Content-Based Tag Processing for Internet Social Images

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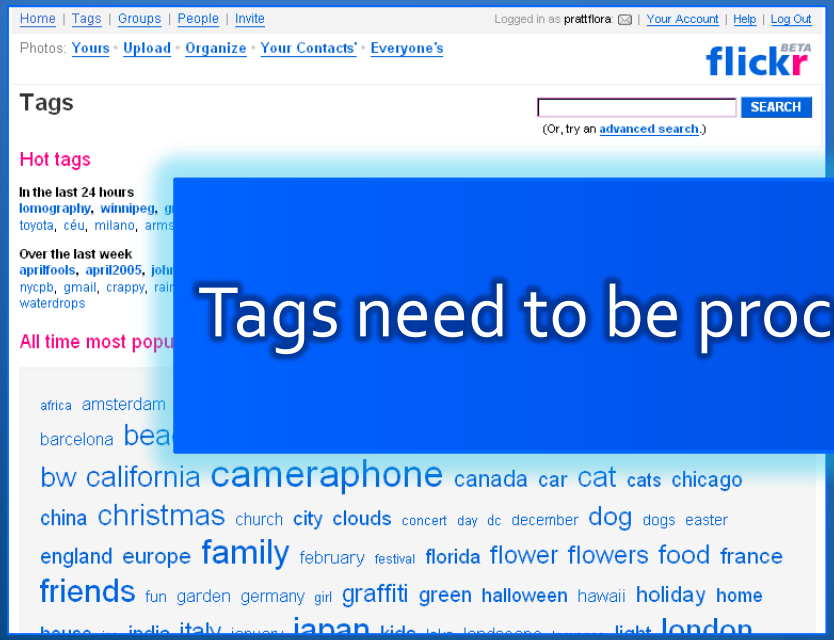
Internet Concept: Tag

- "Tag" has become one of the most popular Internet concepts in the last three years.
  - Tag
  - Social Network
  - Micro-blogging

Challenge

Social tags are good, but they are

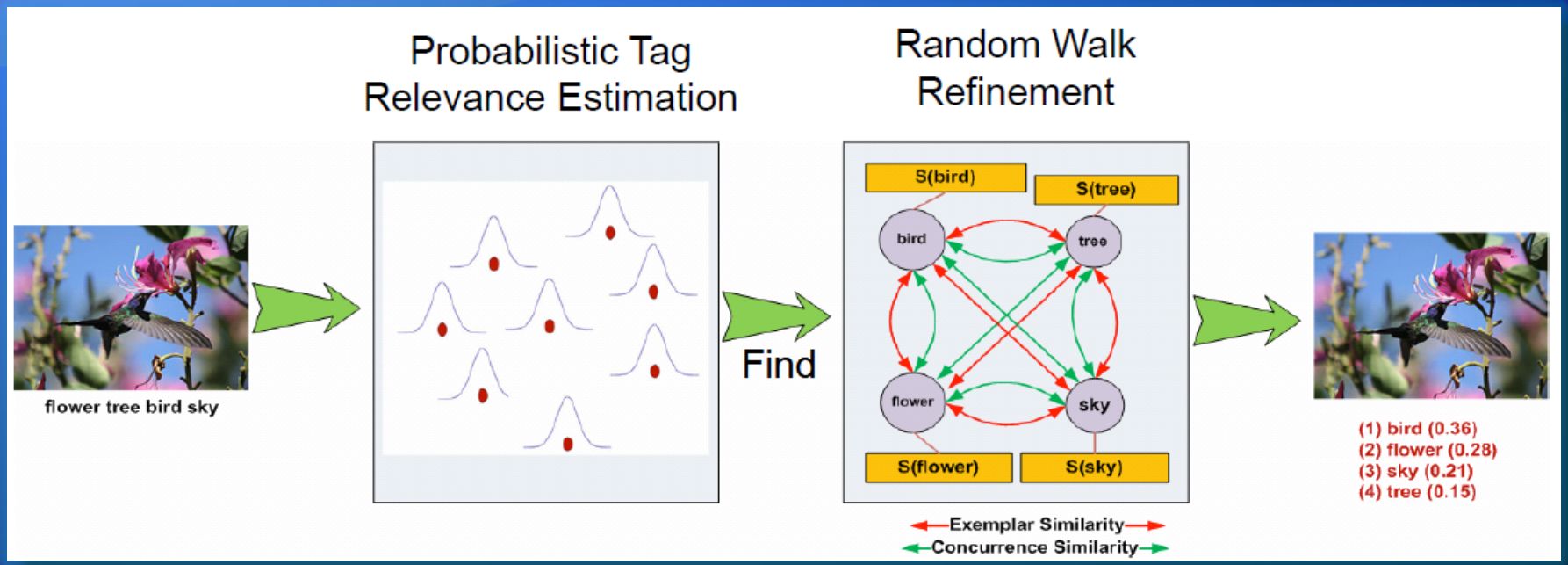
- Lack of relevance information
- Noisy and incomplete
- Annotated only at the image level



