Report

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1 Algorithmic Methods of Data Mining

1.1 Homework 4

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```
In [1]: import itertools
        import json
        import matplotlib.pyplot as plt
        import networkx as nx
        import numpy as np
        import pandas as pd
        import pprint
```

1.2 Exercise 1

```
In [2]: import Modules as hw4
```

```
In [3]: G=hw4.create_graph('full_dblp.json')
```

```
In [4]: print('Our Graph have this info: ', nx.info(G))
```

```
Our Graph have this info:  Name: Data Scientist Network
Type: Graph
Number of nodes: 904664
Number of edges: 3679473
Average degree:   8.1345
```

1.3 Exercise 2

1.3.1 a)

```
In [5]: conf=int(input('Insert a conference id '))
        subgraph=hw4.inducted_subgraph(G,conf)
```

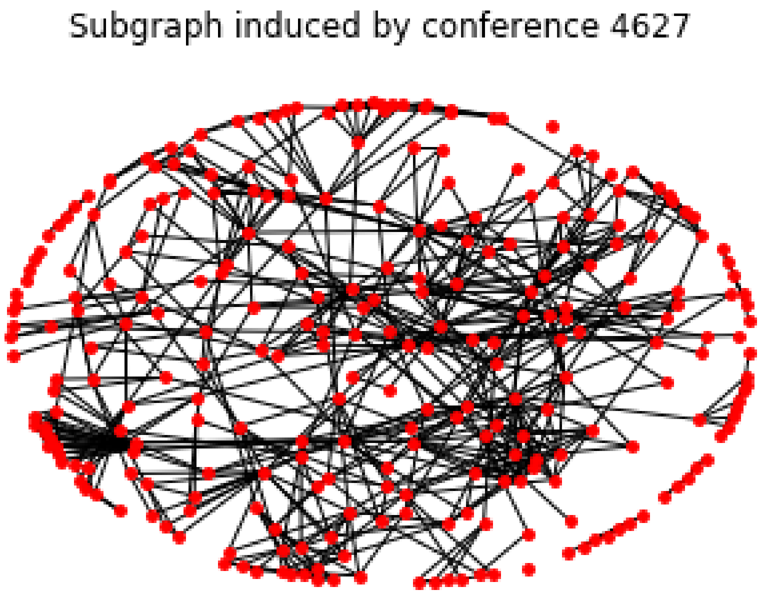
```
Insert a conference id 4627
```

The new subgraph have this info

```
In [6]: print(nx.info(subgraph))
```

```
Name: Data Scientist Network
Type: Graph
Number of nodes: 275
Number of edges: 742
Average degree:   5.3964
```

