Link Analysis (Cont.)

Social Networks - June 2020

MCQ Assignment - Week 8

1. Observe the graph shown in Figure 1, where A, B, P1, P2 and P3 are the points contained by the respective nodes. According to the principle of repeated improvement, which of the following is correct?:

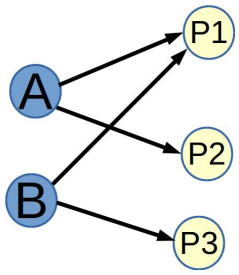

Figure 1: The Graph

   A. $A = P1 \times P2, B = P1 \times P3, P1 = A + B, P2 = A, P3 = B$
   B. $A = P1 + P2, B = P1 + P3, P1 = A + B, P2 = A, P3 = B$
   C. $A = P1 + P2, B = P1 + P3, P1 = A \times B, P2 = A, P3 = B$
   D. $A = P1 + P2, B = P1 + P3, P1 = A \times B, P2 = 0, P3 = 0$

   B. Using the concept of hubs and authorities, A receives points from $P1$ and $P2$; B gets points from $P1$ and $P3$; $P1$ gets pointed by both A and B; hence gets points from both; $P2$ is pointed only by A; $P3$ gets pointed only by B. All the points one node gets added up.

2. Let C be the unit circle with (0,0) as its origin in the XY - plane. Then A, the point at which the vector (6,8) intersects C, is

   A. (0,0)
   B. (6, 8)
   C. (0.6, 0.8)
   D. (0.006, 0.008)

   ANSWER: C

3. For what values of pageranks of the nodes in Figure 2 does the process converge, i.e. pageranks of the nodes do not change after this configuration?

   A. Node 1: 1/5, Node 2: 1/5, Node 3: 1/5, Node 4 = 1/5, Node 5 : 1/5
   B. Node 1 : 1/5, Node 2 : 1/5, Node 3 : 2/5, Node 4 : 1/10, Node 5 = 1/10
   C. Node 1 : 3/10, Node 2 : 1/10, Node 3 : 1/10, Node 4 : 2/10, Node 5 : 3/10
   D. Node 1 : 1/10, Node 2 : 3/10, Node 3 : 2/10, Node 4 : 1/10, Node 5 = 3/10

   ANSWER: C The points after updation for all the four options are shown in Figure 3.

4. In Hubs and Authorities algorithm, the authority update rule is defined as

   A. For each page p, update *auth(p)* to be the sum of the hub scores of all pages that point to it.
   B. For each page p, update *auth(p)* to be the sum of the authority scores of all pages that it points to.

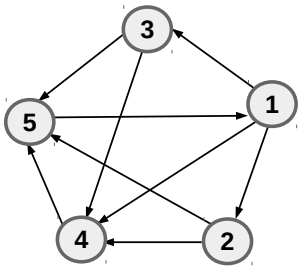

Figure 2: A graph with five nodes

	Node	1	2	3	4	5
Option A	**Before Update**	1/5	1/5	1/5	1/5	1/5
	After update	1/5	0.07	0.07	0.27	0.40
Option B	**Before Update**	0.200	0.200	0.400	0.100	0.100
	After update	0.100	0.067	0.067	0.367	0.400
Option C	**Before Update**	0.300	0.100	0.100	0.200	0.300
	After update	0.300	0.100	0.100	0.200	0.300
Option D	**Before Update**	0.100	0.300	0.200	0.100	0.300
	After update	0.300	0.033	0.033	0.283	0.350

Figure 3: Points after updation

C. For each page p, update *auth(p)* to be the sum of the hub scores of all pages that it points to.
D. For each page p, update *auth(p)* to be the sum of the authority scores of all pages that points to it.

A. The idea is to use the quality of the hubs to refine the estimates for the quality of the authorities. Hence, we consider all the hub pages which point to the given authority page and add their scores.

5. In the graph shown in Figure 4, assume that the current pagerank values of A, B and C are 0.2, 0.4 and 0.4 respectively. What will be their pagerank values after one iteration?

