United States Airlines Analysis

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

In [17]:
```python
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≈cjima 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 (
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 (
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
1	Allegiant Air	NaN	G4	AAY	ALLEGIANT	Las VegasCincinnatiFort Walton BeachIndianapol...	1997.0
2	American Airlines	NaN	AA	AAL	AMERICAN	Dallas/Fort WorthCharlotteChicago-O'HareLos An...	1926.0
3	Avelo Airlines	NaN	XP	VXP	AVELO	BurbankNew HavenOrlando	1987.0
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

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
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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
```

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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]
```

```
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
```

```
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
```

```
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
```

```
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
vbar-collapse{float:left;text-align:left}.mw-parser-output .navbar-boxtext{word-sp
acing:0}.mw-parser-output .navbar ul{display:inline-block;white-space:nowrap;line-
height:inherit}.mw-parser-output .navbar-brackets::before{margin-right:-0.125em;co
ntent:"[ "}.mw-parser-output .navbar-brackets::after{margin-left:-0.125em;conten
t:" ]"}.mw-parser-output .navbar li{word-spacing:-0.125em}.mw-parser-output .navba
r a>span,.mw-parser-output .navbar a>abbr{text-decoration:inherit}.mw-parser-outpu
t .navbar-mini abbr{font-variant:small-caps;border-bottom:none;text-decoration:non
e;cursor:inherit}.mw-parser-output .navbar-ct-full{font-size:114%;margin:0 7em}.mw
-parser-output .navbar-ct-mini{font-size:114%;margin:0 4em}vteMajor airports in th
e United States  \
0  Atlanta (Hartsfield–Jackson – ATL) Austin (Aus...
1                                        Statistics

  .mw-parser-output .navbar{display:inline;font-size:88%;font-weight:normal}.mw-pa
rser-output .navbar-collapse{float:left;text-align:left}.mw-parser-output .navbar-
boxtext{word-spacing:0}.mw-parser-output .navbar ul{display:inline-block;white-spa
ce:nowrap;line-height:inherit}.mw-parser-output .navbar-brackets::before{margin-ri
ght:-0.125em;content:"[ "}.mw-parser-output .navbar-brackets::after{margin-left:-
0.125em;content:" ]"}.mw-parser-output .navbar li{word-spacing:-0.125em}.mw-parser
-output .navbar a>span,.mw-parser-output .navbar a>abbr{text-decoration:inherit}.m
w-parser-output .navbar-mini abbr{font-variant:small-caps;border-bottom:none;text-
decoration:none;cursor:inherit}.mw-parser-output .navbar-ct-full{font-size:114%;ma
rgin:0 7em}.mw-parser-output .navbar-ct-mini{font-size:114%;margin:0 4em}vteMajor
airports in the United States.1
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]:

