OLIVE – A Conceptual Web Image Search Engine

Adrian Popescu
CEA/LIST – LIC2M
18 route du Panorama
92260, Fontenay aux Roses, France
+33146548013
adrian.popescu@cea.fr

Pierre-Alain Moëllic
CEA/LIST – LIC2M
18 route du Panorama
92260, Fontenay aux Roses, France
+33146549619
pierre-alain.moellic@cea.fr

ABSTRACT
In this paper we describe Olive, a concept based image search engine implemented using the WordNet nouns hierarchy. The system reformulates textual queries and performs an on the fly search for Google images corresponding to leaf nodes that are found under the currently demanded term. The retrieved pictures are rendered in a conceptually structured fashion and semantically related queries are presented to the user. In addition, a content based search in conceptually controlled neighborhoods is proposed.

Categories and Subject Descriptors
H.3.3 [Information Storage and Retrieval]: Information Search and Retrieval – *retrieval models, search process.*

General Terms
Algorithms, Experimentation

Keywords
Conceptual image retrieval, CBIR, ontology, WordNet, Google

1. INTRODUCTION
The main actors of Web information retrieval have indexed huge amounts of data. The number of pictures it is possible to retrieve with Google largely exceeds one billion items [1]. Although current Web image search solutions are rapid and robust, an important number of extraneous pictures appear among the answers to a given query. Moreover, the results are presented as a plain list and the interaction possibilities are limited to navigating in the response set and seeing the full-size image. Studies in information retrieval showed that an organized presentation of results is preferred over an unstructured one [5] and that the reaction of the users to the introduction of increased interactivity options is positive [4].

We propose an image retrieval application that is based on WordNet [7], a large scale ontology (more than 100000 English nouns). The framework described in [6] addresses the drawbacks of current Web search engines cited above: the quality of answers sets, the organization of results and an increased interactivity. The answers are structured using leaf subconcepts under the current query and the browsing of the unstructured results sets in Google is replaced with navigation in the subtypes set.

MM'07, September 23–28, 2007, Augsburg, Bavaria, Germany.
ACM 978-1-59593-701-8/07/0009.

Each results page equally contains suggestions for narrower, expanded and sister terms for the given query. In addition, Olive provides a simple and efficient CBIR functionality. Similar images are retrieved among the pictures that belong to the same specialized category. The system is plugged on Google and performs live image retrieval, a characteristic that allows it to evolve at the same rate as the base search engine does and to work without a locally stored image database. For the moment the application supports only one term queries but, as these the last represent a hefty chunk of the image requests on the Web [2], its usefulness remains high.

2. SYSTEM DESIGN
In Fig. 1, we present a functional diagram of Olive.

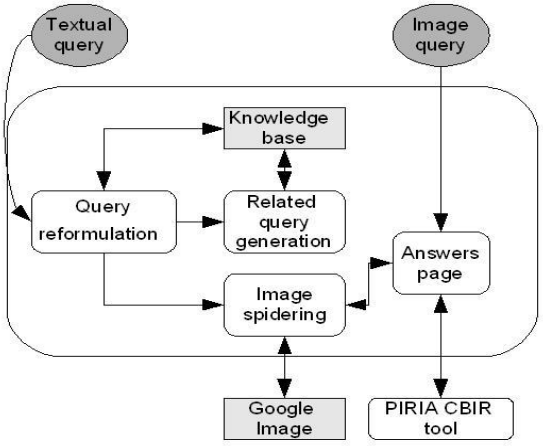

Figure 1. Functional diagram of Olive. The user interaction parts are represented in the ellipses, the resources Olive employs are drawn as rectangles and the active components of the application in rounded rectangles.

A typical interaction in Olive[1] goes as follows: a query is typed and it is reformulated by the system using some relevant knowledge about the given concept extracted from WordNet. The output of this step constitutes the entry for the image spidering module, which employs an external application, Google to collect Web picutres. In the same time, a list of categories that are close to the query is generated using WordNet knowledge. Once these two processes are finished, an answers page is generated. For each image on the answers page, it is possible to search for visually related images using the PIRIA [3] application.

[1] Demonstration video available at http://moromete.net/olive.mpg

In the following we describe in more detail the main components of Olive. We used the WordNet nouns hierarchy [7] so as to extract the synonymy and hyponymy information. This lexical hierarchy contains over 81000 synsets and each one of them is stored in a separate file which contains: a row that separates terminal nodes from other classes, a list of related classes and, for non-terminal synsets, a list of leaf subcategories (the only ones having associated picture sets). The close concepts and the leaf subtypes are ordered using the number of corresponding image in Google Image. This organization is particularly important for terms having a lot of subcategories and related classes, where a choice of the displayed categories is compulsory.

The term typed by a user is searched in the knowledge base. If the concept exists, the system checks if it has synonyms and whether they are ambiguous or not. In case of ambiguity, separate sets of pictures are proposed for each meaning (see Fig. 2). Further, Olive checks if the concept has subtypes and if so, an ordered list of these last is provided to the image spidering module. In Fig. 2, the images for the first three node classes under duck *(mallard*, *drake* and *pintail*) are presented.

