Group 3 - Project 1

Flights Delays and Cancellation

Data

The U.S. Department of Transportation's (DOT) Bureau of Transportation Statistics tracks the on-time performance of domestic flights operated by large air carriers. Summary information on the number of on-time, delayed, canceled, and diverted flights is published in DOT's monthly Air Travel Consumer Report and in this dataset of 2015 flight delays and cancellations. https://www.kaggle.com/usdot/flight-delays/home (https://www.kaggle.com/usdot/flight-delays/home) In "flights.csv" Rows: 5819079 Columns: 31

Index(['YEAR', 'MONTH', 'DAY', 'DAY_OF_WEEK', 'AIRLINE', 'FLIGHT_NUMBER', 'TAIL_NUMBER', 'ORIGIN_AIRPORT', 'DESTINATION_AIRPORT', 'SCHEDULED_DEPARTURE', 'DEPARTURE_TIME', 'DEPARTURE_DELAY', 'TAXI_OUT', 'WHEELS_OFF', 'SCHEDULED_TIME', 'ELAPSED_TIME', 'AIR_TIME', 'DISTANCE', 'WHEELS_ON', 'TAXI_IN', 'SCHEDULED_ARRIVAL', 'ARRIVAL_TIME', 'ARRIVAL_DELAY', 'DIVERTED', 'CANCELLED', 'CANCELLATION_REASON', 'AIR_SYSTEM_DELAY', 'SECURITY_DELAY', 'AIRLINE_DELAY', 'LATE_AIRCRAFT_DELAY', 'WEATHER_DELAY'], dtype='object')

Check files existence

In [2]:

```
import os
print(os.listdir("."))
```

```
['flights.csv', 'test.txt', 'airlines.csv', 'old', '620Group3_Project1_ver2.ipy
nb', '620Group3_Project1_ver2.pdf', 'airports.csv', '.ipynb_checkpoints']
```

Read flights to networkx

either by raw csv or from Saved Pajek file

In [3]:

```
import networkx as nx
import matplotlib.pyplot as plt



g=nx.DiGraph()
```

In [4]:

```
def is_number(n):
    is_number = True
    try:
        num = float(n)
        # check for "nan" floats
        is_number = num == num   # or use `math.isnan(num)`
    except ValueError:
        is_number = False
    return is_number
```

In [5]:

```
#read and add to graph if pajet network data doesn't exist

if not os.path.isfile(r'flights_edges.txt'):
    print("read from flights.csv")
    myfile = open("flights.csv", encoding='utf-8' )


    line = myfile.readline()

    while line:
        line = myfile.readline()
        v = line.split(',')

        if( len(v) == 31 ):
            if( len(v[7]) == 3 and len(v[8]) == 3 and is_number(v[11]) ): #skip
airport code is not xxx
                length_value = int(v[11])
                g.add_weighted_edges_from([(v[7], v[8], length_value)])


    myfile.close()
    print (nx.info(g))
    #Saving network data
    nx.write_pajek(g,r'flights_edges.txt')

else:
    print("read from flight_edges.txt")
    g = nx.read_pajek(r'flights_edges.txt')
    print (nx.info(g))
```

```
read from flights.csv
Name:
Type: DiGraph
Number of nodes: 322
Number of edges: 4691
Average in degree:  14.5683
Average out degree:  14.5683
```

In [8]:

```
### Check edge weights
```

In [9]:

```
for n, nbrs in g.adj.items():
    for nbr, eattr in nbrs.items():
        wt = eattr['weight']
        print('(%s, %s, %.3f)' % (n, nbr, wt))
```

```
(ANC, SEA, -8.000)
(ANC, PDX, -5.000)
(ANC, PHX, 4.000)
(ANC, MSP, 0.000)
(ANC, OTZ, 2.000)
(ANC, SCC, 13.000)
(ANC, JNU, -2.000)
(ANC, OGG, 0.000)
(ANC, OME, 0.000)
(ANC, BET, 16.000)
(ANC, HNL, -9.000)
(ANC, ADK, -9.000)
(ANC, SFO, 28.000)
(ANC, ORD, -13.000)
(ANC, LAS, -8.000)
(ANC, FAI, -5.000)
(ANC, LAX, -5.000)
(ANC, DEN, -10.000)
(ANC, KOA, -7.000)
(ANC, ADQ, -8.000)
(ANC, CDV, 5.000)
(ANC, BRW, 14.000)
(ANC, IAH, 22.000)
(ANC, LGB, 0.000)
(ANC, ATL, -2.000)
(ANC, SLC, -6.000)
(ANC, DFW, 0.000)
(ANC, DLG, -15.000)
(ANC, AKN, 22.000)
(ANC, EWR, 36.000)
(SEA, ANC, 0.000)
(SEA, MSP, 16.000)
(SEA, MIA, -3.000)
(SEA, PHX, 0.000)
(SEA, DEN, 9.000)
(SEA, IAH, 2.000)
(SEA, DFW, 2.000)
(SEA, EWR, 12.000)
(SEA, SJC, -3.000)
(SEA, OAK, 15.000)
(SEA, SFO, 0.000)
(SEA, LAS, -5.000)
(SEA, IAD, 0.000)
(SEA, LAX, -5.000)
(SEA, SNA, -2.000)
(SEA, ORD, 1.000)
(SEA, MDW, 9.000)
(SEA, ATL, -4.000)
(SEA, PHL, -3.000)
(SEA, SAN, -7.000)
(SEA, SLC, -7.000)
(SEA, PSP, 2.000)
(SEA, SMF, -1.000)
(SEA, DTW, 7.000)
(SEA, PDX, 0.000)
(SEA, JFK, -6.000)
(SEA, ONT, 2.000)
(SEA, JNU, 11.000)
(SEA, KTN, -1.000)
(SEA, BUR, -4.000)
(SEA, GEG, -3.000)
(SEA, MCO, 5.000)
(SEA, DCA, -3.000)
```

