Probabilistic Web Image Gathering

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1. Objective & background
2. Related work
3. Method
4. Experiments

(Long-term) Objective of our *Web Image Gathering*

Gather several hundreds of images associated with one concept from the Web *without human intervention*

- It's **not** *image search.*
  - Non-interactive. No feedback. Fully-automatic.
    - We can gather 10,000 kinds of images while sleeping !!
    - We can use as much time as we need for processing.

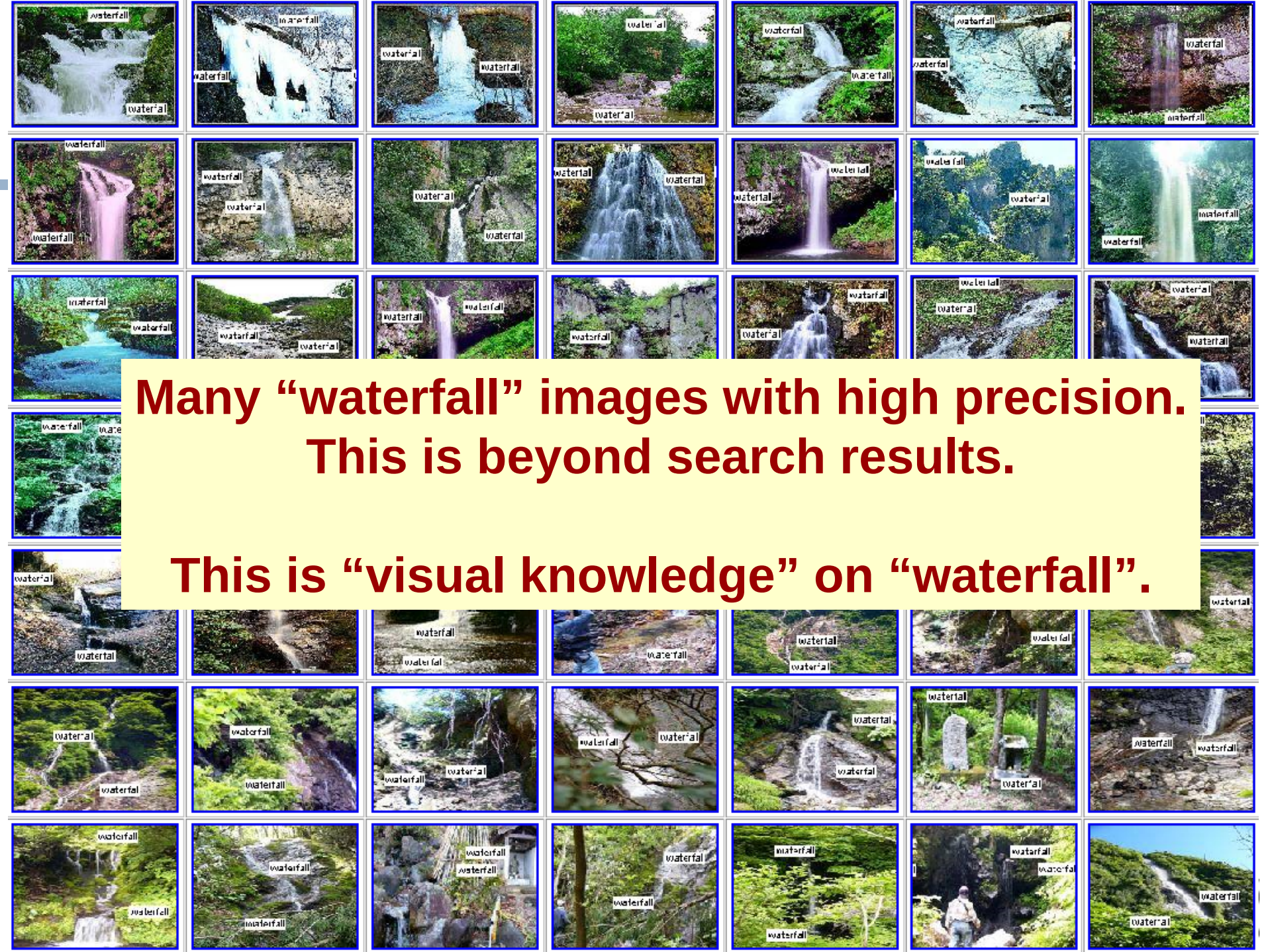
- A large number of "X" images

➡ **visual knowledge of "X"**

Acquisition of visual knowledge for realizing generic object recognition for any concepts

Extracting visual knowledge from Web images
is promising approach to solve it, *I believe.*

Gathering Web images with high precision is the first step.

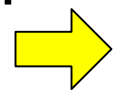


Many “waterfall” images with high precision.
This is beyond search results.

This is “visual knowledge” on “waterfall”.

Objective of this paper

- **Introduce a probabilistic method to our Web image gathering system** [MM03]
  - Import **a simplified translation model** [ICCV01]
  - Select relevant images using a probabilistic model
  - No supervision, No feedback, No human intervention, No prior knowledge

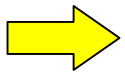


Just provide “keywords”

2. Related work

Web image search

- "Search" does not need a lot of images as output.
  - High precision and quick response are the most important.
  - Some systems assume interaction (RF).

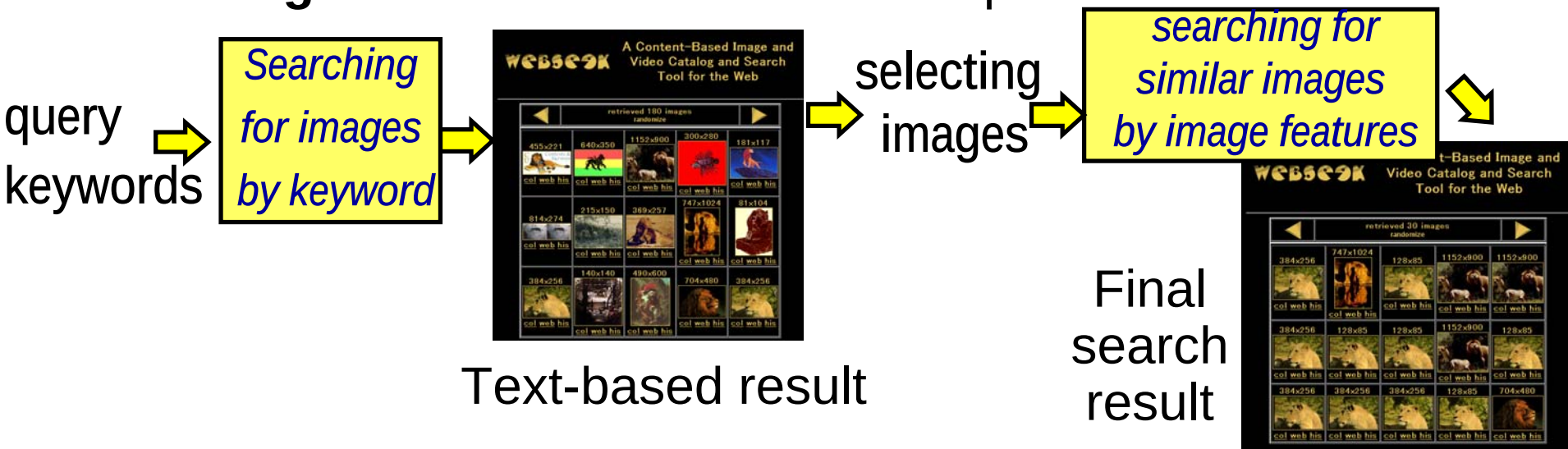


different from "gathering"

