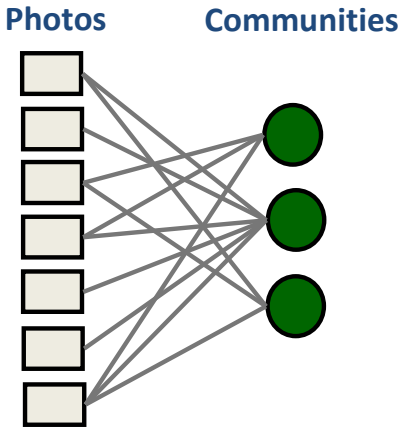
Connecting Content to Community in Social Media

Via image content, user tags and user communication



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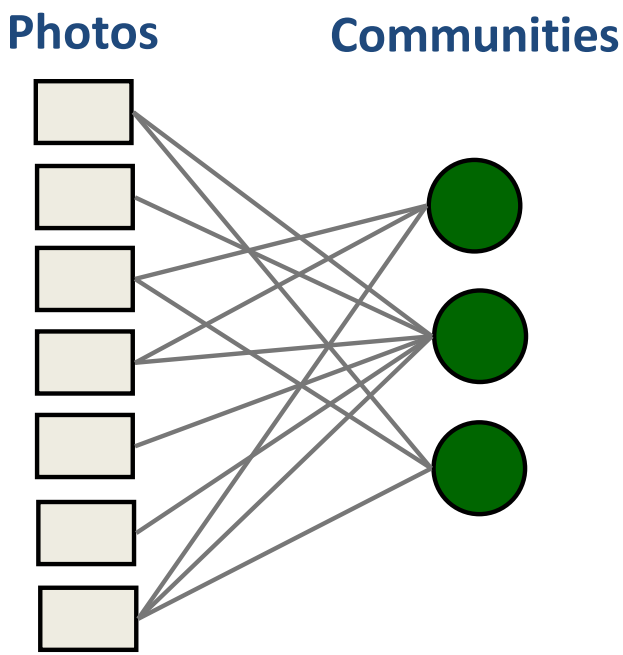
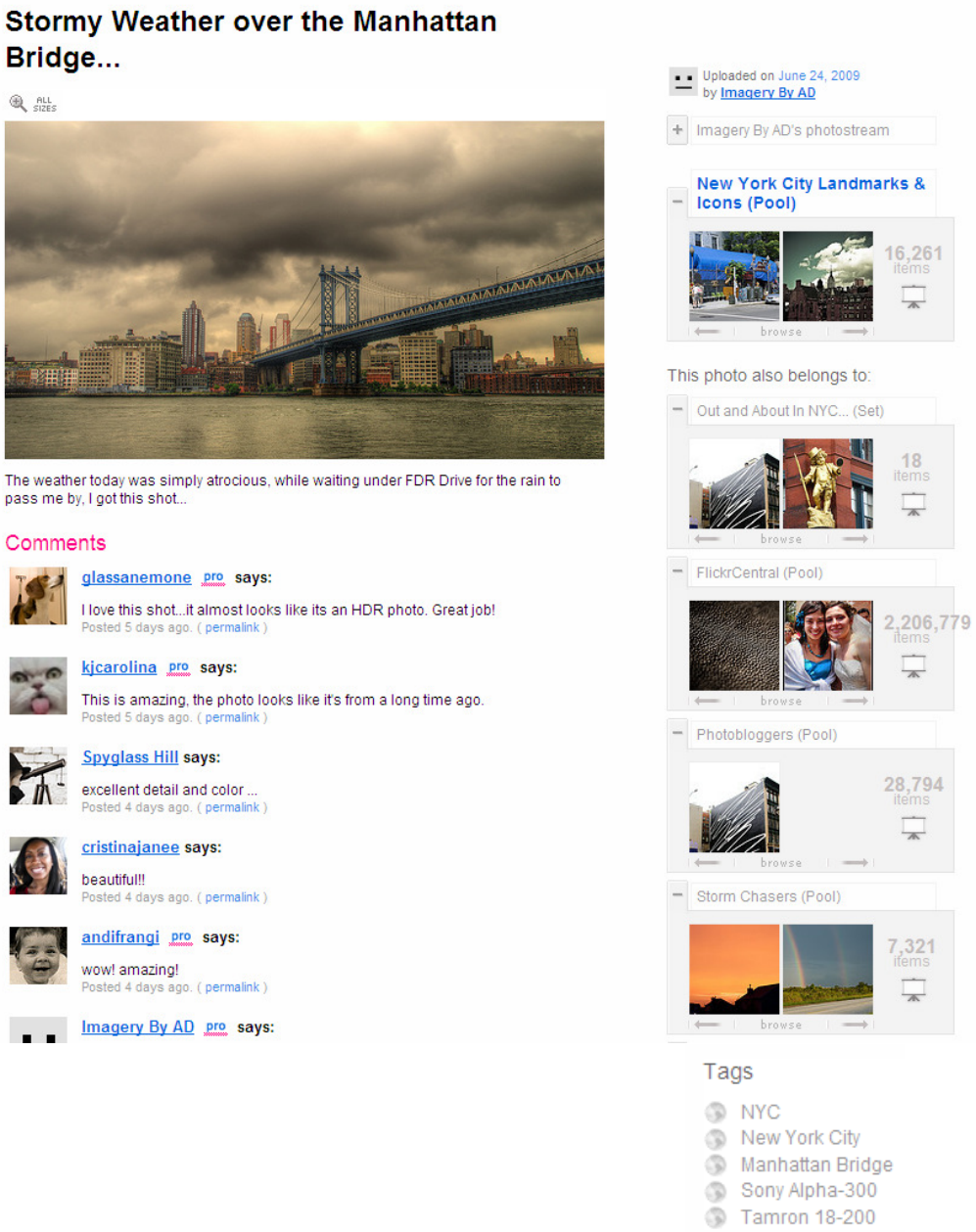
@ ICME 2009



The Problem

Given an image, how do we recommend the relevant communities that would enable social interaction and enhance its “reachability” to other users?

