Visual Query Suggestion

Zheng-Jun Zha¹, Linjun Yang², Tao Mei², Meng Wang², Zengfu Wang³

¹University of Science and Technology of China
²Microsoft Research Asia

Outline

• Motivation
• Visual Query Suggestion (VQS)
  - Framework
  - Keyword suggestion mining
  - Image suggestion mining
  - Image Search with VQS
• Experiments
• Conclusions

Motivation

• Users can imagine what they want, but cannot express it in precise words

Towards bridging intention gap

• Intention prediction: search engine guesses users’ search intention
• Query suggestion: search engine provides a list of suggested queries
Textual query suggestion

- Textual query suggestion: treat image search query suggestion as text search query suggestion, i.e., suggest a list of words

New query suggestion scheme

- **Visual Query Suggestion (VQS):** a query suggestion scheme tailored to image search
  - provide both image and keyword suggestions
  - refine the text-based image search using image suggestions as query examples

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Query suggestion mining

- **Goal:** discover both image and keyword suggestions to help users express their search intention
- Possible data sources
  - Query logs
  - Click-through
  - Search results
  - Flickr/Photobucket/Wikipedia/…

Visual query suggestion framework

- **Query suggestion mining:** discover image and keyword suggestions
- **Suggestion presentation:** present query suggestion responding to user’s operation
- **Search with query suggestion:** perform image search with image and keyword suggestions
Query suggestion mining

- Possible solution
  - Select keyword → select image
  - Select image → select keyword
  - Select image and keyword simultaneously

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Keyword suggestion mining

Goal: Find a set of keywords with the following properties.

- **Relevance**: The selected keywords should be relevant to the query
- **Informativeness**: The selected keywords should be informative enough to reflect different aspects of the query

How to measure them?

Relevance

- Normalized Co-occurrence
  \[
  C(q, Q) = \frac{\#c(q, Q)}{\#o(Q)}
  \]

- Relevance of keyword \( q \)
  \[
  R(q, Q) = f(C(q, Q))
  \]

- Relevance of keyword set
  \[
  R(S_Q) = \sum_{q \in S_Q} R(q, Q)
  \]

Informativeness

Assumption: keyword \( q_i \) and \( q_j \) can reflect different aspects of \( Q \), if the keywords co-occurring with \((Q, q_i)\) and \((Q, q_j)\) are different, i.e., the distributions \( f(q_i | Q) \) and \( f(q_j | Q) \) are different.

- KL divergence
  \[
  KL(q_i | q_j) = \sum_p p(q_i | Q) \log \frac{p(q_i | Q)}{p(q_j | Q)}
  \]

- Informativeness of keyword pair
  \[
  I(q_i, q_j) = KL(q_i | q_j) + KL(q_j | q_i)
  \]

- Informativeness of keyword set
  \[
  I(S_Q) = \sum_{q_i \in S_Q} I(q_i, q_j)
  \]
**Keyword suggestion mining**

- Optimization function

\[
\max_{i} \left[ \lambda \frac{R(i)}{S(i)} + (1 - \lambda) \frac{I(i)}{S(i)} \right]
\]

- Solution

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**Image suggestion mining**

**Goal**: find a small number of images which can represent the corresponding keyword

**Affinity propagation**

- Data graph
  - Full graph
  - Sparse graph

- Message propagation: three kinds of messages are recursively transmitted via the edges of the graph

- Exemplar selection: the exemplar of image \( i \) is selected through the following equation:

\[
\max \left[ r(i, j) + a(i, j) \right]
\]
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Image search with VQS

Experiments
- Suggestion quality evaluation
- Search performance evaluation

Suggestion quality evaluation

- Data and Setting
- ≈ 3 million images, ≈15 million tags from Flickr
- 30 professional users, 10 average users
- 25 queries covering different semantics, such as scene, object, event, etc.

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Familiar with image search?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professional user</td>
<td>researcher, graduated student</td>
</tr>
<tr>
<td>Average user</td>
<td>marketing people, government officer, etc.</td>
</tr>
</tbody>
</table>
Data and Setting
- ≈3 million images, ≈15 million tags from Flickr
- 30 professional users, 10 average users
- 25 queries covering different semantics, such as scene, object, event, etc.
  
airshow, animal, apple, building, camping, car, disaster, flag, flight, flower, fruit, game, insect, panorama, Paris, plant, portrait, road, scenic, season, sky, sports, sunset, travel, weather.

Dose VQS perform much better, better, closely, worse, or much worse than existing engines?

Is the visual query suggestion very useful, somewhat useful, or unuseful for eliciting users' search intention?

Suggestion quality evaluation

Experiments
- Suggestion quality evaluation
- Search performance evaluation

Search performance evaluation
- Experimental setting
  - Comparing methods
    - Text-based image search with initial query (Baseline)
    - Text-based image search with textual query suggestion (TQS)
  - Evaluation Metric: NDCG@k

\[
\text{NDCG@k} = \sum_{i=1}^{k} \frac{2^{r(i)} - 1}{\log(1 + r(i))}
\]
### Conclusions

- **Visual Query Suggestion**
  - provides both keyword and image suggestions
  - helps users specify and deliver the search intention more precisely
  - refines the text-based search results by using visual information

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**Demo**

**Thanks**