- Commercial: apply text search methods to images
  - Google Image Search, Picsearch, AltaVista Image Search, Lycos
  - Only based on HTML analysis,
    - Image analysis for billions of images is too expensive
  - Cannot expect good (high-precision) results

Web image search (-2002)

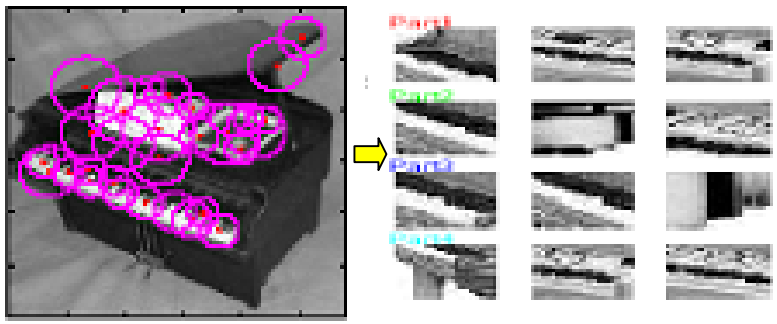
- Research: combine textual and image features
  - [until 2002] HTML and image analysis after Web-crawling by their original crawler
    - WebSeer [Frankel 96], WebSEEk [Smith 97], Image Rover [Scarloff 99]
    - **Interactive 2-step search**: [1st]Text search -> [2nd]CBIR
    - **Original Crawler**: Small-scale experiments.



Web image search (recent)

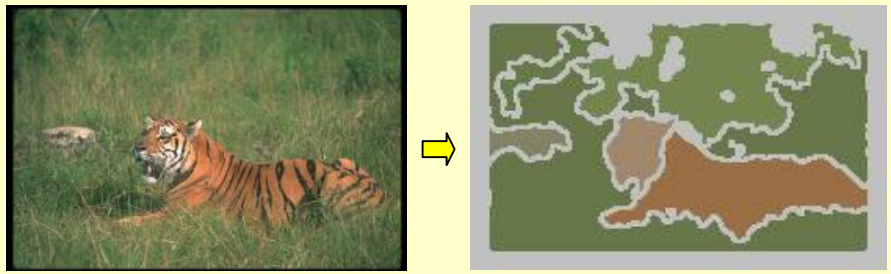
- [recently] Filtering the results of Google Image Search
  - [Feng MM04] Co-learning of textual and image features with SVM : Need (a little) supervision *interactive*
  - [Fergus CVPR04, ICCV05] (the latest *object recognition* technique) Unsupervised part-based probabilistic image classification

similar to ours



Part-based

We're region-based !!

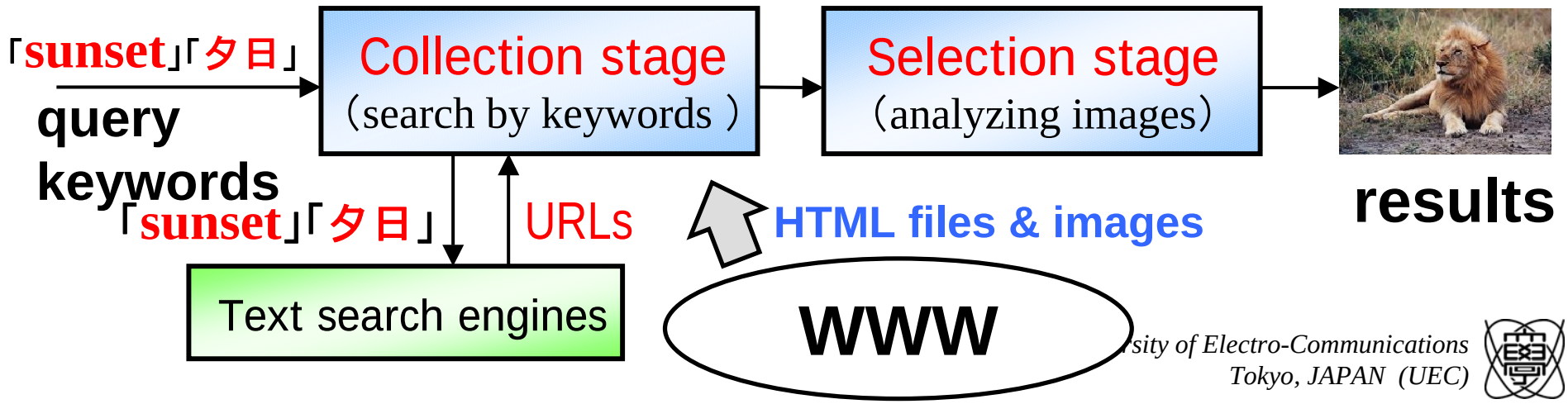


Region-based

3. System overview & probabilistic method

Overview of the method

- Collection stage : same as our previous system [MM03]
  - Obtain URL of HTML files related to the query keywords by using text search engines
  - Gather images from WWW by using those URLs
- Selection Stage : Replace CBIR-based by prob.-based
  - Select images based on their image features



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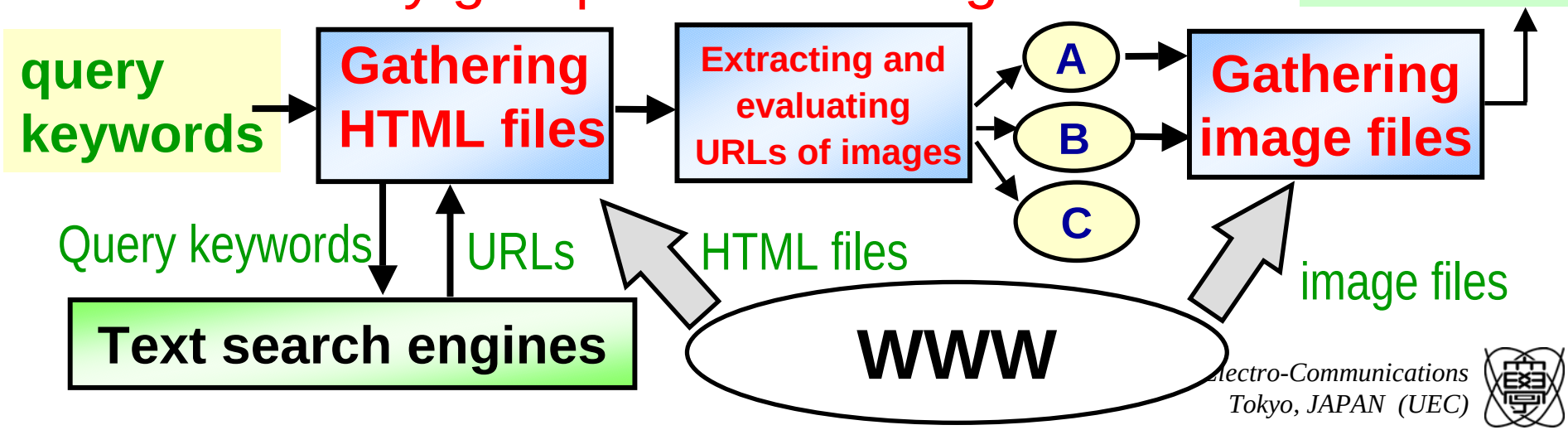
Collection stage [MM03]