```
In [7]: nx.draw_networkx(subgraph, with_labels = False, node_size=15)
        limits = plt.axis('off')
        plt.title('Subgraph induced by conference %s'%conf)
        plt.show()
```



After having calculated the centrality measurements (degree, closeness, betweeness) for all the nodes, we show a table with the top 20.

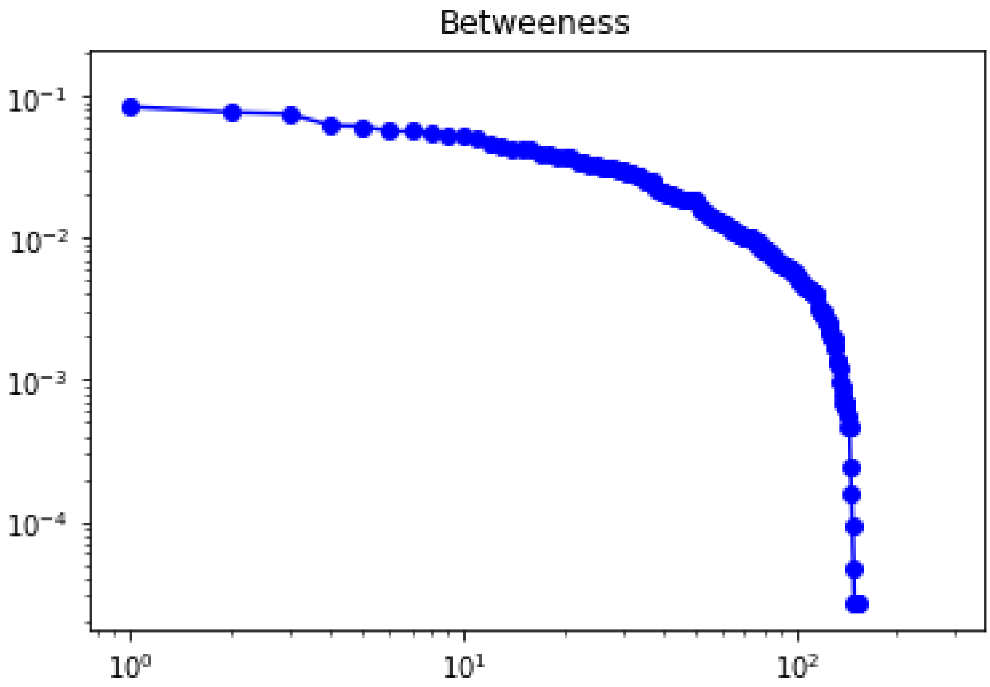
```
In [8]: centr=hw4.centralities(subgraph)
```

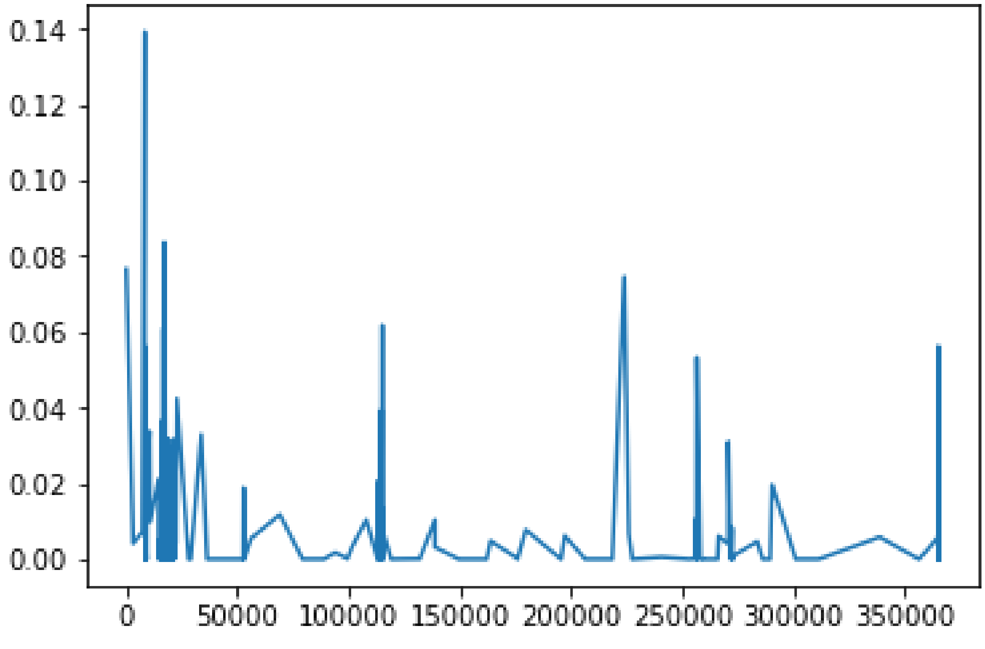
```
In [9]: nodes={'degree':list(centr['degree'].values()),
               'closeness':list(centr['closeness'].values()),
               'betweeness':list(centr['betweeness'].values())}

        summary_data = pd.DataFrame(nodes, index=list(centr['closeness'].keys()))
        summary_data.head(20)
```

```
Out[9]:         betweeness  closeness  degree
        206361    0.000000   0.000000       0
        240513    0.000561   0.191594       4
        20752     0.004182   0.212904       6
        3330      0.004182   0.212904       6
        364796    0.005864   0.183597       5
        158503    0.000000   0.167800       3
        21484     0.020522   0.188622       6
        15952     0.015604   0.185408       6
        21688     0.000000   0.106727       2
        114923    0.000000   0.106727       2
        114661    0.012620   0.121534       3
        8861      0.038918   0.277863      12
        8862      0.042887   0.267093      13
        8860      0.000000   0.222051       3
        8864      0.006480   0.251803      12
        364806    0.001408   0.237894       8
        94086     0.001747   0.232804       7
        364807    0.010497   0.251803      10
        8557      0.139403   0.298743      23
        266235    0.006029   0.253968      12
```

