Evaluating semantic techniques for the exploration of image archives on the example of the ImageNotion system

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Semantic based search techniques have a big potential in exploring image archives as they provide better search results than traditional full-text search. Within our ImageNotion application, we develop and combine these techniques to improve end user experience by providing innovative query refinement and navigation features. We have already reported on our work on the ImageNotion methodology and tools, which includes collaborative and work-integrated ontology creation, semantic annotation, and the possibility to automate the annotation process using text mining and image processing techniques to construct the image archive. In this paper, we describe some novel techniques in our ImageNotion application for visual query refinement and navigation through image parts to be used by image searchers. We conducted an online survey with more than hundred participants who tested the publicly available online version of this system. We analyzed the results, and showed what users think about the potential of semantic techniques for the exploration of image archives based on this concrete and working semantic image search application. The insights we gained will guide the further development of the ImageNotion system, and will be interesting for all kinds of semantic multimedia information systems in general.

تقنيات البحث المبنية على معانى النص ينتظرها مستقبل عظيم في استكشاف مخازن الصور حيث انها توفر نتائج بحث اجود من تلك الناتجة عن وسائل البحث التقليدية المبنية على النص الكامل. في اطار نظام الـــ ImageNotion نطور ونستخدم مجموعة من هذه التقنيات لتحسين وتسهيل التعامل للمستخدم النهائي للنظام وذلك عن طريق ابتكار طرق حديثة لتنقية وتصحيح الاستعلام والتنقل السلس بين محتوى النتيجة. فلسفة الـــ ImageNotion مبنية على توفير طرق وادوات تساعد على التطوير المشترك والمتكامل بداخل وحدات العمل وذلك لخلق هياكل تمثيل المعانى والتعليقات المبنية على معانى النص وتقنيات معالجة الصور لبناء مخازن الصور. في هذا البحث نتعرض لطرق جديدة في نظام الـــ ImageNotion لتنقية وتصحيح الاستعلام بطريقة بصرية والتركل السلس بين اجزاء الصور لاستخدامها عن طريق الباحثين عن الصور. لقد نفذنا استبيان على شبكة الانترنت شارك فيه اكثر من مائة مشترك قاموا باختبار النسخة الكاملة للنظام والموجودة على شبكة الانترنت. في هذا البحث نحلل نتائج هذا الاستبيان ونوضح آراء المشاركين فيه حول امكانيات استخدام التقنيات المبنية على معانى النص في استكشاف مخازن الصور وذلك عن طريق النظام العملى والموجود فعليا في الـــ ImageNotion. النتائج التى حصلنا عليها ستساعدنا على تحسين النسخات القادمة من النظام وتعتبر مهمة لكل انواع قواعد البيانات المحتوية على وسائط متعددة

Keywords: ImageNotion, Semantic image search, Navigation through image archives

1. Introduction

Semantic search techniques have many advantages over traditional text based approaches for exploring image archives. For example, ontologies and thesauri make it possible to separate homonymous meanings of a tag into dierent ontology elements; e.g., "Paris" as a person (Paris Hilton) and "Paris" as a city. Additionally, they allow proposing similar images in an image archive by using "narrower/broader term" relations of thesauri, as in Riya [1]; or "subclass-of" and "is-a" relations of ontologies, as in SemSpace [2].

Our goal in *ImageNotion* is twofold. We support the collaborative creation of ontology and semantic annotations by domain experts who are not necessarily ontology engineers and the development and extension of visual navigation schemes for end users who are

definitely not familiar with the formal principles of ontologies. The ultimate target is to support experienced image searchers, such as history students and editors of text books, in their image retrieval work from professional image archives in a user friendly and simple manner.

For example, consider the case of finding images of "all French generals involved in the First World War". To perform this generic, topical search request, users prefer to explore the contents of an image archive instead of formulating precise queries [3]. Then, they would like to graphically navigate to related images to explore related places, persons and events in the context of their current search request see fig. 1.

The key issues to the success of such a system are adequate mechanisms for creating professional annotation of images by image owners, and easily understandable search refinement and navigation techniques for image searchers.

