

# Airlines Data Challenge Solution

**Q1. The 10 busiest round-trip routes in terms of number of round-trip flights in the quarter. Exclude canceled flights when performing the calculation.**

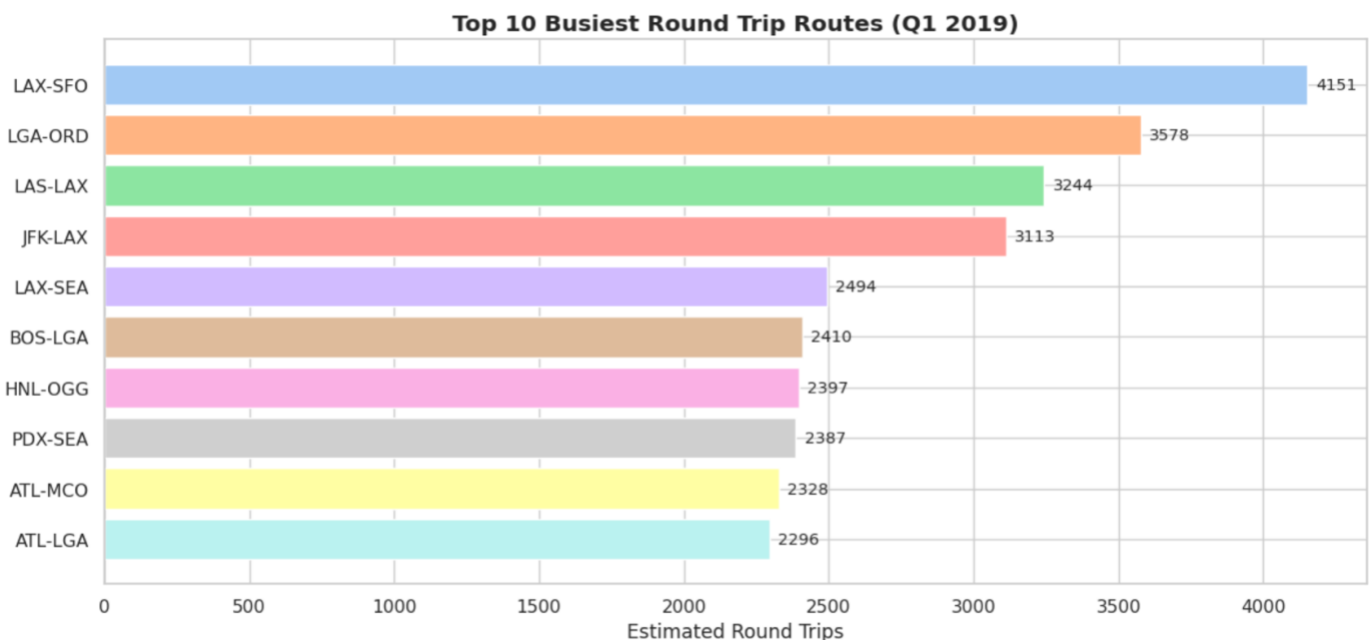
**Output** - This function finds the top 10 busiest round trip routes by counting how often each route is flown and dividing that by two to estimate round trips. It helps show which routes have the most flights and are most used.

Top 10 Busiest Round Trip Routes (Estimated Round Trips):		
	ROUTE	Round_Trips
2147	LAX-SFO	4151
2188	LGA-ORD	3578
2051	LAS-LAX	3244
1995	JFK-LAX	3113
2146	LAX-SEA	2494
548	BOS-LGA	2410
1758	HNL-OGG	2397
2601	PDX-SEA	2387
191	ATL-MCO	2328
187	ATL-LGA	2296

## Data Interpretation - Top 10 Busiest Round Trip Routes (Q1 2019)

This chart shows the 10 routes with the highest number of round trip flights in the first quarter of 2019.