1. Send the query to text search engines, and obtain URLs of HTML files related to the keyword.
2. Gather HTML files from WWW.
3. Extract URLs of images from HTML files.
4. Evaluate relevancy between images and the keywords, and classifying images into A, B
5. Gather only group A and B images from W

Selection stage



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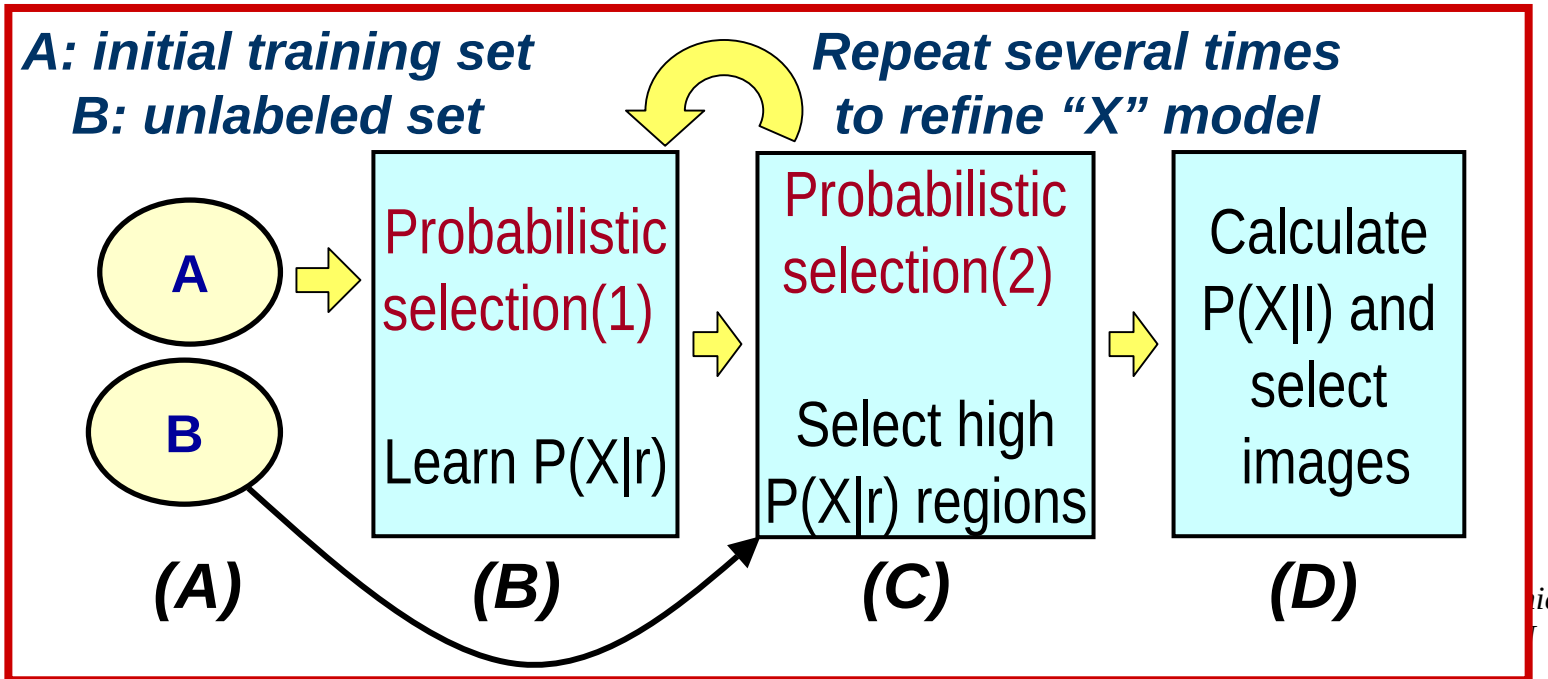
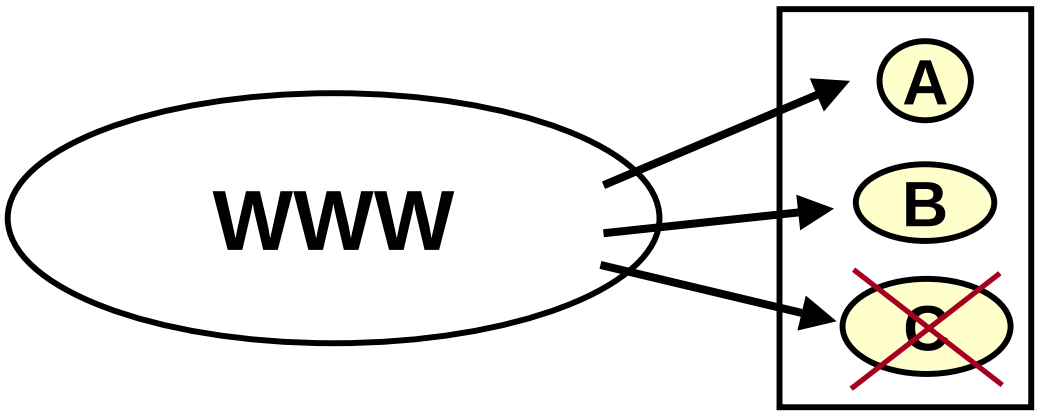
Sellection stage [new]

(A) Segment imgs. & extract region features
(B) Learn P(X|r) with GMM and EM
(C) Select high P(X|r) regions, repeat to (B)
(D) Calculate P(X|I) and select high P(X|I) images



