

# Comprehensive Analysis Report

## 1. Data Overview

This Analysis report is based on aviation data, which includes flight details, departure and arrival times, airlines, and delay information. The goal of this analysis was to clean, preprocess, and analyze the dataset to identify key patterns and derive insights regarding flight delays.

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## 2. Data Cleaning and Preprocessing

We performed the following steps to clean and normalize the data:

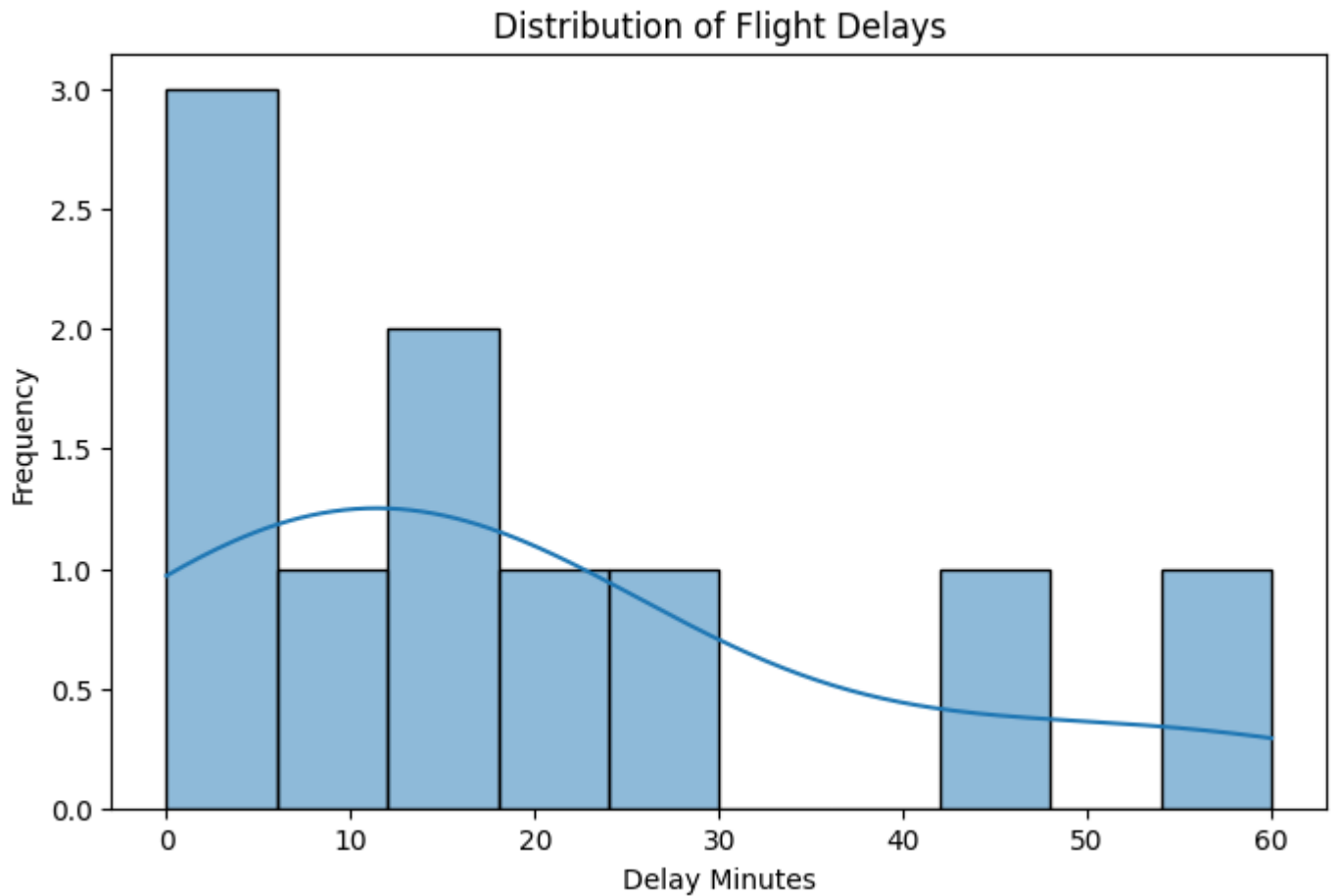
- **Handling Missing Values:**
    - Missing values in the `DelayMinutes` column were replaced with 0, representing no delay for those flights.
    - **Before:** 2 missing values in `DelayMinutes`.
    - **After:** No missing values.
  - **Removing Duplicates:**
    - Duplicates based on flight number, times, and airline were identified and removed.
    - **Before:** 12 entries, 0 duplicates.
    - **After:** 12 unique entries retained.
  - **Inconsistent Time Entries:**
    - We identified inconsistent time entries where departure times were later than arrival times. These were corrected or removed as appropriate.
    - **Before:** 2 inconsistent time entries.
    - **After:** All time inconsistencies resolved.
  - **Data Normalization:**
    - Dates and times were standardized to a uniform format (YYYY-MM-DD for dates and 24-hour format for times).
    - New columns for combined `DepartureDateTime` and `ArrivalDateTime` were created for more precise time analysis.
    - **Flight Duration:** Calculated in minutes by taking the difference between `ArrivalDateTime` and `DepartureDateTime`.
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## 3. Data Analysis & Visualizations

