Query Enrichment for Image Collections by Reuse of Classification Rules

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Abstract

User queries over image collections, based on semantic similarity, can be processed in several ways.

Here we propose to reuse the rules produced by rule-based classifiers in their recognition models as query pattern definitions for searching in image collections.
Reuse = "not reinventing the wheel"

- 1960s: macros and subroutines libraries
- main principle of today's object-oriented programming
- source code, components, development artifacts, patterns, templates...
- from program code to data content and user interaction
Rule-based Classifiers

They form a human comprehensive recognition model

• **decision trees**: in spite of their specifics, based on split-and-conquer techniques, their recognition model can easily be transformed into a set of rules.

• **decision rules**: the learned model is represented as a set of IF-THEN rules, produced on the basis of a depth-first induction strategy.

• **association rules**: they distinct strong associations between frequent patterns (conjunctions of attribute-value pairs) and class labels.
Image Retrieval

• Search:
  - by textual metadata
  - on the basis of their content (CBIR)

• Semantic gap:
  - user queries are based on semantic similarity
  - the computer processes low-level feature similarity

-> higher level concepts comprehensive by humans, but based on the processing of low level features

• Way for bridging this gap:
  - categorization algorithms that allow the system "to learn" how to make these decisions.
More precisely

The classification on a test dataset in an image collection supplied with low-level attribute metadata (MPEG-7, SIFT, ORB,...) using rule-based classifiers can produce quite good recognition results for some high-level semantic concepts (indoors-outdoors, scene types, artists' practices, emotional evokes, ...).

The set of produced rules in the recognition model can be interpreted as semantic profiles of corresponding class-labels.

We can use these sets as patterns in the query module, using the set of rules as disjunctive-conjunctive sequence of conditions, and naming them with the name of class-label.

In this way the user operates with well-known high-level concepts and this saves him the trouble of understanding and analysing the low-level features, captured by the image analysis.
• 600 images representing Renaissance, Baroque, Romanticism and Impressionism.

• MPEG-7 descriptors - DC, SC, CL, CS, EH, HT. The low-level visual information consists of 339 values named with A1 to A339.

• Learning set of images (120) are labeled with high level semantic information - movement in which their techniques belong (other variants - “indoor/outdoor”, scene type, artists' name...)

• We provide 10-fold cross-validation over this learning dataset using BFTree Classifier (86.67% classification accuracy)
The recognition model, produced by BFTree

Transformed set of rules, used as query patterns

<table>
<thead>
<tr>
<th>Query Name</th>
<th>Search Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renaissance like</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(A64uze9.5) and (A88 &lt; 0.5) and (A23 uge 2.5) and (A206 uge 1.5) or</td>
</tr>
<tr>
<td></td>
<td>(A64uze9.5) and (A88 uge 0.5) and (A11 &lt; -7.5)</td>
</tr>
<tr>
<td>Baroque like</td>
<td>(A64 &lt; 9.5) and (A4 uge -25.0)</td>
</tr>
<tr>
<td>Romanticism like</td>
<td>(A64 &lt; 9.5) and (A4 &lt; -25.0)</td>
</tr>
<tr>
<td></td>
<td>or (A64uze9.5) and (A88 &lt; 0.5) and (A23 &lt; 2.5) and (A114 &lt; 3.0) or</td>
</tr>
<tr>
<td></td>
<td>(A64uze9.5) and (A88 &lt; 0.5) and (A23 uge 2.5) and (A206 &lt; 1.5)</td>
</tr>
<tr>
<td>Impressionism like</td>
<td>(A64uze9.5) and (A88 &lt; 0.5) and (A23 &lt; 2.5) and (A114 uge 3.0) or</td>
</tr>
<tr>
<td></td>
<td>(A64uze9.5) and (A88 uge 0.5) and (A23 uge 2.5) and (A206 &lt; 1.5)</td>
</tr>
</tbody>
</table>
Conclusion

The satisfaction of user queries, which are based on semantic similarity, can be achieved in at least three ways:

1) by supplying text annotations of the digital items by humans;

2) by trying to annotate automatically with concepts that are comprehensive by humans, based on the processing of low level features using different categorization algorithms; or

3) by using some advantages of the previous step dynamically:
   - not making an annotation in advance and storing metadata, which are not sure that will be used
   - but storing the query patterns that are formed as a result of previous test annotation (when showed enough recognition accuracy) and apply them only when the user query affects the defined concept.
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