```
!pip install python-igraph
```

```
    Collecting python-igraph
      Downloading https://files.pythonhosted.org/packages/2f/d9/4f0a1b01ec1020dd0
         |████████████████████████████████| 3.2MB 8.6MB/s
    Collecting texttable>=1.6.2
      Downloading https://files.pythonhosted.org/packages/06/f5/46201c428aebe0eec
    Installing collected packages: texttable, python-igraph
    Successfully installed python-igraph-0.9.4 texttable-1.6.3
```

```
import igraph
import igraph as ig
import os
import datetime
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from random import randint
plt.style.use('ggplot')

from google.colab import drive
drive.mount('/content/drive')
```

```
    Drive already mounted at /content/drive; to attempt to forcibly remount, call
```

2. Let's Help Santa!

2. Build Your Graph

```
from google.colab import drive
drive.mount('/content/drive')
```

```
    Mounted at /content/drive
```

```
import pandas as pd
import json
import numpy as np
import networkx as nx
import matplotlib.pyplot as plt
```

```
#travel_time_path = "/content/drive/MyDrive/UCLA/large scale social and complex ne
#geo_path = "/content/drive/MyDrive/UCLA/large scale social and complex networks/p

# i added a shortcut of shared project to my drive and uploaded the data into the
travel_time_path = "/content/drive/My Drive/ECE 232E Project/Project 4/los_angeles
geo_path = "/content/drive/My Drive/ECE 232E Project/Project 4/los_angeles_censust

# travel_time_path = "/content/los_angeles-censustracts-2019-4-All-MonthlyAggregat
# geo_path = "/content/los_angeles_censustracts.json"


time_data = pd.read_csv(travel_time_path)
time_data = time_data[time_data['month']==12].reset_index(drop=True)
geo_data = pd.read_json(geo_path)
geo_data = pd.json_normalize(geo_data['features'])
```

```
---------------------------------------------------------------------------
FileNotFoundError                         Traceback (most recent call last)
<ipython-input-3-e7ada495afa0> in <module>()
     11
     12
---> 13 time_data = pd.read_csv(travel_time_path)
     14 time_data = time_data[time_data['month']==12].reset_index(drop=True)
     15 geo_data = pd.read_json(geo_path)

                                  4 frames
/usr/local/lib/python3.7/dist-packages/pandas/io/parsers.py in __init__(self,
src, **kwds)
   2008         kwds["usecols"] = self.usecols
   2009
-> 2010         self._reader = parsers.TextReader(src, **kwds)
   2011         self.unnamed_cols = self._reader.unnamed_cols
   2012

pandas/_libs/parsers.pyx in pandas._libs.parsers.TextReader.__cinit__()

pandas/_libs/parsers.pyx in
pandas._libs.parsers.TextReader._setup_parser_source()

FileNotFoundError: [Errno 2] No such file or directory: '/content/drive/My
Drive/ECE 232E Project/Project 4/los_angeles-censustracts-2019-4-All-
MonthlyAggregate.csv'
```

```
print(time_data[time_data['sourceid']==665])
print(time_data[time_data['sourceid']==1522])
```

```
print(time_data[time_data['dstid']==665])
print(time_data[time_data['dstid']==1522])
```

```
         sourceid  ...  geometric_standard_deviation_travel_time
3759          665  ...                                     1.36
8286          665  ...                                     1.30
9322          665  ...                                     1.26
9900          665  ...                                     1.34
12961         665  ...                                     1.30
...           ...  ...                                      ...
1688313       665  ...                                     1.27
1690933       665  ...                                     1.32
1691977       665  ...                                     1.25
1692144       665  ...                                     1.29
1692315       665  ...                                     1.29

[869 rows x 7 columns]
         sourceid  ...  geometric_standard_deviation_travel_time
3642         1522  ...                                     1.33
7471         1522  ...                                     2.11
25168        1522  ...                                     1.35
73294        1522  ...                                     1.28
78939        1522  ...                                     1.31
...           ...  ...                                      ...
1579888      1522  ...                                     1.30
1639064      1522  ...                                     1.37
1645545      1522  ...                                     1.39
1677208      1522  ...                                     1.33
1678617      1522  ...                                     1.31

[93 rows x 7 columns]
         sourceid  ...  geometric_standard_deviation_travel_time
762          1140  ...                                     1.33
3366         1746  ...                                     1.41
11952        1890  ...                                     1.28
14619          15  ...                                     1.36
16889        1141  ...                                     1.30
...           ...  ...                                      ...
1677654      2403  ...                                     2.24
1677841       264  ...                                     1.27
1685059       609  ...                                     1.52
1689492        99  ...                                     1.41
1691513      1266  ...                                     1.30

[911 rows x 7 columns]
         sourceid  ...  geometric_standard_deviation_travel_time
39285        1365  ...                                     1.25
73271        1565  ...                                     1.26
113311       1542  ...                                     1.36
```

```
162647       1517  ...                                          1.23
164275       1964  ...                                          1.39
...           ...  ...                                           ...
1636484      1345  ...                                          1.24
1645318      1531  ...                                          1.27
1649787      1519  ...                                          1.45
1660348      1966  ...                                          1.35
1686551      1576  ...                                          1.33

[91 rows x 7 columns]
```

```
# This code-block is just for debugging.

#with open(geo_path, "r") as geo_f:
#    geo_json = json.load(geo_f)
#    geo_data = pd.json_normalize(geo_json)
#print(geo_json['features'])
#for i, row in enumerate(geo_json['features']):
#    if i<1000:
#        print(row)


print(time_data.columns)
print(geo_data.columns)
#print(geo_data.loc[:,'properties.DISPLAY_NAME'])
print(geo_data.loc[:,'geometry.coordinates'])
```

```
Index(['sourceid', 'dstid', 'month', 'mean_travel_time',
       'standard_deviation_travel_time', 'geometric_mean_travel_time',
       'geometric_standard_deviation_travel_time'],
      dtype='object')
Index(['type', 'properties.MOVEMENT_ID', 'properties.TRACT',
       'properties.DISPLAY_NAME', 'geometry.type', 'geometry.coordinates'],
      dtype='object')
0       [[[-118.11683, 34.107225], [-118.116311, 34.10...
1       [[[-118.134669, 34.098771], [-118.134644, 34.0...
2       [[[-118.134532, 34.091566], [-118.134623, 34.0...
3       [[[-118.12276, 34.10447], [-118.12386, 34.1039...
4       [[[-118.141784, 34.098765], [-118.141783, 34.0...
                              ...
2711    [[[-117.988457, 33.795667], [-117.988062, 33.7...
2712    [[[-118.072178, 33.795185], [-118.072182, 33.7...
2713    [[[-118.081682, 33.794065], [-118.08155, 33.79...
2714    [[[-118.07618, 33.785512], [-118.07618, 33.785...
2715    [[[-117.993727, 33.895404], [-117.992209, 33.8...
Name: geometry.coordinates, Length: 2716, dtype: object
```

```
from tqdm import tqdm
edge_dict = {}
edge_count = {}

for sourceid, dstid, time in tqdm(zip(time_data["sourceid"], time_data['dstid'], t
    idx = (sourceid, dstid)
    if idx in edge_dict:
        edge_count[idx] += 1
        num = edge_count[idx]
        edge_dict[idx] = (num-1)/num * edge_dict[idx] + 1/num * time

    else:
        edge_count[idx] = 1
        edge_dict[idx] = time

edge_list = []
for key in tqdm(edge_dict):
    edge_list.append((key[0], key[1], edge_dict[key]))
```

```
 1692450it [00:02, 608063.06it/s]
 100%|██████████| 1692450/1692450 [00:01<00:00, 1294207.85it/s]
```

```
# print(geo_data)
#print(dict((geo_data.head(2)['features'])))
def calculate_row_mean(geo_type, geo_coor):
    data = np.array(geo_coor)
    post_data = []
    #print(geo_type)
    #print(data.shape)
    if geo_type == "MultiPolygon":
        if data.shape[0]!=1 and len(data.shape)<=2: #handle Multipolygon case
            for i in data:
                for ii in i:
                    post_data.append(np.array(ii).mean(axis=0))
            post_data = np.array(post_data)
            cent_coor = post_data.mean(axis=0)
        elif data.shape[0]!=1 and len(data.shape)==4: #handle multippolygon but we
            for i in data:
                post_data.append(i[0].mean(axis=0))
            post_data = np.array(post_data)
            cent_coor = post_data.mean(axis=0)
            #print(cent_coor)
        else:
            print(data)
```

```
        else:
            if data.shape[0]!=1 and len(data.shape)!=2: # handle polygon case but weir
                for i in data:
                    post_data.append(np.array(i).mean(axis=0))
                post_data = np.array(post_data)
                cent_coor = post_data.mean(axis=0)
                #print(cent_coor)
            elif data.shape[0]==1 and len(data.shape)==3:
                data = data.squeeze()
                cent_coor = data.mean(axis=0)
                #print(cent_coor)
                #for i in data[0][0]:
                #    print(len(i))
            else:
                print("hi")
        if cent_coor.shape[0]!=2:
            print(cent_coor.shape)
            print(geo_type)
            print(data.shape)
        return cent_coor
        '''
        if geo_type == "MultiPolygon":
            data = []
            for l in geo_coor:
                print(geo_type)
                print(np.array(l).shape)
        else:
            data = []
            print(geo_coor)
            print(np.array(geo_coor).shape)
            print(np.array(geo_coor))
        '''

    geo_data_rename = geo_data.rename(columns={'type':'type', 'properties.MOVEMENT_ID'
                                               "properties.DISPLAY_NAME":'display_name

    geo_data_rename = geo_data_rename.drop(columns=['type', 'tract'])

    #geo_data_rename['id'] = np.arange(len(geo_data_rename)) + 1
    #for i, row in enumerate(geo_data_rename['geo_coor']):
    node_list = []
    for geo_type, geo_coor, id, display_name in zip(geo_data_rename['geo_type'], geo_d
        cent_coor = calculate_row_mean(geo_type, geo_coor)
        node_list.append((int(id), {"cent_coor":cent_coor, "display_name": display_nam
```

```
#head_row = geo_data_rename.head(5)
#head_row.apply(calculate_row_mean)
#for row in head_row:
#    calculate_row_mean(row)
#a = geo_data_rename.head(1)['centroid'].to_numpy()
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
<ipython-input-3-c85636256ec6> in <module>()
     54     '''
     55
---> 56 geo_data_rename = geo_data.rename(columns={'type':'type',
'properties.MOVEMENT_ID': "movement_id", "properties.TRACT": 'tract',
     57
"properties.DISPLAY_NAME":'display_name', "geometry.type": "geo_type",
"geometry.coordinates":"geo_coor"})
     58

NameError: name 'geo_data' is not defined
```

```
# Create Graph with node list and edge list generated from above
G = nx.Graph()
G.add_nodes_from(node_list)
G.add_weighted_edges_from(edge_list)

# Only take the largest connected graph subgraph
largest_cc = max(nx.connected_components(G), key=len)
G0 = G.subgraph(largest_cc)

for n, i in G0.nodes(data=True):
    if i['display_name']=='Census Tract 265301':
        print(i['cent_coor'][::-1])
```

```
[  34.07228988 -118.44451639]
```

