Delay Analysis for USA Aviation

Business Scenario

Problem statement:

According to air travel consumer reports, a large proportion of consumer complaints are about frequent flight delays.
Out of all the complaints received from consumers about airline services, 32% were related to cancellations, delays, or other deviations from the airlines' schedules.
There are unavoidable delays that can be caused by air traffic, no passengers at the airport, weather conditions, mechanical issues, passengers coming from delayed connecting flights, security clearance, and aircraft preparation.

Objective:

The objective of this project is to identify the factors that contribute to avoidable flight delays.
You are also required to build a model to predict if the flight will be delayed.

Dataset Snapshot

Airlines.xlsx

id	Airline	Flight	AirportFror	AirportTo	DayOfWeek	Time	Length	Delay
1	CO	269	SFO	IAH	3	15	205	1
2	US	1558	PHX	CLT	3	15	222	1
3	AA	2400	LAX	DFW	3	20	165	1
4	AA	2466	SFO	DFW	3	20	195	1
5	AS	108	ANC	SEA	3	30	202	0
6	CO	1094	LAX	IAH	3	30	181	1
7	DL	1768	LAX	MSP	3	30	220	0
8	DL	2722	PHX	DTW	3	30	228	0
9	DL	2606	SFO	MSP	3	35	216	1
10	AA	2538	LAS	ORD	3	40	200	1
11	CO	223	ANC	SEA	3	49	201	1
12	DL	1646	PHX	ATL	3	50	212	1
13	DL	2055	SLC	ATL	3	50	210	0
14	AA	2408	LAX	DFW	3	55	170	0
15	AS	132	ANC	PDX	3	55	215	0
16	US	498	DEN	CLT	3	55	179	0
17	B6	98	DEN	JFK	3	59	213	0
18	CO	1496	LAS	IAH	3	60	162	0
19	DL	1450	LAS	MSP	3	60	181	0
20	CO	507	ONT	IAH	3	75	167	0

Dataset Description

Airlines.xlsx

Variables	Description
id	Flight number
Airline	Type of commercial airlines
Flight	Type of aircraft
AirportFrom	Source airport
AirportTo	Destination airport
DayOfWeek	Day of the week
Time	Departure time measured in minutes from midnight (range is from 10 to 1439)
Length	Duration of the flight in minutes
Delay	If the flight is delayed

Dataset Snapshot

airports.xlsx

id	ident	type	name	latitude_de	longitude_	elevation_	continent	iso_countr	iso_region	municipali	scheduled_	gps_code
6523	00A	heliport	Total Rf Helip	40.0708008	-74.933601	11	NA	US	US-PA	Bensalem	no	00A
323361	00AA	small_airport	Aero B Ranch	38.704022	-101.47391	3435	NA	US	US-KS	Leoti	no	00AA
6524	00AK	small_airport	Lowell Field	59.947733	-151.69252	450	NA	US	US-AK	Anchor Point	no	00AK
6525	00AL	small_airport	Epps Airpark	34.8647995	-86.770302	820	NA	US	US-AL	Harvest	no	00AL
6526	00AR	closed	Newport Hos	35.6087	-91.254898	237	NA	US	US-AR	Newport	no	
322127	00AS	small_airport	Fulton Airport	34.9428028	-97.818019	1100	NA	US	US-OK	Alex	no	00AS
6527	00AZ	small_airport	Cordes Airpo	34.3055992	-112.165	3810	NA	US	US-AZ	Cordes	no	00AZ
6528	00CA	small_airport	Goldstone (G	35.35474	-116.88533	3038	NA	US	US-CA	Barstow	no	00CA
324424	00CL	small_airport	Williams Ag /	39.427188	-121.76343	87	NA	US	US-CA	Biggs	no	00CL
322658	00CN	heliport	Kitchen Creel	32.7273736	-116.45974	3350	NA	US	US-CA	Pine Valley	no	00CN
6529	00CO	closed	Cass Field	40.622202	-104.344	4830	NA	US	US-CO	Briggsdale	no	
6531	00FA	small_airport	Grass Patch /	28.6455002	-82.219002	53	NA	US	US-FL	Bushnell	no	00FA
6532	00FD	closed	Ringhaver He	28.8466	-82.345398	25	NA	US	US-FL	Riverview	no	
6533	00FL	small_airport	River Oak Air	27.2308998	-80.9692	35	NA	US	US-FL	Okeechobee	no	00FL
6534	00GA	small_airport	Lt World Airp	33.7675018	-84.068298	700	NA	US	US-GA	Lithonia	no	00GA
6535	00GE	heliport	Caffrey Helip	33.887982	-84.736983	957	NA	US	US-GA	Hiram	no	00GE
6536	00HI	heliport	Kaupulehu He	19.832881	-155.97835	43	OC	US	US-HI	Kailua-Kona	no	00HI
6537	00ID	small_airport	Delta Shores	48.1453018	-116.214	2064	NA	US	US-ID	Clark Fork	no	00ID
322581	00IG	small_airport	Goltl Airport	39.724028	-101.39599	3359	NA	US	US-KS	McDonald	no	00IG
6538	00II	closed	Bailey Genera	41.644501	-87.122803	600	NA	US	US-IN	Chesterton	no	

Dataset Description

airports.xlsx

Variables	Description
id	This is an identifier for the airport. It will stay persistent even if the airport code changes.
ident	This is the text identifier used in the *OurAirports* URL. This will be the International Civil Aviation Organization (ICAO) code if available. Otherwise, it will be a local airport code (if there is no conflict) or will be an internally-generated code starting with the ISO2 country code followed by a dash and a four-digit number.
type	This shows the type of the airport. The values allowed here are *closed_airport*, *heliport*, *large_airport*, *medium_airport*, *seaplane_base*, and *small_airport*.
name	This shows the official name of the airport, including *Airport* and *Airstrip*
latitude_deg	This shows the latitude of the airport in decimal degrees (north is positive).
longitude_deg	This shows the longitude of the airport in decimal degrees (east is positive).

Dataset Description

airports.xlsx

Variables	Description
elevation_ft	This shows the elevation MSL of the airport in feet (not meters).
continent	This shows the code for the continent where the airport is (primarily) located. The allowed values include *AF* (Africa), *AN* (Antarctica), *AS* (Asia), *EU* (Europe), *NA* (North America), *OC* (Oceania), or *SA* (South America).
iso_country	This shows the two-character ISO 3166:1-alpha2 code for the country where the airport is (primarily) located. A handful of unofficial, non-ISO codes are also in use, such as *XK* for Kosovo.
iso_region	This is an alphanumeric code for the high-level administrative subdivision of a country where the airport is primarily located (e.g., province and governorate) prefixed by the ISO2 country code and a hyphen. *OurAirports* uses ISO 3166:2 codes whenever possible, preferring higher administrative levels, but also includes some custom codes.
municipality	This shows the primary municipality that the airport serves (when available). Note that this is not necessarily the municipality where the airport is physically located.

Dataset Description

airports.xlsx

Variables	Description
scheduled_service	This shows *yes* if the airport currently has scheduled airline service and *no* if otherwise.
gps_code	This shows the code that an aviation GPS database (such as, Jeppesen's or Garmin's) would normally use for the airport. This will always be the ICAO code if one exists. Note that, unlike the *ident* column, this is not guaranteed to be globally unique.
iata_code	This shows the three-letter IATA code for the airport (if it has one).
local_code	This shows the local country code for the airport if it’s different from the *gps_code* and *iata_code* fields (used mainly for US airports).
home_link	This shows the URL of the airport's official home page on the web if one exists.
wikipedia_link	This shows the URL of the airport's page on Wikipedia if one exists.
Keywords	This field contains other keywords or phrases to assist with the search. These are separated by a comma. It may also include former names for the airport, alternate codes, names in other languages, and nearby tourist destinations.

Dataset Snapshot

runways.xlsx

id	airport_ref	airport_ident	length_ft	width_ft	surface	lighted	closed	le_ident	le_latitude_d	le_longitude_	le_elevation_	le_heading_c
269408	6523	00A	80	80	ASPH-G	1	0	H1				
255155	6524	00AK	2500	70	GRVL	0	0	N				
254165	6525	00AL	2300	200	TURF	0	0	1				
270932	6526	00AR	40	40	GRASS	0	0	H1				
322128	322127	00AS	1450	60	Turf	0	0	1				
257681	6527	00AZ	1700	60	GRAVEL	0	0	15				
245528	6528	00CA	6000	80	ASPH	0	0	4	35.3493004	-116.893		50
250597	6529	00CO	3900	20	TURF-G	0	0	16				
247972	6531	00FA	3200	100	TURF	0	0	8				
265037	6532	00FD	74	74	TURF	0	0	H1				
250414	6533	00FL	4090	100	TURF	0	0	12				
253429	6534	00GA	2600	80	TURF	0	0	9				
265038	6535	00GE	125	95	ASPH	1	0	H1				
265039	6536	00HI	1155	45	ASPH-G	0	0	H1				
246648	6537	00ID	3300	40	TURF	0	0	8				
246649	6537	00ID	2700	40	TURF	0	0	11				
252182	6539	00IL	2500	75	TURF-F	0	0	18				
265040	6540	00IN	40	40	MATS	1	0	H1				
254597	6541	00IS	1600	70	TURF	0	0	9				
256603	6542	00KS	2600	85	TURF	0	0	17				

Dataset Description

runways.xlsx

Variables	Description
id	This shows the internal *OurAirports* integer identifier for the runway. This will stay persistent even if the runway numbering changes.
airport_ref	This shows the internal integer foreign key matching the *id* column for the associated airport in **airports.csv**. Here, *airport_ident* is a better alternative.
airport_ident	This shows the externally-visible string foreign key matching the *ident* column for the associated airport in **airports.csv**.
length_ft	This shows the length of the full runway surface (including displaced thresholds and overrun areas) in feet.
width_ft	This shows the width of the runway surface in feet.
surface	This shows the code for the runway surface type. This is not a controlled vocabulary yet but probably will be soon. Some common values include *ASP* (asphalt), *TURF* (turf), *CON* (concrete), *GRS* (grass), *GRE* (gravel), *WATER* (water), and *UNK* (unknown).

Dataset Description

runways.xlsx

Variables	Description
lighted	This shows *1* if the surface is lit at night and *0* if not. Note that this is inconsistent with **airports.csv** which uses *yes* and *no* instead.)
closed	This shows *1* if the runway surface is currently closed and *0* if not.
le_ident	This shows the identifier for the low-numbered end of the runway.
le_latitude_deg	This shows the latitude of the center of the low-numbered end of the runway in decimal degrees (north is positive) if available.
le_longitude_deg	This shows the longitude of the centre of the low-numbered end of the runway in decimal degrees (east is positive) if available.
le_elevation_ft	This shows the elevation above MSL of the low-numbered end of the runway in feet.
le_heading_degT	This shows the heading of the low-numbered end of the runway in degrees true (not magnetic).

Dataset Description

runways.xlsx

Variables	Description
le_displaced_threshold_ft	This shows the length of the displaced threshold (if any) for the low-numbered end of the runway in feet.
he_ident	This shows the identifier for the high-numbered end of the runway.
he_latitude_deg	This shows the latitude of the centre of the high-numbered end of the runway in decimal degrees (north is positive) if available.
he_longitude_deg	This shows the longitude of the centre of the high-numbered end of the runway in decimal degrees (east is positive) if available.
he_elevation_ft	This shows the elevation above MSL of the high-numbered end of the runway in feet.
he_heading_degT	This shows the heading of the high-numbered end of the runway in degrees true (not magnetic).
he_displaced_threshold_ft	This shows the length of the displaced threshold (if any) for the high-numbered end of the runway in feet.

Project Task: Week 1

Applied data science with Python

1. Import and aggregate data:

   a. Collect information related to flights, airports (e.g., type of airport and elevation), and runways (e.g., *length_ft*, *width_ft*, *surface*, and number of runways). Gather all fields you believe might cause avoidable delays in one dataset.

Hint: In this case, you would have to determine the keys to join the tables. A data description will be useful.

   b. When it comes to on-time arrivals, different airlines perform differently based on the amount of experience they have. The major airlines in this field include US Airways Express (founded in 1967) Continental Airlines (founded in 1934), and Express Jet (founded in 19860. Pull such information specific to various airlines from the Wikipedia page link given below. https://en.wikipedia.org/wiki/List_of_airlines_of_the_United_States.

Hint: Here, you should use web scraping to learn how long an airline has been operating.

Project Task: Week 1

Applied data science with Python

   c. You should then get all the information gathered so far in one place.

   d. The total passenger traffic may also contribute to flight delays. The term *hub* refers to busy commercial airports. *Large hubs* are airports that account for at least 1 percent of the total passenger enplanements in the United States. Airports that account for 0.25 percent to 1 percent of total passenger enplanements are considered medium hubs. Pull passenger traffic data from the Wikipedia page given below using web scraping and collate it in a table.

      https://en.wikipedia.org/wiki/List_of_the_busiest_airports_in_the_United_States

2. You should then examine the missing values in each field, perform missing value treatment, and justify your actions.

Project Task: Week 1

Applied data science with Python

3. Perform data visualization and share your insights on the following points:
   a. According to the data provided, approximately 70% of Southwest Airlines flights are delayed. Visualize it to compare it with the data of other airlines.
   b. Flights were delayed on various weekdays. Which day of the week is the safest for travel?
   c. Which airlines should be recommended for short-, medium-, and long-distance travel?
   d. Do you notice any patterns in the departure times of long-duration flights?
4. How many flights were delayed at large hubs compared to medium hubs? Use appropriate visualization to represent your findings.

Project Task: Week 1

Applied data science with Python

5. Use hypothesis testing strategies to discover:
   a. If the airport's altitude has anything to do with flight delays for incoming and departing flights
   b. If the number of runways at an airport affects flight delays
   c. If the duration of a flight (length) affects flight delays

Hint: Test this from the perspective of both the source and destination airports

6. Find the correlation matrix between the flight delay predictors, create a heatmap to visualize this, and share your findings

Project Task: Week 1

Machine learning

1. Use OneHotEncoder and OrdinalEncoder to deal with categorical variables
2. Perform the following model building steps:
   a. Apply logistic regression (use stochastic gradient descent optimizer) and decision tree models
   b. Use the stratified five-fold method to build and validate the models

Note: Make sure you use standardization effectively, ensuring no data leakage and leverage pipelines to have a cleaner code

   c. Use RandomizedSearchCV for hyperparameter tuning, and use k-fold for cross-validation
   d. Keep a few data points (10%) for prediction purposes to evaluate how you would make the final prediction, and do not use this data for testing or validation

Project Task: Week 1

Machine learning

Note: The final prediction will be based on the voting (majority class by 5 models created using the stratified 5-fold method)

   g. Compare the results of logistic regression and decision tree classifier

3. Use the stratified five-fold method to build and validate the models using the XGB classifier, compare all methods, and share your findings

Project Task: Week 2

Tableau

1. Create a dashboard in Tableau by selecting appropriate chart types and metrics for the business

Note: Put more emphasis on data storytelling

Project Task: Week 2

Excel

1. Create an Excel dashboard showcasing the following (use form controls to make a dynamic chart):
   a. Compare different airlines based on their on-time performance
   b. Compare the percentage of delayed flights for different days of the week
   c. Create a trend chart for the number of passengers at large and medium hubs
   d. Visualize the count of delayed and on-time flights for different pairs of source and destination airports
      - Create a dynamic chart that allows users to select a source and destination airport.

Project Task: Week 2

SQL

1. Determine the number of flights that are delayed on various days of the week
2. Determine the number of delayed flights for various airlines
3. Determine how many delayed flights land at airports with at least 10 runways
4. Compare the number of delayed flights at airports higher than average elevation and those that are lower than average elevation for both source and destination airports

Delay Analysis for USA Aviation

In [1]:
```
# Let's import the necessary library.
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
%matplotlib inline
```

In [2]:
```
# Let's remove the unnecessary warnings.
import warnings
warnings.filterwarnings("ignore")
```

Project Task: Week 1 (Applied data science with Python)

1. Import and aggregate data:

a. Collect information related to flights, airports (e.g., type of airport and elevation), and runways (e.g., length_ft, width_ft, surface, and number of runways). Gather all fields you believe might cause avoidable delays in one dataset.

Hint: In this case, you would have to determine the keys to join the tables. A data description will be useful.

In [3]:
```
# Now let's import the data for the further operation.
airline = pd.read_excel("Airlines.xlsx")
```

In [4]:
```
airline.shape
```

Out[4]:
```
(518556, 9)
```

In [5]:
```
airline.head()
```

Out[5]:

	id	Airline	Flight	AirportFrom	AirportTo	DayOfWeek	Time	Length	Delay
0	1	CO	269	SFO	IAH	3	15	205	1
1	2	US	1558	PHX	CLT	3	15	222	1
2	3	AA	2400	LAX	DFW	3	20	165	1
3	4	AA	2466	SFO	DFW	3	20	195	1
4	5	AS	108	ANC	SEA	3	30	202	0

In [6]:
```
airpot = pd.read_excel("airports.xlsx")
```

In [7]:
```
airpot.shape
```

Out[7]:
```
(73805, 18)
```

In [8]:
```
airpot.head()
```

Out[8]:

	id	ident	type	name	latitude_deg	longitude_deg	elevation_ft	continent	iso_
0	6523	00A	heliport	Total Rf Heliport	40.070801	-74.933601	11.0	NaN	
1	323361	00AA	small_airport	Aero B Ranch Airport	38.704022	-101.473911	3435.0	NaN	
2	6524	00AK	small_airport	Lowell Field	59.947733	-151.692524	450.0	NaN	
3	6525	00AL	small_airport	Epps Airpark	34.864799	-86.770302	820.0	NaN	
4	6526	00AR	closed	Newport Hospital & Clinic Heliport	35.608700	-91.254898	237.0	NaN	

In [9]:
```
runway = pd.read_excel("runways.xlsx")
```

In [10]:
```
runway.shape
```

Out[10]:
```
(43977, 20)
```

In [11]:
```
runway.head()
```

Out[11]:

	id	airport_ref	airport_ident	length_ft	width_ft	surface	lighted	closed	le_ident	le_lati
0	269408	6523	00A	80.0	80.0	ASPH-G	1	0	H1	
1	255155	6524	00AK	2500.0	70.0	GRVL	0	0	N	
2	254165	6525	00AL	2300.0	200.0	TURF	0	0	1	
3	270932	6526	00AR	40.0	40.0	GRASS	0	0	H1	
4	322128	322127	00AS	1450.0	60.0	Turf	0	0	1	

In [12]:
```
# Before merging the data lets drop the columns that will not play an important ro
runway.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 43977 entries, 0 to 43976
Data columns (total 20 columns):
 #   Column                     Non-Null Count  Dtype  
---  ------                     --------------  -----  
 0   id                         43977 non-null  int64  
 1   airport_ref                43977 non-null  int64  
 2   airport_ident              43977 non-null  object 
 3   length_ft                  43753 non-null  float64
 4   width_ft                   41088 non-null  float64
 5   surface                    43520 non-null  object 
 6   lighted                    43977 non-null  int64  
 7   closed                     43977 non-null  int64  
 8   le_ident                   43793 non-null  object 
 9   le_latitude_deg            15016 non-null  float64
 10  le_longitude_deg           15000 non-null  float64
 11  le_elevation_ft            12781 non-null  float64
 12  le_heading_degT            14624 non-null  float64
 13  le_displaced_threshold_ft  2883 non-null   float64
 14  he_ident                   37332 non-null  object 
 15  he_latitude_deg            14971 non-null  float64
 16  he_longitude_deg           14973 non-null  float64
 17  he_elevation_ft            12620 non-null  float64
 18  he_heading_degT            16428 non-null  float64
 19  he_displaced_threshold_ft  3176 non-null   float64
dtypes: float64(12), int64(4), object(4)
memory usage: 6.7+ MB
```

In [13]:
```
runways = runway.drop(['le_ident', 'le_latitude_deg','le_longitude_deg', 'le_eleva
       'le_displaced_threshold_ft', 'he_ident', 'he_latitude_deg','he_longitude_de
       'he_displaced_threshold_ft'], axis = 1)
```

In [14]:
```
runways
```

Out[14]:

	id	airport_ref	airport_ident	length_ft	width_ft	surface	lighted	closed
0	269408	6523	00A	80.0	80.0	ASPH-G	1	0
1	255155	6524	00AK	2500.0	70.0	GRVL	0	0
2	254165	6525	00AL	2300.0	200.0	TURF	0	0
3	270932	6526	00AR	40.0	40.0	GRASS	0	0
4	322128	322127	00AS	1450.0	60.0	Turf	0	0
...	...	...	...	...	...	...	...	...
43972	235186	27243	ZYTX	10499.0	148.0	CON	1	0
43973	235169	27244	ZYYJ	8530.0	148.0	CON	1	0
43974	354997	317861	ZYYK	8202.0	NaN	NaN	0	0
43975	346789	346788	ZZ-0003	1800.0	15.0	Turf	0	0
43976	313663	313629	ZZZZ	1713.0	82.0	concrete	0	0

43977 rows × 8 columns

In [15]:
```
# Now lets remove the feature from the airpot data that is not usefull.
airpot.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 73805 entries, 0 to 73804
Data columns (total 18 columns):
 #   Column             Non-Null Count  Dtype  
---  ------             --------------  -----  
 0   id                 73805 non-null  int64  
 1   ident              73805 non-null  object 
 2   type               73805 non-null  object 
 3   name               73805 non-null  object 
 4   latitude_deg       73805 non-null  float64
 5   longitude_deg      73805 non-null  float64
 6   elevation_ft       59683 non-null  float64
 7   continent          38086 non-null  object 
 8   iso_country        73546 non-null  object 
 9   iso_region         73805 non-null  object 
 10  municipality       68739 non-null  object 
 11  scheduled_service  73805 non-null  object 
 12  gps_code           42996 non-null  object 
 13  iata_code          9160 non-null   object 
 14  local_code         32975 non-null  object 
 15  home_link          3492 non-null   object 
 16  wikipedia_link     10705 non-null  object 
 17  keywords           13951 non-null  object 
dtypes: float64(3), int64(1), object(14)
memory usage: 10.1+ MB
```

In [16]:
```
airpots = airpot.drop(['continent', 'iso_country', 'iso_region','municipality', 'g
                       'wikipedia_link', 'keywords'], axis=1)
```

In [17]:
```
airpots
```

Out[17]:

	id	ident	type	name	latitude_deg	longitude_deg	elevation_ft	schedule
0	6523	00A	heliport	Total Rf Heliport	40.070801	-74.933601	11.0	
1	323361	00AA	small_airport	Aero B Ranch Airport	38.704022	-101.473911	3435.0	
2	6524	00AK	small_airport	Lowell Field	59.947733	-151.692524	450.0	
3	6525	00AL	small_airport	Epps Airpark	34.864799	-86.770302	820.0	
4	6526	00AR	closed	Newport Hospital & Clinic Heliport	35.608700	-91.254898	237.0	
...	...	...	...	...	...	...	...	
73800	46378	ZZ-0001	heliport	Sealand Helipad	51.894444	1.482500	40.0	
73801	307326	ZZ-0002	small_airport	Glorioso Islands Airstrip	-11.584278	47.296389	11.0	
73802	346788	ZZ-0003	small_airport	Fainting Goat Airport	32.110587	-97.356312	690.0	
73803	342102	ZZZW	closed	Scandium City Heliport	69.355287	-138.939310	4.0	
73804	313629	ZZZZ	small_airport	Satsuma I≈çjima Airport	30.784722	130.270556	338.0	

73805 rows × 9 columns

In [18]:
```
# Now lets merge the runways and airport data.
airpot_runway = pd.merge(airpots, runways, left_on = "ident", right_on = "airport_
airpot_runway.drop(['id_x', 'id_y'], axis=1, inplace=True)
```

In [19]:
```
airpot_runway
```

Out[19]:

	ident	type	name	latitude_deg	longitude_deg	elevation_ft	scheduled
0	00A	heliport	Total Rf Heliport	40.070801	-74.933601	11.0	
1	00AK	small_airport	Lowell Field	59.947733	-151.692524	450.0	
2	00AL	small_airport	Epps Airpark	34.864799	-86.770302	820.0	
3	00AR	closed	Newport Hospital & Clinic Heliport	35.608700	-91.254898	237.0	
4	00AS	small_airport	Fulton Airport	34.942803	-97.818019	1100.0	
...	...	...	...	...	...	...	
43972	ZYTX	large_airport	Shenyang Taoxian International Airport	41.639801	123.483002	198.0	
43973	ZYYJ	medium_airport	Yanji Chaoyangchuan Airport	42.882801	129.451004	624.0	
43974	ZYYK	medium_airport	Yingkou Lanqi Airport	40.542524	122.358600	NaN	
43975	ZZ-0003	small_airport	Fainting Goat Airport	32.110587	-97.356312	690.0	
43976	ZZZZ	small_airport	Satsuma I≈çjima Airport	30.784722	130.270556	338.0	

43977 rows × 15 columns

In [20]:
```
# Now lets merge the final column airline.
final_df = pd.merge(airline,airpot_runway,how = "inner", left_on = "AirportFrom",
```

In [21]:
```
final_df.drop_duplicates(subset=['id'], keep='first', inplace=True)
```

In [22]:
```
final_df
```

Out[22]:

	id	Airline	Flight	AirportFrom	AirportTo	DayOfWeek	Time	Length	Delay	ide
0	1	CO	269	SFO	IAH	3	15	205	1	KSI
4	4	AA	2466	SFO	DFW	3	20	195	1	KSI
8	9	DL	2606	SFO	MSP	3	35	216	1	KSI
12	129	DL	1580	SFO	DTW	3	345	270	0	KSI
16	150	UA	756	SFO	DEN	3	348	158	0	KSI
...	...	...	...	...	...	...	...	...	...	
2160266	451344	CO	2	GUM	HNL	1	400	430	1	PGU
2160268	469866	CO	2	GUM	HNL	2	400	430	1	PGU
2160270	488365	CO	2	GUM	HNL	3	400	430	0	PGU
2160272	506855	CO	2	GUM	HNL	4	400	430	1	PGU
2160274	525138	CO	2	GUM	HNL	5	400	430	1	PGU

518525 rows × 24 columns

b. When it comes to on-time arrivals, different airlines perform differently based on the amount of experience they have. The major airlines in this field include US Airways Express (founded in 1967) Continental Airlines (founded in 1934), and Express Jet (founded in 19860. Pull such information specific to various airlines from the Wikipedia page link given below.https://en.wikipedia.org/wiki/List_of_airlines_of_the_Unitec

Hint: Here, you should use web scraping to learn how long an airline has been operating.

