Predictive Ranking

A Novel Page Ranking Approach by Estimating the Web Structure

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MOTIVATIONS

The page ranks computed by PageRank are inaccurate because of its incomplete information about the Web structure. To avoid such inaccuracy, we

☐ Distinguish different kinds of nodes:

- **Type 1: nodes that are found, but not visited or not visited successfully.**
- **Type 2: those visited but without outlink.**
- **Type 3: those visited and with at least one outlink.**

☐ Predict the web structure according to assumptions:

- **The number of found links to a page is proportional to the real number of links to the page.**
- **The estimated links are shared by all Type 1 pages.**

NOTATION

- **V: all the pages that are found (|V|=n);**
- **S: all the pages of Type 3 (|S|=m);**
- **D^1 : all the pages of Type 2 ($|D^1|=m_1$);**
- **D^2: all the pages of Type 1 ($|D^2|=n-m-m_1$) ;**
- **$d^-(i)$: the true indegree of node i;**
- **$fd^-(i)$: the number of the found links to node i;**
- **A: the matrix that models the users' behavior; the element a(i,j) means the probability of jumping from node j to node i.**
- **$l_i = (d^-(i) - fd^-(i))/m_2 Z$, Z is a normalized factor.**

PREDITIVE RANKING MODEL

(1) Predict $d^-(i)$ by the formula: $d^-(i) = n/(m+m_1)\, fd^-(i)$

(2) Divide A by

$$A = \begin{pmatrix} C & P & M \\ D & Q & N \end{pmatrix}$$

where C and D are used to model the known link structure from S to D^1 and D^2 , c(i,j) in C and d(i,j) are defined as $1/d_j$ if there is a link from j to i and 0 otherwise. M and N are used to model the link structure from D^2 to D^1 and D^2 , and are defined according to the estimated link information:

$$\begin{pmatrix} M & N \end{pmatrix}^T = diag\{l_1, l_2, \ldots, l_n\} 1_{n\times(n-m-m_1)}$$

P and Q are used to model the link structure from D^1 to D^1 and D^2 , and are defined in (4).

(3) Assume that the users will jump to page i with a probability of f_i. The matrix modeling the teleportaion is fe^T .

(4) Assume that the user follows the same kind of teleportation as in (3) when there is no outlink that the users can follow. So

$$\begin{pmatrix} P & Q \end{pmatrix}^T = diag\{f_1, f_2, \ldots, f_n\} 1_{n\times m_1}$$

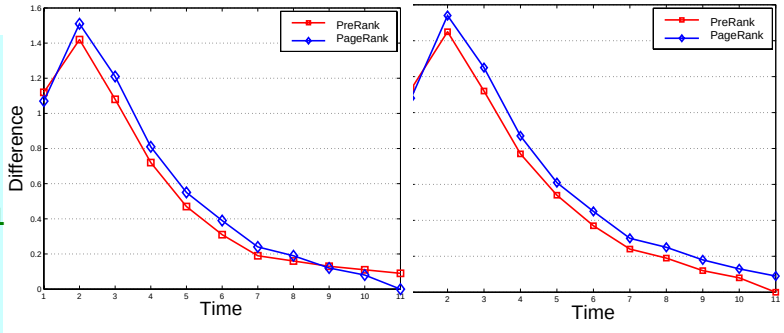
(5) Rank x_i should satisfy

$$x = [(1-\alpha) fe^T + \alpha A]x$$

EXPERIMENTS

Time	1	2	3	4	5	6	7	8	9	10	11
Pages viited	7,712	78,662	109,383	160,019	252,522	301,701	373,579	411,724	444,974	471,684	502,610
Pages found	18,542	120,970	157,196	234,701	355,720	404,728	476,961	515,534	549,162	576,139	607,170

- **Both PreR and PageRank are applied to these 11 datasets collected at different time.**
- **Compute difference between the early results with the PreR and PageRank results at time 11.**
- **The left figure is based on PageRank result at time 11. The right is based on PreR at time 11.**



CONCLUSION

■ **The results of PreR are more accurate than those of PageRank even when we consider PageRank as the reference (bias against ours).**

■ **Our approach to predicting the Web structure is simple and efficient.**

REFERENCES

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