Tags need to be processed before using them.

Tag Ranking

Liu, Hua, Yang, Zhang, *Tag Ranking*, WWW09

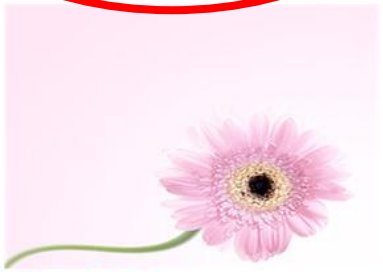


- *Basic Idea:*
  - Large *tag clusters* should be promoted.
  - Semantically close tags should be ranked closely.

Original Tag List:
blue winter sky white mountain snow photography gold nikon paradise view top greece drama
Ranked Tag List:
mountain sky white snow winter blue nikon photography view paradise gold greece top drama

Original Tag List:
ocean city summer brazil praia beach water architecture fantastic warm paradise desert great playa best resort arena
Ranked Tag List:
beach water ocean summer architecture fantastic paradise great resort playa city brazil best desert praia arena warm

Original Tag List:
blue pakistan portrait green bird nature yellow gold powershot karachi
Ranked Tag List:
bird nature blue green yellow portrait gold powershot pakistan karachi



Original Tag List:
pink light white flower green nature yellow spring flora gerbera
Ranked Tag List:
flower white pink nature light green yellow spring flora gerbera

Original Tag List:
sun sunlight animal cat kitten kitty gata gatto
Ranked Tag List:
cat kitty kitten animal sunlight sun gata gatto

Original Tag List:
family wedding friends sunset red sea love beach silhouette nikon flickr day colours maldives
Ranked Tag List:
sunset sea red beach nikon silhouette maldives love colours flickr friends family day wedding

Original Tag List:
park morning mist holland tree bird water fog duck baum
Ranked Tag List:
tree water bird fog park mist morning duck holland baum

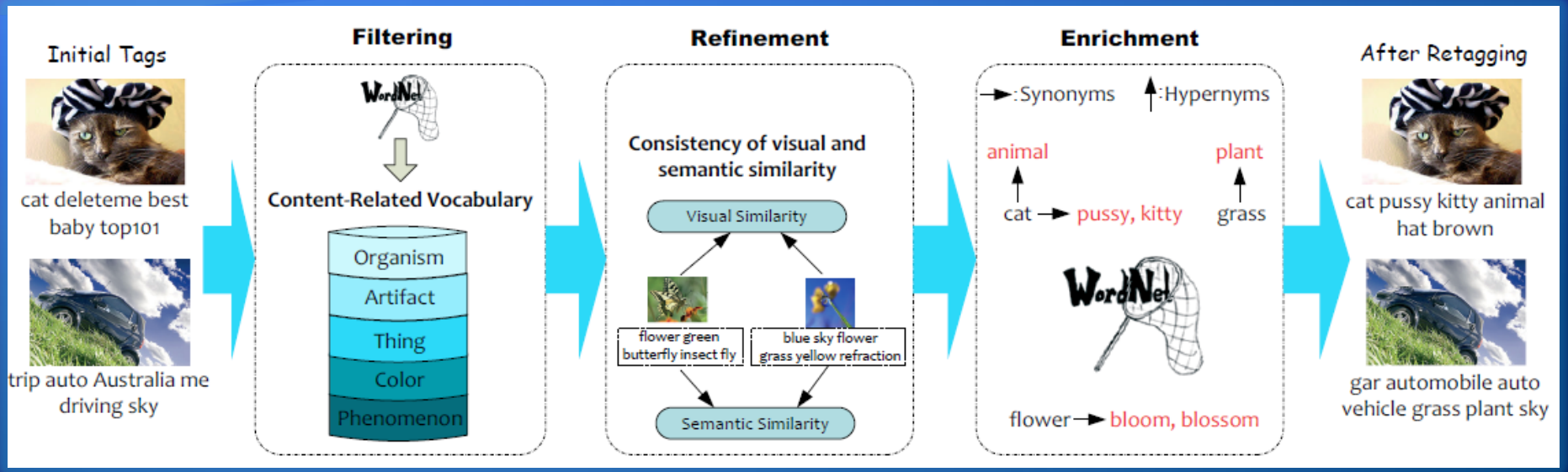
Original Tag List:
ocean travel blue sea water philippines adventure
Ranked Tag List:
sea water ocean blue travel philippines adventure