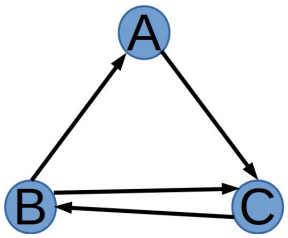

Figure 4: The Graph

A. $A : 0.4, B : 0.4, C : 0.4$

B. $A : 0.2, B : 0.4, C : 0.4$
C. $A : 0.4, B : 0.2, C : 0.4$
D. $A : 0.4, B : 0.4, C : 0.2$

B. A gets half of the points from B, i.e. 0.2. B gets all the points of C, i.e. 0.4 points. C gets all the points of A and half of the points of B, i.e. $0.2 + 0.2 = 0.4$ points. Hence, the correct answer is **B**.

6. Given two linearly independent vectors v_1 and v_2 in the $X - Y$ plane, which of the following is true?

   A. Any other vector can be written as difference of $v1$ and $v2$. i.e. $z = v1 - v2$.
   B. Any other vector can be written as the linear combination of v_1 and v_2. i.e. $z = \alpha\ v1 + \beta\ v2$, where α and β are some real numbers.
   C. Any other vector can be written as sum of $v1$ and $v2$. i.e. $z = v1 + v2$.
   D. Any other vector can be written as multiplication of $v1$ and $v2$. i.e. $z = v1 \times v2$.

   ANSWER: B
   In a 2D plane, any vector can be written as the linear combination of two linearly independent vectors. Hence the answer is **B**

7. What is the score value of hub and authority respectively for node 1 in figure 5 after applying 2-step hub-authority computation (i.e. when k is 2)?

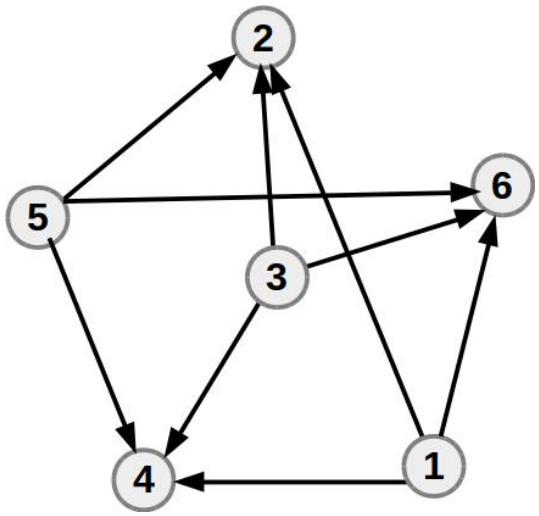

Figure 5: A graph of web pages

A. $a^{(2)} = 81,\ h^{(2)} = 0$
B. $a^{(2)} = 0,\ h^{(2)} = 81$
C. $a^{(2)} = 0,\ h^{(2)} = 27$
D. $a^{(2)} = 27,\ h^{(2)} = 0$

B. Let the authority score of a node i at $k = t$ be represented as $a_i^{(t)}$ and the hub score of a node i at $k = t$ be represented as $h_i^{(t)}$.

1. Initially, when $k = 0$, the hub score for all the nodes is 1. Hence, $h_1^{(0)} = h_2^{(0)} = h_3^{(0)} = h_4^{(0)} = h_5^{(0)} = h_6^{(0)} = 1$

2. In every iteration, every node updates its authority score by adding the hub scores of the nodes pointing at it. Then, every node updates its hub score by adding the authority scores of the nodes it is pointing to.
   Authority scores in the first iteration are calculated as follows

- $a_1^{(1)} = 0$
- $a_2^{(1)} = h_1^{(0)} + h_3^{(0)} + h_5^{(0)} = 1 + 1 + 1 = 3$
- $a_3^{(1)} = 0$
- $a_4^{(1)} = h_1^{(0)} + h_3^{(0)} + h_5^{(0)} = 1 + 1 + 1 = 3$
- $a_5^{(1)} = 0$
- $a_6^{(1)} = h_1^{(0)} + h_3^{(0)} + h_5^{(0)} = 1 + 1 + 1 = 3$

