Ranking: Metric Query Postprocessing

Petra Budikova
budikova@ics.muni.cz
Masaryk University, Brno, Czech Republic

Michal Batko
batko@fi.muni.cz
Masaryk University, Brno, Czech Republic

Pavel Zezula
zezula@fi.muni.cz
Masaryk University, Brno, Czech Republic

Large-Scale Multimedia Searching

Text-based approach

- Strategy: search in annotations of multimedia objects using existing tools for text search
  - applied by the major commercial image search systems (Google, Bing)
- Weak points:
  - does not work on data without text annotations
  - results are often not similar in content
- Enhancements: employ content-based ranking on the result of text-based search
  - provides better results
  - search quality still depends on quality of text annotations
  - existing techniques do not support personalized ranking

Content-based aproach

- Strategy: use the specific properties of the data objects to define a pairwise distance function that evaluates dissimilarity of any two objects
  - query-by-example paradigm
  - based on a metric space model
- Weak points:
  - semantic gap between human understanding of similarity and the definition of distance
- Solutions:
  - machine learning of the semantics – applicable only for smaller domains with clear semantic categories
  - result postprocessing

Two-phase Similarity Searching

- Extension of the content-based approach
- Standard similarity query is evaluated in Phase I
- Search results are further processed in Phase II
  - result quality improvement
  - low costs as only the result set (a small subset of the whole database) is processed

Phase I: Initial Search

$F_{initial}(q) = kNN(q,k) = \{R \subseteq \mathcal{D}, |R| = k \wedge \forall x \in R, y \in \mathcal{D} \setminus R : d(q,x) \leq d(q,y)\}$

Phase II: Ranking

$F_{rank}(o) = RANK_{type}(o, context) = \{i \in \mathbb{N},$ i is the rank of o in the given context$\}$

Ranking Strategies

User-defined Ranking

- After Phase I, the initial result is displayed and user can provide additional information
  - preferred objects, keywords, other data properties
  - user-defined similarity measure

Relevance feedback ranking

- User chooses relevant images from the initial result
- System uses them as mutliple query objects in the ranking phase

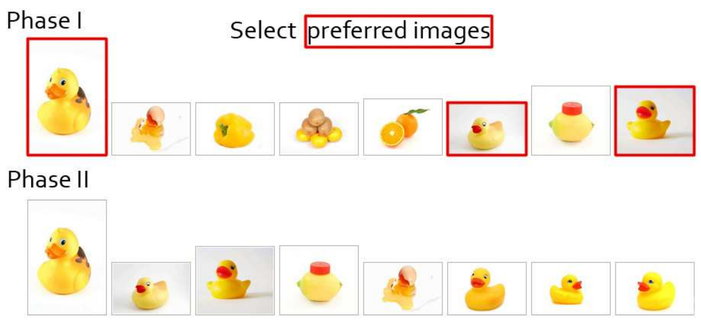

Figure 1 Feedback ranking.

User-defined keyword ranking

- User chooses relevant keywords
- System prompts the most frequent keywords from the initial result

Figure 2 Keyword ranking.

Automatic Ranking

- Uses only information available from the query definition and the statistical properties of the initial result
  - keywords, location, object popularity, etc.
  - may exploit a different measure of content-based similarity, e.g. local image descriptors

Keyword ranking

- Keywords associated with the query object are used for ranking (Figure 3a)

Word cloud ranking

- The most frequent words from the initial result can be used for ranking (Figure 3b)
- The intersection of the most frequent words and the query object keywords may be chosen for ranking (Figure 3c)

Combined visual and text ranking

- The initial ranking from Phase I is taken into consideration
- The final distance is computed as a weighted sum of the visual and text distance (Figure 3d)

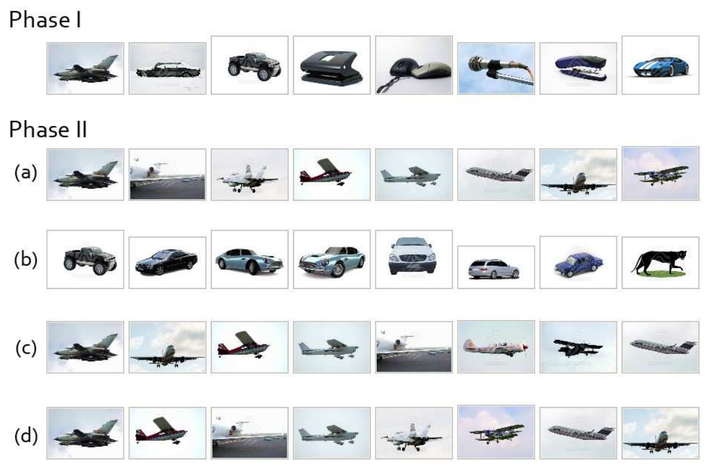

Figure 3 Automatic ranking methods.

Adaptive ranking

- Apply heuristics to select the most suitable ranking method from the above mentioned, using statistical data obtained from the evaluation of random queries and the initial result characteristics

Evaluation

- Real-world image collection from the Pixmac photo-bank
  - 8 million images
  - rich and precise annotations
- User-satisfaction experiments
  - 20 users
  - 100 random query images
  - 800 evaluated results

Ranking method	User-percieved result quality
Initial result	36.2 %
Feedback ranking	59.2 %
User-defined keyword ranking	50.6 %
Keyword ranking	55.4 %
Word cloud ranking	42.0 %
Cloud&keywords ranking	51.9 %
Combined visual&text ranking	56.8 %
Adaptive ranking	58.2 %

Table 1 Evaluation of ranking methods.

Conclusion

- Ranking provides overall improvement of user satisfaction
  - 15-24 % improvement with user-defined ranking
  - 8-22 % improvement with automatic ranking
- Small computation costs increase
  - Phase I: 500 ms; Phase II: 30 ms
- Two-phase search model provides a general, scalable and flexible solution to content-based retrieval

Future work

- Evaluate the proposed ranking methods on a different dataset with worse annotations
  - use WordNet to improve the quality of text data

References

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