Original Tag List:
ferrari concept car auto automobile
Ranked Tag List:
automobile car auto ferrari concept

Image Retagging

Liu, X. Hua, H. Zhang, *Image Retagging*, MM10.

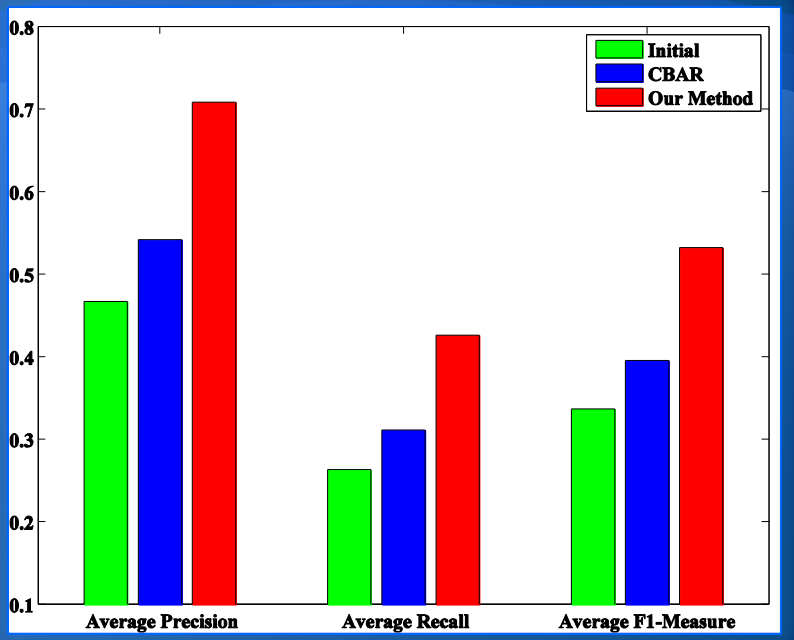
$$\min_{\mathbf{Y},\boldsymbol{\alpha}} \mathcal{L} = \sum_{i,j=1}^{n} (W_{ij} - \sum_{k,l=1}^{m} Y_{ik} S_{kl} Y_{jl})^2 + C \sum_{j=1}^{n} \sum_{l=1}^{m} (Y_{jl} - \alpha_j \widehat{Y}_{jl})^2 \exp(\widehat{Y}_{jl}),$$
$$s.t. \quad Y_{jl}, \alpha_j \geq 0, \quad j = 1, 2, \ldots, n, \quad l = 1, 2, \ldots, m.$$



- *Basic idea*
  - Assign *visually* similar images with similar tags.
  - Exclude the *content-unrelated* tags.
  - Expand the tags with *synonyms* and *hypernyms*.

Results

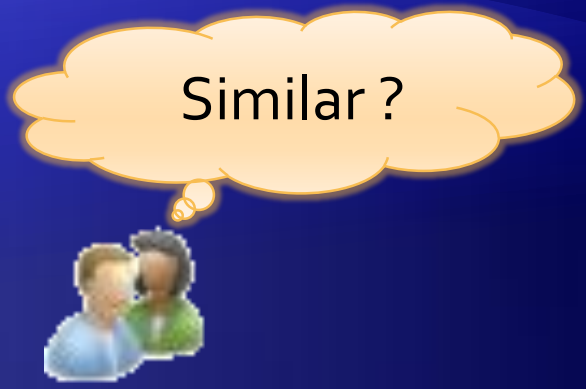
- In term of average precision,recall and F1-Measure
  - 50,000 Flickr images
  - 106,565 unique tags
  - 5000 test images (each tag was judged by human labelers to decide whether it is related to image content.)