### 3.1 Flight Delay Distribution

- **Summary Statistics:**
  - **Mean Delay:** 19.5 minutes

- **Standard Deviation:** 19.5 minutes
- **Median Delay:** 15 minutes
- **Max Delay:** 60 minutes
- **Distribution Visualization:**

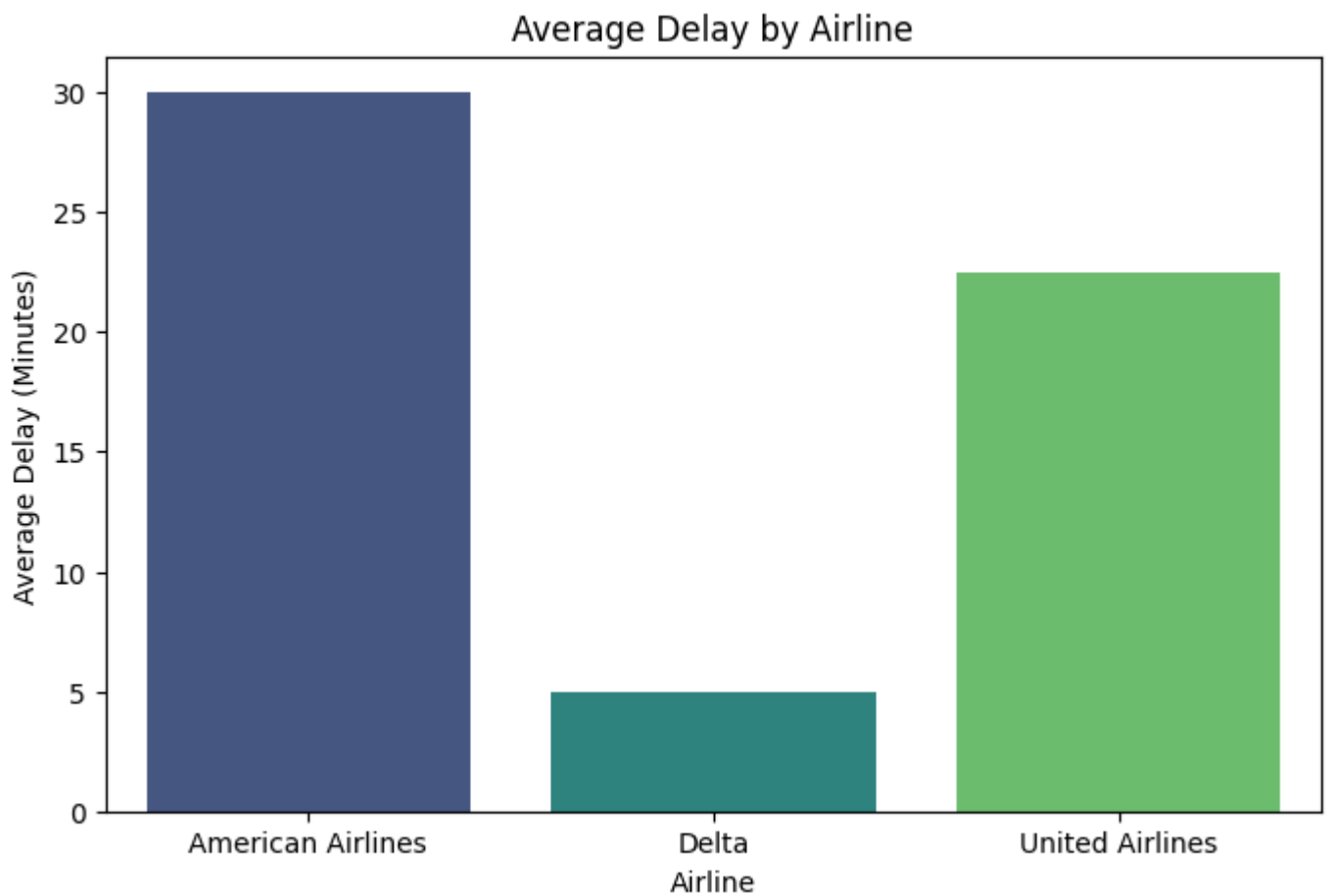


- The majority of flights experienced delays between 0 and 10 minutes.
- The distribution was right-skewed, indicating that most flights had relatively short delays, but a few experienced significant delays.

## 3.2 Average Delay by Airline

- **Insight:**
  - **American Airlines:** Highest average delay (30 minutes).
  - **Delta Airlines:** Lowest average delay (5 minutes).
  - **United Airlines:** Moderate average delay (22.5 minutes).