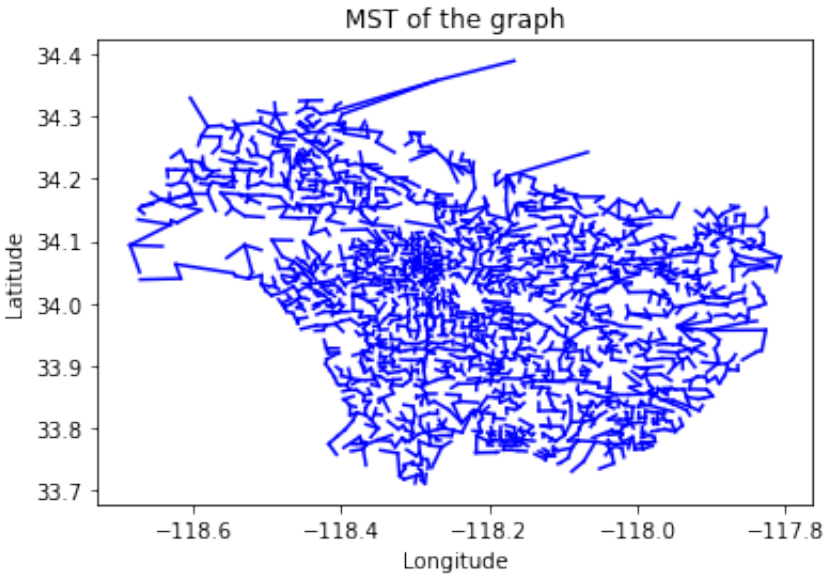
```
# Question 6
print("number of edges: ", len(G0.edges()))
print("number of nodes: ", len(G0.nodes()))
```

```
number of edges:  1004955
number of nodes:  2649
```

```
# find the minimum spanning tree

MST = nx.minimum_spanning_tree(G0)


print("number of edges in MST: ", len(MST.edges()))
print("number of nodes in MST: ", len(MST.nodes()))
```

```
    number of edges in MST:  2648
    number of nodes in MST:  2649
```

```
for u, v, d in MST.edges(data=True):
    x = [MST.nodes[u]['cent_coor'][0], MST.nodes[v]['cent_coor'][0]]
    y = [MST.nodes[u]['cent_coor'][1], MST.nodes[v]['cent_coor'][1]]
    plt.plot(x, y, color = 'b')
plt.xlabel('Longitude')
plt.ylabel('Latitude')
plt.title('MST of the graph')
plt.show()
```



```
# display first 5 edges
for u, v, d in list(MST.edges(data=True))[:5]:
    print("Mean Traveling time: ", d['weight'])
    print(MST.nodes[u]['display_name'], "<-------->", MST.nodes[v]['display_name'])
    print(MST.nodes[u]['cent_coor'][::-1], "<-------->", MST.nodes[v]['cent_coor'][
    print(" ")
```

```
Mean Traveling time:  112.88
Census Tract 480302 <--------> Census Tract 481002
[  34.10309557 -118.12053321] <--------> [  34.09585388 -118.11656383]

Mean Traveling time:  128.71
Census Tract 480302 <--------> Census Tract 480400
[  34.10309557 -118.12053321] <--------> [  34.10349303 -118.13224544]

Mean Traveling time:  86.31
Census Tract 480303 <--------> Census Tract 480304
[  34.09645121 -118.13785063] <--------> [  34.09626386 -118.13138209]

Mean Traveling time:  118.03
Census Tract 480303 <--------> Census Tract 480400
[  34.09645121 -118.13785063] <--------> [  34.10349303 -118.13224544]

Mean Traveling time:  128.74
Census Tract 480303 <--------> Census Tract 480500
[  34.09645121 -118.13785063] <--------> [  34.0986815  -118.14492317]
```

```
!pip install python-igraph
import json
import numpy as np
import pandas as pd
import igraph as ig
import matplotlib.pyplot as plt
```

```
Collecting python-igraph
  Downloading https://files.pythonhosted.org/packages/2f/d9/4f0a1b01ec1020dd0
     |████████████████████████████████| 3.2MB 23.2MB/s
Collecting texttable>=1.6.2
  Downloading https://files.pythonhosted.org/packages/06/f5/46201c428aebe0eec
Installing collected packages: texttable, python-igraph
Successfully installed python-igraph-0.9.4 texttable-1.6.3
```

```
# Question 8
df = pd.read_csv(travel_time_path)
```

```
df = df[df['month']==12][['sourceid','dstid','mean_travel_time']] #only december
new_df = pd.DataFrame(df.values,columns=['sourceid','dstid','mean_travel_time'])
new_df = new_df.groupby(['sourceid','dstid']).mean().reset_index()
new_df_vals = new_df.values



outfile = open("graph.txt", "w")
for i in range(len(new_df_vals)):
    line=str('%d'%int(new_df_vals[i][0]))+'\t'+str('%d'%int(new_df_vals[i][1]))+'\
    outfile.write(line)
outfile.close()



g = ig.Graph.Read(f = 'graph.txt', format = 'ncol', directed = False)
graph = g.components().giant()

# 8
triangles = []
while len(triangles)<1000:
    vertices = np.random.randint(1,high=len(graph.vs),size=3)
    try:
        e1 = graph.get_eid(vertices[0],vertices[1])
        e2 = graph.get_eid(vertices[1],vertices[2])
        e3 = graph.get_eid(vertices[2],vertices[0])
        weights = [graph.es['weight'][e1], graph.es['weight'][e2], graph.es['weigh
        triangles.append(weights)
    except: continue

count = 0
for i in triangles:
    w1 = i[0]
    w2 = i[1]
    w3 = i[2]
    if w1+w2>w3 and w1+w3>w2 and w3+w2>w1:
        count+=1
print("The percentage of triangles in the graph is: ", count/len(triangles) * 100,
```

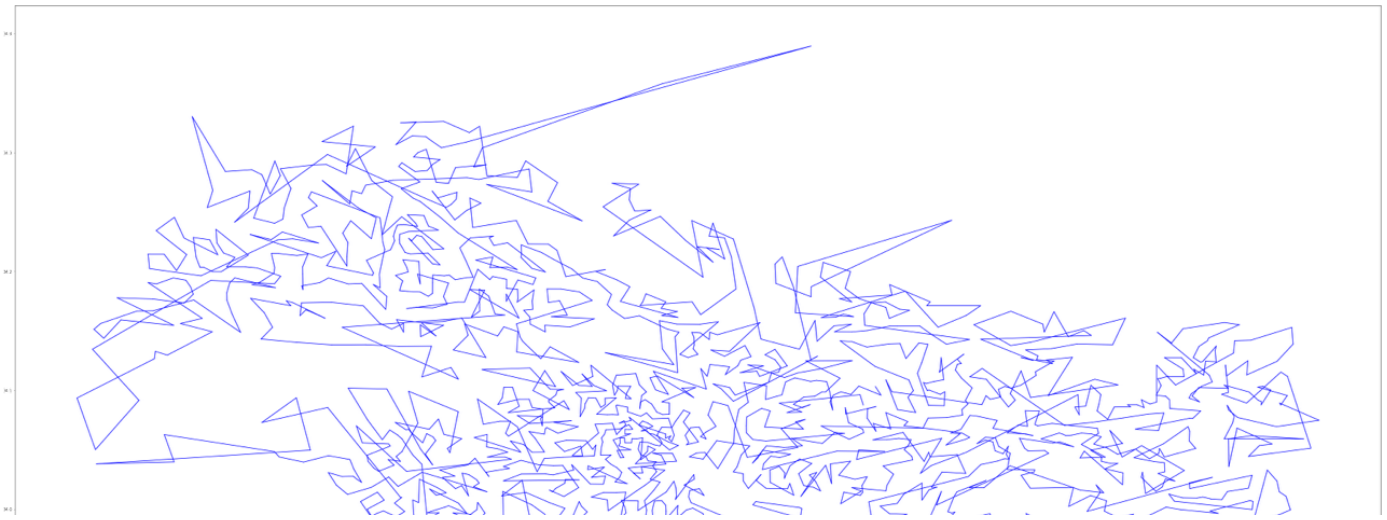
```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
<ipython-input-2-4943f7525ef5> in <module>()
      1 # Question 8
----> 2 df = pd.read_csv(travel_time_path)
      3 df = df[df['month']==12][['sourceid','dstid','mean_travel_time']]
#only december
      4 new_df = pd.DataFrame(df.values,columns=
['sourceid','dstid','mean_travel_time'])
      5 new_df = new_df.groupby(['sourceid','dstid']).mean().reset_index()

NameError: name 'travel_time_path' is not defined
```