ImageNotion aims to fulfill these requirements by providing a practically usable system exploiting semantic technologies for semantic annotation of images on the content provider side and for semantic search on the image searcher side. We already reported on the ontology development and semantic annotations aspects of the system [4, 6]. On the image searcher side, ImageNotion aims to fulfill the query refinement and result set navigation use cases for exploring professional image archives.

Fig. 1. Using semantic techniques for the navigation through image archives.

In this paper, we present several concepts of search refinement and navigation that we implement in our system. Guided by a detailed field study involving more than one hundred users, we assess the user experience with our Ajax-based web interface, which provides the look and feel of thick clients on the browser. We were interested in user feedback about the currently available semantic search refinement and navigation methods in the ImageNotion application, and about potential extensions we already have in mind. For this reason, we created an online survey, where users could express their opinions about the current state of the system. Based on this concrete and working system, we also explained some of our ideas for potential extensions, and asked the participants of the survey to comment on those, too. We believe that the techniques we apply in the ImageNotion application are generally applicable for multimedia information systems, therefore the results of the evaluation are of general interest. All in all, more than a hundred participants filled out the complete survey that provides enough data for some general insights.

The rest of the paper is organized as follows. We first give a short overview of the ImageNotion system in Section 2. In Section 3, we present related work about search refinement and navigation in image archives. Section 4 describes the implemented query refinement and result set navigation techniques that are evaluated in the survey. The results of our evaluation are presented in Section 5. Section 6 provides an overview of our next steps based on the user feedback while Section 7 concludes the paper.

2. Building the image archive

Image archives based on simple tags are well known by most content providers and image searchers. To provide semantic search, on the other hand, semantic image annotations and domain ontologies must be created. In contrast to simple tags, ontologies are very often considered as too complicated to use them in practical systems [4], because users fail to understand the ontologies created by knowledge engineers.

To overcome these problems, we let the image owners create, extend and maintain required ontologies for the semantic annotation of images by themselves. The ImageNotion approach is to construct a visual methodology which supports collaborative, work-integrated ontology development, collaborative semantic annotation and visual semantic search. The ImageNotion methodology and tools are developed in the framework of the a EU Project IMAGINATION. The main driving force for the methodology is that it should be easily usable and understandable especially for non ontology experts, such as employees of image agencies. We give here only a very brief overview of the methodology and the construction of the image archive. For further readings, please refer to [4 - 6].

2.1. Semantic image annotation

We call ontology elements (concepts and instances) imagenotions; formed from the words image and notion. An imagenotion graphically represents an ontology element through corresponding images. This visual representation of ontology elements helps the annotators to get a better understanding of their meaning. The system allows the association of descriptive data with an imagenotion, such as language specific labels, creation date and links to web pages giving further background information about semantic elements. Additionally, it is possible to create semantic relations among imagenotions.

In the ImageNotion application, imagenotions are used for the semantic image annotation instead of textual tags as in traditional image archives. Image annotators of the content provide agencies like the idea of this visual representation of ontology elements since they are used to work with highly interactive image processing programs. Using drag and drop and making few mouse clicks on the web interface, they succeeded in building ontologies in a work integrated way during the semantic annotation of images for historical images. Within and after a workshop [5], six image annotators have collaboratively created 231 imagenotions for the semantic annotation of 500 images within three weeks.

Conceptually, the methodology is based on the ontology maturing process model [4] and therefore consists of three different phases see fig. 2:

1. The creation of new imagenotions.
2. The consolidation of imagenotions in communities of users. In this phase, a stable definition of the concept emerges as users communicate with each other, or work on the same concept definition.
3. The formalization of imagenotions by defining creation rules (such as naming conventions) and relations.

Imagenotions from each maturing grade may be used for semantic image annotations immediately after creation.

2.2. Ontology formalisms

In ImageNotion, it is not necessary to build ontologies completely from scratch. It is possible to import existing ontologies, such as the the standardized multimedia ontology CIDOC-CRM [7]. Already, the content providers imported the core concepts from CIDOC-CRM in the system; which include concepts, such as thing, place, event, person, and object.

