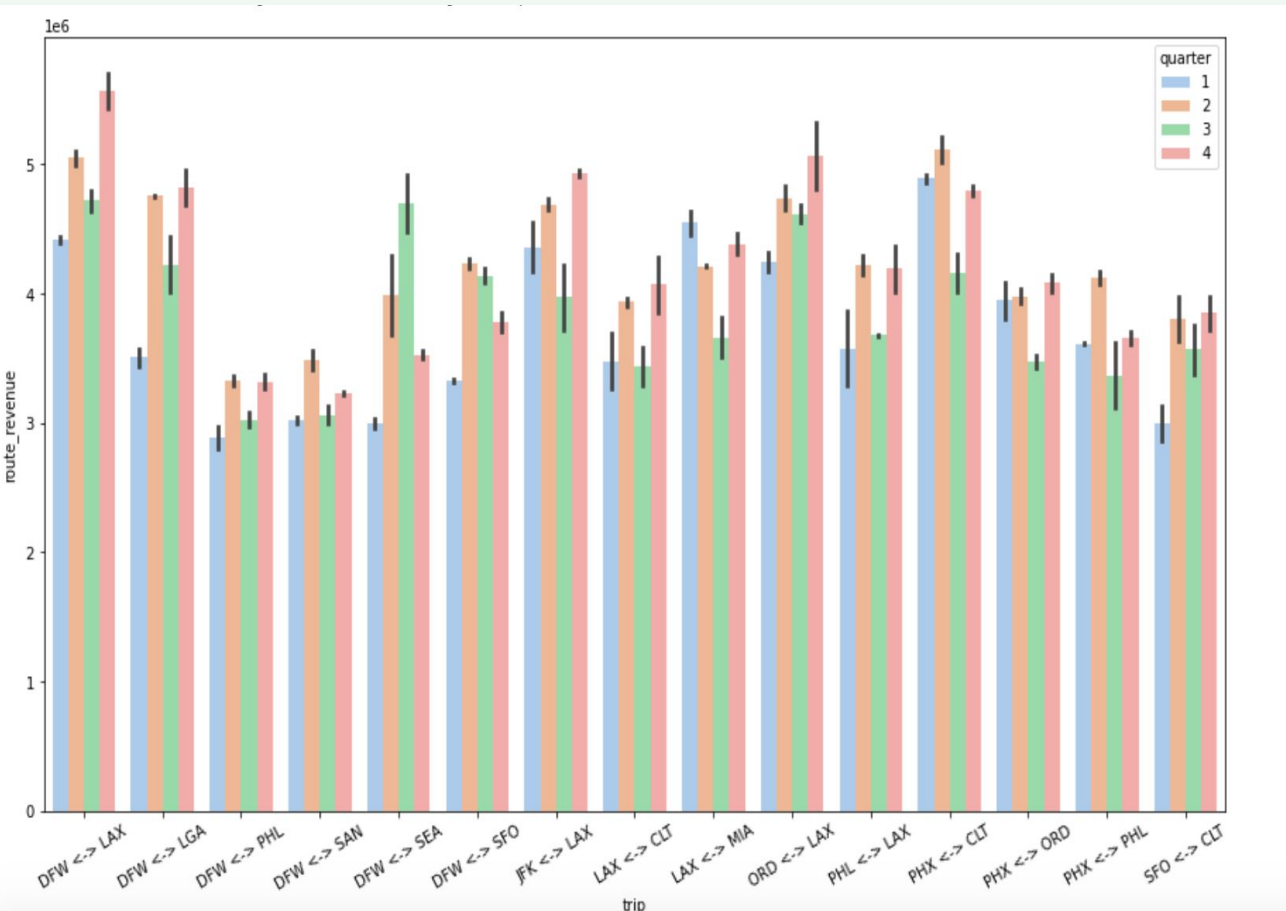


Route revenue (top) vs. Average price (bottom) for AA



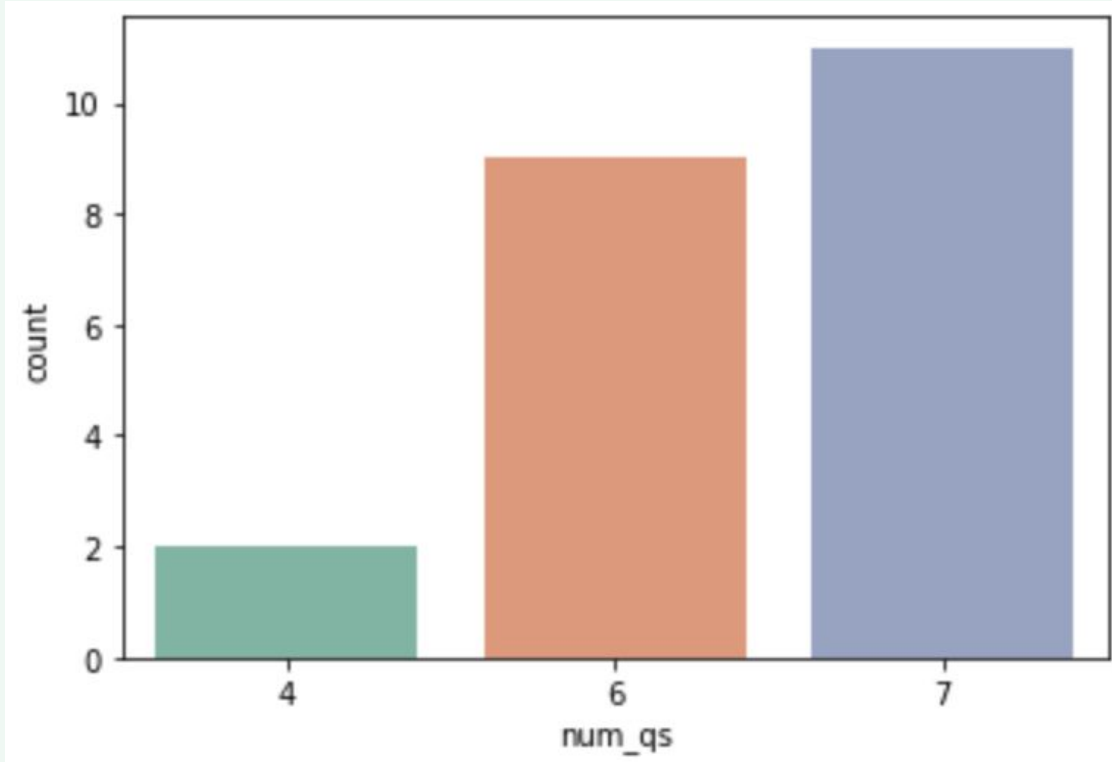
Route revenue (top) vs. Average price (bottom) for UA

When thinking about revenue we will relate it to the **level of individual ticket price**, We visualize **revenue** and their **average ticket price for top 15 revenue-making round trips**, separated by airlines. Two bar plots shown on the left are revenue vs. average price for AA and UA, sorted by descending revenue. It’s shown that different airlines can have different degree of discrepancy. Also, both plots show that the average seat price **does not correspond** to the pattern in revenue.



By further breaking down AA’s revenue by quarters (bar plot above), it’s shown that for a round trip, revenue can be very different in each quarter, therefore it’s interesting to explore what factors cause these **differences among quarters** in further research.

Flight Frequency vs. Revenue



Out of the **top 25 percentile** of profitable flight routes, these are routes that run less than 8 times per year (each route runs for all 4 quarters). For United Airlines alone, the missed revenue adds up to over **\$7.4 million**. This is a margin that could increase UA’s profit margin by **0.3% annually**

Profitable (top 25 percentile) flight routes with **higher revenue (by at least 5%) and lower tickets sold or lower revenue (by 5%) and higher tickets** show significant opportunity for optimization because the cost of operating the flight is the same for both paths. These “discrepancy” routes makeup **4.6% of the profitable routes**.