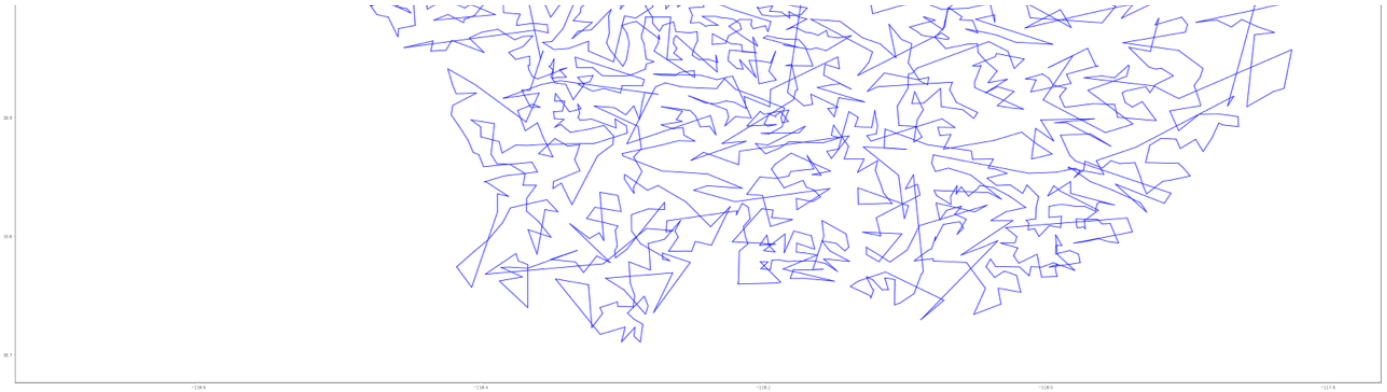
```
# Question 9

# The bound would be 2 since it is the 1-approximation algo
```

```
# Question 10

bi_edge_list = []

MST_cost = 0
for u, v, d in MST.edges(data=True):
    bi_edge_list.append((u, v))
    bi_edge_list.append((v, u))
    MST_cost += d['weight']

H = nx.DiGraph()
H.add_nodes_from(MST)
H.add_edges_from(bi_edge_list)
edge_iter = nx.eulerian_path(H)

#print(len(H.edges))
#print(len([(u, v) for u, v in edge_iter]))
# if wanna print all the edges
plt.figure(figsize=(60,40))
traj = []
for u, v in edge_iter:
    traj.append(u)
    #x = [MST.nodes[u]['cent_coor'][0], MST.nodes[v]['cent_coor'][0]]
    #y = [MST.nodes[u]['cent_coor'][1], MST.nodes[v]['cent_coor'][1]]
    #plt.plot(x, y, color = 'b')
```

```
    #plt.arrow(x[0],y[0], x[1]-x[0], y[1]-y[0])
traj_once = []
for node in traj:
    if node not in traj_once:
        traj_once.append(node)
traj_len = 0
for i in range(len(traj_once)-1):
    try:
        traj_len += G0.edges[traj_once[i], traj_once[i+1]]['weight']
    except:
        traj_len += nx.shortest_path_length(G0, traj_once[i], traj_once[i+1])
    x = [MST.nodes[traj_once[i]]['cent_coor'][0], MST.nodes[traj_once[i+1]]['cent_
    y = [MST.nodes[traj_once[i]]['cent_coor'][1], MST.nodes[traj_once[i+1]]['cent_
    plt.plot(x, y, color = 'b')
    #plt.arrow(x[0],y[0], x[1]-x[0], y[1]-y[0])
print(MST_cost)
print(traj_len)
print(MST_cost*2)
print(traj_len/MST_cost)
plt.show()
#plt.xlabel('Longitude')
#plt.ylabel('Latitude')
#plt.title('MST of the graph')
#plt.show()

#travel_path = []
#for u, v in edge_iter:
#    travel_path.append((MST.nodes[u]['cent_coor'], MST.nodes[v]['cent_coor']))
```

```
260551.60000000033
447269.3399999993
521103.20000000065
1.7166248067561234
```

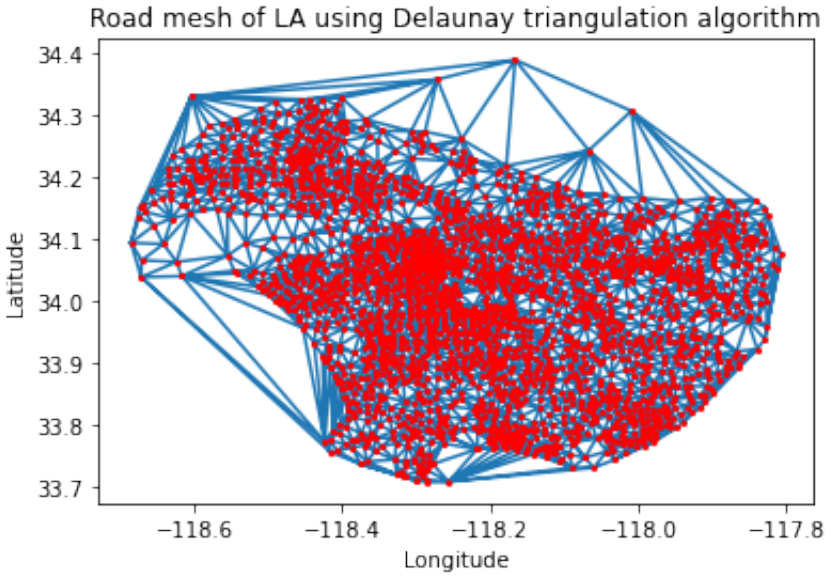




```
# This code-block requires google-map api.
import gmplot

apikey = '' # (your API key here)
gmap = gmplot.GoogleMapPlotter(travel_path[0][0][1], travel_path[0][0][0], 13, api

for i, pair in enumerate(travel_path[:30]):
    gmap.marker(pair[0][1], pair[0][0], label=i)

gmap.draw('map.html')
```

```
#Question 11
from scipy.spatial import Delaunay

lonlat_location = {}
with open(geo_path, 'r') as f:
    data = json.loads(f.readline())
    features = data['features']
    for feature in features:
        latitude = 0.0
        longitude = 0.0
        if feature['geometry']['type']=='Polygon':
            coordinates = np.array(feature['geometry']['coordinates'][0])

            for coordinate in coordinates:
                latitude += coordinate[1]
                longitude += coordinate[0]
        if feature['geometry']['type']=='MultiPolygon':
            coordinates = np.array(feature['geometry']['coordinates'][0][0])
            for coordinate in coordinates:
                latitude += coordinate[1]
                longitude += coordinate[0]
        latitude /= len(coordinates)
        longitude /= len(coordinates)

        lonlat_location[feature['properties']['MOVEMENT_ID']] = (feature['properti

lat=[]
lon=[]
for i in range(1,len(lonlat_location)+1):
    lat.append(lonlat_location[str(i)][1])
    lon.append(lonlat_location[str(i)][2])
lat_lon = tuple(zip(lat, lon))
tri = Delaunay(lat_lon)

g_delaunay=ig.Graph()
g_delaunay.add_vertices(len(tri.points))
vert=g_delaunay.vs()
i=0
for v in vert:
    v['lat']=lat[i]
    v['lon']=lon[i]
    i+=1

duplicates=set()
for i in range(len(tri.simplices)):
```

```
        a=((tri.simplices[i][0], tri.simplices[i][1]))
        b=((tri.simplices[i][0], tri.simplices[i][2]))
        c=((tri.simplices[i][1], tri.simplices[i][2]))
        list(a).sort()
        list(b).sort()
        list(c).sort()
        if not a in duplicates:
            duplicates.add(a)
            g_delaunay.add_edges([a])
        if not b in duplicates:
            duplicates.add(b)
            g_delaunay.add_edges([b])
        if not c in duplicates:
            duplicates.add(c)
            g_delaunay.add_edges([c])

plt.triplot(lon, lat, tri.simplices)
plt.plot(lon, lat,'r.',markersize=4)
plt.xlabel('Longitude')
plt.ylabel('Latitude')
plt.title('Road mesh of LA using Delaunay triangulation algorithm')
plt.show()
```



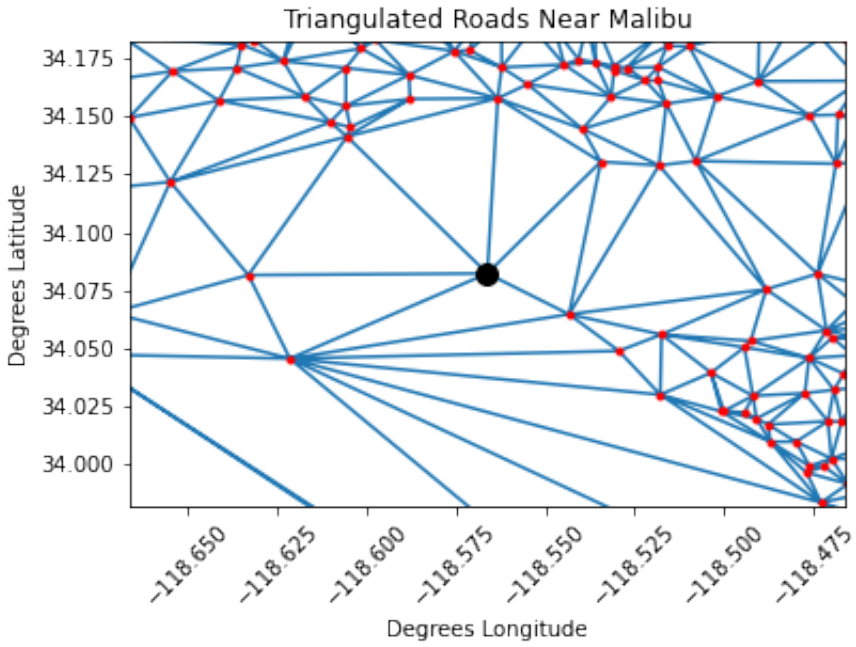

```
# Question 12 see report


# Question 13
with open(geo_path) as json_data:
    geo_info = json.load(json_data)
```

```
geo_info = geo_info['features']
location_dict = {}
for features in geo_info:
    entry = {}
    coord = features['geometry']['coordinates'][0][0]
    if len(coord) > 2:
      mean_coord = np.mean(np.asarray(coord),axis=0)
    else:
      mean_coord = coord
    movement_id = features['properties']['MOVEMENT_ID']
    entry['coord'] = coord
    entry['mean_coord'] = mean_coord
    location_dict[movement_id] = entry

ig.Graph.write_ncol(graph,'data_q13.txt')
data_q13 = np.loadtxt('data_q13.txt')
data_q13_graph = {}
for row in data_q13:
    location_index = tuple(np.sort(row[0:2]).astype('int'))
    data_q13_graph[location_index] = row[2]
data_q13_ids = np.concatenate([data_q13[:,0],data_q13[:,1]])
data_q13_ids = np.unique(data_q13_ids).astype('int')

mean_coords = np.zeros((len(data_q13_ids),2))
for n,location_key in enumerate(data_q13_ids):
    mean_coords[n,:] = location_dict[str(location_key)]['mean_coord']
tri_q13 = Delaunay(mean_coords)

malibu= [34.04, -118.56]
long_beach =  [33.77, -118.18]

def get_flow(loc1, loc2, transit_time_graph):
    coord1 = location_dict[str(loc1)]['mean_coord']
    coord2 = location_dict[str(loc2)]['mean_coord']
    distance_miles = 69 * np.sqrt(np.sum(np.square(np.array(coord2)-np.array(coord
    if (loc1,loc2) in transit_time_graph.keys():
        travel_time_hours = transit_time_graph[(loc1,loc2)] / 3600
        speed_mph = distance_miles / travel_time_hours
        flow = (2*speed_mph) / (0.003 + (speed_mph/1800))
        return flow
    else:
        return 0
```

```
def add_triangulated_edge(graph,triangle):
    edge12 = tuple(np.sort(triangle[:2]))
    edge13 = tuple(np.sort(triangle[0::2]))
    edge23 = tuple(np.sort(triangle[1:]))

    flow12 = get_flow(edge12[0],edge12[1],data_q13_graph)
    flow13 = get_flow(edge13[0],edge13[1],data_q13_graph)
    flow23 = get_flow(edge23[0],edge23[1],data_q13_graph)
    if edge12 not in graph.keys() and flow12 > 0:
        graph[edge12] = flow12
    if edge13 not in graph.keys() and flow13 > 0:
        graph[edge13] = flow13
    if edge23 not in graph.keys() and flow23 > 0:
        graph[edge23] = flow23


triangulated_graph = {}
for triangle_idx in tri_q13.simplices:
    triangle = [data_q13_ids[triangle_idx[0]], data_q13_ids[triangle_idx[1]], data
    add_triangulated_edge(triangulated_graph,triangle)


with open('/triangulated_graph.txt','w') as f:
    for locations in triangulated_graph:
        string = '{} {} {:.2f}\n'.format(int(locations[0]),int(locations[1]),trian
        f.write(string)

diff = np.ones(len(location_dict))
for i in location_dict.keys():
    diff[int(i)-1] = (np.stack(location_dict[i]['mean_coord'])[0]-(malibu[1]))**2+
argmin_malibu = np.argmin(diff)
for i in location_dict.keys():
    diff[int(i)-1] = (np.stack(location_dict[i]['mean_coord'])[0]-(long_beach[1]))
argmin_long_beach = np.argmin(diff)




print("Degree of vertex for Malibu: ", g_delaunay.degree(argmin_malibu))
print("Degree of vertex for Long Beach: ", g_delaunay.degree(argmin_long_beach))
print("Number of edge disjoint paths:", g_delaunay.adhesion(argmin_malibu,argmin_l

    Degree of vertex for Malibu:  6
    Degree of vertex for Long Beach:  6
    Number of edge disjoint paths: 6
```