For the sake of simplicity for the annotators in IMAGINATION, this system currently uses a relatively simple ontology formalism based on the W3C standard specification SKOS [8] that provides a limited set of standard relation types. However, the ImageNotion methodology supports any number of arbitrary relation types or even stronger ontology formalisms, e.g. subclass-of relations from OWL [9].

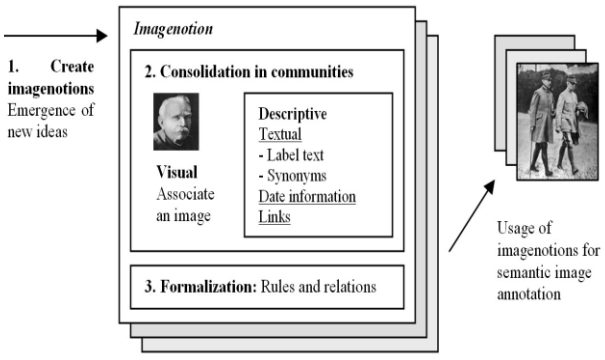

Fig. 2. The imageNotion methodology.

The content providers in IMAGINATION have an interest in further improving their semantic annotations to meet the requirements of their image searchers. Before doing so, however, they first want to know how image searchers would like to use semantic search technologies, before investing time in creating new relations or using stronger ontology formalism. Some additional evaluations were already done in this area and described in [10].

2.3. The application

The system is publicly available at www.imagenotion.com. Currently the user may choose between two versions. The IMAGINATION version was used for the evaluation in this paper, where images were pre-annotated by domain experts. In addition, another publicly available version also supports the upload and annotation of user images. Further versions of the system will be continuously published on this web site when they are available.

3. Related work

In this section, we report on available methods for search refinement and navigation through image archives. We exclude the part of building the image archive, since it is not in the scope of this paper.

3.1. Text based refinement of search results

Systems implementing these techniques use textual image annotations only. Based on a textual query, they propose possible combinations of search words, to allow the refinement of a search result. A user can choose one of these combinations to start a new search that returns a more specific result. For example in Yahoo! image search [11], after a search for "Bush", the system proposes "Sophia Bush" and "George Bush" as possible refinements of this search. This technique, however, does not allow users to distinguish between the former and current presidents of the USA; both called "George Bush".

3.2. Tag cluster

Based on tags, Flickr [12] provides a mechanism called "tag cluster" for the refinement of a search request. Here, the tags that are most frequently used together in image descriptions are grouped to clusters. From each cluster, the first five images are displayed. To refine a search, a user can select one cluster and see all images in that cluster. For example, the search for "Paris" proposes the clusters "france, eifel, tower" and "seine, river, bridge". Semantic techniques would also allow finding clusters for more complex groups, such as "Famous places in Paris", a feature that is not possible with this technique.

3.3. Browsing ontologies

In SemSpace it is possible to navigate through the image archive by browsing ontologies, e.g., to search for "all astronauts". However, SemSpace and other proposed semantic indexing schemes, valet and et al. [13] do not exploit relations in ontologies for the refinement of search requests. Using relations for search refinement would allow more specific search requests, such as "all French astronauts".

3.4. Navigation through image parts

Annotated parts of images defined by bounding boxes, show persons or objects, over a visual mechanism for the navigation through an image archive. A user can click on such a bounding box to start a new search using the corresponding annotation. In Riya [1], the annotations are text based, in SemSpace [2] the annotations are based on semantic elements. In both applications, however, a completely new search is started. Specifying combined search requests, e.g., for images that contain two specific persons, is not possible. In other words, navigation is supported, while query refinement is not optimally supported.

3.5. Other methods

In addition to the already proposed approaches, further methods based on temporal (such as the timeline feature of Google Picasa) or spatial information (such as images in Google Earth) are also possible. However, we do not consider those methods in this context since they are orthogonal to the semantic search process.

3.6. Discussion

Although all of the above mentioned techniques contribute to a more user friendly search in an image archive, no individual technique presents a complete solution to both navigation and query refinement.