Evaluation of images by analyzing HTML files

Classifying URLs of image files



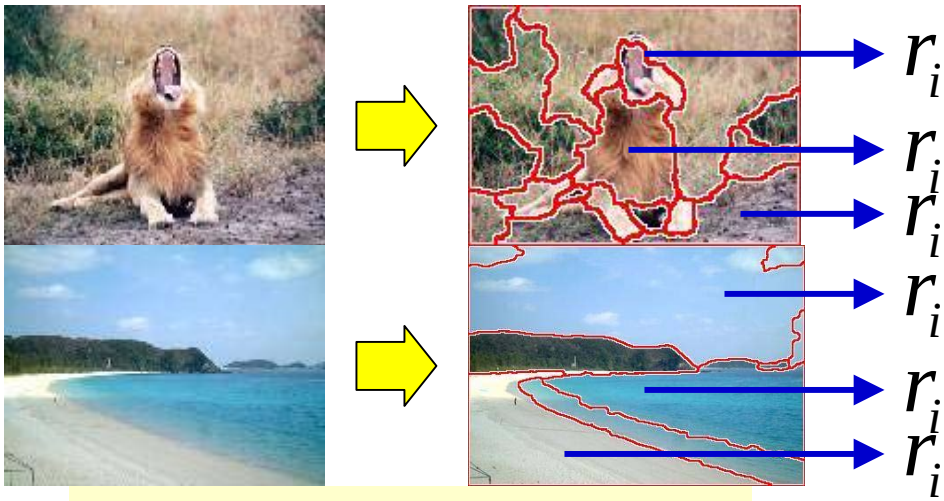
- file name, ALT tag, link words ⇨ **A**
- title tag, neighborhood of the image-tag ⇨ **B**
- Otherwise ⇨ **C**

Examples

<IMG SRC="lion.jpg" ALT="lion in Ueno zoo"> ⇨ **A**

<A HREF="raion01.jpg">a photo of a lion ⇨ **A**

Region features



Segmentation（JSEG）

Extract region features from regions the size of which are larger than a threshold.

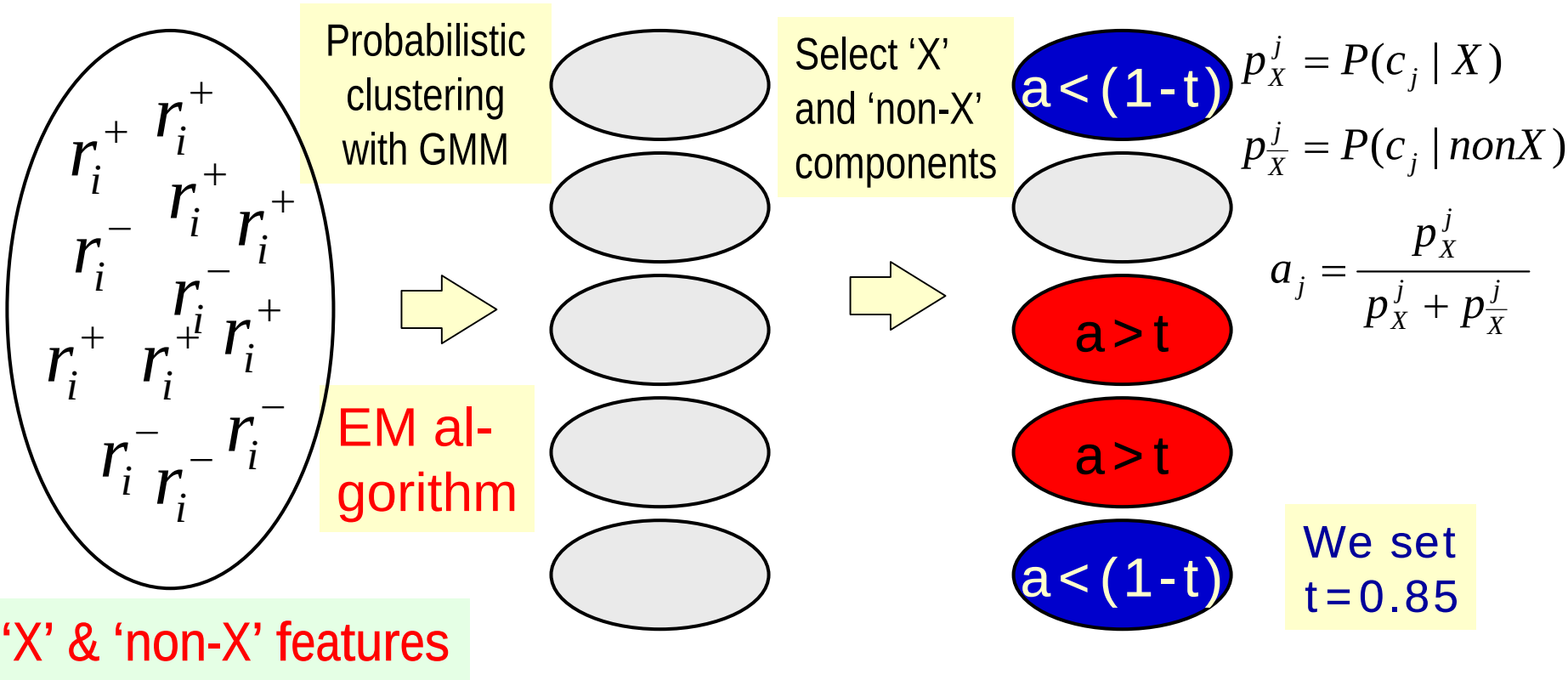
color
texture
shape
} 24 dim. vector

- Need to prepare negative images (backgrounds)
  Collect a lot of images from the Web

random Web images

Probabilistic region selection (1)

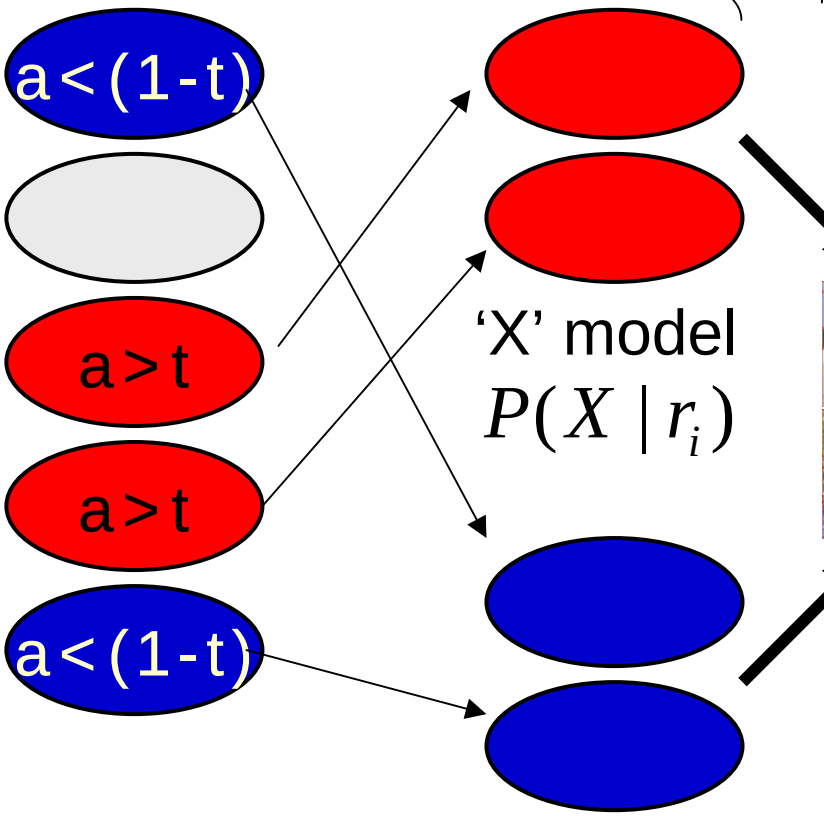
- Positive regions from rank-A images : r_i^+
- Negative regions from background images : r_i^-



