Leveraging Publication Metadata and Social Data into FolkRank for Scientific Publication Recommendation

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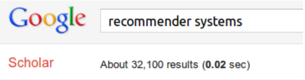
Publication Overload



- # papers doubles every 10 years
- # journals doubles every 15 years
- → information overload

typical approach: scientific article recommender
e.g., in collaborative tagging systems

Agenda

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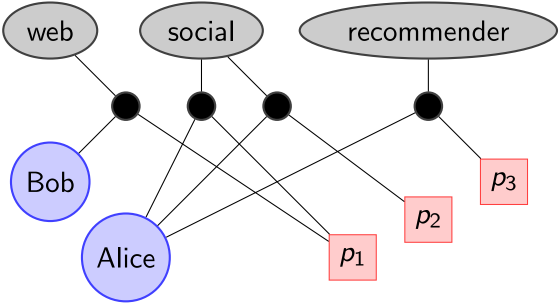
Item Recommendations in Folksonomies

Folksonomy

A *folksonomy* is a quadruple $\mathbb{F} := (U, T, R, Y)$, where U, T, and R are finite sets, whose elements are called *users*, *tags* and *resources*, resp., and Y is a ternary relation between them, i.e., $Y \subseteq U \times T \times R$, whose elements are called *tag assignments*.



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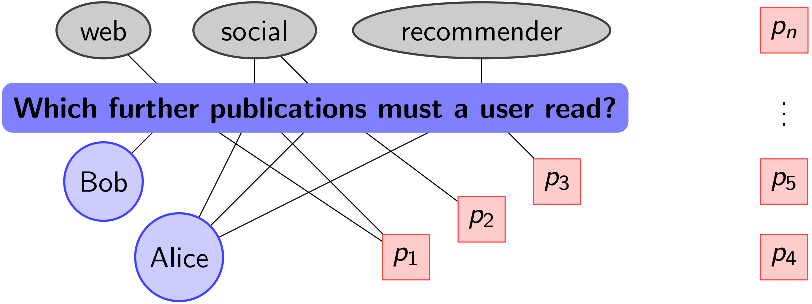
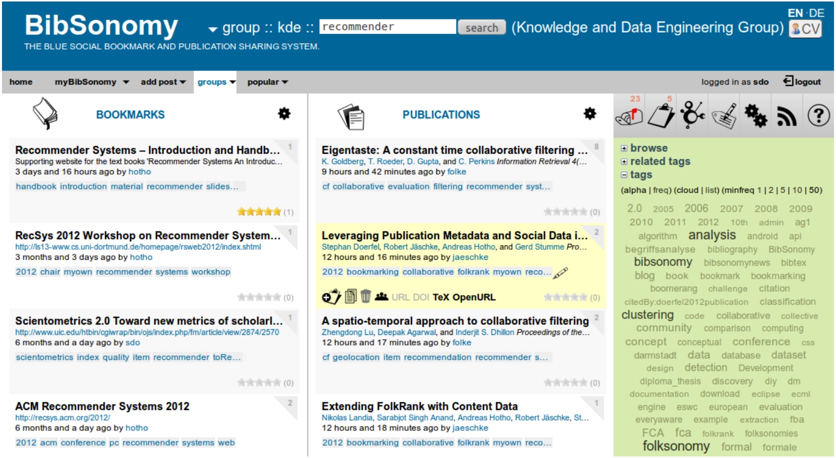


BibSonomy


BibSonomy
THE BLUE SOCIAL BOOKMARK AND PUBLICATION SHARING SYSTEM.
group :: kde ::
recommender
search
(Knowledge and Data Engineering Group)
EN · DE
CV
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K. Goldberg, T. Roeder, D. Gupta, and C. Perkins Information Retrieval 4(…
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A spatio-temporal approach to collaborative filtering
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Extending FolkRank with Content Data
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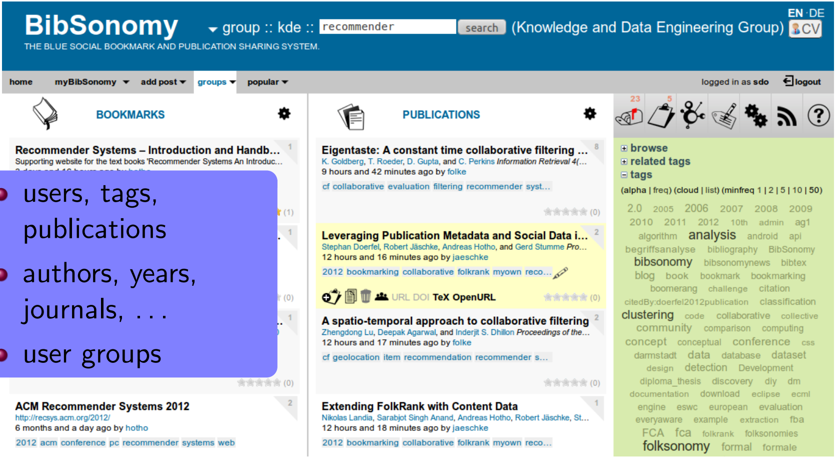
BibSonomy