4. Search refinement and navigation techniques in the imagenotion system

We launched the first version of the ImageNotion system within the IMAGINATION EU Project. In this version, we implement several techniques for visual semantic search. In this section, we give an overview of these techniques.

In the following discussion we will use the same search scenario for the sake of consistency. The scenario is simplified without loss of generality. Our hypothetical history student is interested in images of "Philippe Petain", a French general in WWI. In our image archive, the student would use a search term such as "petain" to trigger the search process. If there are many persons with this family name, the search must be manually refined, e.g. using "general petain", to get only images from this French general. Finally, the student would also like to browse related persons, e.g., search for "other French generals from WWI", places visited by these generals, or events attended by them, etc.

4.1. Visual refinement of a textual query to a semantic query

Using imagenotions we can provide semantic image search instead of full-text search. However, since users are familiar with text based systems, they are used to start with a simple text based query [14] and [15]. Therefore, we also support this way of interaction by allowing users to start with a textual query and visually resolve it to a semantic query.

In our scenario, when a user searches for "petain", all imagenotions are proposed that contain the given search word. According to a ranking system, the imagenotion representing "Philippe Petain" is proposed by the system for a possible switch to a semantic search see fig. 3.

By selecting the desired imagenotion with a simple drag and drop operation, a semantic search request is implicitly defined and is executed by the system at once. All images which contain this imagenotion as semantic annotation for an image part or the complete image are returned.

4.2. Visual search refinement using clustering

Our system internally implements an automated image clustering technique. After a semantic search, annotations of the resulting images are analyzed, and the imagenotions that are most frequently used together with the imagenotion(s) forming the semantic search are grouped together in a cluster. In further searches, they are displayed as possible *combinations*. The user then can simply refine the semantic search by selecting one imagenotion from the combinations set. This imagenotion is then added to the semantic query, and the query is executed again, retrieving only images that are annotated with all of the imagenotions in the query. e.g., for the query "Philippe Petain", the system proposes imagenotions representing "Ferdinand Foch" or "Georges Clemenceau" (other French protagonists of the WWI, see fig. 4.

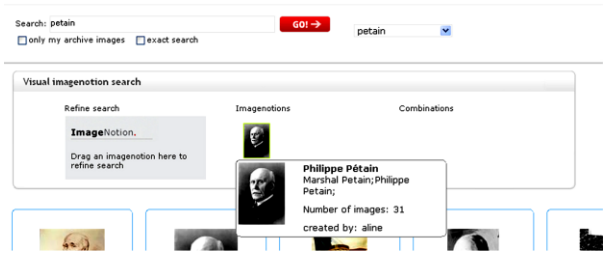

Fig. 3. Semantic search refinement using ImageNotion.

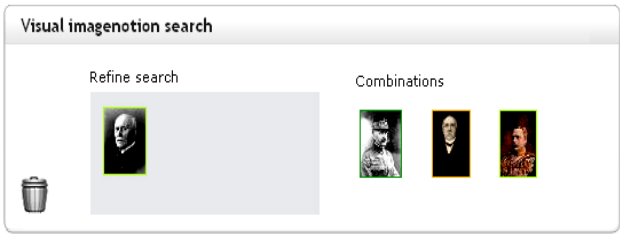

Fig. 4. Visual search refinement with combinations of imagenotions.

4.3. Navigation through image parts

Our system implements the navigation through image parts see fig. 5, similar as to in Riya. The main difference is that it is based on semantic annotations instead of textual ones. An image in the ImageNotion system may contain an arbitrary number of image parts (also termed: bounding boxes or annotation boxes). Typically this is the case for bounding boxes marking the face of a person or the contours of a famous building. Annotated bounding boxes can be used to change the current search request. In the current implementation, a click on an annotation box starts a completely new search using the semantic annotation of the annotation box, e.g., by clicking on the annotation box representing the face of "Ferdinand Foch", a new imagenotion semantic search for "Ferdinand Foch" is executed.