```
In [10]: db=sorted(centr['betweeness'].values(), reverse=True)
         plt.loglog(db, 'b-', marker='o')
         plt.title('Betweeness')
         plt.show()
         lists = sorted(centr['betweeness'].items())
         x, y = zip(*lists)
         plt.plot(x, y)
         plt.show()
```



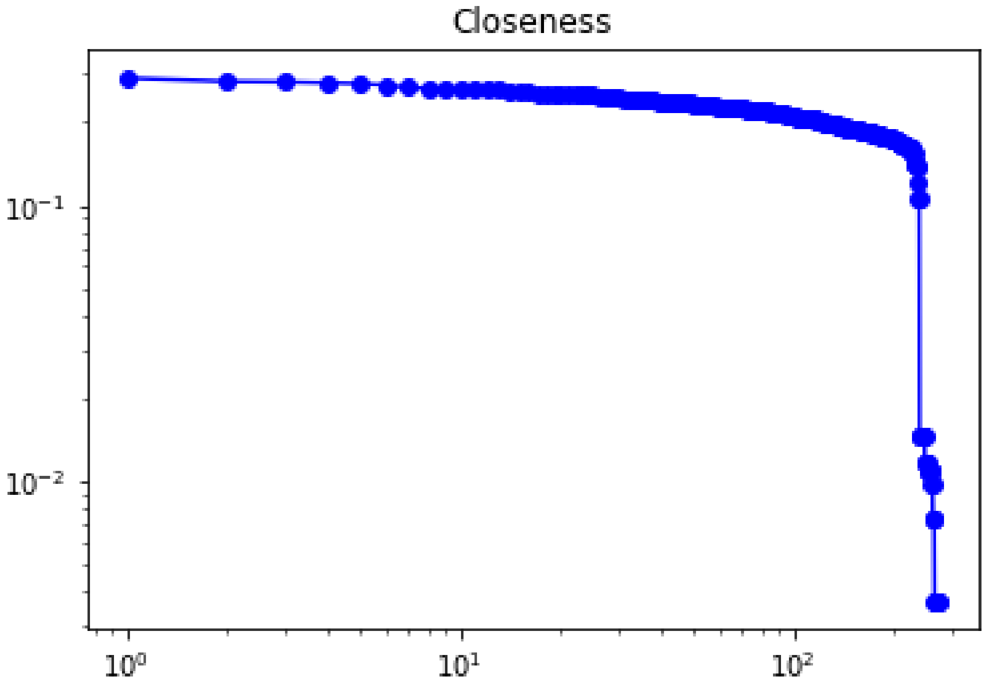


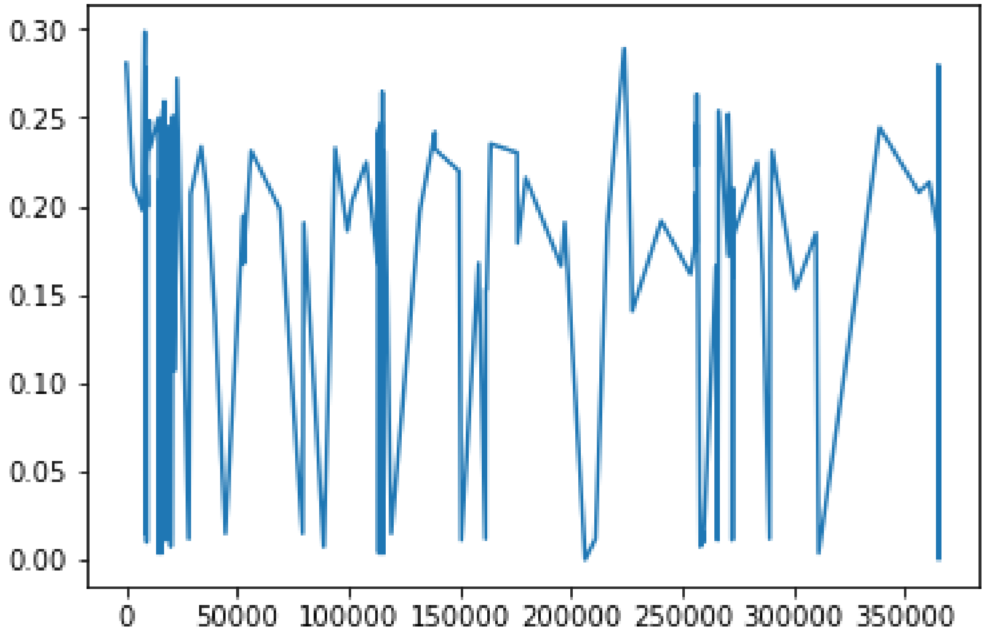
The Betweenness Centrality is an analytic that determines the influence of a vertex in a graph by measuring the ratio of shortest paths passing through it to the total number of shortest paths between all pairs of vertices. Intuitively, this ratio determines how well a vertex connects pairs of vertices in the network.

The fastest known algorithm for computing betweenness centrality has O(mn) time complexity for graphs with n vertices and m edges.

In our graph, we can see that the nodes are more represented by the first 35.000 values.