Community contributed social media…



Media-sharing

Concept-sharing (tagging)

Communication (commenting)

Nature and Colors

Canon 350D

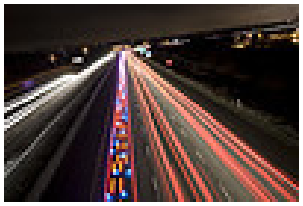
Travel

New York City

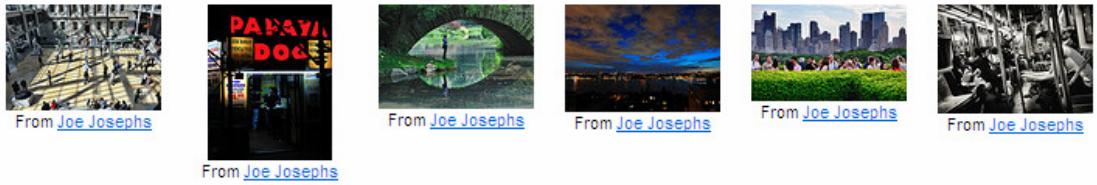
Pleasure

Long Exposure

Portraiture Photography



New York City Landmarks & Icons

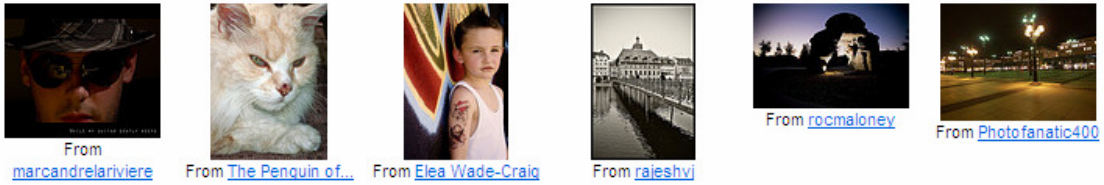


?

b&w new york city (& the people in it)

?

Photography Critique



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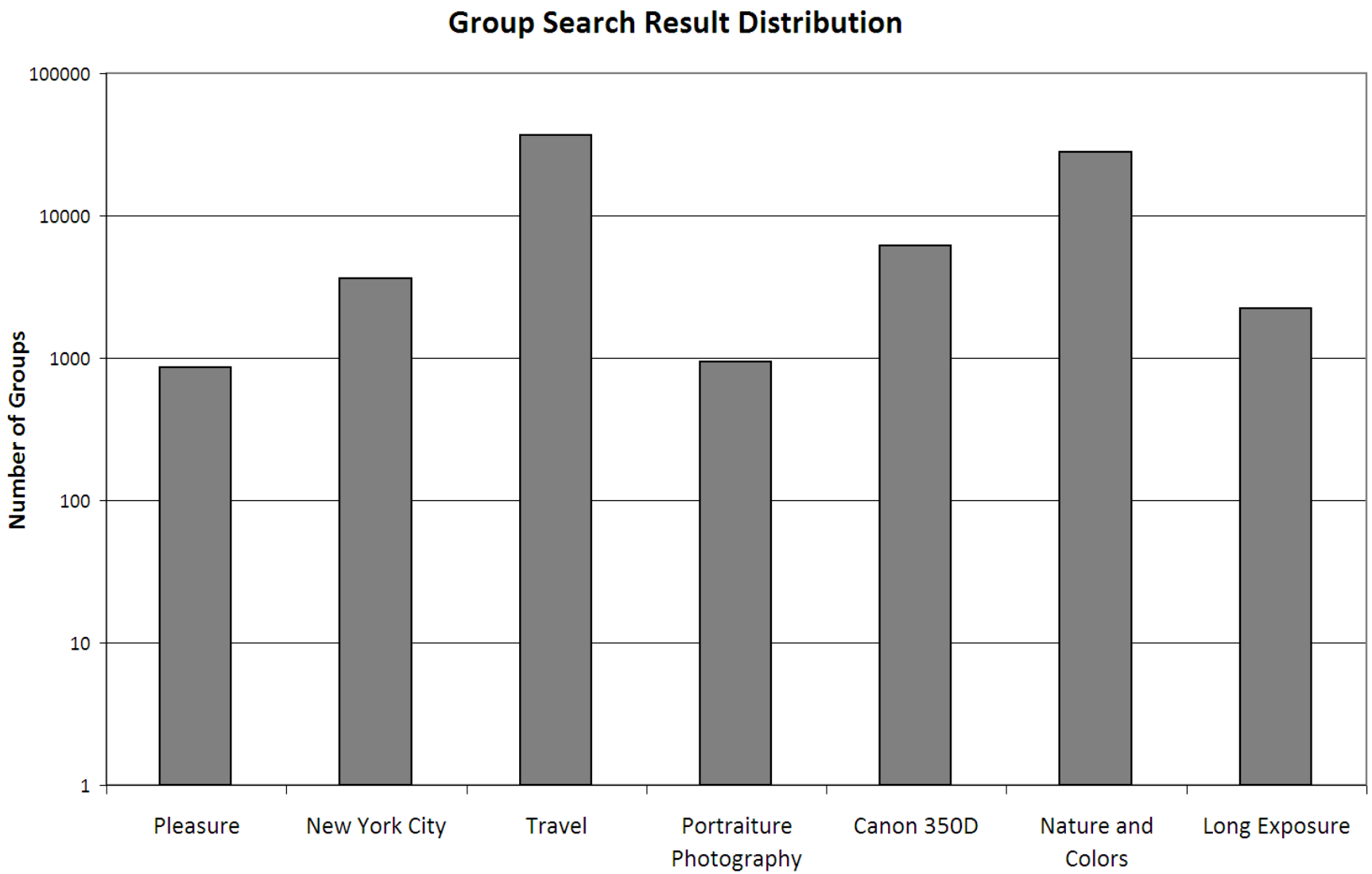
Why is this problem challenging?

