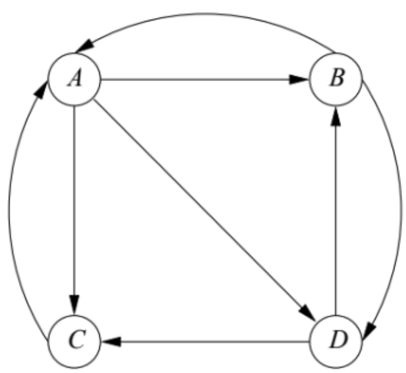
Graph Mining CSF426
Lab session 2
Time: 2pm-4 pm
Date: Sept 02, 2021

Instructions: All questions need to be answered. **You are required to submit programs in jupyter notebook on canvas only**. For theoretical questions, you can type answers in the jupyter notebook itself. There is no need to create a separate text file. You are free to choose any library package (unless you are explicitly asked to implement a module) in python for the implementation of the programs. Class notes support is allowed during lab sessions. **[Total Marks =30]**



Q1.

a) Create the adjacency and transition matrices for web graph G (shown in figure) and display them such that each column expresses the outgoing edges from one node to others. **[3 marks]**

b) Implement power method (on your own) to compute pagerank v of all the webpages assuming initial uniform probability distribution for all nodes. Print the number of iterations at which steady state is reached and the final pagerank vector **[3 + 1+ 2 = 6 marks]**

Q2. Remove edge from C to A in the given graph and recompute ***a)*** and ***b)*** on the resultant graph. What are the changes observed and why? Give comments **[3+2=5 marks]**

Q3. Remove edge from C to A and add edge from C to C in the web graph shown in figure and recompute a) and b) on the resultant graph. What are the challenges encountered and their effect on pagerank? Give comments **[3+2=5 marks]**

Q4. To address the problem in resultant graph from Q3, apply teleportation with rate $\beta = 0.1$ and computes pagerank fares on the graph. Print vector in all the iterations. Explain how teleportation helps to address the challenges of graphs in Q2 and Q3. **[5 marks]**

Q5. For unnormalized graph laplacian, demonstrate the proof of the following theorem with the help of a program implementation.

Theorem: The geometric multiplicity of the 0 eigenvalue of the Laplacian L corresponds to the number of connected components in the graph.

Hint: Construct two graphs of your choice ***a)*** with 1-connected component ***b)*** with 2 or 3 connected components. Calculate the eigenvalues and eigenvectors in both cases and prove the theorem. **[3 +3 = 6 marks]**