```
In [11]: dc=sorted(centr['closeness'].values(), reverse=True)
         plt.loglog(dc, 'b-', marker='o')
         plt.title('Closeness')
         plt.show()
         lists = sorted(centr['closeness'].items())
         x, y = zip(*lists)
         plt.plot(x, y)
         plt.show()
```



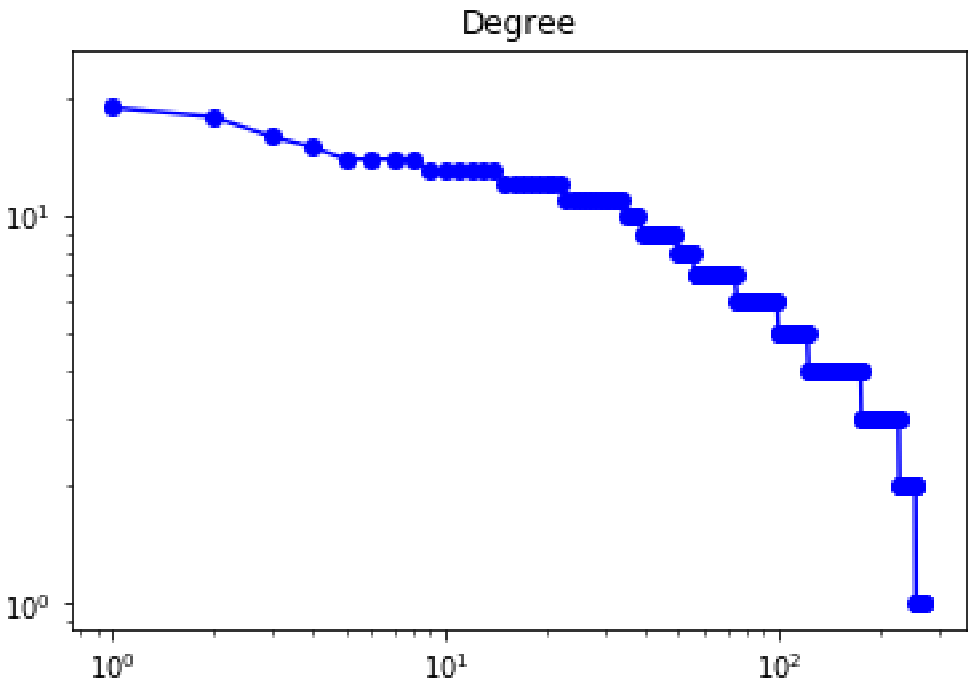


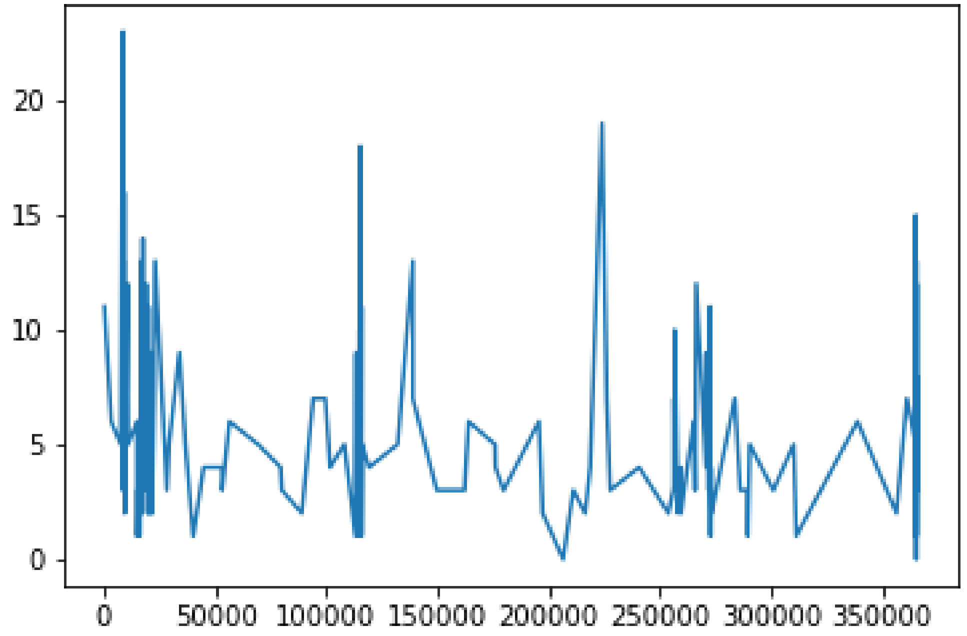
Closeness centrality measures the mean distance from a vertex to other vertices: the more central a node is, the closer it is to all other nodes. We have to remark that the bigger the value the LESS central the node is (because they are farther away from everyone).

When a node has a low closeness score (i.e., is highly central), it tends to receive anything flowing through the network very quickly. This is because the speed with which something spreads in a network is a function of the number of links in the paths traversed. Since nodes with low closeness scores are close to all nodes, they receive things quickly.

Although being numerically more grouped in the first terms we notice a constantly fluctuating trend.

