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A Probabilistic Approach to Personalized Tag Recommendation

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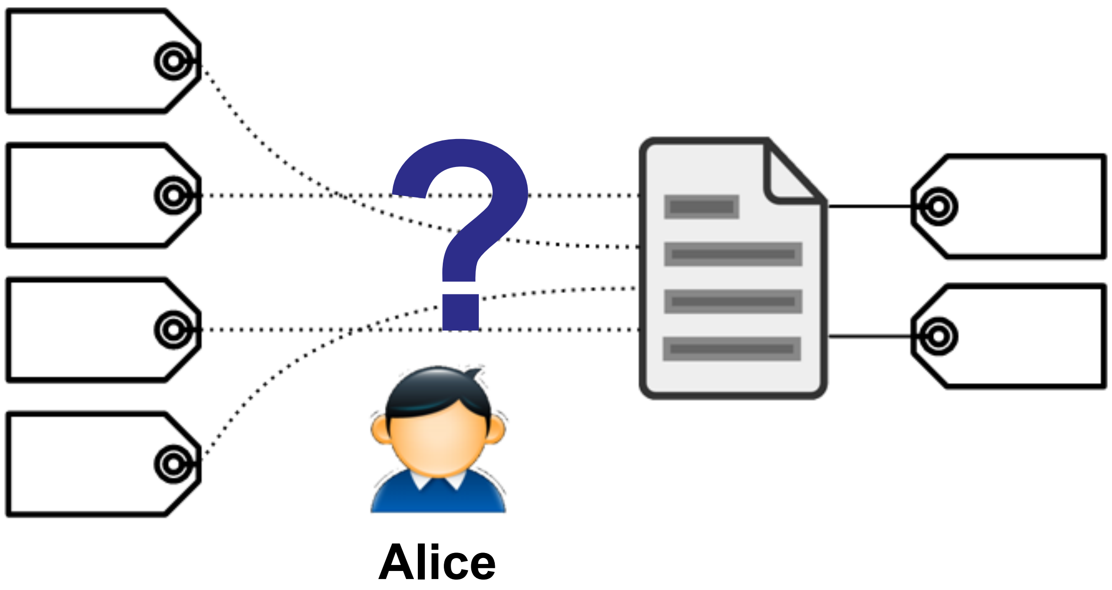
Social Tagging

- Social tagging allows *users* to annotate resources with tags.
  - organize
    - tags are keywords, serving as (personalized) index terms that group relevant resources
  - store
    - online storage gives mobility and convenience to access
  - share
    - published bookmarks can be viewed by other users
  - explore
    - to leverage collective wisdom to find interesting resources

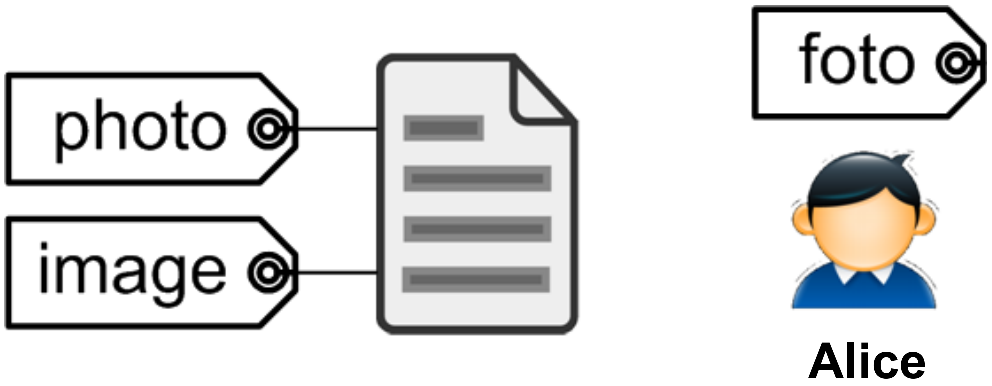
Personalized Tag Recommendation

- Personalized tag recommendation aims to recommend tags to the query user for annotating the query resource.
- Recommendation eases the tagging process.
  - avoids misspelling, provides consistency



Why Personalize Recommendations?

