Random Walk and Feedback on Scholarly Network

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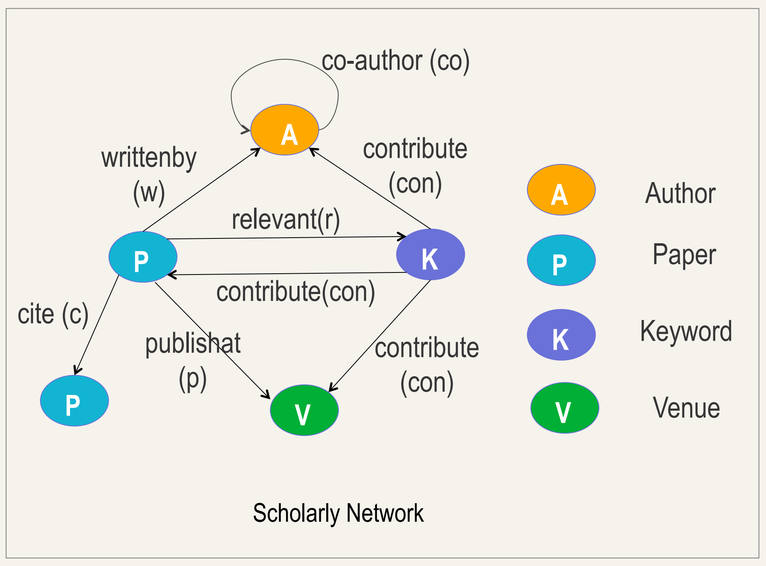
Introduction

Meta-path based random walk on heterogeneous graph is an effective way to enhance the recommendation performance.

Meta-paths: $P^* \xrightarrow{w} A \xrightarrow{co} A \xleftarrow{w} P^?$

$P^* \xrightarrow{w} A \xleftarrow{w} P \xrightarrow{c} P^?$

P^* is seed node, $P^?$ is candidate node.



Scholarly Network

What will happen if we have different types of feedback nodes?

What will happen if we have positive / negative feedback nodes?

Will other nodes be affected by feedback information?

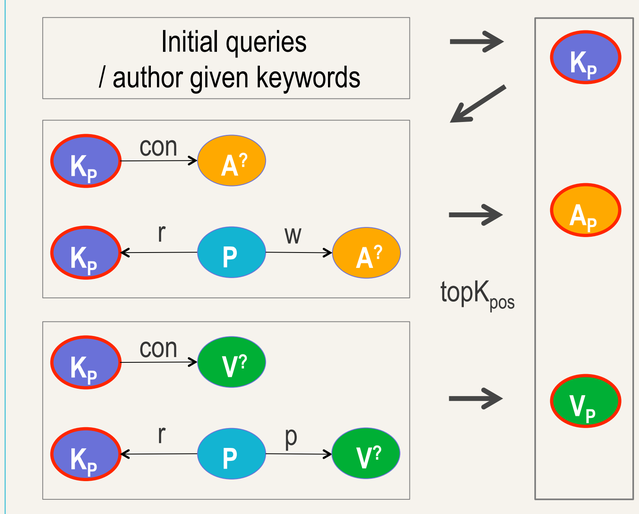
Contributions

- **The feedback is not limited to documents. Generate multiple feedbacks automatically.**
- **Infer the usefulness probability of nodes via sigmoid function.**
- **Improve the original random walk function.**