Probabilistic region selection (2)

Learning an “X” region model

Select “X” regions



‘X’ model

$P(X \mid r_i)$

‘nonX’ model

$P(nonX \mid r_i)$

r_1 r_8 r_5 r_2

selected ‘X` regions

$P(X \mid r_i) > P(nonX \mid r_i)$

r_4 r_3 r_6 r_7

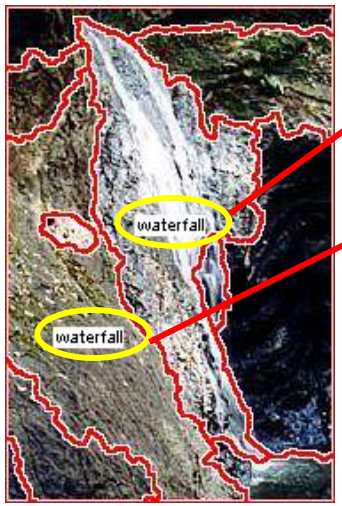
Selected ‘nonX` regions

$P(X \mid r_i) < P(nonX \mid r_i)$

Repeat learning & selecting

Final Image Selection

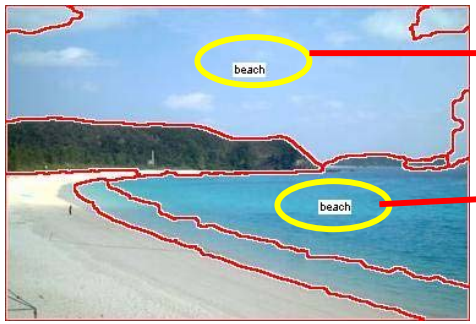
- Select top T regions regarding $P(X \mid r_i)$ $(r_i \in I_j)$ for each image I_j and average them



$P(X \mid r_{top1_j})$

$P(X \mid r_{top2_j})$

$$P(X \mid I_j) = \frac{P(X \mid r_{top1_j}) + P(X \mid r_{top2_j})}{2}$$



$P(X \mid r_{top2_{j'}})$

$P(X \mid r_{top2_{j'}})$

Finally, images of $P(X \mid I_j) \geq th$ are selected as final results.

4. Experimental results

Experiments for 10 words

- sunset, mountain, waterfall, beach, ramen (Chinese noodle), flower, lion, apple, baby, laptop-PC





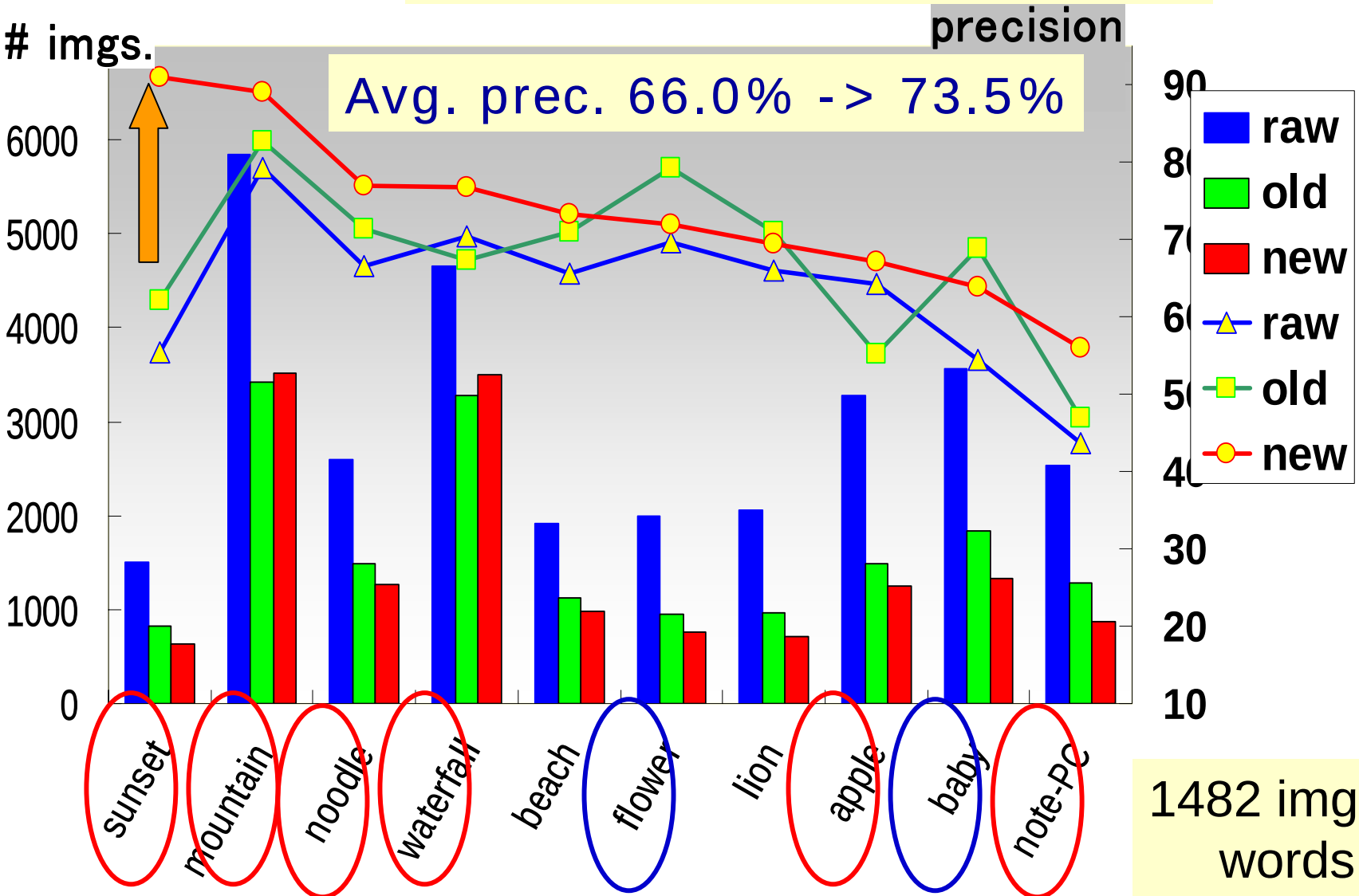

- Method:

  raw (only HTML analysis) **29,944** images for **10** words
  old[MM03] (color-histogram) **16,687**
  new (propoosed method) **14,825**

- Evaluation:
  precision, # of output images
- Time: about 6 hours/concepts with 10PCs

