2020 Introduction to Massive Data Analysis

Assignment 2

Deadline: 2020/10/28 (WED) 23:59

Question: PageRank

Given a big matrix M. Specifically the column-normalized adjacency matrix where each column represents a webpage (vertex) and where it links to the non-zero entries. Write a program that calculates Google Matrix A:

$$A = \beta\, M + (1 - \beta) \left[\frac{1}{N}\right]_{N \times N}$$

With PageRank equation [Brin-Page, '98]

$$r_j = \sum_{i \to j} \beta \frac{r_i}{d_i} + (1 - \beta) \frac{1}{N}$$

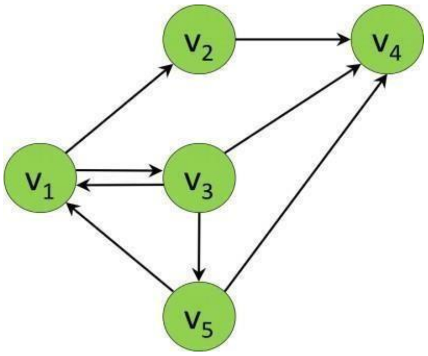
forming recursive problem: r=A· r

If M contains dead-ends, we have to renormalize r^{new} :

$$\forall \boldsymbol{j}: \boldsymbol{r}_j^{new} = \boldsymbol{r}'^{new}_j + \frac{\mathbf{1}-\boldsymbol{S}}{\boldsymbol{N}} \qquad \textbf{where: } S = \sum_j r'^{new}_j$$

NOTE: Please set β =0.8, and initial PageRank value = 1/N in this homework.

Example:

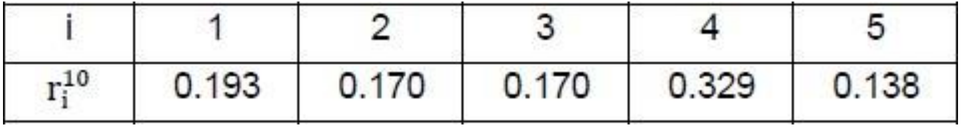


V={1,2,3,4,5} and E={(1,2),(1,3),(2,4),(3,1),(3,4),(3,5),(5,1),(5,4)}

i	1	2	3	4	5
r_i^1	0.205	0.152	0.152	0.365	0.125

If we set β =0.8, initial PageRank value = 1/5, and run a single round of PageRank, we get the following values:

If we run 10 rounds of PageRank, we get the following values:

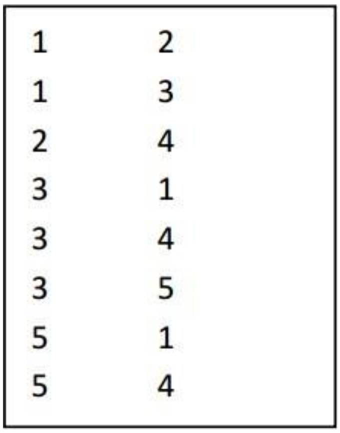


i	1	2	3	4	5
r_i^{10}	0.193	0.170	0.170	0.329	0.138

Data format:

Input:

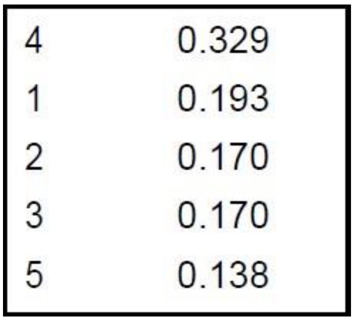
A file that contains one line for each link, and each line contains a pair of numbers that represent the vertices that are connected by the link.



```
1    2
1    3
2    4
3    1
3    4
3    5
5    1
5    4
```

Output:

There should be one line for each vertex, and each line should contain the vertex identifier and the PageRank values.



```
4    0.329
1    0.193
2    0.170
3    0.170
5    0.138
```

Structure:

[Mapper] A node passes its PageRank “contributions” to the nodes it is connected to.

[Reducer]Each node sums up all PageRank contributions that have been passed to it.

Assignment Requirements:

Part1 Code (80%)

Please make sure that your .java file has the same name as your class name, which must be **PageRank**.

If you implement the algorithm with Python, please name your .ipynb file as **PageRank**, too.

Part2 Report (20%)

a. Final output. (We require **20** iterations result)
Please show the **top 10 vertices** sorted by rank**.**

b. Explain how you design your mapper and reducer.

If you implement with the algorithm Python, You can write your report in .ipynb file

Please pack above files into a zip file. Name it as**"MDA_HW2_studentID.zip".**