

MODELING ACTIVATION PROCESSES IN HUMAN MEMORY TO IMPROVE TAG RECOMMENDATIONS

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GOAL

The goal of this work is to develop a tag recommender algorithm that **mimics the way humans draw on items (e.g., words or tags) in their long term memory**. Additionally, this work should act as an example of **how recommender systems can be designed / improved if cognitive aspects are taken into account**.

MOTIVATION

- **Social tagging** is the process of collaboratively annotating content and can be used to structure, search and discuss Web content (i.e., meaning making).
- **Tag recommender algorithms** support users in this process by suggesting a set of tags for a user u and resource r .
- They **support the individual** to find relevant tags, the **collective** to consolidate a shared tag vocabulary (improve **semantic stabilization**), and increase the **indexing quality** of resources.
- **Problem:** Current approaches ignore research from cognitive science about how people access items (e.g., words or tags) in their memory (i.e., **activation processes in human memory**).

DATASETS

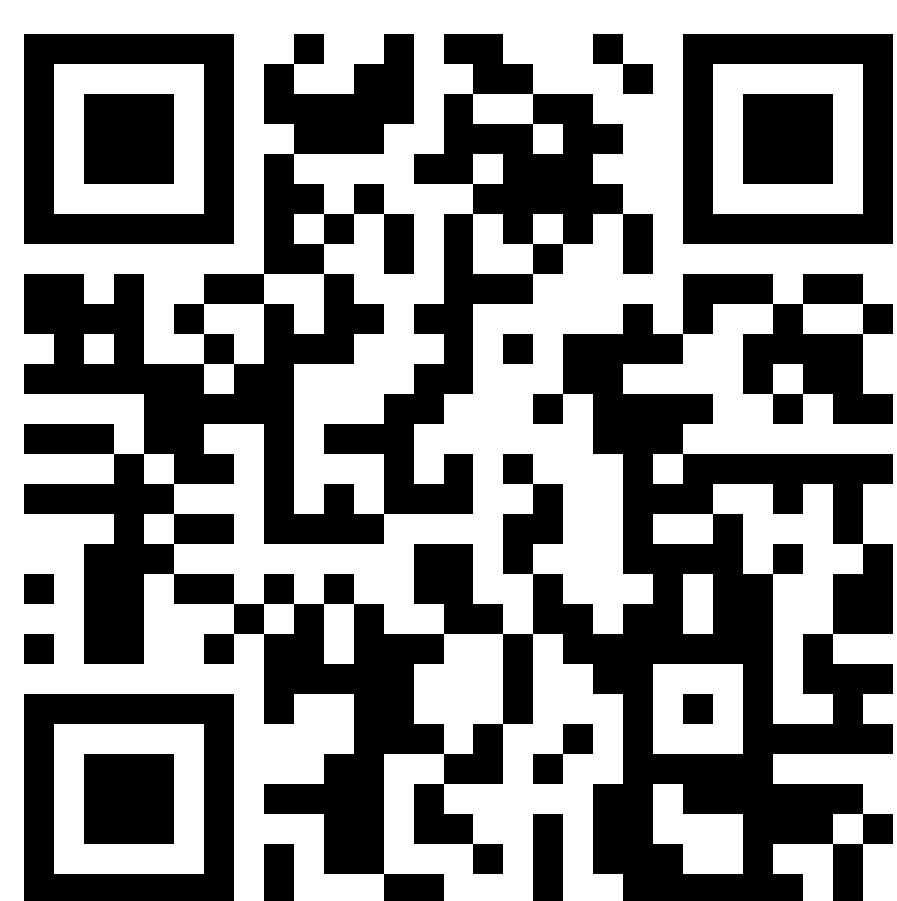
Dataset	UI	RI	PI	PI / RI
Flickr	9,590	856,755	856,755	1.000
CiteULike	18,474	811,175	900,794	1.110
BibSonomy	10,179	683,478	772,108	1.129
Delicious	15,980	963,741	1,447,267	1.501
LastFM	1,892	12,522	71,062	5.674
MovieLens	4,009	7,601	55,484	7.299

FUTURE WORK

- Incorporate **resource content** and personalized modeling of **tag imitation**.
- Evaluate real user acceptance in **online study** (e.g., in BibSonomy).
- Use this model for **recommending also other types of entities** (e.g., Web resources, users or hashtags).