- The LAX-SFO route comes out on top with more than 4100 round trips, showing how busy this short California route is likely due to a mix of business and leisure travel between Los Angeles and San Francisco.
- LGA-ORD and LAS-LAX are also very busy, with over 3200 round trips each, connecting major city hubs and popular tourist destinations.
- JFK-LAX appears both in the most profitable and busiest route lists, making it a key route for both volume and revenue.
- Routes like ATL-LGA, ATL-MCO, and BOS-LGA show how airports like Atlanta, Boston and New York play a big role in connecting different parts of the country.
- Shorter routes such as PDX-SEA and LAX-SEA show strong demand for regional travel especially along the West Coast.



**Q2. The 10 most profitable round trip routes (without considering the upfront airplane cost) in the quarter. Along with the profit, show total revenue, total cost, summary values of other key components and total round trip flights in the quarter for the top 10 most profitable routes. Exclude canceled flights from these calculations.**

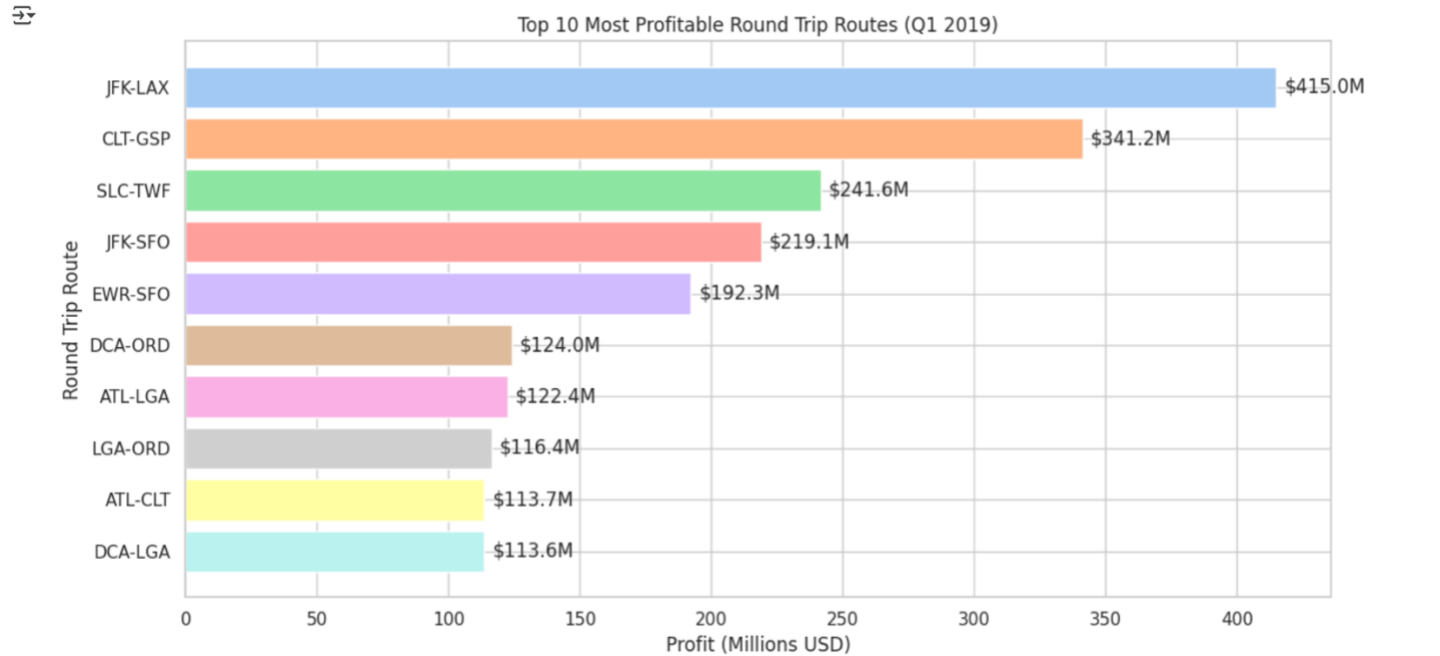
**Output - Top 10 Most Profitable Round Trip Routes**