An empirical observation…

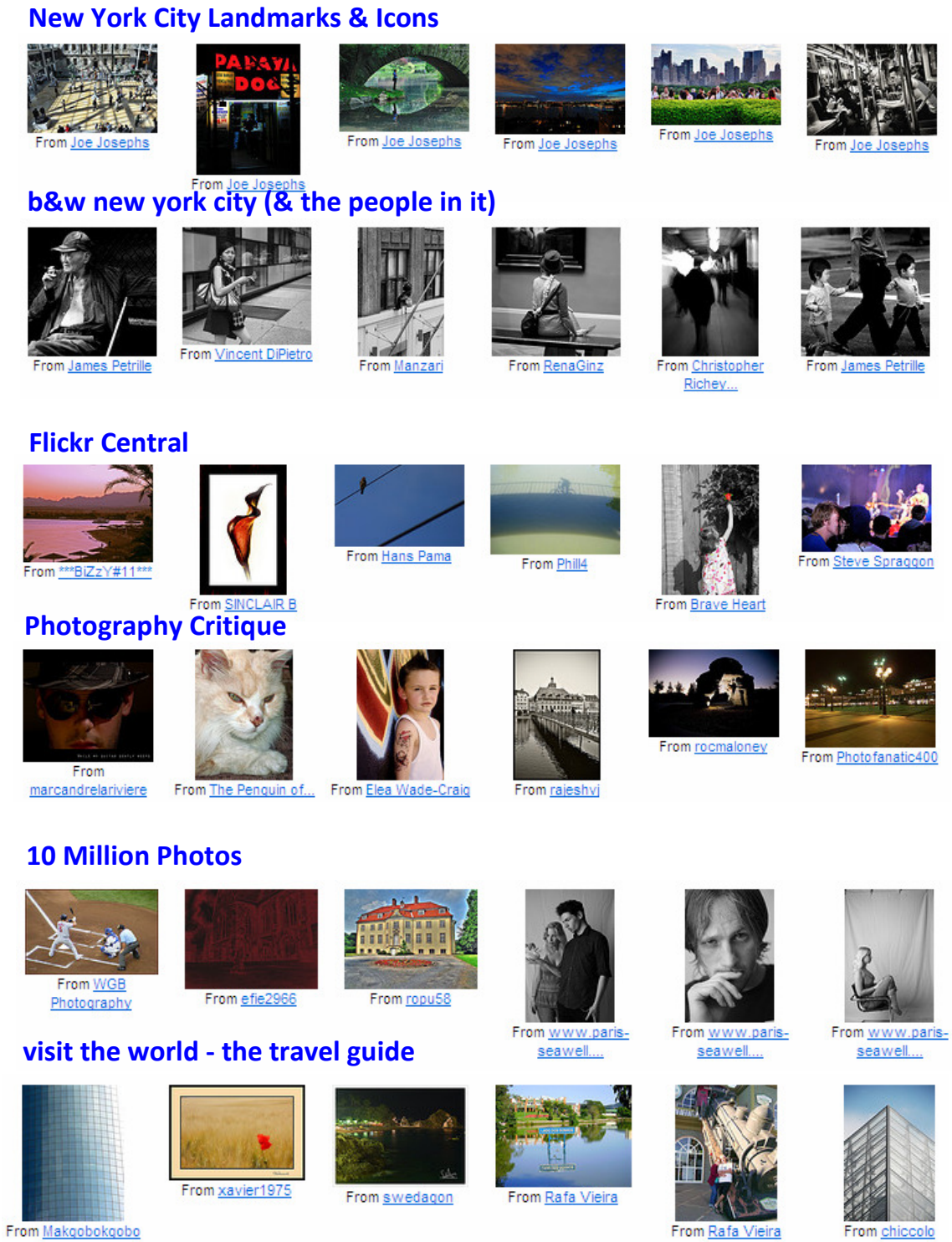


Simple keyword search returns too many groups!

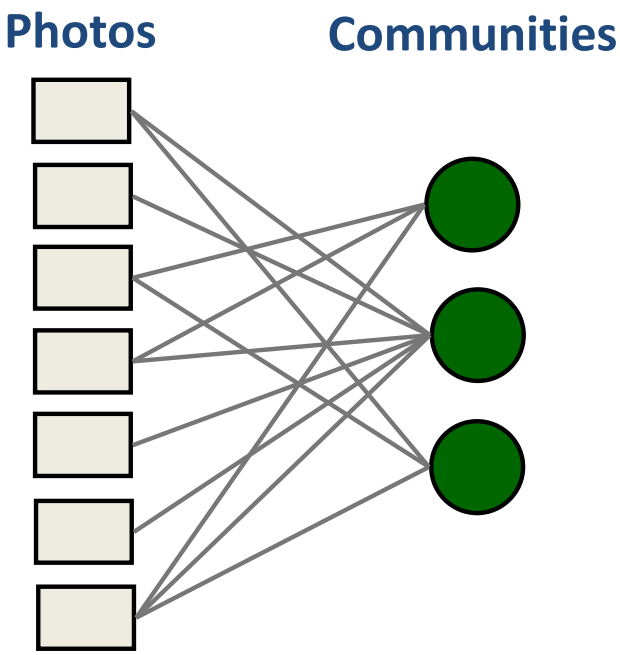
“Most relevant”

“Most recent activity”