Results: # images and precision

#clusters:150, repeat: 2times



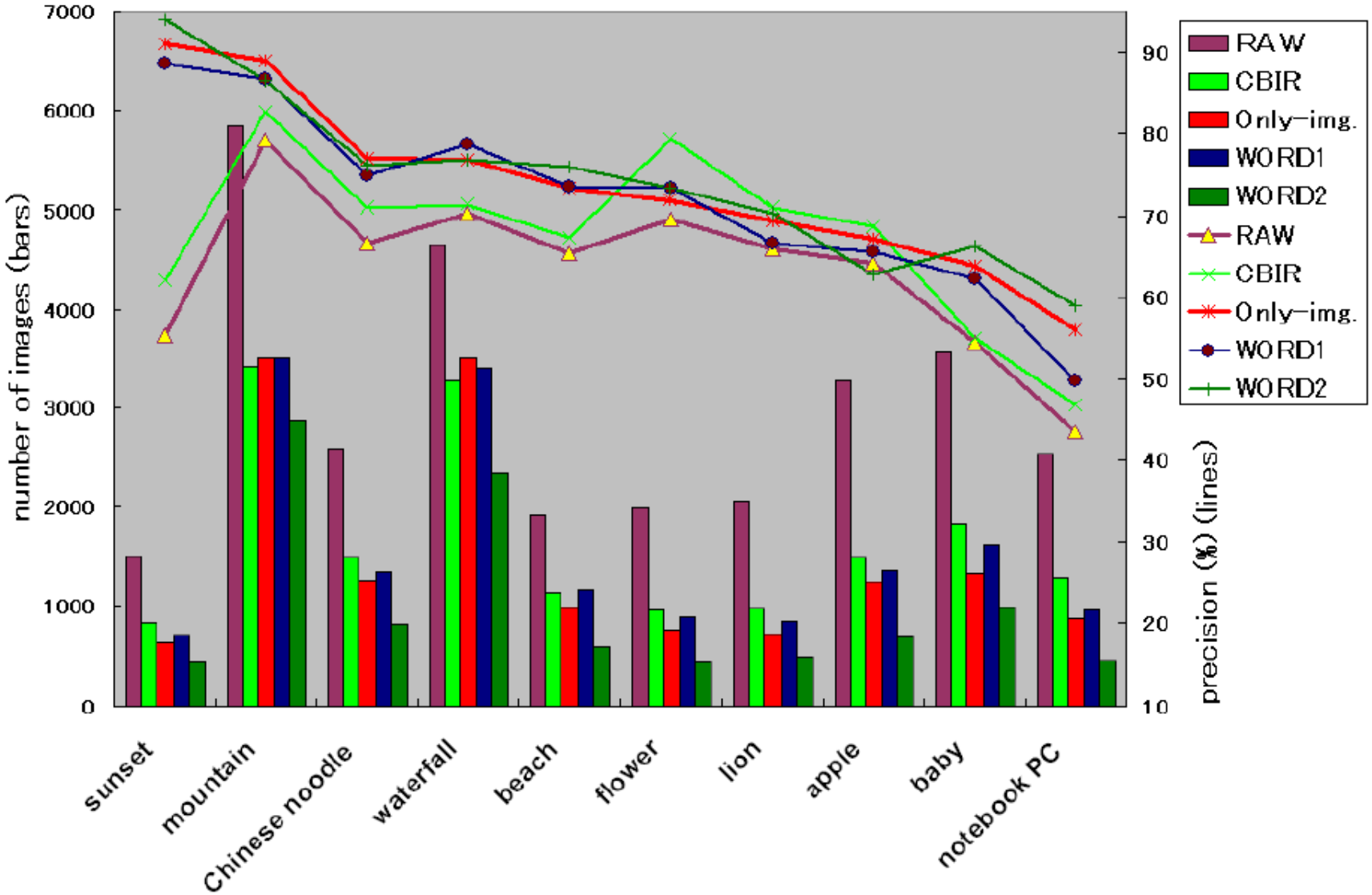
1482 imgs/ words

Many result images

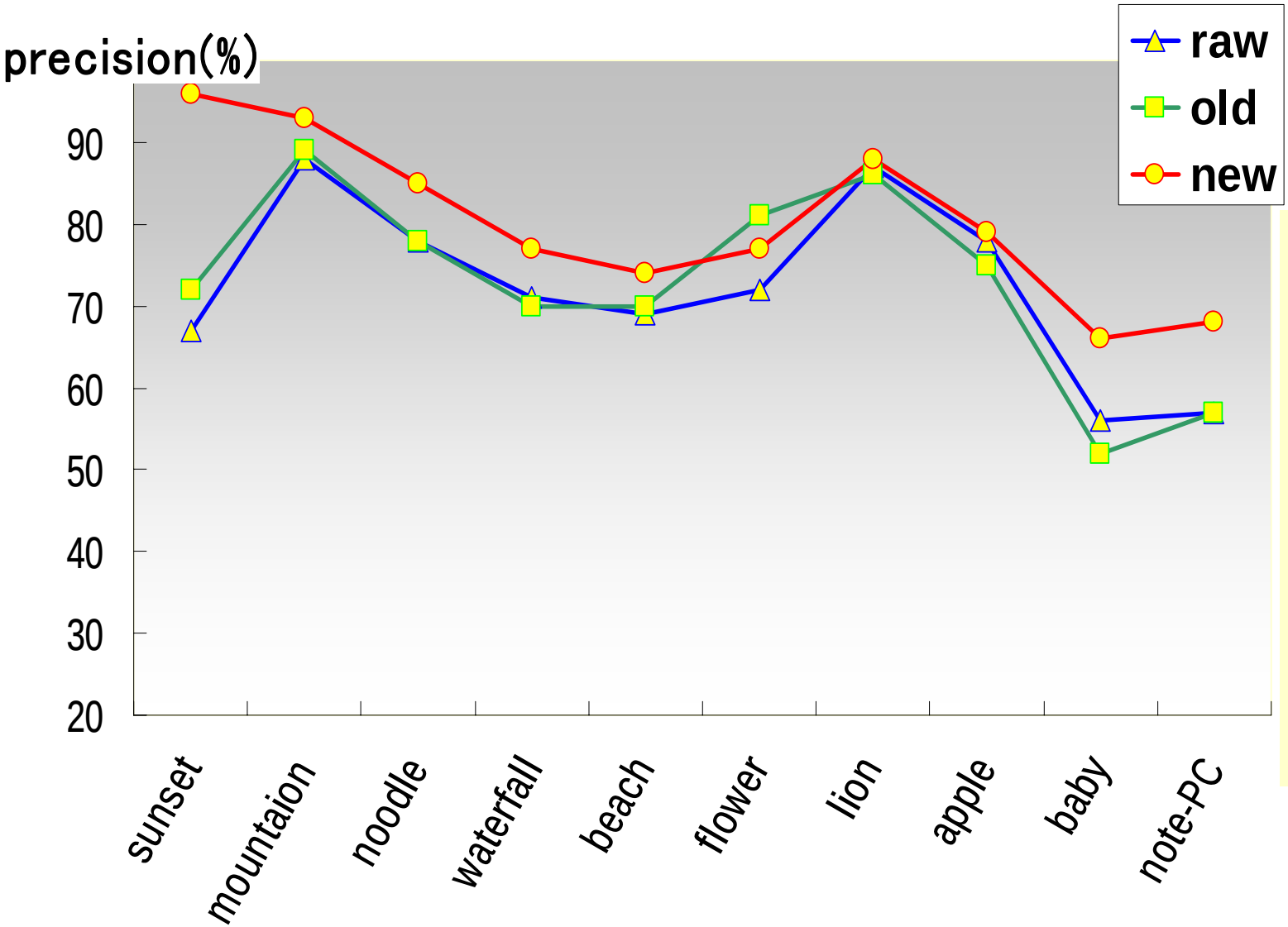
- Sunset (positive and negative)
- Mountain (positive and negative)
- waterfall
- laptop-PC