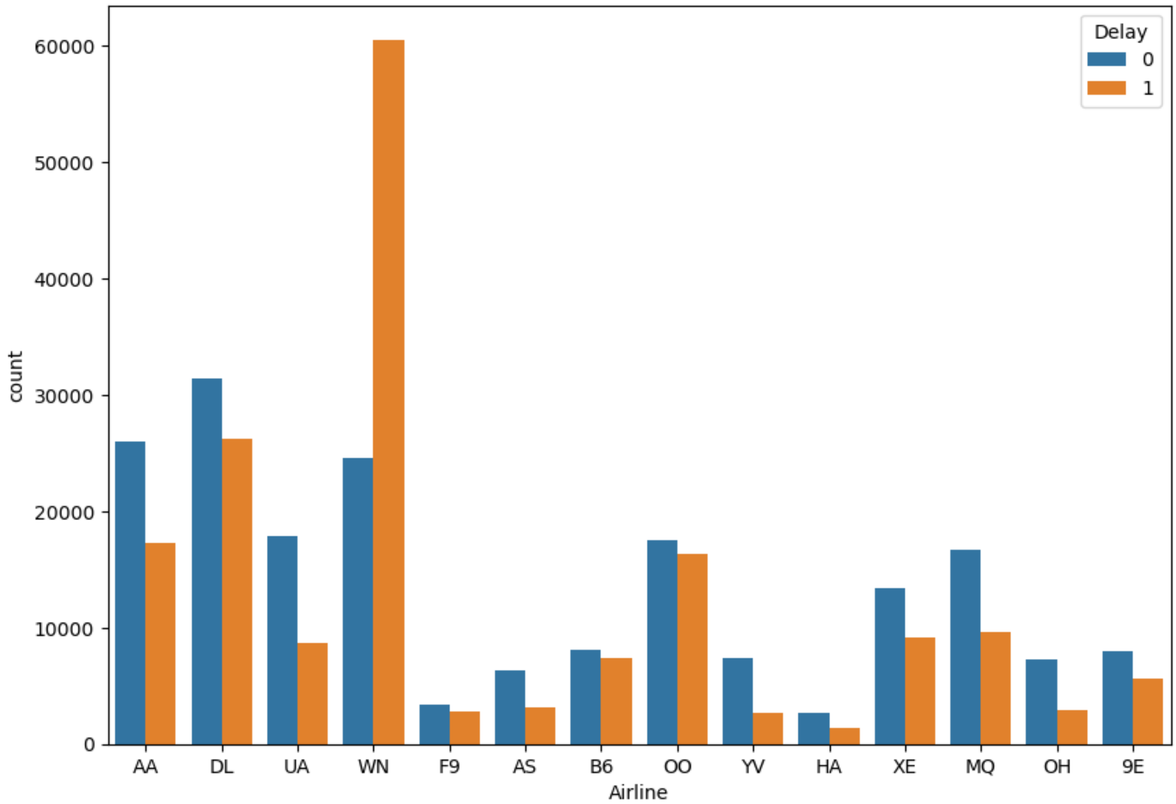
	Airline	Flight	DayOfWeek	Time	Length	Delay	type	latitude_deg	longitude_deg	el
0	AA	2466	3	20	195	1	large_airport	37.618999	-122.375	
1	AA	526	3	360	215	0	large_airport	37.618999	-122.375	
2	AA	552	3	360	315	1	large_airport	37.618999	-122.375	
3	AA	810	3	385	255	0	large_airport	37.618999	-122.375	
4	AA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