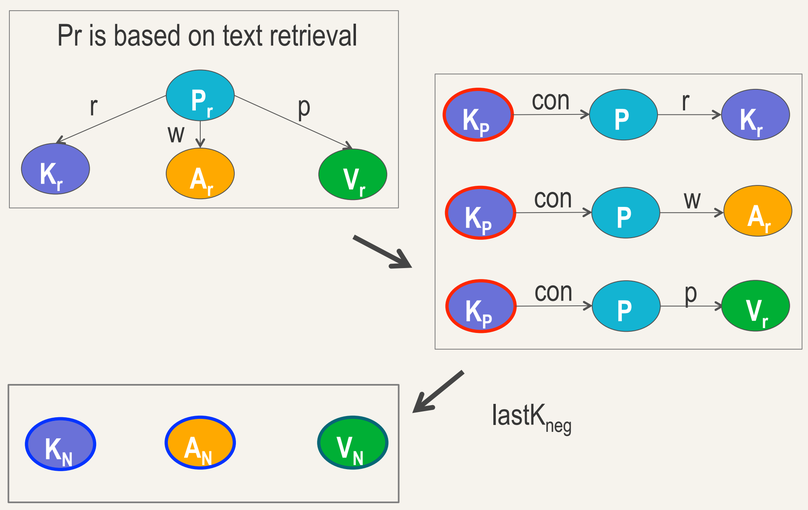
Research Methods

1. Generate Multiple Feedback Nodes (Keyword, Author and Venue)

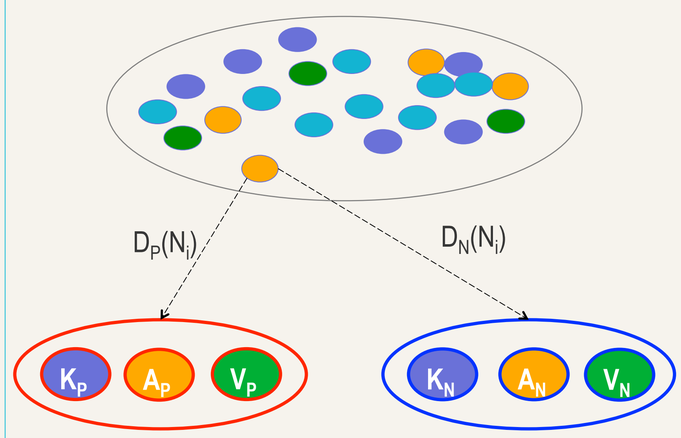
Positive Feedback Nodes



Negative Feedback Nodes

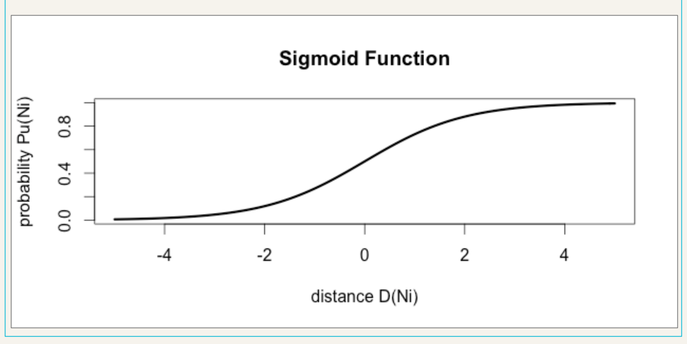


2. Infer Usefulness Probability of Node



SIGMOID Function

$$P_u(N_i) = \frac{1}{1+e^{-D(N_i)}} = \frac{1}{1+e^{-(D_N(N_i)-D_P(N_i))}}$$



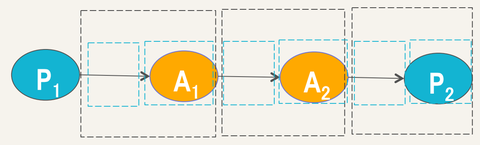
3. Improve Random Walk Based-on Meta-path

$$RW(t) = \prod_j w(a_{ij}^{(j)}, a_{i,j+1}^{(j+1)})$$

Improved

$$RW(t) = \prod_j [\beta \cdot w(a_{ij}^{(j)}, a_{i,j+1}^{(j+1)}) + (1-\beta) \cdot P_u(a_{i,j+1}^{(j+1)})]$$

Example path t:



$$RW(t) = [\beta \cdot w(P_1, A_1) + (1-\beta) \cdot P_u(A_1)]$$
$$\cdot [\beta \cdot w(A_1, A_2) + (1-\beta) \cdot P_u(A_2)]$$
$$\cdot [\beta \cdot w(A_2, P_2) + (1-\beta) \cdot P_u(P_2)]$$

Experiments

We used 41,370 publications (as candidate citation collection), published between 1951 and 2011, on computer science for the experiment (mainly from the ACM digital library).

For the evaluation part, we used a test collection with 274 papers. The selected papers have more than 15 citations from the candidate citation collection.

Meta-paths Used in Experiment:

NO.	Meta-path
1	$P^* \xrightarrow{w} A \xleftarrow{w} P^?$
2	$P^* \xrightarrow{c} P^?$
3	$P^* \xrightarrow{c} P \xrightarrow{c} P^?$
4	$P^* \xrightarrow{c} P \xrightarrow{w} A \xleftarrow{w} P^?$
5	$P^* \xrightarrow{w} A \xrightarrow{co} A \xleftarrow{w} P^?$
6	$P^* \xrightarrow{w} A \xleftarrow{w} P \xrightarrow{c} P^?$
7	$P^* \xrightarrow{p} V \xleftarrow{p} P \xrightarrow{c} P^?$
8	$P^* \xrightarrow{p} V \xleftarrow{p} P \xrightarrow{w} A \xleftarrow{w} P^?$

Results and Conclusions

NO.	N/Y	MAP	MAP@5	MAP@10	NDCG	NDCG@5	NDCG@10
1	N	0.0277	0.0085	0.0129	0.1035	0.0306	0.0394
	Y	0.0365 ***	0.015 ***	0.0211 ***	0.1149 ***	0.0459 **	0.0565 ***
2	N	0.1315	0.0552	0.0773	0.2193	0.1427	0.1548
	Y	0.1459 ***	0.0678 ***	0.0904 ***	0.2307 **	0.1656 ***	0.1705 **
3	N	0.0744	0.0306	0.0404	0.1539	0.0689	0.0766
	Y	0.0948 ***	0.0441 ***	0.0582 *	0.1707 ***	0.0945 *	0.1002 **
4	N	0.027	0.0042	0.0076	0.1378	0.0146	0.025
	Y	0.038 ***	0.0109 ***	0.0153 ***	0.1521 ***	0.0381 ***	0.0387 ***
5	N	0.0436	0.0121	0.0187	0.1672	0.0476	0.0585
	Y	0.0561 ***	0.0257 ***	0.0328 ***	0.1854 ***	0.0867 ***	0.0885 ***
6	N	0.0327	0.0234	0.03	0.0734	0.0693	0.0748
	Y	0.0872 ***	0.0359 ***	0.0471 ***	0.1962 ***	0.0805 *	0.09 *
7	N	0.0238	0.0083	0.0097	0.1529	0.0216	0.0224
	Y	0.0373 ***	0.0133 ***	0.0163 ***	0.1718 ***	0.0371 **	0.0344 **
8	N	0.0092	0.0005	0.0007	0.1397	0.0011	0.0013
	Y	0.012 ***	0.0011 ***	0.0017 ***	0.1476 ***	0.0027 ***	0.0045 ***

Note. p < 0.05: *,p < 0.01: **,p < 0.001: ***

The multiple kinds of positive/negative feedbacks enhance the random walk performance quite well.

We also used t-test to verify this improvement and most meta-paths are significantly refined.