- users, tags, publications
- authors, years, journals, . . .
- user groups

FolkRank

$$\mathbb{F} = (U, T, R, Y) \;\rightarrow\; \text{undirected graph } G_{\mathbb{F}} = (U \,\dot\cup\, T \,\dot\cup\, R, E)$$
$$(u, t, r) \in Y \;\rightarrow\; \{u, t\}, \{u, r\}, \{t, r\} \in E$$

$$\textit{Adapted PageRank (APR)}\ \vec{w}^d \;:\; \vec{w}^d_{i+1} \leftarrow dA^{\mathrm{T}}\vec{w}^d_i + (1-d)\vec{p}$$
$$\textit{FolkRank} \;:\; \vec{w}^d - \vec{w}^1$$

$$A = \text{the row-stochastic adjacency matrix of } G_{\mathbb{F}}$$
$$\vec{p} = \text{preference vector}$$
$$d \in [0, 1] = \text{parameter for the influence of } \vec{p}$$

Modifications to Folkrank

Adding new Dimensions to the Graph

$\mathbb{F} + M := (U, T, R, M, Y')$ extends the folksonomy $\mathbb{F}$ where

- Y' is a relation $Y' \subseteq U \times T \times R \times M$ and
- each triple of Y is extended with those elements of M that one of the elements of the triple is associated with.

Modifications to the Preference Vector

Select certain users, resources or tags and assign them some weight in $\vec{p}$.

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Four Datasets

Publication posts of BibSonomy[1]

- D_{08} challenge dataset from 2008
- D_{12} recent dataset from 2012
- D_R each publication in ≥ 2 posts
- D_{UR} each publications in ≥ 2 posts, each user ≥ 20 posts

dataset	users	publications
$D_{12,R}$	2,886	29,921
$D_{12,UR}$	541	25,072
$D_{08,R}$	729	13,001
$D_{08,UR}$	150	11,689

[1] http://www.kde.cs.uni-kassel.de/bibsonomy/dumps/

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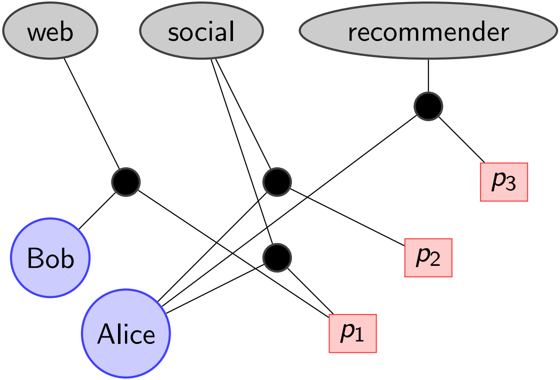
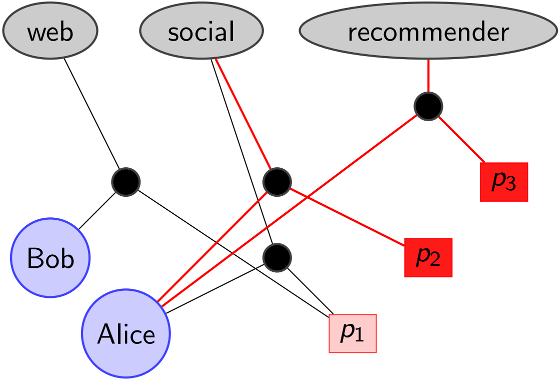
Experimental Methodology