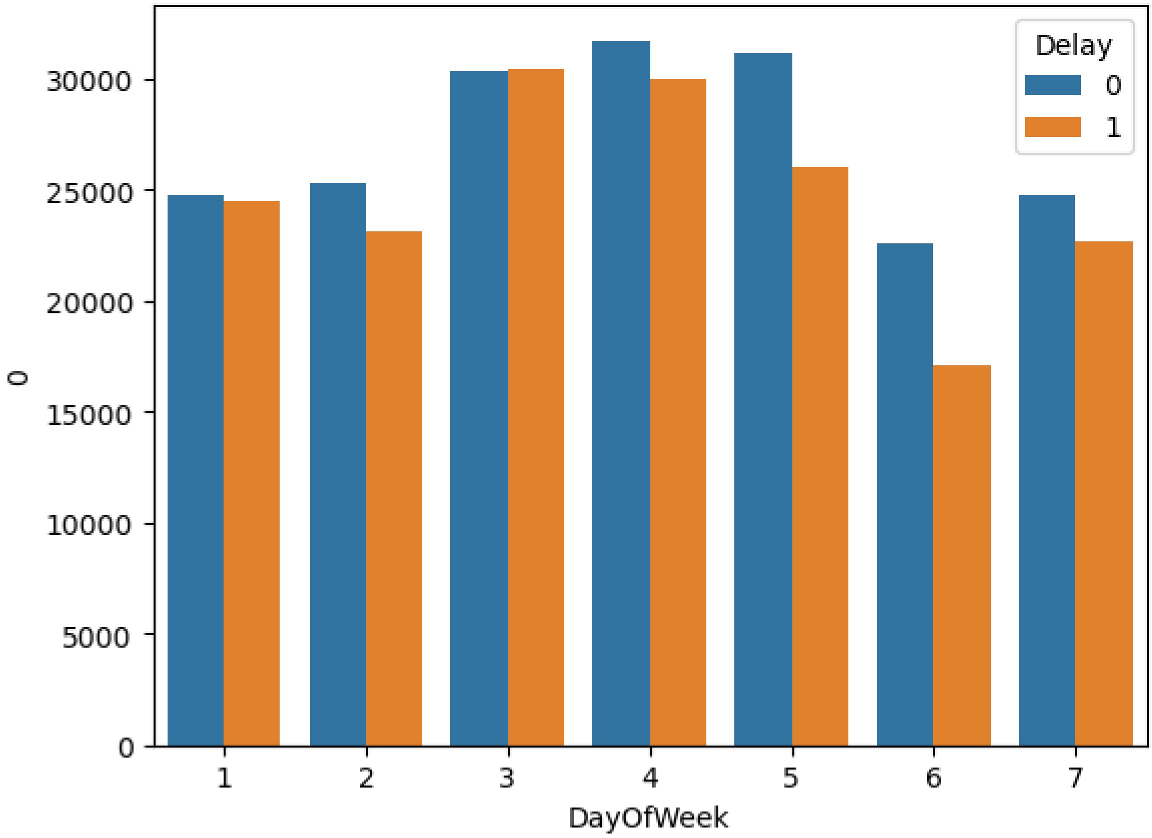
The graph clear show that 70% of flight of south west airline is delayed

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'>
```

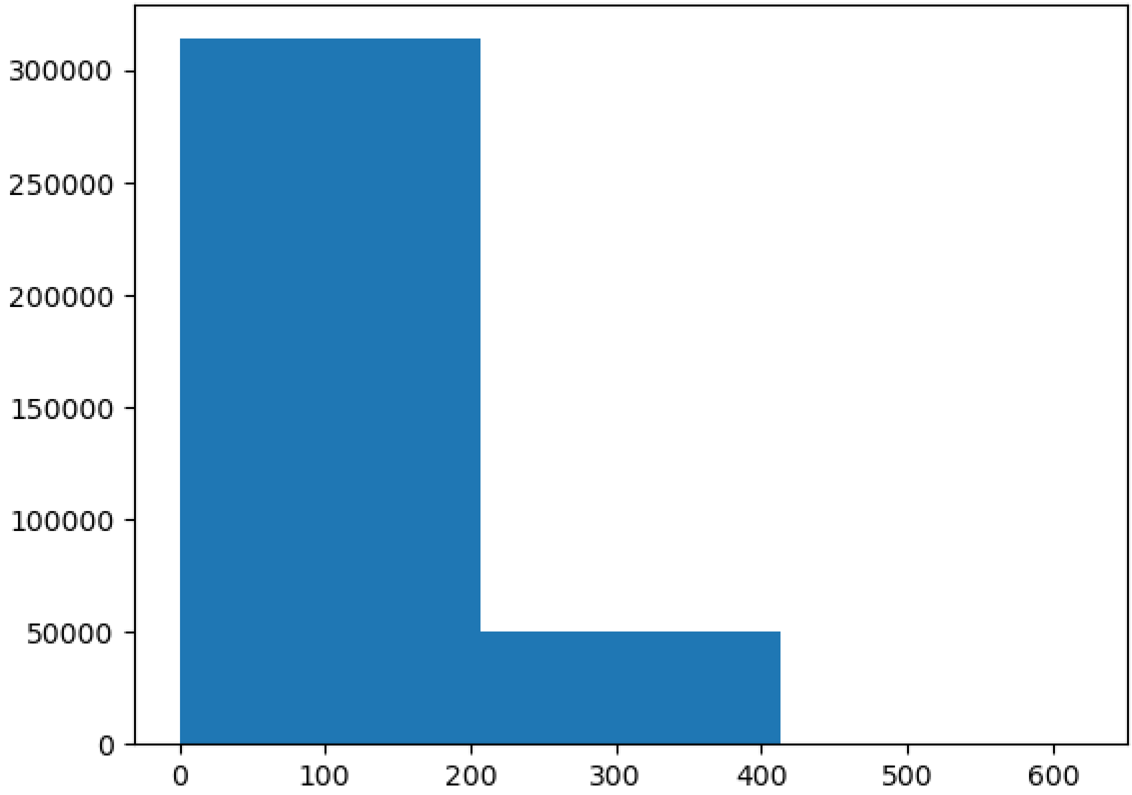


On the 5th day of week its clear that there is less no of flight delay.

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]
```

