

An Examination of Departure Delays

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Introduction

As the number of passengers on flights has increased, rising fuel costs, decreasing levels of customer service, and the occasional terrible public relations story has left the airline industry reeling. One of the most common passenger complaints is having a flight delay. Our goal is to better understand departure delays in an effort to improve overall adherence to schedule.

Data

We were provided information about a sample of 500 flights from 2008 collected by the Bureau of Transportation Statistics.

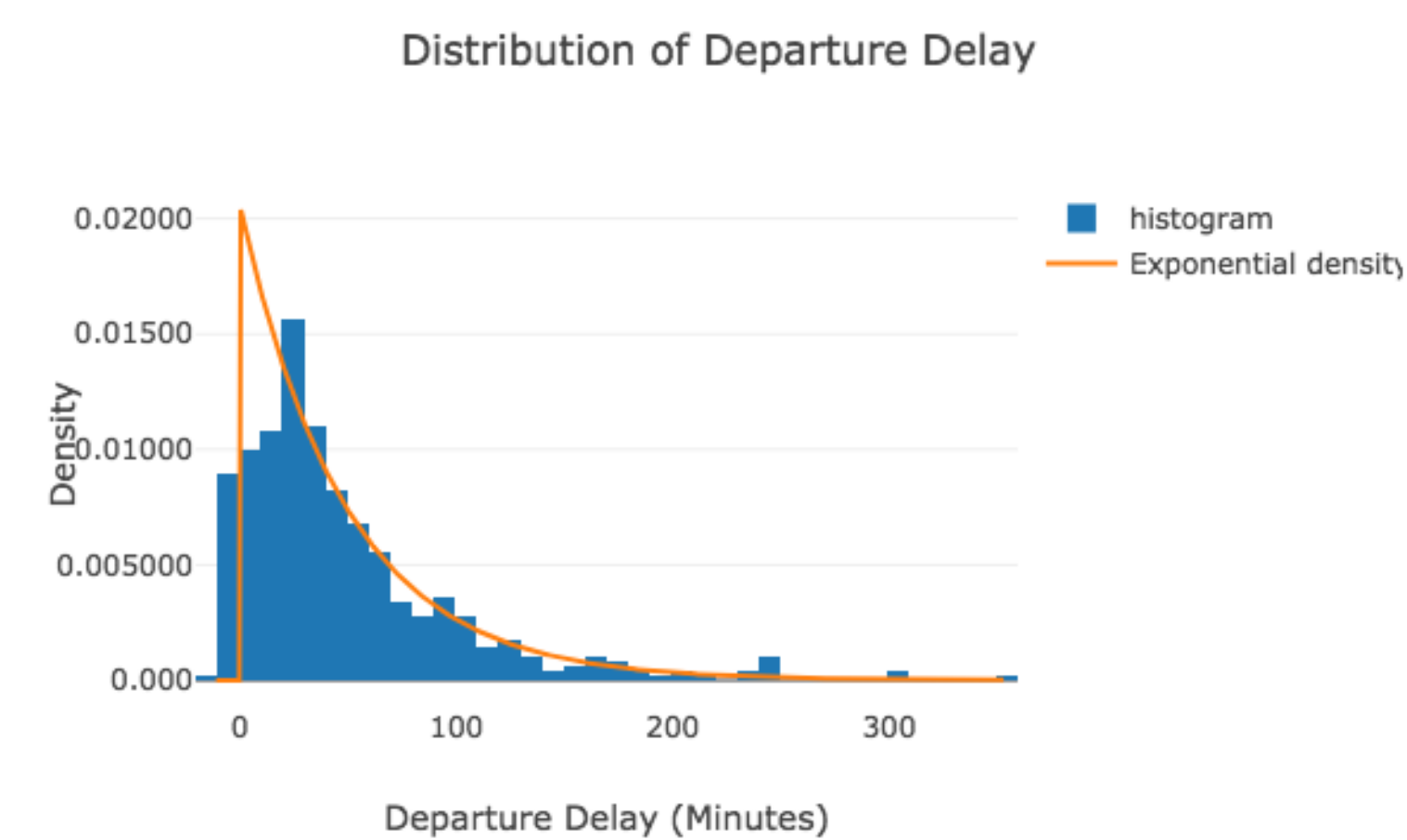
- Variable of interest: Departure Delay (Mean: 48.678 minutes, Standard Deviation: 52.68 minutes)
- Other Variables:
- Day of Week: Friday most popular, Sunday least popular
- Arrival Delay (Mean: 55.81 minutes, Standard Deviation of 49.76 minutes)

Table 1: Distribution of Day of the Week

Day	Flights
Monday	75 (15%)
Tuesday	69 (13.8%)
Wednesday	69 (13.8%)
Thursday	70 (13.8%)
Friday	94 (18.8%)
Saturday	63 (12.6%)
Sunday	60 (12%)

Distribution of Response Variable

Given that the airlines are working hard to maintain the flight schedule in order to minimize flight disruption costs and customer dissatisfaction (and given anecdotal evidence), most of the flights likely have a short departure delay of between 10-20 minutes with an average delay of 30 minutes or less.