Leave*N*PostsOut

Experimental Methodology



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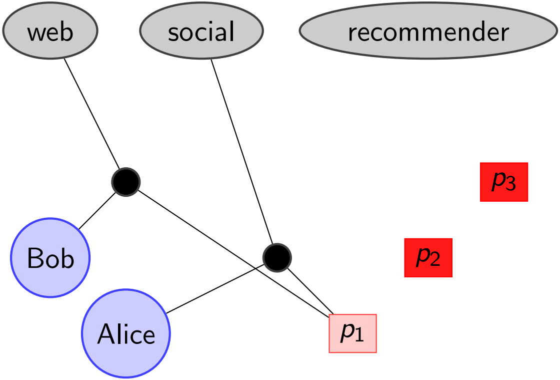

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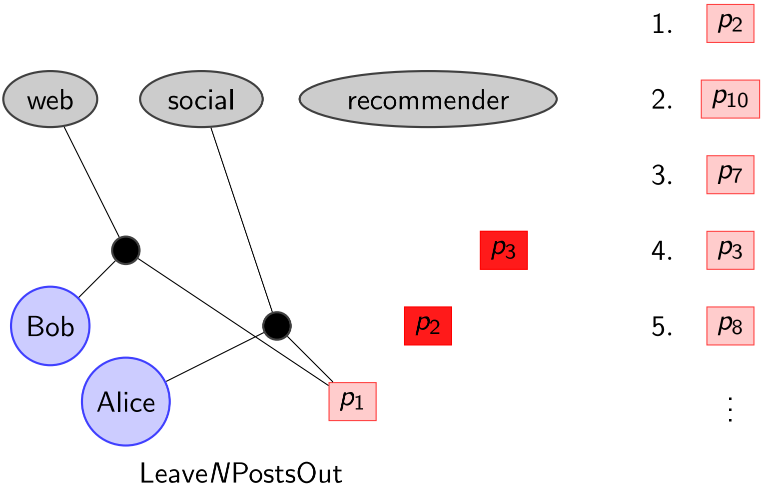

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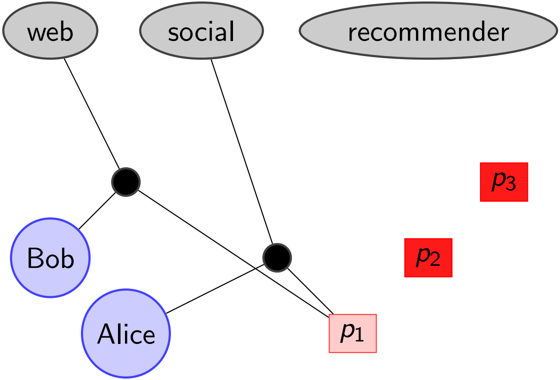

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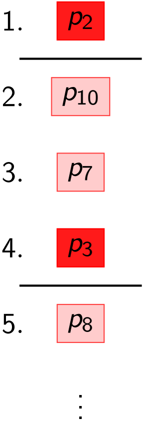

MAP = Mean Average Precision

Baselines

Most Popular

- global ranking
- suggesting the most often bookmarked publications to a user

User-Based Collaborative Filtering

- users are represented as vectors in
  - the tag vector space → CF_T
  - or the resource vector space → CF_R
- using a similarity function, one determines a set of similar users and recommends publications that are popular among them

Experiment: Who has the publications to recommend?

How many similar users does it take, to find the 10 left-out resources? – The average coverage of the withheld resources in differently sized neighborhoods of similar users:

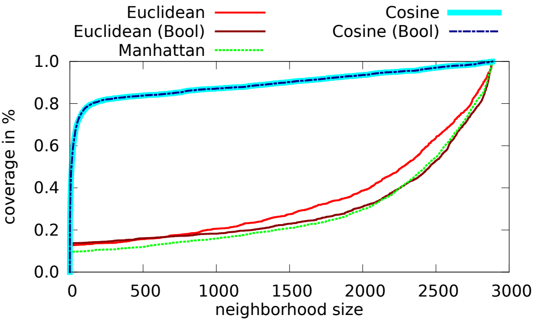

Figure: $D_{12,R}$ as resource vector space.