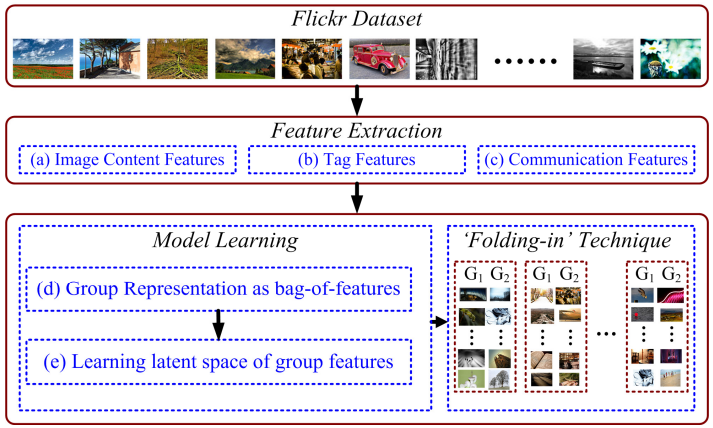
“Group size”



Quality of content?
Community practices?
Richness of communication?

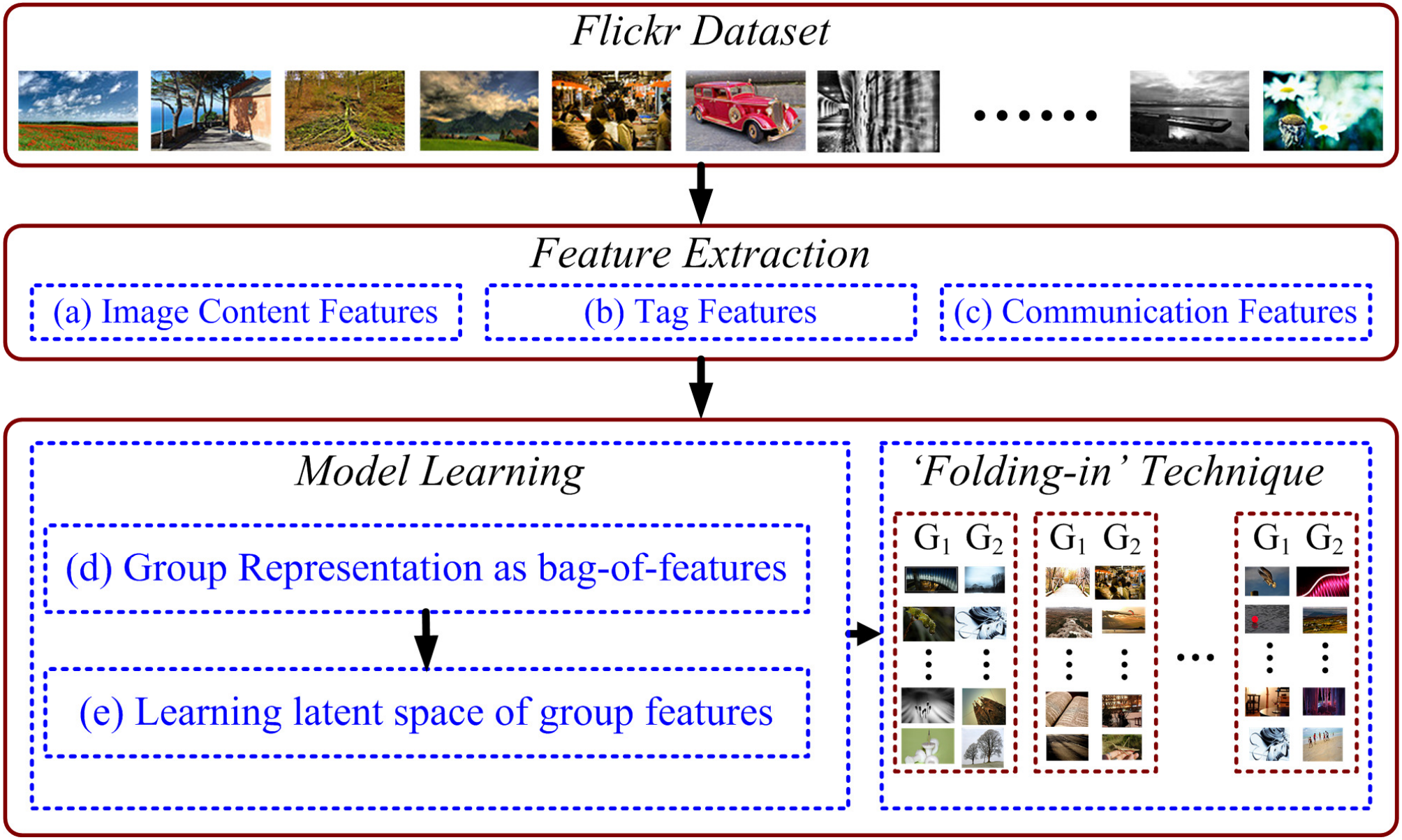


I want to find the *right* set of communities for my photos… help!

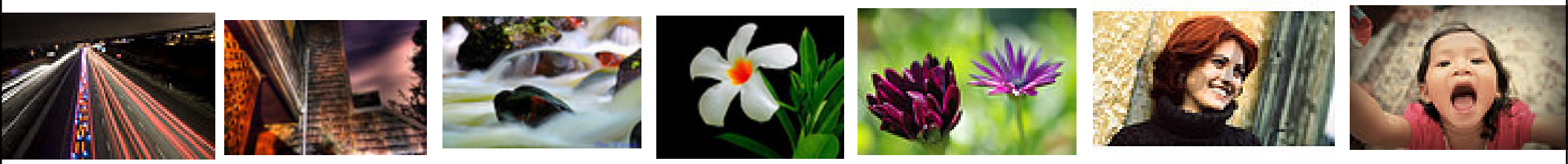

Flickr Dataset
Feature Extraction
(a) Image Content Features
(b) Tag Features
(c) Communication Features
Model Learning
(d) Group Representation as bag-of-features
(e) Learning latent space of group features
'Folding-in' Technique
G1 G2
G1 G2
G1 G2