```
In [12]: dg=sorted(centr['degree'].values(), reverse=True)
         plt.loglog(dg, 'b-', marker='o')
         plt.title('Degree')
         plt.show()
         lists = sorted(centr['degree'].items())
         x, y = zip(*lists)
         plt.plot(x, y)
         plt.show()
```





The degree centrality of a node refers to the number of edges attached to the node, it can also be interpreted in terms of the immediate risk of a node for catching whatever is flowing through the network.

Also in this case although being numerically more grouped in the first terms we notice a constantly fluctuating trend; furthermore, in the loglog plot we see a trend like a power law distribution.

1.3.2 b)

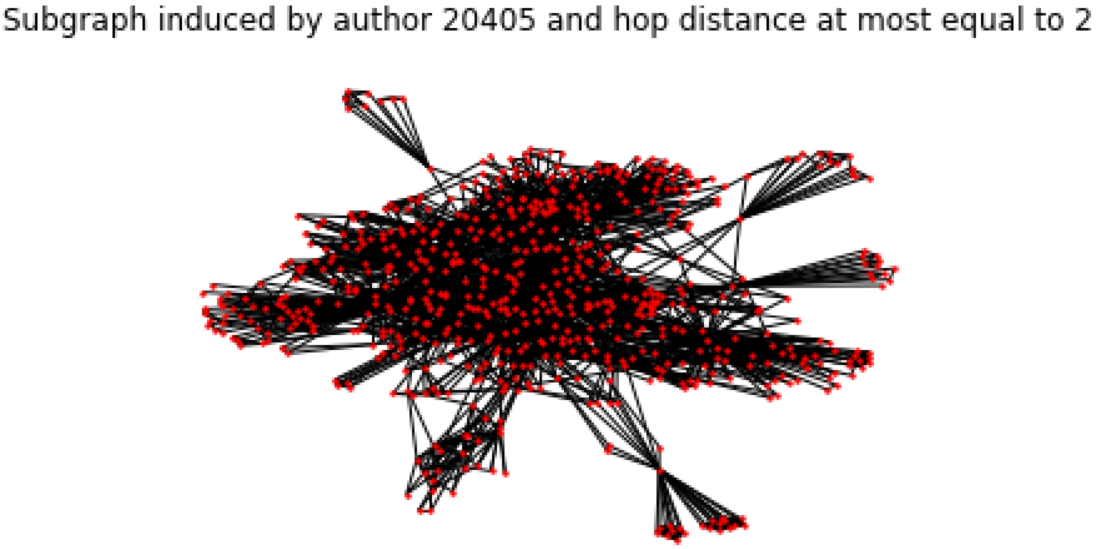
```
In [13]: aut=int(input('Insert an author id '))
         hop=int(input('Insert an integer d '))
         ego=hw4.subgraph_inducted_by_author(G,aut,hop)
```