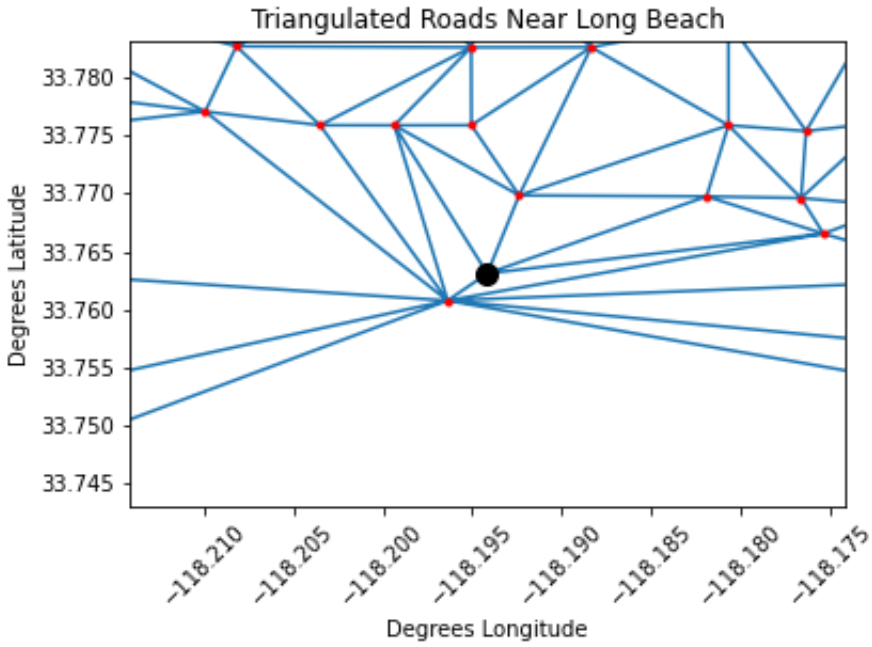
```
Malibu_coords = location_dict[str(argmin_malibu)]['mean_coord']
print("Malibu Coordinates: ", Malibu_coords)
plt.triplot(mean_coords[:,0], mean_coords[:,1], tri_q13.simplices.copy())
plt.plot(mean_coords[:,0], mean_coords[:,1],'r.')
plt.plot(Malibu_coords[0],Malibu_coords[1],'k.',ms=20)
plt.xlim((Malibu_coords[0]-0.1,Malibu_coords[0]+0.1))
plt.ylim((Malibu_coords[1]-0.1,Malibu_coords[1]+0.1))
plt.xticks(rotation = 45)
plt.xlabel('Degrees Longitude')
plt.ylabel('Degrees Latitude')
plt.title('Triangulated Roads Near Malibu')
plt.show()
```

```
Malibu Coordinates:  [-118.566222, 34.082256]
```



```
LongBeach_coords = location_dict[str(argmin_long_beach)]['mean_coord']
print("Long Beach Coordinates: ", Malibu_coords)
plt.triplot(mean_coords[:,0], mean_coords[:,1], tri_q13.simplices.copy())
plt.plot(mean_coords[:,0], mean_coords[:,1],'r.')
plt.plot(LongBeach_coords[0],LongBeach_coords[1],'k.',ms=20)
plt.xlim((LongBeach_coords[0]-0.02,LongBeach_coords[0]+0.02))
plt.ylim((LongBeach_coords[1]-0.02,LongBeach_coords[1]+0.02))
plt.xticks(rotation = 45)
plt.xlabel('Degrees Longitude')
plt.ylabel('Degrees Latitude')
plt.title('Triangulated Roads Near Long Beach')
plt.show()
```

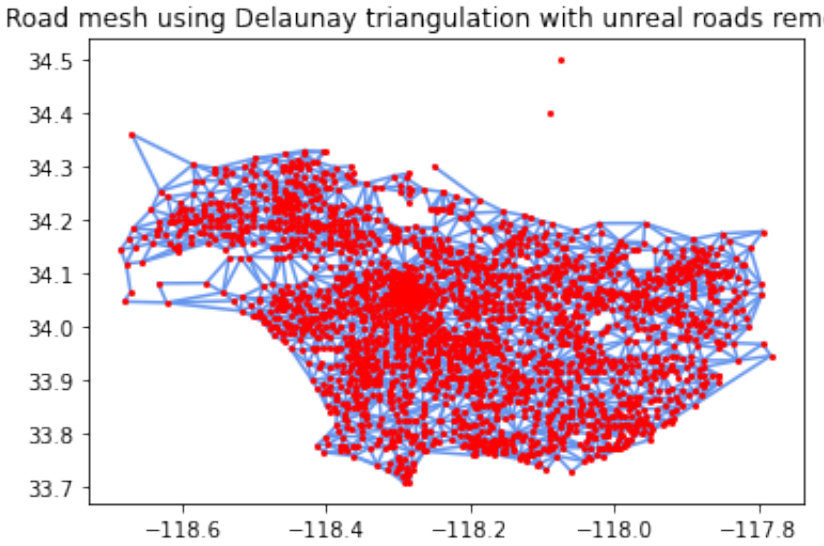
```
Long Beach Coordinates:  [-118.566222, 34.082256]
```



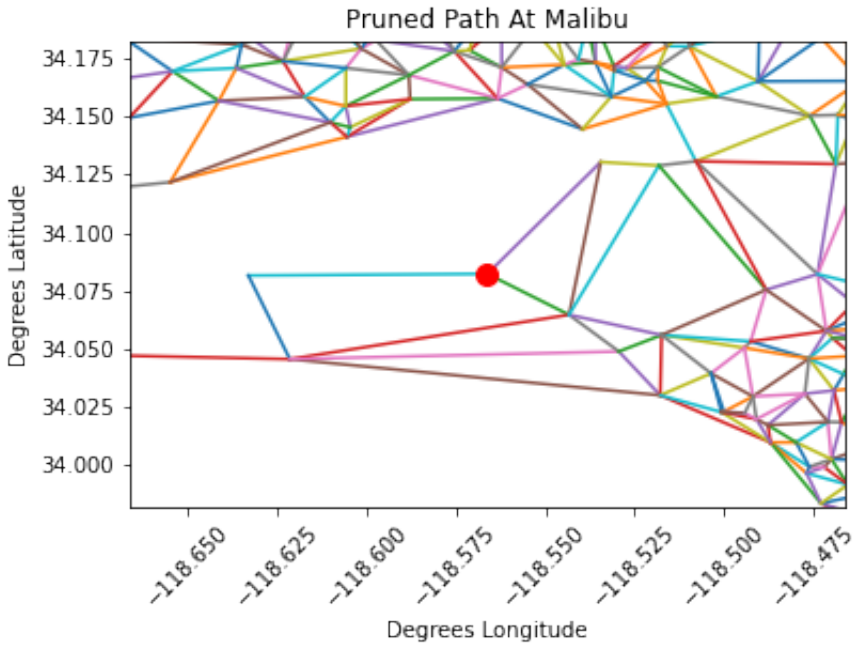
```
def add_triangulated_edge(graph, triangle):
    edge12 = tuple(np.sort(triangle[:2]))
    edge13 = tuple(np.sort(triangle[0::2]))
    edge23 = tuple(np.sort(triangle[1:]))

    flow12 = get_flow(edge12[0],edge12[1],data_q13_graph)
    flow13 = get_flow(edge13[0],edge13[1],data_q13_graph)
    flow23 = get_flow(edge23[0],edge23[1],data_q13_graph)
    if edge12 not in graph.keys() and flow12 > 0:
        graph[edge12] = flow12
    if edge13 not in graph.keys() and flow13 > 0:
        graph[edge13] = flow13
    if edge23 not in graph.keys() and flow23 > 0:
        graph[edge23] = flow23


triangulated_graph = {}
i=0
for triangle_idx in tri_q13.simplices:
    if(i == argmin_malibu):
        triangle = [data_q13_ids[triangle_idx[0]], data_q13_ids[triangle_idx[1]],
        add_triangulated_edge(triangulated_graph,triangle)
    i+=1

# triangulated_graph = {}
# triangle = [data_q13_ids[tri_q13.simplices[argmin_malibu][0]], data_q13_ids[tri_
# add_triangulated_edge(triangulated_graph,triangle)


# Question 14
triangulated_time_graph = {}
threshold = 60*12

def add_travel_time_edge(graph,triangle,thresh):
    edge12 = tuple(np.sort(triangle[:2]))
    edge13 = tuple(np.sort(triangle[0::2]))
    edge23 = tuple(np.sort(triangle[1:]))

    time12, time13, time23 = 0,0,0
    if (edge12[0],edge12[1]) in data_q13_graph.keys():
        time12 = data_q13_graph[(edge12[0],edge12[1])]
    if (edge13[0],edge13[1]) in data_q13_graph.keys():
        time13 = data_q13_graph[(edge13[0],edge13[1])]
    if (edge23[0],edge23[1]) in data_q13_graph.keys():
```

```
        time23 = data_q13_graph[(edge23[0],edge23[1])]
    if edge12 not in graph.keys() and time12 < thresh and time12 > 0:
        graph[edge12] = time12
    if edge13 not in graph.keys() and time13 < thresh and time13 > 0:
        graph[edge13] = time13
    if edge23 not in graph.keys() and time23 < thresh and time23 > 0:
        graph[edge23] = time23

for triangle_idx in tri_q13.simplices:
    triangle = [data_q13_ids[triangle_idx[0]], data_q13_ids[triangle_idx[1]], data
    add_travel_time_edge(triangulated_time_graph, triangle, threshold)


plt.figure()
counter = 0
for edges in triangulated_time_graph.keys():
    coords1 = location_dict[str(edges[0])]['mean_coord']
    coords2 = location_dict[str(edges[1])]['mean_coord']
    plt.plot([coords1[0],coords2[0]],[coords1[1],coords2[1]],color='cornflowerblue
plt.plot(mean_coords[:,0], mean_coords[:,1],'r.', ms = 4)
plt.title('Road mesh using Delaunay triangulation with unreal roads removed')
```

