Network Analytics

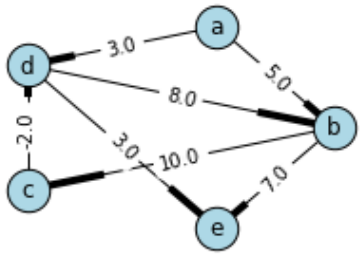
Homework 1 - Group Part

Group 1

November 22, 2016

Exercise 1

In this exercise we will use the directed graph specified in the `HW1_problem1.txt` file. The directed graph is shown in the following figure.



(a) First print the node-arc incidence matrix, where each row represents a node and each column represents an edge. If an edge goes from node i to node j then $\alpha_{ik} = -1$ and $\alpha_{jk} = 1$. The rest of the elements are equal to zero. The resulting matrix is as follows:

Table 1: Adjacency matrix of directed graph

	0	1	2	3	4	5	6
a	0	0	-1	-1	0	0	0
b	-1	-1	1	0	1	0	0
c	0	1	0	0	0	0	-1
d	0	0	0	1	-1	-1	1
e	1	0	0	0	0	1	0

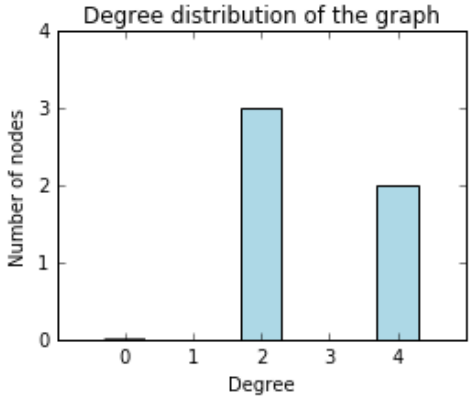
(b) Next, we will calculate and print the shortest-path matrix which presents the shortest paths amongst all the nodes. In case there is no possible path from node i to node j, then $\alpha_{ij} = \infty$. The matrix is the following:

Table 2: Shortest paths matrix of directed graph

	a	b	c	d	e
a	0	5	15	3	6
b	∞	0	10	8	7
c	∞	6	0	-2	1
d	∞	8	18	0	3
e	∞	∞	∞	∞	0

(c) The diameter d of the graph, which is the maximal of the shortest path, is the maximum non-infinite element in the second table, and is in this case 18.

(d) The degree distribution of the graphs represents the number of edges each node is connected to and is shown in the following bar chart.



(e) Finally, we will check whether the graph is connected. As it is a directed graph it can be either *strongly connected*, which is the case when there is a path from each node to every other node in the graph, or *weakly connected*, which is the case when the equivalent undirected graph is connected. Our graph is weakly connected but not strongly connected.

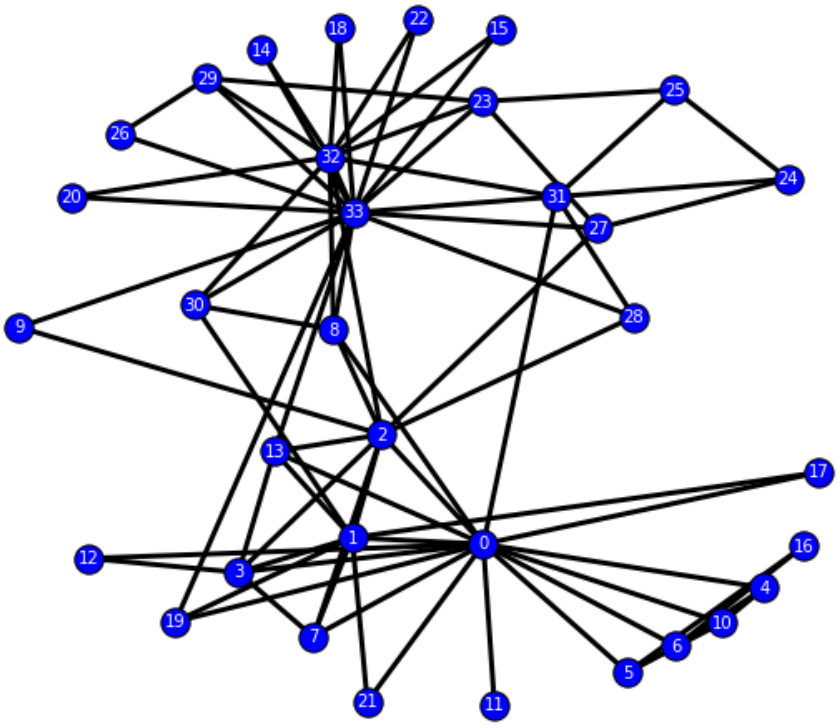
Exercise 2

In this exercise we will use the undirected graph specified in the `HW1_problem2.txt` file.