Method	Precision	Recall	F1-Measure	Relevant tag number
Before Enrichment	0.71	0.34	0.46	3.09 (4.80 in all)
After Enrichment	0.90	0.66	0.76	9.34 (10.38 in all)

- After Tag enrichment, the tag quality is further improved.

Issue: image similarity



For concept *flower*: similar

For concept *dog*: dissimilar

- Whether two images are similar actually depends on what semantic tags we are caring about.
- Our Strategy: Learn tag-specific visual representation.

Tag-Specific Visual Vocabulary

Airplane

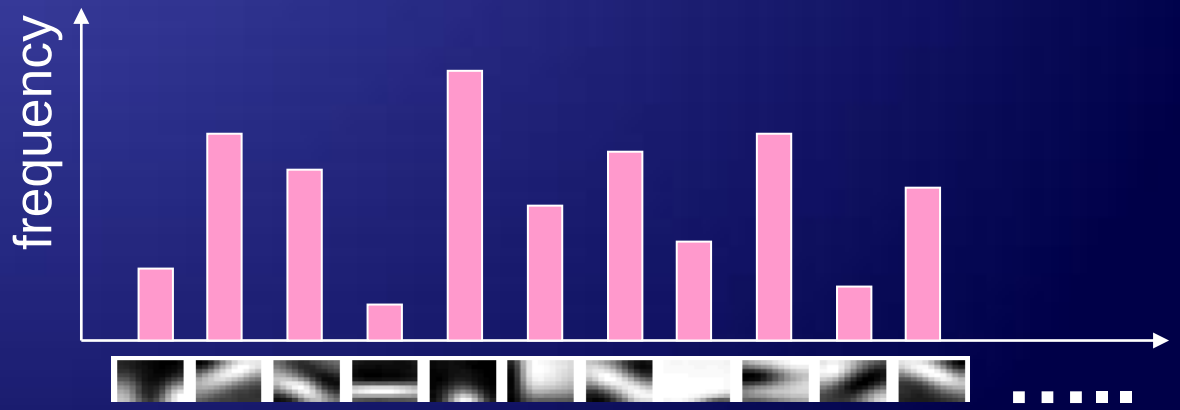
$$\min_{\mathbf{f}} \; Q(\mathbf{f}) = \sum_{i=1}^{N} (f_i - q_i)^2 + c_1 \sum_{i,j=1, i \neq j}^{N} o_{ij} (f_i - f_j)^2 - c_2 \sum_{k=1}^{M} P_{I_k},$$