ROUTE	Flight_Count	Total_Revenue	Total_Cost	Profit	Ticket_Revenue	Baggage_Revenue	Variable_Cost	Delay_Cost	Airport_Cost
JFK-LAX	6226	\$688,339,781	\$273,389,483	\$414,950,298	\$674,180,776	\$14,159,005	\$141,457,833	\$7,411,650	\$124,520,000
CLT-GSP	1547	\$374,659,006	\$33,476,084	\$341,182,921	\$371,141,856	\$3,517,150	\$1,065,110	\$1,470,975	\$30,940,000
SLC-TWF	582	\$251,904,169	\$10,258,608	\$241,645,561	\$250,543,369	\$1,360,800	\$934,983	\$593,625	\$8,730,000
JFK-SFO	3603	\$384,104,766	\$164,991,571	\$219,113,195	\$375,921,241	\$8,183,525	\$85,533,346	\$7,398,225	\$72,060,000
EWB-SFO	2424	\$304,512,360	\$112,258,526	\$192,253,834	\$298,998,565	\$5,513,795	\$57,077,201	\$6,701,325	\$48,480,000

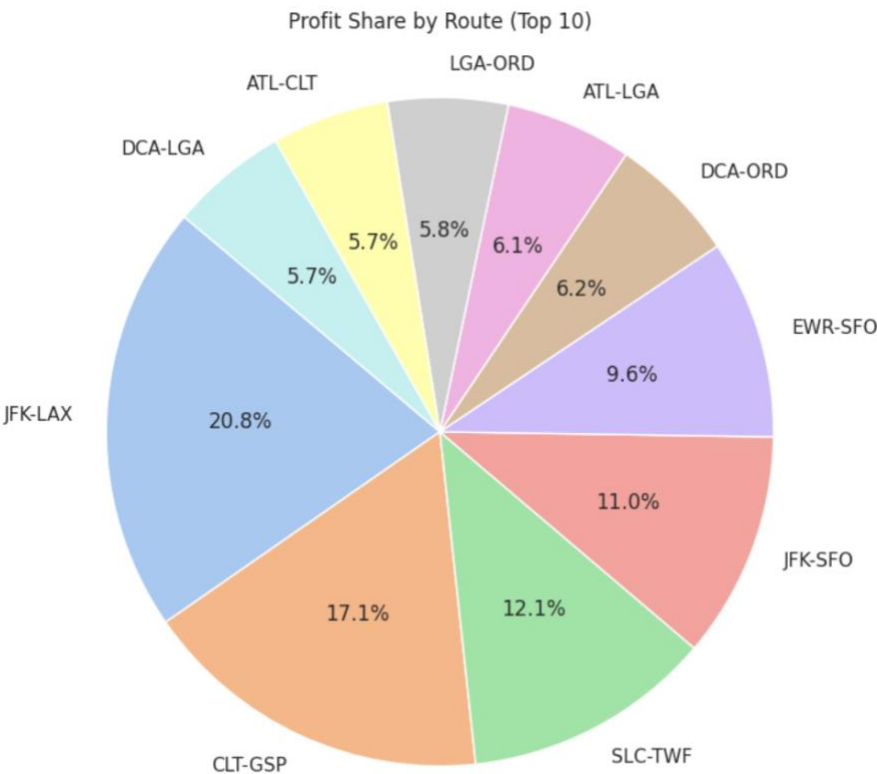
**Data Interpretation – Top 10 Most Profitable Routes**

- The JFK–LAX route stands out as the top profit earner, generating over \$415 million in profit and accounting for nearly 21% of the total among the top 10 routes.
- Routes like CLT–GSP and SLC–TWF also show strong financial performance, with profits of \$341M and \$242M respectively. This suggests that even regional and mid-range routes can deliver high returns when managed effectively.
- Interestingly, several short-haul routes such as DCA–ORD, ATL–LGA, and DCA–LGA made the top 10. This points to the importance of flight frequency and consistent demand, not just distance, in driving profitability.
- Overall, the chart reveals that a small group of routes contribute a large portion of total profit, highlighting the need to prioritize and protect these high-performing city pairs.
- At the same time, routes with smaller profit shares (around 5–6%) still serve a strategic purpose by enhancing network connectivity and supporting broader route ecosystems.

**Data Visualization Plot – Bar Plot**



Pie Chart for displaying the profit share



Q3. The 5 round trip routes that you recommend to invest in based on any factors that you choose.