EVALUATION FRAMEWORK

[1] D. Kowald, E. Lacic, and C. Trattner. Tagrec: Towards a standardized tag recommender benchmarking framework. In *Proceedings of the 25th ACM Conference on Hypertext and Social Media, HT'14*, NY, USA, 2014. ACM. (best poster)

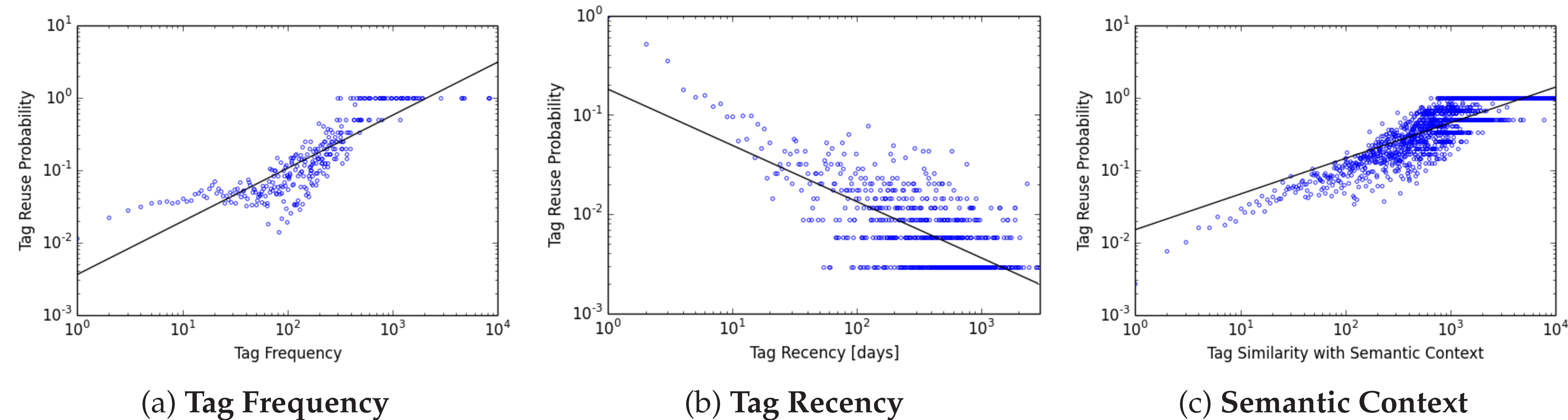


<https://github.com/learning-layers/TagRec/>

RQ1

Which activation processes in human memory are appropriate to account for a tag's probability of being reused in a social tagging system?

Research on human memory (Anderson & Schooler, 1991) showed that the activation of a human memory unit depends on its general usefulness in the past (usage frequency and recency) and its usefulness in the current context. Is this also valid in a system like BibSonomy?



Frequency, recency and semantic context are all important factors for a user's tag reuse and thus, can be explained by activation processes in human memory [under review in JWS].