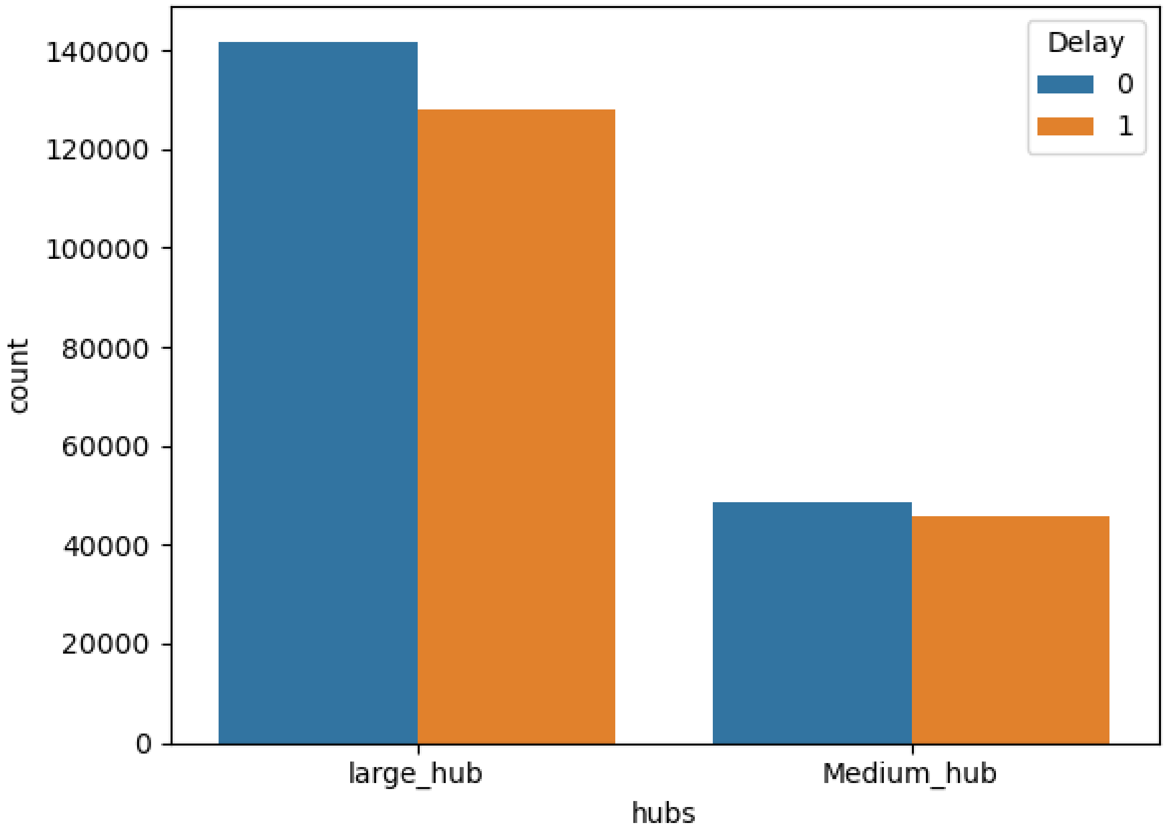
Out[58]:
```
46345     1045
46348     1045
46356     1045
46364     1045
46367     1045
          ...
315043    1416
315049    1416
315055    1416
315061    1416
315067    1416
Name: Time, Length: 1207, dtype: int64
```

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.