We note the following about the distribution:

- Large standard deviation with respect to the mean
- 25% of flights are below 15.5 minutes is evidence that most flight delays are non-trivial
- One mode at approximately 40-50 minutes
- Skewed to the right
- Potential outliers at 250, and 300 minutes
- Approximately 40 flights with zero or negative delays meaning they left early

Hypothesis

- Null Hypothesis: True average departure delay is 30 minutes.
- Alternate Hypothesis: True average departure delay is less than 30 minutes
- Z-Score: 7.9283
- P-Value: Approximately 1
- Most similar to the exponential distribution
- For all reasonable levels we do not find evidence for a true average departure delay less than 30 minutes.

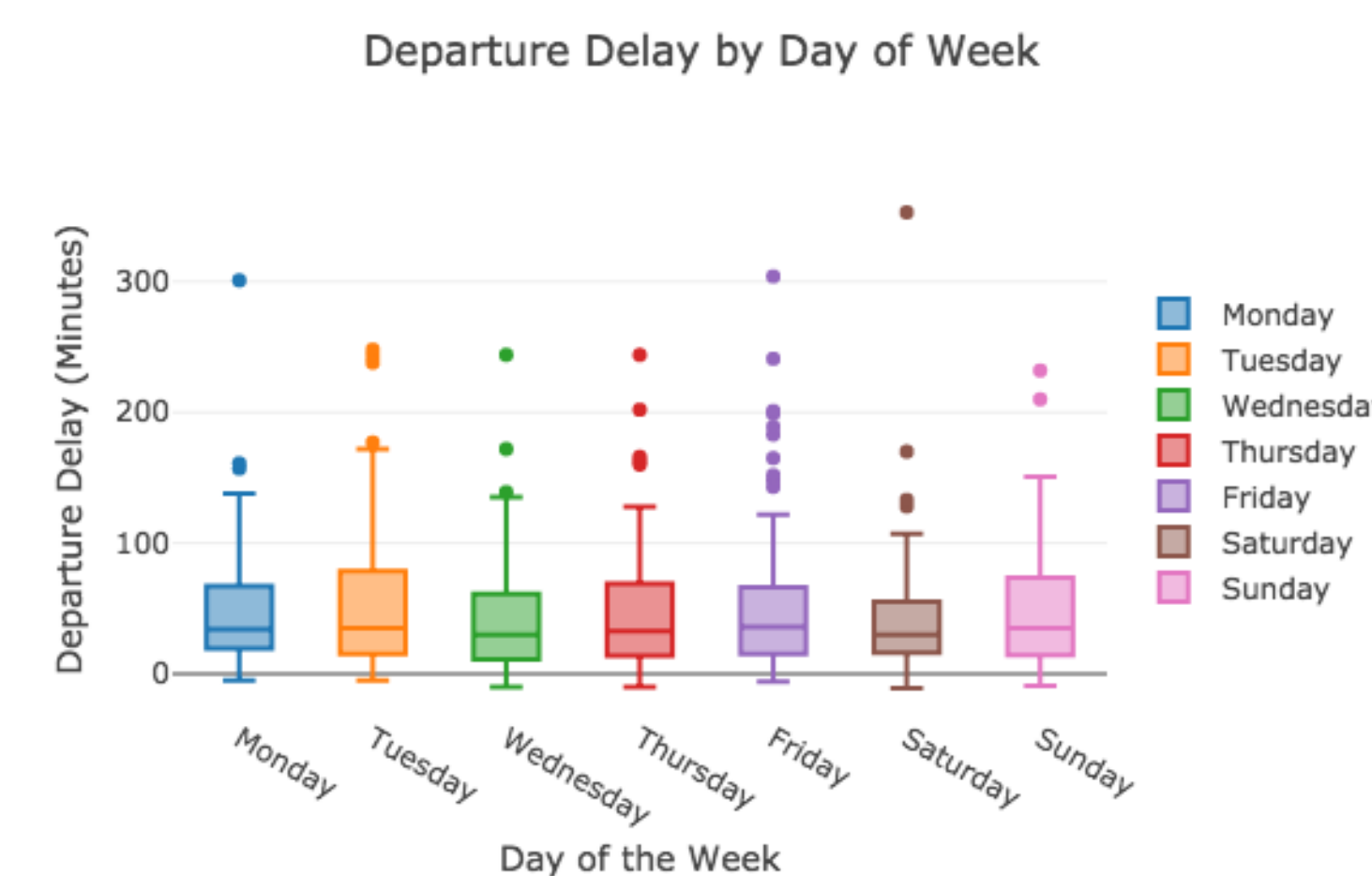
Scenario 1: Departure Delay and Day of Week

As there are groups of people flying at different times (business commuters on Monday morning, Thursday evening; tourists on Friday morning, Sunday night), it seems reasonable that there might be different distributions of departure delays on different days.

