CSCI 6370 IR and Web Search
ASSIGNMENT 4
Due is 06/29/2020 23:59

Ulvi Bajarani
Student ID 20539914
E-mail: ulvi.bajarani01@utrgv.edu

Answers of the Assignment 4

Answer 1. The HITS Algorithm answers.

Note: For an easy calculation, the matrix view is provided.

Initial authority a_0 for P_1, P_2, P_3, P_4 is $\begin{bmatrix}1\\1\\1\\1\end{bmatrix}$

Initial hubs h_0 for P_1, P_2, P_3, P_4 is $\begin{bmatrix}1\\1\\1\\1\end{bmatrix}$

Using the scheme provided in the assignment, we can create an Adjacent Matrix (A):

Adjacency Matrix (A)

	P_1	P_2	P_3	P_4
P_1	0	0	1	1
P_2	1	0	1	0
P_3	0	0	0	1
P_4	0	1	0	0

Using the Adjacent Matrix (A) provided above, we can create an Transpose Matrix (A^T):

Matrix Transposition (A^T)

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

For the a_k, we should calculate $a_k = (A^T \times A) \times a_{k-1}$. For the h_k, we should calculate $h_k = (A \times A^T) \times h_{k-1}$. This is done at the each k step. The matrix of $A^T \times A$ and $A \times A^T$ are provided below:

Matrix Multiplication ($A^T \times A$)

$$\begin{bmatrix} 1 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 \\ 1 & 0 & 2 & 1 \\ 0 & 0 & 1 & 2 \end{bmatrix}$$

Matrix Multiplication ($A \times A^T$)

$$\begin{bmatrix} 2 & 1 & 1 & 0 \\ 1 & 2 & 0 & 0 \\ 1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

The steps of the calculation:

	Authorities (k=1)	Hubs (k=1)	Authorities (k=1, normalized)	Hubs (k=1, normalized)
P_1	2	4	0.365148371670111	0.730296743340221
P_2	1	3	0.182574185835055	0.547722557505166
P_3	4	2	0.730296743340221	0.365148371670111
P_4	3	1	0.547722557505166	0.182574185835055

	Authorities (k=2)	Hubs (k=2)	Authorities (k=2, normalized)	Hubs (k=2, normalized)
P_1	1.09544511501033	2.37346441585572	0.342997170285017	0.743160535617539
P_2	0.182574185835055	1.82574185835055	0.057166195047503	0.571661950475029
P_3	2.37346441585572	1.09544511501033	0.743160535617539	0.342997170285017
P_4	1.82574185835055	0.182574185835055	0.571661950475029	0.057166195047503

	Authorities (k=3)	Hubs (k=3)	Authorities (k=3, normalized)	Hubs (k=3, normalized)
P_1	1.08615770590256	2.40098019199512	0.335091269106517	0.740728068551244
P_2	0.057166195047503	1.8864844365676	0.017636382584554	0.582000625290265
P_3	2.40098019199512	1.08615770590256	0.740728068551244	0.335091269106517
P_4	1.8864844365676	0.057166195047503	0.582000625290265	0.017636382584554

	Authorities (k=4)	Hubs (k=4)	Authorities (k=4, normalized)	Hubs (k=4, normalized)
P_1	1.07581933765776	2.39854803149927	0.331394514948728	0.738846787426673
P_2	0.017636382584554	1.90472931913177	0.005432696966373	0.58673127236824
P_3	2.39854803149927	1.07581933765776	0.738846787426673	0.331394514948728
P_4	1.90472931913177	0.017636382584554	0.58673127236824	0.005432696966373

	Authorities (k=5)	Hubs (k=5)	Authorities (k=5, normalized)	Hubs (k=5, normalized)
P_1	1.0702413023754	2.39581936217031	0.329619989073432	0.737880280108545
P_2	0.005432696966373	1.91230933216315	0.001673197914078	0.588965665755573
P_3	2.39581936217031	1.0702413023754	0.737880280108545	0.329619989073432
P_4	1.91230933216315	0.005432696966373	0.588965665755573	0.001673197914078

Answer 2. The PageRank Algorithm answers. The initial values are:

	E (Initial)	R (Initial)	Out links
P_1	0.0375	0.25	2
P_2	0.0375	0.25	2
P_3	0.0375	0.25	1
P_4	0.0375	0.25	1

The calculation steps:

	$R^{'}\ (i=1)$	$c(i=1)$	$R^{'}=R^{'}c\ (i=1)$
P_1	0.5375	0.714285714285714	0.383928571428571
P_2	0.4125	0.714285714285714	0.294642857142857
P_3	0.2875	0.714285714285714	0.205357142857143
P_4	0.1625	0.714285714285714	0.116071428571429

	$R^{'}\ (i=2)$	$c(i=2)$	$R^{'}=R^{'}c\ (i=2)$
P_1	0.358928571428572	0.883280757097791	0.317034700315457
P_2	0.434821428571429	0.883280757097791	0.384069400630915
P_3	0.153571428571429	0.883280757097791	0.135646687697161
P_4	0.184821428571429	0.883280757097791	0.163249211356467

	$R^{'}\ (i=3)$	$c(i=3)$	$R^{'}=R^{'}c\ (i=3)$
P_1	0.336395899053628	0.910461693114095	0.306275579809004
P_2	0.331664037854889	0.910461693114095	0.30196740145042
P_3	0.200749211356467	0.910461693114095	0.182774466862928
P_4	0.229534700315458	0.910461693114095	0.208982551877648

	$R^{'}\ (i=4)$	$c(i=4)$	$R^{'}=R^{'}c\ (i=4)$
P_1	0.429257018740576	0.807992318648453	0.34683637386832
P_2	0.37341225676743	0.807992318648453	0.301714235157268
P_3	0.246482551877648	0.807992318648453	0.199156008598008
P_4	0.18848370072521	0.807992318648453	0.152293382376404

	$R^{'}\ (i=5)$	$c(i=5)$	$R^{'}=R^{'}c\ (i=5)$
P_1	0.388949390974412	0.849492026286296	0.330409406261674
P_2	0.410074195532168	0.849492026286296	0.348354759290345
P_3	0.189793382376404	0.849492026286296	0.161227964970661
P_4	0.188357117578634	0.849492026286296	0.16000786947732