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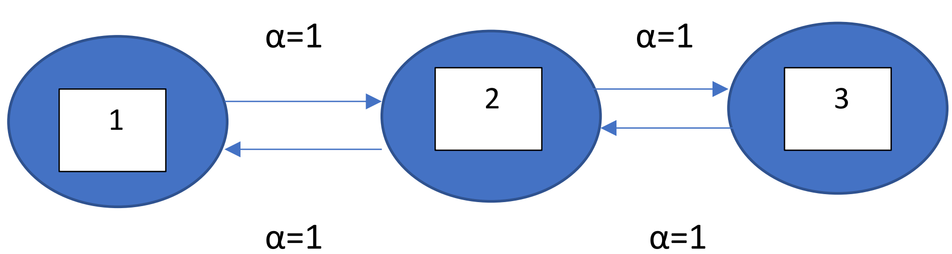
CSCE 5200 – Information Retrieval and Web Search
Transition probability matrices of the surfer's walk

Question: Repeat calculations fulfilled in the Example 6. 1 of the Chapter 6 for the following two values of the teleport probability: α=0 and α=1. For this purpose, write down transition probability matrices for the surfer's walk with teleporting. Describe the input data, method, algorithm, example and obtained results in the related report. Upload the report to the UNT Canvas environment.

Answer →

The following illustrates web graph:



Transition probability matrices for surfer's walk with teleporting as follows:

Data Input →

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

Method →

We can convert the Adjacency Matrix (A) to Transition Probability Matrix (P).
If the random surfer is at 1, and

- he did not teleport → Probability = 1- α

- he teleports →
  reach state 3 - Probability = $\alpha/3$
  reach state 2 - Probability = $\alpha/3$

Algorithm →

1. Divide each 1 by number 1's in a row
2. Multiply the matrix by 1- α
3. Add α/N to every entry in the resulting matrix

Case 1: we consider α = 0

1. Step 1. Divide each 1 by number 1's in a row

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

2. Step 2. Multiply the matrix by 1- α

$$A = [1-\alpha] \begin{bmatrix} 0 & 1 & 0 \\ 1/2 & 0 & 1/2 \\ 0 & 1 & 0 \end{bmatrix}$$

$$A = [1-0] \begin{bmatrix} 0 & 1 & 0 \\ 1/2 & 0 & 1/2 \\ 0 & 1 & 0 \end{bmatrix}$$

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

3. Step 3. Add $\alpha/N = 0/3 = 0$

Result →

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

This is the final transitional probability matrix when α = 0

Case 2: we consider $\alpha = 1$

1. Step 1. Divide each 1 by number 1's in a row

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

2. Step 2. Multiply the matrix by $1- \alpha$

$$A = [1- \alpha] \begin{bmatrix} 0 & 1 & 0 \\ 1/2 & 0 & 1/2 \\ 0 & 1 & 0 \end{bmatrix}$$

$$A = [1- 1] \begin{bmatrix} 0 & 1 & 0 \\ 1/2 & 0 & 1/2 \\ 0 & 1 & 0 \end{bmatrix}$$

$$A = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

3. Step 3. Add $\alpha/N = 1/3$

Result →

$$A = \begin{bmatrix} 1/3 & 1/3 & 1/3 \\ 1/3 & 1/3 & 1/3 \\ 1/3 & 1/3 & 1/3 \end{bmatrix}$$

This is the final transitional probability matrix when $\alpha = 1$