http://img.cs.uec.ac.jp/mm05/

Results: using word vectors as well as image features



Precision of A-images

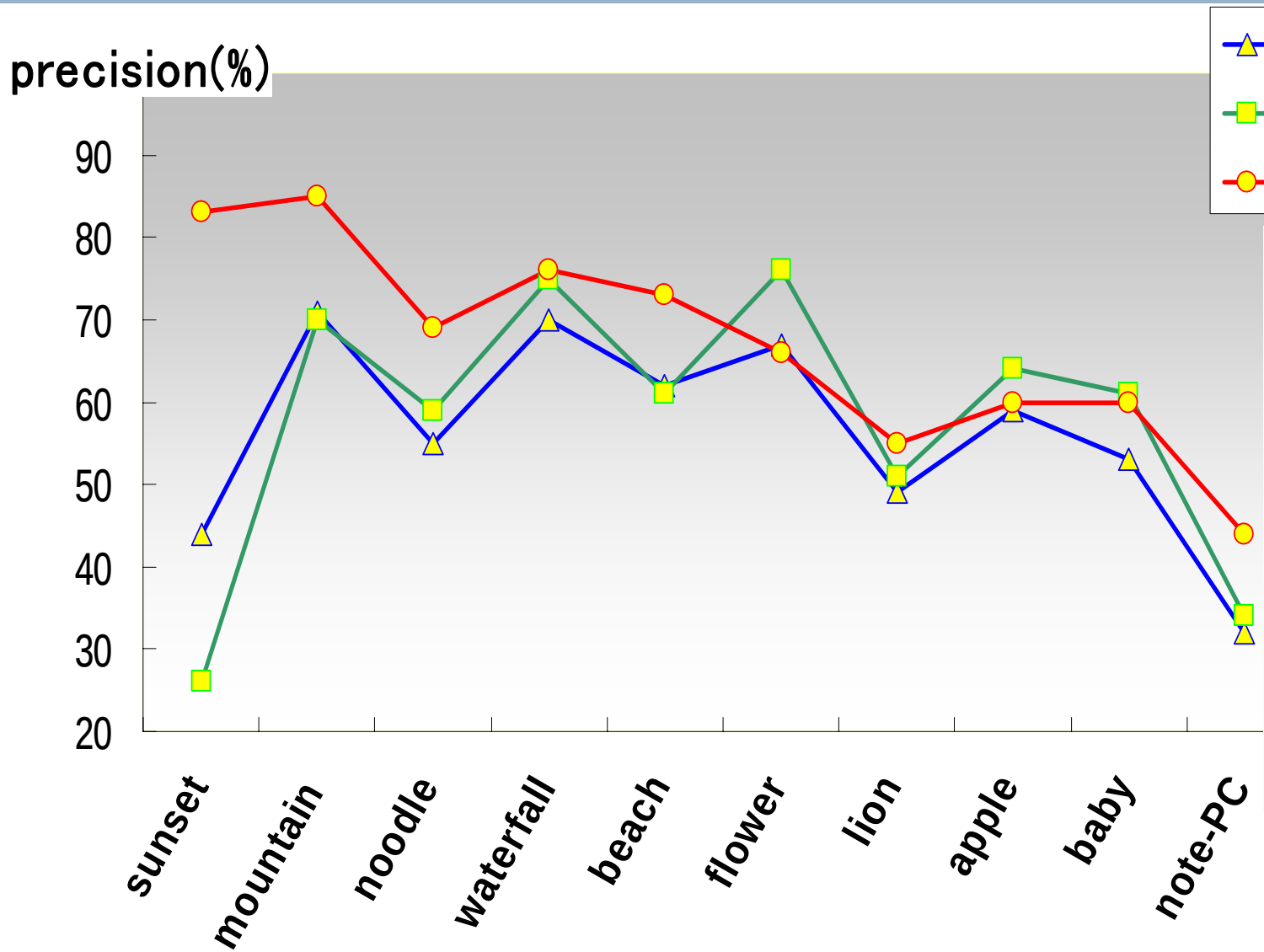


Avg.
raw
72%
old
73%

new
80%
(617.1img)

Precision of B-images

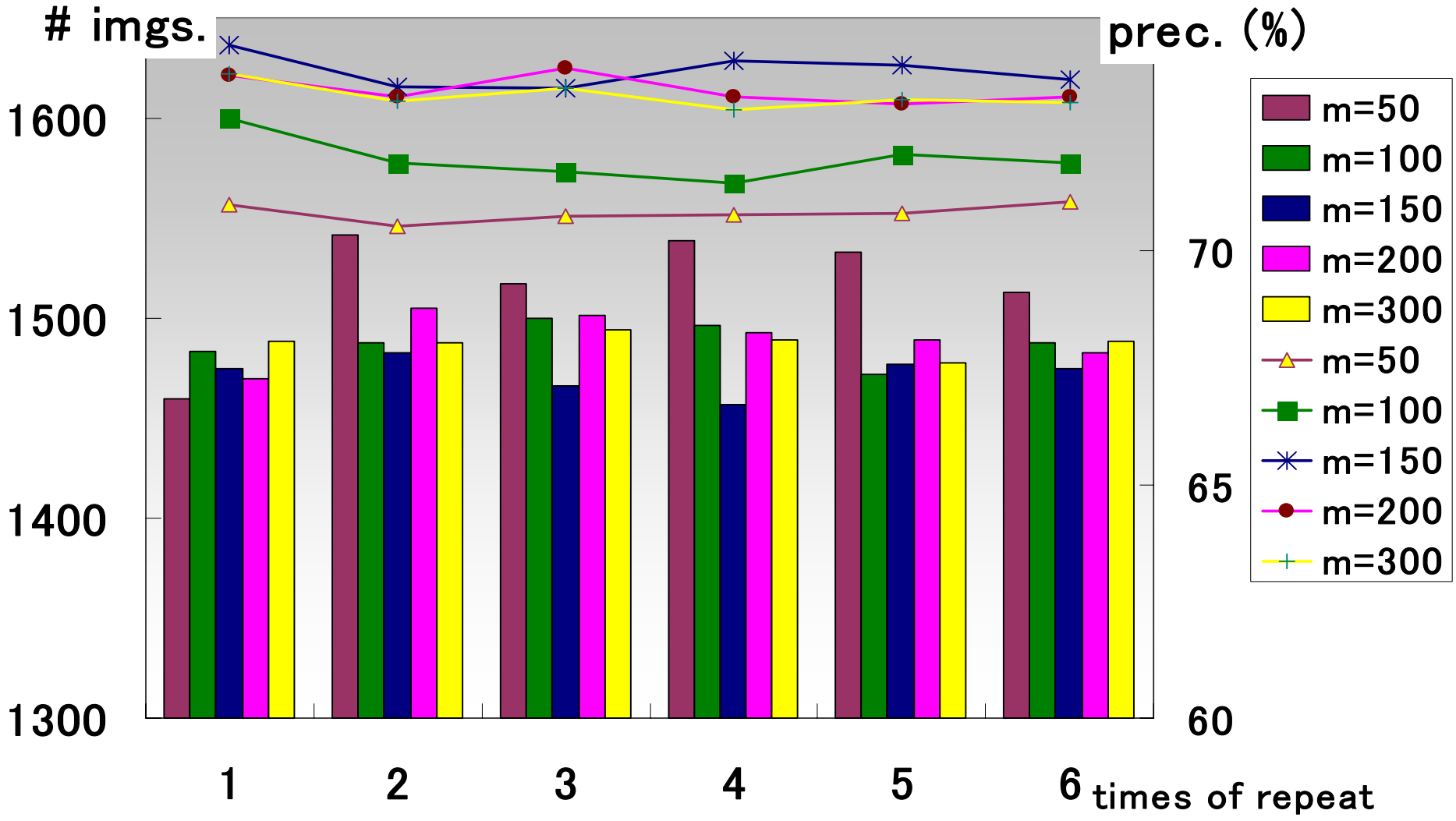
(equivalent to the recognition results by the models)