- Tag recommendation should be personalized.
  - users exhibit individualized choice of tag terms
    - e.g., language preference



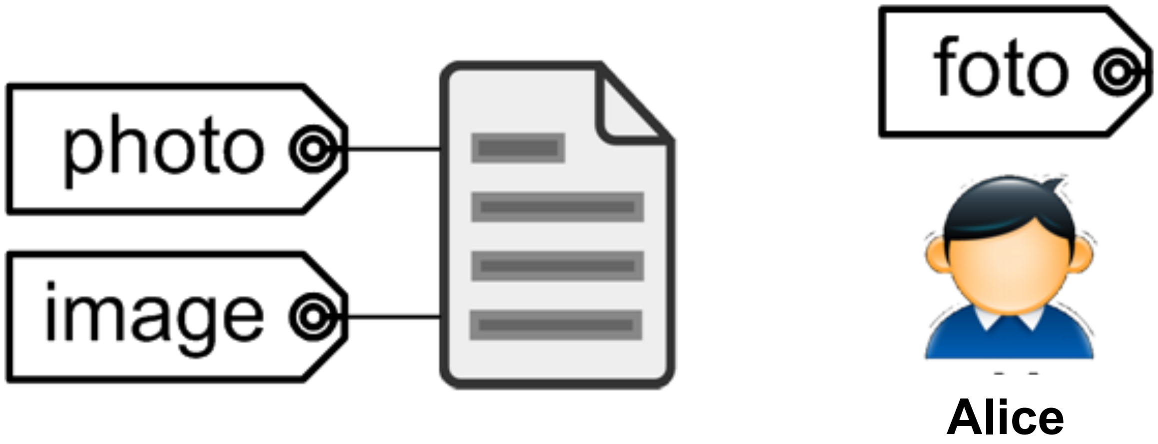
  - personalized index for personal consumption and consistency

Problem Formulation and A Basic Method

- Problem Formulation: $p(t|r_q,u_q)$

- A Basic Method: **freq-r**, to recommend most frequent tags
  - assuming that *the more people have used this tag, the more likely it will be used again*
    - Ref. [Golder & Huberman 2006]
  - current state-of-the-art in many social tagging sites, e.g.,
  - fails to personalize the recommendations for the query user

Three Scenarios



Scenario 1: ‘foto’ is an infrequent tag for the resource.

Scenario 2: ‘foto’ has not been used for the resource, but has been used by the user for annotating other resources in the past.

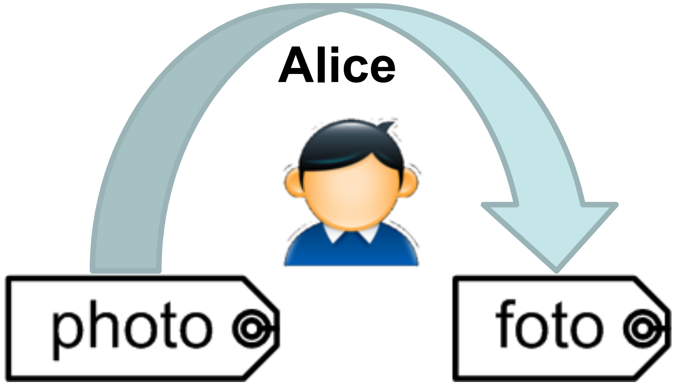
Scenario 3: ‘foto’ has not been used for the resource, neither has it been used by the query user, but has been used by other users for annotating other resources.

Collaborative Filtering Method

- A Method based on Collaborative Filtering: (**knn**)
  - select the *k-nearest neighbors* of the query user, and
  - recommend tags used by these neighbors for annotating the resource
  - classic collaborative filtering, without ratings
    - Ref. [Marinho & Schmidt-Thienme 2008]
  - addresses scenario 1, but fails scenario 2,3