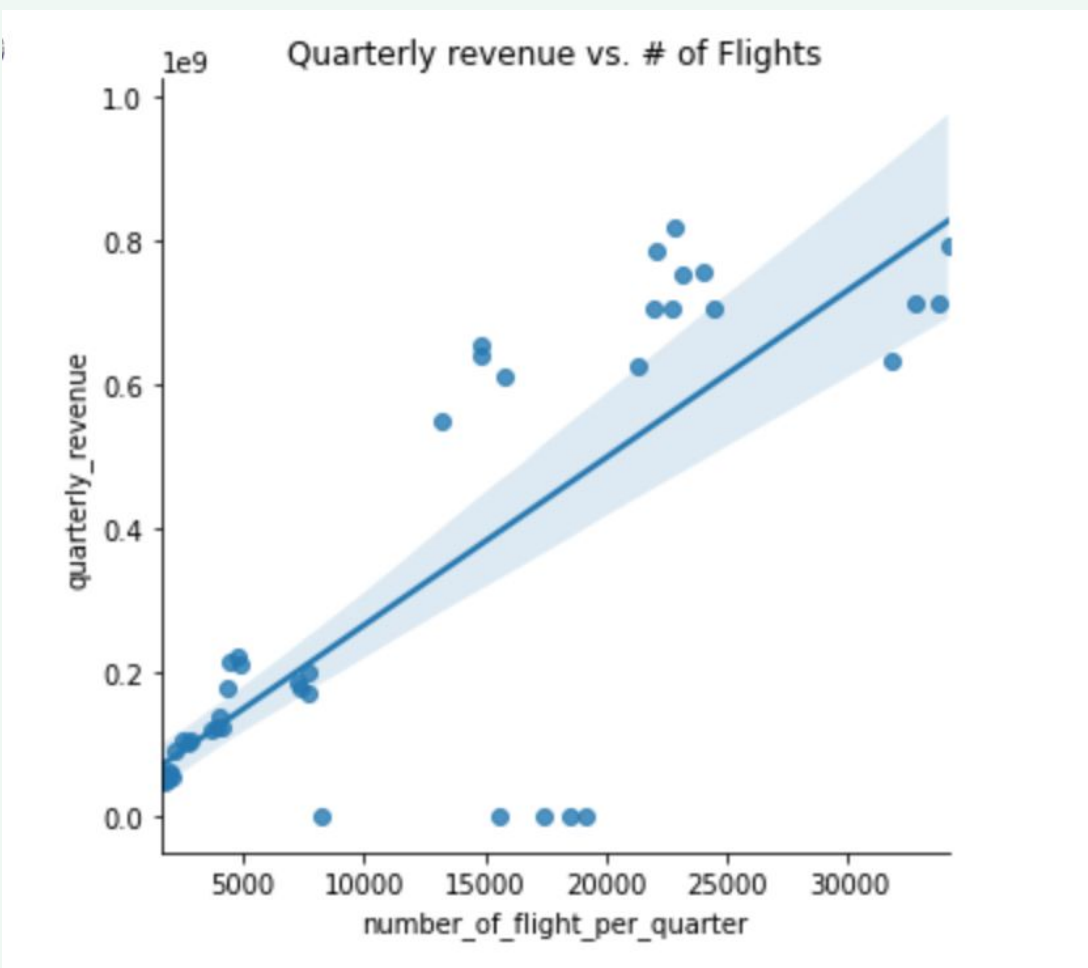


Fig. 1 Quarterly revenue has a positive correlation with number of flights in that quarter