```
Insert an author id 20405
Insert an integer d 2
```

```
In [14]: print(nx.info(ego))
```

```
Name: Data Scientist Network
Type: Graph
Number of nodes: 644
Number of edges: 2846
Average degree:   8.8385
```

```
In [16]: nx.draw_networkx(ego, with_labels = False, node_size=2)
         limits = plt.axis('off')
         plt.title('Subgraph induced by author %s and hop distance at most equal to %s' %(aut,h
         plt.show()
```



Subgraph induced by author 20405 and hop distance at most equal to 2

1.4 Exercise 3

1.4.1 a)

Since Aris is our mentor, let's calculate the 'Aris Number' to describe the "collaborative distance" between Aris (id 256176) and other authors, let's start with Stefano Leonardi (id 365188).

```
In [17]: original_id = int(input("Please tell me the id of the author you want to connect with
         print("Computing the distance between Aris and ", hw4.tell_me_the_name(original_id),
         destination_id = hw4.tell_me_the_id("aris anagnostopoulos")
         sol = hw4.my_dijkstra(G,256176,original_id)
         if type(sol) == float:
             print("The shortest path has weight ", sol)
         else:
             print("They are not connected, so sorry.")
```

```
Please tell me the id of the author you want to connect with Aris: 365188
Computing the distance between Aris and  stefano leonardi  ...
The shortest path has weight  0.7777777777777778
```

Computing also for Adriano Fazzone (id 272067) we obtain:

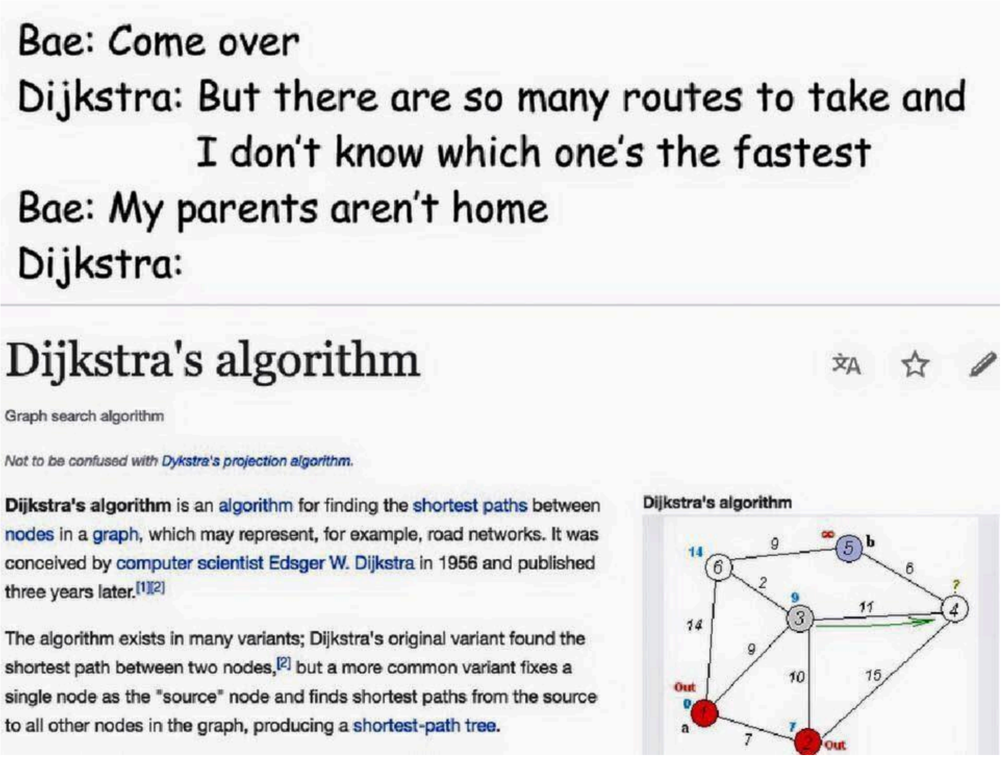
```
In [18]: original_id = int(input("Please tell me the id of the author you want to connect with
         print("Computing the distance between Aris and ", hw4.tell_me_the_name(original_id),
         destination_id = hw4.tell_me_the_id("aris anagnostopoulos")
         sol = hw4.my_dijkstra(G,256176,original_id)
         if type(sol) == float:
             print("The shortest path has weight ", sol)
         else:
             print("They are not connected, so sorry.")
```