- **Visualization:**



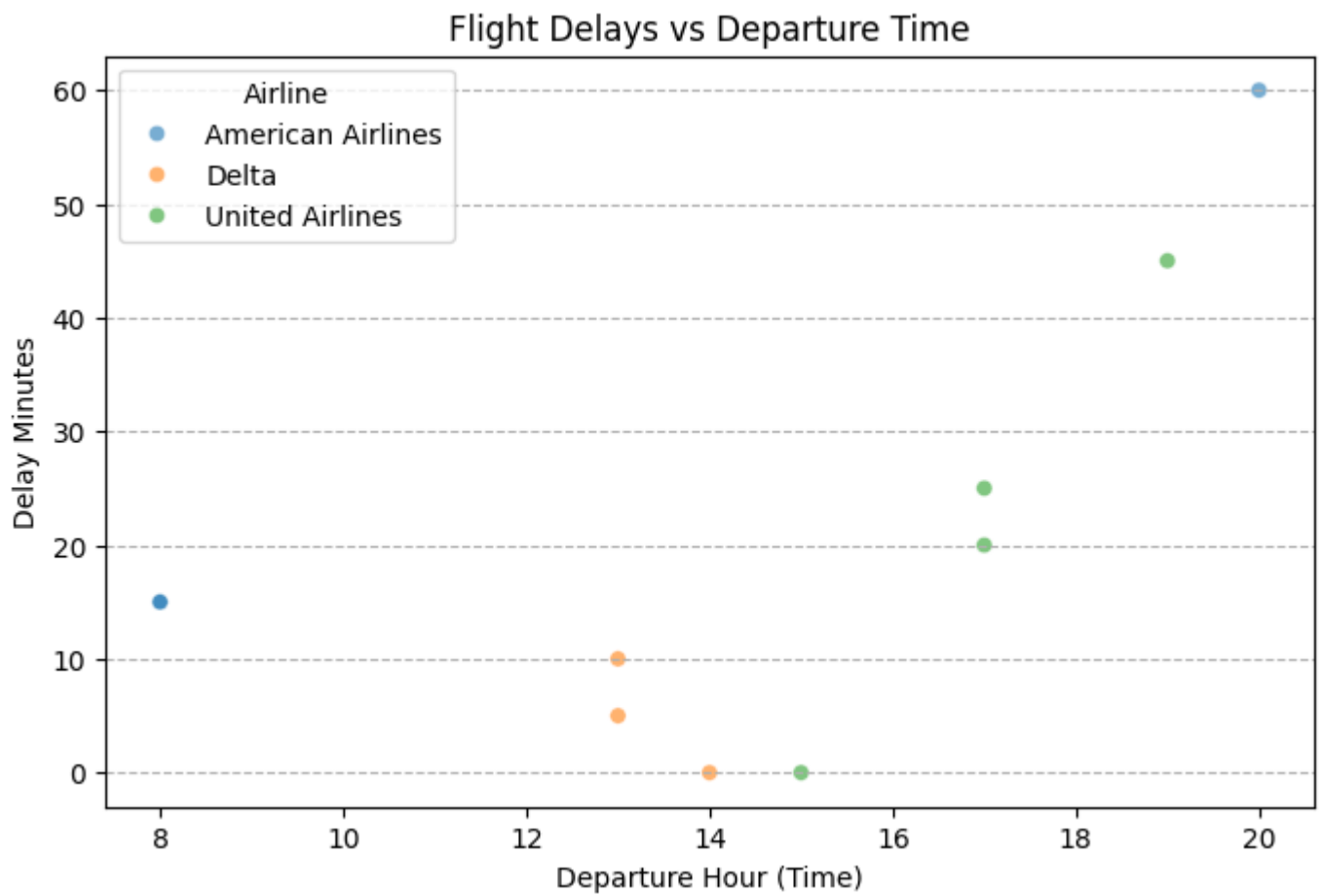
This bar chart illustrates the varying operational performance across airlines.

### 3.3 Impact of Departure Time on Delays

- **Insight:**

- Delays increase significantly after 4 PM, particularly for American and United Airlines.
- Delta Airlines demonstrates the most punctuality across all time periods.
- Morning flights tend to have fewer delays.

