Linear Algebra HW4
Page Rank

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Introduction - PageRank

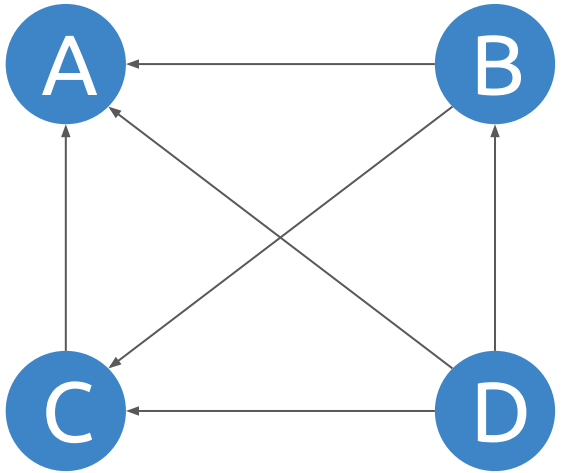
- PageRank is an algorithm to measure the importance of a website.
- It was developed by Larry Page and Sergey Brin in 1996.
- The more links a website received from other websites, the more important it is.
- The algorithm iteratively calculate the importance of a website according to the websites that have links to it and their importance.

Introduction

$$PR(A) = PR(B) + PR(C) + PR(D)$$

$$PR(A) = \frac{PR(B)}{2} + \frac{PR(C)}{1} + \frac{PR(D)}{3}$$

$$PR(A) = \left(\frac{PR(B)}{2} + \frac{PR(C)}{1} + \frac{PR(D)}{3}\right) d + \frac{1-d}{4}$$



Introduction

$$\mathrm{PageRank}(p_i) = \frac{1-d}{N} + d \sum_{p_j \in M(p_i)} \frac{\mathrm{PageRank}(p_j)}{L(p_j)}$$

$$\mathbf{R} = \begin{bmatrix} \mathrm{PageRank}(p_1) \\ \mathrm{PageRank}(p_2) \\ \vdots \\ \mathrm{PageRank}(p_N) \end{bmatrix}$$

$$\mathbf{R}' = \begin{bmatrix} (1-d)/N \\ (1-d)/N \\ \vdots \\ (1-d)/N \end{bmatrix} + d \begin{bmatrix} \ell(p_1,p_1)/L(p_1) & \ell(p_1,p_2)/L(p_2) & \cdots & \ell(p_1,p_N)/L(p_N) \\ \ell(p_2,p_1)/L(p_1) & \ddots & & \\ \vdots & & \ell(p_i,p_j)/L(p_j) & \\ \ell(p_N,p_1)/L(p_1) & & & \ell(p_N,p_N)/L(p_N) \end{bmatrix} \mathbf{R}$$

transition matrix

$\ell(p_i,p_j)$: 1 if p_j has a link to p_i, else 0

, repeat util R' ≈ R

ToDo

- Download hw4.zip here.
- Write hw4.py that can
  - Make the transition matrix.
  - Calculate the rank of every node.
- Answer the question here.

ToDo

- Finish 3 ToDos in hw4.py
  - get_tran() -> get the transition matrix
  - cal_rank() -> calculate the rank of every node
    - d = 0.85
  - save() -> save the transition matrix, ranks to 1.txt, 2.txt
- Run the code to get 1.txt, 2.txt
  - python3 hw4.py graph.txt
  - use graph_n.txt according to last number of your student ID (b01234567 -> graph_7.txt)
  - 1.txt and 2.txt should be in the same directory as where hw4.py is

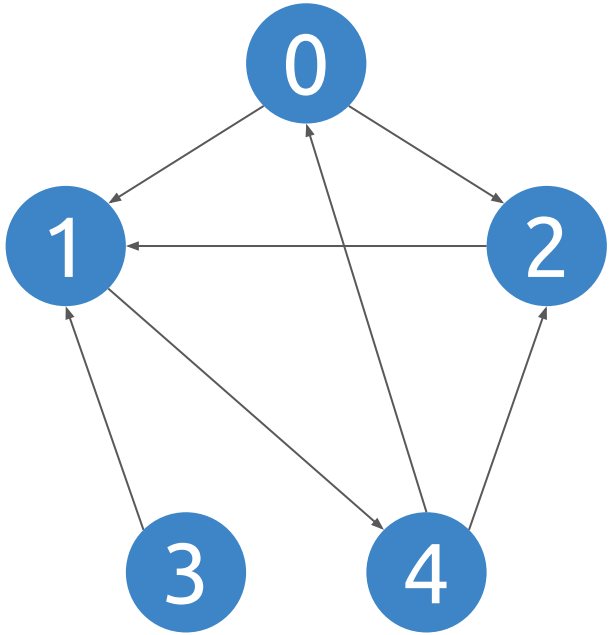
ToDo - cal_rank()