$$s.t. \;\; 0 \leq f_i \leq 1, \;\; i = 1, 2, \ldots, N,$$

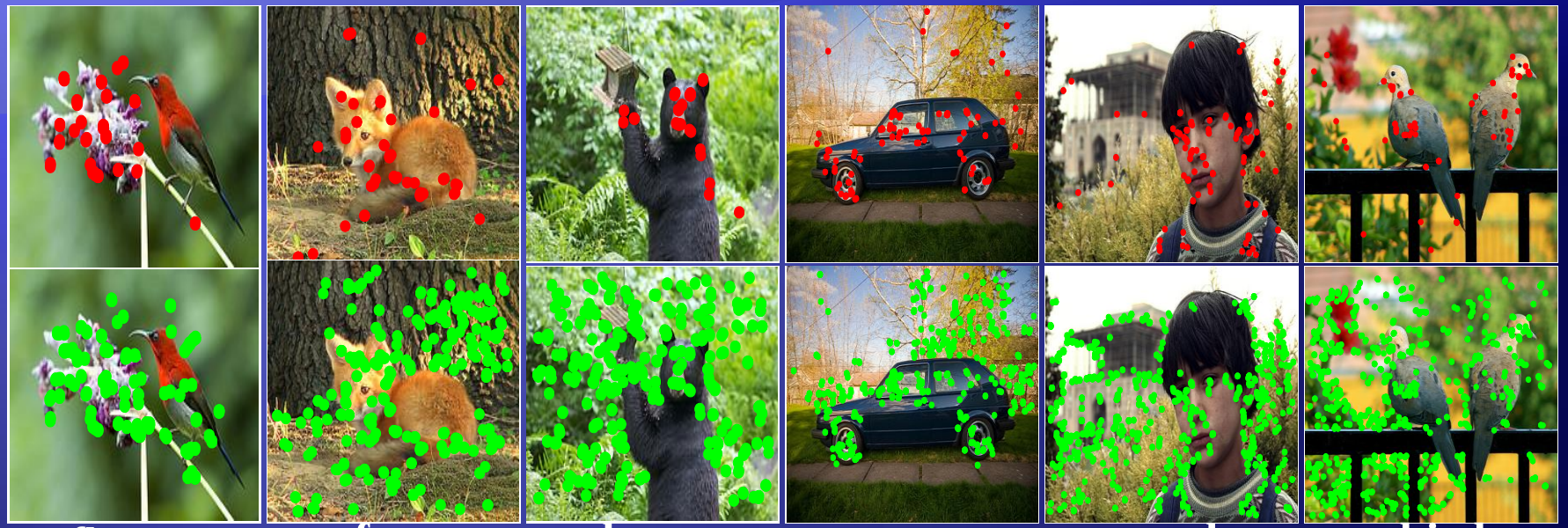
Noise-Tolerant Learning Algorithm

Visual Vocabulary for *airplane*

.....



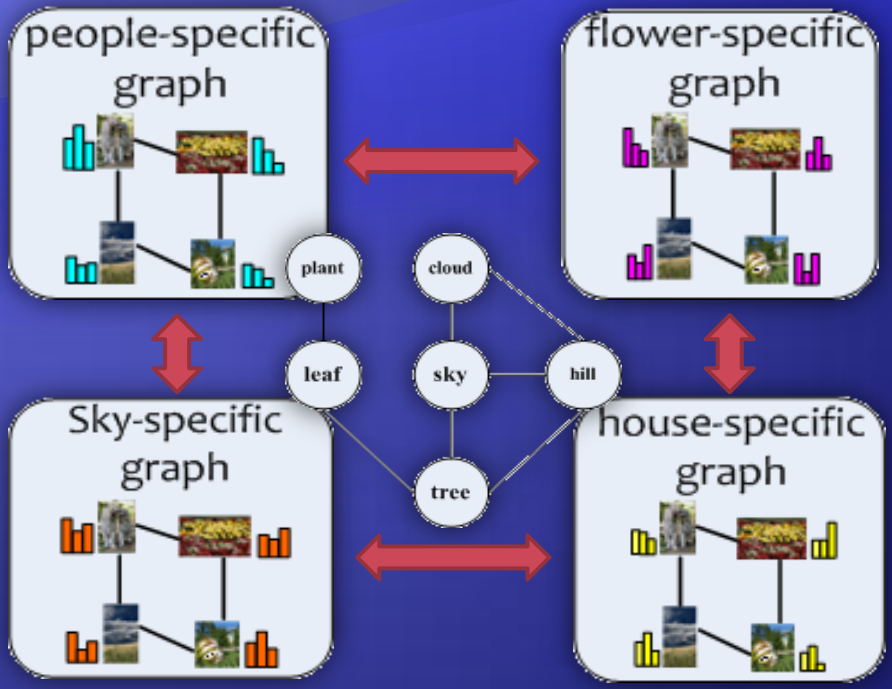
Tag-Specific Visual Vocabulary



- *Technical Contributions*
  - Descriptive visual vocabulary construction.
  - Learning with noises.

