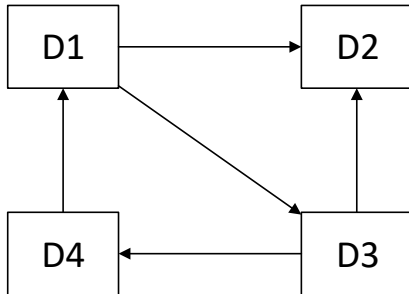# LAB 6: Exercises

1.   **HITS:** Given is the network shown in the image below. Find hubs and authorities vectors for this network. Complete the matrix L and L^T for this network and calculate matrix LL^T. Use online eigenvector calculator to find vectors h and a.

$$L = \begin{bmatrix} 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 \\ 1 & 0 & 0 & 0 \end{bmatrix}$$

$$L^T = \begin{bmatrix} 0 & 0 & 0 & 1 \\ 1 & 0 & 1 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix}$$

$$LL^T = \begin{bmatrix} 2 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 \\ 1 & 0 & 2 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$
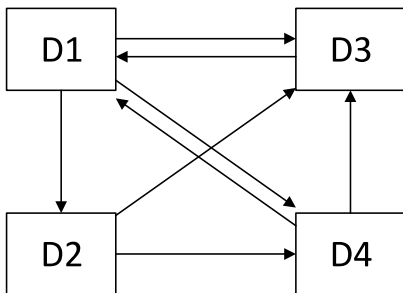
$$L^TL = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 2 & 1 & 1 \\ 0 & 1 & 1 & 0 \\ 0 & 1 & 0 & 1 \end{bmatrix}$$

h = [1, 0 , 1 , 0], a = [0 , 2 , 1 , 1]
h_{norm} = [1 , 0 , 1 , 0], a_{norm} = [0 , 1 , 1/2 , 1/2]

The best hub is page: …1 or 3……., the best authority is page: …2……….

2.   **PageRank:** Given is the network shown in the picture below. Find stochastic matrix M, write and solve the equation system for finding PageRank values for this network (use basic PageRank model – without a damping factor).
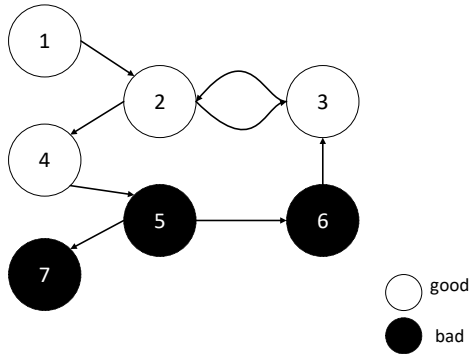

$$M = \begin{bmatrix} 0 & 0 & 1 & 0 \\ 1/3 & 0 & 0 & 1 \\ 1/3 & 1/2 & 0 & 0 \\ 1/3 & 1/2 & 0 & 0 \end{bmatrix}$$

Equation system:

v1 = v3
v2 = 1/3*v1 + v4
v3 = 1/3*v1 + 1/2*v2
v4=1/3*v1 + 1/2 *v2

3.   **TrustRank:** Find initial TrustRank vector d (seed = {2, 4, 5} and write equations for finding TrustRank for pages 2, 3, and 5, q = 0.15.

$M =$

$$d = [\ldots, \ldots, \ldots, \ldots, \ldots, \ldots, \ldots]$$
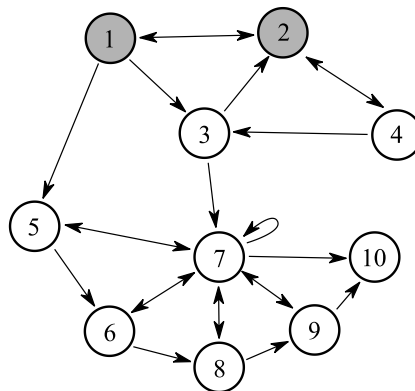
$\text{TR}(2) =$

$\text{TR}(3) =$

$\text{TR}(5) =$

4.   **Programming Assignment (deadline +1 week)**

Given is the following web structure:

Download the pr_tr.py python script from the lab directory. The above structure is kept in L matrix (matrix of indices). Complete the TODOs:

   TODO 1.   Compute stochastic matrix M (function getM).
   TODO 2.   Compute pagerank vector and return the results (sorted pairs -> [page id : **pagerank**]). Which pages have the greatest pagerank? Why?
   TODO 3.   Which pages do you think belong to the link farm? Compute trustrank vector. Pages 1 and 2 are marked as "good". Analyze the results. What has changed?
   TODO 4.   Repeat TODO3 but remove connections 1->5 and 3->7. Analyze the computed trustrank vector.