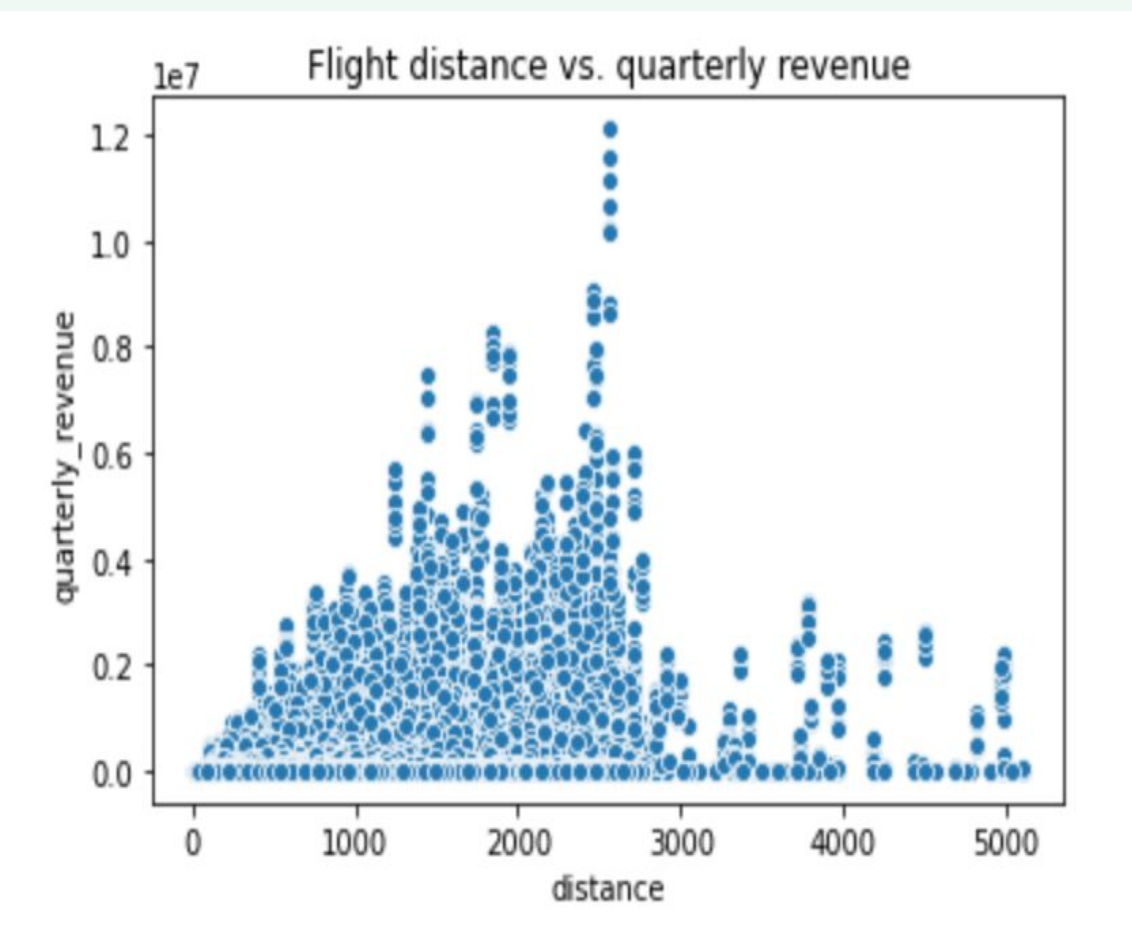


Fig. 2 Quarterly revenue seems to have a positive correlation with flight