```
Please tell me the id of the author you want to connect with Aris: 272067
Computing the distance between Aris and  adriano fazzone  ...
The shortest path has weight  0.9473684210526316
```

And for Mario Frank (id 9451):

```
In [19]: original_id = int(input("Please tell me the id of the author you want to connect with
         print("Computing the distance between Aris and ", hw4.tell_me_the_name(original_id),
         destination_id = hw4.tell_me_the_id("aris anagnostopoulos")
         sol = hw4.my_dijkstra(G,256176,original_id)
         if type(sol) == float:
             print("The shortest path has weight ", sol)
         else:
             print("They are not connected, so sorry.")
```

```
Please tell me the id of the author you want to connect with Aris: 9451
Computing the distance between Aris and  mario frank  ...
They are not connected, so sorry.
```



Bae: Come over

Dijkstra: But there are so many routes to take and I don't know which one's the fastest

Bae: My parents aren't home

Dijkstra:

Dijkstra's algorithm

Graph search algorithm

Not to be confused with Dykstra's projection algorithm.

Dijkstra's algorithm is an algorithm for finding the shortest paths between nodes in a graph, which may represent, for example, road networks. It was conceived by computer scientist Edsger W. Dijkstra in 1956 and published three years later.[1][2]

The algorithm exists in many variants; Dijkstra's original variant found the shortest path between two nodes,[2] but a more common variant fixes a single node as the "source" node and finds shortest paths from the source to all other nodes in the graph, producing a shortest-path tree.

Dijkstra's algorithm

title

We note therefore that both Stefano Leonardi and Adriano Fazzone are closely related with Aris (in particular Adriano Fazzone) while there is no connection with Mario Frank.

1.4.2 b)

Here we ask the user to give us the number of authors he or she wants to define as the set and their names.

```
In [21]: n= int(input("Please tell me the number of authors you are going to give me: "))
         l = []
         for i in range(n):
             l.append(int(input("Tell me an identifier: ")))

         group_number = hw4.my_dijkstra_group(G,l)
         print("The group number for all the nodes is: ")
         pp = pprint.PrettyPrinter(indent=4)
         ele={k: v for k, v in group_number.items() if v != None}
         first25 = {k: ele[k] for k in list(ele)[:25]}
         pp.pprint(first25)
```

```
Please tell me the number of authors you are going to give me: 2
Tell me an identifier: 365188
Tell me an identifier: 272067
Computing the distance between  stefano leonardi  and all the other authors...
Computing the distance between  adriano fazzone  and all the other authors...
The group number for all the nodes is:
{   248: 365188,
    287: 365188,
    1304: 365188,
    2730: 365188,
    2979: 365188,
    2980: 365188,
    2981: 365188,
    3079: 365188,
    3981: 365188,
    4017: 365188,
    4689: 365188,
    5364: 365188,
    5587: 365188,
    5619: 365188,
    5620: 365188,
    5661: 365188,
    5799: 365188,
    6958: 365188,
    7132: 365188,
    7179: 365188,
    7180: 365188,
    7181: 365188,
    7182: 365188,
    7224: 365188,
    7424: 365188}
```

```
In [ ]:
```