Approach

System Overview



Feature Extraction



$$\vec{\mathbf{f}}_i = \left[\alpha_1 \vec{\mathbf{C}}_i,\ \alpha_2 \vec{\mathbf{T}}_i,\ \alpha_3 \vec{\mathbf{O}}_i\right]$$

Image content features –

color histogram, color moment, GLCM, phase symmetry, radial symmetry, phase congruency, SIFT, $\mathbf{C}_i \in \Re_+^{1\times m}$

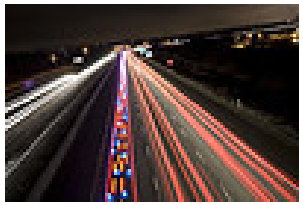
User tagging history features –

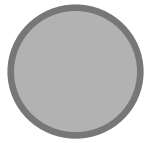
frequency distribution of user tags in the past, $\mathbf{T}_i \in \Re_+^{1\times n}$

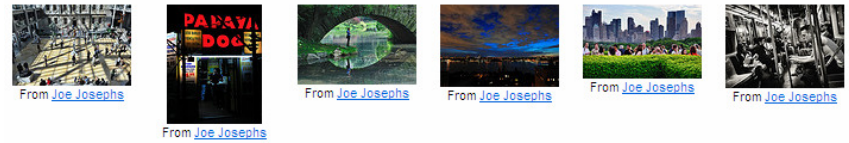
User communication features –

frequency of comments by the user on various groups, $\mathrm{O}_i \in \Re_+^{1\times p}$

Image-group association often depends upon latent intent of the user – based on content, her prior tagging activity or communication…







$$\vec{\mathbf{f}}_i = \left[\alpha_1 \vec{\mathbf{C}}_i,\ \alpha_2 \vec{\mathbf{T}}_i,\ \alpha_3 \vec{\mathbf{O}}_i\right]$$

latent state, z_i

group, G_j, $\mathbf{Y}_j = \frac{1}{|G_j|} \sum_{i \in G_j} \mathbf{f}_i$

Probability of recommending group G_j to image i:

$$P(G_j \mid i) \propto P(G_j, i)$$

$$P(G_j, i) = \sum_z P(z).P(i \mid z).P(G_j \mid z)$$

$$\propto \sum_z \boxed{P(z \mid i)}.\boxed{P(G_j \mid z)}$$

Model learning

Folding-in technique

Model Learning –

maximize the expectation of the feature space F_m of the groups G_j

$$E\text{-step: } P(z \mid F_m, G_j) = \frac{P(z).P(F_m \mid z).P(G_j \mid z)}{\sum_{z'} P(z').P(F_m \mid z').P(G_j \mid z')}.$$

$$M\text{-step: } P(G_j \mid z) \propto \sum_m \mathbf{Y}_{m,j}.P(z \mid F_m, G_j),$$

$$P(F_m \mid z) \propto \sum_j \mathbf{Y}_{m,j}.P(z \mid F_m, G_j),$$

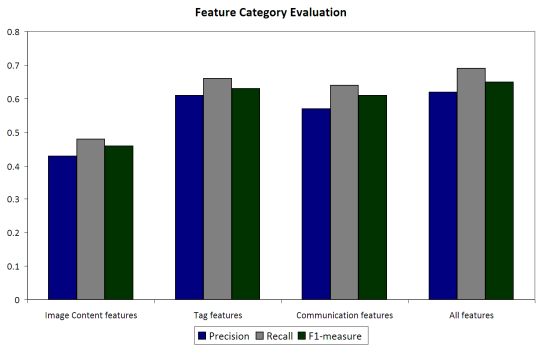
$$P(z) \propto \sum_m \sum_j \mathbf{Y}_{m,j}.P(z \mid F_m, G_j).$$

Folding-in Technique –

for a new image *i*, maximize the expectation of the feature space F_m given the latent state *z*

$$E\text{-step: } P(z \mid i, F_m) \propto P(F_m \mid z).P(z \mid i).$$

$$M\text{-step: } P(z \mid i) \propto \sum_m \mathbf{Z}_{m,i}.P(z \mid i, F_m),$$



Experimental Results

Flickr Dataset

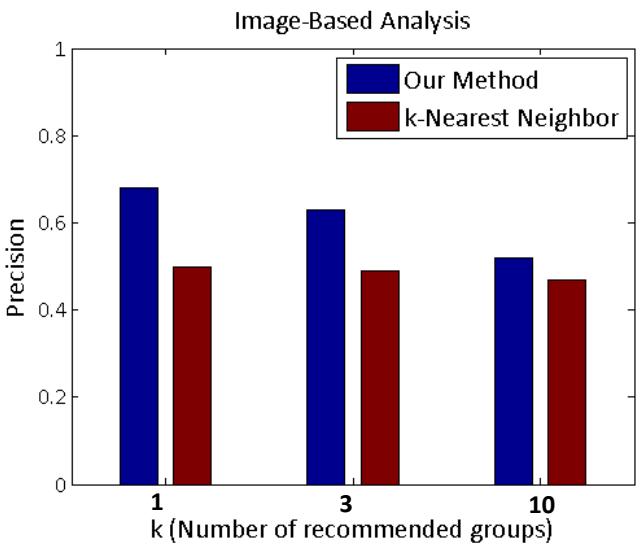
- Seed crawling from images ranked by Flickr's proprietary "interestingness" criterion.
- 15,689 images
- 925 groups
- Upload time period from March 21, 2008 to August 20, 2008