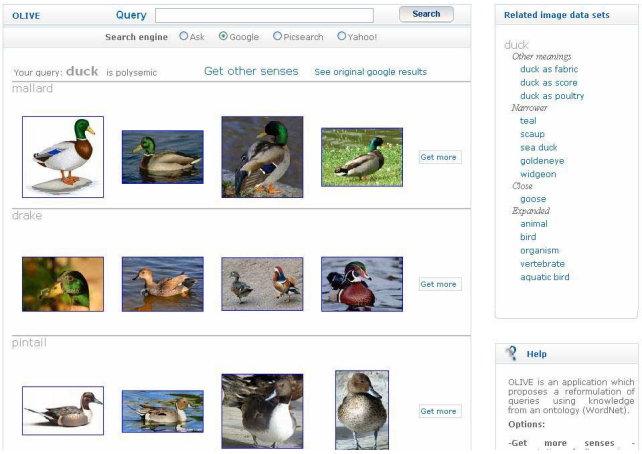

Figure 2. Olive answers for a query with *duck*. On the right side of the image, a selection of other meanings of the term, of narrower, close and expanded terms is presented.

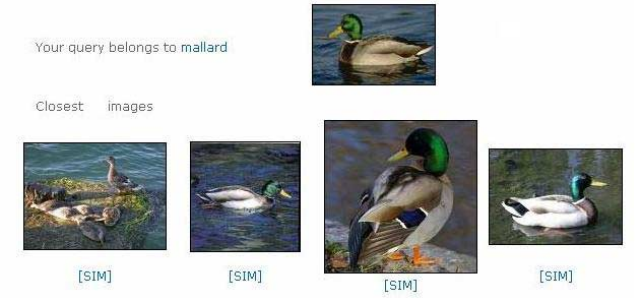

Figure 3. Example of CBIR results in Olive for a query with an image of *mallard* (the one in the upper part of the figure).

We use a parallelized Perl script to recuperate and display the images recuperated from Google Image. As we mentioned, the items displayed by Olive are recuperated on the fly. The close classes are extracted from the knowledge base and proposed for browsing. Three types of relations were retained and we exemplify using *duck* as initial query. Narrower concepts help the user to refine his query. They include: *teal*, *scaup* or *sea duck*. Sister terms are concepts having the same parent as duck: *goose*. Extended queries are proposed in case the user wants to enlarge his search*: animal*, *bird*, *aquatic bird*.

Olive proposes a query-by-example facility. The retrieval process is performed among the first 300 Google answers for a given leaf term. The semantic filtering of the images ensures that a significant part of the retrieved images are conceptually related to the query. An example is presented in fig. 3. The visual similarity is calculated using the PIRIA [3] engine and is based on color and texture.

The response time is an important parameter for interactive applications. In Olive, it is mainly dependent of the Internet connection speed which turns around 1Mbps for the host machine. In this condition, the results are displayed in a maximum of 5 seconds for the concept based retrieval and around 10 seconds for the content based queries.

3. CONCLUSIONS

The introduction of a semantic layer in the framework of image search engines can improve the quality of the results returned by the system [4], [6]. We presented Olive, a prototype system that employs a large scale knowledge base and works using Google Images recuperated on the fly. Both textual queries and visual queries are supported in Olive. Future work includes the extension of the knowledge base and the generalization of the approach to more complex queries. Although the response times are acceptable for a demonstration, we shall propose a distributed version of the demonstration which will shorten them further.

4. REFERENCES

[1] Google Image, http://images.google.com/imghp

[2] Jansen, B.J, Spink, A., Pedersen, J. An Analysis of Multimedia Searching on Altavista. In *Proc. of the 5th ACM SIGMM international workshop on Multimedia information retrieval* (Berkeley, CA, USA, 2004).

[3] Joint, M., Moëllic, P.A., Hède, P., and Adam, P. PIRIA: A general tool for indexing, search and retrieval of multimedia content. In *Proc. of SPIE Image processing: algorithms and systems* (San Jose, California, January, 2004), 116-125.

[4] Liao, S.P., Cheng, P.J., Chen, R.C., Chien, L.F. LiveImage: Organizing Web Images by Relevant Concepts. In *Proc. of the Workshop on the Science of the Artificial* (Hualien, Taiwan, Dec. 2005), 210-220.

[5] Liu, H., Xie, X., Tang, X., Li, Z.W., Ma, W.Y. Effective browsing of web image search results. In *Proc. of the 6th ACM SIGMM international workshop on Multimedia information retrieval* (New York, NY, USA, 2004), 84-90.

[6] Popescu, A., Grefenstette, G., Möellic, P.A. A Conceptual Approach to Web Image Retrieval. Submitted for the *ACM SIGMM international workshop on Multimedia information retrieval* , 2007.

[7] WordNet, http://wordnet.princeton.edu