distance, but there are outliers.

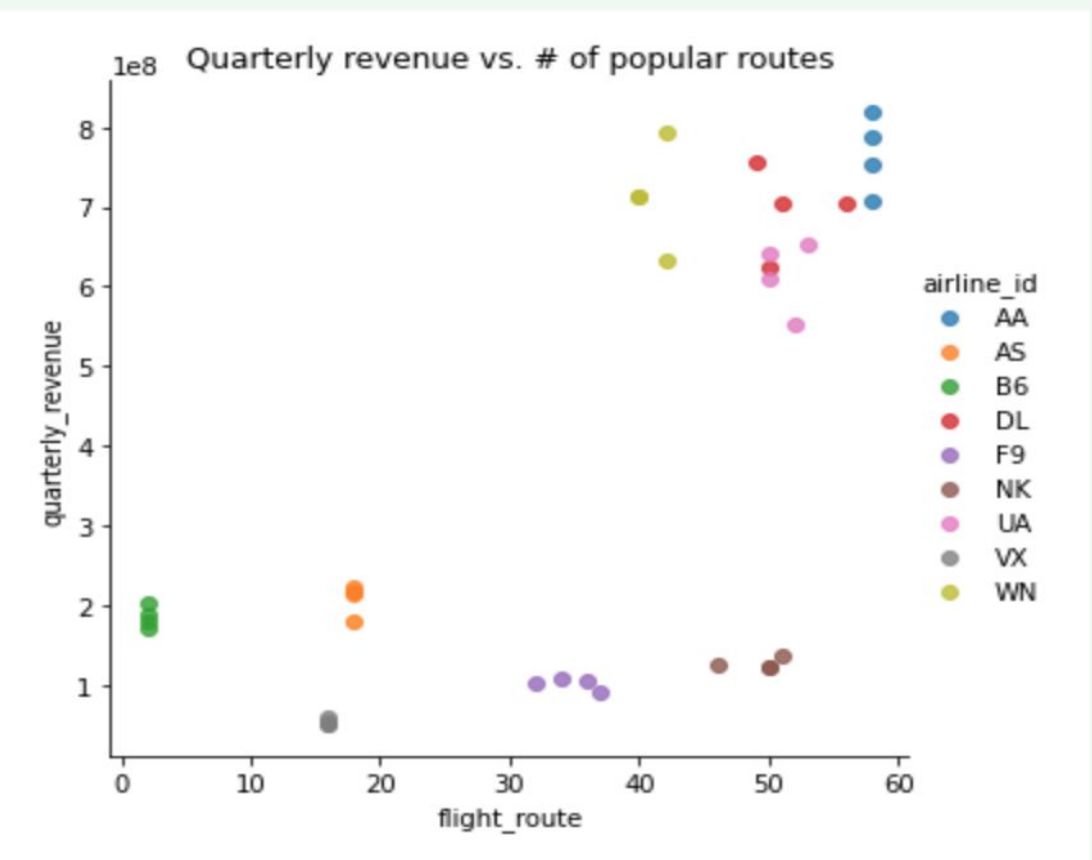
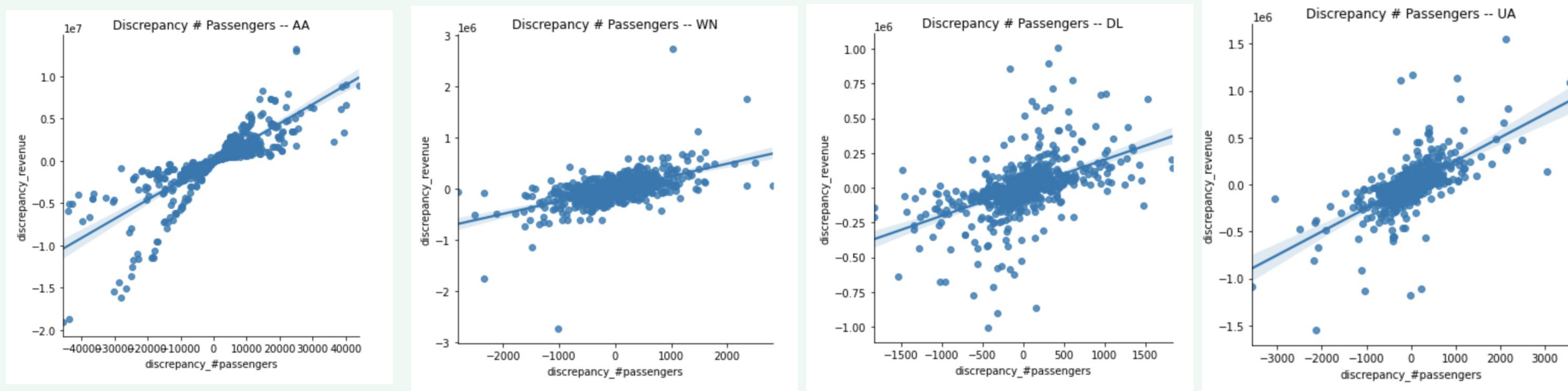