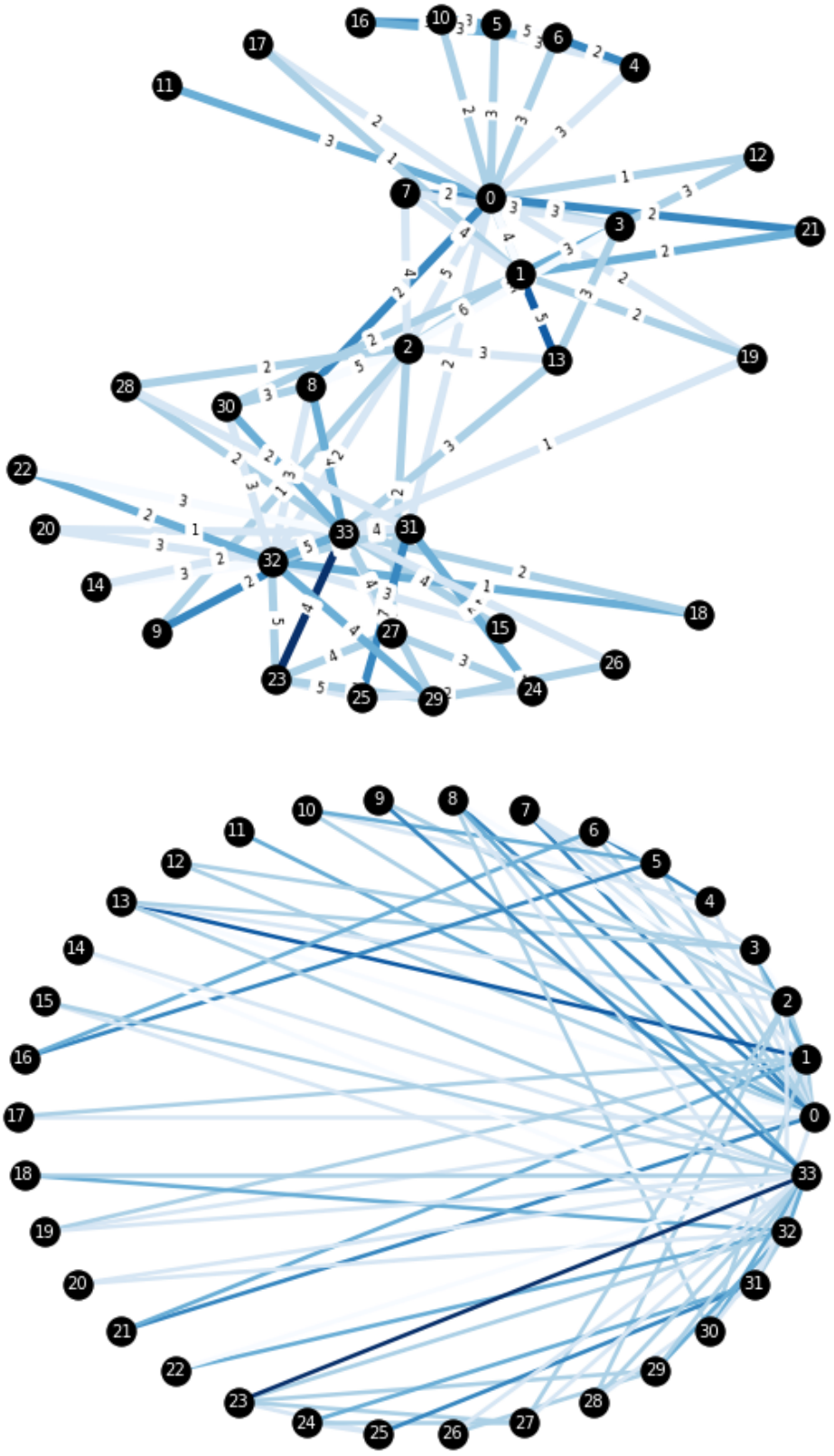
The file containts information about an undirected graph of 34 nodes and is consisted of a matrix of 68 rows and 34 columns. The first 34 rows represent the adjacency matrix of the undirected graph and the rest of the rows contain the weights associated with each edge.

Before drawing the graph, we create and apply the function `graphAdjMatrix()` to the two matrices that represent the adjacency matrix and the corresponding weights to check if the adjacency matrix contains more edges than the weighted adjacency matrix (i.e. edges with 0 weight). In case it does, the function adds 0-weight edges to the final graph for the edges that are actually represented in the adjacency matrix but cannot be recognised in the weight-related matrix due to the value of their weight which is equal to zero. In our case though, we do not have such instances.

We first draw the undirected network without the weights. The resulting graph is as follows:



Then we add the weights to the graph which are represented by both labels and the color of the edges. We present the graph in two different formats.



The last circular format of the graph which includes weights gives a more clear image of the structure of the graph, as we can easily see which nodes are the ones with more edges and which ones are not. At the same time, we can easily compare the weights of different edges that belong to the same nodes.

Notes

The code used in the assignment is included in the `Group1_HW1.py` file.