→ Winner: Cosine similarity in the resource vector space

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Baselines and plain FolkRank and APR

MAP scores	$D_{12,R}$	$D_{08,R}$	$D_{12,UR}$	$D_{08,UR}$
CF_R $k = 10$	**0.109**	**0.141**	**0.120**	**0.152**
FolkRank	0.090	0.118	0.099	0.129
adapted PageRank (APR)	0.066	0.058	0.070	0.062
CF_T $k = 4$	0.062	0.081	0.060	0.088
most popular	0.006	0.013	0.007	0.013

$$\mathrm{CF}_R > \mathit{FolkRank} > \begin{cases} \mathit{APR} \\ \mathrm{CF}_T \end{cases} > \text{most popular}$$

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Including New Dimensions

MAP scores	$D_{12,R}$	$D_{08,R}$	$D_{12,UR}$	$D_{08,UR}$
(plain) FolkRank	**0.090**	**0.118**	0.099	**0.129**
$\mathbb{F}$ + first authors	0.089	0.113	**0.102**	0.126
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first authors > last authors > all authors

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comparable to plain FolkRank

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$\mathbb{F}$ + posting year, publication year, tag clusters, venues, ...

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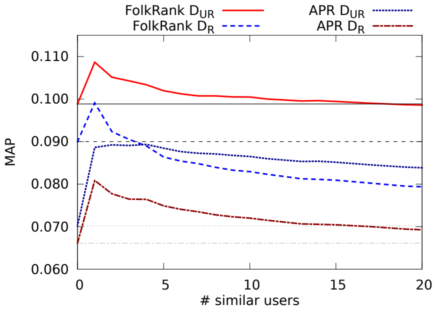
Exploiting Similar Users

Motivation: Good results of CF_R.

For user u select the k most similar users, insert their similarity value to u into $\vec{p}$.



All scenarios profit from the *inclusion of* at least very small *user neighborhoods*.

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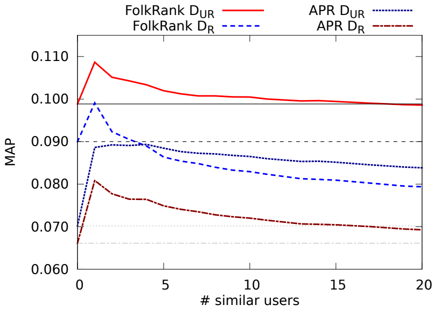


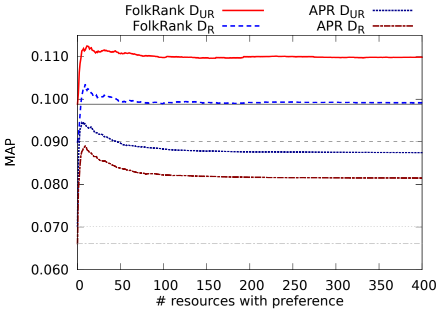
- *Best results*: only the single most similar user gets additional preference
- APR profits even more from the inclusion of similar users, also for larger neighborhoods
- Using the *Euclidean distance decreases* MAP.

All scenarios profit from the *inclusion of* at least very small *user neighborhoods*.

Exploiting Recent Resources

Motivation: User's interests vary during the use of the system.

For user u select the k most recently posted resources, assign the same weight to them in $\vec{p}$.



Comparable to the scores of *CF_R*.

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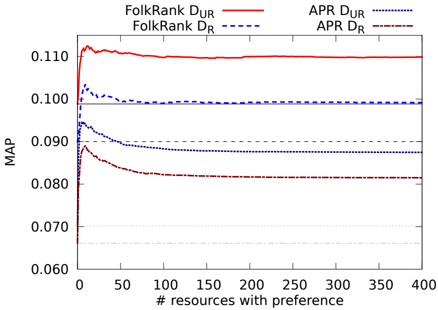

- *Significantly exceeds FolkRank* (for ≥ 3 resources on all datasets).
- Highest MAP scores for different number of recent resources.
- Constant MAP for larger numbers of recent resources.

Comparable to the scores of CF_R.

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Conclusions

- Cosine similarity is the measure of choice (CF_R or $\vec{p}$ in FolkRank).
- Generally FolkRank below CF_R but better than CF_T.
- Using resources seems to be more beneficial than using tags.
- Authors or groups as additional dimension → scores comparable to plain FolkRank.
- Small user neighborhoods can improve FolkRank recommendations.
- Recency of a post is a valuable indicator for the current interests of a user (best FolkRank results).

Future Work

- Repeat the more successful experiments on further datasets.
- Investigate whether certain types of users can benefit more from the inclusion of certain data than others.
- Truly capture a recommender's performance: Online-Evaluation in BibSonomy
- Use different versions of FolkRank as candidates for hybrid-recommenders.

http://www.kde.cs.uni-kassel.de/bibsonomy/dumps/

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Thank you for your attention!

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