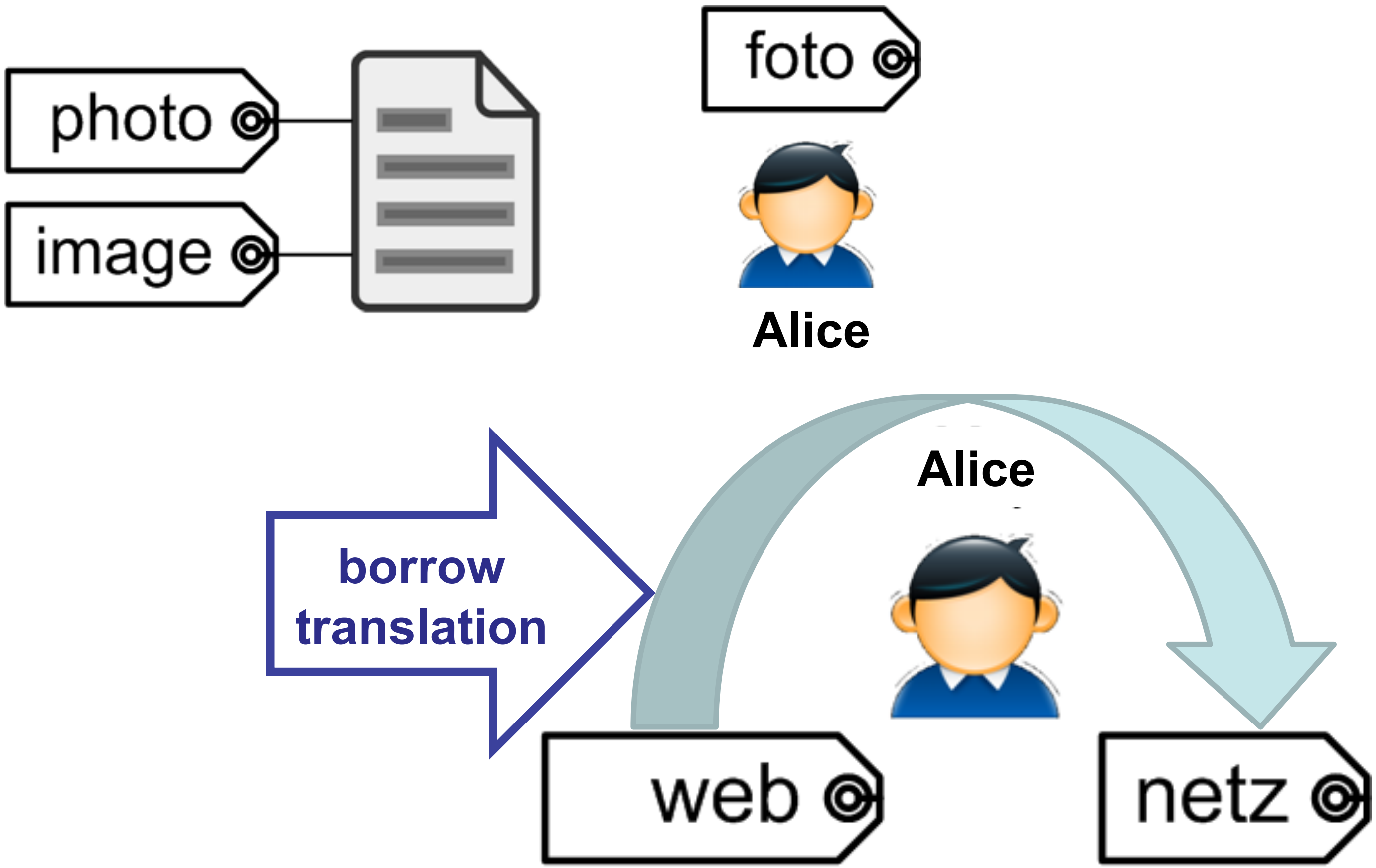
Personomy Translation Method

- To translate the resource tags to the user's personal tags (**trans-u**)
  - to learn p(t='foto'|u=Alice, t_r='photo')
    - Ref. [Wetzker et al. 2009]



  - addresses scenario 2, but fails scenario 3, since Alice has never used 'foto'