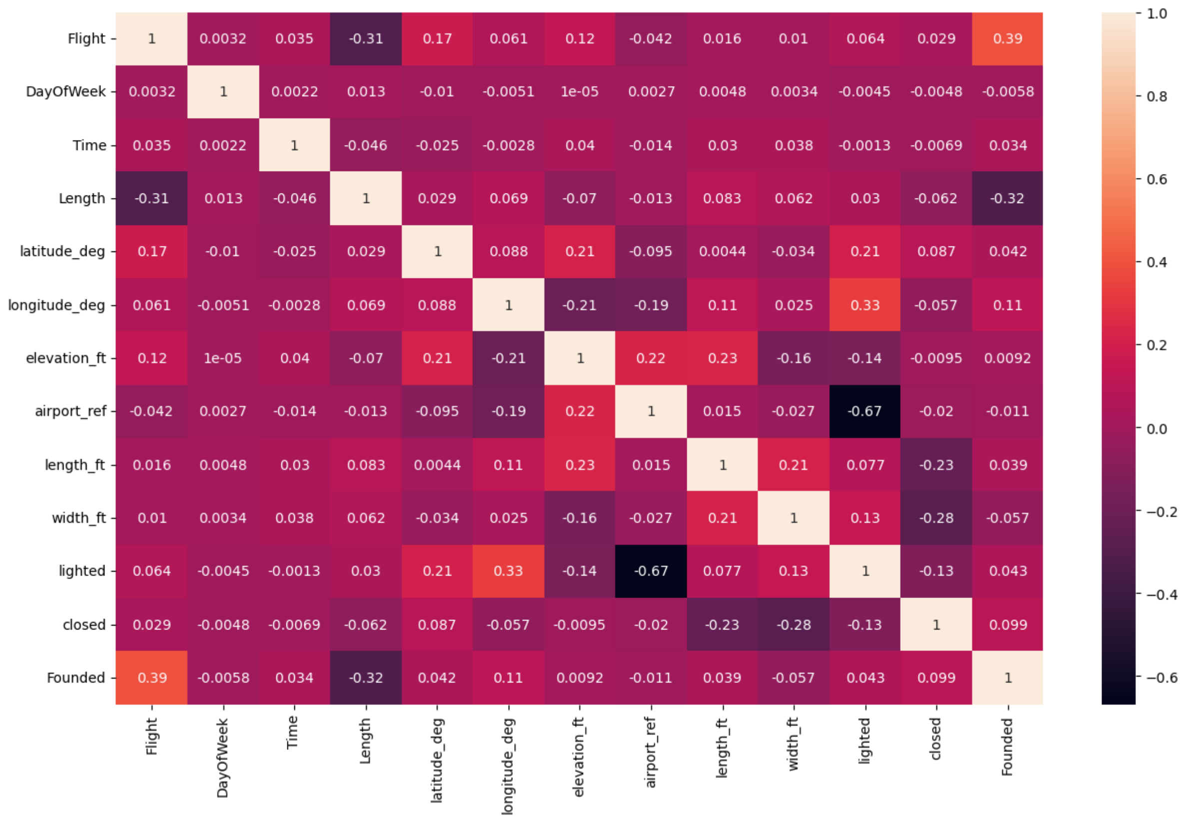
6. Find the correlation matrix between the flight delay predictors, create a heatmap to visualize this, and share your findings

In [63]:
```
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]:
```
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 furt
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_st
```

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 [ ]: