

DS 600 Project Data Mining on Flights

In [1]:

1

import pandas as pd

2

import numpy as np

In [2]:

1

import matplotlib as mpl

2

import matplotlib.pyplot as plt

3

import seaborn as sns

4

import scipy.fftpack as fftpack

5

import warnings

6

warnings.filterwarnings("ignore")

In [3]:

1

df = pd.read_csv('airline.csv')

In [4]:

1

df.info()

<class 'pandas.core.frame.DataFrame'>

RangeIndex: 277374 entries, 0 to 277373

Data columns (total 21 columns):

year

277374 non-null int64

month

277374 non-null int64

carrier

277374 non-null object

carrier_name

277374 non-null object

airport

277374 non-null object

airport_name

277374 non-null object

arr_flights

276999 non-null float64

arr_del15

276941 non-null float64

carrier_ct

276999 non-null float64

weather_ct

276999 non-null float64

nas_ct

276999 non-null float64

security_ct

276999 non-null float64

late_aircraft_ct

276999 non-null float64

arr_cancelled

276999 non-null float64

arr_diverted

276999 non-null float64

arr_delay

276999 non-null float64

carrier_delay

276999 non-null float64

weather_delay

276999 non-null float64

nas_delay

276999 non-null float64

security_delay

276999 non-null float64

late_aircraft_delay

276999 non-null float64

dtypes: float64(15), int64(2), object(4)

memory usage: 44.4+ MB

In [5]:

1

df.head()

Out[5]:

	year	month	carrier	carrier_name	airport	airport_name	arr_flights	arr_del15	carrier_ct	weather_ct	...	security_ct	late_aircraft_ct	arr_cancelled
0	2004	1	DL	Delta Air Lines Inc.	PBI	West Palm Beach/Palm Beach, FL: Palm Beach Int...	650.0	126.0	21.06	6.44	...	1.0	45.92	4
1	2004	1	DL	Delta Air Lines Inc.	PDX	Portland, OR: Portland International	314.0	61.0	14.09	2.61	...	0.0	10.05	30
2	2004	1	DL	Delta Air Lines Inc.	PHL	Philadelphia, PA: Philadelphia International	513.0	97.0	27.60	0.42	...	0.0	17.12	15
3	2004	1	DL	Delta Air Lines Inc.	PHX	Phoenix, AZ: Phoenix Sky Harbor International	334.0	78.0	20.14	2.02	...	0.0	16.45	3
4	2004	1	DL	Delta Air Lines Inc.	PIT	Pittsburgh, PA: Pittsburgh International	217.0	47.0	8.08	0.44	...	0.0	16.59	4

5 rows × 21 columns

In [6]:

1 df.isnull().sum()

Out[6]:

year	0
month	0
carrier	0
carrier_name	0
airport	0
airport_name	0
arr_flights	375
arr_del15	433
carrier_ct	375
weather_ct	375
nas_ct	375
security_ct	375
late_aircraft_ct	375
arr_cancelled	375
arr_diverted	375
arr_delay	375
carrier_delay	375
weather_delay	375
nas_delay	375
security_delay	375
late_aircraft_delay	375

dtype: int64

In [7]:

1 df= df.dropna()

In [8]:

1 df.isnull().sum()

Out[8]:

year	0
month	0
carrier	0
carrier_name	0
airport	0
airport_name	0
arr_flights	0
arr_del15	0
carrier_ct	0
weather_ct	0
nas_ct	0
security_ct	0
late_aircraft_ct	0
arr_cancelled	0
arr_diverted	0
arr_delay	0
carrier_delay	0
weather_delay	0
nas_delay	0
security_delay	0
late_aircraft_delay	0

dtype: int64

In [9]:

1 df.nunique()

Out[9]:

year	18
month	12
carrier	28
carrier_name	32
airport	406
airport_name	406
arr_flights	7132
arr_del15	2300
carrier_ct	17520
weather_ct	5461
nas_ct	20456
security_ct	1098
late_aircraft_ct	21564
arr_cancelled	565
arr_diverted	137
arr_delay	26798
carrier_delay	13519
weather_delay	5149
nas_delay	13755
security_delay	629
late_aircraft_delay	17078

dtype: int64

In [10]:

1df.describe()

Out[10]:

	year	month	arr_flights	arr_del15	carrier_ct	weather_ct	nas_ct	security_ct	late_aircraft_ct	a
count	276941.000000	276941.000000	276941.000000	276941.000000	276941.000000	276941.000000	276941.000000	276941.000000	276941.000000	27
mean	2011.190272	6.521432	396.809775	77.560744	21.758212	2.756241	26.010714	0.178455	26.857183	
std	4.953442	3.466662	1055.373010	206.911642	47.700162	10.367470	89.750606	0.839823	78.527039	
min	2003.000000	1.000000	1.000000	0.000000	0.000000	0.000000	-0.010000	0.000000	0.000000	
25%	2007.000000	3.000000	61.000000	10.000000	3.570000	0.000000	2.050000	0.000000	2.000000	
50%	2011.000000	7.000000	125.000000	25.000000	8.970000	0.680000	6.250000	0.000000	6.730000	
75%	2016.000000	10.000000	285.000000	60.000000	20.630000	2.170000	16.780000	0.000000	18.600000	
max	2020.000000	12.000000	21977.000000	6377.000000	1792.070000	717.940000	4091.270000	80.560000	1885.470000	

In [11]:

1df.info()

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 276941 entries, 0 to 277373
Data columns (total 21 columns):
year                276941 non-null int64
month              276941 non-null int64
carrier            276941 non-null object
carrier_name       276941 non-null object
airport           276941 non-null object
airport_name       276941 non-null object
arr_flights        276941 non-null float64
arr_del15          276941 non-null float64
carrier_ct         276941 non-null float64
weather_ct         276941 non-null float64
nas_ct            276941 non-null float64
security_ct        276941 non-null float64
late_aircraft_ct   276941 non-null float64
arr_cancelled      276941 non-null float64
arr_diverted       276941 non-null float64
arr_delay          276941 non-null float64
carrier_delay      276941 non-null float64
weather_delay      276941 non-null float64
nas_delay          276941 non-null float64
security_delay     276941 non-null float64
late_aircraft_delay 276941 non-null float64
dtypes: float64(15), int64(2), object(4)
memory usage: 46.5+ MB
```

Clusters by Kmeans

In [12]:

1#selected arrival flights and arrival delayed flights
2x = df.iloc[:, [7,8]].values
3x

Out[12]:

```
array([[126.  ,  21.06],
       [ 61.  ,  14.09],
       [ 97.  ,  27.6 ],
       ...,
       [ 26.  ,   4.67],
       [ 35.  ,   6.83],
       [  4.  ,   1.16]])
```

In [13]:

1from sklearn.cluster import KMeans
2wcss = []

In [14]:

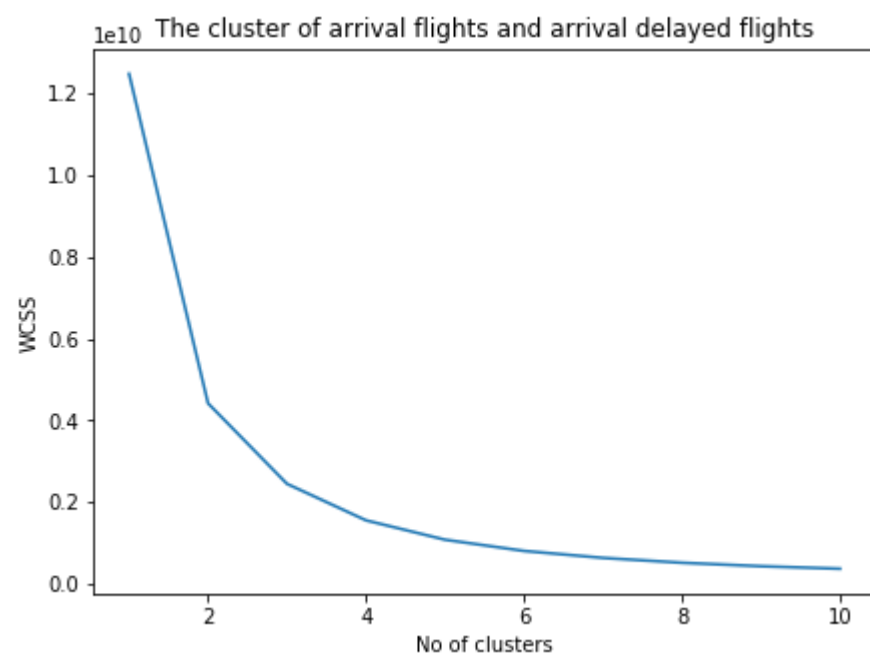
1%%time
2
3for i in range(1,11):
4 kmeans = KMeans(n_clusters = i, init = 'k-means++', random_state = 0)
5 kmeans.fit(x)
6 wcss.append(kmeans.inertia_)

CPU times: user 1min 43s, sys: 12.5 s, total: 1min 55s
Wall time: 57 s

```

In [15]: 1 %%time
          2
          3 #find out cluster using Elbow method
          4 plt.figure(figsize= (7,5))
          5 plt.plot(range(1,11),wcss)
          6 plt.title('The cluster of arrival flights and arrival delayed flights')
          7 plt.xlabel('No of clusters')
          8 plt.ylabel('WCSS')
          9 plt.style.use('bmh')
         10 plt.savefig('cluster1Graph.png',dpi=400, bbox_inches='tight')
         11 plt.show()

```



CPU times: user 1.58 s, sys: 26.5 ms, total: 1.61 s
 Wall time: 1.62 s

```

In [16]: 1 %%time
          2
          3 #from graph we got 3 clusters
          4
          5 kmeansmodel = KMeans(n_clusters = 3, init = 'k-means++', random_state= 0)
          6 y_kmeans= kmeansmodel.fit_predict(x)
          7 y_kmeans

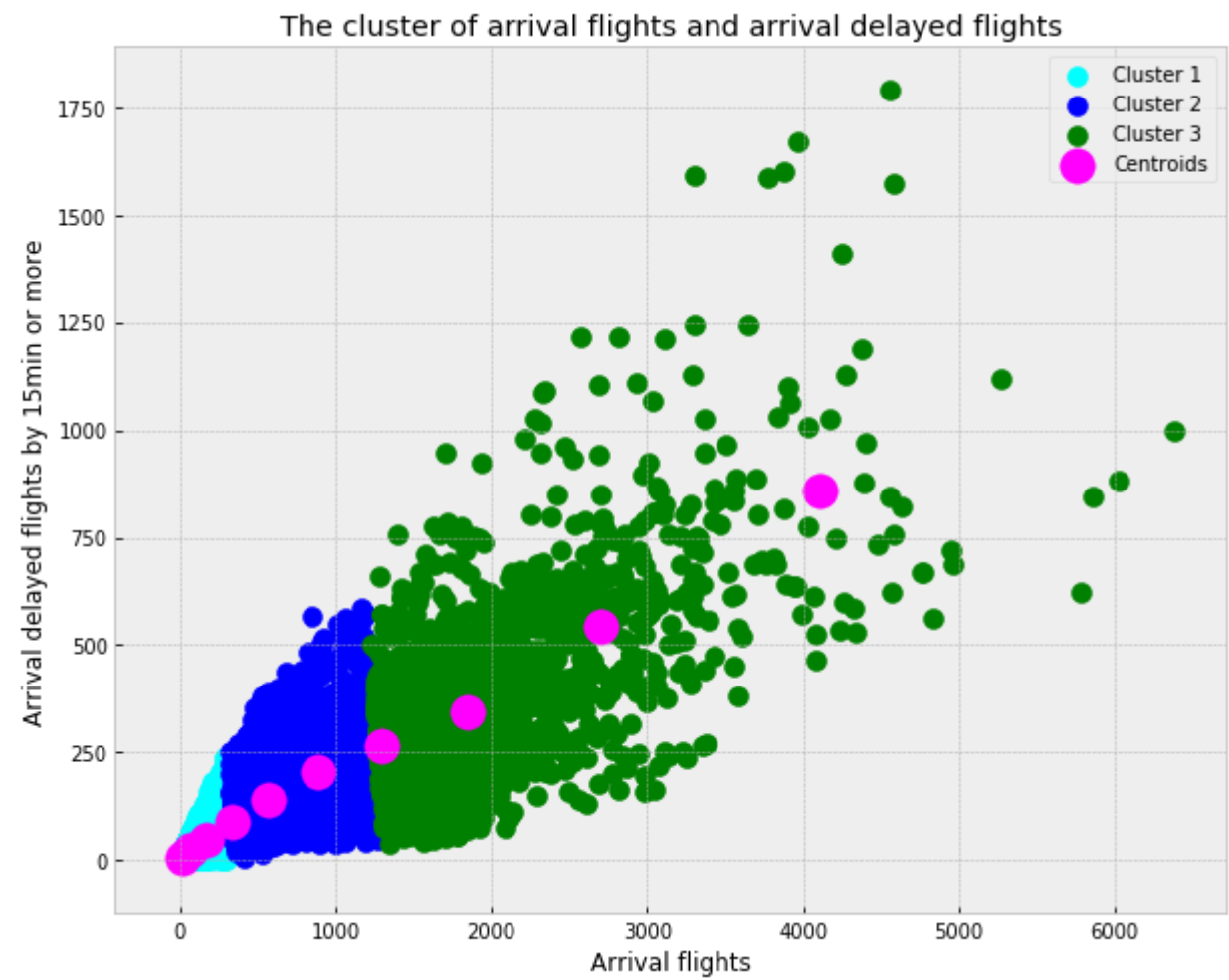
```

CPU times: user 7.67 s, sys: 1.08 s, total: 8.75 s
 Wall time: 2.73 s

Out[16]: array([0, 0, 0, ..., 0, 0, 0], dtype=int32)

In [17]:

```
1 %%time
2
3 #plotting cluster graph along with centroids
4 plt.figure(figsize= (10,8))
5 plt.scatter(x[y_kmeans == 0, 0], x[y_kmeans == 0, 1], s = 100, c = 'cyan', label = 'Cluster 1')
6 plt.scatter(x[y_kmeans == 1, 0], x[y_kmeans == 1, 1], s = 100, c = 'blue', label = 'Cluster 2')
7 plt.scatter(x[y_kmeans == 2, 0], x[y_kmeans == 2, 1], s = 100, c = 'green', label = 'Cluster 3')
8 plt.scatter(kmeans.cluster_centers[:, 0], kmeans.cluster_centers[:, 1], s = 300, c = 'magenta', label = 'Centroids')
9 plt.title('The cluster of arrival flights and arrival delayed flights')
10 plt.xlabel('Arrival flights')
11 plt.ylabel('Arrival delayed flights by 15min or more')
12 plt.style.use('bmh')
13 plt.legend()
14 plt.savefig('cluster2Graph.png',dpi=400, bbox_inches='tight')
15 plt.show()
```



CPU times: user 14.9 s, sys: 307 ms, total: 15.2 s
Wall time: 14.8 s

- CLUSTER 1 : Low flights, Lowest delayed CLUSTER and centroid distance is near to each other.
 - 2 : Average arrivals, Average delayed CLUSTER
 - 3 : High arrival, High delayed CLUSTER and centroid point distance has been increased over a period
- Our target would be cluster 3 wherein carrier companies need to improve their performance for further not getting delayed

Exploratory Data Analysis

Which is busiest airport in United States?

In [20]:

```
1 dfairpot = df[['year','month','carrier','carrier_name','airport','airport_name',
2               'arr_flights','arr_del15','carrier_ct','weather_ct',
3               'nas_ct','security_ct','late_aircraft_ct','arr_cancelled','arr_diverted']]
4 dfairpot= dfairpot.groupby(['airport_name']).mean().reset_index()
5 dfairpot.head()
```

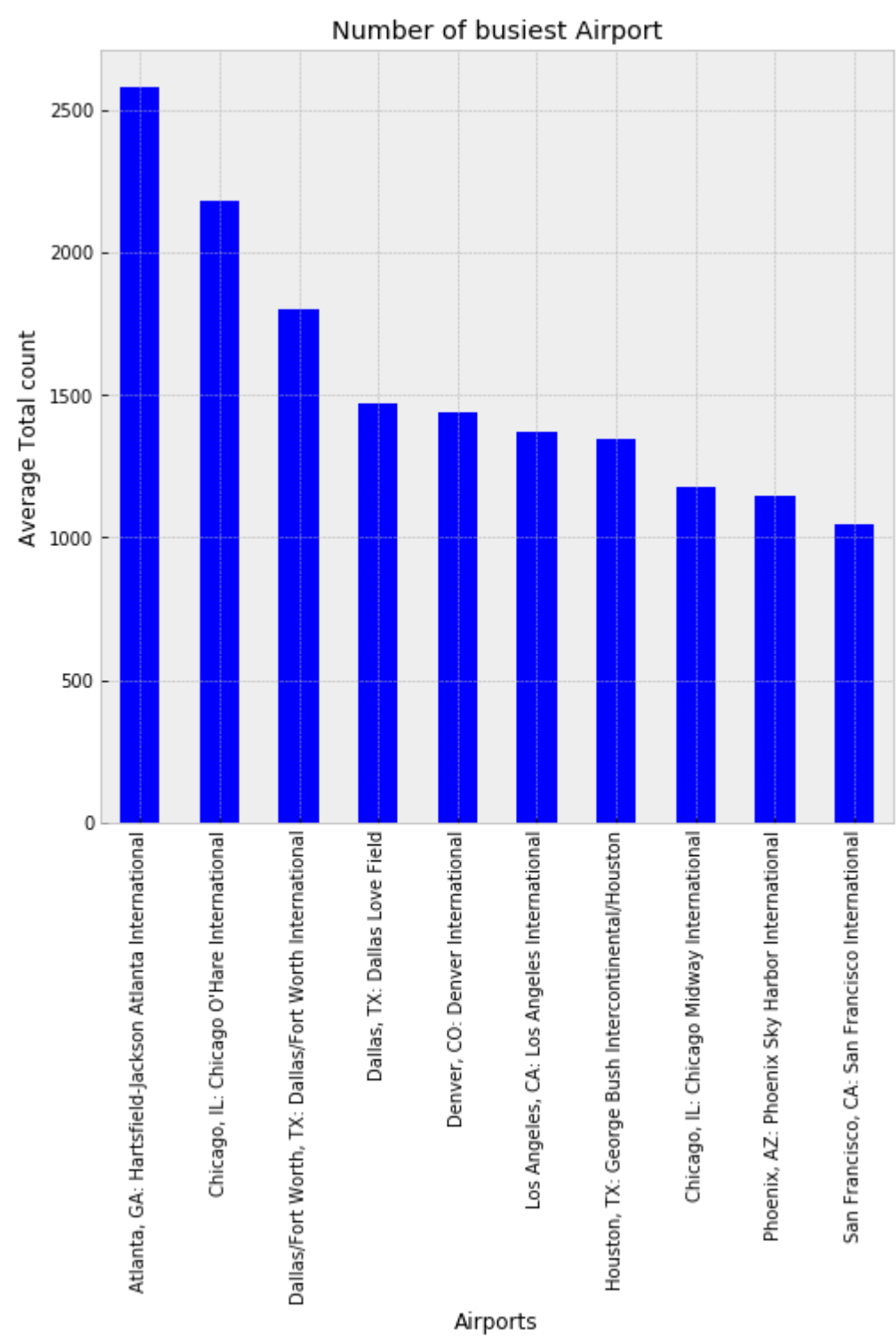
Out[20]:

	airport_name	year	month	arr_flights	arr_del15	carrier_ct	weather_ct	nas_ct	security_ct	late_aircraft_ct	arr_cancelled	arr_divert
0	Aberdeen, SD: Aberdeen Regional	2015.551020	6.602041	60.642857	6.285714	2.257449	0.360612	1.765102	0.000000	1.902959	0.979592	0.1734
1	Abilene, TX: Abilene Regional	2010.017544	6.425439	169.258772	36.061404	14.716711	3.961272	5.977544	0.056798	11.348640	3.885965	0.1622
2	Adak Island, AK: Adak	2011.288557	6.537313	8.641791	1.606965	0.509303	0.077413	0.538358	0.016965	0.465025	0.557214	0.0149
3	Aguadilla, PR: Rafael Hernandez	2012.171429	6.534066	52.789011	13.848352	5.371648	0.390725	3.665736	0.072769	4.347560	0.764835	0.0747
4	Akron, OH: Akron-Canton Regional	2011.328330	6.582552	124.475610	26.941839	8.961492	1.359193	5.811135	0.021135	10.788959	2.424953	0.2326

In [21]:

```
plt.figure()
plt.figure(figsize=(8,8))
dfairpot.groupby("airport_name").arr_flights.mean().sort_values(ascending=False)[:10].plot(kind = 'bar',colors
plt.title('Number of busiest Airport')
plt.xlabel('Airports')
plt.ylabel('Average Total count')
plt.savefig('Graph1.png',dpi=300, bbox_inches='tight')
plt.show()
9
```

<Figure size 432x288 with 0 Axes>

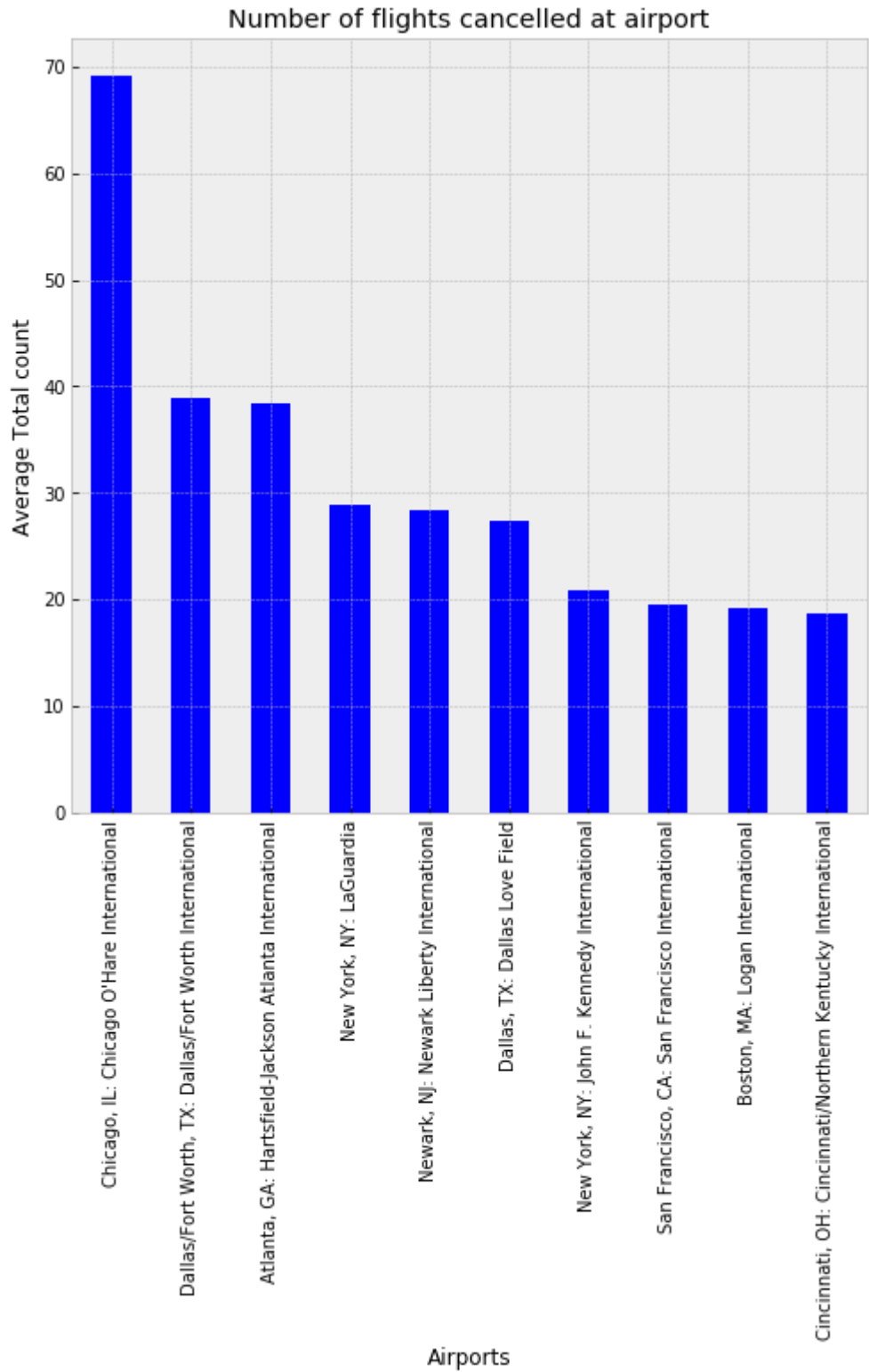


Atlanta is the busiest airport amongst top 10 airport in United States.

At Which airport most flight has been cancelled?

```
In [22]: 1 plt.figure()  
2 plt.figure(figsize=(8,8))  
3 dfairport.groupby("airport_name").arr_cancelled.mean().sort_values(ascending=False)[:10].plot(kind='bar',  
4                                                         colors= 'blue')  
5 plt.title('Number of flights cancelled at airport')  
6 plt.xlabel('Airports')  
7 plt.ylabel('Average Total count')  
8 plt.savefig('Graph2.png',dpi=300, bbox_inches='tight')  
9 plt.show()  
10
```

<Figure size 432x288 with 0 Axes>

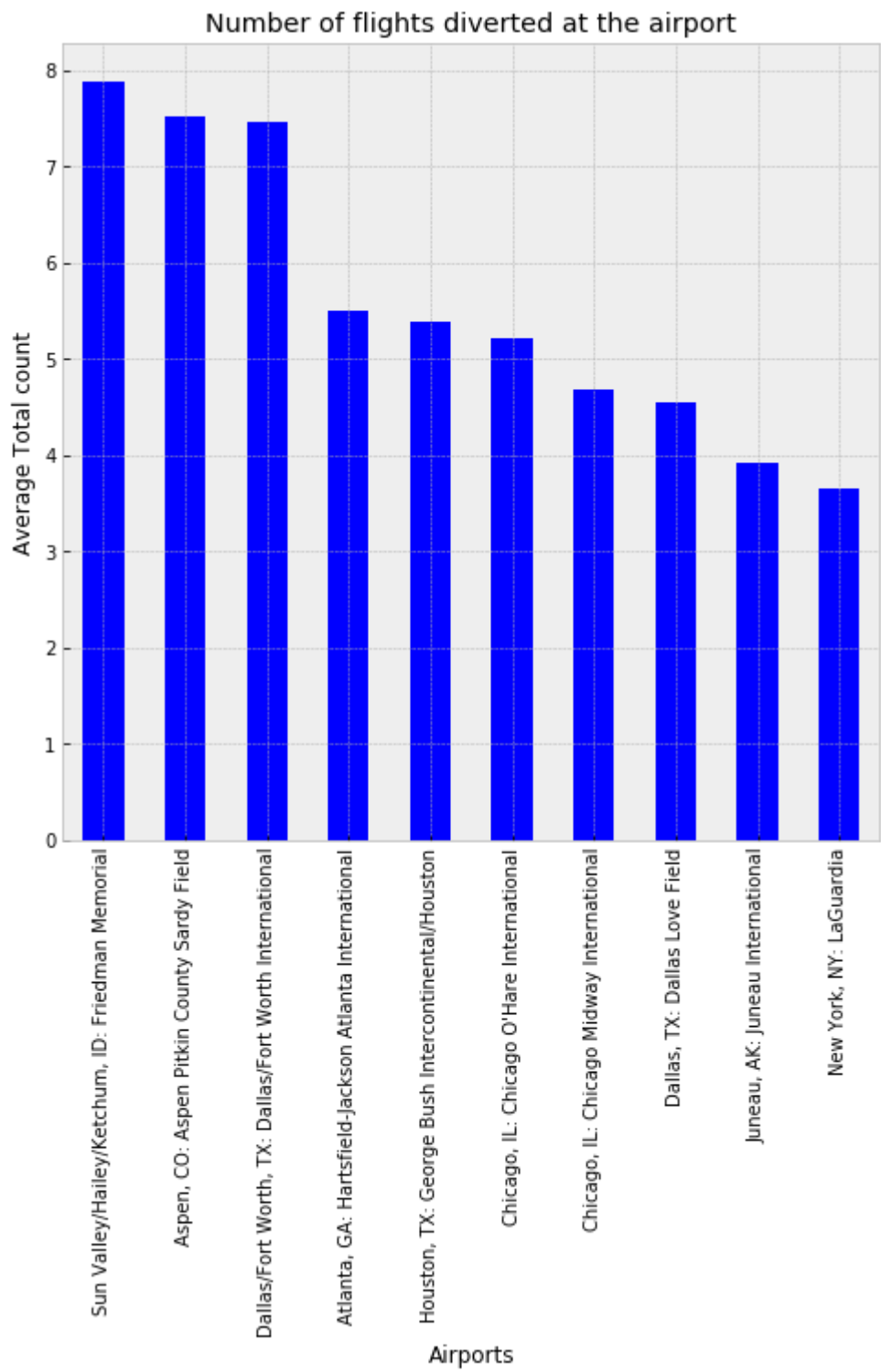


At **Chicago O'Hare international** airport has been most flights cancelled.

At which airport most flights has been diverted?


```
In [23]: 1 plt.figure()  
2 plt.figure(figsize=(8,8))  
3 dfairport.groupby("airport_name").arr_diverted.mean().sort_values(ascending=False)[:10].plot(kind='bar',color='blue')  
4 plt.title('Number of flights diverted at the airport')  
5 plt.xlabel('Airports')  
6 plt.ylabel('Average Total count')  
7 plt.savefig('Graph3.png',dpi=300, bbox_inches='tight')  
8 plt.show()  
9
```

<Figure size 432x288 with 0 Axes>



At Sun Valley, Aspen and Dallas fort worth inetrnational airport most flights has been diverted

Problem statement

The study focus on which are the best airlines has most reliable carriers.

In [19]:

```
1 dfcarrier = df[['year','month','carrier','carrier_name','airport','airport_name',
2               'arr_flights','arr_dell5','carrier_ct','weather_ct',
3               'nas_ct','security_ct','late_aircraft_ct','arr_cancelled','arr_diverted']]
4 dfcarrier= dfcarrier.groupby(['carrier_name']).mean().reset_index()
5 dfcarrier.head()
```

Out[19]:

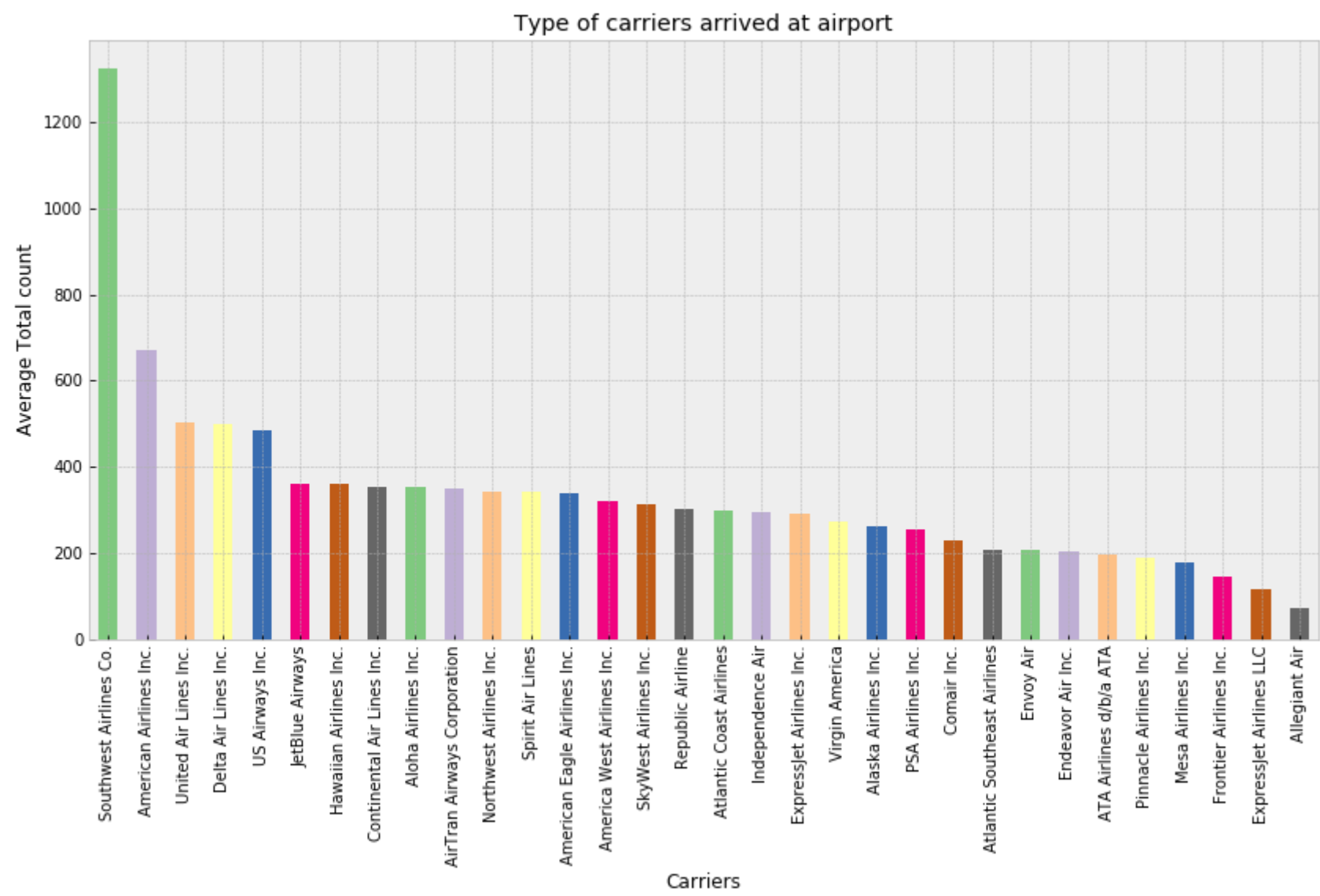
	carrier_name	year	month	arr_flights	arr_del15	carrier_ct	weather_ct	nas_ct	security_ct	late_aircraft_ct	arr_cancelled	arr_diver
0	ATA Airlines d/b/a ATA	2004.399782	6.875817	197.672113	38.450980	7.149967	0.262952	19.800000	0.366187	10.871874	2.028322	0.087
1	AirTran Airways Corporation	2008.772394	6.577139	349.067146	69.921927	13.210239	0.622456	26.814306	0.000000	29.274893	3.417829	0.801
2	Alaska Airlines Inc.	2012.076741	6.549112	260.460264	44.479199	12.357491	0.817403	16.541396	0.320614	14.442357	2.698134	0.716
3	Allegiant Air	2018.621709	6.107897	70.852779	15.079298	4.191355	0.909734	3.671371	0.072099	6.234972	0.488463	0.177
4	Aloha Airlines Inc.	2006.695652	6.652174	353.940711	25.193676	12.877391	0.160316	2.296364	0.211304	9.648419	4.644269	0.142

Which carrier is most arrived at airports?

In [20]:

```
1 plt.figure()
2 plt.figure(figsize=(14,7))
3 dfcarrier.groupby("carrier_name").arr_flights.mean().sort_values(ascending=False).plot(kind='bar',
4                                                         colors=plt.cm.Accent)
5 plt.title('Type of carriers arrived at airport')
6 plt.xlabel('Carriers')
7 plt.ylabel('Average Total count')
8 plt.savefig('Graph4.png',dpi=400, bbox_inches='tight')
9 plt.show()
```

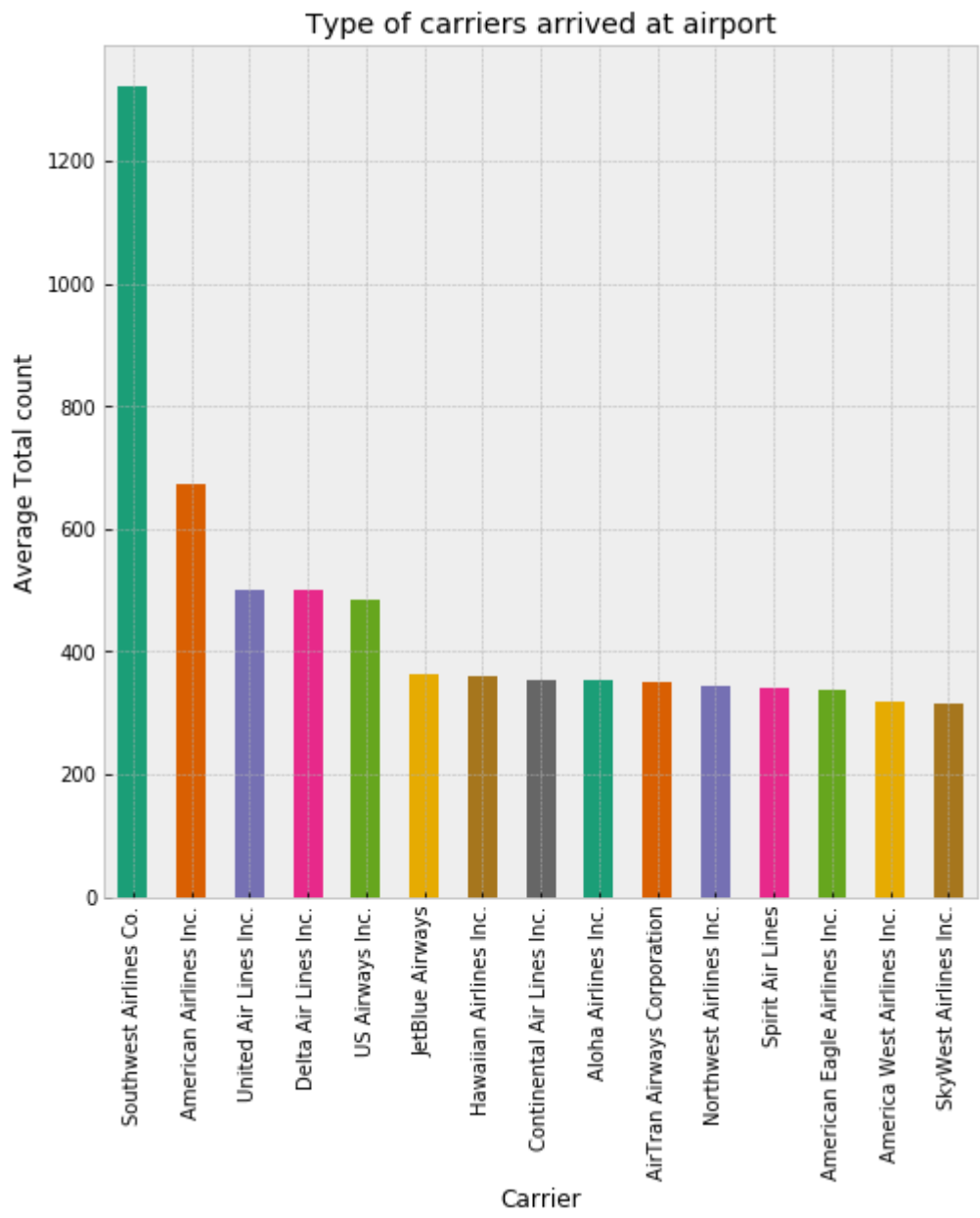
<Figure size 432x288 with 0 Axes>



In [21]:

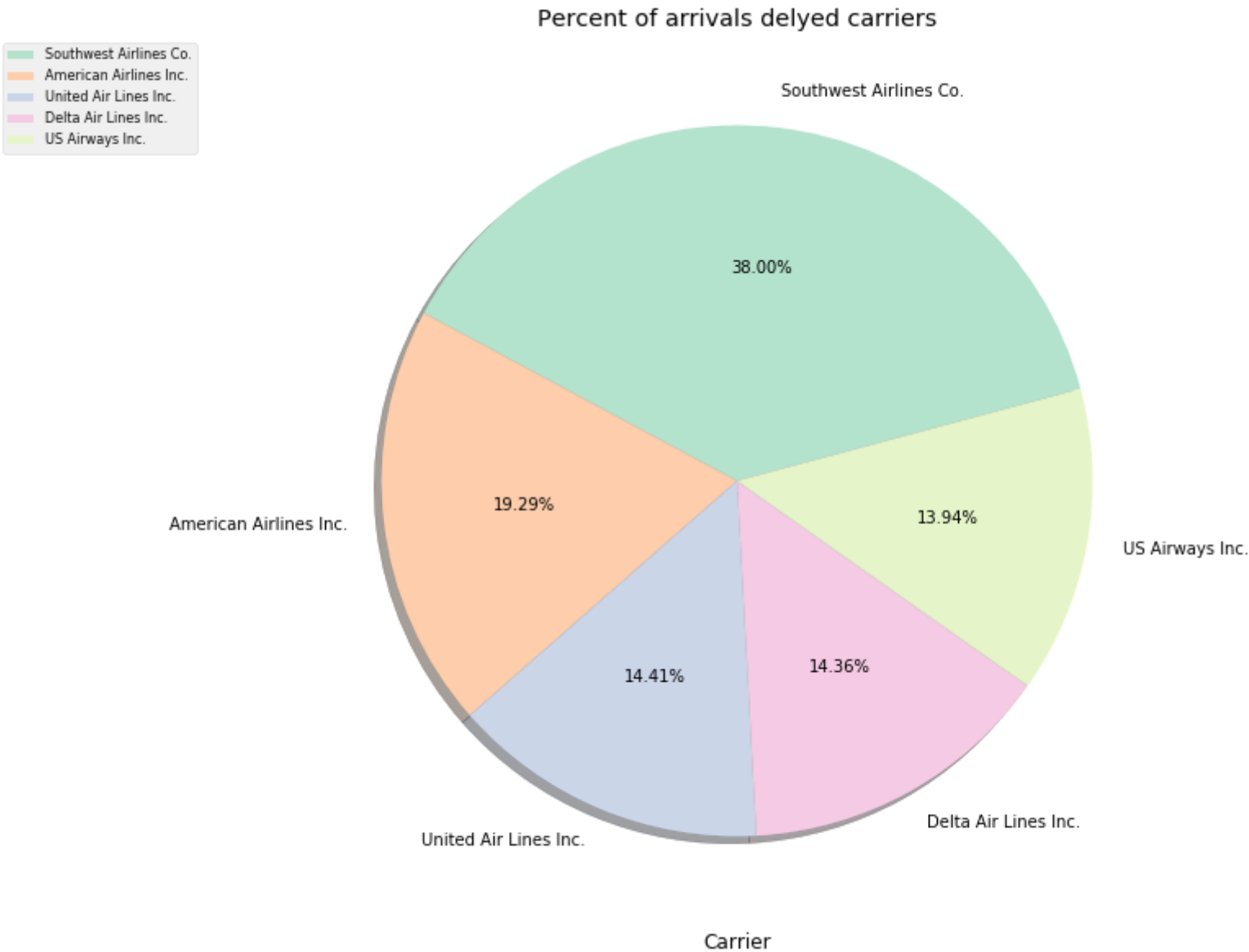
```
1 plt.figure()  
2 plt.figure(figsize=(8,8))  
3 dfcarrier.groupby("carrier_name").arr_flights.mean().sort_values(ascending=False)[:15].plot(kind='bar',  
4                                                                    colors=plt.cm.Da  
5 plt.title('Type of carriers arrived at airport')  
6 plt.xlabel('Carrier')  
7 plt.ylabel('Average Total count')  
8 plt.savefig('Graph5.png',dpi=400, bbox_inches='tight')  
9 plt.show()  
10
```

<Figure size 432x288 with 0 Axes>



```
In [35]: arr_delay: Total time (minutes) of delayed flights.
2
3figure()
4figure(figsize=(10,10))
5carrier.groupby("carrier_name").arr_flights.mean().sort_values(ascending=False)[:5].plot(kind='pie',
6                                                    autopct='%1.2f%%',
7                                                    startangle=15,
8                                                    shadow = True,
9                                                    colors=plt.cm.Pastel2.
10
11title('Percent of arrivals delyed carriers')
12xlabel('Carrier')
13legend(bbox_to_anchor=(-0.1, 1.),fontSize=8,loc="best")
14ylabel("")
15
16savefig('piechart1.png', bbox_inches='tight')
17
18show()
```

<Figure size 432x288 with 0 Axes>



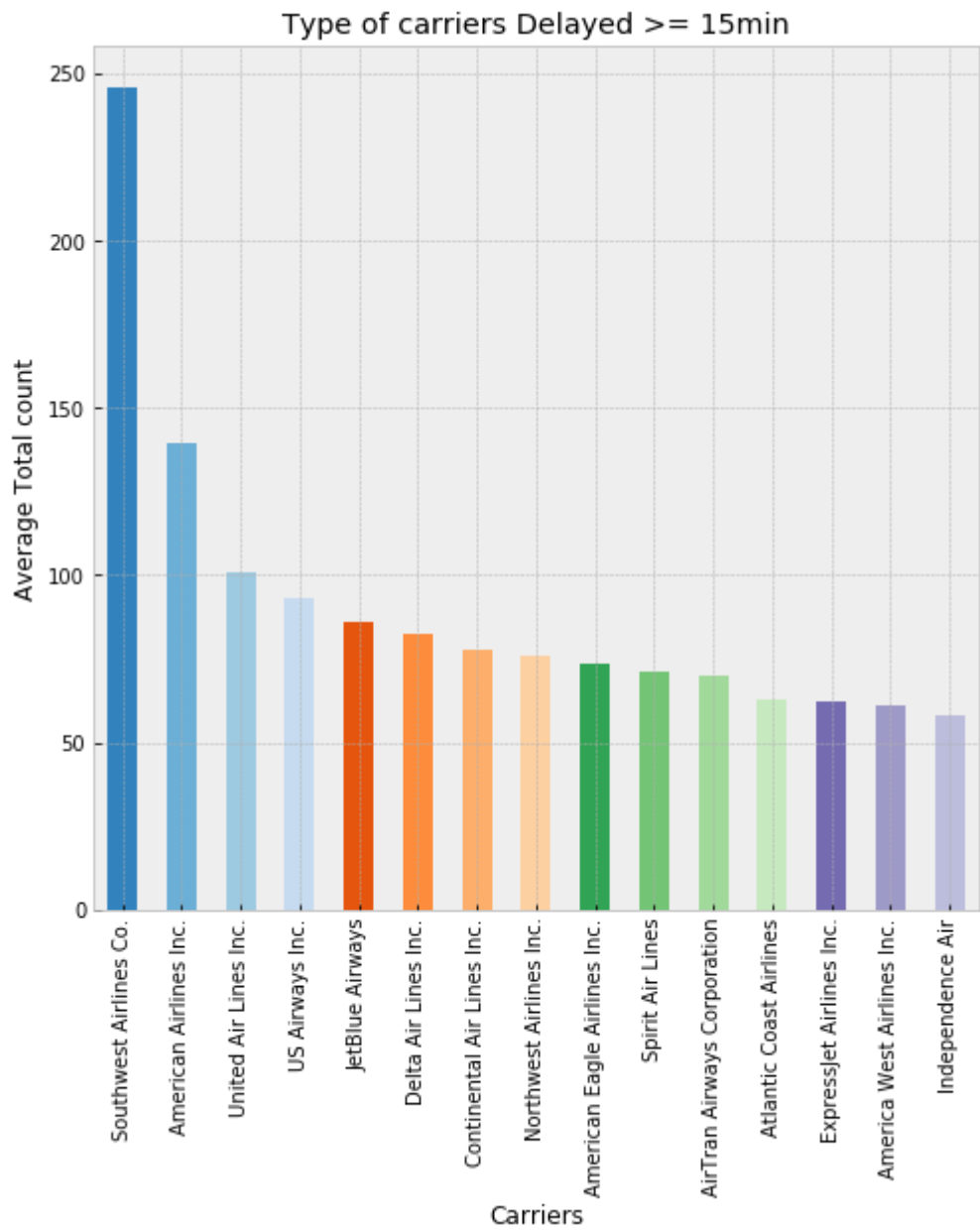
Out of 32 carriers I have selected top 15 busiest carriers for Analysis.

Southwest Airline comapny has more number of arrivals comapared to its competitors.

Which carriers are most delayed at airport?

```
In [28]: 1 plt.figure()  
2 plt.figure(figsize=(8,8))  
3 dfcarrier.groupby("carrier_name").arr_del15.mean().sort_values(ascending=False)[:15].plot(kind = 'bar',  
4                                                         colors = plt.cm.t  
5 plt.title('Type of carriers Delayed >= 15min')  
6 plt.xlabel('Carriers')  
7 plt.ylabel('Average Total count')  
8 plt.savefig('Graph6.png',dpi=400, bbox_inches='tight')  
9 plt.show()  
10
```

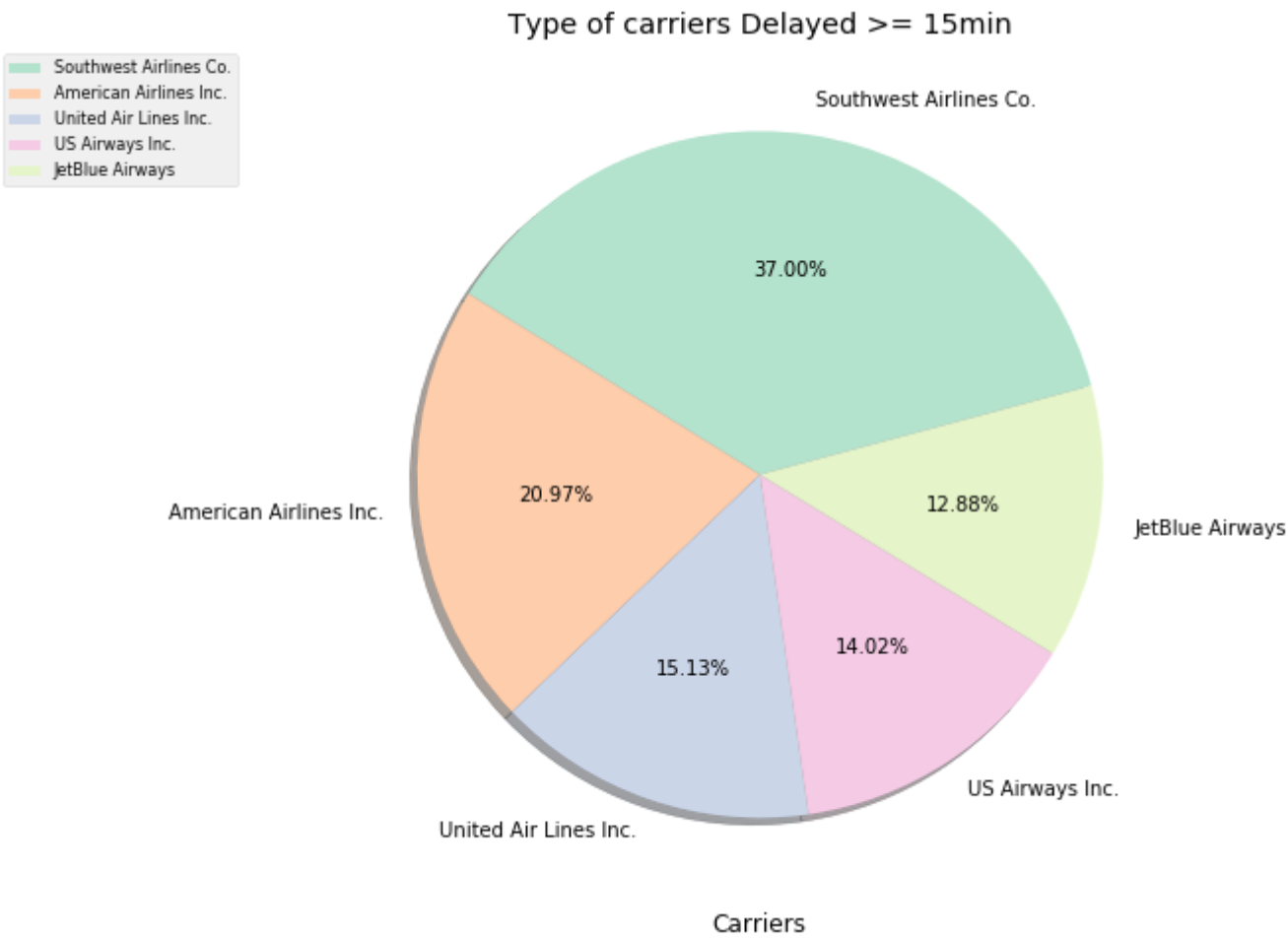
<Figure size 432x288 with 0 Axes>



In [37]:

```
1 plt.figure()
2 plt.figure(figsize=(8,8))
3 cmap = plt.get_cmap('Spectral')
4 colors = [cmap(i) for i in np.linspace(0, 1, 8)]
5 dfcarrier.groupby("carrier_name").arr_del15.mean().sort_values(ascending=False)[:5].plot(kind='pie',
6
7
8
9
10 plt.title('Type of carriers Delayed >= 15min')
11 plt.xlabel('Carriers')
12 plt.legend(bbox_to_anchor=(-0.1, 1.),fontsize=8,loc="best")
13 plt.ylabel("")
14 plt.savefig('piechart2.png', bbox_inches='tight')
15
16 plt.show()
17
```

<Figure size 432x288 with 0 Axes>

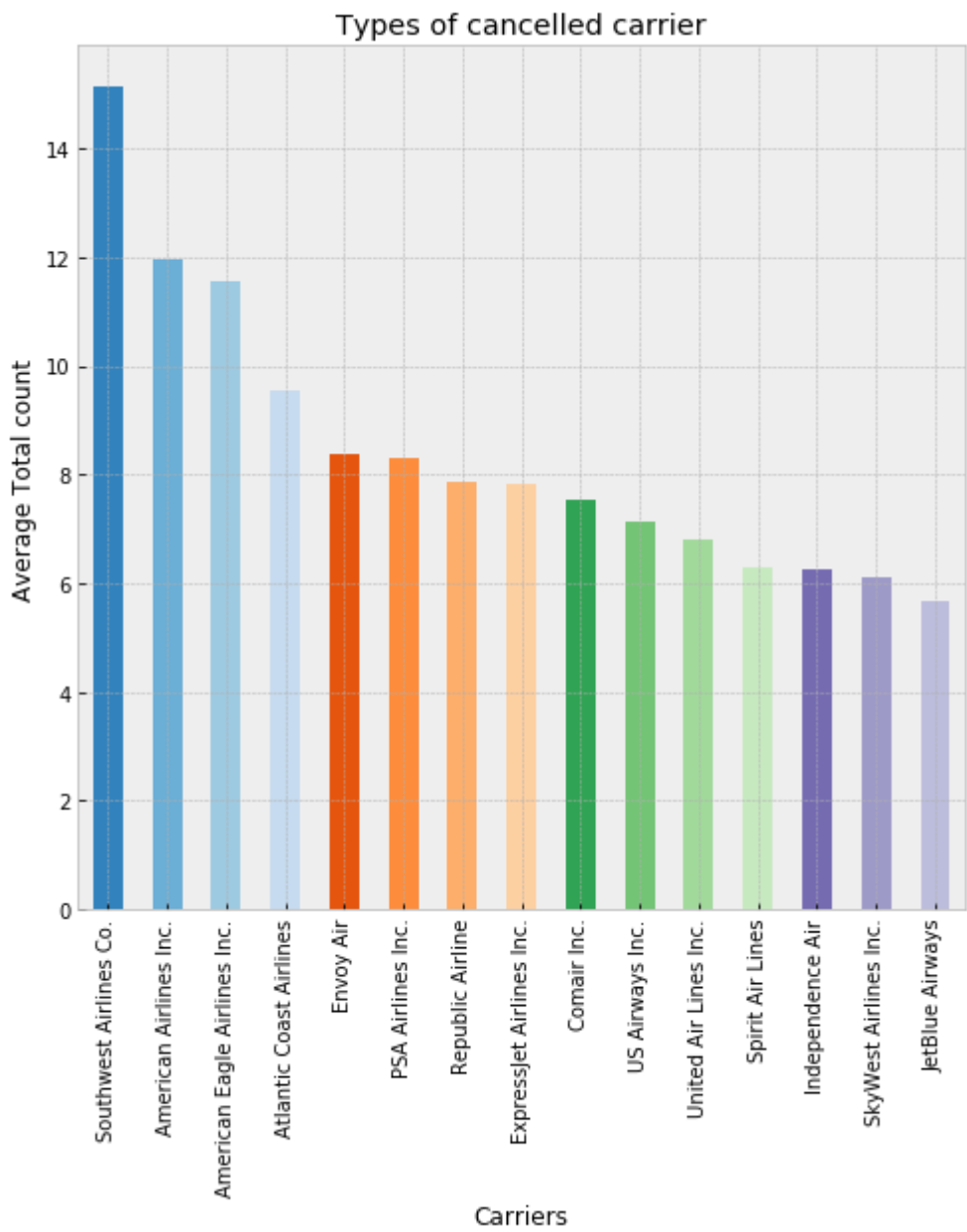


In this part of analysis I observed southwest airlines has most number of delayed compared to its competitors because they have most number of flyings and arrivals count. Whereas only flights are listed above delayed by greater than equal to 15 mintues.

Which carrier has been most cancelled at airports?

```
In [30]: plt.figure()
plt.figure(figsize=(8,8))
dfcarrier.groupby("carrier_name").arr_cancelled.mean().sort_values(ascending=False)[:15].plot(kind = 'bar',
4
                                                colors = plt.cm.tab20)
plt.title('Types of cancelled carrier')
plt.xlabel('Carriers')
plt.ylabel('Average Total count')
plt.savefig('Graph7.png',dpi=400, bbox_inches='tight')
plt.show()
```

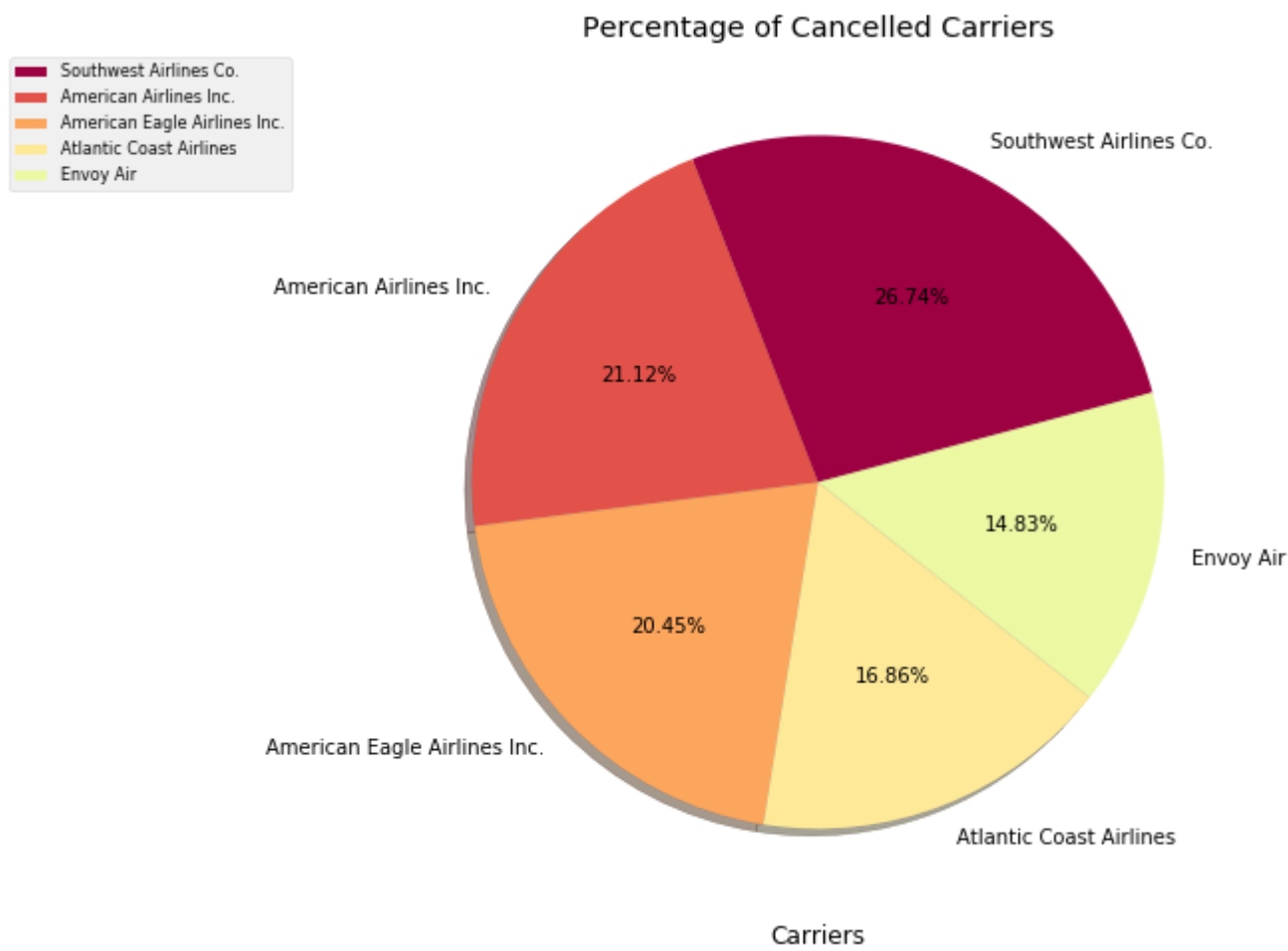
<Figure size 432x288 with 0 Axes>



In [34]:

```
1 plt.figure()
2 plt.figure(figsize=(8,8))
3 cmap = plt.get_cmap('Spectral')
4 colors = [cmap(i) for i in np.linspace(0, 1, 8)]
5 dfcarrier.groupby("carrier_name").arr_cancelled.mean().sort_values(ascending=False)[:5].plot(kind='pie',
6                                                                                                     autopct='%1.2f%%',
7                                                                                                     startangle=15,
8                                                                                                     shadow = True,
9                                                                                                     colors=colors)
10 plt.title('Percentage of Cancelled Carriers')
11 plt.xlabel('Carriers')
12 plt.legend(bbox_to_anchor=(-0.1, 1.),fontsize=8,loc="best")
13 plt.ylabel("")
14 plt.savefig('piechart3.png', bbox_inches='tight')
15
16 plt.show()
```

<Figure size 432x288 with 0 Axes>

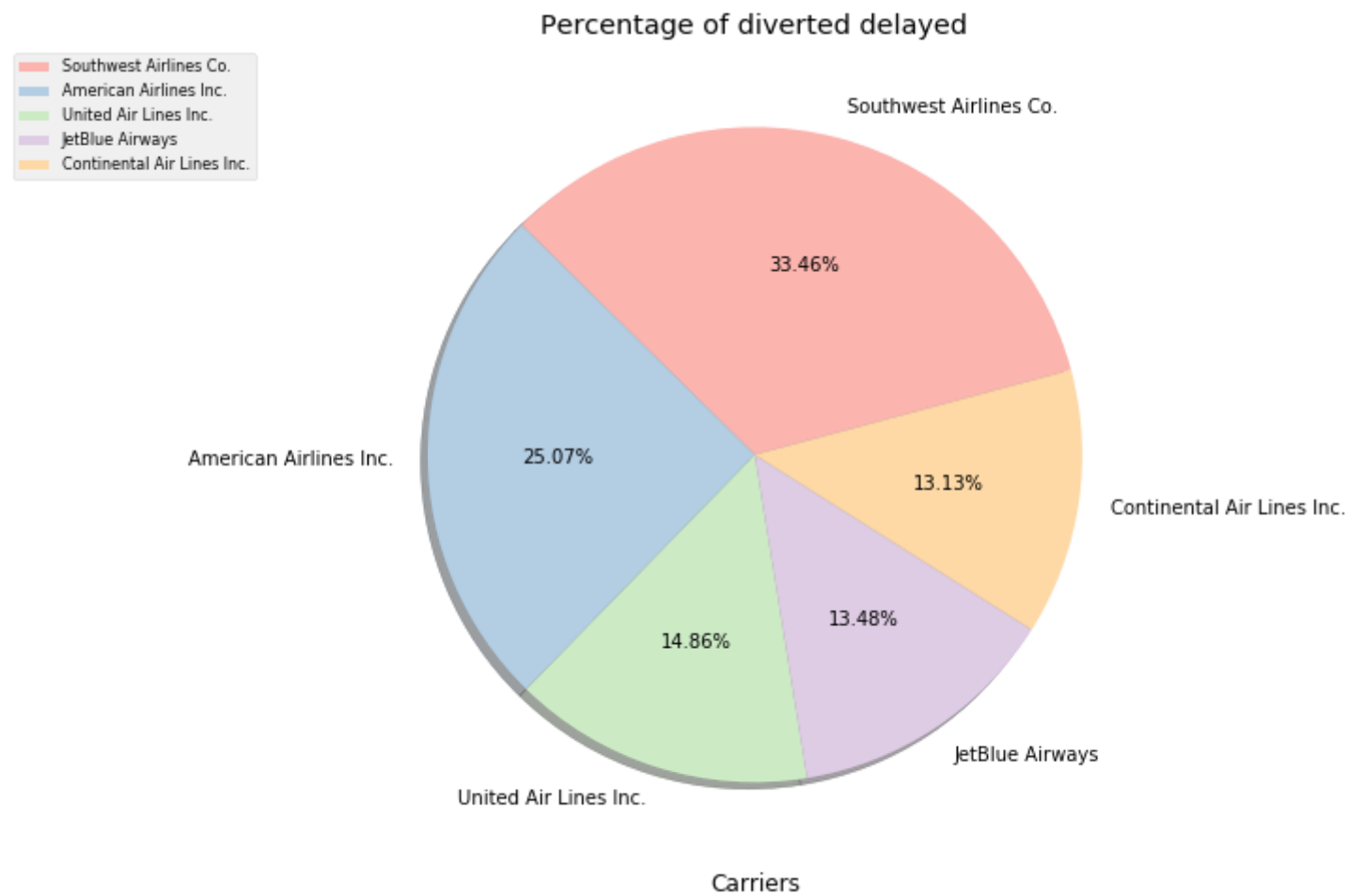


Which carrier has been divered at the airport?