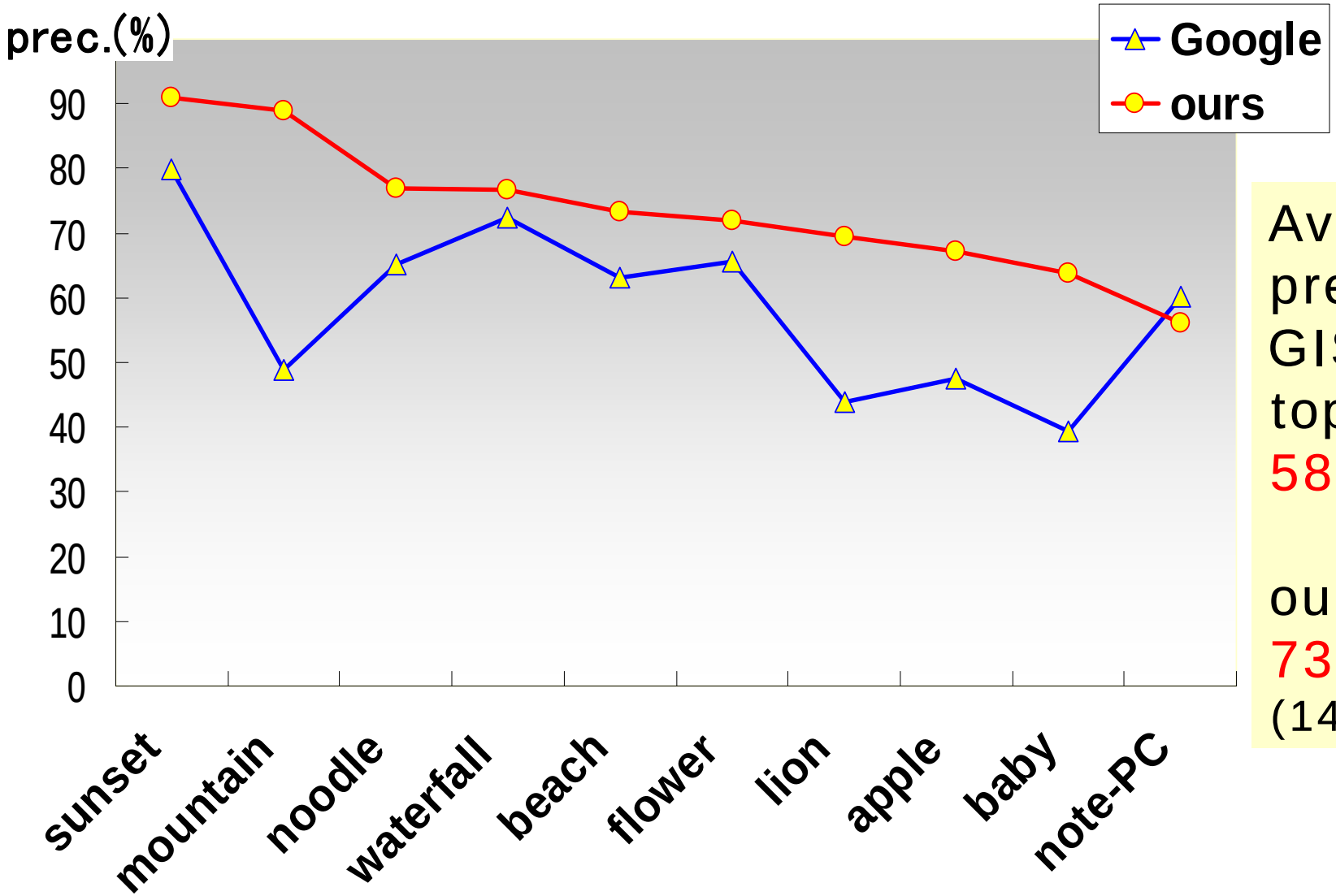
Avg.
raw
56%
old
58%

new
67%
(865.4img)

Results in case of varying times of repeat and # GMM components.



Comparison with Google Image Search



Avg. prec.
GIS top500
58.6%

ours
73.5%
(1483)

Comparison with related work

- [Feng MM04] Co-learning of textual and image features with a little supervision
  - *54.0 F-measure for 15 concepts*
- [Fergus CVPR04] Unsupervised
  - *65.9% precision at 15% recall for 11 concepts*
- [Fergus ICCV05] Unsupervised + improved model
  - *69.9% precision at 15% recall for 7 concepts*
  - Good at “objects” such as airplane, car, and bike
- Our results: good at “scene” such as sunset and mountain
  - *63.0 F-mesures (pre.73,5% , rec.55.1%) for 10*

Conclusion

- We Introduced region-based probabilistic image selection method into Web image gathering.
  - Iterative algorithm with GMM and EM enabled training from imperfect data.
  - We used images evaluated highly in HTML analysis as initial training set.
- Precision 73.5% , Recall 55.1% for 10 concepts

Future work

- Improve by combining part-based and region-based approach
  - Part-based seems to be better for “object”
- Build real world image corpus for generic object recognition
  - 1000 images/concept for 1000 concepts

We can build it while sleeping !


Thank you!
You can eat all the results at
http://img.cs.uec.ac.jp/mm05/


ramen
サッポロ
生ラーメン
行列のできる店のちゃんぽん
長崎