Hub scores in the first iteration are calculated as follows

- $h_1^{(1)} = a_2^{(1)} + h_4^{(1)} + h_6^{(1)} = 3 + 3 + 3 = 9$
- $h_2^{(1)} = 0$
- $h_3^{(1)} = a_2^{(1)} + h_4^{(1)} + h_6^{(1)} = 3 + 3 + 3 = 9$
- $h_4^{(1)} = 0$
- $h_5^{(1)} = a_2^{(1)} + h_4^{(1)} + h_6^{(1)} = 3 + 3 + 3 = 9$
- $h_6^{(1)} = 0$

3. Authority scores in the second iteration are calculated as follows

- $a_1^{(2)} = 0$
- $a_2^{(2)} = h_1^{(1)} + h_3^{(1)} + h_5^{(1)} = 9 + 9 + 9 = 27$
- $a_3^{(2)} = 0$
- $a_4^{(2)} = h_1^{(1)} + h_3^{(1)} + h_5^{(1)} = 9 + 9 + 9 = 27$
- $a_5^{(2)} = 0$
- $a_6^{(2)} = h_1^{(1)} + h_3^{(1)} + h_5^{(1)} = 9 + 9 + 9 = 27$

Hub scores in the first iteration are calculated as follows

- $h_1^{(2)} = a_2^{(2)} + h_4^{(2)} + h_6^{(2)} = 27 + 27 + 27 = 81$
- $h_2^{(2)} = 0$
- $h_3^{(2)} = a_2^{(2)} + h_4^{(2)} + h_6^{(2)} = 27 + 27 + 27 = 81$
- $h_4^{(2)} = 0$
- $h_5^{(2)} = a_2^{(2)} + h_4^{(2)} + h_6^{(2)} = 27 + 27 + 27 = 81$
- $h_6^{(2)} = 0$

8. For what values of pageranks of the nodes in Figure 6 does the process converge, i.e. pageranks of the nodes do not change after this configuration?

A. Node 1 = 3/10, Node 2 = 1/10, Node 3 = 1/10, Node 4 = 1/10, Node 5 = 3/10, Node 6 = 1/10
B. Node 1 = 3/20, Node 2 = 3/20, Node 3 = 1/10, Node 4 = 1/5, Node 5 = 1/10, Node 6 = 3/10
C. Node 1 = 1/5, Node 2 = 1/5, Node 3 = 2/5, Node 4 = 1/10, Node 5 = 1/20, Node 6 = 1/20
D. None of these

D. None of the options gives the pagerank values which are converged. Below, we show the values before an d after the update in the order of nodes $1, 2, 3, 4, 5, 6$ respectively.

1. Option - A
   - Before: 0.3, 0.1, 0.1, 0.1, 0.3, 0.1
   - After: 0.073, 0.14, 0.14, 0.29, 0.073, 0.287
2. Option - B
   - Before: 0.15, 0.15, 0.1, 0.2, 0.1, 0.2
   - After: 0.11, 0.11, 0.13, 0.21, 0.13, 0.21

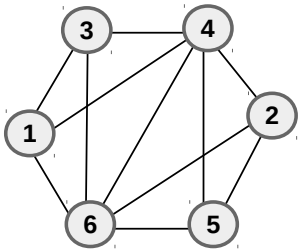

Figure 6: A web graph of 6 nodes

3. Option - C
   - Before: 0.2, 0.2, 0.4, 0.1, 0.05, 0.05
   - After: 0.16, 0.0467, 0.0967, 0.29, 0.0967, 0.303

The values for which the pagerank values for this graph converge are $2.8636, 2.8636, 2.8636, 4.77, 2.8636, 4.77$ for nodes $1, 2, 3, 4, 5 and$ 6 respectively.