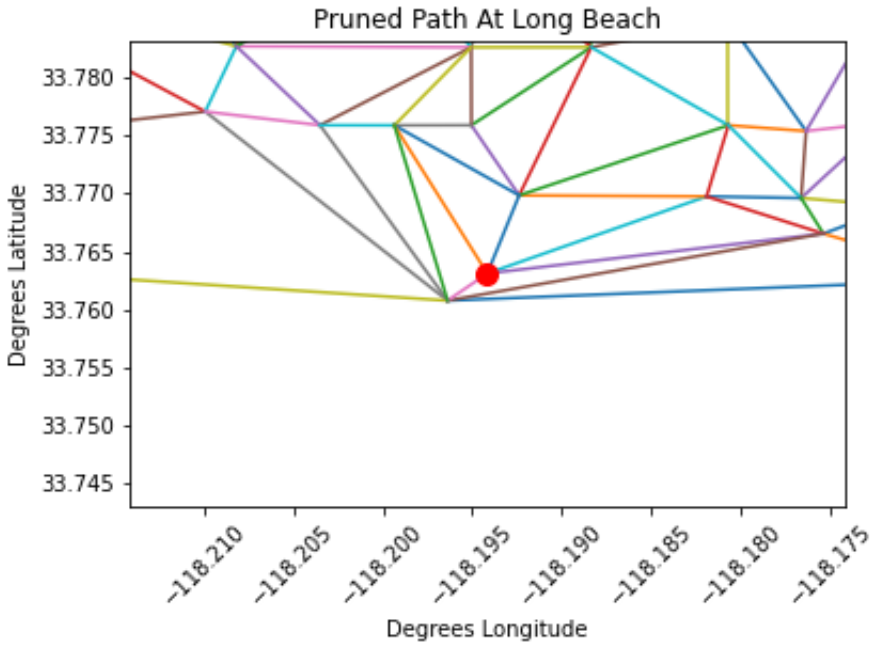
```
Text(0.5, 1.0, 'Road mesh using Delaunay triangulation with unreal roads remo
```



```
# Question 15
Malibu_coords = location_dict[str(argmin_malibu)]['mean_coord']
for edges in triangulated_time_graph.keys():
    coords1 = location_dict[str(edges[0])]['mean_coord']
    coords2 = location_dict[str(edges[1])]['mean_coord']
    plt.plot([coords1[0],coords2[0]],[coords1[1],coords2[1]])
plt.plot(Malibu_coords[0],Malibu_coords[1],'r.',ms=20)
plt.xlim((Malibu_coords[0]-0.1,Malibu_coords[0]+0.1))
plt.ylim((Malibu_coords[1]-0.1,Malibu_coords[1]+0.1))
plt.xlabel('Degrees Longitude')
plt.xticks(rotation = 45)
plt.ylabel('Degrees Latitude')
plt.title('Pruned Path At Malibu')
plt.show()
```



```
LongBeach_coords = location_dict[str(argmin_long_beach)]['mean_coord']
for edges in triangulated_time_graph.keys():
    coords1 = location_dict[str(edges[0])]['mean_coord']
    coords2 = location_dict[str(edges[1])]['mean_coord']
    plt.plot([coords1[0],coords2[0]],[coords1[1],coords2[1]])
plt.plot(LongBeach_coords[0],LongBeach_coords[1],'r.',ms=20)
plt.xlim((LongBeach_coords[0]-0.02,LongBeach_coords[0]+0.02))
plt.ylim((LongBeach_coords[1]-0.02,LongBeach_coords[1]+0.02))
plt.xticks(rotation = 45)
plt.xlabel('Degrees Longitude')
plt.ylabel('Degrees Latitude')
plt.title('Pruned Path At Long Beach')
plt.show()
```



Define your own Task

Day of week data

```
travel_time_path = "/content/drive/MyDrive/UCLA/large scale social and complex net
geo_path = "/content/drive/MyDrive/UCLA/large scale social and complex networks/pr

# i added a shortcut of shared project to my drive and uploaded the data into the
#travel_time_path = "/content/drive/My Drive/ECE 232E Project/Project 4/los_angele
#geo_path = "/content/drive/My Drive/ECE 232E Project/Project 4/los_angeles_census

# travel_time_path = "/content/los_angeles-censustracts-2019-4-All-MonthlyAggregat
# geo_path = "/content/los_angeles_censustracts.json"


time_data = pd.read_csv(travel_time_path)
#time_data = time_data[time_data['month']==12].reset_index(drop=True)
print(time_data)
geo_data = pd.read_json(geo_path)
geo_data = pd.json_normalize(geo_data['features'])
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
<ipython-input-1-d310f5318bfb> in <module>()
     10
     11
---> 12 time_data = pd.read_csv(travel_time_path)
     13 #time_data = time_data[time_data['month']==12].reset_index(drop=True)
     14 print(time_data)

NameError: name 'pd' is not defined
```

SEARCH STACK OVERFLOW

```
time_data_weekday = time_data[(time_data['dow']>=1) & (time_data['dow']<=5)]
time_data_weekend = time_data[time_data['dow']>5]


# print(geo_data)
#print(dict((geo_data.head(2)['features'])))
def calculate_row_mean(geo_type, geo_coor):
    data = np.array(geo_coor)
    post_data = []
    #print(geo_type)
    #print(data.shape)
    if geo_type == "MultiPolygon":
        if data.shape[0]!=1 and len(data.shape)<=2: #handle Multipolygon case
```

```
            for ii in i:
                post_data.append(np.array(ii).mean(axis=0))
            post_data = np.array(post_data)
            cent_coor = post_data.mean(axis=0)
        elif data.shape[0]!=1 and len(data.shape)==4: #handle multippolygon but we
            for i in data:
                post_data.append(i[0].mean(axis=0))
            post_data = np.array(post_data)
            cent_coor = post_data.mean(axis=0)
            #print(cent_coor)
        else:
            print(data)
    else:
        if data.shape[0]!=1 and len(data.shape)!=2: # handle polygon case but weir
            for i in data:
                post_data.append(np.array(i).mean(axis=0))
            post_data = np.array(post_data)
            cent_coor = post_data.mean(axis=0)
            #print(cent_coor)
        elif data.shape[0]==1 and len(data.shape)==3:
            data = data.squeeze()
            cent_coor = data.mean(axis=0)
            #print(cent_coor)
            #for i in data[0][0]:
            #    print(len(i))
        else:
            print("hi")
    if cent_coor.shape[0]!=2:
        print(cent_coor.shape)
        print(geo_type)
        print(data.shape)
    return cent_coor
    '''
    if geo_type == "MultiPolygon":
        data = []
        for l in geo_coor:
            print(geo_type)
            print(np.array(l).shape)
    else:
        data = []
        print(geo_coor)
        print(np.array(geo_coor).shape)
        print(np.array(geo_coor))
    '''
```

```
geo_data_rename = geo_data.rename(columns={'type':'type', 'properties.MOVEMENT_ID'
                                           "properties.DISPLAY_NAME":'display_name

geo_data_rename = geo_data_rename.drop(columns=['type', 'tract'])

#geo_data_rename['id'] = np.arange(len(geo_data_rename)) + 1
#for i, row in enumerate(geo_data_rename['geo_coor']):
node_list = []
for geo_type, geo_coor, id, display_name in zip(geo_data_rename['geo_type'], geo_d
    cent_coor = calculate_row_mean(geo_type, geo_coor)
    node_list.append((int(id), {"cent_coor":cent_coor, "display_name": display_nam
```

```
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:4: VisibleDeprec
  after removing the cwd from sys.path.
```

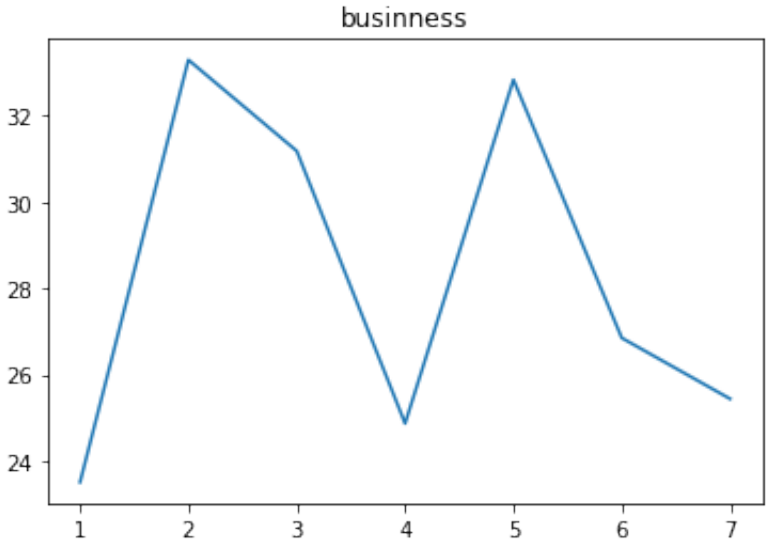
```
#UCLA: 265301: 1535
#senta monica: 701402, id: 1956
#Abbot Kinney Venice id: 1594
#Finantial dist id: 1254

for loc in node_list:
    if loc[1]['display_name']=='Census Tract 265301':
        print("UCLA id: ", loc[0])

    elif loc[1]['display_name']=='Census Tract 273300':
        print("Abbot Kinney Venice id: ", loc[0])

    elif loc[1]['display_name']=='Census Tract 207500':
        print("Finantial district id: ", loc[0])
        print(loc[1]['cent_coor'][::-1])

distant = []
target_coor = [34.05324612573105, -118.25152621317241]
for loc in node_list:
    #print(target_coor - loc[1]['cent_coor'][::-1])
    d = target_coor - loc[1]['cent_coor'][::-1]
    d = np.sum(d**2)
    distant.append(d)


distant = np.array(distant)
print(distant.shape)
idx = np.argsort(distant)[0]
print(np.sort(distant))
print(node_list[idx])
print(node_list[idx][1]['cent_coor'][::-1])
```