In [23]:
```
# Now lets use the web scrapping to import the data frome the wikipedia.
url = "https://en.wikipedia.org/wiki/List_of_airlines_of_the_United_States"
tables = pd.read_html(url)
```

In [24]:
```
print(tables)
```

```
[                Airline  Image IATA ICAO        Callsign  \
0        Alaska Airlines    NaN   AS  ASA          ALASKA
1          Allegiant Air    NaN   G4  AAY       ALLEGIANT
2      American Airlines    NaN   AA  AAL        AMERICAN
3         Avelo Airlines    NaN   XP  VXP           AVELO
4         Breeze Airways    NaN   MX  MXY            MOXY
5        Delta Air Lines    NaN   DL  DAL           DELTA
6       Eastern Airlines    NaN   2D  EAL         EASTERN
7      Frontier Airlines    NaN   F9  FFT  FRONTIER FLIGHT
8      Hawaiian Airlines    NaN   HA  HAL        HAWAIIAN
9               JetBlue    NaN   B6  JBU         JETBLUE
10    Southwest Airlines    NaN   WN  SWA       SOUTHWEST
11       Spirit Airlines    NaN   NK  NKS     SPIRIT WINGS
12  Sun Country Airlines    NaN   SY  SCX      SUN COUNTRY
13       United Airlines    NaN   UA  UAL          UNITED

                          Primary hubs, Secondary hubs  Founded  \
0   Seattle/TacomaAnchoragePortland (OR)San Franci...     1932
1   Las VegasCincinnatiFort Walton BeachIndianapol...     1997
2   Dallas/Fort WorthCharlotteChicago-O'HareLos An...     1926
3                              BurbankNew HavenOrlando     1987
4      CharlestonHartfordNew OrleansNorfolkProvoTampa     2018
5   AtlantaBostonDetroitLos AngelesMinneapolis/St....     1924
6                                    MiamiNew York-JFK     2010
7   DenverAtlantaChicago-O'HareCincinnatiCleveland...     1994
8                                      HonoluluKahului     1929
9   New York-JFKBostonLos AngelesFort LauderdaleOr...     1998
10  Dallas-LoveAtlantaBaltimoreChicago-MidwayDenve...     1967
11  Atlantic CityDetroitLas VegasFort LauderdaleCh...     1980
12     Minneapolis/St. PaulDallas/Fort WorthLas Vegas     1982
13  Chicago-O'HareDenverGuamHouston-Intercontinent...     1926

                                                Notes
0   Founded as McGee Airways and commenced operati...
1   Founded as WestJet Express and commenced opera...
2   Founded as American Airways and commenced oper...
3   First did business as Casino Express Airlines ...
4                                                 NaN
5   Founded as Huff Daland Dusters and commenced o...
6                                                 NaN
7                                                 NaN
8   Founded as Inter-Island Airways in early 1929 ...
9   Founded as New Air and commenced operations in...
10  Founded as Air Southwest and commenced operati...
11                              Founded as Charter One.
12  Commenced operations in 1983.Operates some Ama...
13  Founded as Varney Air Lines and commenced oper...  ,              Airline  Im
age IATA ICAO      Callsign  \
0      Air Wisconsin    NaN   ZW  AWI     WISCONSIN
1           Cape Air    NaN   9K  KAP          CAIR
2          CommutAir    NaN   C5  UCA     COMMUTAIR
3    Contour Airlines    NaN   LF  VTE     VOLUNTEER
4       Elite Airways    NaN   7Q  MNU        MAINER
5        Endeavor Air    NaN   9E  EDV      ENDEAVOR
6           Envoy Air    NaN   MQ  ENY         ENVOY
7      GoJet Airlines    NaN   G7  GJS     LINDBERGH
8         Horizon Air    NaN   QX  QXE       HORIZON
9       Mesa Airlines    NaN   YV  ASH   AIR SHUTTLE
10  Piedmont Airlines    NaN   PT  PDT      PIEDMONT
11       PSA Airlines    NaN   OH  JIA   BLUE STREAK
12   Republic Airways    NaN   YX  RPA     BRICKYARD
13     Silver Airways    NaN   3M  SIL  SILVER WINGS
14   SkyWest Airlines    NaN   OO  SKW       SKYWEST
```

```
                               Primary Hubs, Secondary Hubs  Founded  \
0   AppletonChicago-O'HareColumbiaMilwaukeeWashing...     1965   
1   HyannisBillingsBostonNantucketSt. LouisSan Jua...     1988   
2                       DenverNewarkWashington-Dulles     1989   
3                                         Smyrna (TN)     1982   
4             Melbourne/OrlandoNewarkPortland (Maine)     2006   
5   Minneapolis/St. PaulAtlanta CincinnatiDetroitN...     1985   
6               Dallas/Fort WorthChicago-O'Hare Miami     1984   
7                               Chicago-O'HareDenver     2004   
8                         Seattle/TacomaPortland (OR)     1981   
9   As American Eagle:Phoenix-Sky HarborDallas/For...     1980   
10           CharlottePhiladelphiaWashington-National     1961   
11           CharlottePhiladelphiaWashington-National     1979   
12  As American Eagle:IndianapolisColumbus (OH)Kan...     1998   
13                        Fort LauderdaleOrlandoTampa     2011   
14  As Delta Connection:AtlantaBoiseColorado Sprin...     1972   

                                                Notes  
0                         Operates as United Express  
1                                                 NaN  
2                        Operates as United Express.  
3                                                 NaN  
4                      Commenced operations in 2014.  
5   Founded as Express Airlines I. Operates as Del...  
6   Founded as American Eagle Airlines. Operates a...  
7   Commenced operations in 2005. Operates as Unit...  
8                       Operates as Alaska Airlines.  
9   Founded as Mesa Air Shuttle. All but one aircr...  
10  Founded as Henson Aviation and commenced opera...  
11  Founded as Vee Neal Airlines. Operates as Amer...  
12  Commenced operations in 2005. Operates as Amer...  
13                                                NaN  
14  Operates as Delta Connection, United Express, ...  ,
Airline  Image IATA ICAO      Callsign  \
0                   Advanced Air    NaN   AN  WSN      WINGSPAN   
1                   Air Sunshine    NaN   YI  RSI  AIR SUNSHINE   
2                     Bering Air    NaN   8E  BRG    BERING AIR   
3                   Boutique Air    NaN   4B  BTQ      BOUTIQUE   
4                     Everts Air    NaN   5V  VTS        EVERTS   
5                        Gem Air    NaN  NaN  NaN           NaN   
6          Grand Canyon Airlines    NaN   YR  CVU   CANYON VIEW   
7   Grand Canyon Scenic Airlines    NaN   YR  SCE        SCENIC   
8                 Grant Aviation    NaN   GV  GUN          HOOT   
9        Griffing Flying Service    NaN  NaN  NaN           NaN   
10                Island Airways    NaN  NaN  NaN           NaN   
11                           JSX    NaN   XE  JSX     BIGSTRIPE   
12                  Kenmore Air    NaN   M5  KEN       KENMORE   
13                  Key Lime Air    NaN   KG  LYM      KEY LIME   
14             Mokulele Airlines    NaN   MW  MHO        MAHALO   
15          New England Airlines    NaN   EJ  NEA   NEW ENGLAND   
16          Penobscot Island Air    NaN  NaN  NaN           NaN   
17                  Reliant Air    NaN  NaN  RLI       RELIANT   
18             San Juan Airlines    NaN  NaN  NaN      SKYFERRY   
19                  Servant Air    NaN   8D  NaN           NaN   
20       Southern Airways Express    NaN   9X  FDY      FRIENDLY   
21                      Surf Air    NaN  NaN   UF       SURFAIR   
22                    Taquan Air    NaN   K3  TQN        TAQUAN   
23            Tradewind Aviation    NaN   TJ  GPD     GOODSPEED   
24          Ultimate Air Shuttle    NaN   UE  UJC      ULTIMATE   
25                 Utah Airways    NaN  NaN  NaN           NaN   
26       Warbelow's Air Ventures    NaN   4W  WAV      WARBELOW   
27            Wright Air Service    NaN   8V  WRF  WRIGHT FLYER   

                               Primary Hubs, Secondary Hubs  Founded  \
```

```
0                                           Hawthorne     2005
1                                            San Juan     1982
2                                NomeKotzebueUnalakleet     1979
3           Dallas/Fort WorthDenverPhoenix-Sky Harbor     2007
4                                  FairbanksAnchorage     1978
5                                              Salmon     2014
6                          Boulder CityGrand CanyonPage     1927
7                                        Grand Canyon     1967
8    AnchorageBethelCold BayDillinghamEmmonakKenaiK...     1971
9                                        Port Clinton     1937
10                                         Charlevoix     1945
11     BurbankOaklandLas VegasSanta AnaPhoenixConcord     2016
12            KenmoreSeattle-Lake UnionSeattle-Boeing     1946
13   Denver-CentennialDenverDenver-Rocky MountainGr...     1997
14                                  Kailua-KonaKahului     1994
15                                           Westerly     1970
16                                           Rockland     2004
17                                            Danbury     1988
18                                         Bellingham     2002
19                                             Kodiak     2003
20          MemphisDestinPittsburghWashington-Dulles     2013
21     HawthorneOaklandSan CarlosSanta BarbaraTruckee     2012
22                                    Ketchikan Harbor     1977
23                 Oxford (CT)San Juan White Plains     2001
24                                   Cincinnati-Lunken     2009
25                                              Ogden     2015
26                                          Fairbanks     1958
27                                          Fairbanks     1966

                                                 Notes
0    Has the EAS contract to serve Grant County Air...
1                                                  NaN
2                                                  NaN
3                                                  NaN
4                   Founded as Tatonduk Flying Service.
5                                                  NaN
6                           Founded as Scenic Airways.
7                          Founded as Scenic Airlines.
8                       Founded as Delta Air Services.
9                                                  NaN
10               Founded as McPhillips Flying Service.
11             Operator of Taos Air flights from 2022.
12                      Founded as Mines Collins Munro.
13                   Operates as Denver Air Connection.
14                  Founded as Mokulele Flight Service.
15                                                 NaN
16                                                 NaN
17                                                 NaN
18                                                 NaN
19                                                 NaN
20                                                 NaN
21                                                 NaN
22                                                 NaN
23                                                 NaN
24                                                 NaN
25                                                 NaN
26                                                 NaN
27                                                 NaN  ,
Airline  Image IATA ICAO       Callsign  \
0                  Air Charter Bahamas    NaN  NaN  NaN            NaN
1                  Air Flight Charters    NaN  NaN  FLL            NaN
2                             Airshare    NaN  NaN  XSR       AIRSHARE
3                       Berry Aviation    NaN  NaN  BYA          BERRY
4                      Bighorn Airways    NaN  NaN  BHR    BIGHORN AIR
```

```
5              Charter Air Transport    NaN   VC  SRY        STINGRAY
6                     Choice Airways    NaN  NaN  CSX      CHOICE AIR
7                          ExcelAire    NaN  NaN  XLS       EXCELAIRE
8         Global Crossing Airlines    NaN   G6  GXA          GEMINI
9                    Great Lakes Air    NaN  NaN  NaN             NaN
10                 Gryphon Airlines    NaN   Y3  VOS             NaN
11                    IAero Airways    NaN   WQ  SWQ     SWIFTFLIGHT
12                      IBC Airways    NaN   II  CSQ         CHASQUI
13  L-3 Flight International Aviation  NaN  NaN  RTD         RIPTIDE
14          Liberty Jet Management    NaN  NaN  LRT     LIBERTY JET
15                          NetJets    NaN   1I  EJA         EXECJET
16          Omni Air International    NaN   X9  OAE    OMNI-EXPRESS
17              Omni Air Transport    NaN  NaN  DRL         DRILLER
18                Pacific Coast Jet    NaN  NaN  PXT      PACK COAST
19              Pentastar Aviation    NaN  NaN  DCX           TANGO
20                      Phoenix Air    NaN  NaN  PHA       GRAY BIRD
21                       PlaneSense    NaN  NaN  CNS         CHRONOS
22             Presidential Airways    NaN  NaN  PRD    PRESIDENTIAL
23           Sierra Pacific Airlines    NaN   SI  SPA  SIERRA PACIFIC
24                           Skymax    NaN  NaN  SMX          SKYMAX
25                 Songbird Airways    NaN   SK  SGB        SONGBIRD
26               Stampede Aviation    NaN  NaN  NaN             NaN
27             Superior Air Charter    NaN  NaN  RSP       REDSTRIPE
28               Superior Aviation    NaN   SO  HKA       SPEND AIR
29               Talkeetna Air Taxi    NaN  NaN  NaN             NaN
30             Tropic Ocean Airways    NaN  NaN  NaN             NaN
31           World Atlantic Airlines    NaN   K8  WAL  WORLD ATLANTIC
32              XOJET Aviation LLC    NaN  NaN  XOJ           XOJET

   Primary Hubs, Secondary Hubs  Founded  \
0                           NaN      NaN
1              Fort Lauderdale   1987.0
2                           NaN   2000.0
3                    San Marcos   1983.0
4                      Sheridan   1947.0
5            Cleveland-Lakefront   1997.0
6    Fort Lauderdale-Executive   2009.0
7               Long Island/Islip   1993.0
8   Atlantic CityLas VegasMiami   2019.0
9                    St. Ignace      NaN
10                          NaN      NaN
11                        Miami   1997.0
12              Fort Lauderdale   1991.0
13                 Newport News   1972.0
14            Long Island/Islip   2006.0
15                     Columbus   1964.0
16                        Tulsa   1993.0
17                        Tulsa      NaN
18                          NaN   2006.0
19                    Waterford   1964.0
20                 Cartersville   1978.0
21              Portsmouth (NH)   1992.0
22            Melbourne/Orlando      NaN
23                       Tucson   1970.0
24              Fort Lauderdale   1997.0
25                        Miami   1990.0
26              Healy/Denali NP   2011.0
27                          NaN   2006.0
28                      Lansing   1979.0
29                    Talkeetna   1947.0
30              Fort Lauderdale   2009.0
31                        Miami   2002.0
32         Sacramento-McClellan   2006.0
```

```
                                                 Notes
0                                                  NaN
1                                                  NaN
2                 Founded as Executive Flight Services
3                                                  NaN
4                                                  NaN
5                                                  NaN
6                                                  NaN
7                                                  NaN
8                                                  NaN
9                                                  NaN
10                                                 NaN
11                                Founded as Swift Air
12                                                 NaN
13                                                 NaN
14                                                 NaN
15               Founded as Executive Jets Aviation.
16                                                 NaN
17                                                 NaN
18                                                 NaN
19           Founded as Chrysler Air Transportation.
20                                                 NaN
21                                                 NaN
22                                                 NaN
23                      Commenced operations in 1971.
24                      Commenced operations in 2013.
25                                                 NaN
26                                                 NaN
27                                                 NaN
28                                                 NaN
29                Founded as Talkeetna Flying Service.
30                                                 NaN
31  Founded as Caribbean Sun Airlines and commence...
32                                                 NaN  ,                           A
irline  Image IATA  ICAO         Callsign  \
0                          21 Air    NaN   2I   CSB      CARGO SOUTH
1                         ABX Air    NaN   GB   ABX             ABEX
2              Air Cargo Carriers    NaN   2Q   SNC      NIGHT CARGO
3                  AirNet Express    NaN  NaN   USC       STAR CHECK
4   Air Transport International     NaN   8C   ATN    AIR TRANSPORT
5          Alaska Central Express    NaN   KO   AER          ACE AIR
6                 Aloha Air Cargo    NaN   KH   AAH            ALOHA
7              Alpine Air Express    NaN   5A   AIP       ALPINE AIR
8                      Amazon Air    NaN  AFW  KAFW       AMAZON AIR
9                     Ameriflight    NaN   A8   AMF         AMFLIGHT
10        Amerijet International    NaN   M6   AJT         AMERIJET
11          Ameristar Jet Charter    NaN   7Z   AJI        AMERISTAR
12         Asia Pacific Airlines    NaN   P9   MGE         MAGELLAN
13                      Atlas Air    NaN   5Y   GTI            GIANT
14               Bemidji Airlines    NaN   CH   BMJ          BEMIDJI
15                 Castle Aviation    NaN  NaN   CSJ           CASTLE
16                   Corporate Air    NaN  NaN   CPT          AIRSPUR
17                        CSA Air    NaN  NaN   IRO         IRON AIR
18                Empire Airlines    NaN   EM   CFS           EMPIRE
19               Everts Air Cargo    NaN   5V   VTS           EVERTS
20                 FedEx Express    NaN   FX   FDX            FEDEX
21       Freight Runners Express    NaN  NaN   FRG  FREIGHT RUNNERS
22                      IFL Group    NaN   IF   IFL           EIFFEL
23                    Kalitta Air    NaN   K4   CKS           CONNIE
24               Kalitta Charters    NaN   CB   KFS          KALITTA
25               Lynden Air Cargo    NaN   L2   LYC           LYNDEN
26                     Martinaire    NaN  NaN   MRA           MARTEX
27                 Merlin Airways    NaN  NaN   MEI           AVALON
28             Mountain Air Cargo    NaN   C2   MTN         MOUNTAIN
```

```
29           National Airlines    NaN   N8   NCR   NATIONAL CARGO
30          Northern Air Cargo    NaN   NC   NAC            YUKON
31             Polar Air Cargo    NaN   PO   PAC            POLAR
32           Royal Air Freight    NaN  NaN   RAX        AIR ROYAL
33           Ryan Air Services    NaN   7S   RYA         RYAN AIR
34             Sky Lease Cargo    NaN   GG   KYE        SKY CUBE
35          Skyway Enterprises    NaN   KI   SKZ       SKYWAY-INC
36                   Strat Air    NaN  NaN   NaN              NaN
37    Trans Executive Airlines    NaN   KH   MUI  RHOADES EXPRESS
38                UPS Airlines    NaN   5X   UPS              UPS
39            USA Jet Airlines    NaN   UJ   JUS          JET USA
40                    West Air    NaN  NaN   PCM       PAC VALLEY
41     Western Global Airlines    NaN   KD   WGN   WESTERN GLOBAL
42             Wiggins Airways    NaN   WG   WIG  WIGGINS AIRWAYS

                         Primary Hubs, Secondary Hubs  Founded  \
0                                               Miami   2014.0   
1                     Wilmington (OH)CincinnatiMiami   1980.0   
2                                MilwaukeeCincinnati   1986.0   
3                               Columbus-Rickenbacker   1974.0   
4                           Wilmington (OH)Cincinnati   1978.0   
5                                           Anchorage   1996.0   
6                                            Honolulu   1946.0   
7                            ProvoBillingsSioux Falls   1971.0   
8   Fort Worth/AllianceCincinnatiLeipzig/HalleSan ...   2015.0   
9                                   Dallas/Fort Worth   1968.0   
10                                MiamiPort of Spain   1974.0   
11                   Dallas-AddisonEl PasoWillow Run   2000.0   
12                                      GuamHonolulu   1998.0   
13  New York-JFKAnchorageCincinnatiHoustonHuntsvil...   1992.0   
14                        BemidjiMinneapolis/St. Paul   1946.0   
15                                       Akron/Canton   1986.0   
16                                           Billings   1981.0   
17                                      Iron Mountain   1998.0   
18                              Coeur d' AleneSpokane   1977.0   
19                                 FairbanksAnchorage   1995.0   
20  MemphisAnchorageCologne/BonnDubaiFort WorthGre...   1971.0   
21                                          Milwaukee   1985.0   
22                                     WaterfordMiami   1983.0   
23  YpsilantiAnchorageBahrainCincinnatiHong KongNe...   1967.0   
24                                          Ypsilanti      NaN   
25                                          Anchorage   1995.0   
26                                            Addison   1978.0   
27                              BillingsMiamiSan Juan   1983.0   
28                                            Kinston   1974.0   
29                                    Orlando/Sanford   1985.0   
30                                     AnchorageMiami   1956.0   
31  AnchorageCincinnatiHong KongHonoluluLos Angele...   1993.0   
32                                          Waterford   1961.0   
33  AnchorageAniakBethelEmmonakKotzebueNomeSt. Mar...   1953.0   
34                                              Miami   1969.0   
35                                                NaN   1981.0   
36                                              Miami   2018.0   
37                                           Honolulu   1982.0   
38  LouisvilleChicago/RockfordCologne/BonnColumbia...   1988.0   
39                                     YpsilantiLaredo   1994.0   
40         Las VegasOaklandOntarioSacramentoSan Diego   1988.0   
41      Miami Liege, Belgium; AnchorageFort Myers, FL   2013.0   
42                                         Manchester   1929.0   

                                                Notes  
0                                                 NaN  
1   Founded as Airborne Express. Operates some Ama...  
2                          Commenced operations in 1980.  
```

```
3                    Founded as Financial Air Express.
4   Founded as US Airways and commenced operations...
5                                                 NaN
6   Founded as Trans-Pacific Airlines and separate...
7                                                 NaN
8                            Formerly Amazon Prime Air
9                   Founded as California Air Charter.
10                                                NaN
11                                                NaN
12                                                NaN
13  Commenced operations in 1993. Operates some Am...
14                       Commenced operations in 1947.
15                                                NaN
16                                                NaN
17                                                NaN
18                                                NaN
19                                                NaN
20  Founded as Federal Express and commenced opera...
21                                                NaN
22                      Founded as Air Contract Cargo.
23         Founded as American International Airways.
24                                                NaN
25                                                NaN
26                                                NaN
27                                                NaN
28                                                NaN
29                       Commenced operations in 1986.
30                                                NaN
31                                                NaN
32                                                NaN
33                     Founded as Unalakleet Air Taxi.
34  Founded as Wrangler Aviation and commenced ope...
35                       Commenced operations in 1983.
36                                                NaN
37                                                NaN
38                                                NaN
39                                                NaN
40                                                NaN
41                                                NaN
42                                                NaN  ,                  Airline
Image  IATA  ICAO  Callsign  \
0   AirMed International    NaN   NaN   NaN       NaN
1            Air Methods    NaN   NaN   NaN       NaN
2  Critical Air Medicine    NaN   NaN   NaN       NaN
3               Lifestar    NaN   NaN   NaN       NaN
4              Life Lion    NaN   NaN   NaN       NaN

  Primary Hubs, Secondary Hubs  Founded                             Notes
0     Birmingham-Shuttlesworth   1987.0  Founded as MEDjet International.
1            Denver-Centennial   1980.0                               NaN
2                          NaN   1984.0                               NaN
3                          NaN      NaN                               NaN
4                          NaN      NaN                               NaN  ,
Airline  Image  IATA ICAO  \
0                                      Comco    NaN   NaN  NaN
1                                      Janet    NaN   NaN  WWW
2  Justice Prisoner and Alien Transportation System    NaN   NaN  JUD

  Callsign Primary Hubs, Secondary Hubs  Founded  \
0      NaN                          NaN     2002
1    JANET                    Las Vegas     1972
2  JUSTICE                Oklahoma City     1980

                          Notes
```

```
0                          NaN
1                          NaN
2  Commenced operations in 1995.  ,                                  vteLists of a
irlines  \
0                                     By airline codes
1                                         By continent
2                                           By country
3                             vteExpand for full list
4   A Abkhazia Afghanistan Akrotiri and Dhekelia Å...
5                                                   A
6                                                   B
7                                                   C
8                                                   D
9                                                   E
10                                                  F
11                                                  G
12                                                  H
13                                                  I
14                                                  J
15                                                  K
16                                                  L
17                                                  M
18                                                  N
19                                                  O
20                                                  P
21                                                  Q
22                                                  R
23                                                  S
24                                                  T
25  U Uganda Ukraine United Arab Emirates United K...
26                                                  U
27                                                  V
28                                                  W
29                                                  Y
30                                                  Z
31                                           See also

                             vteLists of airlines.1
0   All 0-9 A B C D E F G H I J K L M N O P Q R S ...
1                 Africa Americas Asia Europe Oceania
2   vteExpand for full listA Abkhazia Afghanistan ...
3                             vteExpand for full list
4   A Abkhazia Afghanistan Akrotiri and Dhekelia Å...
5   Abkhazia Afghanistan Akrotiri and Dhekelia Åla...
6   The Bahamas Bahrain Bangladesh Barbados Belaru...
7   Cambodia Cameroon Canada Cape Verde Cayman Isl...
8   Denmark Dhekelia Djibouti Dominica Dominican R...
9   East Timor Ecuador Egypt El Salvador Equatoria...
10  Falkland Islands Faroe Islands Fiji Finland Fr...
11  Gabon The Gambia Georgia Germany Ghana Gibralt...
12                 Haiti Honduras Hong Kong Hungary
13  Iceland India Indonesia Iran Iraq Ireland Isra...
14                       Jamaica Japan Jersey Jordan
15  Kazakhstan Kenya Kiribati North Korea South Ko...
16  Laos Latvia Lebanon Lesotho Liberia Libya Liec...
17  Macau Macedonia, Republic of Madagascar Malawi...
18  Namibia Nauru Nepal Netherlands Netherlands An...
19                                               Oman
20  Pakistan Palau Palestine Panama Papua New Guin...
21                                              Qatar
22                               Romania Russia Rwanda
23  Sahrawi Arab Democratic Republic Saint Barthél...
24  Taiwan Tajikistan Tanzania Thailand Togo Tokel...
25  U Uganda Ukraine United Arab Emirates United K...
```

```
26  Uganda Ukraine United Arab Emirates United Kin...
27  Vanuatu Vatican City Venezuela Vietnam British...
28                                  Wallis and Futuna
29                                              Yemen
30                                    Zambia Zimbabwe
31  List of airline holding companies List of airl...  ,
vteExpand for full list  \
0   A Abkhazia Afghanistan Akrotiri and Dhekelia Å...
1                                                   A
2                                                   B
3                                                   C
4                                                   D
5                                                   E
6                                                   F
7                                                   G
8                                                   H
9                                                   I
10                                                  J
11                                                  K
12                                                  L
13                                                  M
14                                                  N
15                                                  O
16                                                  P
17                                                  Q
18                                                  R
19                                                  S
20                                                  T
21  U Uganda Ukraine United Arab Emirates United K...
22                                                  U
23                                                  V
24                                                  W
25                                                  Y
26                                                  Z

                         vteExpand for full list.1
0   A Abkhazia Afghanistan Akrotiri and Dhekelia Å...
1   Abkhazia Afghanistan Akrotiri and Dhekelia Åla...
2   The Bahamas Bahrain Bangladesh Barbados Belaru...
3   Cambodia Cameroon Canada Cape Verde Cayman Isl...
4   Denmark Dhekelia Djibouti Dominica Dominican R...
5   East Timor Ecuador Egypt El Salvador Equatoria...
6   Falkland Islands Faroe Islands Fiji Finland Fr...
7   Gabon The Gambia Georgia Germany Ghana Gibralt...
8                  Haiti Honduras Hong Kong Hungary
9   Iceland India Indonesia Iran Iraq Ireland Isra...
10                     Jamaica Japan Jersey Jordan
11  Kazakhstan Kenya Kiribati North Korea South Ko...
12  Laos Latvia Lebanon Lesotho Liberia Libya Liec...
13  Macau Macedonia, Republic of Madagascar Malawi...
14  Namibia Nauru Nepal Netherlands Netherlands An...
15                                              Oman
16  Pakistan Palau Palestine Panama Papua New Guin...
17                                             Qatar
18                              Romania Russia Rwanda
19  Sahrawi Arab Democratic Republic Saint Barthél...
20  Taiwan Tajikistan Tanzania Thailand Togo Tokel...
21  U Uganda Ukraine United Arab Emirates United K...
22  Uganda Ukraine United Arab Emirates United Kin...
23  Vanuatu Vatican City Venezuela Vietnam British...
24                                  Wallis and Futuna
25                                              Yemen
26                                    Zambia Zimbabwe  ,     0
1
```

```
0   A  Abkhazia Afghanistan Akrotiri and Dhekelia Åla...
1   B  The Bahamas Bahrain Bangladesh Barbados Belaru...
2   C  Cambodia Cameroon Canada Cape Verde Cayman Isl...
3   D  Denmark Dhekelia Djibouti Dominica Dominican R...
4   E  East Timor Ecuador Egypt El Salvador Equatoria...
5   F  Falkland Islands Faroe Islands Fiji Finland Fr...
6   G  Gabon The Gambia Georgia Germany Ghana Gibralt...
7   H                    Haiti Honduras Hong Kong Hungary
8   I  Iceland India Indonesia Iran Iraq Ireland Isra...
9   J                          Jamaica Japan Jersey Jordan
10  K  Kazakhstan Kenya Kiribati North Korea South Ko...
11  L  Laos Latvia Lebanon Lesotho Liberia Libya Liec...
12  M  Macau Macedonia, Republic of Madagascar Malawi...
13  N  Namibia Nauru Nepal Netherlands Netherlands An...
14  O                                                 Oman
15  P  Pakistan Palau Palestine Panama Papua New Guin...
16  Q                                                Qatar
17  R                                 Romania Russia Rwanda
18  S  Sahrawi Arab Democratic Republic Saint Barthél...
19  T  Taiwan Tajikistan Tanzania Thailand Togo Tokel...,    0
1
0  U  Uganda Ukraine United Arab Emirates United Kin...
1  V  Vanuatu Vatican City Venezuela Vietnam British...
2  W                                 Wallis and Futuna
3  Y                                             Yemen
4  Z                                   Zambia Zimbabwe,                     vteAi
rlines of the United States  \
0                                         Mainline
1                                         Regional
2                                       Affiliated
3                                      Independent
4                                            Cargo
5                                          Charter
6                               Air taxi and tours
7                                     Air ambulance
8                                       Government
9  List of airline holding companies List of airl...

                  vteAirlines of the United States.1
0  Alaska Airlines Allegiant Air American Airline...
1  Affiliated Air Wisconsin CommutAir Endeavor Ai...
2  Air Wisconsin CommutAir Endeavor Air Envoy Air...
3  Advanced Air Air Flamenco Air Sunshine Bering ...
4  ABX Air Air Cargo Carriers Air Transport Inter...
5  Air Charter Bahamas Airstream Jets Alerion Avi...
6  Gem Air Grand Canyon Scenic Airlines Griffing ...
7  Air Evac Lifeteam AirMed International Air Met...
8                 Comco Janet JPATS Patriot Express
9  List of airline holding companies List of airl...  ,            0
1
0   Affiliated  Air Wisconsin CommutAir Endeavor Air Envoy Air...
1  Independent  Advanced Air Air Flamenco Air Sunshine Bering ...,
vteList of airlines of the Americas  \
0  United States and Canada Latin America and the...
1  Latin America Hispanic North America Northern ...
2                                    Sovereign states
3                 Dependencies andother territories

               vteList of airlines of the Americas.1  \
0  United States and Canada Latin America and the...
1  Latin America Hispanic North America Northern ...
2  Antigua and Barbuda Argentina Bahamas Barbados...
3  Anguilla Aruba Bermuda Bonaire British Virgin ...
```

```
                vteList of airlines of the Americas.2
0  United States and Canada Latin America and the...
1                                              NaN
2                                              NaN
3                                              NaN  ,
0                    1
0  Authority control: National libraries  Israel United States]
```