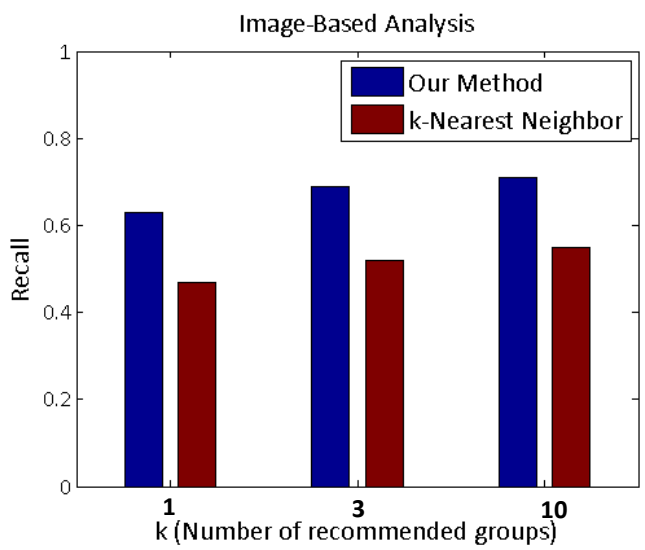
Mean number of tags per photo	6
Mean number of groups per photo	3
Mean number of comments per photo	14

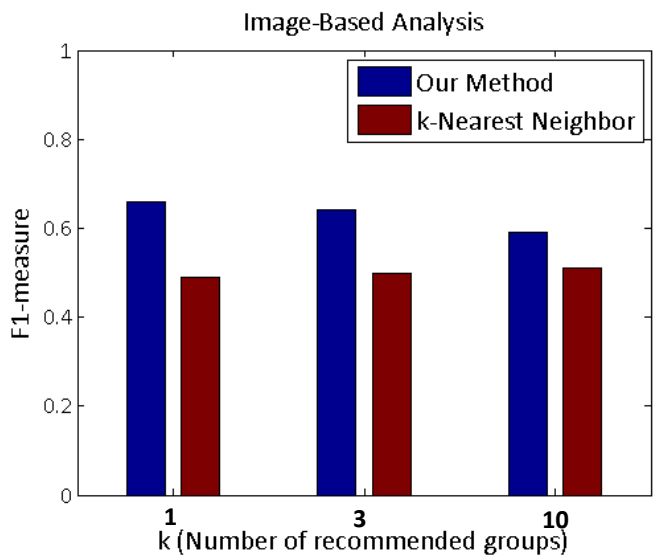
Evaluation of Recommendations

Experimental Setup:

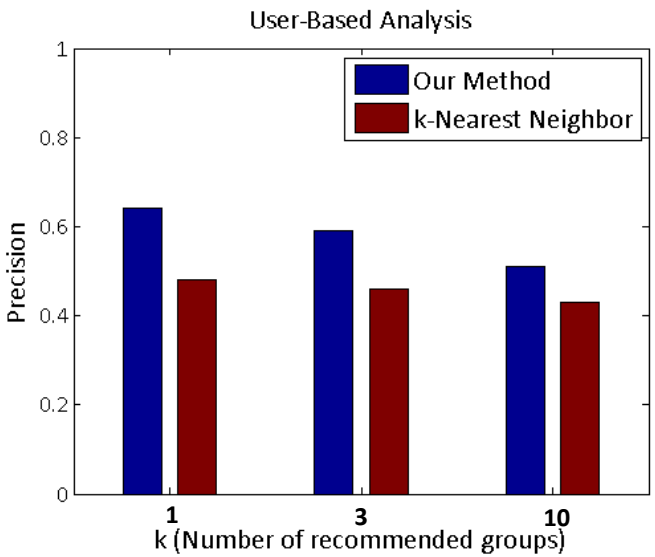
- 80% training (12,551 images) , 20% testing (3,138 images)
- Metrics are computed at *k*=1, 3, 10
- Three recommendation analysis scenarios:
  - *Image-based*
  - *User-based*
  - *Group-based*

