Sim Rank Numerical

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- SimRank is an intuitive and general approach in the similarity measure.

- It is applicable in any domain with object-to-object relationships, measuring the similarity of an object based on the relationship with other objects.

- The key of SimRank is
- **Two objects are considered to be similar if they are referenced by similar objects.**

- The algorithm steps are listed below
- Initialize the SimRank of every pair of the nodes following
    ```
    if(node1 == node2):
    SimRank(node1, node2) = 1
    else:
    SimRank(node1, node2) = 0
    ```
- For each iteration, update the SimRank of every pair of nodes in the graph
- If both nodes are the same, SimRank(a, b) = 1
- If one of the nodes has no in-neighbors, SimRank(a,b) = 0
- Else, the new SimRank follows the equation

$$S(a,b) = \frac{C}{|I(a)||I(b)|} \sum_{i=1}^{|I(a)|} \sum_{j=1}^{|I(b)|} S\big(I_i(a), I_j(b)\big)$$

- We calculate the new SimRank based on the SimRank from the previous iteration (Defined recursively but computed iteratively)

Example
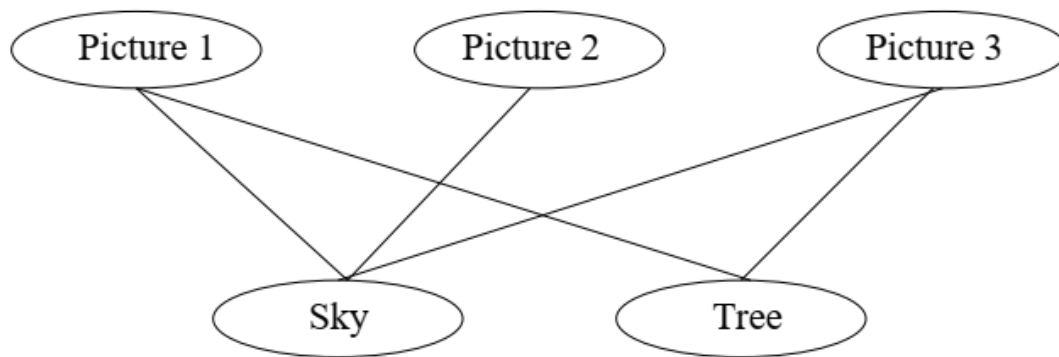
$$\begin{bmatrix} 0 & 0 & 0 & 1/3 & 1/2 \\ 0 & 0 & 0 & 1/3 & 0 \\ 0 & 0 & 0 & 1/3 & 1/2 \\ 1/2 & 1 & 1/2 & 0 & 0 \\ 1/2 & 0 & 1/2 & 0 & 0 \end{bmatrix}$$

$$\mathbf{v}' = \beta M \mathbf{v} + (1 - \beta)\mathbf{e}_N$$

- $\beta = 0.8$

$\mathbf{v'}$ of the distribution that we must iterate is

$$\mathbf{v'} = \begin{bmatrix} 0 & 0 & 0 & 4/15 & 2/5 \\ 0 & 0 & 0 & 4/15 & 0 \\ 0 & 0 & 0 & 4/15 & 2/5 \\ 2/5 & 4/5 & 2/5 & 0 & 0 \\ 2/5 & 0 & 2/5 & 0 & 0 \end{bmatrix} \mathbf{v} + \begin{bmatrix} 1/5 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

$$\mathbf{v}' = \begin{bmatrix} 1/5 & 1/5 & 1/5 & 7/15 & 3/5 \\ 0 & 0 & 0 & 4/15 & 0 \\ 0 & 0 & 0 & 4/15 & 2/5 \\ 2/5 & 4/5 & 2/5 & 0 & 0 \\ 2/5 & 0 & 2/5 & 0 & 0 \end{bmatrix} \mathbf{v}$$

If we start with $\mathbf{v} = \mathbf{e}_N$, then the sequence of estimates of the distribution of the walker that we get is

$$\begin{bmatrix} 1 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}, \begin{bmatrix} 1/5 \\ 0 \\ 0 \\ 2/5 \\ 2/5 \end{bmatrix}, \begin{bmatrix} 35/75 \\ 8/75 \\ 20/75 \\ 6/75 \\ 6/75 \end{bmatrix}, \begin{bmatrix} 95/375 \\ 8/375 \\ 20/375 \\ 142/375 \\ 110/375 \end{bmatrix}, \begin{bmatrix} 2353/5625 \\ 568/5625 \\ 1228/5625 \\ 786/5625 \\ 690/5625 \end{bmatrix}, \ldots, \begin{bmatrix} .345 \\ .066 \\ .145 \\ .249 \\ .196 \end{bmatrix}$$

Thank You