Output - Top 5 Investment-Worthy Routes

ROUNDTrip_ROUTE	TOTAL_PROFIT	COMBINED_ON_TIME_PCT	AVG_REVENUE_TO_COST_RATIO	AVG_DELAY_COST	AVG_OCCUPANCY_RATE	TOTAL_ROUNDTrip_FLIGHTS	score
JFK-LAX	\$414.95M	84.3%	2.54	1190.435271	0.65	3113.0	0.82
CLT-GSP	\$341.18M	87.5%	11.40	950.856496	0.65	773.5	0.79
SLC-TWF	\$241.65M	86.2%	25.45	1019.974227	0.67	291.0	0.75
JFK-SFO	\$219.11M	76.2%	2.35	2053.351374	0.65	1801.5	0.56
EWR-SFO	\$192.25M	71.9%	2.75	2764.573020	0.65	1212.0	0.52

Summary of Route Investment Recommendation Analysis

To support data-driven expansion decisions, a scoring-based model was developed to identify the top five round-trip routes that are most suitable for future investment. This model evaluates routes not only on financial performance but also on key operational efficiency indicators.

**Methodology Summary** The analysis uses a composite scoring system to rank each round-trip route. The score is calculated by weighing several performance factors:

- Total Profit (50% weight) – Measures the absolute financial return from the route.
- On-Time Performance (20%) – Combines departure and arrival punctuality.
- Revenue-to-Cost Efficiency (15%) – Indicates how much revenue is generated per unit of cost.
- Average Delay Cost (10%) – Routes with lower delay-related expenses score higher.

- Occupancy Rate (5%) – Reflects how well the aircraft capacity is being utilized.

This scoring approach ensures that routes are evaluated holistically, balancing profitability with service quality and cost control. The output is sorted by score, and the top five routes are selected for investment consideration.

Data Interpretation of Top 5 Investment-Worthy Routes

- JFK–LAX leads with the highest score and profit, making it a clear strategic priority. Its combination of strong demand, good punctuality, and efficiency makes it a top-tier investment route.
- CLT–GSP offers strong profitability with the lowest average delay cost and excellent on-time performance, indicating high operational reliability.
- SLC–TWF stands out for its remarkable cost efficiency (25.45 revenue-to-cost ratio), suggesting lean operations and strong fare optimization.
- While JFK–SFO and EWR–SFO remain profitable, their lower scores are driven by higher delay-related costs and less favorable on-time metrics, indicating areas for operational improvement.

Strategic Recommendations

- Prioritize investment in JFK–LAX and SLC–TWF, where both profitability and efficiency align.
- Monitor and improve operational reliability on routes like EWR–SFO to unlock greater profit potential.
- Use this scoring framework quarterly to re-evaluate route performance and support agile decision-making for capacity planning and aircraft allocation.

**Q4. The number of round trip flights it will take to breakeven on the upfront airplane cost for each of the 5 round trip routes that you recommend. Print key summary components for these routes.**

Output –

ROUNDRIP_ROUTE	TOTAL_PROFIT	TOTAL_ROUNDTRIP_FLIGHTS	Profit_per_Round_Trip_million	BreakEven_Trips_Required	score
JFK-LAX	\$414.95M	3113	\$0.13M	675	0.82
CLT-GSP	\$341.18M	773	\$0.44M	204	0.79
SLC-TWF	\$241.65M	291	\$0.83M	108	0.75
JFK-SFO	\$219.11M	1801	\$0.12M	740	0.56
EWR-SFO	\$192.25M	1212	\$0.16M	567	0.52

Summary

The `calculate_break_even_roundtrips()` function estimates how many round trip flights are required for each of the top 5 investment-worthy routes to recover the upfront cost of a \$90 million airplane. It does so by calculating the profit generated per round trip (in millions) and dividing the total aircraft cost by this per-trip profit to determine the break-even point. The function also formats key performance indicators such as total profit, total round trips, profit per trip, break-even trip count, and the investment score for clear presentation. The inclusion of the score in this analysis is important, as it reflects a weighted combination of financial and operational KPIs including profitability, on-time performance, cost efficiency, delay impact, and occupancy rate. While the break-even figure shows how quickly a route can repay an aircraft investment, the score helps validate whether that route is also reliable, efficient, and strategically sustainable. This ensures that investment decisions are not based solely on revenue potential, but also on long-term route performance.