In [25]:
```
tables[0]
```

Out[25]:

	Airline	Image	IATA	ICAO	Callsign	Primary hubs, Secondary hubs	Founded	
0	Alaska Airlines	NaN	AS	ASA	ALASKA	Seattle/TacomaAnchoragePortland (OR)San Franci...	1932	Fou Airw com c
1	Allegiant Air	NaN	G4	AAY	ALLEGIANT	Las VegasCincinnatiFort Walton BeachIndianapol...	1997	Fou Exp com
2	American Airlines	NaN	AA	AAL	AMERICAN	Dallas/Fort WorthCharlotteChicago-O'HareLos An...	1926	Fou A Airw com
3	Avelo Airlines	NaN	XP	VXP	AVELO	BurbankNew HavenOrlando	1987	bus A
4	Breeze Airways	NaN	MX	MXY	MOXY	CharlestonHartfordNew OrleansNorfolkProvoTampa	2018	
5	Delta Air Lines	NaN	DL	DAL	DELTA	AtlantaBostonDetroitLos AngelesMinneapolis/St....	1924	Fou Huf Dus com
6	Eastern Airlines	NaN	2D	EAL	EASTERN	MiamiNew York-JFK	2010	
7	Frontier Airlines	NaN	F9	FFT	FRONTIER FLIGHT	DenverAtlantaChicago-O'HareCincinnatiCleveland...	1994	
8	Hawaiian Airlines	NaN	HA	HAL	HAWAIIAN	HonoluluKahului	1929	Fou Inte Ai early
9	JetBlue	NaN	B6	JBU	JETBLUE	New York-JFKBostonLos AngelesFort LauderdaleOr...	1998	Fou New com op
10	Southwest Airlines	NaN	WN	SWA	SOUTHWEST	Dallas-LoveAtlantaBaltimoreChicago-MidwayDenve...	1967	Fou Air So com c
11	Spirit Airlines	NaN	NK	NKS	SPIRIT WINGS	Atlantic CityDetroitLas VegasFort LauderdaleCh...	1980	Fou Char
12	Sun Country Airlines	NaN	SY	SCX	SUN COUNTRY	Minneapolis/St. PaulDallas/Fort WorthLas Vegas	1982	Com opera 1983.C som
13	United Airlines	NaN	UA	UAL	UNITED	Chicago-O'HareDenverGuamHouston-	1926	Fou Va

Airline	Image	IATA	ICAO	Callsign	Primary hubs, Secondary hubs	Founded	
					Intercontinent...		Li com

In [26]:
```
tables[6]
```

Out[26]:

	Airline	Image	IATA	ICAO	Callsign	Primary Hubs, Secondary Hubs	Founded	Notes
0	Comco	NaN	NaN	NaN	NaN	NaN	2002	NaN
1	Janet	NaN	NaN	WWW	JANET	Las Vegas	1972	NaN
2	Justice Prisoner and Alien Transportation System	NaN	NaN	JUD	JUSTICE	Oklahoma City	1980	Commenced operations in 1995.

In [27]:
```
# Lets first merge all wikipedia table.
wiki_table = [tables[0],tables[1],tables[2],tables[3],tables[4],tables[5],tables[6
```

In [28]:
```
wiki_tables = pd.concat(wiki_table, ignore_index=True)
```

In [29]:
```
wiki_tables
```

Out[29]:

	Airline	Image	IATA	ICAO	Callsign	Primary hubs, Secondary hubs	Founded	
0	Alaska Airlines	NaN	AS	ASA	ALASKA	Seattle/TacomaAnchoragePortland (OR)San Franci...	1932.0	F A c
1	Allegiant Air	NaN	G4	AAY	ALLEGIANT	Las VegasCincinnatiFort Walton BeachIndianapol...	1997.0	F E c
2	American Airlines	NaN	AA	AAL	AMERICAN	Dallas/Fort WorthCharlotteChicago-O'HareLos An...	1926.0	F A c
3	Avelo Airlines	NaN	XP	VXP	AVELO	BurbankNew HavenOrlando	1987.0	I
4	Breeze Airways	NaN	MX	MXY	MOXY	CharlestonHartfordNew OrleansNorfolkProvoTampa	2018.0	
...	...	...	...	...	...	...	...	
136	Lifestar	NaN	NaN	NaN	NaN	NaN	NaN	
137	Life Lion	NaN	NaN	NaN	NaN	NaN	NaN	
138	Comco	NaN	NaN	NaN	NaN	NaN	2002.0	
139	Janet	NaN	NaN	WWW	JANET	NaN	1972.0	
140	Justice Prisoner and Alien Transportation System	NaN	NaN	JUD	JUSTICE	NaN	1980.0	C

141 rows × 9 columns

c. You should then get all the information gathered so far in one place.

In [30]:

```
# First we got only that column from wiki pedia table that we need to merge.
wiki_df = wiki_tables[['IATA', "Founded"]]
wiki_df
```

Out[30]:

	IATA	Founded
0	AS	1932.0
1	G4	1997.0
2	AA	1926.0
3	XP	1987.0
4	MX	2018.0
...	...	...
136	NaN	NaN
137	NaN	NaN
138	NaN	2002.0
139	NaN	1972.0
140	NaN	1980.0

141 rows × 2 columns

In [31]:
```
# Now we gather all the information that we got from wiki pedia link and the data i
df = final_df.merge(wiki_df, left_on ='Airline', right_on = "IATA")
```

In [32]:
```
df
```

Out[32]:

	id	Airline	Flight	AirportFrom	AirportTo	DayOfWeek	Time	Length	Delay	ident
0	4	AA	2466	SFO	DFW	3	20	195	1	KSFO
1	231	AA	526	SFO	DFW	3	360	215	0	KSFO
2	234	AA	552	SFO	MIA	3	360	315	1	KSFO
3	905	AA	810	SFO	ORD	3	385	255	0	KSFO
4	1739	AA	24	SFO	JFK	3	425	325	1	KSFO
...	...	...	...	...	...	...	...	...	...	...
434919	497838	9E	4292	LWB	JFK	3	890	110	1	KLWB
434920	516333	9E	4292	LWB	JFK	4	890	110	0	KLWB
434921	534123	9E	4292	LWB	JFK	5	890	110	0	KLWB
434922	69058	9E	3752	ABR	MSP	7	410	76	1	KABR
434923	189396	9E	3752	ABR	MSP	7	410	76	0	KABR

434924 rows × 26 columns

d. The total passenger traffic may also contribute to flight delays. The term hub refers to busy commercial airports. Large hubs are airports that account for at least 1 percent of the total passenger enplanements in the United States. Airports that account for 0.25 percent to 1 percent of total passenger enplanements are considered medium hubs. Pull

passenger traffic data from the Wikipedia page given below using web scraping and collate it in a table.

https://en.wikipedia.org/wiki/List_of_the_busiest_airports_in_the_United_State

In [33]:
```
# Now lets use the web scrapping to import the data frome the wikipedia.
url2 = "https://en.wikipedia.org/wiki/List_of_the_busiest_airports_in_the_United_St
table = pd.read_html(url2)
```

In [34]:
```
print(table)
```

```
[    Rank(2021)                          Airports (large hubs) IATACode  \
0           1  Hartsfield–Jackson Atlanta International Airport      ATL   
1           2           Dallas/Fort Worth International Airport      DFW   
2           3                      Denver International Airport      DEN   
3           4                      O'Hare International Airport      ORD   
4           5                 Los Angeles International Airport      LAX   
5           6           Charlotte Douglas International Airport      CLT   
6           7                     Orlando International Airport      MCO   
7           8                  Harry Reid International Airport      LAS   
8           9          Phoenix Sky Harbor International Airport      PHX   
9          10                       Miami International Airport      MIA   
10         11              Seattle–Tacoma International Airport      SEA   
11         12              George Bush Intercontinental Airport      IAH   
12         13             John F. Kennedy International Airport      JFK   
13         14              Newark Liberty International Airport      EWR   
14         15  Fort Lauderdale–Hollywood International Airport      FLL   
15         16     Minneapolis–Saint Paul International Airport      MSP   
16         17             San Francisco International Airport      SFO   
17         18                      Detroit Metropolitan Airport      DTW   
18         19                       Logan International Airport      BOS   
19         20              Salt Lake City International Airport      SLC   
20         21                Philadelphia International Airport      PHL   
21         22        Baltimore/Washington International Airport      BWI   
22         23                       Tampa International Airport      TPA   
23         24                   San Diego International Airport      SAN   
24         25                                 LaGuardia Airport      LGA   
25         26                      Midway International Airport      MDW   
26         27                   Nashville International Airport      BNA   
27         28           Washington Dulles International Airport      IAD   
28         29         Ronald Reagan Washington National Airport      DCA   
29         30            Austin–Bergstrom International Airport      AUS   

            Major cities served State   2021[3]   2020[4]   2019[5]  \
0                       Atlanta    GA  36676010  20559866  53505795   
1            Dallas & Fort Worth    TX  30005266  18593421  35778573   
2                        Denver    CO  28645527  16243216  33592945   
3                       Chicago    IL  26350976  14606034  40871223   
4                   Los Angeles    CA  23663410  14055777  42939104   
5                     Charlotte    NC  20900875  12952869  24199688   
6                       Orlando    FL  19618838  10467728  24562271   
7                     Las Vegas    NV  19160342  10584059  24728361   
8                       Phoenix    AZ  18940287  10531436  22433552   
9                         Miami    FL  17500096   8786007  21421031   
10                      Seattle    WA  17430195   9462411  25001762   
11                      Houston    TX  16242821   8682558  21905309   
12                New York City    NY  15273342   8269819  31036655   
13       Newark & New York City    NJ  14514049   7985474  23160763   
14   Fort Lauderdale & Hollywood    FL  13598994   8015744  17950989   
15      Minneapolis & Saint Paul    MN  12211409   7069720  19192917   
16                San Francisco    CA  11725347   7745057  27779230   
17                      Detroit    MI  11517696   6822324  18143040   
18                       Boston    MA  10909817   6035452  20699377   
19               Salt Lake City    UT  10795906   5753239  12840841   
20                 Philadelphia    PA   9820222   5753239  16006389   
21  Baltimore & Washington, D.C.    MD   9253561   5451355  13284687   
22                        Tampa    FL   8847197   4966775  10978756   
23                    San Diego    CA   7836360   4637856  12648692   
24                New York City    NY   7827307   4147116  15393601   
25                      Chicago    IL   7680617   4236603  10081781   
26                    Nashville    TN   7594049   4013995   8935654   
27             Washington, D.C.    VA   7227875   3862658  11884117   
28             Washington, D.C.    VA   6731737   3573489  11595454   
29                       Austin    TX   6666215   3141505   8683711   
```

```
     2018[6]   2017[7]   2016[8]   2015[9]  2014[10]  2013[11]  2012[12]
0   51865797  50251964  50501858  49340732  46604273  45308407  45798928
1   32821799  31816933  31283579  31589839  30804567  29038128  28022904
2   31362941  29809097  28267394  26280043  26000591  25496885  25799841
3   39873927  38593028  37589899  36305668  33843426  32317835  32171795
4   42624050  41232432  39636042  36351272  34314197  32425892  31326268
5   22281949  22011251  21511880  21913166  21537725  21346601  20033816
6   23202480  21565448  20283541  18759938  17278608  16884524  17159427
7   23795012  23364393  22833267  21857693  20620248  19946179  19959651
8   21622580  21185458  20896265  21351504  20344867  19525109  19560870
9   21021640  20709225  20875813  20986349  19471466  19420089  18987488
10  24024908  22639124  21887110  20148980  17888080  16690295  16121123
11  21157398  19603731  20062072  20595881  19772087  18952840  19039000
12  30620769  29533154  29239151  27782369  26244928  25036358  24520981
13  22797602  21571198  19923009  18684818  17773405  17546506  17055993
14  17612331  15817043  14263270  13061632  12031860  11538140  11445103
15  18361942  18409704  18123844  17634273  16972678  16280835  15943878
16  27790717  26900048  25707101  24190560  22770783  21704626  21284236
17  17436837  17036092  16847135  16255520  15775941  15683523  15599879
18  20006521  18759742  17759044  16290362  15507561  14810153  14293695
19  12226730  11615954  11143738  10634538  10139065   9668048   9579840
20  15292670  14271243  14564419  15101349  14792339  14727945  14589337
21  13371816  12976554  12340972  11738845  11022200  11132731  11186444
22  10368514   9548580   9194994   9150458   8531561   8267752   8218487
23  12174224  11139933  10340164   9985763   9333152   8878772   8686621
24  15058501  14614802  14762593  14319924  13535372  13372269  12818717
25  10678018  10912074  11044387  10830850  10311996   9915646   9436387
26   8017347   6902771   6338517   5715205   5396958   5050989   4797102
27  11621623  11024306  10596942  10363974  10415948  10570993  10816216
28  11367176  11506310  11470854  11242375  10057794   9838034   9462231
29   7921797   6973115   6095545   5797547   5219982   4900959   4606252  ,     Ra
nk(2021)                             Airports (medium hubs) IATACode  \
0          31                               Dallas Love Field      DAL
1          32             Daniel K. Inouye International Airport      HNL
2          33                     Portland International Airport      PDX
3          34                           William P. Hobby Airport      HOU
4          35            Southwest Florida International Airport      RSW
5          36            St. Louis Lambert International Airport      STL
6          37                   Sacramento International Airport      SMF
7          38             Luis Muñoz Marín International Airport      SJU
8          39               Raleigh-Durham International Airport      RDU
9          40  Louis Armstrong New Orleans International Airport      MSY
10         41                      Oakland International Airport      OAK
11         42                                John Wayne Airport      SNA
12         43                  Kansas City International Airport      MCI
13         44                  San Antonio International Airport      SAT
14         45    Norman Y. Mineta San José International Airport      SJC
15         46            Cleveland Hopkins International Airport      CLE
16         47                 Indianapolis International Airport      IND
17         48                   Pittsburgh International Airport      PIT
18         49  Cincinnati/Northern Kentucky International Air...      CVG
19         50                                   Kahului Airport      OGG
20         51           John Glenn Columbus International Airport      CMH
21         52                   Palm Beach International Airport      PBI
22         53                 Jacksonville International Airport      JAX
23         54                      Bradley International Airport      BDL
24         55            Milwaukee Mitchell International Airport      MKE
25         56                      Ontario International Airport      ONT
26         57          Ted Stevens Anchorage International Airport      ANC
27         58                   Charleston International Airport      CHS
28         59                          Hollywood Burbank Airport      BUR
29         60                                   Eppley Airfield      OMA
30         61                                     Boise Airport      BOI
31         62                      Memphis International Airport      MEM
```

```
32          63                  Reno-Tahoe International Airport      RNO
33          64                Albuquerque International Sunport      ABQ
34          65                     Norfolk International Airport      ORF

                City served  State  2021[3]  2020[4]  2019[5]  2018[6]  \
0                    Dallas     TX  6487563  3669930  8408457  8134848   
1                  Honolulu     HI  5830928  3126391  9988678  9578505   
2                  Portland     OR  5759879  3455877  9797408  9940866   
3                   Houston     TX  5560780  3127178  7069614  6937061   
4                Fort Myers     FL  5080805  2947139  5144467  4719568   
5                 St. Louis     MO  5070471  3041765  7946986  7822274   
6                Sacramento     CA  4760275  2710342  6454413  6031630   
7                  San Juan     PR  4738725  2362851  4590117  4033412   
8                   Raleigh     NC  4311049  2337496  6919429  6416822   
9               New Orleans     LA  4017147  2632606  6717105  6565482   
10                  Oakland     CA  4011953  2271294  6560230  6798321   
11            Orange County     CA  3807205  1824836  5153276  5317149   
12              Kansas City     MO  3795290  2167616  5759419  5935131   
13              San Antonio     TX  3677643  1919958  5022980  4844427   
14                 San Jose     CA  3619690  2283186  7828885  7140616   
15                Cleveland     OH  3552402  1990156  4894541  4836580   
16             Indianapolis     IN  3487100  1989126  4709183  4695040   
17               Pittsburgh     PA  3069259  1742406  4715947  4670033   
18  Cincinnati & Covington  OH/KY  3050597  1729395  4413457  4269258   
19                  Kahului     HI  2933315  1135141  3791807  3572133   
20                 Columbus     OH  2825259  1577596  4172067  4054572   
21          West Palm Beach     FL  2567897  1518732  3460429  3263042   
22             Jacksonville     FL  2425685  1367501  3479923  3118540   
23                 Hartford     CT  2273259  1150033  3323614  3330734   
24                Milwaukee     WI  2231010  1263385  3374073  3548817   
25                  Ontario     CA  2201528  1237946  2723002  2499171   
26                Anchorage     AK  2184959  1157301  2713843  2642901   
27               Charleston     SC  2015277   944660  2375868  2192893   
28                  Burbank     CA  1942417  1056838  2988720  2680240   
29                    Omaha     NE  1829912  1036245  2455274  2457087   
30                    Boise     ID  1809000   991241  2057750  1943181   
31                  Memphis     TN  1793073  1015981  2318442  2213083   
32                     Reno     NV  1781785   976937  2162250  2048916   
33              Albuquerque     NM  1688646   868922  2641450  2647269   
34                  Norfolk     VA  1658024   884882  1990864  1846031   

    2017[7]  2016[8]  2015[9]  2014[10]  2013[11]  2012[12]  
0   7876769  7554596  7040921   4522341   4023779   3902628  
1   9743989  9656340  9656340   9463000   9466995   9225848  
2   9435473  9071154  8340234   7878760   7452603   7142620  
3   6741870  6285181  5937944   5800726   5377050   5043737  
4   4461304  4350650  4231134   4025959   3788870   3634152  
5   7372805  6793076  6239231   6108758   6216104   6208750  
6   5460526  4969366  4816440   4384616   4255145   4357899  
7   4163587  4343354  4218785   4150828   4103197   4204478  
8   5851004  5401714  4954717   4673869   4482016   4490374  
9   6005527  5569705  5329696   4870569   4576539   4293624  
10  6530308  5934639  5506672   5069257   4770716   4926683  
11  5195047  5217242  4945175   4584147   4540628   4381172  
12  5744918  5391557  5135127   4982722   4836221   4866850  
13  4521611  4179994  4091389   4046856   4005874   4036625  
14  6225148  5321603  4885690   4621003   4315839   4077654  
15  4562740  4205739  4083476   3686315   4375448   4346941  
16  4376432  4216766  3889567   3605908   3535015   3586422  
17  4327431  3986114  3890677   3827860   3812460   3892338  
18  3926158  3269979  3036697   2874684   2776377   2937850  
19  3442189  3352813  3220753   3019338   2955304   2861278  
20  3765007  3567864  3312496   3115501   3063822   3095575  
21  3166532  3100624  3113485   2926242   2844507   2796359  
```

```
22  2759067  2799587  2716465   2589198   2549070   2579023
23  3214976  2982194  2926047   2913380   2681181   2647610
24  3452544  3383271  3229876   3228607   3214811   3710384
25  2247645  2127387  2089801   2037346   1970538   2142393
26  2556188  2563524  2525876   2381826   2325030   2249717
27  1945699  1811695  1669988   1539326   1441415   1283970
28  2402106  2077892  1973897   1928491   1918011   2027203
29  2303223  2127387  2046155   2020354   1975339   2018738
30  1777642  1633507  1487777   1378352   1313741   1307505
31  2102739  2016089  1873716   1800268   2301003   3359668
32  1953028  1771864  1669876   1611572   1671926   1685333
33  2412328  2341719  2323883   2354184   2477783   2630574
34  1694329  1602631  1515200   1488114   1560754   1651440  ,    Rank Rank change
Airport name  \
   Rank Rank change                                       Airport name
0     1         NaN   Hartsfield–Jackson Atlanta International Airport
1     2         2.0            Dallas/Fort Worth International Airport
2     3         2.0                       Denver International Airport
3     4         1.0                       O'Hare International Airport
4     5         3.0                  Los Angeles International Airport
5     6         5.0            Charlotte Douglas International Airport
6     7         2.0                   Harry Reid International Airport
7     8         5.0          Phoenix Sky Harbor International Airport
8     9         1.0                      Orlando International Airport
9    10         2.0               Seattle–Tacoma International Airport
10   11         3.0                        Miami International Airport
11   12         3.0               George Bush Intercontinental Airport
12   13         7.0                John F. Kennedy International Airport
13   14         5.0    Fort Lauderdale–Hollywood International Airport
14   15         8.0                San Francisco International Airport
15   16         4.0               Newark Liberty International Airport
16   17         NaN       Minneapolis–Saint Paul International Airport
17   18         NaN                         Detroit Metropolitan Airport
18   19         3.0  General Edward Lawrence Logan International Ai...
19   20         3.0               Salt Lake City International Airport
20   21         1.0                 Philadelphia International Airport
21   22         NaN        Baltimore/Washington International Airport
22   23         4.0                        Tampa International Airport
23   24         NaN                    San Diego International Airport
24   25         4.0               Chicago Midway International Airport
25   26         1.0            Washington Dulles International Airport
26   27         4.0                    Nashville International Airport
27   28         7.0                                 LaGuardia Airport
28   29         4.0                                 Dallas Love Field
29   30         4.0          Ronald Reagan Washington National Airport
30   31         1.0                     Portland International Airport
31   32         4.0              Daniel K. Inouye International Airport
32   33         NaN                             William P. Hobby Airport
33   34         2.0              Austin–Bergstrom International Airport
34   35         1.0            St. Louis Lambert International Airport

                       Location IATA Code    Traffic               Aircraft  \
                       Location IATA Code Passengers % chg.2019/20 Movements
0         College Park, Georgia       ATL   42918685          61.2       NaN
1                 Irving, Texas       DFW   39364990          47.6       NaN
2              Denver, Colorado       DEN   33741129          51.1       NaN
3             Chicago, Illinois       ORD   30860251          63.5       NaN
4       Los Angeles, California       LAX   28779527          67.3       NaN
5     Charlotte, North Carolina       CLT   27205082          45.8       NaN
6              Paradise, Nevada       LAS   22201479          56.9       NaN
7              Phoenix, Arizona       PHX   21978708          52.5       NaN
8              Orlando, Florida       MCO   21617803          57.3       NaN
9            SeaTac, Washington       SEA   20061507          61.3       NaN
10               Miami, Florida       MIA   18663858          59.4       NaN
```