To Address Scenario 3



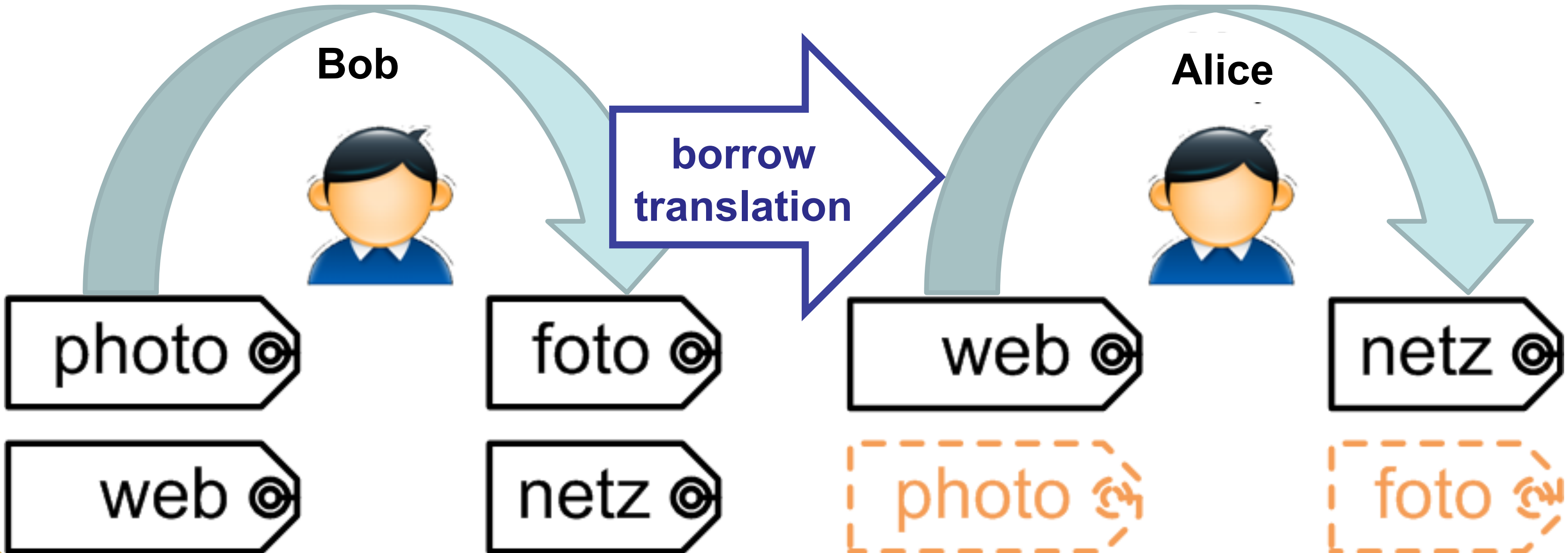
1. Personomy Translation
2. A Framework
3. Measuring User Similarity

A PROBABILISTIC FRAMEWORK

Proposed Framework

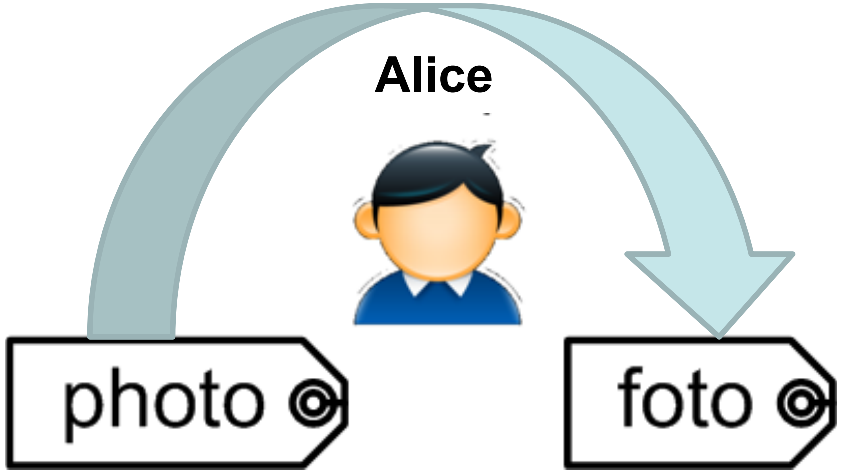
$$p(t|r_q, u_q) = \frac{\sum_u sim(u, u_q) \times p(t|r_q, u)}{\sum_u sim(u, u_q)}$$

- To learn p(t='foto'|u=Bob,t_r='photo') and sim (u=Bob,u_q=Alice)



Personomy Translation

- To learn p(t='foto'|u=Alice,t_r='photo')