4.4. Browsing the ontology

Our system enables browsing through ontology elements, i.e., imagenotions. For the sake of ease of use, it is possible to search for ontology elements with text based queries. A user can also navigate to related imagenotions by following the defined semantic relations. Additionally, for each ontology element, the descriptive information of these imagenotions is displayed. A direct shortcut to searching for images that are annotated with this imagenotion is also possible.

The browsing of ontology elements allows the exploration of the image archive, e.g., the user can easily find "images French generals" by starting from the "general" imagenotion and follow the relations to "Philippe Petain" or "Ferdinand Foch" see fig. 6.

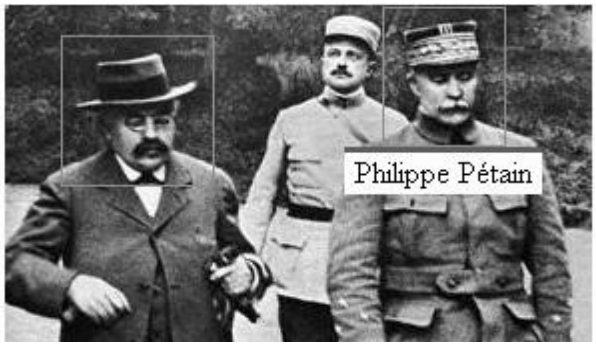

Fig. 5. Search refinement using image parts with semantic annotations.

5. Evaluation

5.1. Goals of the user acceptance survey

The main goal of our evaluation was to assess whether non-expert image searchers understand the concept of semantic search and are able to easily use the web interface to the system. Moreover, we were interested in the users' opinion about the various search refinement, navigation and visualization techniques that we provide to the image searcher. The current implementation of the ImageNotion system served as the basis for the evaluation. This gave our evaluators the possibility to experiment with the system, collect hands-on experience, and see some of the proposed techniques in action. In addition, we shared some of our ideas for further development with the users, and collected their feedback about these ideas, as well.

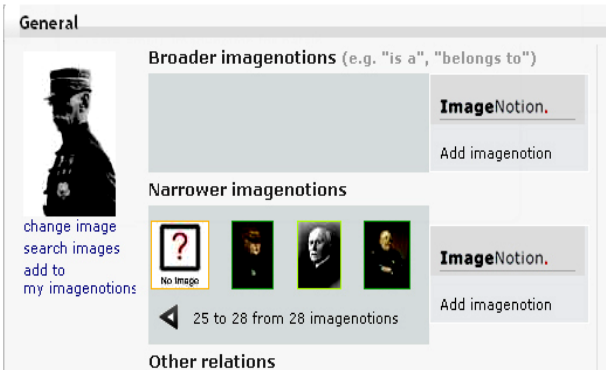

Fig. 6. Ontology browsing in ImageNotion.

The evaluation was conducted by executing an online survey. We sent email invitations to mailing lists of currently running EU projects (such as Theseus, Mature-IP and IMAGINATION), to German and French image agencies, professional image searchers, historical archives, universities and companies. Altogether, we reached over 1.000 recipients with our email invitations. 137 users accepted the invitation and participated in our survey. Most of the users had absolutely no or little experience with semantic technologies, see fig. 7. This allowed us to make sound statements about the opinion of non-expert users about semantic technologies in image archives.
In this field study, the users were asked to conduct several search refinement scenarios and report on their user experience. Beside normal questionnaire with yes/no and multiple choice questions, the survey also included free text feedback from the users, which were analyzed and taken into consideration in our plan for the upcoming version of the system.

5.2. Usability of ImageNotion and basic navigation concepts

In the first part of our evaluation, we were interested in the general usability of semantic technologies for image search. With 95.6%, nearly all the participants understood the concept of an imagenotion see table 1. Most of the users, 87.1% see table 1, succeeded in performing the first semantic search task, which was the resolution of the text based search request "Barroso" to an imagenotion based semantic search request about "Jose Manuel Barroso", the current President of the European Commission see Section 4.1.