Key Columns Explanation

ROUNDTRIP\_ROUTE: Route the plane is dedicated to. TOTAL\_PROFIT: Total profit generated from this route during the quarter. TOTAL\_ROUNDTRIP\_FLIGHTS: Total round trip flights flown for the route. Profit\_per\_Round\_Trip\_million: Average profit made per round trip flight (in millions). BreakEven\_Trips\_Required: Number of round trip flights needed to recover the \$90M airplane cost. score: Investment attractiveness score from Q3.

Data Interpretation - Break-Even Analysis for Top 5 Routes

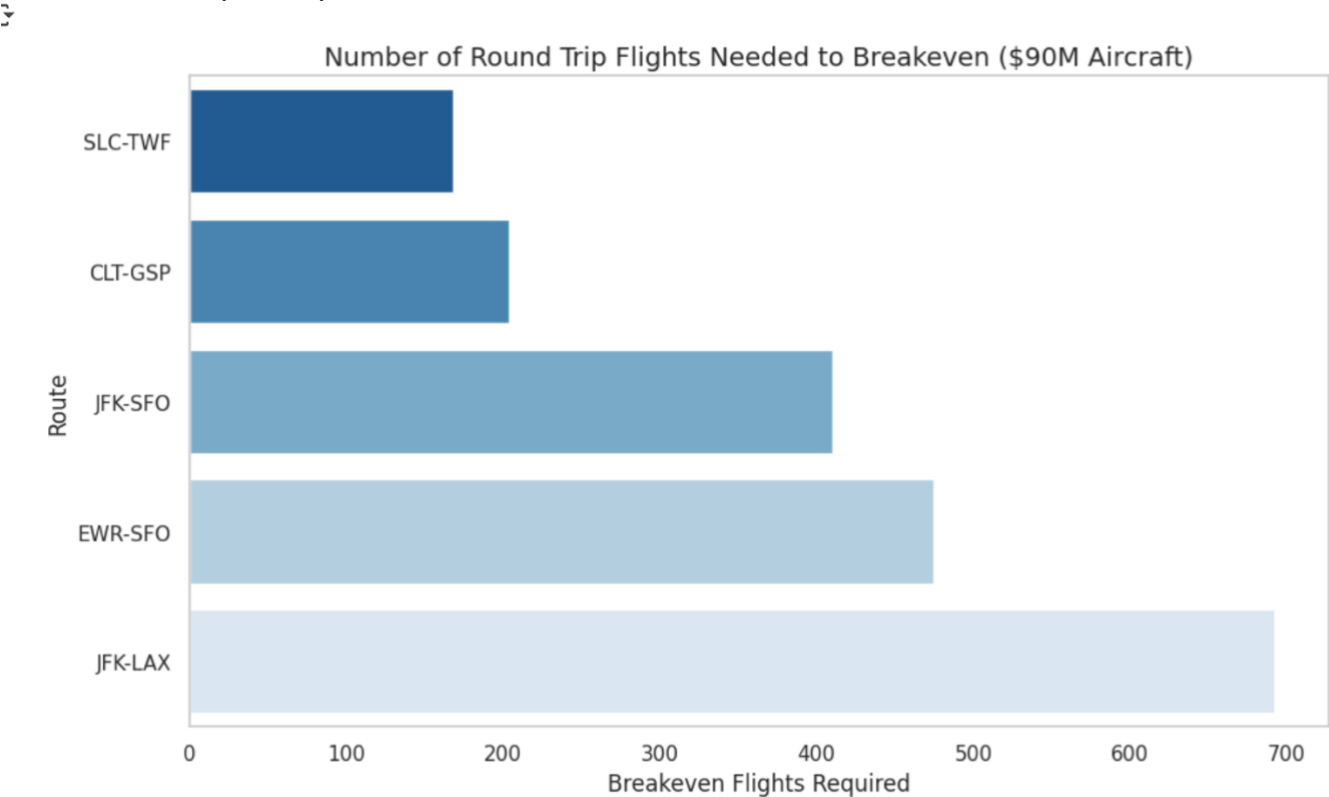
- SLC–TWF stands out as the most cost-effective route, needing only 108 round trips to recover the \$90M investment, thanks to its high profit per trip of \$0.83M.
- CLT–GSP also shows strong efficiency, requiring just 204 trips to break even, with a healthy \$0.44M profit per trip.
- JFK–LAX, despite generating the highest overall profit (\$414.95M), needs 675 trips to break even due to its lower per-trip margin (\$0.13M).
- JFK–SFO and EWR–SFO have decent total profits, but higher delay costs and lower per-trip profits push their break-even points to 740 and 567 trips, respectively.
- Overall, the results show that routes with higher profit margins per trip (even if flown less frequently) can achieve break-even much faster than high-volume routes with lower efficiency.