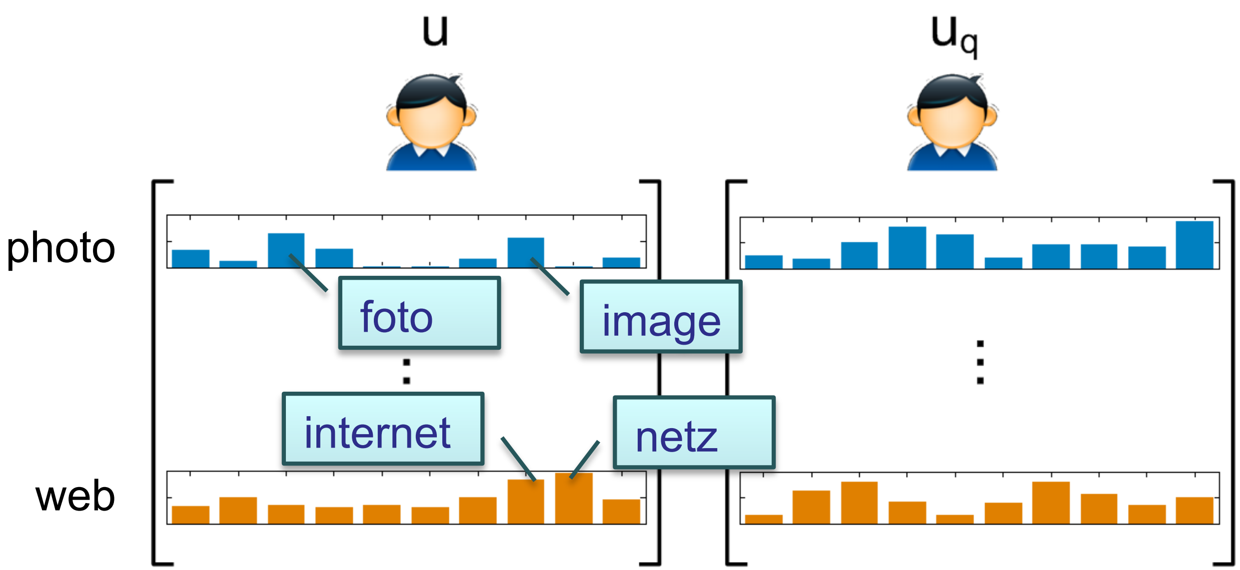


$$p(t|r_q,u) = \sum_{t_r \in \mathbf{t}_r} p(t|u,t_r) \times p(t_r|r_q)$$
$$p(t|u,t_r) = \sum_{r \in \mathbf{r}_u} p(t|r,u) \times p(r|t_r)$$

[Wetzker et al. 2009]

Measuring Similarity between Users

- sim(u,u_q)
  – assuming that *users are similar if they perform similar translations*
- User profile