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11              Houston, Texas       IAH   18213571          59.8        NaN
12            Queens, New York       JFK   16630642          73.4        NaN
13      Fort Lauderdale, Florida     FLL   16484132          55.1        NaN
14  San Mateo County, California     SFO   16409625          71.5        NaN
15          Newark, New Jersey       EWR   15892892          65.7        NaN
16      Minneapolis, Minnesota       MSP   14851289          59.8        NaN
17            Romulus, Michigan      DTW   14105007          61.6        NaN
18        Boston, Massachusetts      BOS   12618128          70.3        NaN
19         Salt Lake City, Utah      SLC   12559026          53.2        NaN
20   Philadelphia, Pennsylvania      PHL   11865006          64.1        NaN
21   Linthicum Heights, Maryland     BWI   11204511          58.5        NaN
22              Tampa, Florida       TPA   10238151          54.5        NaN
23        San Diego, California      SAN    8991533          64.3        NaN
24            Chicago, Illinois      MDW    8853948          57.5        NaN
25             Dulles, Virginia      IAD    8333460          66.4        NaN
26         Nashville, Tennessee      BNA    8284570          54.7        NaN
27            Queens, New York       LGA    8245192          73.5        NaN
28               Dallas, Texas       DAL    7684653          54.2        NaN
29          Arlington, Virginia      DCA    7574966          68.4        NaN
30             Portland, Oregon      PDX    7084543          64.4        NaN
31            Honolulu, Hawaii       HNL    6656825          69.6        NaN
32              Houston, Texas       HOU    6476309          55.2        NaN
33               Austin, Texas       AUS    6472579          62.7        NaN
34           St Louis, Missouri      STL    6302402          60.3        NaN


   % chg.2019/20
0            0.0
1            NaN
2            NaN
3            NaN
4            NaN
5            NaN
6            NaN
7            NaN
8            NaN
9            NaN
10           NaN
11           NaN
12           NaN
13           NaN
14           NaN
15           NaN
16           NaN
17           NaN
18           NaN
19           NaN
20           NaN
21           NaN
22           NaN
23           NaN
24           NaN
25           NaN
26           NaN
27           NaN
28           NaN
29           NaN
30           NaN
31           NaN
32           NaN
33           NaN
34           NaN  ,   Location of 35 busiest airports in the United States
0  .mw-parser-output .locmap .od{position:absolut...  ,    Rank Rank change
Airport name  \
```

```
    Rank Rank change                                      Airport name
0      1         NaN   Hartsfield–Jackson Atlanta International Airport
1      2         NaN             Los Angeles International Airport[13]
2      3         NaN                     O'Hare International Airport
3      4         NaN           Dallas/Fort Worth International Airport
4      5         NaN                     Denver International Airport
5      6         NaN         John F. Kennedy International Airport[14]
6      7         NaN              San Francisco International Airport
7      8         NaN          Seattle–Tacoma International Airport[15]
8      9         NaN            Harry Reid International Airport[16]
9     10         NaN                    Orlando International Airport
10    11         NaN           Charlotte Douglas International Airport
11    12         NaN          Newark Liberty International Airport[17]
12    13         1.0      Phoenix Sky Harbor International Airport[18]
13    14         1.0                      Miami International Airport
14    15         NaN          George Bush Intercontinental Airport[19]
15    16         NaN  General Edward Lawrence Logan International Ai...
16    17         NaN   Minneapolis–Saint Paul International Airport[21]
17    18         1.0                 Detroit Metropolitan Airport[22]
18    19         1.0  Fort Lauderdale–Hollywood International Airpor...
19    20         NaN               Philadelphia International Airport
20    21         NaN                             LaGuardia Airport[24]
21    22         NaN        Baltimore/Washington International Airport
22    23         NaN          Salt Lake City International Airport[25]
23    24         NaN              San Diego International Airport[26]
24    25         NaN           Washington Dulles International Airport
25    26         NaN         Ronald Reagan Washington National Airport
26    27         1.0                  Tampa International Airport[27]
27    28         1.0        Daniel K. Inouye International Airport[28]
28    29         2.0            Chicago Midway International Airport
29    30         NaN               Portland International Airport[29]
30    31         1.0              Nashville International Airport[30]
31    32         1.0           Austin–Bergstrom International Airport
32    33         2.0                             Dallas Love Field[31]
33    34         NaN        St. Louis Lambert International Airport[32]
34    35         NaN  Norman Y. Mineta San Jose International Airpor...

                      Location IATA Code    Traffic              Aircraft  \
                      Location IATA Code Passengers % chg.2018/19 Movements
0         College Park, Georgia       ATL  110531300           2.3  904301.0
1       Los Angeles, California       LAX   88068013           0.6  691257.0
2             Chicago, Illinois       ORD   84649115           1.7  919704.0
3                 Irving, Texas       DFW   75066956           8.6  720007.0
4              Denver, Colorado       DEN   69015703           7.0  640098.0
5              Queens, New York       JFK   62551072           1.5  456060.0
6   San Mateo County, California       SFO   57488023           0.5  458496.0
7            SeaTac, Washington       SEA   51829239           4.0  450487.0
8              Paradise, Nevada       LAS   51537638           3.7  552962.0
9              Orlando, Florida       MCO   50613072           6.1  357689.0
10     Charlotte, North Carolina       CLT   50168783           8.0  578263.0
11           Newark, New Jersey       EWR   46336452           1.0  446320.0
12             Phoenix, Arizona       PHX   46288337           3.0  438891.0
13               Miami, Florida       MIA   45924466           2.0  416773.0
14               Houston, Texas       IAH   45264059           3.3  478070.0
15         Boston, Massachusetts       BOS   42522411           3.9  427176.0
16       Minneapolis, Minnesota       MSP   39555035           4.0  406076.0
17            Romulus, Michigan       DTW   36769279           4.3  396909.0
18      Fort Lauderdale, Florida       FLL   36747622           2.2  331447.0
19    Philadelphia, Pennsylvania       PHL   33018886           4.2  390321.0
20             Queens, New York       LGA   31084894           3.3  373356.0
21   Linthicum Heights, Maryland       BWI   26993896           0.6  262597.0
22         Salt Lake City, Utah       SLC   26808014           4.9  344715.0
23       San Diego, California       SAN   25216947           4.0  231354.0
24             Dulles, Virginia       IAD   24817677           3.1  285042.0
```

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25         Arlington, Virginia       DCA   23945527           1.8  292682.0
26              Tampa, Florida       TPA   22497953           5.7  217360.0
27            Honolulu, Hawaii       HNL   21870691           4.2  326832.0
28           Chicago, Illinois       MDW   20844860           5.4  232084.0
29            Portland, Oregon       PDX   19891365           0.0  238384.0
30         Nashville, Tennessee      BNA   18273434          14.2       NaN
31               Austin, Texas       AUS   17343729           9.6  209726.0
32               Dallas, Texas       DAL   16780158           3.4  231879.0
33          St Louis, Missouri       STL   15878527           1.6  193925.0
34         San Jose, California      SJC   15650444           9.3  207111.0


   % chg.2018/19
0            1.0
1            2.3
2            1.8
3            7.9
4            6.1
5            0.1
6            2.5
7            2.8
8            2.4
9            2.9
10           5.1
11           1.6
12           1.1
13           0.2
14           2.4
15           0.7
16           0.3
17           0.8
18           0.6
19           2.8
20           0.4
21           1.5
22           2.2
23           2.8
24           3.9
25           0.4
26           5.0
27          10.7
28           4.6
29           1.9
30           NaN
31           0.2
32           0.3
33           0.2
34          19.4  ,    Rank Rank change                                       Airp
ort name  \
   Rank Rank change                                       Airport name
0     1         NaN  Hartsfield–Jackson Atlanta International Airpo...
1     2         NaN              Los Angeles International Airport[35]
2     3         NaN                   O'Hare International Airport[36]
3     4         NaN       Dallas/Fort Worth International Airport[37]
4     5         NaN                   Denver International Airport[38]
5     6         NaN          John F. Kennedy International Airport[39]
6     7         NaN            San Francisco International Airport[40]
7     8         1.0           Seattle–Tacoma International Airport[41]
8     9         1.0              Harry Reid International Airport[42]
9    10         2.0                  Orlando International Airport[43]
10   11         1.0        Charlotte Douglas International Airport[44]
11   12         1.0           Newark Liberty International Airport[45]
12   13         1.0                    Miami International Airport[46]
13   14         1.0      Phoenix Sky Harbor International Airport[47]
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14  15        NaN        George Bush Intercontinental Airport[48]
15  16        NaN  General Edward Lawrence Logan International Ai...
16  17        NaN   Minneapolis–Saint Paul International Airport[50]
17  18        1.0  Fort Lauderdale–Hollywood International Airpor...
18  19        1.0                Detroit Metropolitan Airport[52]
19  20        NaN          Philadelphia International Airport[53]
20  21        NaN                          LaGuardia Airport[54]
21  22        NaN     Baltimore/Washington International Airport[55]
22  23        NaN         Salt Lake City International Airport[56]
23  24        2.0              San Diego International Airport[57]
24  25        NaN       Washington Dulles International Airport[58]
25  26        2.0      Ronald Reagan Washington National Airport[59]
26  27        NaN          Chicago Midway International Airport[60]
27  28        NaN                  Tampa International Airport[61]
28  29        NaN            Daniel K. Inouye International Airport
29  30        NaN               Portland International Airport[62]
30  31        NaN                           Dallas Love Field[63]
31  32        1.0              Nashville International Airport[64]
32  33        1.0        Austin–Bergstrom International Airport[65]
33  34        2.0        St. Louis Lambert International Airport[66]
34  35        NaN  Norman Y. Mineta San Jose International Airpor...

                          Location IATA Code    Traffic                \
                          Location IATA Code Passengers % chg.2017/18
0           College Park, Georgia       ATL  107394029           3.3
1          Los Angeles, California       LAX   87534384           3.5
2               Chicago, Illinois       ORD   83245472           4.3
3                    Irving, Texas       DFW   69112607           3.0
4                Denver, Colorado       DEN   64494613           5.1
5               Queens, New York       JFK   61909148           3.9
6   South San Francisco, California       SFO   57793313           3.5
7              SeaTac, Washington       SEA   49849520           6.2
8               Las Vegas, Nevada       LAS   49716584           2.5
9                Orlando, Florida       MCO   47696627           6.9
10      Charlotte, North Carolina       CLT   46444380           1.2
11            Newark, New Jersey       EWR   46065175           6.6
12                 Miami, Florida       MIA   45044312           2.2
13               Phoenix, Arizona       PHX   44943686           2.3
14                 Houston, Texas       IAH   43807539           7.6
15         Boston, Massachusetts       BOS   40941925           6.6
16          Minneapolis, Minnesota       MSP   38037381           0.0
17        Fort Lauderdale, Florida       FLL   35963370          10.6
18              Romulus, Michigan       DTW   35236676           1.5
19     Philadelphia, Pennsylvania       PHL   31691956           7.1
20              Queens, New York       LGA   30094074           1.8
21     Linthicum Heights, Maryland       BWI   27145831           2.9
22           Salt Lake City, Utah       SLC   25554244           5.6
23         San Diego, California       SAN   24238300           9.3
24              Dulles, Virginia       IAD   24060709           5.1
25           Arlington, Virginia       DCA   23464618           1.8
26              Chicago, Illinois       MDW   22027737           1.9
27                 Tampa, Florida       TPA   21289390           8.5
28               Honolulu, Hawaii       HNL   20990932           1.1
29               Portland, Oregon       PDX   19882788           4.2
30                  Dallas, Texas       DAL   16229151           3.2
31          Nashville, Tennessee       BNA   15996194          13.2
32                  Austin, Texas       AUS   15819912          13.9
33            St Louis, Missouri       STL   15632586           5.9
34          San Jose, California       SJC   14319292          14.7

    Aircraft
   Movements % chg.2017/18
0     895682          01.7
1     707833          01.1
```

```
2     903747          04.2
3     667213          02.0
4     603403          03.6
5     455529          01.6
6     470164          02.1
7     438391          05.4
8     539857          00.6
9     347672          05.1
10    550013          00.4
11    458674          04.6
12    416032          00.7
13    434252          00.8
14    466738          03.6
15    424024          05.6
16    407476          02.1
17    329662          05.4
18    393681          00.4
19    379665          02.6
20    372025          00.8
21    266569          01.9
22    337276          03.1
23    225058          07.5
24    274281          03.6
25    293827          00.2
26    243322          03.2
27    206938          05.9
28    295233          5.30
29    233993          02.2
30    231110          01.6
31    216966          05.2
32    210080          05.2
33         -             -
34    173389         011.3  ,    Rank                                       Airpor
t name  \
   Rank                                      Airport name
0     1   Hartsfield–Jackson Atlanta International Airport
1     2                Los Angeles International Airport
2     3                     O'Hare International Airport
3     4             Dallas/Fort Worth International Airport
4     5               John F. Kennedy International Airport
5     6                     Denver International Airport
6     7              San Francisco International Airport
7     8                 Harry Reid International Airport
8     9               Seattle–Tacoma International Airport
9    10                      Miami International Airport
10   11             Charlotte Douglas International Airport
11   12            Phoenix Sky Harbor International Airport
12   13                    Orlando International Airport
13   14               George Bush Intercontinental Airport
14   15               Newark Liberty International Airport
15   16        Minneapolis–Saint Paul International Airport
16   17  General Edward Lawrence Logan International Ai...
17   18                     Detroit Metropolitan Airport
18   19                Philadelphia International Airport
19   20                                LaGuardia Airport
20   21    Fort Lauderdale–Hollywood International Airport
21   22         Baltimore/Washington International Airport
22   23          Ronald Reagan Washington National Airport
23   24               Salt Lake City International Airport
24   25               Chicago Midway International Airport
25   26             Washington Dulles International Airport
26   27                  San Diego International Airport
27   28                   Honolulu International Airport
28   29                      Tampa International Airport
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29   30                    Portland International Airport
30   31                                 Dallas Love Field
31   32           St. Louis Lambert International Airport
32   33                   Nashville International Airport
33   34                          William P. Hobby Airport
34   35            Austin–Bergstrom International Airport
35   36                     Oakland International Airport

                           Location IATA Code    Traffic                \
                           Location IATA Code Passengers % chg.2015/16
0            College Park, Georgia       ATL  104171935            02.6
1          Los Angeles, California       LAX   80921527            08.0
2                Chicago, Illinois       ORD   77960588            01.3
3                    Irving, Texas       DFW   65670697            00.2
4                  Queens, New York      JFK   59105513            03.9
5                 Denver, Colorado       DEN   58266515            07.9
6    South San Francisco, California     SFO   53099282            06.1
7                Las Vegas, Nevada       LAS   47496614            04.5
8               SeaTac, Washington       SEA   45736700            08.0
9                   Miami, Florida       MIA   44584603            00.5
10       Charlotte, North Carolina       CLT   44422022            01.0
11                Phoenix, Arizona       PHX   43302381            01.6
12                Orlando, Florida       MCO   41923399            08.0
13                  Houston, Texas       IAH   41622594            03.3
14              Newark, New Jersey       EWR   40563285            08.2
15          Minneapolis, Minnesota       MSP   37413728            02.3
16           Boston, Massachusetts       BOS   36356917            08.5
17               Romulus, Michigan       DTW   34401254            02.9
18      Philadelphia, Pennsylvania       PHL   30155090            04.1
19                Queens, New York       LGA   29786769            04.7
20         Fort Lauderdale, Florida      FLL   29205002            08.4
21     Linthicum Heights, Maryland       BWI   25122651            05.4
22             Arlington, Virginia       DCA   23568586            02.4
23            Salt Lake City, Utah       SLC   23157445            04.5
24               Chicago, Illinois       MDW   22677859            02.1
25                Dulles, Virginia       IAD   21817340            01.5
26           San Diego, California       SAN   20725801            03.2
27                Honolulu, Hawaii       HNL   19878659          – 00.0
28                  Tampa, Florida       TPA   18931922            00.6
29                Portland, Oregon       PDX   18352767            08.9
30                  Dallas, Texas        DAL   15562738            07.3
31              St Louis, Missouri       STL   13959126            09.5
32            Nashville, Tennessee       BNA   12979803           011.2
33                  Houston, Texas       HOU   12909075            06.1
34                   Austin, Texas       AUS   12436849            04.5
35             Oakland, California       OAK   12070967            07.7

    Aircraft
   Movements % chg.2015/16
0     898356          01.8
1     697138          06.3
2     867635          00.9
3     672748          01.3
4     452415          03.0
5     565503          04.5
6     450388          04.8
7     541428          02.1
8     412170          08.1
9     414234          00.3
10    545742          00.3
11    440643          00.1
12    316981          02.9
13    470780          06.4
14    435907          05.3
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15    412872          02.0
16    372930          02.5
17    393427          03.7
18    394022          04.2
19    369987          02.7
20    290239          04.4
21    248585          00.9
22    295038          00.8
23    320137          02.7
24    253046          00.2
25    265743          01.5
26    197132          01.5
27    316154          01.1
28         –             –
29    227709          04.4
30    224193          03.7
31    190560          02.5
32    194758          05.6
33    200741          00.1
34    192032          00.4
35    222771          03.3  ,     Rank                                       Airpo
rt name  \
0      1             John F. Kennedy International Airport
1      2                       Miami International Airport
2      3                 Los Angeles International Airport
3      4              George Bush Intercontinental Airport
4      5              Newark Liberty International Airport
5      6           Dallas/Fort Worth International Airport
6      7   Hartsfield–Jackson Atlanta International Airport
7      8                      O'Hare International Airport
8      9    Fort Lauderdale–Hollywood International Airport
9     10           Washington Dulles International Airport
10    11               San Francisco International Airport
11    12  General Edward Lawrence Logan International Ai...
12    13           Charlotte Douglas International Airport
13    14                      Denver International Airport
14    15                     Orlando International Airport
15    16              Seattle–Tacoma International Airport
16    17          Phoenix Sky Harbor International Airport
17    18                Philadelphia International Airport
18    19          Detroit Metropolitan Wayne County Airport
19    20                  Harry Reid International Airport

                          Location IATA Code  2021[68]  2020[69]  2019[70]
0               Queens, New York       JFK  12466165   8219317  33432159
1                 Miami, Florida       MIA  11592445   6565834  20735658
2        Los Angeles, California       LAX   7862532   6246602  25210140
3                 Houston, Texas       IAH   6458473   3491935  10764589
4            Newark, New Jersey       EWR   6250880   3688541  14087622
5                  Irving, Texas       DFW   5852397   3268822   9103438
6          College Park, Georgia       ATL   5474264   3347184  12268779
7              Chicago, Illinois       ORD   5148494   3481860  13412885
8       Fort Lauderdale, Florida       FLL   4016553   2839383   8524251
9              Dulles, Virginia       IAD   3230027   1917510   7990292
10  South San Francisco, California       SFO   3139041   3210024  14357960
11         Boston, Massachusetts       BOS   2046561   1574712   7534504
12      Charlotte, North Carolina       CLT   1989704   1069001   3405907
13             Denver, Colorado       DEN   1856124    934563   3037012
14             Orlando, Florida       MCO   1837706   1525177   6957048
15           SeaTac, Washington       SEA   1393603   1273179   5392147
16             Phoenix, Arizona       PHX   1223856    750138   1958468
17   Philadelphia, Pennsylvania       PHL    988733    682030   3847253
18            Romulus, Michigan       DTW    966375    873744   3717775
19             Paradise, Nevada       LAS    738257    711614   3462627  ,   R
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ank                                        Airport name  \
  Rank                                        Airport name
0    1                    Memphis International Airport
1    2        Ted Stevens Anchorage International Airport
2    3      Louisville Muhammad Ali International Airport
3    4                     O'Hare International Airport
4    5                      Miami International Airport
5    6                Los Angeles International Airport
6    7  Cincinnati/Northern Kentucky International Air...
7    8               Indianapolis International Airport
8    9          Dallas/Fort Worth International Airport
9   10                    Ontario International Airport

                  Location IATA code        Cargo
                  Location IATA code         Ibs. % chg.2017/16
0       Memphis, Tennessee       MEM  23949525780        00.35%
1        Anchorage, Alaska       ANC  17337337377        02.79%
2     Louisville, Kentucky       SDF  13403682652        04.68%
3        Chicago, Illinois       ORD  10373559593       010.84%
4           Miami, Florida       MIA   7963988407        00.82%
5  Los Angeles, California       LAX   7197930264        03.85%
6         Hebron, Kentucky       CVG   5700282994       033.32%
7    Indianapolis, Indiana       IND   5138500318       0-3.58%
8           Irving, Texas       DFW   4155362297        07.65%
9      Ontario, California       ONT   3522510318       015.81%  ,   .mw-parser-ou
tput .navbar{display:inline;font-size:88%;font-weight:normal}.mw-parser-output .na
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1                                        Statistics

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0  Atlanta (Hartsfield–Jackson – ATL) Austin (Aus...
1                                        Statistics
,   vteList of the busiest airports in North America  \
0                                 Sovereign states
1                Dependencies andother territories

  vteList of the busiest airports in North America.1
0  Antigua and Barbuda Bahamas Barbados Belize Ca...
1  Anguilla Aruba Bermuda Bonaire British Virgin ...  ,        vteLists of the bus
iest airports by continent  \
0  Africa Asia Europe North America Oceania South...

     vteLists of the busiest airports by continent.1
0  Africa Asia Europe North America Oceania South...  ,                        vte
```

```
Aviation statistics  \
0                          Airports worldwide
1   Busiest airports by continent and country
2                                      Africa
3                                        Asia
4                                      Europe
5                               North America
6                                     Oceania
7                               South America
8                                   By region
9                                    Airlines
10                                     Routes

                             vteAviation statistics.1
0   Busiest airports by continent By aircraft move...
1   Africa Morocco South Africa Asia China (exclud...
2                               Morocco South Africa
3   China (excluding Hong Kong and Macau) India In...
4   Austria Belgium Bulgaria Croatia France German...
5   Canada Dominican Republic Mexico United States...
6                               Australia New Zealand
7   Argentina Brazil Chile Colombia Ecuador Paragu...
8   Baltic Caribbean Central America Latin America...
9   World's largest airlines Airline holding compa...
10  Busiest passenger air routes General aviation ...  ,                0
1
0         Africa                              Morocco South Africa
1           Asia  China (excluding Hong Kong and Macau) India In...
2         Europe  Austria Belgium Bulgaria Croatia France German...
3  North America  Canada Dominican Republic Mexico United States...
4        Oceania                             Australia New Zealand
5  South America  Argentina Brazil Chile Colombia Ecuador Paragu...
6      By region  Baltic Caribbean Central America Latin America...]
```