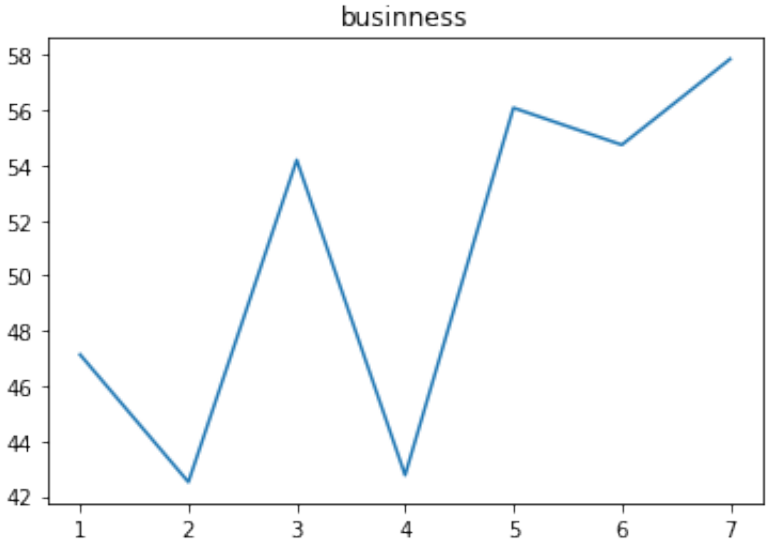
```
UCLA id:  1535
Abbot Kinney Venice id:  1594
(2716,)
[8.69811015e-06 9.03364919e-06 4.31867151e-05 ... 1.93386260e-01
 1.98694087e-01 2.01226212e-01]
(1232, {'cent_coor': array([-118.25434041,   34.05412841]), 'display_name': '
[  34.05412841 -118.25434041]
```

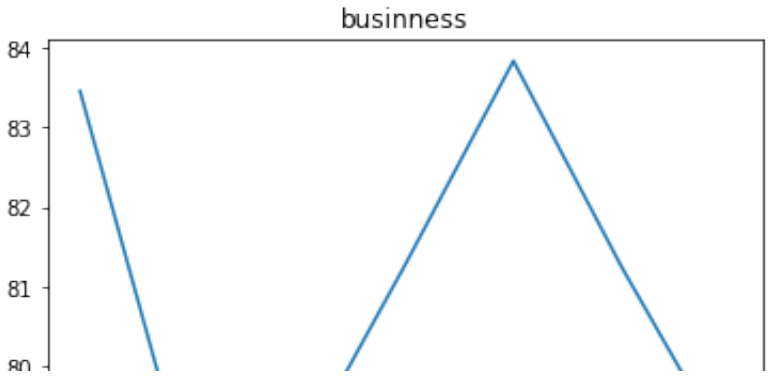
```
#time_data[(time_data['dow']>=1) & (time_data['dow']<=5)]
def search_mean_travel_time(time_data, id, day):
    day_data = time_data[time_data['dow']==day]
```

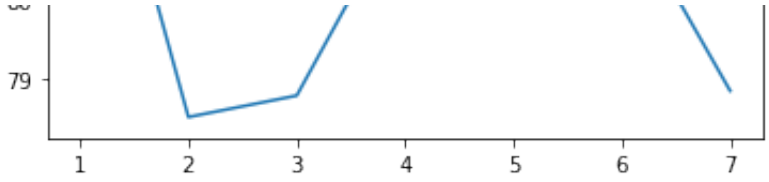
```
    day_id_data = day_data[(day_data['sourceid']==id) | (day_data['dstid']==id)]
    if len(day_id_data)==0:
        return 0
    return np.min(day_id_data['geometric_mean_travel_time'])
    #return len(day_id_data)

time_bus_dist = []
for day in range(7):
    t = search_mean_travel_time(time_data, 1254, day+1)
    time_bus_dist.append(t)
plt.plot(np.arange(7)+1, time_bus_dist)
plt.title("businness")
plt.show()

time_bus_dist = []
for day in range(7):
    t = search_mean_travel_time(time_data, 1535, day+1)
    time_bus_dist.append(t)
plt.plot(np.arange(7)+1, time_bus_dist)
plt.title("businness")
plt.show()

time_bus_dist = []
for day in range(7):
    t = search_mean_travel_time(time_data, 1232, day+1)
    time_bus_dist.append(t)
plt.plot(np.arange(7)+1, time_bus_dist)
plt.title("businness")
plt.show()

time_ent_dist = []
for day in range(7):
    t = search_mean_travel_time(time_data, 1956, day+1)
    time_ent_dist.append(t)
plt.title("entertainment")
plt.plot(np.arange(7)+1, time_ent_dist)
plt.show()

time_ent_dist = []
for day in range(7):
    t = search_mean_travel_time(time_data, 1594, day+1)
    time_ent_dist.append(t)
plt.title("entertainment")
plt.plot(np.arange(7)+1, time_ent_dist)
plt.show()
```

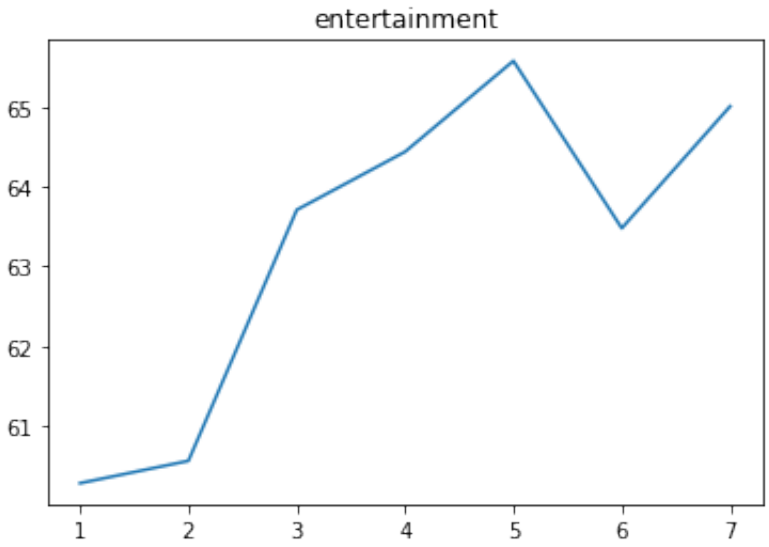
```
time_ent_dist = []
for day in range(7):
    t = search_mean_travel_time(time_data, 2164, day+1)
    time_ent_dist.append(t)
plt.title("entertainment")
plt.plot(np.arange(7)+1, time_ent_dist)
plt.show()
```

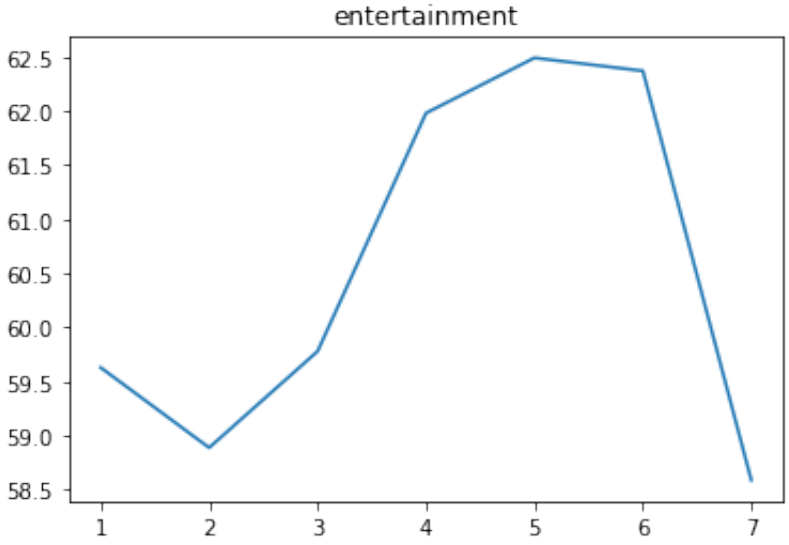


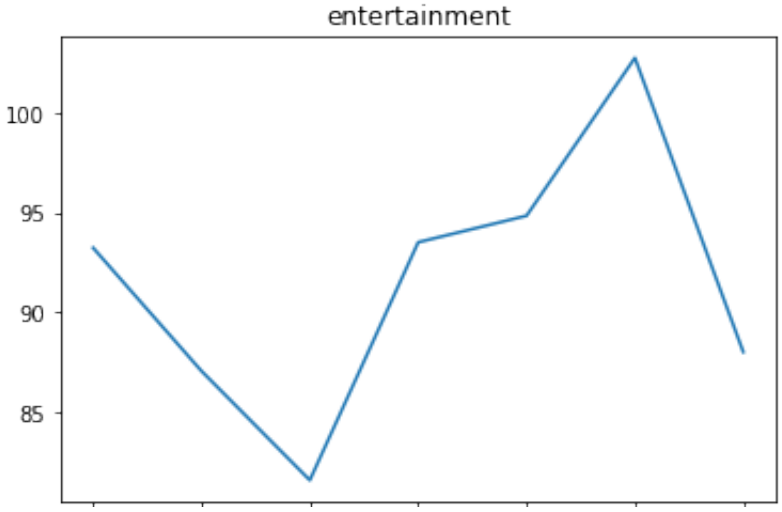


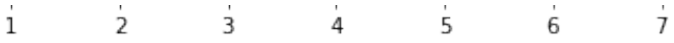



79
1
2
3
4
5
6
7


entertainment
65
64
63
62
61
1
2
3
4
5
6
7


entertainment
62.5
62.0
61.5
61.0
60.5
60.0
59.5
59.0
58.5
1
2
3
4
5
6
7


entertainment
100
95
90
85




```
id = 2164
print(time_data[(time_data['sourceid']==id) | (time_data['dstid']==id)])
```

```
             sourceid  ...  geometric_standard_deviation_travel_time
3415             2129  ...                                     1.21
4434             1789  ...                                     1.21
9773             1484  ...                                     1.34
28640            2123  ...                                     1.17
32840             578  ...                                     1.33
...               ...  ...                                      ...
10430426         2015  ...                                     1.13
10434682          772  ...                                     1.27
10435587          814  ...                                     1.32
10438735          941  ...                                     1.31
10440023         1249  ...                                     1.15

[3391 rows x 7 columns]
```

```
for idx in tqdm(np.random.randint(1, len(node_list), size=25)):
    id = node_list[idx][0]
    dist = []
    if_break = 0
    for day in range(7):
        t = search_mean_travel_time(time_data, id, day+1)
        if t==0:
            if_break = 1
            break
        dist.append(t)
    if if_break !=1:
        dist = np.array(dist)
        dist = dist - np.min(dist)
        dist = dist / np.max(dist)

        plt.plot(np.arange(7)+1, dist)
plt.show()
```