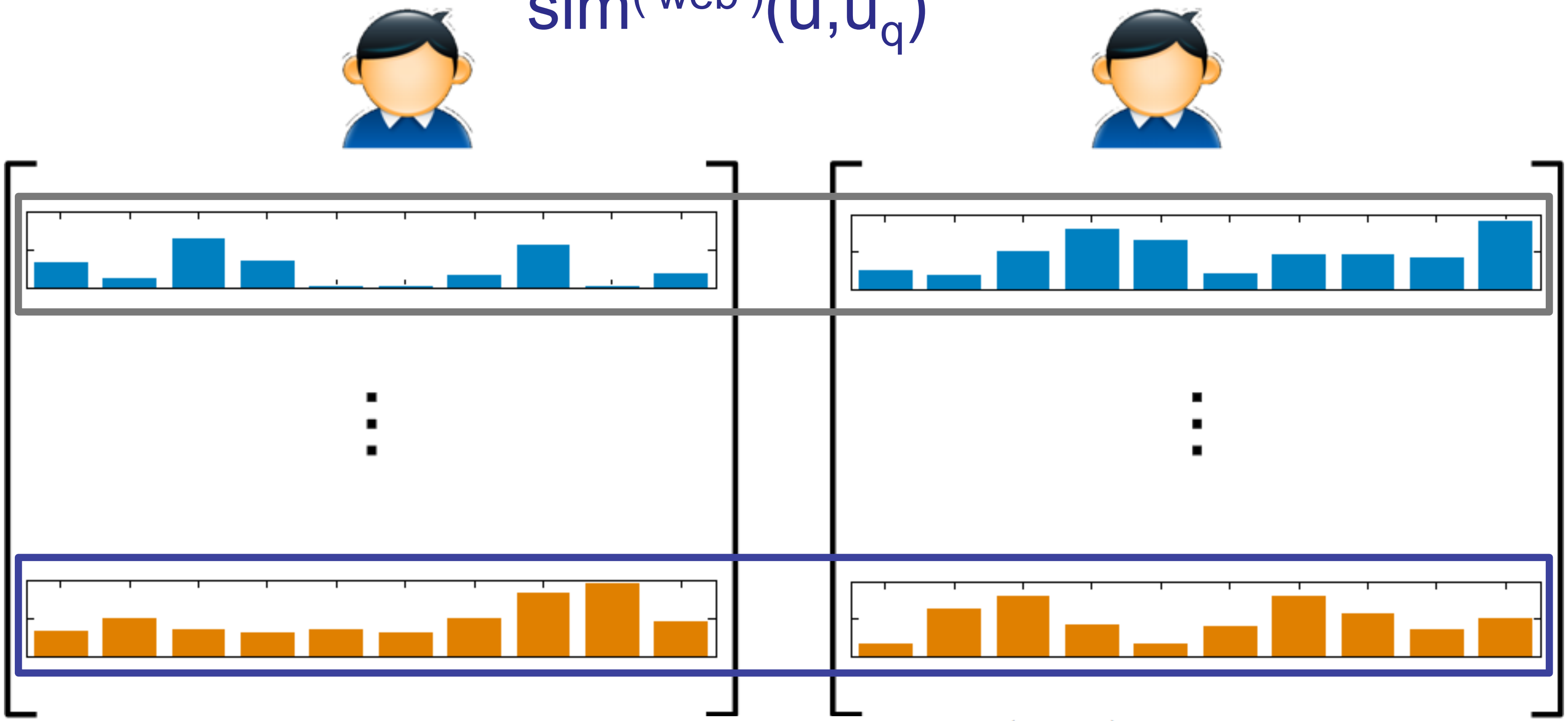
Distributional Divergence between Users

$sim^{(\text{'photo'})}(u,u_q)$ $\Sigma_{tr}\, sim(u,u_q)$

⋮

$sim^{(\text{'web'})}(u,u_q)$

u $\qquad$ u_q



$$sim_{JS}(X,Y) = 10^{-\beta D_{JS}(X,Y)}$$

Ref. [Lee 1997]

Remark on the 3 Scenarios

- This framework is able to address all three scenarios

$$p(t|r_q, u_q) = \frac{\sum_u sim(u, u_q) \times p(t|r_q, u)}{\sum_u sim(u, u_q)}$$

  - addresses scenario 1 by allowing self-translation, e.g., p('photo'|u,'photo')
  - addresses scenario 2 by allowing the query to be most similar to himeself, e.g., $sim(u_q,u_q)$
  - addresses scenario 3 by enabling borrowed translations

1. Data Collection
2. Experimental Setup
3. Recommendation Performance

EXPERIMENTS

Dataset from BibSonomy

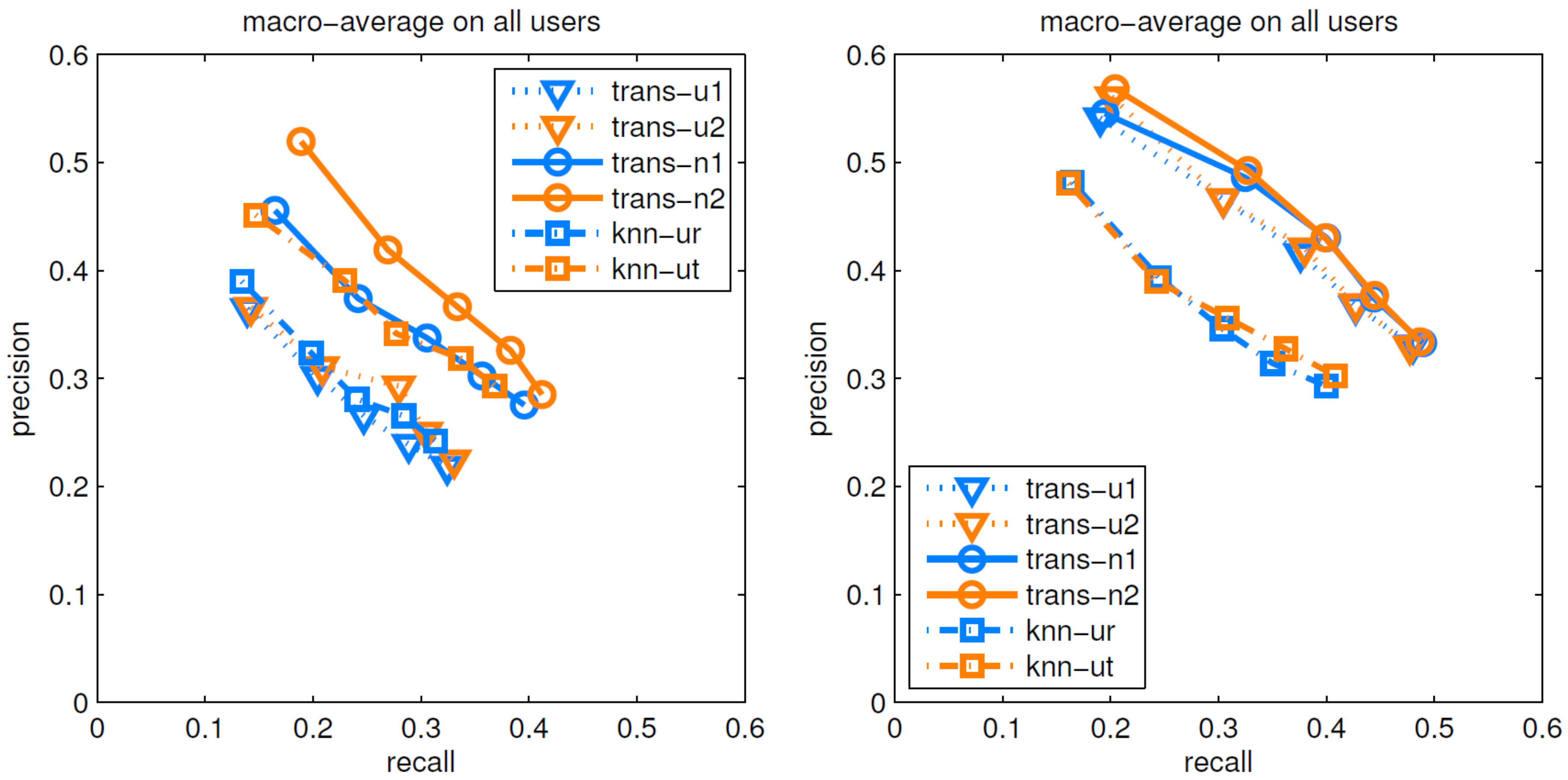
	train	validation	test
time frame	start ~ DEC 08	JAN 09 ~ JUL 09	JUL 09 ~ DEC 09
number of resources	22,389	667	258
number of users	1,185	136	57
number of tags	13,276	862	525
number of assignments	253,615	2,604	1,262
average posts per user	53.695	5.699	4.895
average tag tokens per user	3.955	3.360	4.523
average distinct tags per user	61.833	13.191	14.667