Collaborative Tag Propagation

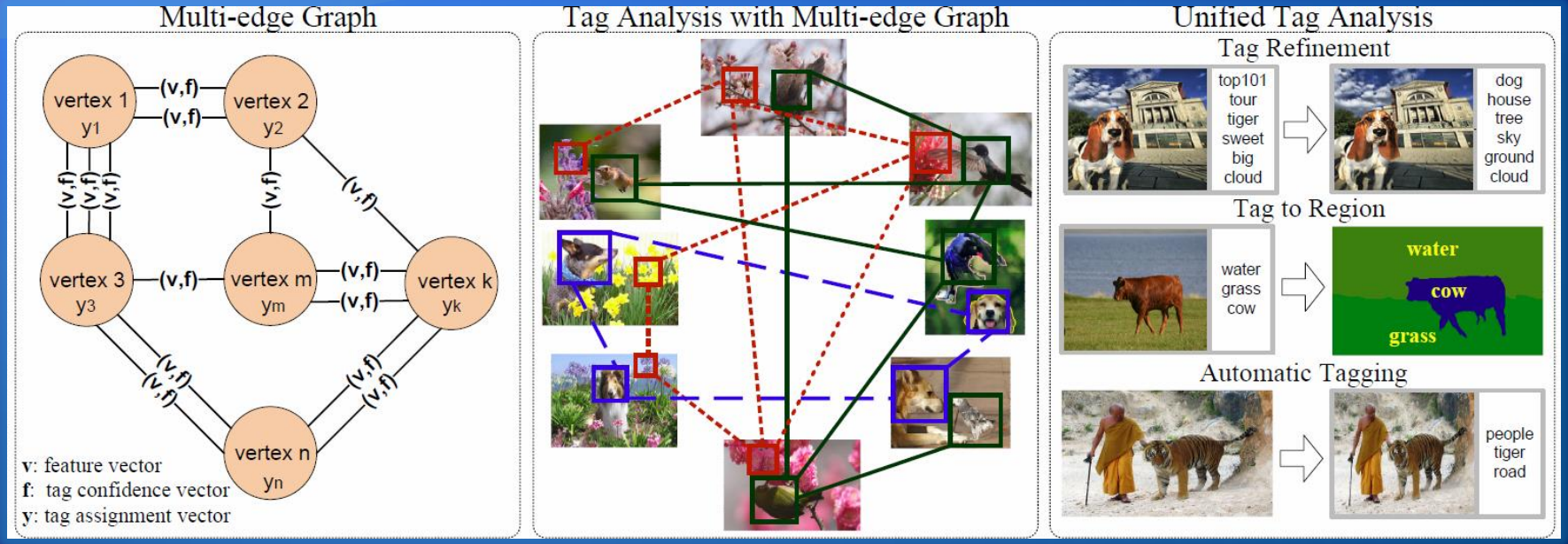
Liu, Yan, Hua, Zhang, *Collaborative Image Retagging*, IEEE TMM



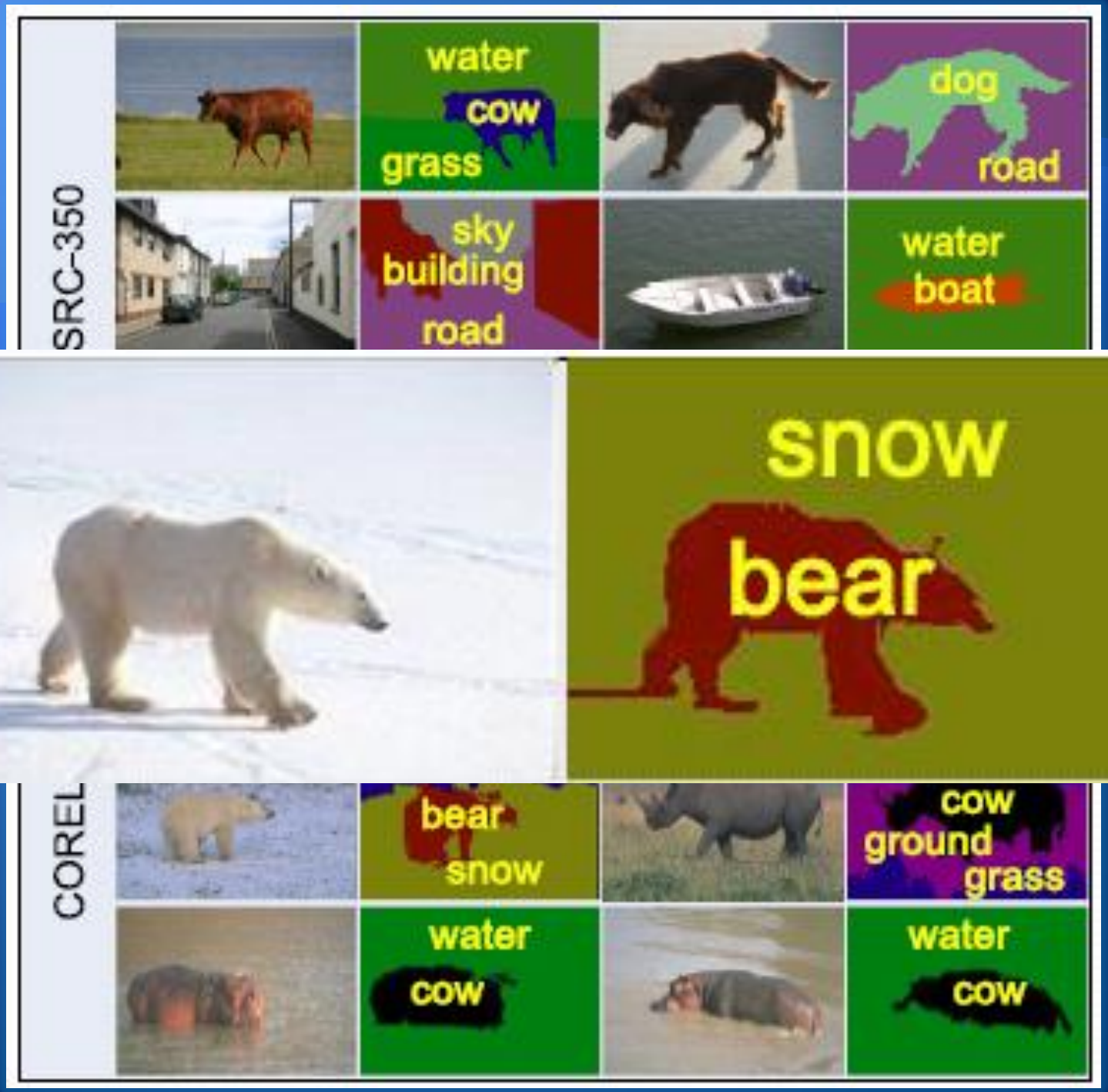
- *Technical Contributions*
  - Scalable multi-graph multi-label learning: **Multiplicative nonnegative update rule derived from KKT condition of Lagrange function**
  - *Inter*-graph and *Intra*-graph label propagation.