In [35]:
```
table[0].head()
```

Out[35]:

	Rank(2021)	Airports (large hubs)	IATACode	Major cities served	State	2021[3]	2020[4]	2019[5]	2018[6]
0	1	Hartsfield–Jackson Atlanta International Airport	ATL	Atlanta	GA	36676010	20559866	53505795	51865797
1	2	Dallas/Fort Worth International Airport	DFW	Dallas & Fort Worth	TX	30005266	18593421	35778573	32821799
2	3	Denver International Airport	DEN	Denver	CO	28645527	16243216	33592945	31362941
3	4	O'Hare International Airport	ORD	Chicago	IL	26350976	14606034	40871223	39873927
4	5	Los Angeles International Airport	LAX	Los Angeles	CA	23663410	14055777	42939104	42624050

In [36]:
```
table[0]['hubs'] = str('large_hub')
table[0] = table[0][['IATACode', 'hubs']]
```

In [37]:
```
table[0]
```

Out[37]:

	IATACode	hubs
0	ATL	large_hub
1	DFW	large_hub
2	DEN	large_hub
3	ORD	large_hub
4	LAX	large_hub
5	CLT	large_hub
6	MCO	large_hub
7	LAS	large_hub
8	PHX	large_hub
9	MIA	large_hub
10	SEA	large_hub
11	IAH	large_hub
12	JFK	large_hub
13	EWR	large_hub
14	FLL	large_hub
15	MSP	large_hub
16	SFO	large_hub
17	DTW	large_hub
18	BOS	large_hub
19	SLC	large_hub
20	PHL	large_hub
21	BWI	large_hub
22	TPA	large_hub
23	SAN	large_hub
24	LGA	large_hub
25	MDW	large_hub
26	BNA	large_hub
27	IAD	large_hub
28	DCA	large_hub
29	AUS	large_hub

In [38]:
```
table[1].head()
```

Out[38]:

	Rank(2021)	Airports (medium hubs)	IATACode	City served	State	2021[3]	2020[4]	2019[5]	2018[6]	20
0	31	Dallas Love Field	DAL	Dallas	TX	6487563	3669930	8408457	8134848	787
1	32	Daniel K. Inouye International Airport	HNL	Honolulu	HI	5830928	3126391	9988678	9578505	974
2	33	Portland International Airport	PDX	Portland	OR	5759879	3455877	9797408	9940866	943
3	34	William P. Hobby Airport	HOU	Houston	TX	5560780	3127178	7069614	6937061	674
4	35	Southwest Florida International Airport	RSW	Fort Myers	FL	5080805	2947139	5144467	4719568	446

In [39]:

```
table[1]['hubs'] = str('Medium_hub')
```

In [40]:

```
table[1] = table[1][['IATACode', 'hubs']]
table[1]
```

Out[40]:

	IATACode	hubs
0	DAL	Medium_hub
1	HNL	Medium_hub
2	PDX	Medium_hub
3	HOU	Medium_hub
4	RSW	Medium_hub
5	STL	Medium_hub
6	SMF	Medium_hub
7	SJU	Medium_hub
8	RDU	Medium_hub
9	MSY	Medium_hub
10	OAK	Medium_hub
11	SNA	Medium_hub
12	MCI	Medium_hub
13	SAT	Medium_hub
14	SJC	Medium_hub
15	CLE	Medium_hub
16	IND	Medium_hub
17	PIT	Medium_hub
18	CVG	Medium_hub
19	OGG	Medium_hub
20	CMH	Medium_hub
21	PBI	Medium_hub
22	JAX	Medium_hub
23	BDL	Medium_hub
24	MKE	Medium_hub
25	ONT	Medium_hub
26	ANC	Medium_hub
27	CHS	Medium_hub
28	BUR	Medium_hub
29	OMA	Medium_hub
30	BOI	Medium_hub
31	MEM	Medium_hub
32	RNO	Medium_hub
33	ABQ	Medium_hub
34	ORF	Medium_hub

In [41]:
```
# Lets first merge all wikipedia table.
wiki_data = [table[0],table[1]]
```

In [42]:
```
wiki_data = pd.concat(wiki_data, ignore_index=True)
```

In [43]:
```
wiki_data
```

Out[43]:

	IATACode	hubs
0	ATL	large_hub
1	DFW	large_hub
2	DEN	large_hub
3	ORD	large_hub
4	LAX	large_hub
...	...	...
60	BOI	Medium_hub
61	MEM	Medium_hub
62	RNO	Medium_hub
63	ABQ	Medium_hub
64	ORF	Medium_hub

65 rows × 2 columns

In [44]:
```
# Now we gather all the information that we got from wiki pedia link and the data i
final_df = df.merge(wiki_data, left_on ='iata_code', right_on = "IATACode")
```

In [45]:
```
final_df
```

Out[45]:

	id	Airline	Flight	AirportFrom	AirportTo	DayOfWeek	Time	Length	Delay	ident
0	4	AA	2466	SFO	DFW	3	20	195	1	KSFO
1	231	AA	526	SFO	DFW	3	360	215	0	KSFO
2	234	AA	552	SFO	MIA	3	360	315	1	KSFO
3	905	AA	810	SFO	ORD	3	385	255	0	KSFO
4	1739	AA	24	SFO	JFK	3	425	325	1	KSFO
...	...	...	...	...	...	...	...	...	...	...
364272	506267	9E	4052	DAL	MEM	4	370	90	0	KDAL
364273	512858	9E	3704	DAL	MEM	4	705	92	1	KDAL
364274	518247	9E	4060	DAL	MEM	4	990	90	0	KDAL
364275	524678	9E	4052	DAL	MEM	5	370	90	1	KDAL
364276	530841	9E	3704	DAL	MEM	5	705	92	0	KDAL

364277 rows × 28 columns

2. You should then examine the missing values in each field, perform missing value treatment, and justify your actions.

In [46]:
```
# Now we have the final data first we remove some column that is not useable.
final_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 364277 entries, 0 to 364276
Data columns (total 28 columns):
 #   Column             Non-Null Count   Dtype  
---  ------             --------------   -----  
 0   id                 364277 non-null  int64  
 1   Airline            364277 non-null  object 
 2   Flight             364277 non-null  int64  
 3   AirportFrom        364277 non-null  object 
 4   AirportTo          364277 non-null  object 
 5   DayOfWeek          364277 non-null  int64  
 6   Time               364277 non-null  int64  
 7   Length             364277 non-null  int64  
 8   Delay              364277 non-null  int64  
 9   ident              364277 non-null  object 
 10  type               364277 non-null  object 
 11  name               364277 non-null  object 
 12  latitude_deg       364277 non-null  float64
 13  longitude_deg      364277 non-null  float64
 14  elevation_ft       364277 non-null  float64
 15  scheduled_service  364277 non-null  object 
 16  iata_code          364277 non-null  object 
 17  airport_ref        364277 non-null  int64  
 18  airport_ident      364277 non-null  object 
 19  length_ft          364277 non-null  float64
 20  width_ft           364277 non-null  float64
 21  surface            364277 non-null  object 
 22  lighted            364277 non-null  int64  
 23  closed             364277 non-null  int64  
 24  IATA               364277 non-null  object 
 25  Founded            364277 non-null  float64
 26  IATACode           364277 non-null  object 
 27  hubs               364277 non-null  object 
dtypes: float64(6), int64(9), object(13)
memory usage: 80.6+ MB
```

In [47]:
```
final_df = final_df.drop(['id','AirportFrom','airport_ident','iata_code','AirportT
                          'IATA', 'IATACode','name'], axis=1)
```

In [48]:
```
final_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 364277 entries, 0 to 364276
Data columns (total 18 columns):
 #   Column             Non-Null Count   Dtype  
---  ------             --------------   -----  
 0   Airline            364277 non-null  object 
 1   Flight             364277 non-null  int64  
 2   DayOfWeek          364277 non-null  int64  
 3   Time               364277 non-null  int64  
 4   Length             364277 non-null  int64  
 5   Delay              364277 non-null  int64  
 6   type               364277 non-null  object 
 7   latitude_deg       364277 non-null  float64
 8   longitude_deg      364277 non-null  float64
 9   elevation_ft       364277 non-null  float64
 10  scheduled_service  364277 non-null  object 
 11  airport_ref        364277 non-null  int64  
 12  length_ft          364277 non-null  float64
 13  width_ft           364277 non-null  float64
 14  lighted            364277 non-null  int64  
 15  closed             364277 non-null  int64  
 16  Founded            364277 non-null  float64
 17  hubs               364277 non-null  object 
dtypes: float64(6), int64(8), object(4)
memory usage: 52.8+ MB
```

In [49]:
```
# Now lets check the null value and treat them.
final_df.isnull().sum()
```

Out[49]:
```
Airline              0
Flight               0
DayOfWeek            0
Time                 0
Length               0
Delay                0
type                 0
latitude_deg         0
longitude_deg        0
elevation_ft         0
scheduled_service    0
airport_ref          0
length_ft            0
width_ft             0
lighted              0
closed               0
Founded              0
hubs                 0
dtype: int64
```

Only one column contain the null value so simply ww will drop that rows of null value because we have plenty of data.

In [50]:
```
final_df = final_df.dropna(axis=0)
```

In [51]:
```
final_df.head()
```

Out[51]:

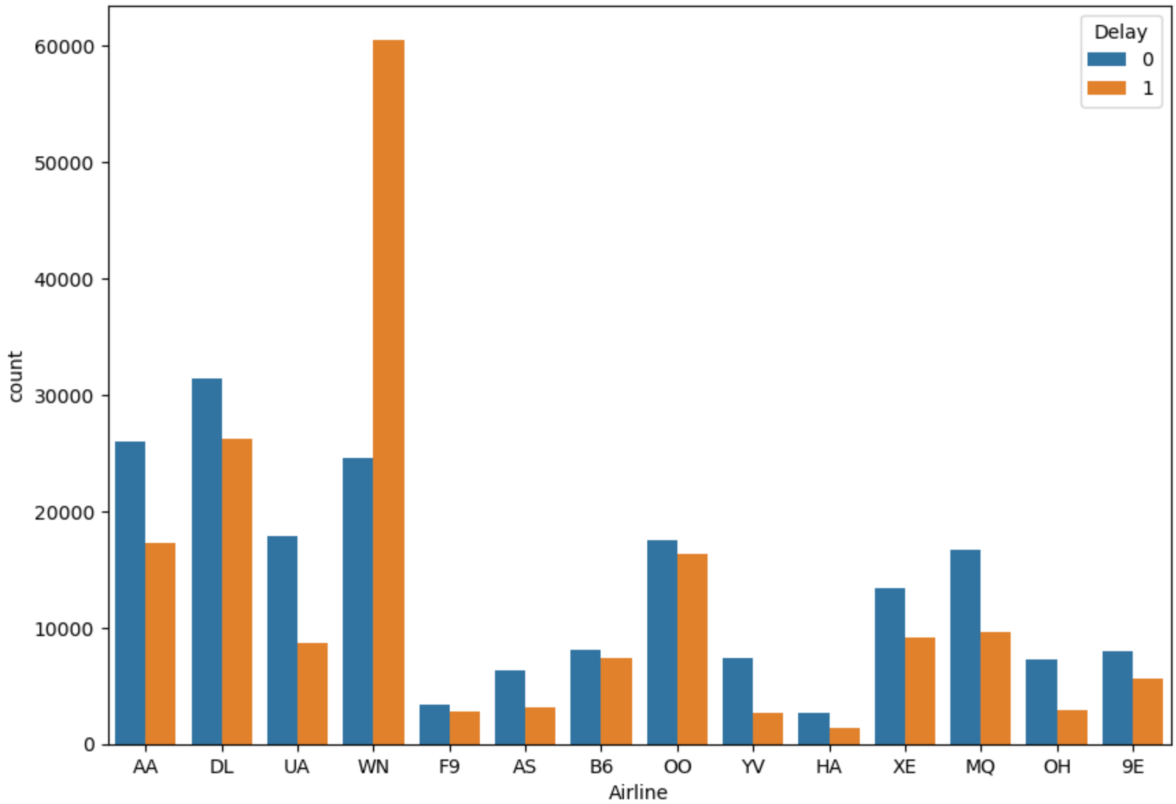
	Airline	Flight	DayOfWeek	Time	Length	Delay	type	latitude_deg	longitude_deg	el
0	AA	2466	3	20	195	1	large_airport	37.618999	-122.375	
1	AA	526	3	360	215	0	large_airport	37.618999	-122.375	
2	AA	552	3	360	315	1	large_airport	37.618999	-122.375	
3	AA	810	3	385	255	0	large_airport	37.618999	-122.375	
4	AA	24	3	425	325	1	large_airport	37.618999	-122.375	

3. Perform data visualization and share your insights on the following points:

a. According to the data provided, approximately 70% of Southwest Airlines flights are delayed. Visualize it to compare it with the data of other airlines.

Airline code WN represent the southwest airlines.

In [52]:
```
plt.figure(figsize=(10,7))
sns.countplot(final_df['Airline'], hue= final_df['Delay'])
plt.show()
```



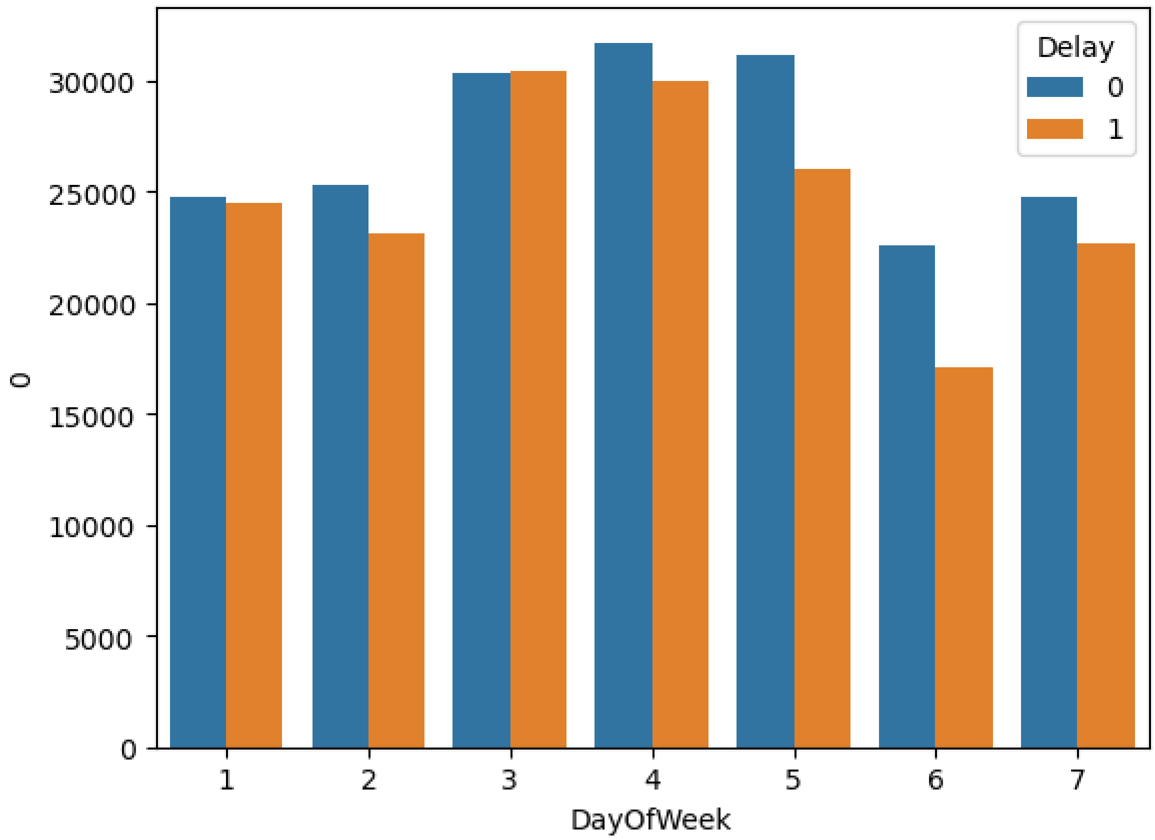
The graph clear show that 70% of flight of south west airline is delayed

b. Flights were delayed on various weekdays. Which day of the week is the safest for travel?

In [53]:
```
weekday_df = final_df[['DayOfWeek','Delay']].value_counts().reset_index()
```

In [54]:
```
sns.barplot(weekday_df['DayOfWeek'], weekday_df[0], hue= weekday_df['Delay'])
```

Out[54]: <AxesSubplot:xlabel='DayOfWeek', ylabel='0'>

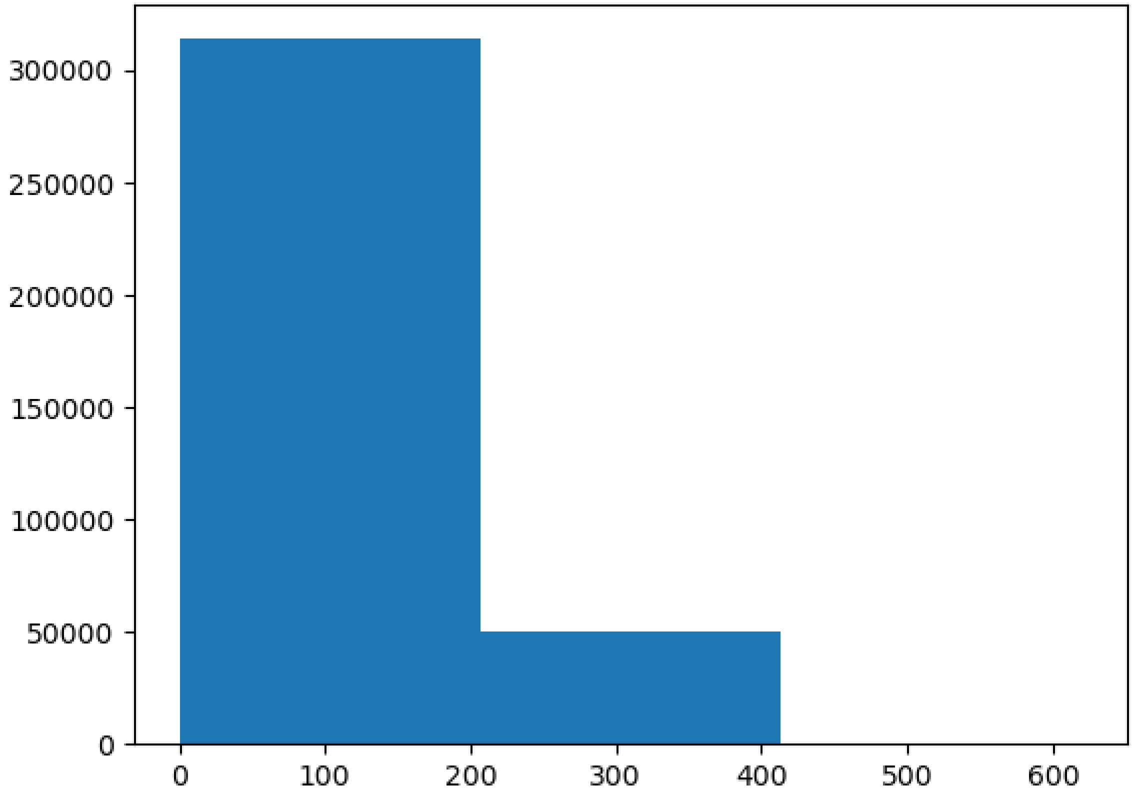


On the 5th day of week its clear that there is less no of flight delay.

c. Which airlines should be recommended for short-, medium-, and long-distance travel?

We divided the length parameter in three range and from that basis we findout airline acc to the distance

In [55]:
```
plt.hist(final_df['Length'], bins = 3)
plt.show()
```



airlines should be recommended for short distance Travel.

In [56]:
```
final_df['Airline'][final_df['Length']<200].value_counts()
```

Out[56]:
```
WN    75941
DL    43872
OO    32965
AA    30246
MQ    26076
XE    22114
UA    16388
9E    13573
B6    11628
OH     9963
YV     9884
AS     6350
F9     5406
HA     3034
Name: Airline, dtype: int64
```

In [57]:
```
final_df['Airline'][final_df['Length']>400].value_counts()
```

Out[57]:
```
UA    549
AA    304
DL    226
B6     83
AS     31
HA     14
Name: Airline, dtype: int64
```

Airlines should be recommended for long distance Travel and remaining for the medium distance.

d. Do you notice any patterns in the departure times of long-duration flights?

In [58]:
```
final_df['Time'][final_df['Length']>400]
```

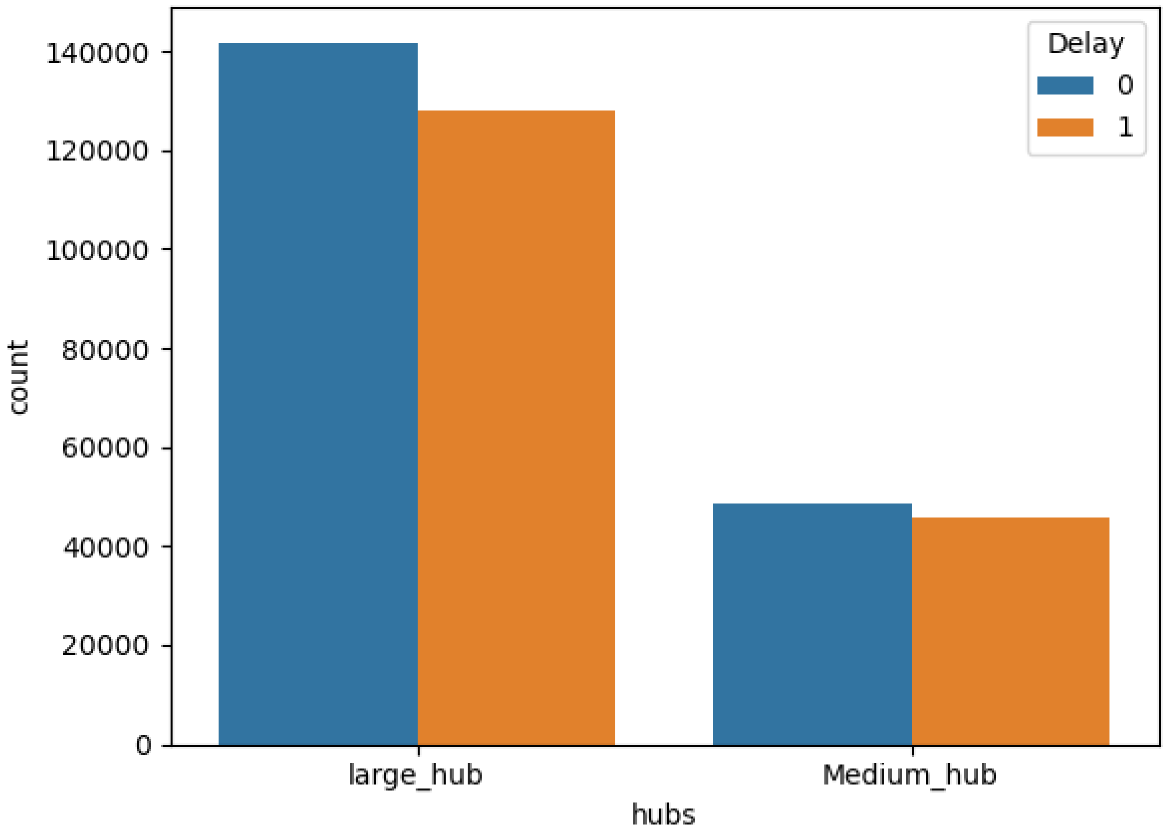
Out[58]:
```
46345     1045
46348     1045
46356     1045
46364     1045
46367     1045
          ...
315043    1416
315049    1416
315055    1416
315061    1416
315067    1416
Name: Time, Length: 1207, dtype: int64
```

It is clear from the above table that is only of that flight which travel a long distance and comman thing in the departure time is all long distance flight leave the airport above 1045 time.

4. How many flights were delayed at large hubs compared to medium hubs? Use appropriate visualization to represent your findings.

In [59]:
```
sns.countplot(final_df['hubs'], hue = final_df['Delay'])
```

Out[59]:
```
<AxesSubplot:xlabel='hubs', ylabel='count'>
```



From the large hubs its clear approx 120000 filght is delayed but from the small hubs aprrox 40000 is delayed.

5. Use hypothesis testing strategies to discover:

a. If the airport's altitude has anything to do with flight delays for incoming and departing flights

In [60]:
```
from scipy.stats import chi2_contingency
table = [final_df['latitude_deg'],final_df['Delay']]
stat, p, dof, expected = chi2_contingency(table)
print('stat=%.3f, p=%.3f' % (stat, p))
if p > 0.05:
    print('Probably independent')
else:
    print('Probably dependent')
```

```
stat=194730.438, p=1.000
Probably independent
```

So its clear from the above hypothesis testing that altitude is nothing to do with the flight delay

b. If the number of runways at an airport affects flight delays

In [61]:
```
from scipy.stats import chi2_contingency
table = [final_df['airport_ref'],final_df['Delay']]
stat, p, dof, expected = chi2_contingency(table)
print('stat=%.3f, p=%.3f' % (stat, p))
if p > 0.05:
    print('Probably independent')
else:
    print('Probably dependent')
```

```
stat=200241.469, p=1.000
Probably independent
```

So its clear from the above hypothesis testing that no of runway is nothing to do with the flight delay

c. If the duration of a flight (length) affects flight delays

In [62]:
```
from scipy.stats import spearmanr
data1 = final_df['Length']
data2 = final_df['Delay']
stat, p = spearmanr(data1, data2)
print('stat=%.3f, p=%.3f' % (stat, p))
if p > 0.05:
    print('Probably independent')
else:
    print('Probably dependent')
```

```
stat=-0.002, p=0.203
Probably independent
```

Both the variable are independent so that length of the flight is not affecting directly the delay.