This section based on hours of day in weekday and weekend data.

```
travel_time_weekday_path = "/content/drive/MyDrive/UCLA/large scale social and com
travel_time_weekend_path = "/content/drive/MyDrive/UCLA/large scale social and com
geo_path = "/content/drive/MyDrive/UCLA/large scale social and complex networks/pr
```

```
time_weekday_data = pd.read_csv(travel_time_weekday_path)
time_weekend_data = pd.read_csv(travel_time_weekend_path)
#time_data = time_data[time_data['month']==12].reset_index(drop=True)
print(time_weekend_data)
geo_data = pd.read_json(geo_path)
geo_data = pd.json_normalize(geo_data['features'])
print(time_weekend_data.columns)
```

```
             sourceid  ...  geometric_standard_deviation_travel_time
    0             633  ...                                     1.30
    1            1117  ...                                     1.39
    2            1417  ...                                     1.53
    3             606  ...                                     1.30
    4            1963  ...                                     1.31
    ...           ...  ...                                      ...
    20515922     1302  ...                                     1.19
    20515923     1220  ...                                     1.41
    20515924     1310  ...                                     1.22
    20515925     1962  ...                                     1.22
    20515926     1566  ...                                     1.31

    [20515927 rows x 7 columns]
    Index(['sourceid', 'dstid', 'hod', 'mean_travel_time',
           'standard_deviation_travel_time', 'geometric_mean_travel_time',
           'geometric_standard_deviation_travel_time'],
          dtype='object')
```

```
id_set = set.intersection(set(time_weekday_data['sourceid']), set(time_weekday_dat
                                    set(time_weekend_data['sourceid']), set(ti
```

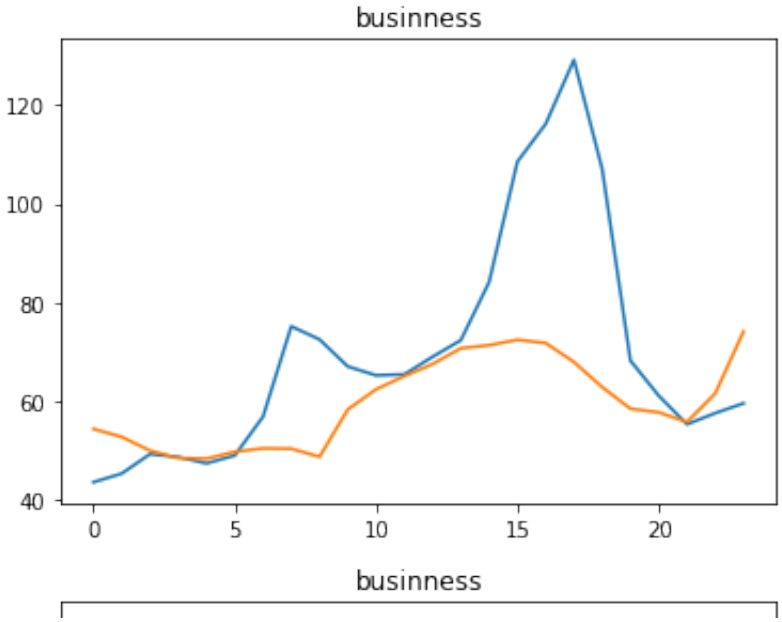
```
print(len(id_set))
```

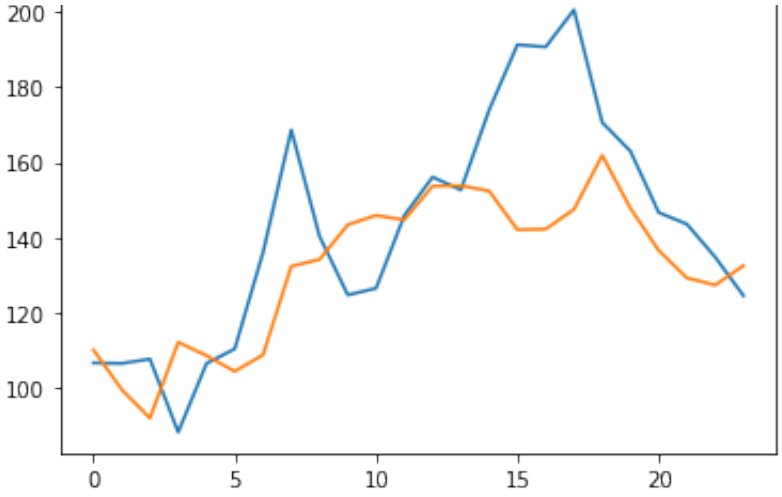
```
    2637
```

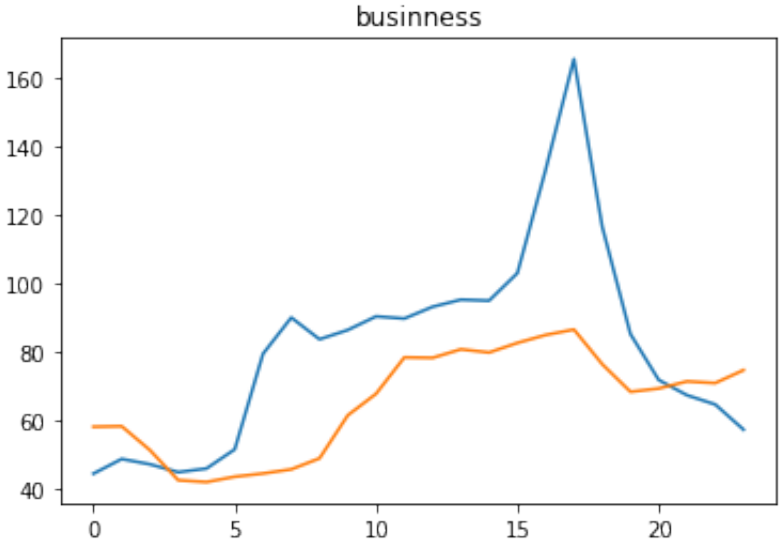
```
node_list_map = np.zeros((len(node_list), len(node_list)))

for i in range(len(node_list)):
    for j in range(i+1, len(node_list)):
        coor1 = node_list[i][1]['cent_coor']
        coor2 = node_list[j][1]['cent_coor']
        d = np.sum((coor1 - coor2)**2)
        node_list_map[i, j] = d
        node_list_map[j, i] = d

node_list_map = np.sqrt(node_list_map)


def norm_func(row):
    i = int(row['sourceid'])
    j = int(row['dstid'])
    return node_list_map[i-1, j-1]

def search_mean_travel_time(time_data, id, hour):
    day_data = time_data[time_data['hod']==hour]
    day_id_data = day_data[(day_data['sourceid']==id) | (day_data['dstid']==id)]
    #dist = day_id_data.apply(lambda row: norm_func(row), axis=1)
    #idx = np.argmin(dist)
    #print(idx)
    if len(day_id_data)==0:
        return 0
    #ret = day_id_data['mean_travel_time'].iloc[idx]/dist.iloc[idx]
    #return ret
    return np.min(day_id_data['mean_travel_time'])
    #return len(day_id_data)



time_bus_weekday_dist = []
for day in range(24):
    t = search_mean_travel_time(time_weekday_data, 1254, day)
    time_bus_weekday_dist.append(t)
time_bus_weekend_dist = []
for day in range(24):
    t = search_mean_travel_time(time_weekend_data, 1254, day)
    time_bus_weekend_dist.append(t)

plt.plot(np.arange(24), time_bus_weekday_dist)
plt.plot(np.arange(24), time_bus_weekend_dist)
plt.title("businness")
```

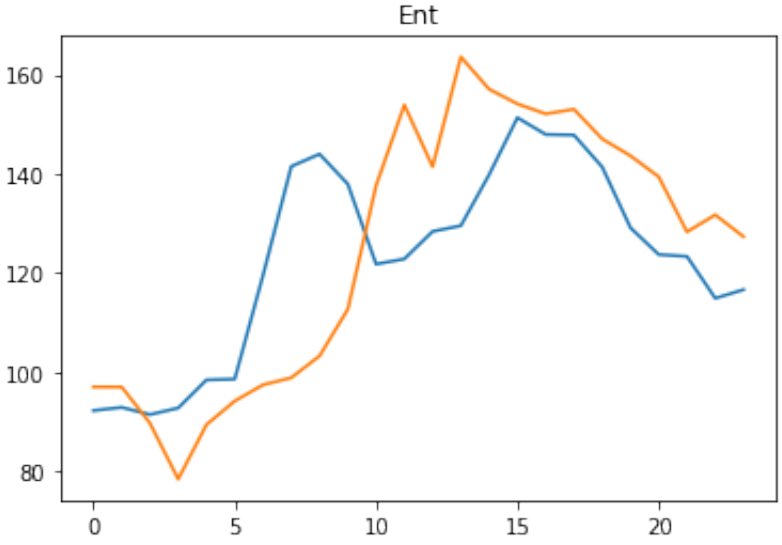
```
plt.show()


time_bus_weekday_dist = []
for day in range(24):
    t = search_mean_travel_time(time_weekday_data, 1535, day)
    time_bus_weekday_dist.append(t)
time_bus_weekend_dist = []
for day in range(24):
    t = search_mean_travel_time(time_weekend_data, 1535, day)
    time_bus_weekend_dist.append(t)

plt.plot(np.arange(24), time_bus_weekday_dist)
plt.plot(np.arange(24), time_bus_weekend_dist)
plt.title("businness")
plt.show()



time_bus_weekday_dist = []
for day in range(24):
    t = search_mean_travel_time(time_weekday_data, 1232, day)
    time_bus_weekday_dist.append(t)
time_bus_weekend_dist = []
for day in range(24):
    t = search_mean_travel_time(time_weekend_data, 1232, day)
    time_bus_weekend_dist.append(t)

plt.plot(np.arange(24), time_bus_weekday_dist)
plt.plot(np.arange(24), time_bus_weekend_dist)
plt.title("businness")
plt.show()

time_bus_weekday_dist = []
for day in range(24):
    t = search_mean_travel_time(time_weekday_data, 1956, day)
    time_bus_weekday_dist.append(t)
time_bus_weekend_dist = []
for day in range(24):
    t = search_mean_travel_time(time_weekend_data, 1956, day)
    time_bus_weekend_dist.append(t)

plt.plot(np.arange(24), time_bus_weekday_dist)
plt.plot(np.arange(24), time_bus_weekend_dist)
plt.title("Ent")
```

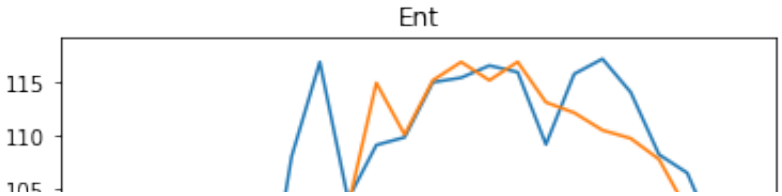
```
plt.show()

time_bus_weekday_dist = []
for day in range(24):
    t = search_mean_travel_time(time_weekday_data, 1594, day)
    time_bus_weekday_dist.append(t)
time_bus_weekend_dist = []
for day in range(24):
    t = search_mean_travel_time(time_weekend_data, 1594, day)
    time_bus_weekend_dist.append(t)

plt.plot(np.arange(24), time_bus_weekday_dist)
plt.plot(np.arange(24), time_bus_weekend_dist)
plt.title("Ent")
plt.show()

time_bus_weekday_dist = []
for day in range(24):
    t = search_mean_travel_time(time_weekday_data, 2164, day)
    time_bus_weekday_dist.append(t)
time_bus_weekend_dist = []
for day in range(24):
    t = search_mean_travel_time(time_weekend_data, 2164, day)
    time_bus_weekend_dist.append(t)

plt.plot(np.arange(24), time_bus_weekday_dist)
plt.plot(np.arange(24), time_bus_weekend_dist)
plt.title("Ent")
plt.show()
```