```
In [32]: plt.figure()
plt.figure(figsize=(8,8))
dfcarrier.groupby("carrier_name").arr_diverted.mean().sort_values(ascending=False)[:15].plot(kind = 'bar',
4
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21
22
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In [33]: 1plt.figure()
2plt.figure(figsize=(8,8))
3dfcarrier.groupby("carrier_name").arr_diverted.mean().sort_values(ascending=False)[:5].plot(kind='pie',
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14plt.title('Percentage of diverted delayed')
plt.xlabel('Carriers')
plt.legend(bbox_to_anchor=(-0.1, 1.),fontsize=8,loc="best")
plt.ylabel("")
plt.savefig('piechart4.png', bbox_inches='tight')
plt.show()
```

<Figure size 432x288 with 0 Axes>



So far we have seen arrival count, delayed count, cancelled count and diverted count in which we can see usual trend for top 3 carrier those are not reliable, whereas trend form Jet Blue to Spirit Airlines are steady.

What are the most delayed reasons for the carrier?

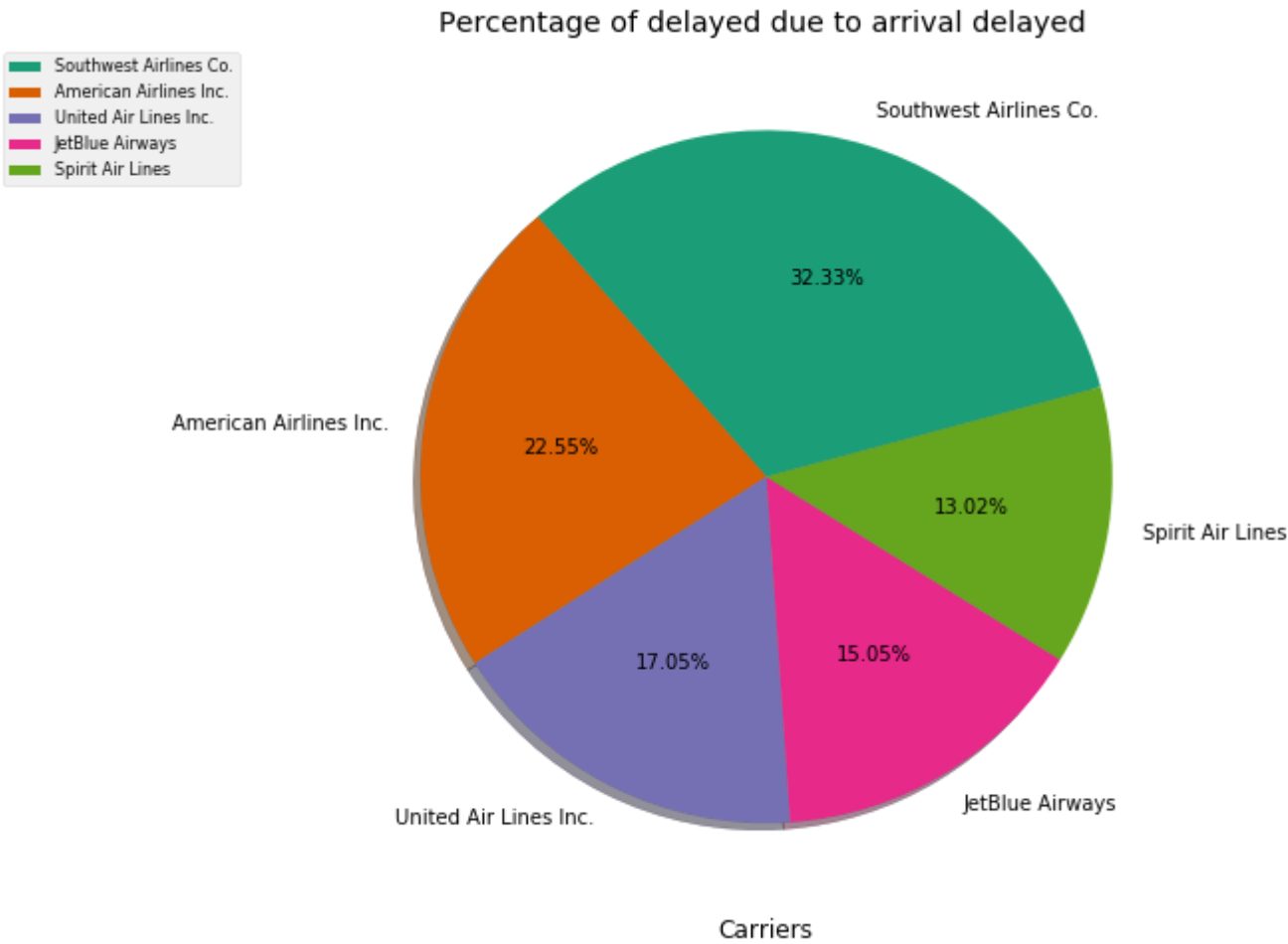
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In [25]: 1 dfdelayed = df[['carrier','carrier_name','arr_delay','carrier_delay',
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In [27]:

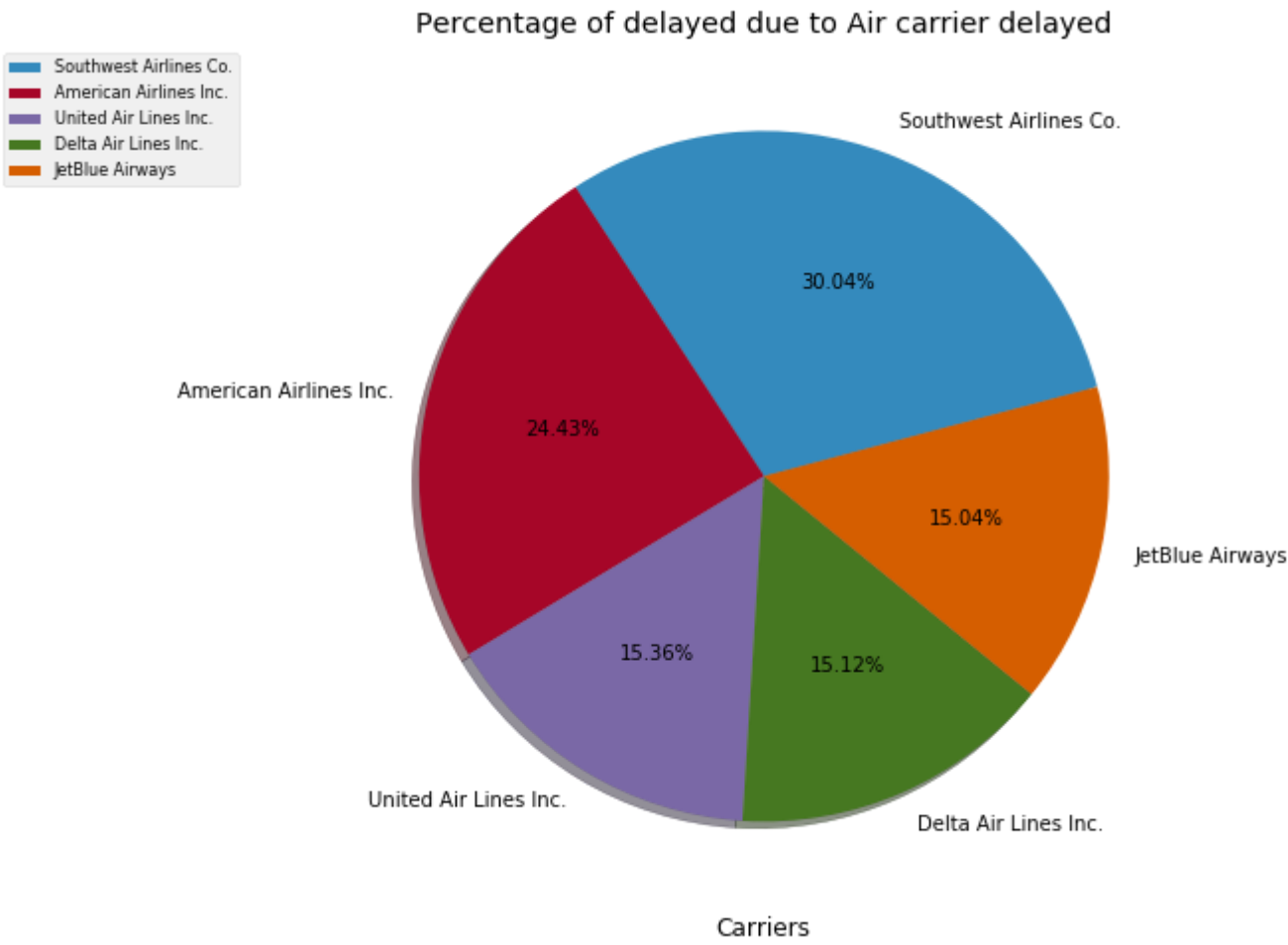
```
1 #arr_delay: Total time (minutes) of delayed flights.
2
3 plt.figure()
4 plt.figure(figsize=(10,8))
5 dfdelayed.groupby("carrier_name").arr_delay.mean().sort_values(ascending=False)[:5].plot(kind='pie',
6                                                                 autopct='%1.2f%%',
7                                                                 startangle=15,
8                                                                 shadow = True,
9                                                                 colors=plt.cm.Dark2.colors)
10 plt.title('Percentage of delayed due to arrival delayed ')
11 plt.xlabel('Carriers')
12 plt.legend(bbox_to_anchor=(-0.1, 1.),fontsize=8,loc="best")
13 plt.ylabel("")
14 plt.savefig('piechart5.png', bbox_inches='tight')
15 plt.show()
16
```

<Figure size 432x288 with 0 Axes>



```
In [28]: #carrier_delay: Total time (minutes) of delayed flights due to air carrier.
2
plt.figure()
plt.figure(figsize=(10,8))
dfdelayed.groupby("carrier_name").carrier_delay.mean().sort_values(ascending=False)[:5].plot(kind='pie',
6
                                                    autopct='%1.2f%%',startangle=90)
plt.title('Percentage of delayed due to Air carrier delayed')
plt.xlabel('Carriers')
plt.legend(bbox_to_anchor=(-0.1, 1.),fontsize=8,loc="best")
plt.ylabel("")
plt.savefig('piechart6.png', bbox_inches='tight')
plt.show()
```

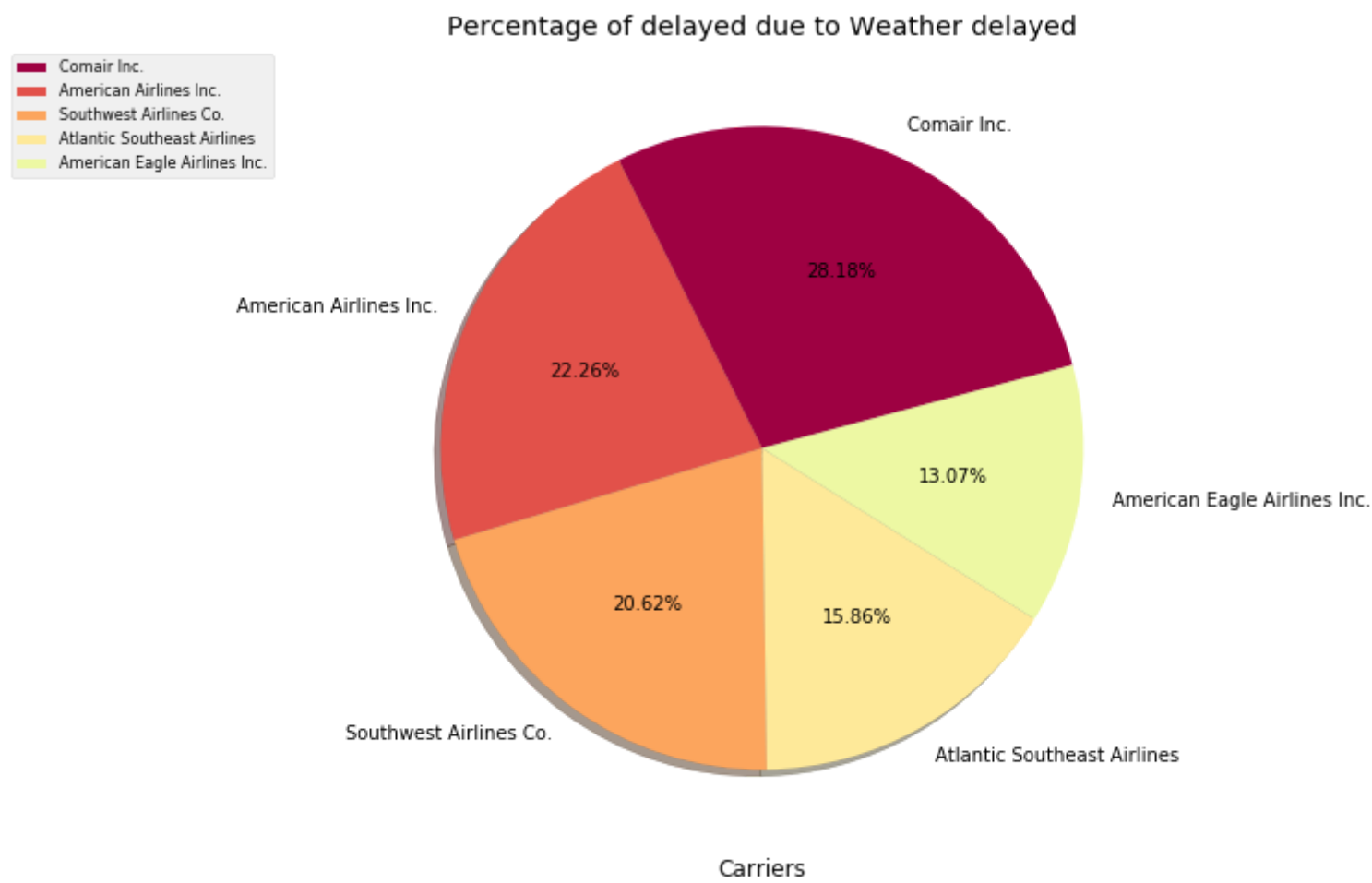
<Figure size 432x288 with 0 Axes>



In [29]:

```
1 #weather_delay: Total time (minutes) of delayed flights due to weather.
2 plt.figure()
3 plt.figure(figsize=(10,8))
4 cmap = plt.get_cmap('Spectral')
5 colors = [cmap(i) for i in np.linspace(0, 1, 8)]
6 dfdelayed.groupby("carrier_name").weather_delay.mean().sort_values(ascending=False)[:5].plot(kind='pie',
7                                                                 autopct='%1.2f%%',
8                                                                 startangle=15,
9                                                                 shadow = True,
10                                                                colors=colors)
11 plt.title('Percentage of delayed due to Weather delayed')
12 plt.xlabel('Carriers')
13 plt.legend(bbox_to_anchor=(-0.1, 1.),fontsize=8,loc="best")
14 plt.ylabel("")
15 plt.savefig('piechart7.png', bbox_inches='tight')
16 plt.show()
```

<Figure size 432x288 with 0 Axes>

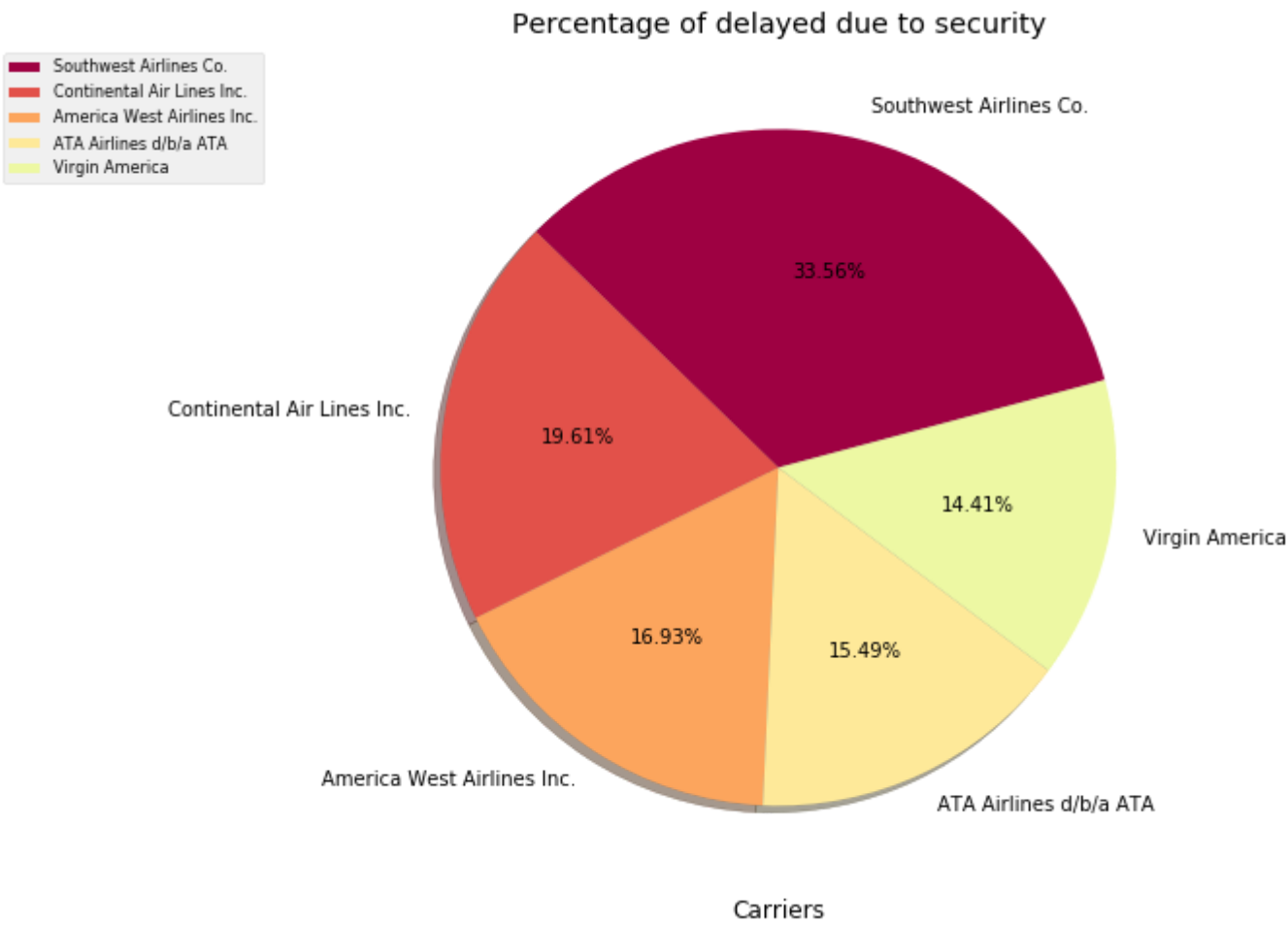


```
In [30]: #nas_delay: Total time (minutes) of delayed flights due to National Aviation System.
plt.figure()
plt.figure(figsize=(10,8))
dfdelayed.groupby("carrier_name").nas_delay.mean().sort_values(ascending=False)[:5].plot(kind='pie',
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In [31]:

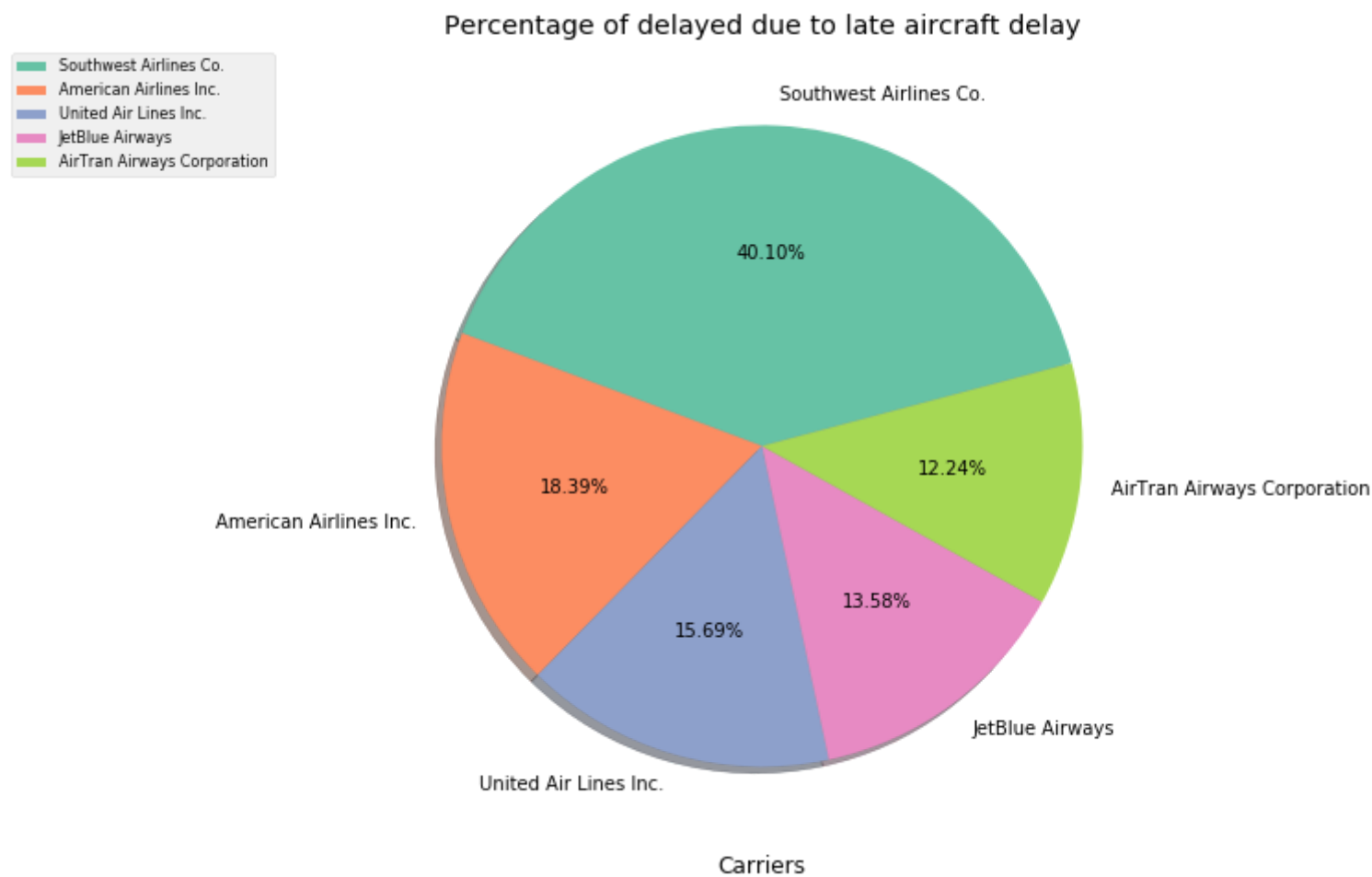
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1 #security_delay: Total time (minutes) of delayed flights due to security.
2 plt.figure()
3 plt.figure(figsize=(10,8))
4 cmap = plt.get_cmap('Spectral')
5 colors = [cmap(i) for i in np.linspace(0, 1, 8)]
6 dfdelayed.groupby("carrier_name").security_delay.mean().sort_values(ascending=False)[:5].plot(kind='pie',
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```
In [32]: 1 #late_aircraft_delay: Total time (minutes) of delayed flights due to a previous flight using the same aircraft
2 plt.figure()
3 plt.figure(figsize=(10,8))
4 dfdelayed.groupby("carrier_name").late_aircraft_delay.mean().sort_values(ascending=False)[:5].plot(kind='pie',
5                                                                                                     autopct='%1.2f%%',
6                                                                                                     startangle=90,
7                                                                                                     shadow=True,
8                                                                                                     colors=palette)
9 plt.title('Percentage of delayed due to late aircraft delay')
10 plt.xlabel('Carriers')
11 plt.legend(bbox_to_anchor=(-0.1, 1.),fontsize=8,loc="best")
12 plt.ylabel("")
13 plt.savefig('piechart10.png', bbox_inches='tight')
14 plt.show()
```

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Mainly there are 6 reasons for flights delayed those are listed and shown above in form of pie charts.

In analysis I observed **Southwest airline and American Airline** are top 2 airlines with most number of delays.

Conclusion

Based on the data, Analysis and visualization I concluded that Southwest Airlines and American airlines are not reliable airlines because of most number of delays.

Whereas Jet blue, Spirit airline and other few airlines are reliable to choose for flying based on their arrival count, delayed count, cancelled count, diverted count and their delayed reasons.

Suggestion

In suggestion for the airlines are getting delayed like **Southwest airline, American airline** etc. should improve thier performance based on delayed causes and increase quality of service and thereby gain customer satisfaction.

```
In [ ]: 1
```