Unified Tag Analysis with Multi-Edge Graph

Liu, Yan, Rui, Zhang, *Unified Tag Analysis With Multi-Edge Graph*, MM10.



- *Basic Idea:*
  - Images with common tags often share similar semantic regions.
  - Uncover the region-to-region correspondences for image pairs.


SRC-350
water
cow
grass
dog
road
sky
building
road
water
boat
snow
bear
COREL
bear
snow
cow
ground
grass
water
cow
water
cow

Discussion: Content-Based Tag Processing

- A new research topic in multimedia research community.
- Learning with hybrid, unreliable sources.
  - Robust, efficient, and scalable solutions .
- Data-driven vs. Model-driven.
- Interplay of data, user and feature.

Future Directions

- Cross-modality tag analysis
  - Learn an intermediate representation that maximizes the correlation between the visual content and semantic tags.
- Visual understanding using tag cues
  - Infer fruitful contextual information about the visual content from the tags .
- Scalable automatic tagging
  - Develop scalable statistical learning algorithms to handle large scale training data with huge number of tags.

Efficient Manual Tagging System Design

dog
horse
airplane
.....

airplane, sky,.....

dog, grass, tree,....

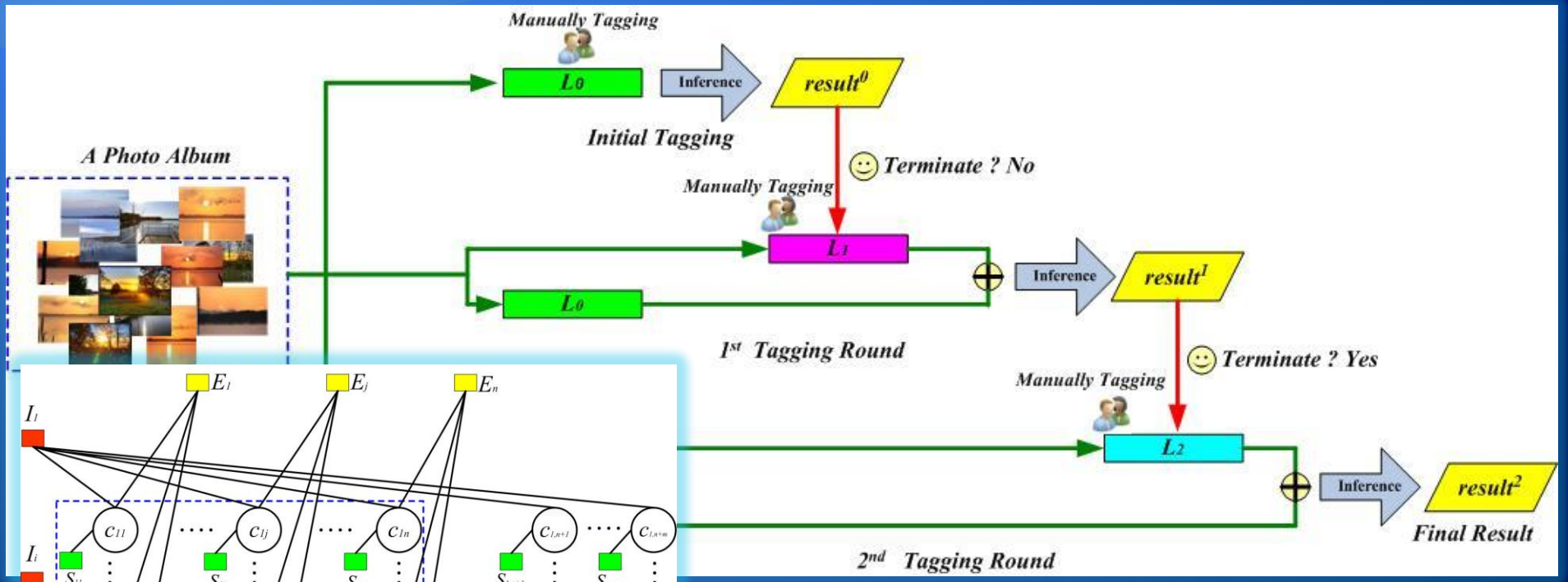
Manual Album Tagging System

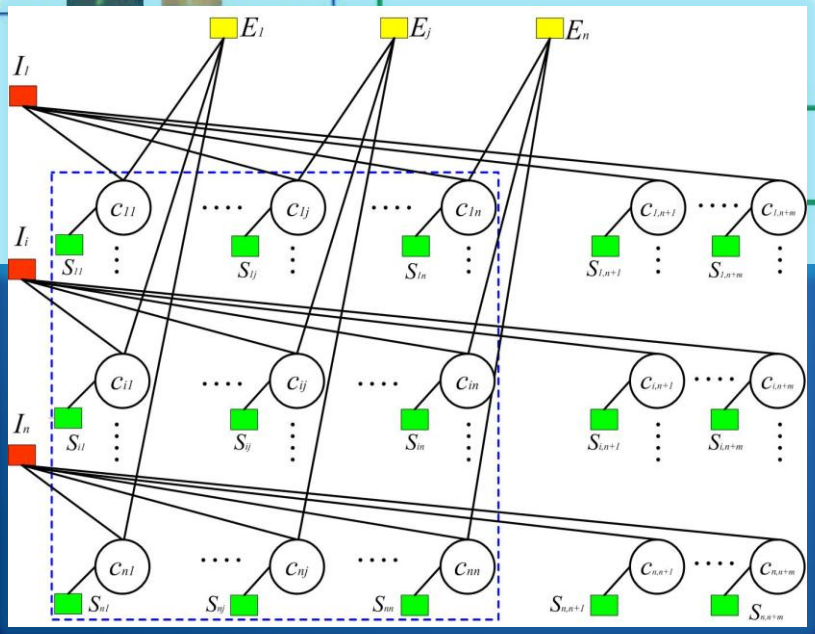
- Batch tagging
  - Pros: The manual efforts can be significantly reduced.
  - Cons: Introduce a lot of imprecise tags to many images.
- Exhaustive tagging
  - Pros: Tagging accuracy is relatively high.
  - Cons: Too labor-intensive and time-consuming.

There is a dilemma between manual efforts and tagging accuracy.

Semi-Automatic Photo Album Tagging

Liu, Wang, Hua, Zhang, *Semi-Automatic Tagging of Photo Albums via Exemplar Selection and Tag Inference , IEEE TMM10.*





- Dynamically adjust the tagging accuracy
- Visual & temporal information
- Ontology-free
- A good trade-off between manual efforts and tagging accuracy

Discussion: User Interaction

- Basic Principles
  - Minimize user's participation
  - Maximize system performance
  - Efficient User Interface design
- Potential directions
  - Historic feedback information
  - Both textual and visual clues
  - Incremental Online Learning