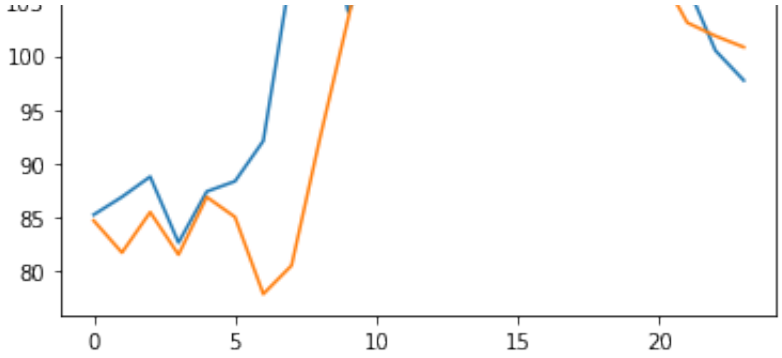


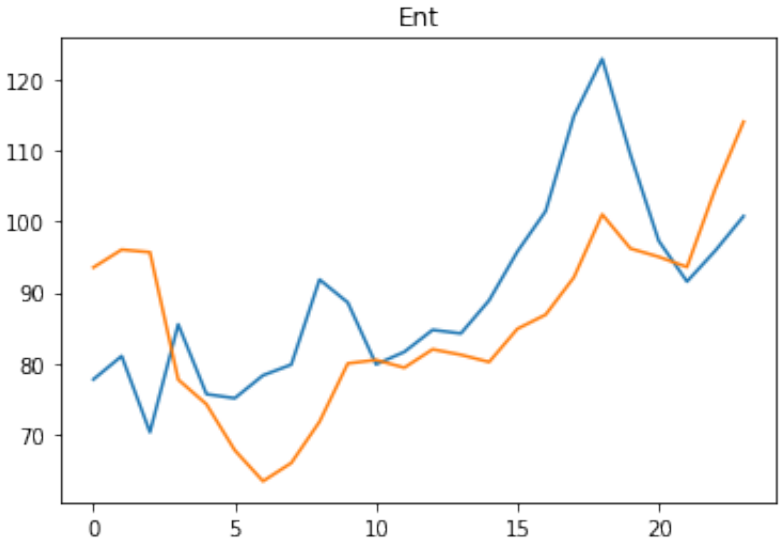

200
180
160
140
120
100
0
5
10
15
20


businness
160
140
120
100
80
60
40
0
5
10
15
20


Ent
160
140
120
100
80
0
5
10
15
20


Ent
115
110


100
95
90
85
80
0
5
10
15
20


Ent
120
110
100
90
80
70
0
5
10
15
20

```
import pickle
ftr = {}
from tqdm.notebook import tqdm
for idx, id in enumerate(tqdm(list(id_set)[2301:])):
    vec = []
    try:
        for hour in range(24): #handle weekday
            t = search_mean_travel_time(time_weekday_data, id, hour)
            vec.append(t)
        for hour in range(24): #handle weekend
            t = search_mean_travel_time(time_weekend_data, id, hour)
            vec.append(t)
    except:
        pass
    ftr[id] = np.array(vec)
    if idx%50 == 0:
        with open('/content/drive/MyDrive/UCLA/large scale social and complex netw
            pickle.dump(ftr, f)

with open('/content/drive/MyDrive/UCLA/large scale social and complex networks/pro
    pickle.dump(ftr, f)


import pickle
with open('/content/drive/MyDrive/UCLA/large scale social and complex networks/pro
    ftr = pickle.load(f)
print(len(ftr))
```

```
2301
```

```
print(data.shape)
```

```
(2301, 48)
```

```
data = []
ids = []
for key in ftr:
    ids.append(key)
    data.append(ftr[key])
```

```
data = np.array(data)
```

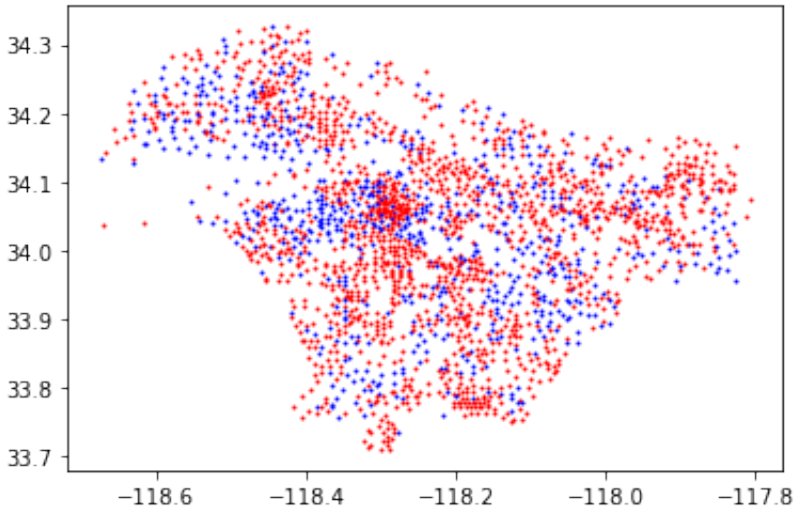
```
data_norm = []
for row in data:
    v = np.array(row[:24]) - np.array(row[24:])
    #v = v - np.min(v)
    #v = v/np.max(v)
    data_norm.append(v)
data_norm = np.array(data_norm)
```

```
from sklearn.cluster import KMeans
kmeans = KMeans(n_clusters=2, random_state=0).fit(data_norm)
print(kmeans.labels_)
```

```
[1 1 1 ... 1 1 1]
```

```
id_bus = [2108, 1697, 1535, 1232, 1197, 1615, 1572, 428, 142, 1320, 1841, 1234, 64
id_ent = [1596, 433, 1089, 1095, 1687, 1916, 1720, 1965, 2164, 2403, 1228, 1229, 1
```

```
bus_label = []
ent_label = []
colors=['b','r']
for i in range(len(ids)):
    id = ids[i]
    coor = node_list[id][1]['cent_coor']
    label = kmeans.labels_[i]
    if id in id_bus:
        bus_label.append(label)
    if id in id_ent:
        ent_label.append(label)
    plt.scatter(coor[0], coor[1], s=1, c=colors[label])
plt.show()
```

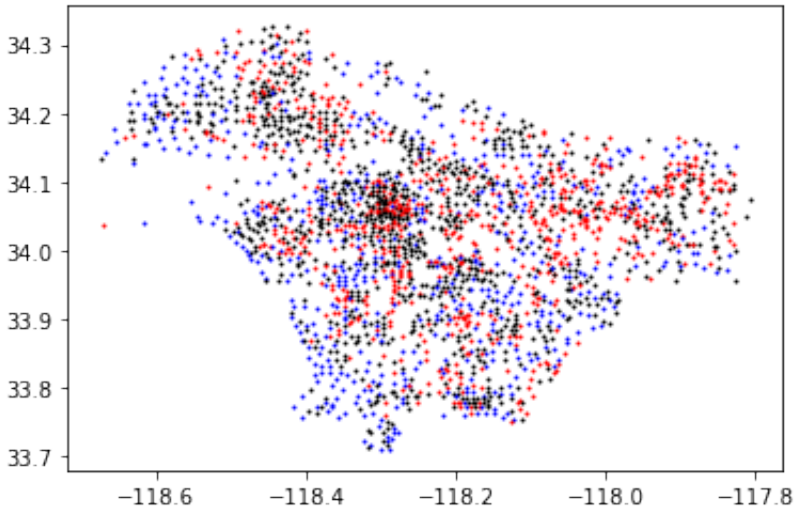


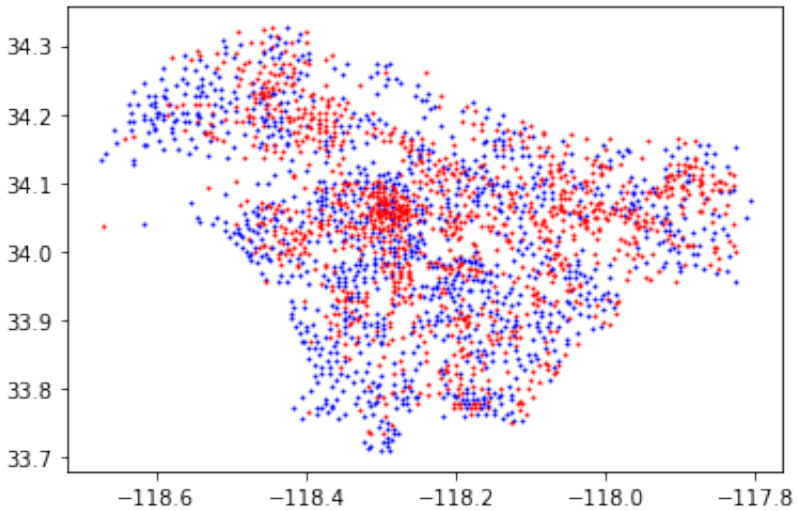

```
print(bus_label)
print(ent_label)
print(np.sum(kmeans.labels_))
print(len(kmeans.labels_))
print("number of business label: ", np.sum(kmeans.labels_))
print("number of ent label:", len(kmeans.labels_)-np.sum(kmeans.labels_))
```

```
[0, 1, 0, 0, 0, 1, 0, 0, 0, 1, 0, 1, 1]
[1, 1, 1, 0, 0, 1, 1, 1, 1, 1, 1, 1]
1590
2301
number of business label:  1590
number of ent label: 711
```

```
data_norm = []
```

```
for row in data[:, :]:
    #v = row - np.min(row)
    #v = v/np.max(v)
    data_norm.append(v)
data_norm = np.array(data_norm)

from sklearn.cluster import KMeans
kmeans = KMeans(n_clusters=3, random_state=0).fit(data_norm)

colors=['b','r', 'k']
for i in range(len(ids)):
    id = ids[i]
    coor = node_list[id][1]['cent_coor']
    label = kmeans.labels_[i]

    plt.scatter(coor[0], coor[1], s=1, c=colors[label])
plt.show()

kmeans = KMeans(n_clusters=2, random_state=0).fit(data_norm)

colors=['b','r', 'k']
for i in range(len(ids)):
    id = ids[i]
    coor = node_list[id][1]['cent_coor']
    label = kmeans.labels_[i]

    plt.scatter(coor[0], coor[1], s=1, c=colors[label])
plt.show()
```


34.3
34.2
34.1
34.0
33.9
33.8
33.7
−118.6
−118.4
−118.2
−118.0
−117.8


34.3
34.2
34.1
34.0
33.9
33.8
33.7
−118.6
−118.4
−118.2
−118.0
−117.8