Based on the result of the "Barroso" semantic search, the next task of the users was to search for images showing Barroso and the former president of the EU commission, Romano Prodi together, using visual search refinement based on clustering, see Section 4.2. About 72.6% found the system to be very easy and intuitive see fig. 8. After this step, 81.1% of the users rated these visual search refinement mechanisms as useful for the semantic search of images, see table 1. Only 8.5% of the users did not succeed in performing this task. We analyzed why those users failed in more detail. It was not a problem of missing knowledge about semantic information systems, since there were only two users from the group "Low, it was my first time I used semantic technologies" and seven users from the group "Low, I have heard about

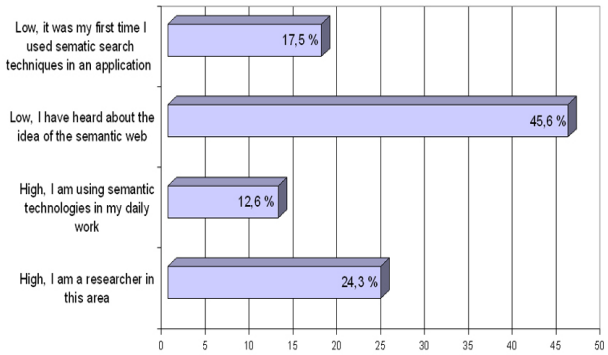

Fig. 7. Rating of personal experiences with semantic technologies.

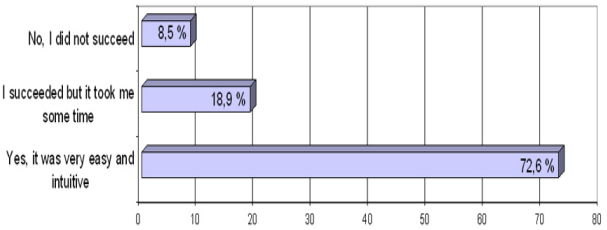

Fig. 8. Expected refinement of a search request using clustering.

Table 1
Yes/no questions of the evaluation

Question	Yes (%)	No (%)
Did you understand the concept of imagenotions?	95.6	4.4
Could you easily switch from text based to imagenotion based search request for "Barroso"?	87.1	12.9
Are refinements and cluster mechanisms useful for the navigation through image archives?	81.1	18.9
Did you understand relations?	83.1	16.9
Are relations important for the refinement of search requests?	84.0	16.0
Do you have a problem with big number of annotation boxes on images?	53.4	46.6
Do you like the idea of filtering annotation boxes?	87.9	12.1

the idea of the semantic web" (most users out of this group even said in a text field, that the task was very easy and intuitive to perform). Three of the failing users came from the group "High, I am using semantic technologies in my daily work" and there was one failing user even from the group "High, I am a researcher in this area". Users could state a reason in a free-text field, why they failed. All users who gave feedback stated technical problems based on JavaScript errors in their browsers, so that the required methods did not work for them. So it seems that there was a temporary technical problem with the system during the evaluation.

5.3. Understandability and usefulness of relations

The focus of the second part of our evaluation was to check whether users understood ontology relations and whether they thought that such relations are useful for the navigation in image archives.

For this part of the evaluation, we first explained what relations are and gave examples for possible uses of relations, see Section 4.4. Fortunately, with 83.1%, most users understand the meaning of relations, see table 1. In the next task, the participants were asked to perform an abstract search instead of directly searching images of "Manuel Barroso". They had to open the ontology browser of our system and search for the ontology element "President". Then, they had to navigate to the imagenotion of "Manuel Barroso". In order to accomplish this task, they had to follow the semantic relations defined for the "President" imagenotion. Fig. 9 shows that more than half of the users rated this task as very easy and intuitive.

Nevertheless, 41.1% took some time to complete the whole exercise and 8.4% failed in performing this task. We analyzed the reason why users failed in more detail. For this task, most users (9 users) who failed were from the two groups with low experiences with semantic technologies. They stated that the task was too complicated and they did not understand what to do. For the users, who took some time, most stated, that the task was completely new to them compared for to e.g. well known text based search requests in search engines like Google. Therefore, they first had to think on a possible solution how to perform this task by understanding the meaning and possibilities with relations. More complex tasks with relations would most probably require us to give more training to the users, e.g., with screen casts showing possible example use cases.