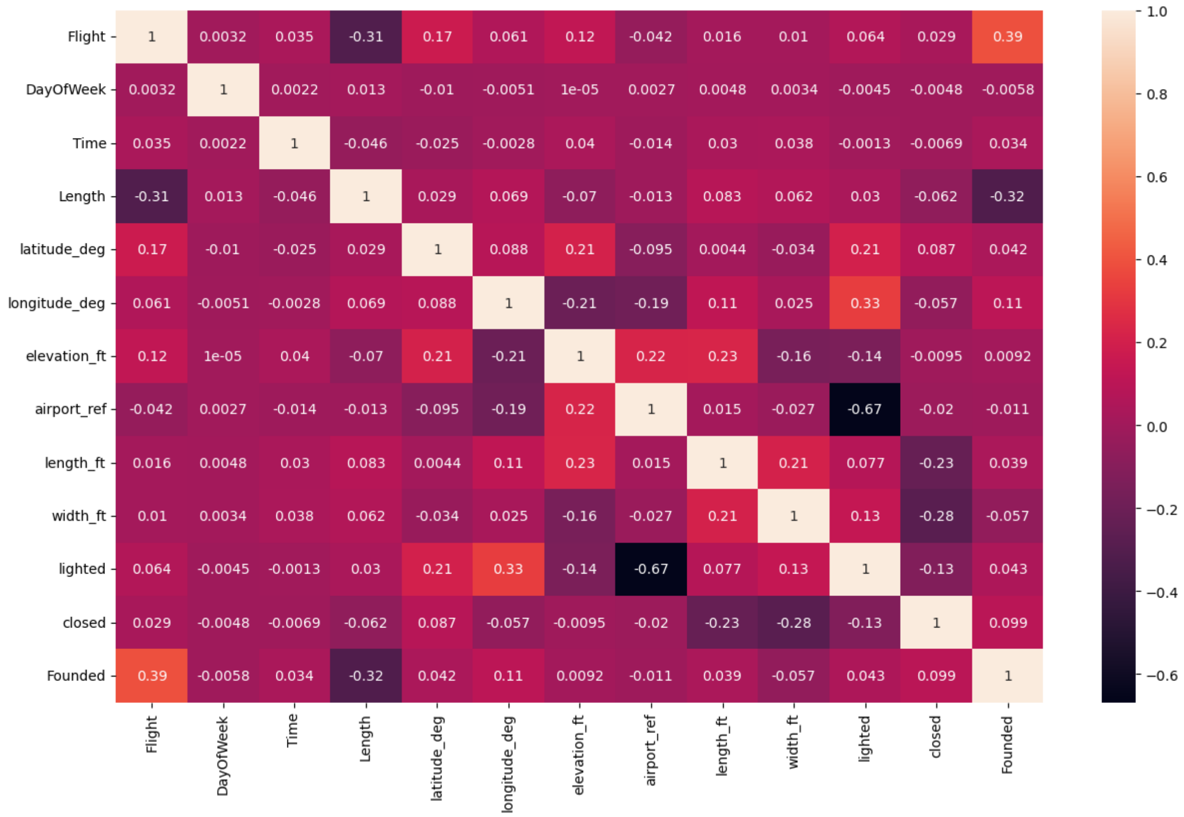
6. Find the correlation matrix between the flight delay predictors, create a heatmap to visualize this, and share your findings

In [63]:
```python
predictor = final_df.drop(['Delay'], axis=1)
corr = predictor.corr()
corr
```

Out[63]:

	Flight	DayOfWeek	Time	Length	latitude_deg	longitude_deg	elevatior
Flight	1.000000	0.003249	0.034959	-0.311840	0.168127	0.061268	0.124
DayOfWeek	0.003249	1.000000	0.002218	0.013059	-0.010100	-0.005075	0.000
Time	0.034959	0.002218	1.000000	-0.045729	-0.024743	-0.002804	0.039
Length	-0.311840	0.013059	-0.045729	1.000000	0.028905	0.068559	-0.070
latitude_deg	0.168127	-0.010100	-0.024743	0.028905	1.000000	0.087885	0.208
longitude_deg	0.061268	-0.005075	-0.002804	0.068559	0.087885	1.000000	-0.208
elevation_ft	0.124437	0.000010	0.039522	-0.070187	0.208233	-0.208175	1.000
airport_ref	-0.042421	0.002675	-0.014048	-0.012986	-0.095324	-0.190519	0.224
length_ft	0.016064	0.004768	0.029940	0.083335	0.004430	0.114385	0.225
width_ft	0.010186	0.003414	0.038049	0.062138	-0.034404	0.024904	-0.155
lighted	0.064012	-0.004520	-0.001339	0.029629	0.205215	0.325019	-0.141
closed	0.029169	-0.004811	-0.006927	-0.062091	0.087013	-0.056677	-0.009
Founded	0.389930	-0.005840	0.033776	-0.318902	0.042304	0.107272	0.009

In [64]:
```python
plt.figure(figsize=(15,9))
sns.heatmap(corr, annot=True)
plt.show()
```



Project Task: Week 1 (Machine learning)

1. Use OneHotEncoder and OrdinalEncoder to deal with categorical variables

In [65]:
```
# Before applying the one hot encodding or the label encoding first we check all fe
final_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 364277 entries, 0 to 364276
Data columns (total 18 columns):
 #   Column             Non-Null Count   Dtype  
---  ------             --------------   -----  
 0   Airline            364277 non-null  object 
 1   Flight             364277 non-null  int64  
 2   DayOfWeek          364277 non-null  int64  
 3   Time               364277 non-null  int64  
 4   Length             364277 non-null  int64  
 5   Delay              364277 non-null  int64  
 6   type               364277 non-null  object 
 7   latitude_deg       364277 non-null  float64
 8   longitude_deg      364277 non-null  float64
 9   elevation_ft       364277 non-null  float64
 10  scheduled_service  364277 non-null  object 
 11  airport_ref        364277 non-null  int64  
 12  length_ft          364277 non-null  float64
 13  width_ft           364277 non-null  float64
 14  lighted            364277 non-null  int64  
 15  closed             364277 non-null  int64  
 16  Founded            364277 non-null  float64
 17  hubs               364277 non-null  object 
dtypes: float64(6), int64(8), object(4)
memory usage: 52.8+ MB
```

In [66]:
```
final_df['Airline'].value_counts()
```

Out[66]:
```
WN    85067
DL    57720
AA    43261
OO    33843
UA    26535
MQ    26308
XE    22566
B6    15497
9E    13573
OH    10211
YV    10002
AS     9477
F9     6180
HA     4037
Name: Airline, dtype: int64
```

In [67]:
```
final_df['type'].value_counts()
```

Out[67]:
```
large_airport     342705
medium_airport     21572
Name: type, dtype: int64
```

In [68]:
```
final_df['scheduled_service'].value_counts()
```

Out[68]:
```
yes    364277
Name: scheduled_service, dtype: int64
```

In [69]:
```
final_df['hubs'].value_counts()
```

Out[69]:
```
large_hub     269953
Medium_hub     94324
Name: hubs, dtype: int64
```

The scheduled_service column throught has same value so it will not help in prediction so lets remove it and other three object column we will change through label encoder.

In [70]:
```
final_df = final_df.drop(['scheduled_service'], axis=1)
```

In [71]:
```
# Now using the ordinal encoder.
from sklearn.preprocessing import LabelEncoder
```

In [72]:
```
le = LabelEncoder()
```

In [73]:
```
final_df['Airline'] = le.fit_transform(final_df['Airline'])
final_df['type'] = le.fit_transform(final_df['type'])
final_df['hubs'] = le.fit_transform(final_df['hubs'])
```

In [74]:
```
final_df.head()
```

Out[74]:

	Airline	Flight	DayOfWeek	Time	Length	Delay	type	latitude_deg	longitude_deg	elevation
0	1	2466	3	20	195	1	0	37.618999	-122.375	1
1	1	526	3	360	215	0	0	37.618999	-122.375	1
2	1	552	3	360	315	1	0	37.618999	-122.375	1
3	1	810	3	385	255	0	0	37.618999	-122.375	1
4	1	24	3	425	325	1	0	37.618999	-122.375	1

2. Perform the following model building steps:

a. Apply logistic regression (use stochastic gradient descent optimizer) and decision tree models

b. Use the stratified five-fold method to build and validate the models

Note: Make sure you use standardization effectively, ensuring no data leakage and leverage pipelines to have a cleaner code

c. Use RandomizedSearchCV for hyperparameter tuning, and use k-fold for cross validation

d. Keep a few data points (10%) for prediction purposes to evaluate how you would make the final prediction, and do not use this data for testing or validation

Note: The final prediction will be based on the voting (majority class by 5 models created using the stratified 5-fold method)

g. Compare the results of logistic regression and decision tree classifier

In [75]:
```
# Lets first seperate the predictors and the output Variable.
x = final_df.drop(['Delay'], axis= 1)
y = final_df["Delay"]
```

In [76]:
```
from sklearn import preprocessing
scaler = preprocessing.MinMaxScaler()
x = scaler.fit_transform(x)
```

In [77]:
```
# First Split the data into the training and testing set before performing the fur
from sklearn.model_selection import train_test_split
```

In [78]:
```
x_train, x_test, y_train, y_test = train_test_split(x, y, train_size=0.9, random_s
```

LogisticRegression

In [79]:
```
# lets apply the logistic regression with the randomsearchcv hypermeter tunning.
from sklearn.linear_model import LogisticRegression
lr = LogisticRegression()
```

In [80]:
```
from sklearn.model_selection import RandomizedSearchCV
```

In [81]:
```
params = {"penalty": ["l1","l2"],
         'solver': ['newton-cg', 'liblinear']}

# Cross Validation
folds = 5

rscv = RandomizedSearchCV(estimator = lr,
                         param_distributions = params,
                         scoring = "accuracy",
                         verbose = 1,
                         cv= folds)

rscv.fit(x_train, y_train)
```

```
Fitting 5 folds for each of 4 candidates, totalling 20 fits
```

Out[81]:
```
RandomizedSearchCV(cv=5, estimator=LogisticRegression(),
                   param_distributions={'penalty': ['l1', 'l2'],
                                        'solver': ['newton-cg', 'liblinear']},
                   scoring='accuracy', verbose=1)
```

In [82]:
```
print(rscv.best_params_)
print(rscv.best_score_)
```

```
{'solver': 'newton-cg', 'penalty': 'l2'}
0.5929315093558369
```

In [83]:
```
lr = LogisticRegression(penalty= 'l2', solver= 'newton-cg')
lr.fit(x_train,y_train).score(x_train,y_train)
```

Out[83]:
```
0.5929193012636915
```

In [84]:
```
lr.score(x_test, y_test)
```

Out[84]:
```
0.5937191171626222
```

DecisionTreeClassifier

In [85]:
```
from sklearn.tree import DecisionTreeClassifier

dt = DecisionTreeClassifier()

params = {'criterion': ["gini", "entropy"],
          'min_samples_leaf' : [2,3,4,5,6,7,8,9],
         "max_depth": [2,3,4,5,6,7,8,9]}

rscv = RandomizedSearchCV(estimator = dt,
                              param_distributions= params,
                              scoring = "accuracy",
                              cv= 5,
                              verbose=1)
rscv.fit(x_train, y_train)
```

```
Fitting 5 folds for each of 10 candidates, totalling 50 fits
```

Out[85]:
```
RandomizedSearchCV(cv=5, estimator=DecisionTreeClassifier(),
                   param_distributions={'criterion': ['gini', 'entropy'],
                                        'max_depth': [2, 3, 4, 5, 6, 7, 8, 9],
                                        'min_samples_leaf': [2, 3, 4, 5, 6, 7,
                                                             8, 9]},
                   scoring='accuracy', verbose=1)
```

In [86]:
```
print(rscv.best_params_)
print(rscv.best_score_)
```

```
{'min_samples_leaf': 9, 'max_depth': 7, 'criterion': 'entropy'}
0.6430124896771539
```

In [87]:
```
dtc = DecisionTreeClassifier(max_depth= 9, criterion= 'entropy',min_samples_leaf= (
```

In [88]:
```
dtc.fit(x_train, y_train).score(x_train, y_train)
```

Out[88]:
```
0.653956547068925
```

In [89]:
```
dtc.score(x_test, y_test)
```

Out[89]:
```
0.6493356758537389
```

After seeing the result its clear decision tree has good accuracy.

3. Use the stratified five-fold method to build and validate the models using the XGB classifier, compare all methods, and share your findings

In [ ]:

In [90]:
```
from xgboost import XGBClassifier


# Create the parameter grid: gbm_param_grid
gbm_param_grid = {
```

```
                     'n_estimators': range(8, 20),
                     'max_depth': range(6, 10),
                     'learning_rate': [.4, .45, .5, .55, .6],
                     'colsample_bytree': [.6, .7, .8, .9, 1]
                      }

# Instantiate the regressor: gbm
gbm = XGBClassifier()

# Perform random search: grid_mse
xgb_random = RandomizedSearchCV(param_distributions=gbm_param_grid,
                                    estimator = gbm, scoring = "accuracy",
                                    verbose = 1, n_iter = 50, cv = 3)

# Fit randomized_mse to the data
xgb_random.fit(x_train, y_train)

# Print the best parameters and lowest RMSE
print("Best parameters found: ", xgb_random.best_params_)
print("Best accuracy found: ", xgb_random.best_score_)
```

```
Fitting 3 folds for each of 50 candidates, totalling 150 fits
Best parameters found:  {'n_estimators': 19, 'max_depth': 9, 'learning_rate': 0.4,
'colsample_bytree': 1}
Best accuracy found:  0.6621798449896141
```

In [91]:
```
xgb = XGBClassifier(n_estimators=14, max_depth=9, learning_rate=0.45, colsample_by
xgb.fit(x_train,y_train).score(x_train,y_train)
```

Out[91]:
```
0.6860200885163596
```

In [92]:
```
# Now lets compare the all method.
print(lr.score(x_test, y_test))
print(dtc.score(x_test, y_test))
print(xgb.score(x_test, y_test))
```

```
0.5937191171626222
0.6493356758537389
0.6633358954650269
```

After comparing the accuracy of the diffrent model the best result we getting from the XGBclassifier.

In [ ]:

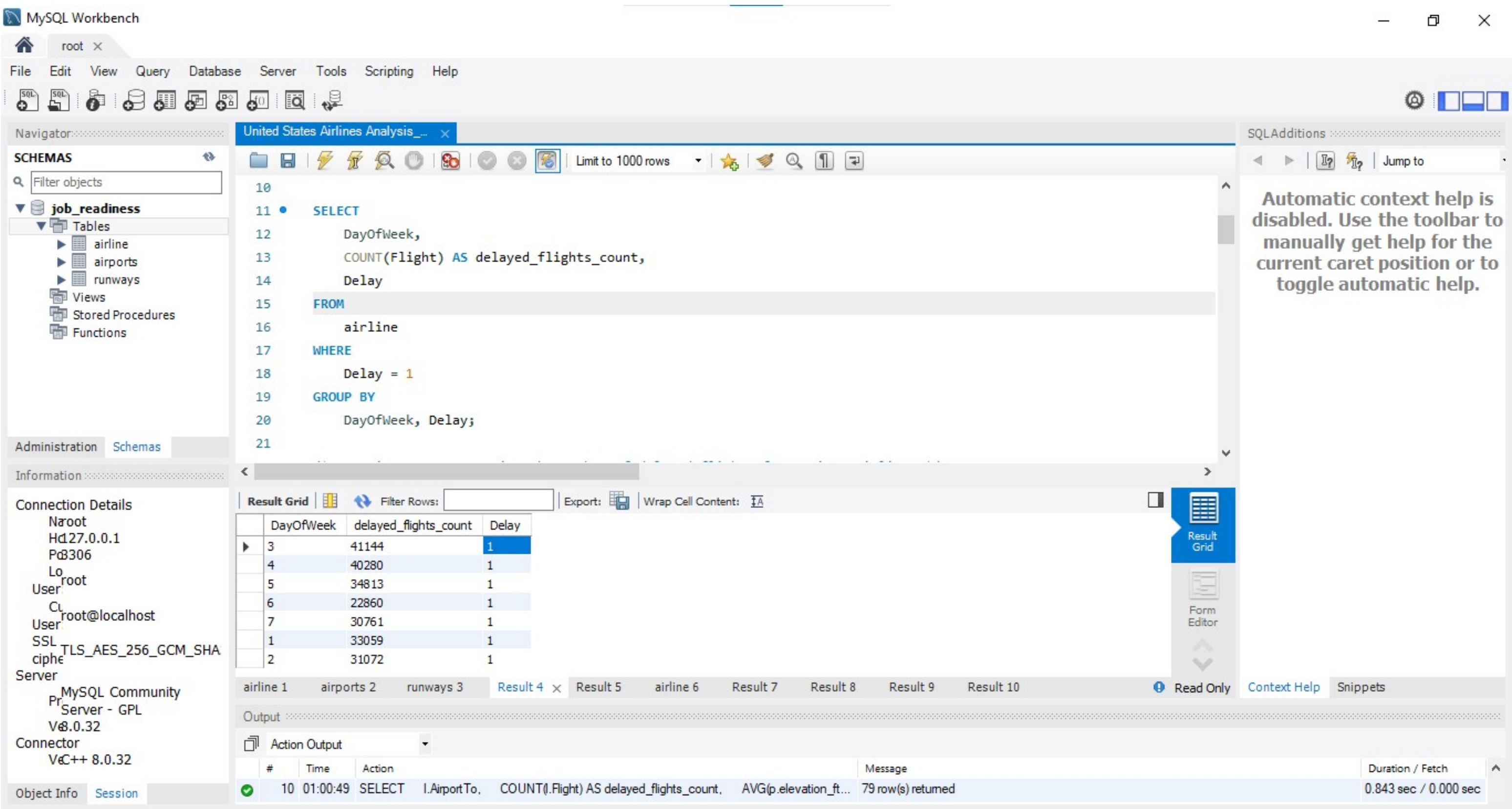
In [ ]:

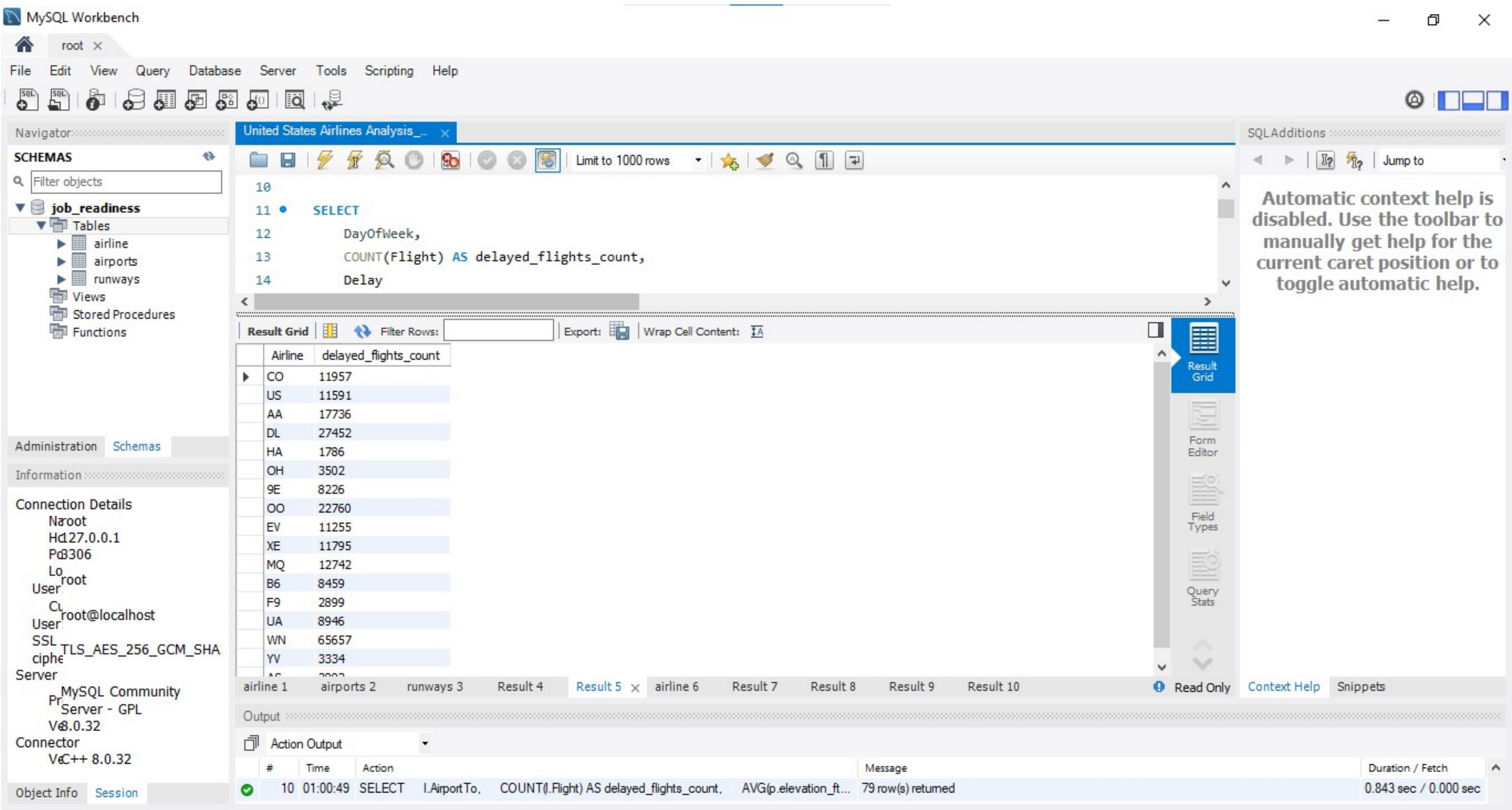
SQL PART

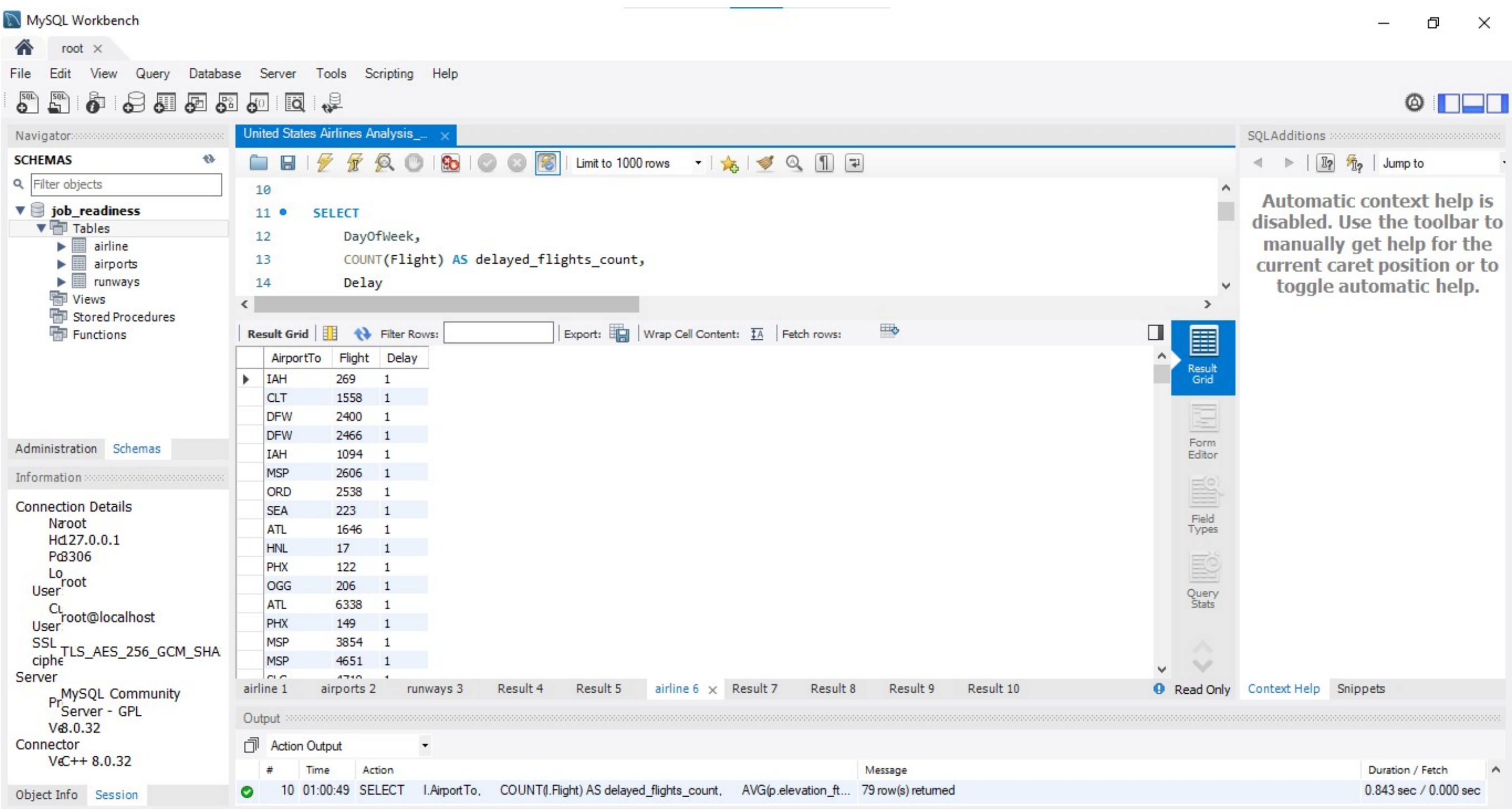
```
/* Question No1:- Determine the number of flights that are delayed on various days of the week
*/

-- First calling the database to import the data.
CREATE DATABASE job_readiness;
USE job_readiness;
-- Import the data set to perform further operation.
SELECT * FROM airline;
SELECT * FROM airports;
SELECT * FROM runways;

SELECT
    DayOfWeek,
    COUNT(Flight) AS delayed_flights_count,
    Delay
FROM
    airline
WHERE
    Delay = 1
GROUP BY
    DayOfWeek, Delay;

/* Question No2:- Determine the number of delayed flights for various airlines */

SELECT
    Airline,
    COUNT(Flight) AS delayed_flights_count
FROM
    airline
WHERE
    Delay = 1
GROUP BY
    Airline;

/* Question No3:- Determine how many delayed flights land at airports with at least 10 runways
*/

SELECT
    AirportTo,
    Flight,
    Delay
FROM
    airline
WHERE
    Delay = 1
GROUP BY
    AirportTo, Flight, Delay;
```