Compute network data

Degrees = the most connected airports

In [10]:
```
deg = nx.degree(g)
```

check deg data type

In [11]:
```
type(deg)
```

Out[11]:
```
networkx.classes.reportviews.DiDegreeView
```

DiDegreeView return two-tuple (node, degree) according to networkX documentation

Sort DiDegreeView to find min and max degree

In [12]:
```
def sorted_map(map):
    ms = sorted(map, key=lambda x: (-x[1],x[0]))
    return ms

sorted_deg = sorted_map(deg)
```

In [13]:

```
for node, degree in sorted_deg:
    print (node, degree)
```

```
ATL 338
ORD 324
DFW 297
DEN 279
MSP 240
IAH 238
DTW 224
SLC 179
EWR 174
LAX 161
SFO 161
PHX 157
LAS 156
MCO 148
SEA 146
LGA 139
CLT 138
IAD 138
MDW 138
BWI 134
JFK 129
BOS 124
TPA 122
FLL 120
DCA 116
MIA 109
DAL 104
HOU 102
STL 97
PDX 95
BNA 93
PHL 93
SAN 93
AUS 84
CVG 81
MCI 81
RSW 79
MSY 75
CLE 72
RDU 71
OAK 69
ANC 60
IND 60
PIT 60
SAT 60
MKE 58
CMH 57
HNL 56
SMF 54
BDL 50
PBI 50
SJC 50
ABQ 46
CHS 46
MEM 46
SJU 46
JAX 44
OKC 44
SNA 44
OMA 40
TTN 37
BUF 36
OGG 36
```

Top 10 Nodes by Degree

In [14]:
```
sorted_deg[0:10]
```

Out[14]:
```
[('ATL', 338),
 ('ORD', 324),
 ('DFW', 297),
 ('DEN', 279),
 ('MSP', 240),
 ('IAH', 238),
 ('DTW', 224),
 ('SLC', 179),
 ('EWR', 174),
 ('LAX', 161)]
```

Bottem 10 Nodes with Degree

In [15]:
```
sorted_deg[-10:]
```

Out[15]:
```
[('STC', 2),
 ('SUX', 2),
 ('TOL', 2),
 ('TRI', 2),
 ('TWF', 2),
 ('TXK', 2),
 ('VEL', 2),
 ('VLD', 2),
 ('WYS', 2),
 ('YUM', 2)]
```

Trim Degree function

In [16]:
```
def trim_degree(g,degree=1):
    g2 = g.copy()
    d = nx.degree(g2)
    for n in g.nodes():
        if d[n] <= degree: g2.remove_node(n)
    return g2
```

get top nodes

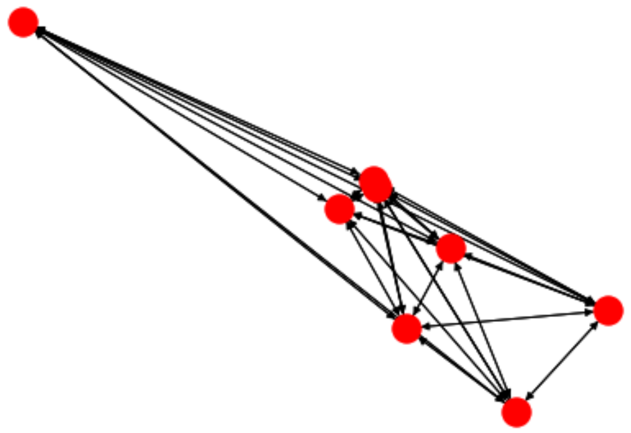
In [17]:
```
topnodes =trim_degree(g,161)
```

Check # of nodes and print nodes

In [18]:
```
len(topnodes)
```

Out[18]:
```
8
```

In [19]:
```
nx.draw(topnodes)
```



Calculate Centrality

Closeness Centrality

In [20]:
```
c = nx.closeness_centrality(topnodes)
```

In [21]:
```
type(c)
```

Out[21]:
```
dict
```

In [22]:
```
print(c)
```

```
{'MSP': 1.0, 'DFW': 1.0, 'ATL': 1.0, 'DEN': 1.0, 'SLC': 1.0, 'IAH': 1.0, 'ORD':
1.0, 'DTW': 1.0}
```

eigenvector_centrality

In [23]:
```
ec = nx.eigenvector_centrality(topnodes)
```

In [24]:
```
type(ec)
```

Out[24]:
```
dict
```

In [25]:
```
print(ec)
```

```
{'MSP': 0.3535533905932738, 'DFW': 0.3535533905932738, 'ATL': 0.353553390593273
8, 'DEN': 0.3535533905932738, 'SLC': 0.3535533905932738, 'IAH': 0.3535533905932
738, 'ORD': 0.3535533905932738, 'DTW': 0.3535533905932738}
```

In [ ]:
```

```