Note:
users in test set must have been appeared in validation set.

Experimental Setup

- Methods to compare
  - trans-n1, trans-n2
  - trans-u1, trans-u2
    - [Wetzker et al. 2009], [Wetzker et al. 2010]
  - knn-ur, knn-ut
  - interpolating with freq-r
- Evaluation metric
  - pr-curve at top 5
  - macro-average for users
- Parameter tuning
  - macro-average f1@5
  - global vs. individual settings

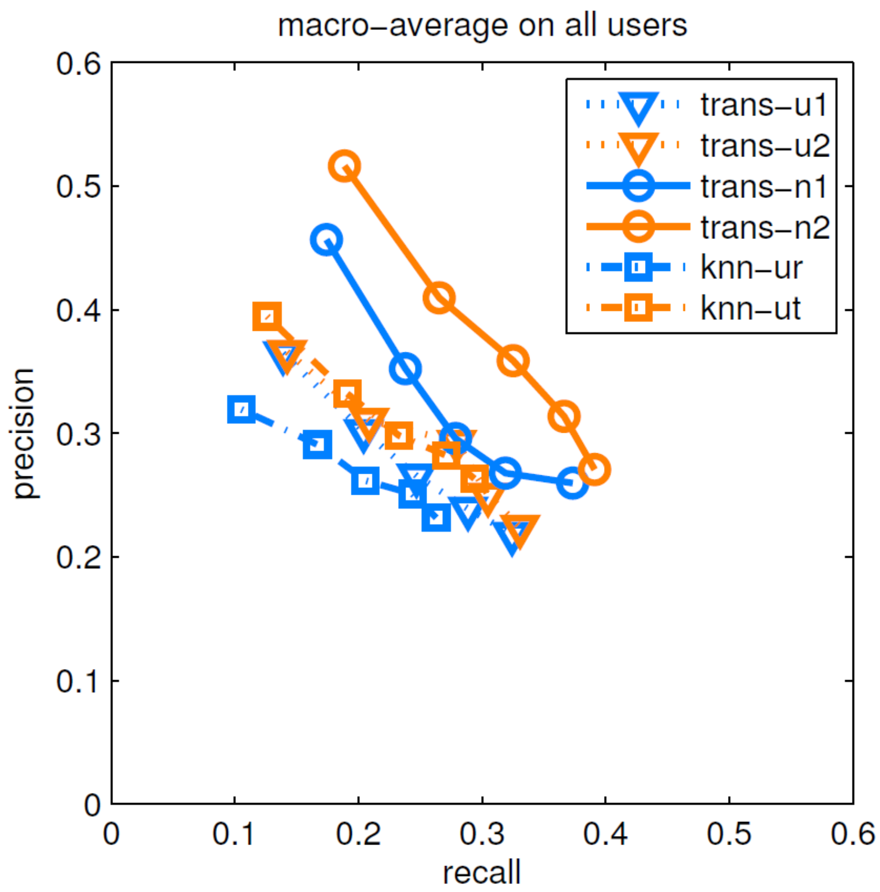
Recommendation Performance
Global Setting