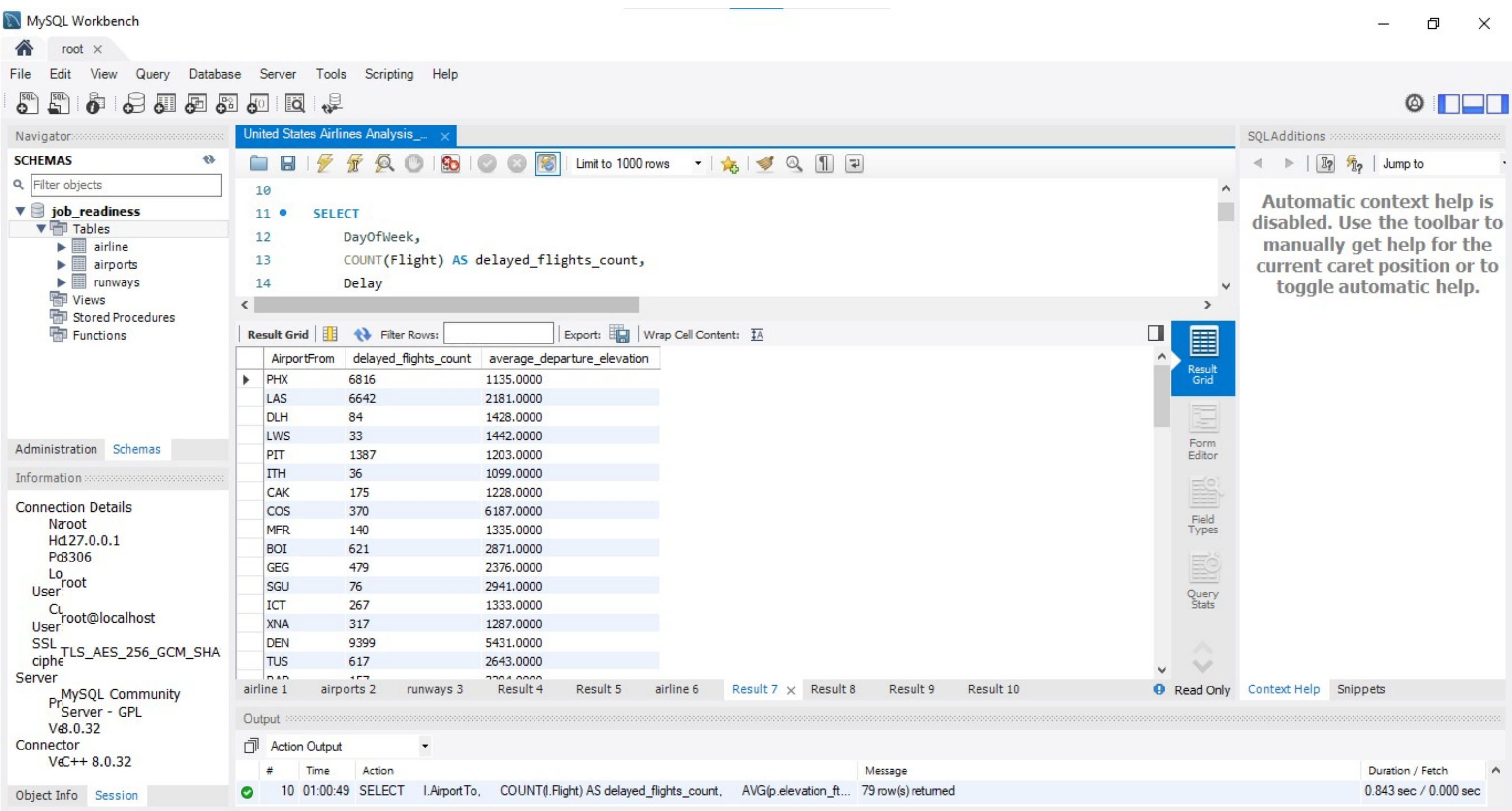
```sql
/* Question No4:- Compare the number of delayed flights at airports higher than average
elevation and those that are lower than average elevation for both source and destination
airports */

-- Lets first compare for the source airport

SELECT
    l.AirportFrom,
    COUNT(l.Flight) AS delayed_flights_count,
    AVG(p.elevation_ft) AS average_departure_elevation
FROM
    airline AS l
    INNER JOIN airports AS p ON p.iata_code = l.AirportFrom
WHERE
    p.elevation_ft > 1037.25
    AND l.Delay = 1
GROUP BY
    l.AirportFrom, p.elevation_ft;


SELECT
    l.AirportFrom,
    COUNT(l.Flight) AS delayed_flights_count,
    AVG(p.elevation_ft) AS average_departure_elevation
FROM
    airline AS l
    INNER JOIN airports AS p ON p.iata_code = l.AirportFrom
WHERE
    p.elevation_ft < 1037.25
    AND l.Delay = 1
GROUP BY
    l.AirportFrom, p.elevation_ft;


-- Lets now compare for the destination airport

SELECT
    l.AirportTo,
    COUNT(l.Flight) AS delayed_flights_count,
    AVG(p.elevation_ft) AS average_destination_elevation,
    p.elevation_ft AS destination_elevation
FROM
    airline AS l
    INNER JOIN airports AS p ON p.iata_code = l.AirportTo
WHERE
    p.elevation_ft > 1037.25
    AND l.Delay = 1
GROUP BY
    l.AirportTo, p.elevation_ft;
```

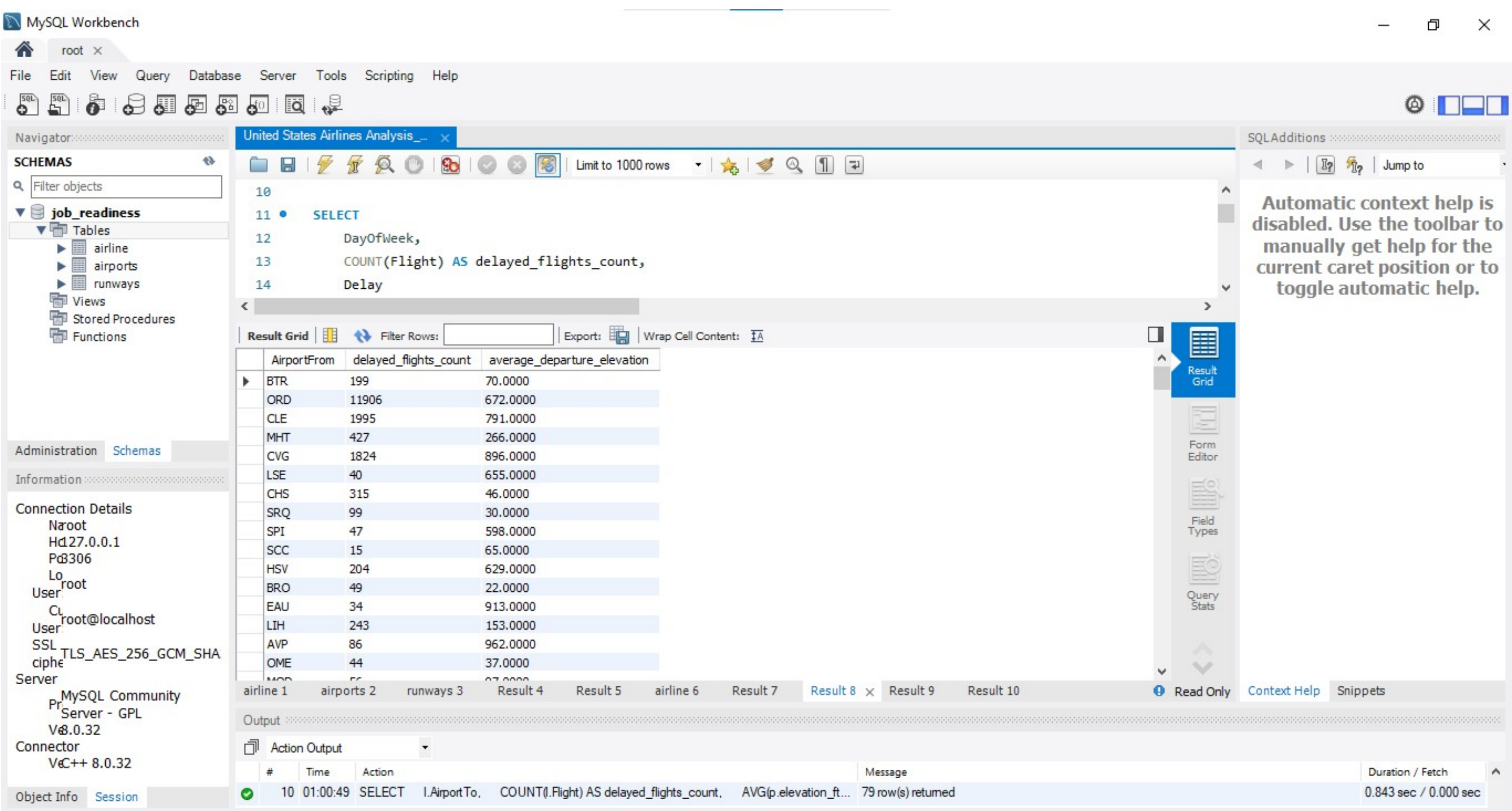
```sql
SELECT
    l.AirportTo,
    COUNT(l.Flight) AS delayed_flights_count,
    AVG(p.elevation_ft) AS average_destination_elevation,
    p.elevation_ft AS destination_elevation
FROM
    airline AS l
    INNER JOIN airports AS p ON p.iata_code = l.AirportTo
WHERE
    p.elevation_ft < 1037.25
    AND l.Delay = 1
GROUP BY
    l.AirportTo, p.elevation_ft;
```

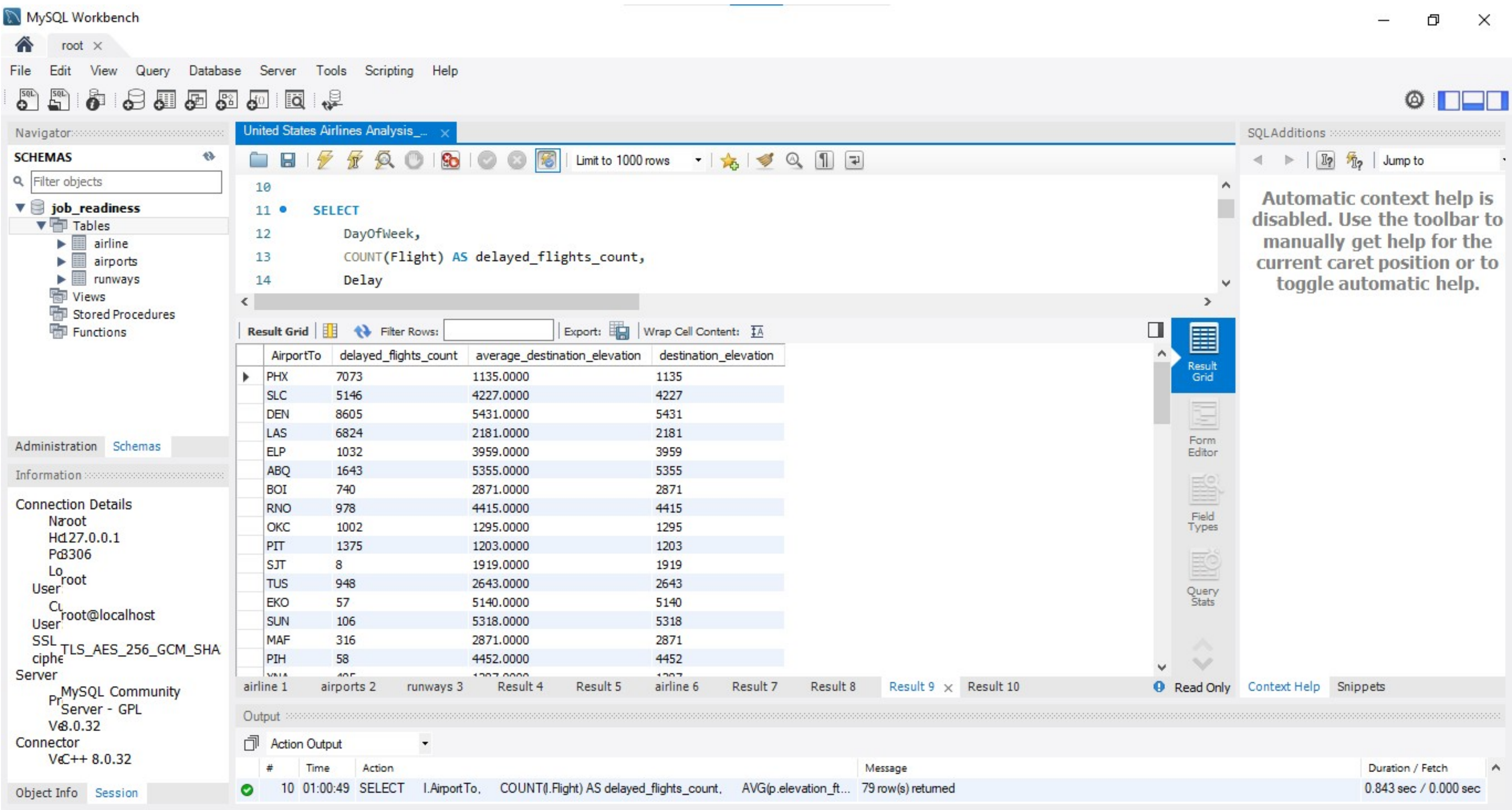


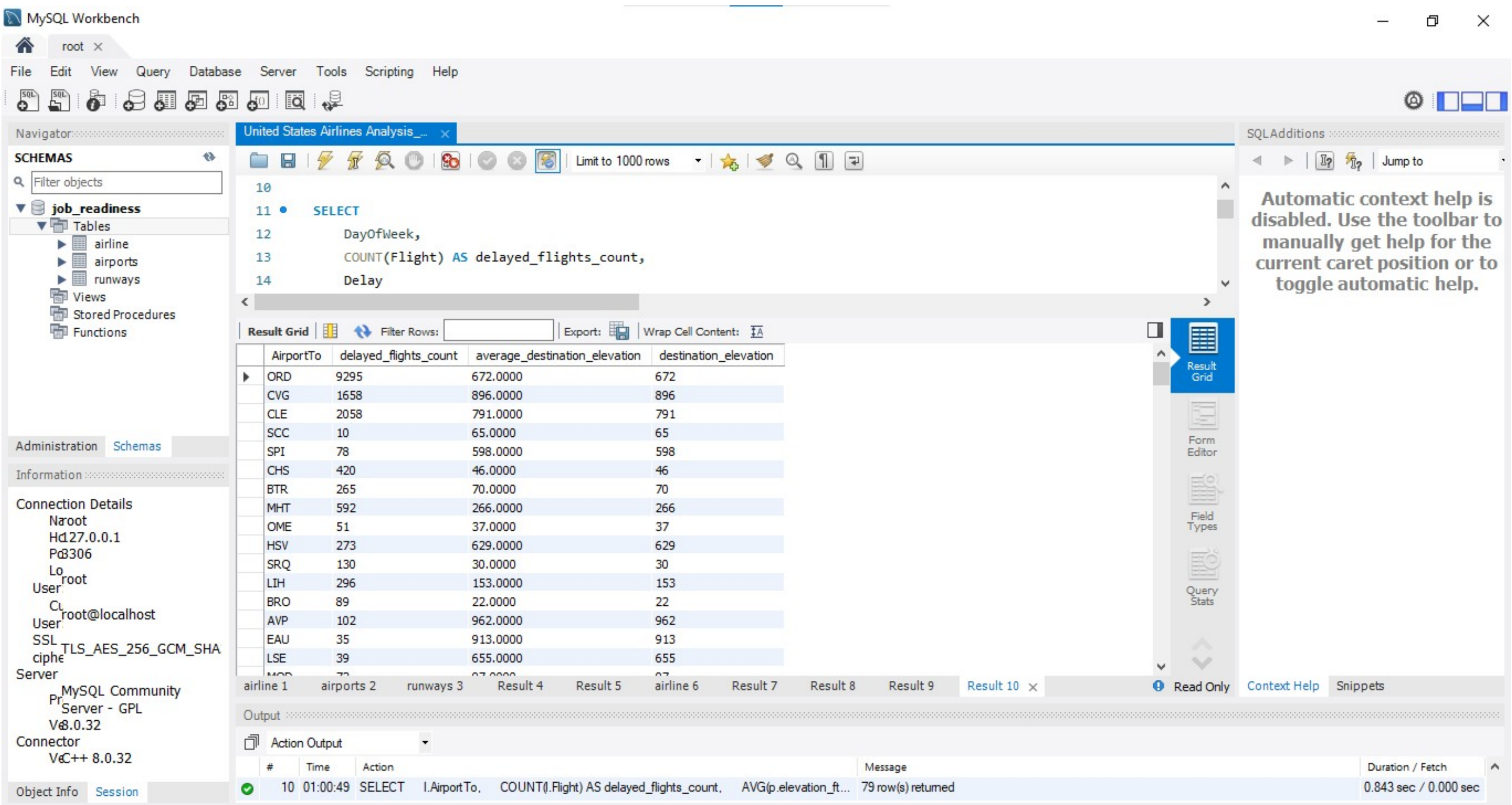

MySQL Workbench
United States Airlines Analysis_...
10
11 SELECT
12 DayOfWeek,
13 COUNT(Flight) AS delayed_flights_count,
14 Delay
Airline delayed_flights_count
CO 11957
US 11591
AA 17736
DL 27452
HA 1786
OH 3502
9E 8226
OO 22760
EV 11255
XE 11795
MQ 12742
B6 8459
F9 2899
UA 8946
WN 65657
YV 3334
airline 1 airports 2 runways 3 Result 4 Result 5 airline 6 Result 7 Result 8 Result 9 Result 10
10 01:00:49 SELECT l.AirportTo, COUNT(l.Flight) AS delayed_flights_count, AVG(p.elevation_ft... 79 row(s) returned 0.843 sec / 0.000 sec


MySQL Workbench
United States Airlines Analysis_...
10
11 SELECT
12 DayOfWeek,
13 COUNT(Flight) AS delayed_flights_count,
14 Delay
AirportTo Flight Delay
IAH 269 1
CLT 1558 1
DFW 2400 1
DFW 2466 1
IAH 1094 1
MSP 2606 1
ORD 2538 1
SEA 223 1
ATL 1646 1
HNL 17 1
PHX 122 1
OGG 206 1
ATL 6338 1
PHX 149 1
MSP 3854 1
MSP 4651 1
airline 1 airports 2 runways 3 Result 4 Result 5 airline 6 Result 7 Result 8 Result 9 Result 10
10 01:00:49 SELECT l.AirportTo, COUNT(l.Flight) AS delayed_flights_count, AVG(p.elevation_ft... 79 row(s) returned 0.843 sec / 0.000 sec


MySQL Workbench
United States Airlines Analysis_
Limit to 1000 rows
10
11 SELECT
12 DayOfWeek,
13 COUNT(Flight) AS delayed_flights_count,
14 Delay
Result Grid
AirportFrom delayed_flights_count average_departure_elevation
PHX 6816 1135.0000
LAS 6642 2181.0000
DLH 84 1428.0000
LWS 33 1442.0000
PIT 1387 1203.0000
ITH 36 1099.0000
CAK 175 1228.0000
COS 370 6187.0000
MFR 140 1335.0000
BOI 621 2871.0000
GEG 479 2376.0000
SGU 76 2941.0000
ICT 267 1333.0000
XNA 317 1287.0000
DEN 9399 5431.0000
TUS 617 2643.0000
SCHEMAS
job_readiness
Tables
airline
airports
runways
Views
Stored Procedures
Functions
Automatic context help is disabled. Use the toolbar to manually get help for the current caret position or to toggle automatic help.
airline 1 airports 2 runways 3 Result 4 Result 5 airline 6 Result 7 Result 8 Result 9 Result 10
Read Only
Output
Action Output
10 01:00:49 SELECT l.AirportTo, COUNT(l.Flight) AS delayed_flights_count, AVG(p.elevation_ft... 79 row(s) returned 0.843 sec / 0.000 sec


MySQL Workbench
United States Airlines Analysis_
Limit to 1000 rows
10
11 SELECT
12 DayOfWeek,
13 COUNT(Flight) AS delayed_flights_count,
14 Delay
Result Grid
AirportFrom delayed_flights_count average_departure_elevation
BTR 199 70.0000
ORD 11906 672.0000
CLE 1995 791.0000
MHT 427 266.0000
CVG 1824 896.0000
LSE 40 655.0000
CHS 315 46.0000
SRQ 99 30.0000
SPI 47 598.0000
SCC 15 65.0000
HSV 204 629.0000
BRO 49 22.0000
EAU 34 913.0000
LIH 243 153.0000
AVP 86 962.0000
OME 44 37.0000
SCHEMAS
job_readiness
Tables
airline
airports
runways
Views
Stored Procedures
Functions
Automatic context help is disabled. Use the toolbar to manually get help for the current caret position or to toggle automatic help.
airline 1 airports 2 runways 3 Result 4 Result 5 airline 6 Result 7 Result 8 Result 9 Result 10
Read Only
Output
Action Output
10 01:00:49 SELECT l.AirportTo, COUNT(l.Flight) AS delayed_flights_count, AVG(p.elevation_ft... 79 row(s) returned 0.843 sec / 0.000 sec

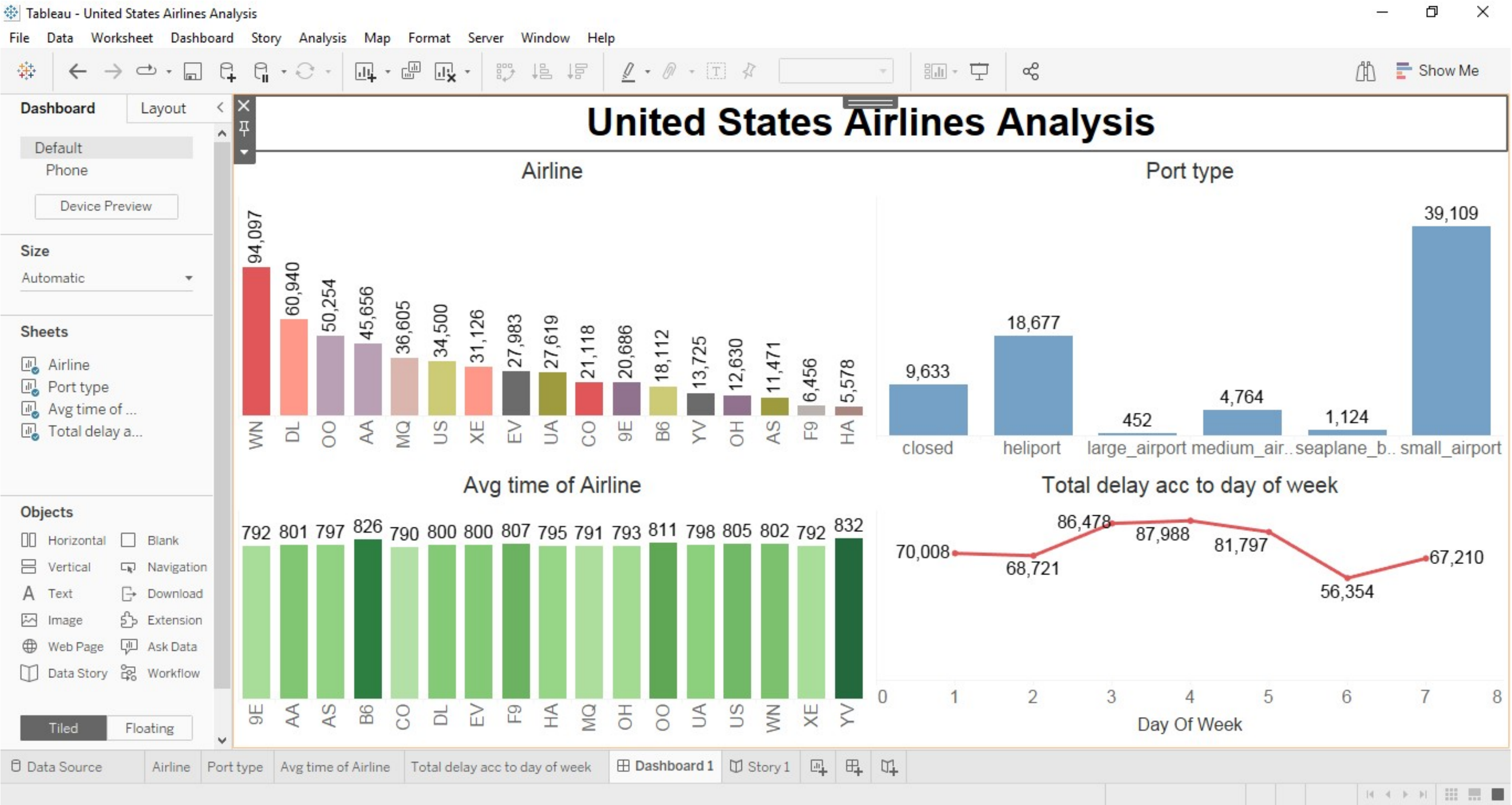

MySQL Workbench
United States Airlines Analysis_...
10
11 SELECT
12 DayOfWeek,
13 COUNT(Flight) AS delayed_flights_count,
14 Delay
AirportTo delayed_flights_count average_destination_elevation destination_elevation
PHX 7073 1135.0000 1135
SLC 5146 4227.0000 4227
DEN 8605 5431.0000 5431
LAS 6824 2181.0000 2181
ELP 1032 3959.0000 3959
ABQ 1643 5355.0000 5355
BOI 740 2871.0000 2871
RNO 978 4415.0000 4415
OKC 1002 1295.0000 1295
PIT 1375 1203.0000 1203
SJT 8 1919.0000 1919
TUS 948 2643.0000 2643
EKO 57 5140.0000 5140
SUN 106 5318.0000 5318
MAF 316 2871.0000 2871
PIH 58 4452.0000 4452
10 01:00:49 SELECT l.AirportTo, COUNT(l.Flight) AS delayed_flights_count, AVG(p.elevation_ft... 79 row(s) returned 0.843 sec / 0.000 sec