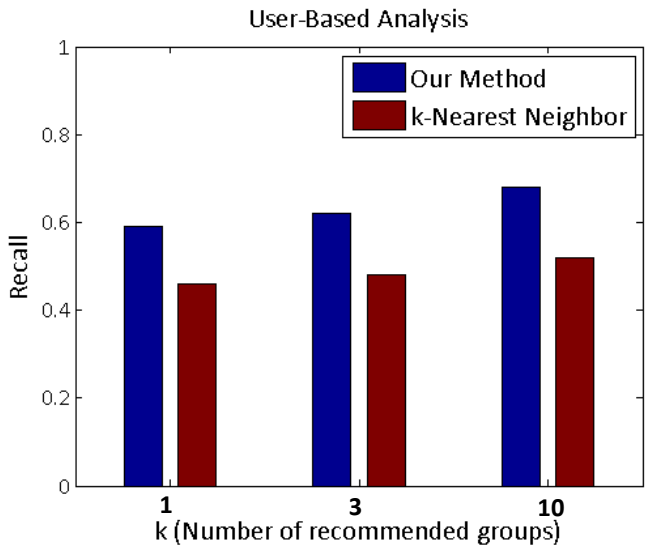


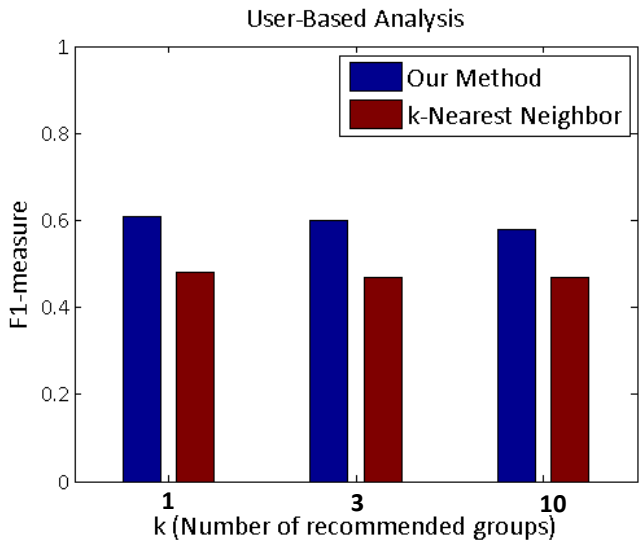


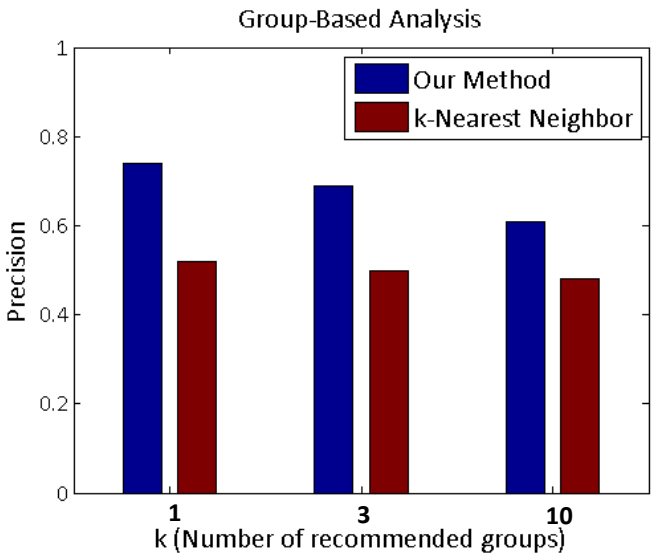


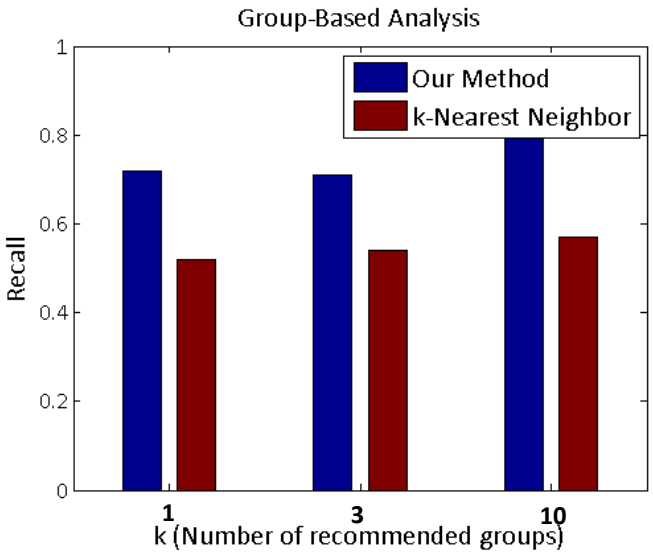
Evaluation of Recommendations

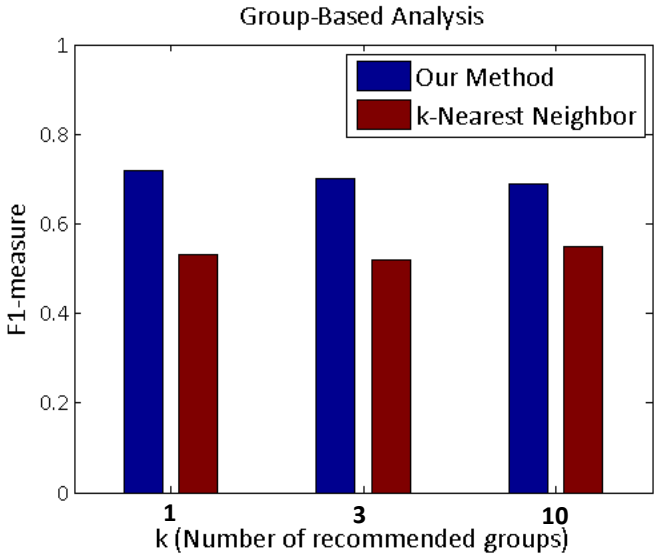








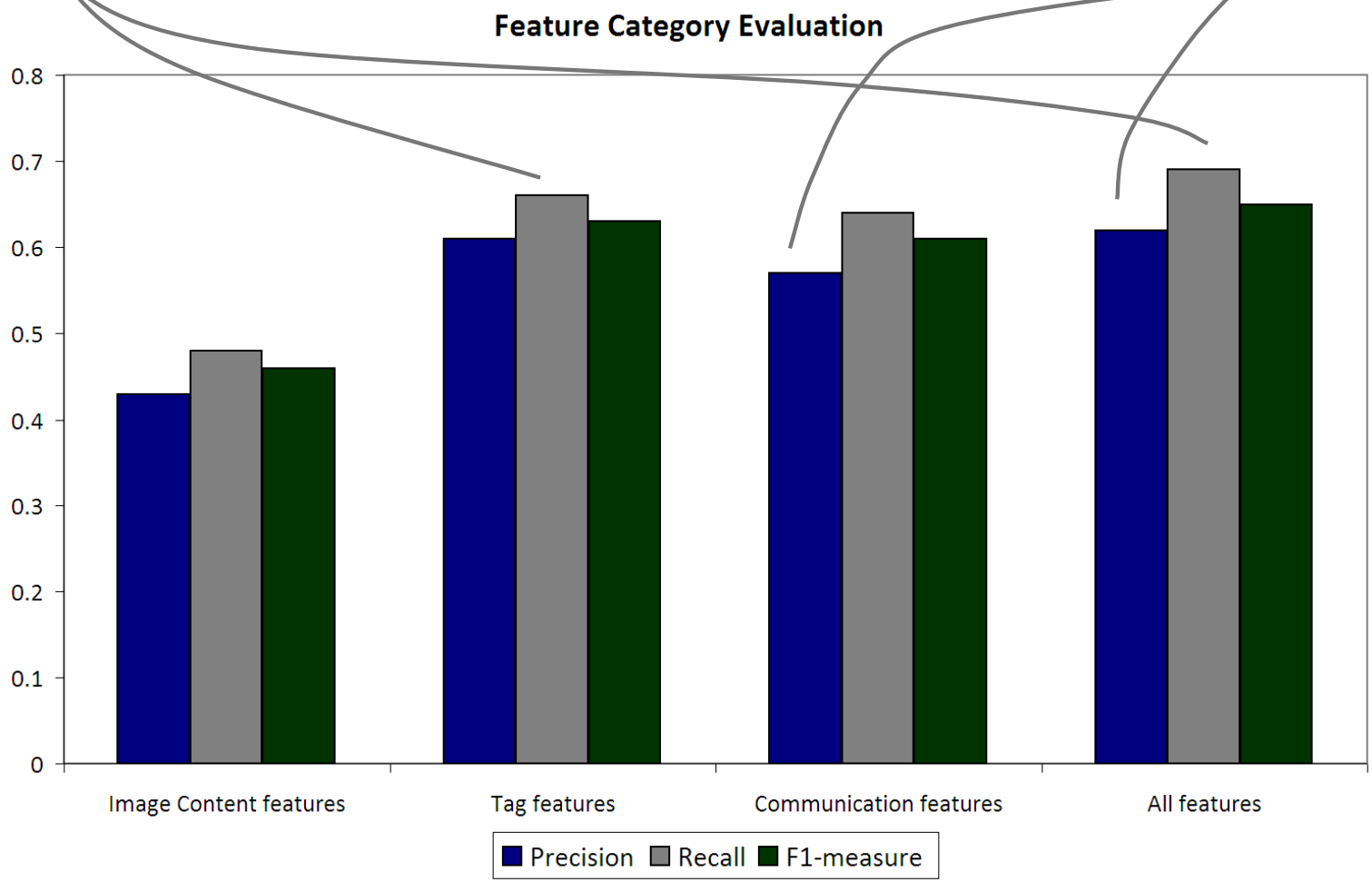


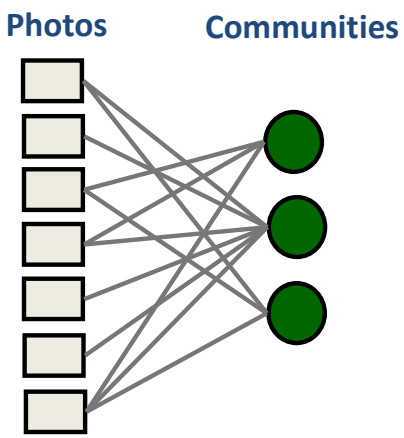


Evaluation of Feature Categories

Significant improvement in recall over tag only features

Significant improvement in precision over communication only features

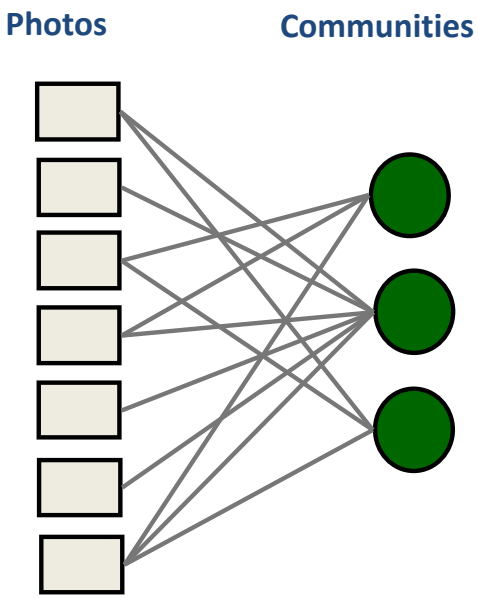


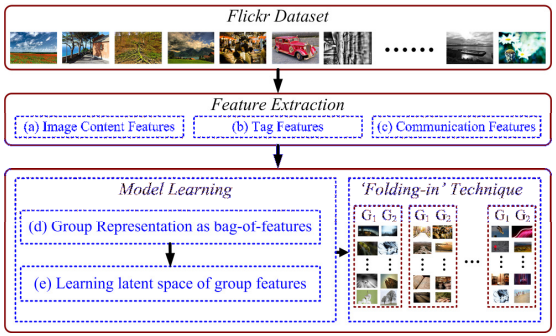


Conclusions

Problem:

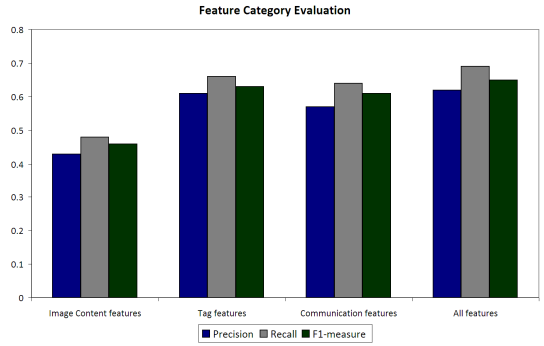
How do we connect shared media to relevant communities?





Approach:

Characterize relationship of images to communities via content, tags and communication



Results:

Meaningful recommendations of communities

Questions? Suggestions?

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Thanks!

Related Work

- Collective learning
  - Recommendation of books, movies; Schein, Popescul, Ungar et al 2002.
  - Dynamic evolution of the properties of the items not considered.
- Social media group and tag recommendation
  - Sigurbjornsson & Zwol 2008, Garg & Weber 2008, Chen, Chang, Chang et al 2008.
  - No consideration of social interaction.
- User behavior in social media groups
  - Negoescu & Gatica-Perez 2008.
  - Connection between media content and group behavior not explicit.