RQ2

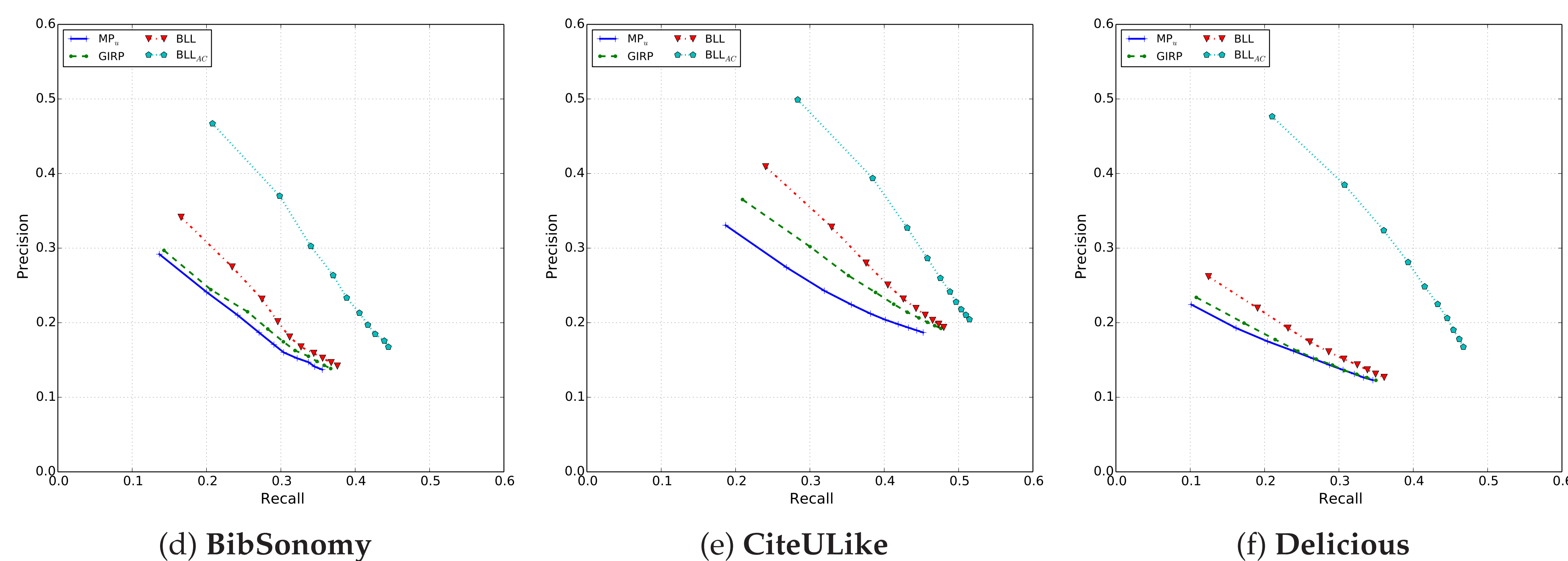
Can the activation equation of the cognitive model ACT-R, that accounts for the activation processes in human memory, be exploited to effectively predict a user's tag reuse?

$$A_i = B_i + \sum_j (W_j \cdot S_{j,i})$$

$$B_i = \ln\left(\sum_{j=1}^n t_j^{-d}\right)$$

$$A(t, u, r) = B(t, u) + \sum_{c \in T_r} (|Y_{c,r}| \cdot S(c, t))$$

$$B(t, u) = \ln\left(\sum_{j=1}^n (time_{u,ref} - time_{t,u,j})^{-d}\right)$$



The activation equation can be used to effectively predict the reuse of tags in comparison to a frequency-based and an alternative time-based method [Kowald et al. @ WWW'14].

RQ3

To what extent can a tag recommender algorithm, that expands the activation equation of the cognitive model ACT-R with tag imitation processes, compete with current state-of-the-art approaches in terms of various recommender evaluation metrics?

$$\tilde{T}_k(u, r) = \underset{\substack{BLL_{AC} \\ BLL_{AC} + MP_r}}{\text{argmax}}_{t \in T_u, T_r} (\beta \underbrace{A(t, u, r)}_{BLL_{AC}} + (1 - \beta) |Y_{t,r}|) \quad (1)$$

Algorithm	Name	Accuracy		Diversity	Novelty	Runtime	Mem.
		narrow	broad				
MP_r	Most popular tags by resource	-	-	-	-	++	+
$MP_{u,r}$	Most popular tags by user & resource	-	-	-	-	++	+
CF	User-based Collaborative Filtering	-	-	+	-	-	-
LDA	Latent Dirichlet Allocation	-	-	++	-	-	-
PITF	Pairwise Interaction Tensor Factorization	-	+	++	+	-	++
FR	FolkRank	-	+	++	-	-	-
GIRPTM	Temporal tag usage patterns and MP_r	+	+	-	-	++	+
3LT+ MP_r	Time-dependent 3Layers and MP_r	++	++	-	-	-	-
BLL_{ac}	BLL equation with context associations	+	+	-	++	+	+
$BLL_{ac} + MP_r$	Mixture of BLL_{ac} and MP_r	++	++	-	++	+	+

The best results are reached by our $BLL_{ac} + MP_r$ approach [Kowald & Lex @ RecSys'15].