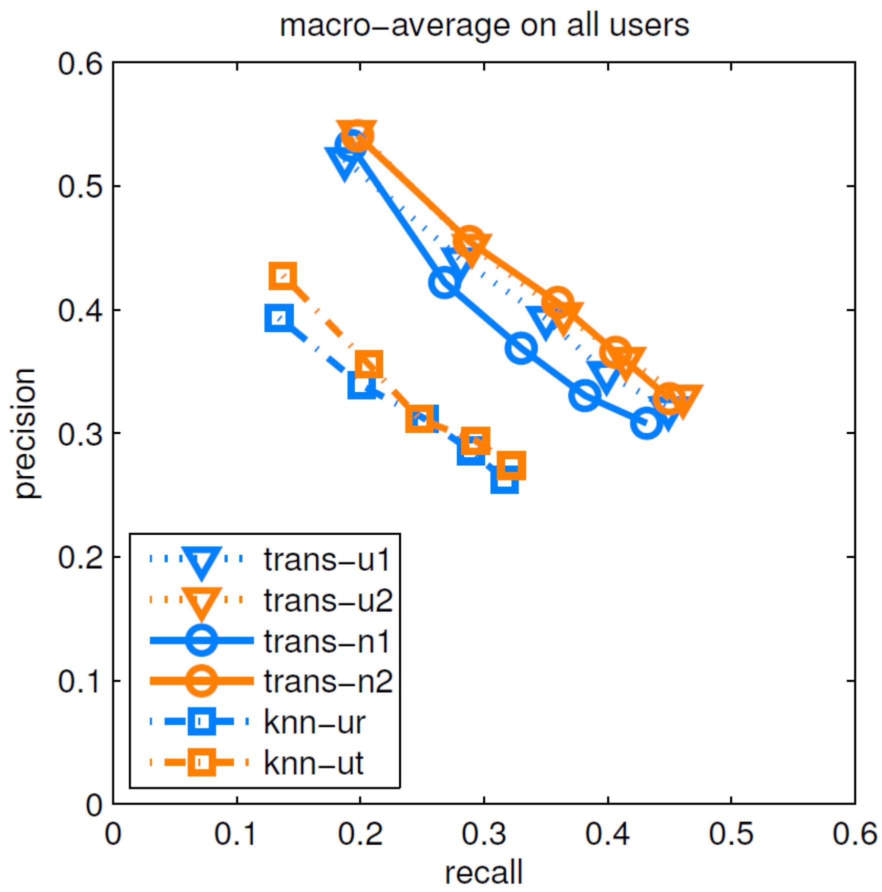
(a) Global Setting, without freq-r

(b) Global Setting, with freq-r

Recommendation Performance Individual Setting



(c) Individual Setting, without freq-r



(d) Individual Setting, with freq-r

Recommendation Case Study

u	r	tags assigned	top 5 recommendations		
			trans-u1	trans-n1	freq-r
920	a45 … 57f	2008, bookmarking, folksonomy, social, spam, folksonomies, tagorapub, web20, 20, integpub, systems, tagger, web	diplomathesis captcha folksonomybackground closelyrelated folksonomy	**folksonomy** tagging **social** **web20** **web**	**spam** **social** myown mining **folksonomy**
1119	d16 … b50	it, news, technology, blog, feed, technologie	kultur online radio kunst cd	**news** web20 **blog** software **technology**	newsticker **news** pc langde heise
3217	467 … 655	annotation, ontology, knowledge, semantic	sql erd eclipse	tagging folksonomy **ontology** web20 **semantic**	tools survey smilegroup semantics **ontology**

scenario 3 tags

Conclusion

- We propose a probabilistic framework for solving the personalized tag recommendation task, which incorporate personomy translation and borrowing translation from neighbors.
- We devise to use distributional divergence to measure similarity between users. Users are similar if they exhibit similar translation behavior.
- We find the proposed methods give superior performance than translation by the query user only and classic collaborative filtering.

Future Work

- Performance gain in successfully recommending scenario 3 tags.
  - e.g., compared with freq-r
  - e.g., resources that are inadequately tagged

- Recommendations strategies from the resources' perspective.

Thank you

References

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