Table 2: Departure Delay by Day of the Week

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Mean Delay	48.4	53.52	44.52	46.4	52.93	44.1	49.05
Std. Dev Delay	47.88	56.64	47.6	52.22	58.57	53.42	50.86

- The median values appear to be similar for most days save for a slightly higher departure delay on Tuesdays
- Longer average delay on Friday may be explained by large outliers
- Large spreads imply that there is not enough evidence to claim that a relationship exists between departure delay and day of the week



Hypothesis

- Null Hypothesis: The mean departure delay time is the same for all days of the week
- Alternate Hypothesis: At least one mean differs from the rest
- F-Score: 0.37
- P-Value: 0.898
- Fail to reject the null hypothesis. We do not have evidence that departure delay differs by day.

Scenario 2: Departure Delay and Arrival Delay Dependent on Late Aircraft

Although a flight's goal is to have no departure or arrival delays, it seems highly likely that any flight with a departure delay will have an arrival delay. If the problem stems from a late aircraft, airlines may be able to make up more time and reduce the arrival delay. We hypothesize that there is a positive linear relationship between arrival delay and departure delay and that this relationship depends on whether or not there is a late aircraft.

Figure 3

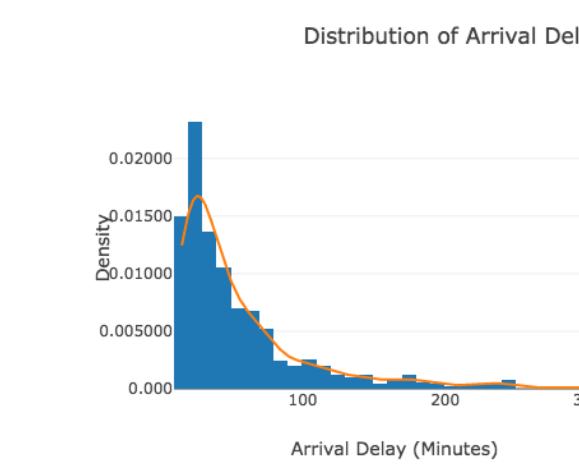
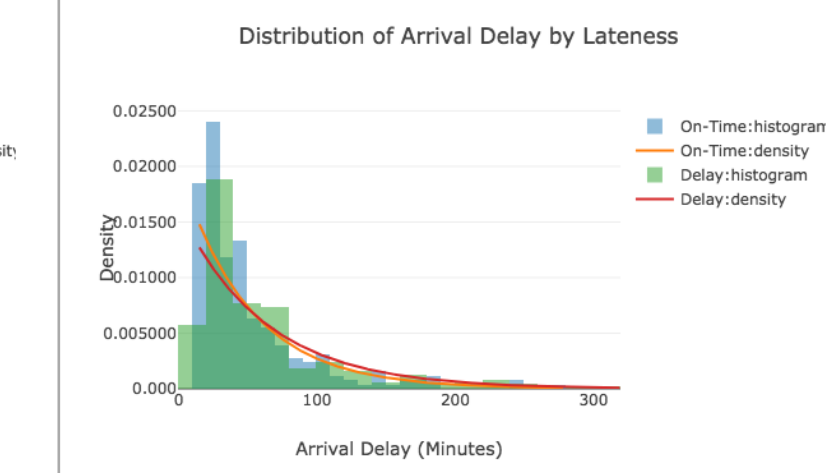


Figure 4



- The distribution of arrival delay for delayed aircraft is shifted to the right and appears to have a larger skew
- Both distributions seem to have similar medians
- The data-driven density suggests that arrival delay follows an exponential distribution

Hypothesis

- Null Hypothesis: The correlation between departure delay and arrival delay is 0
- Alternate Hypothesis: There is a positive correlation between departure and arrival delay
- P-Value: Approximately 0
- Linear Regression Model estimates $ArrDelay = 13.65 + 0.866 * DepDelay$
- Correlation of 0.917
- Reject null hypothesis and have evidence that there is a positive correlation

Scenario 3: Arrival and Departure Delay Linear Regression

With respect to whether this relationship depends on the presence of a late aircraft, we build two regression models - one for the flights with a late aircraft and one for the flights without a late aircraft, including the correlation (Table 3).

Table 3: Predict Arrival Delay with Departure Delay dependent on Late Aircraft

	Late (n = 246; 49.2%)	On Time (n = 254; 50.8%)
Intercept	4.630	20.346
Departure Delay	0.950	0.790
Correlation	0.960	0.861
Z-Score	53.56	26.87
P-Value	Near 0	Near 0

- Use one-sided correlation test
- Null Hypothesis: There is not a correlation between departure and arrival delay controlling for lateness
- Alternate Hypothesis: There is a positive correlation between departure and arrival delay controlling for lateness
- We reject the null hypothesis for each group and have evidence for positive correlations

Discussion

Our analysis focused on departure delays for a sample of 500 flights from 2008 and examined potential relationships with arrival delays, late aircrafts, and day of the week. Overall, we found that flights have a large range of departure delays with the majority between 30-60 minutes. We did not see a strong relationship with day of the week due to the large variation in delays across all days. While the relationship between arrival delay and departure delay was strong (as expected), it did not seem to change much whether or not there was a late aircraft. Future analyses might include season as well; we would expect delays to be weather-dependent. We might also ask the BTS for airline carrier info. There are likely some airlines with lengthier average delays than others.