Strategic Takeaways:

- Prioritize aircraft deployment to SLC-TWF and CLT-GSP for fastest ROI.
- JFK-LAX is profitable overall but needs a longer timeline.
- EWR-SFO and JFK-SFO should be reconsidered unless operational costs or delays are reduced.

**Conclusion** - Investments should target routes with high per-flight profit and quick breakeven timelines. Operationally efficient, medium-scale routes present the best starting point for maximizing return on aircraft investment.

Data Visualization (Bar Plot)



## Q5. Key Performance Indicators (KPI's) that you recommend tracking in the future to measure the success of the round trip routes that you recommend.

**Objective-** To ensure the long-term success of the top 5 recommended round trip routes, a set of financial, operational, and customer-centric Key Performance Indicators (KPIs) should be continuously tracked. These KPIs will enable proactive decision-making, investment validation, and route optimization.

**1. Financial KPIs:** These metrics directly reflect the revenue generation and profitability of each aircraft and route.

- **Total Profit per Route** Measures the cumulative earnings generated by each route over time. It provides a direct view of financial contribution and helps evaluate overall route viability.
- **Profit per Round Trip:** Assesses the average profit generated from a single round trip. This metric is essential for understanding the efficiency and return on investment of each flight cycle.
- **Baggage Revenue per Flight:** Tracks growth in ancillary revenue.
- **Revenue-to-Cost Ratio:** A critical financial efficiency metric that compares total revenue to operating costs. Higher ratios indicate that the route is generating strong returns relative to what it costs to operate.

**2. Operational KPIs:** Critical for maintaining brand promise and minimizing avoidable cost.

- **On-Time Performance (Departure and Arrival)** Reflects the percentage of flights operating on schedule. This KPI directly impacts customer satisfaction and helps reduce operational penalties and downstream disruptions.
- **Average Delay Cost per Flight:** Quantifies the financial burden of delays. Tracking this helps identify operational bottlenecks and encourages improvements in scheduling and turnaround efficiency.

**3. Demand & Utilization KPIs:** These indicators reflect aircraft efficiency, demand strength, and route performance.

- **Occupancy Rate:** Indicates how efficiently seats are being filled. A high load factor typically suggests strong market demand and optimized fleet usage.
- **Passenger Count per Flight:** Volume indicator for route popularity.

**4. Growth & Strategic KPIs:** These help validate the long-term ROI and investment effectiveness.

- **Break-Even Round Trip Count** Tracks how quickly an investment in a new aircraft can be recovered based on route profitability. This is useful for capital planning and route scaling.
- **Route ROI (Cumulative):** Include Route ROI (Cumulative) as a long-term financial KPI, tracked quarterly or annually alongside profit and occupancy. It adds depth to break-even analysis by showing not just when the investment is recovered, but how efficiently the route multiplies that return over time.

**Conclusion:** Establishing a standardized KPI framework enables ongoing monitoring of both financial and operational health of each investment route. These KPIs should be integrated into weekly and monthly dashboards to support fleet management, strategic planning, and profitability tracking. By actively tracking these KPIs, the airline can ensure its investment routes remain both financially sound and operationally reliable. This data-driven approach will support smarter route optimization, fleet deployment, and long-term profitability.