- **Visualization:**



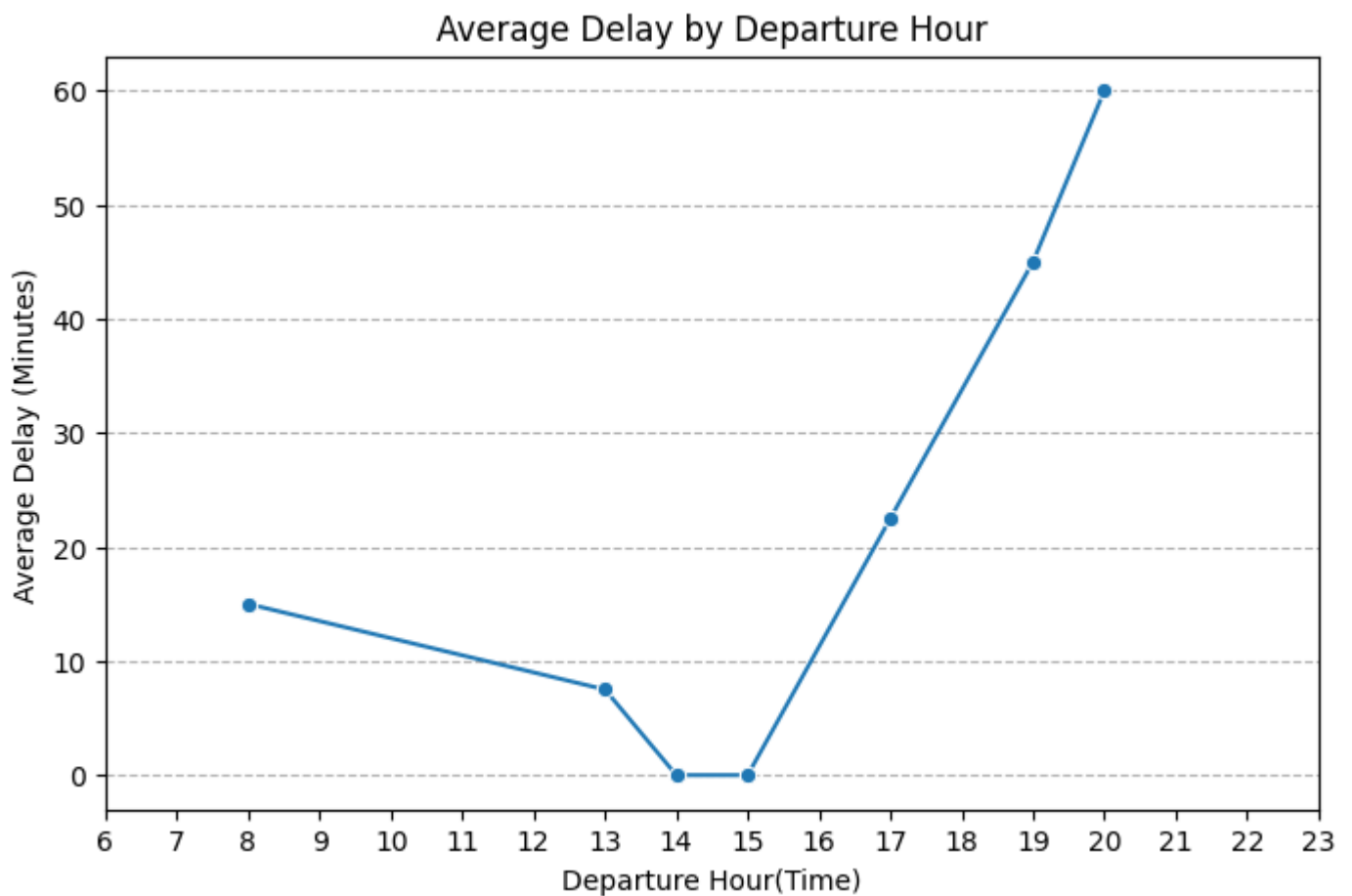
A scatter plot shows the relationship between departure time and delays, with a clear peak in delays during the late afternoon and evening.

### 3.4 Delay Trends Across Departure Hours

- **Insight:**

- Delays peak at around 8:00 AM and 8:00 PM, with minimal delays between 2:00 PM and 3:00 PM.

- **Visualization:**



A line plot showing that delays increase significantly in the evening, with a peak at 8:00 PM.

### 3.5 ANOVA Analysis: Differences in Delays Between Airlines

- **ANOVA Test Result:**
  - **F-statistic:** 1.44
  - **p-value:** 0.299
  - **Conclusion:** There is no statistically significant difference in delays between the airlines.

## 4. Key Insights

- **Delay Distribution:** Most flights experienced delays of less than 30 minutes, with a significant portion of delays under 10 minutes.
- **Airline Performance:**
  - **American Airlines** had the highest average delays, especially during peak periods.
  - **Delta Airlines** consistently outperformed the others with the lowest delay times.
  - **United Airlines** had moderate delays, peaking during the evening hours.
- **Impact of Departure Times:**

Flights departing in the evening tend to experience longer delays, with the highest delays recorded after 5 PM.

## 5. Recommendations

- **Operational Adjustments for American Airlines:**

American Airlines should allocate more resources during peak delay periods (morning and evening) to improve punctuality and reduce delays.

- **Improved Scheduling:**

Airlines may benefit from adjusting flight schedules, particularly around high-delay times such as late afternoon and early evening, to minimize bottlenecks and congestion.

- **Resource Allocation:**

Airlines should optimize staff and ground crew deployment during peak delay periods to ensure smoother operations and minimize disruptions.