MySQL Workbench
United States Airlines Analysis_...
10
11 SELECT
12 DayOfWeek,
13 COUNT(Flight) AS delayed_flights_count,
14 Delay
AirportTo delayed_flights_count average_destination_elevation destination_elevation
ORD 9295 672.0000 672
CVG 1658 896.0000 896
CLE 2058 791.0000 791
SCC 10 65.0000 65
SPI 78 598.0000 598
CHS 420 46.0000 46
BTR 265 70.0000 70
MHT 592 266.0000 266
OME 51 37.0000 37
HSV 273 629.0000 629
SRQ 130 30.0000 30
LIH 296 153.0000 153
BRO 89 22.0000 22
AVP 102 962.0000 962
EAU 35 913.0000 913
LSE 39 655.0000 655
10 01:00:49 SELECT l.AirportTo, COUNT(l.Flight) AS delayed_flights_count, AVG(p.elevation_ft... 79 row(s) returned 0.843 sec / 0.000 sec

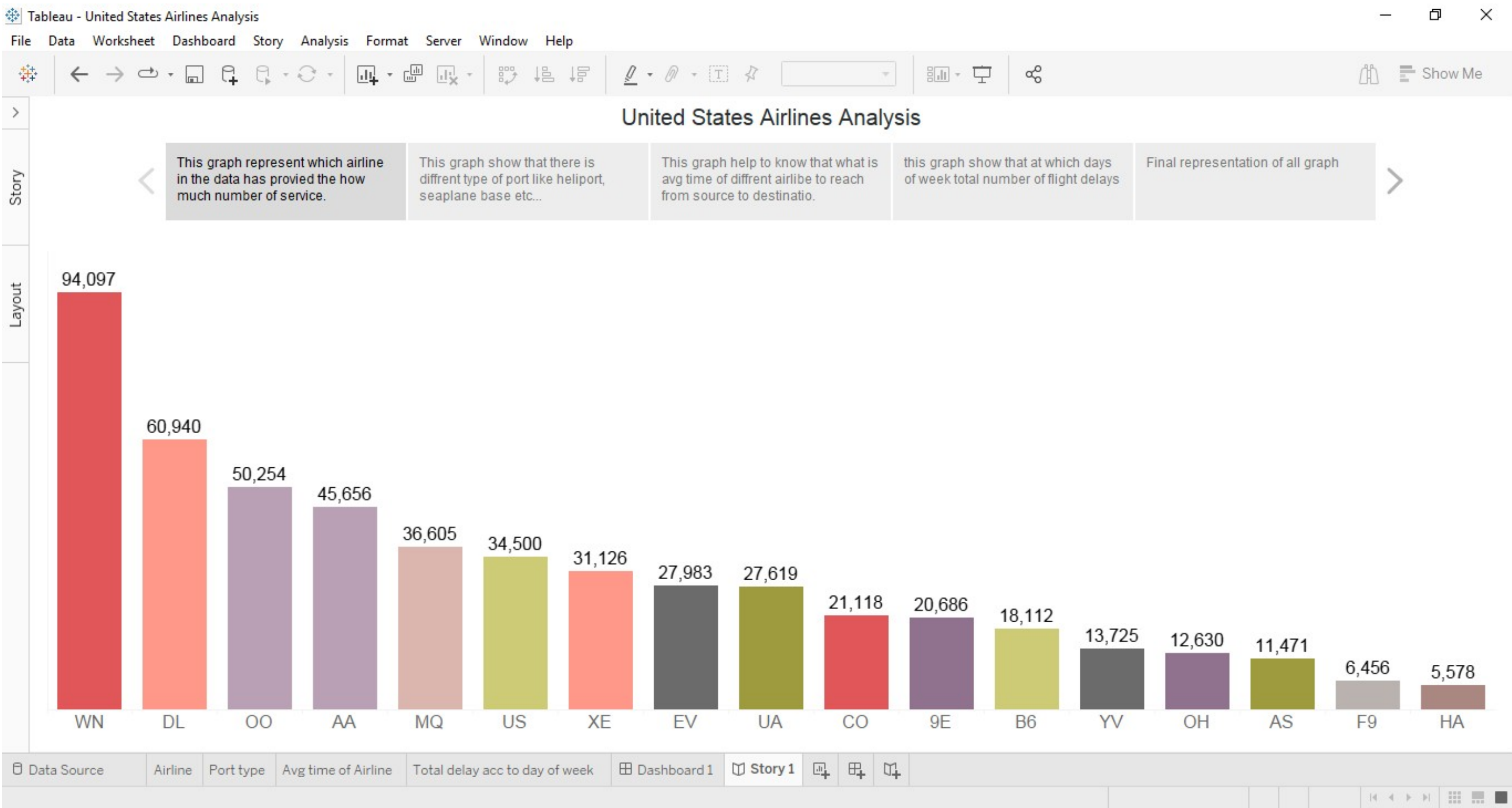
Project Task: Week 2

1. Create a dashboard in Tableau by selecting appropriate chart types and metrics for the business
Note: Put more emphasis on data storytelling
Dashboard
Storytelling

<u>Dashboard</u>



<u>story</u>



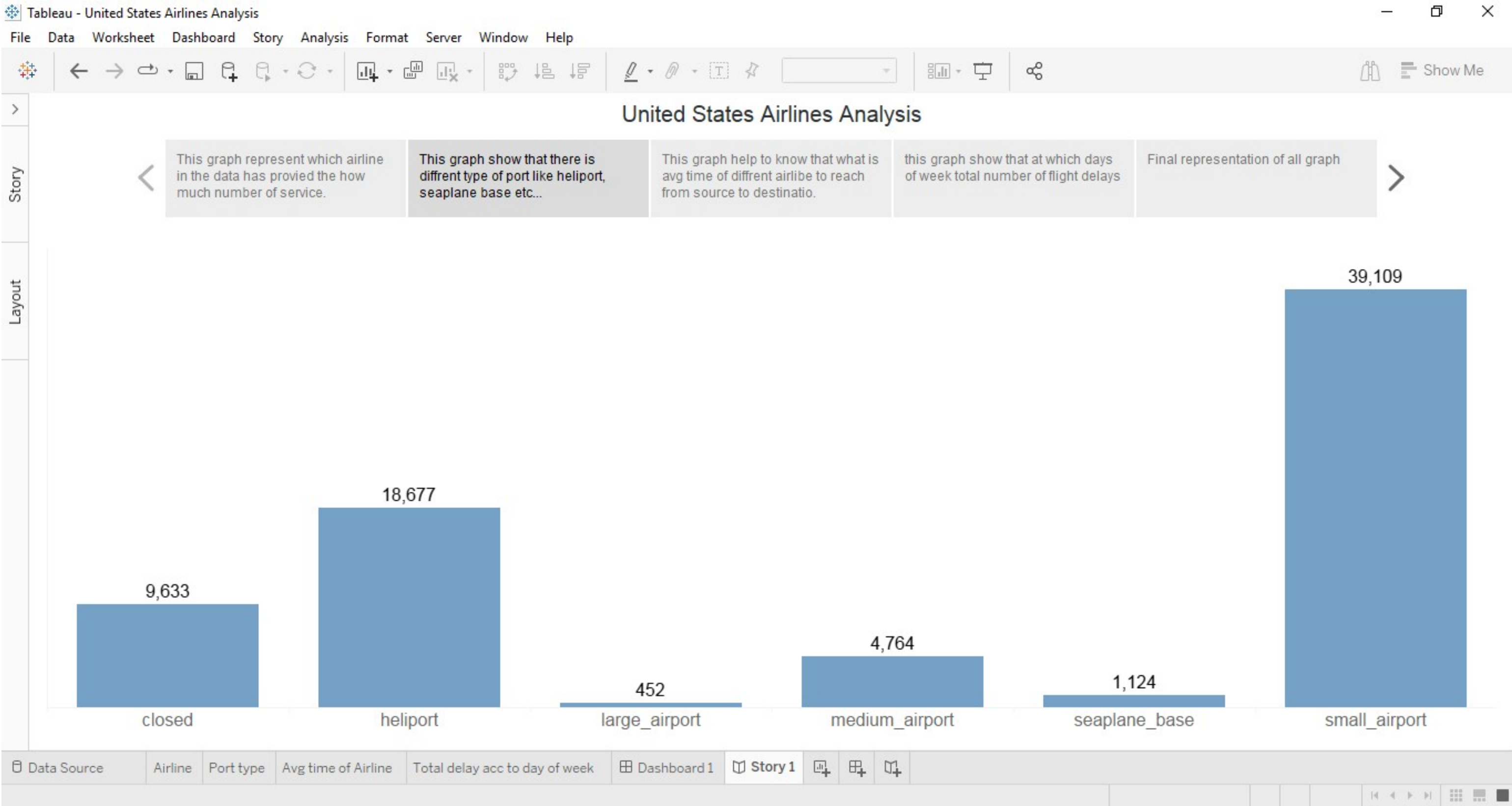


Tableau - United States Airlines Analysis
File Data Worksheet Dashboard Story Analysis Format Server Window Help
Show Me
United States Airlines Analysis
This graph represent which airline in the data has provied the how much number of service.
This graph show that there is diffrent type of port like heliport, seaplane base etc...
This graph help to know that what is avg time of diffrent airlibe to reach from source to destinatio.
this graph show that at which days of week total number of flight delays
Final representation of all graph
Story
Layout
39,109
18,677
9,633
452
4,764
1,124
closed
heliport
large_airport
medium_airport
seaplane_base
small_airport
Data Source
Airline
Port type
Avg time of Airline
Total delay acc to day of week
Dashboard 1
Story 1

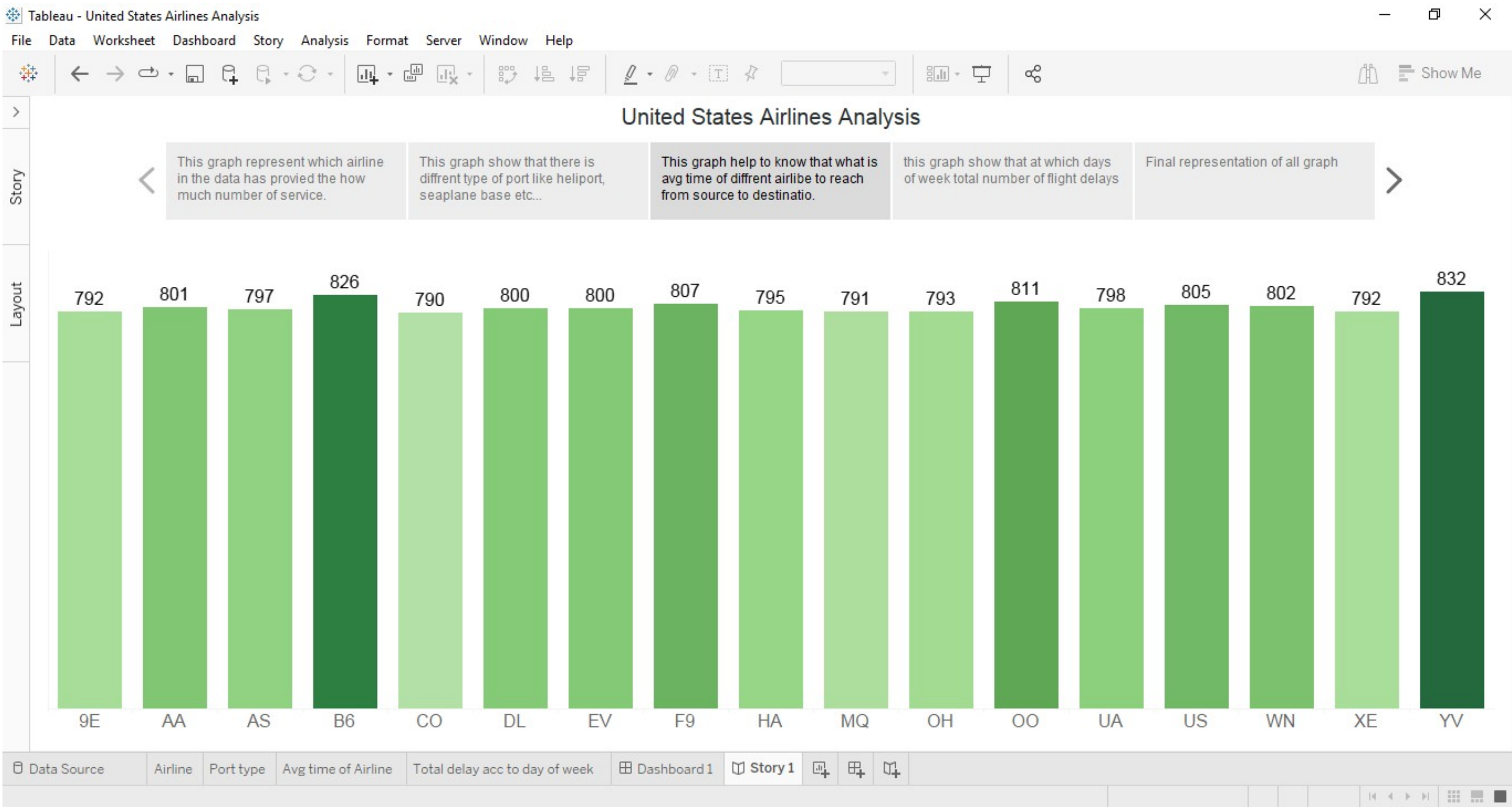


Tableau - United States Airlines Analysis
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This graph help to know that what is avg time of diffrent airlibe to reach from source to destinatio.
this graph show that at which days of week total number of flight delays
Final representation of all graph
Story
Layout
792
801
797
826
790
800
800
807
795
791
793
811
798
805
802
792
832
9E
AA
AS
B6
CO
DL
EV
F9
HA
MQ
OH
OO
UA
US
WN
XE
YV
Data Source
Airline
Port type
Avg time of Airline
Total delay acc to day of week
Dashboard 1
Story 1

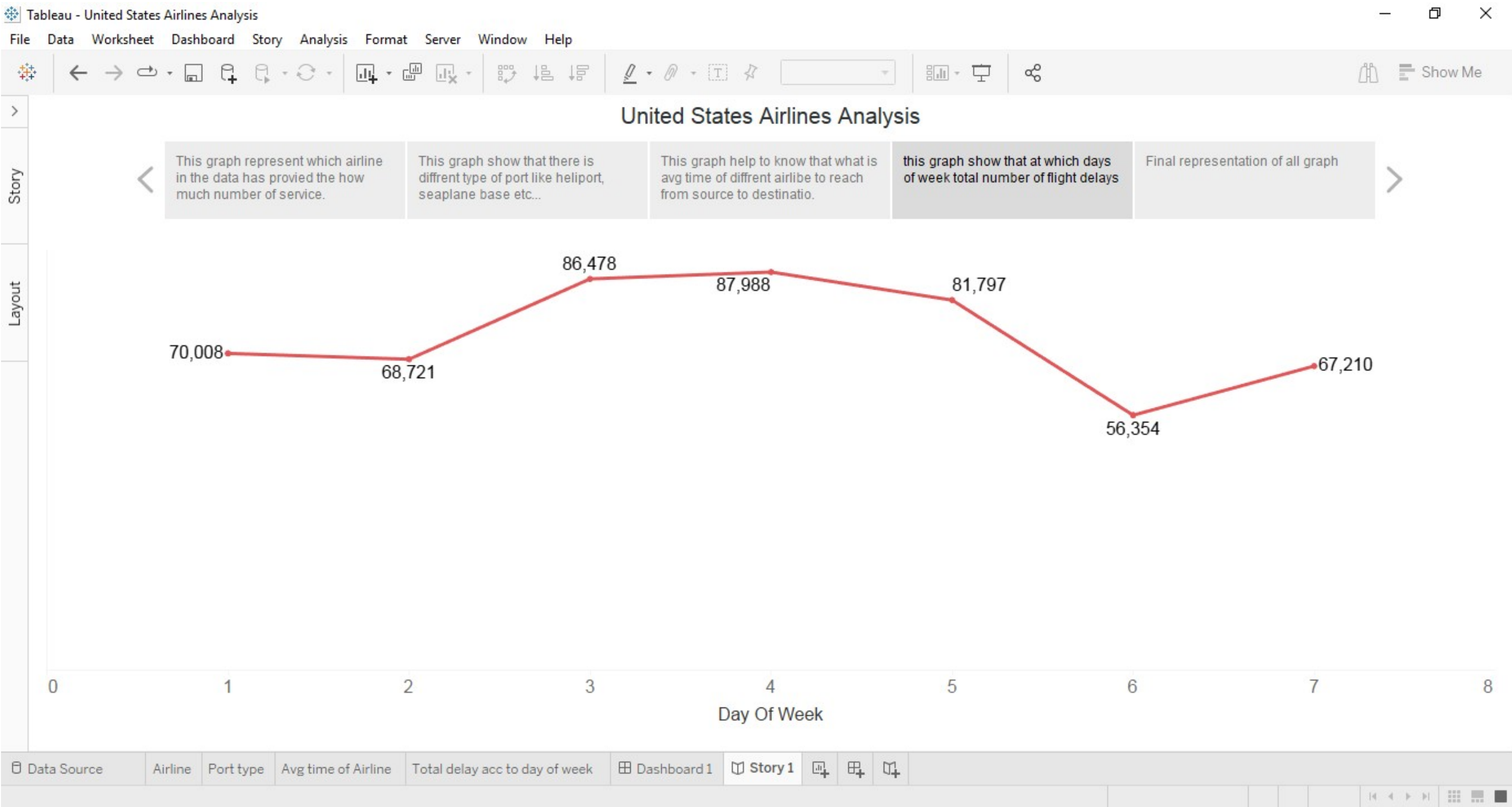
Tableau - United States Airlines Analysis
File Data Worksheet Dashboard Story Analysis Format Server Window Help
Show Me
Story
Layout
United States Airlines Analysis
This graph represent which airline in the data has provied the how much number of service.
This graph show that there is diffrent type of port like heliport, seaplane base etc...
This graph help to know that what is avg time of diffrent airlibe to reach from source to destinatio.
this graph show that at which days of week total number of flight delays
Final representation of all graph
70,008
68,721
86,478
87,988
81,797
56,354
67,210
0 1 2 3 4 5 6 7 8
Day Of Week
Data Source
Airline
Port type
Avg time of Airline
Total delay acc to day of week
Dashboard 1
Story 1

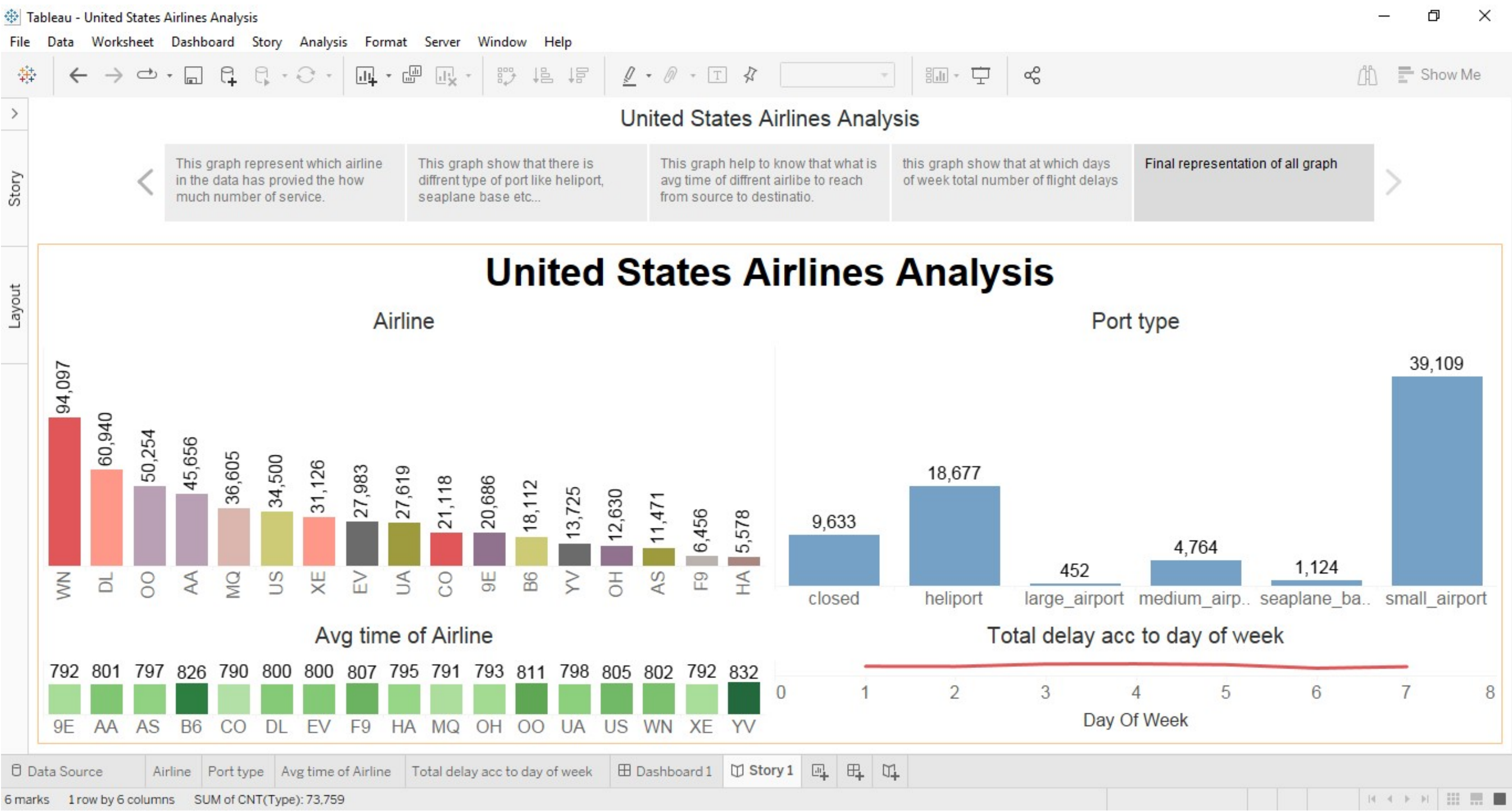
Tableau - United States Airlines Analysis
File Data Worksheet Dashboard Story Analysis Format Server Window Help
Show Me
Story
Layout
United States Airlines Analysis
This graph represent which airline in the data has provied the how much number of service.
This graph show that there is diffrent type of port like heliport, seaplane base etc...
This graph help to know that what is avg time of diffrent airlibe to reach from source to destinatio.
this graph show that at which days of week total number of flight delays
Final representation of all graph
United States Airlines Analysis
Airline
94,097 60,940 50,254 45,656 36,605 34,500 31,126 27,983 27,619 21,118 20,686 18,112 13,725 12,630 11,471 6,456 5,578
WN DL OO AA MQ US XE EV UA CO 9E B6 YV OH AS F9 HA
Port type
9,633 18,677 452 4,764 1,124 39,109
closed heliport large_airport medium_airp.. seaplane_ba.. small_airport
Avg time of Airline
792 801 797 826 790 800 800 807 795 791 793 811 798 805 802 792 832
9E AA AS B6 CO DL EV F9 HA MQ OH OO UA US WN XE YV
Total delay acc to day of week
0 1 2 3 4 5 6 7 8
Day Of Week
Data Source
Airline
Port type
Avg time of Airline
Total delay acc to day of week
Dashboard 1
Story 1
6 marks 1 row by 6 columns SUM of CNT(Type): 73,759

Excel

1. Create an Excel dashboard showcasing the following (use form controls to make a dynamic chart):

a. Compare different airlines based on their on-time performance

b. Compare the percentage of delayed flights for different days of the week

c. Create a trend chart for the number of passenger's at large and medium hubs

d. Visualize the count of delayed and on-time flights for different pairs of source and destination airports

- Create a dynamic chart that allows users to select a source and destination airport.