- Step 1: Initiala all PageRank in R_0 with 1/N. (N: the number of nodes)
- Step 2: Use R_t and transition matrix to calculate R_{t+1}
- Step 3: Repeat Step 2 until:
  - $|| R_{t+1} - R_t ||_1 \leq$ alpha (Use the funcion dist(R_{t+1} , R_t) to calculate $|| R_{t+1} - R_t ||_1$)
  - or when t ≥ max iterations
  - max iterations = 1000, alpha = 0.001

Data Format

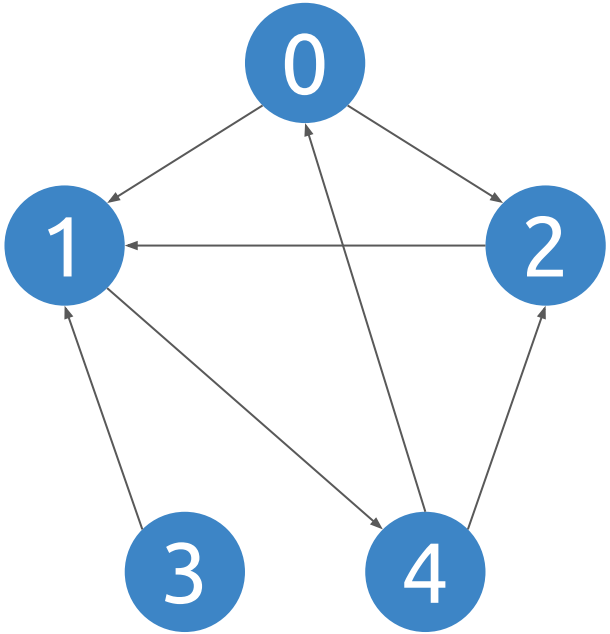
- graph.txt

```
0,1,2
1,4
2,1
3,1
4,0,2
```



Data Format

- 1.txt



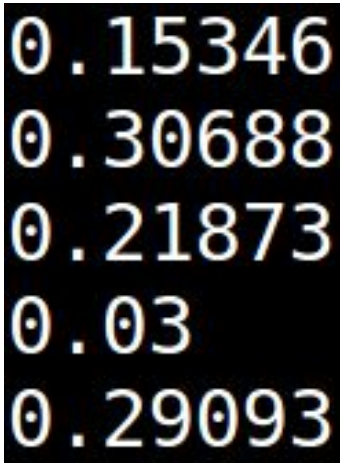

```
0 0 0 0 1
1 0 1 1 0
1 0 0 0 1
0 0 0 0 0
0 1 0 0 0
```

```
0.0 0.0 0.0 0.0 0.5
0.5 0.0 1.0 1.0 0.0
0.5 0.0 0.0 0.0 0.5
0.0 0.0 0.0 0.0 0.0
0.0 1.0 0.0 0.0 0.0
```

this is the transition matrix we want

Data Format

- 2.txt



- Note: don’t worry about the number of the digits, small deviation is allowable

Grading

- Save the transition matrix of the graph in 1.txt. (1%)
  - Check ex/1.txt to make sure that your submission is in correct format.
- Save the rank score of every node in 2.txt. (3%)
  - Check ex/2.txt to make sure that your submission is in correct format.
- Q: If we initial R_0 with random numbers and keep SUM(R_0) = 1, will the ranking be different ? Try to explain it. (2%)
  - Write your answer in report.pdf.
  - No template for report.pdf, but write the answer in 1 page.

Submission

- You should put all your files in a folder and compress it in a zip file.

  b01234567_hw4.zip

  |—./b01234567_hw4.zip

  |—hw4.py

  |—1.txt

  |—2.txt

  |—report.pdf

- Note: do not upload any graph.txt or other files

Rules

- Plagiarism = 0 point
- Upload b01234567_hw4.zip to CEIBA
- DEADLINE: 2018/12/11 (Tue.) 23:59 (GMT+8:00)
- Late submission: total score x 0.8 (per day)
- Any other error: total score x 0.8
- Python packages: numpy, pandas, and any built-in package
- 請確定投影片中出現的紅字都注意看過 :)

FAQ