Fig. 3 Quarterly revenue has a positive correlation with number of popular routes, and this correlation differs by airlines

Number of Passengers vs. Revenue

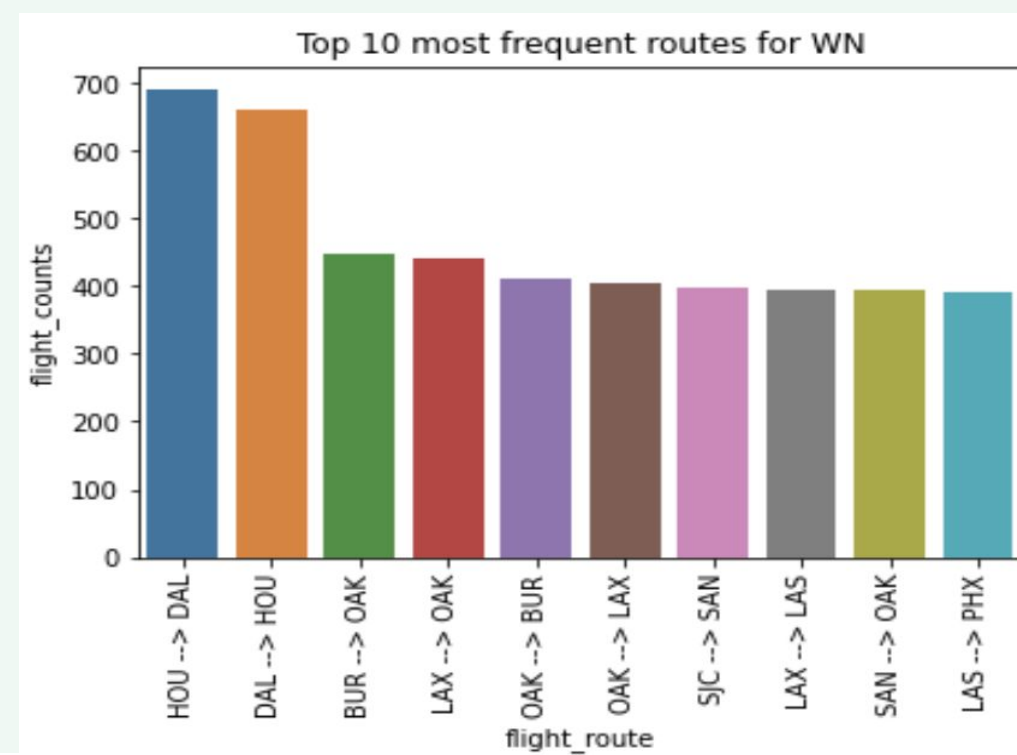
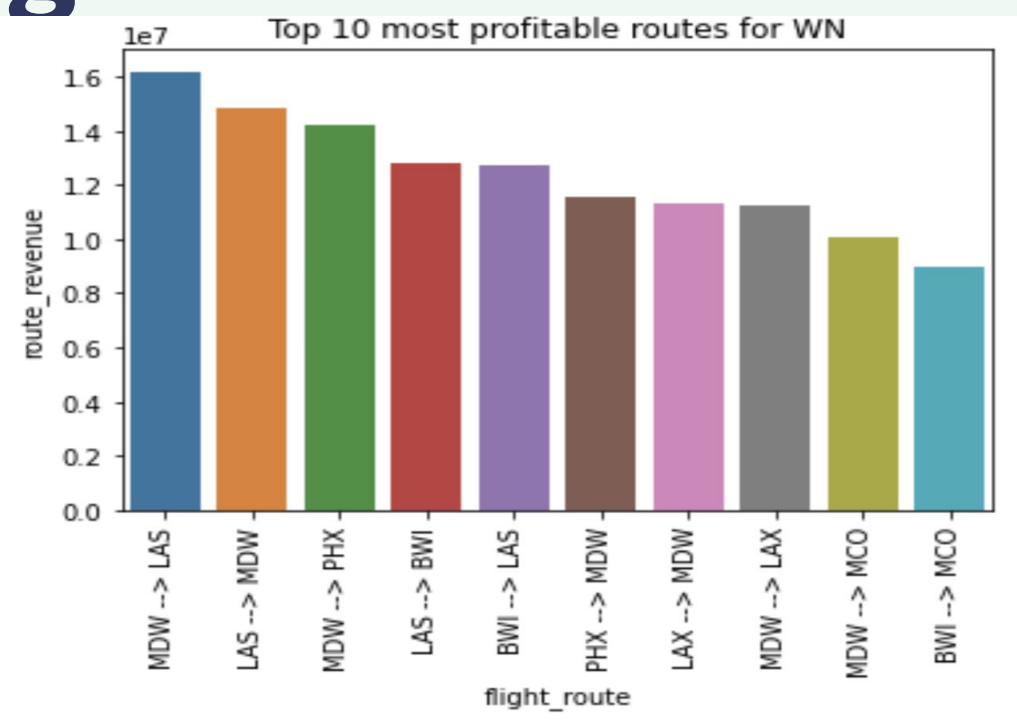


Key observation: As we observe from these graphs, discrepancy in the number of passengers in round trips tend to affect the revenue differently for different airline companies.

Revenue optimization solutions: Airline companies should identify which inbound flights are more popular than outbound flights for the same route, and adjust pricing policy in correspond to the higher demand of passengers or decrease the number of flights for less popular routes.

Profitable Flight Routes vs. Frequent flight routes

In the top right visualization for most profitable flights for Southwest Airlines (WN), the y-axis shows revenue in millions of dollars. From the most profitable flight route between Chicago (MDW) and Las Vegas (LAS), there is a discrepancy in the profit from the flight MDW -> LAS and LAS -> MDW of \$200K. For the same departure and arrival, we can see a trend that **one direction might have a higher potential for revenue optimization** which stems from higher demand or higher customer willingness to pay.



It is worth pointing out that in the lower right visualization, the **most frequent flights are not the most profitable flights**. The most profitable flights span longer distances across the country, while the most popular routes are within a state like Houston <-> Dallas or between Northern California and Southern California.

Further Research

- We hope to look into connecting flights, layovers, and flights which are outbound to large connecting airports or connections to international flights.
- Other factors that might influence marketing, budget allocation, and customer “willingness to pay” such as national conferences, concerts, sporting events, college students relocation.
- Predictive model for quarterly revenue