The last task in this survey part was to answer two questions concerning the usefulness and usability of relations. 84% of the users gave a positive answer to the question, whether relations are important for the refinement of search requests, see table 1. Concerning the use of relations for the refinement of queries, users were asked whether they prefer starting a completely new search, when they select a related imagenotion from the set that is presented for a search request, or the current search should be combined with the selected imagenotion. 88.7% of the users preferred the combination of the search, e.g., in the example we gave in the survey, the search for the German chancelor "Angela Merkel" would be combined with the "Copenhagen Council", an event where she participated, see fig. 10.

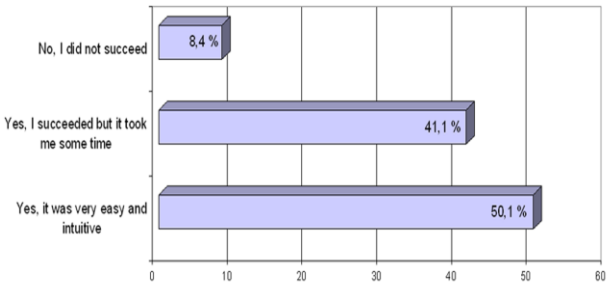

Fig. 9. Evaluation question: "Did you succeed in navigating to the Barroso imagenotion?".

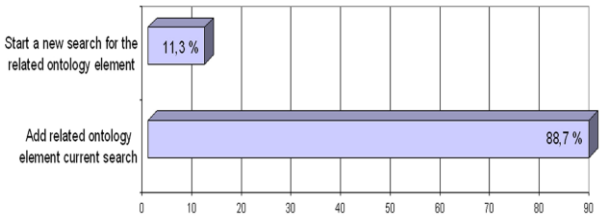

Fig. 10. Expected refinement of a search request using relations.

5.4. Navigation through image parts

In the third part of our evaluation, we were interested in what users expect when using the navigation through image parts feature. The first task was to perform a semantic search for "Angela Merkel". Based on the search result that displays thumbnail images of the current German chancellor, users are asked to open one of these images in a bigger window (displaying the so-called layout image). This image contains annotation boxes for the faces of "Angela Merkel" and "Manuel Barroso", see fig. 11.

We asked the users what should happen when they click on the annotation box for "Manuel Barroso". We listed the following possibilities:

5.4.1. Start a new search

A click on an annotation box starts a completely new search for Barroso (this is the option that is actually implemented by ImageNotion at the time of the evaluation).

5.4.2. Start a boolean search

A click on an annotation box combines the current semantic search with the semantic annotation of the clicked annotation box. Only images are included in the result that contains both Merkel and Barroso.

5.4.3. Start a weighted search, with preference on the annotation of the annotation box (as used in [16])

First, images that contain both Merkel and Barroso are shown, then images containing Barroso, finally images containing Merkel.

5.4.4. Start a weighted search, with preference on the original query

First, images are shown that contain both Merkel and Barroso, then images containing Merkel, finally images containing Barroso.

5.4.5. No search, only imagenotion details

Do not execute a search, but, instead, display the details of the "Barroso" imagenotion.

Fig. 12 shows that more than the half of the users (53.8%) did not want to start a completely new search. Instead, 17.1% of

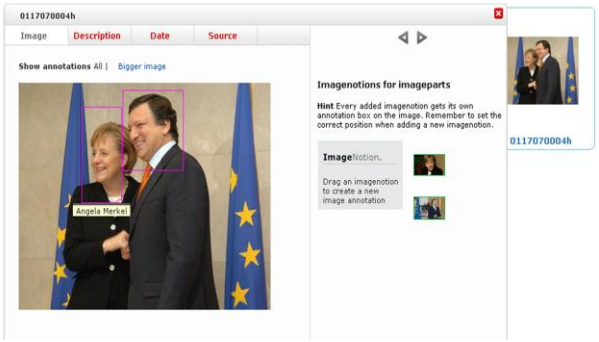

Fig. 11. The image for evaluating navigation through image parts.

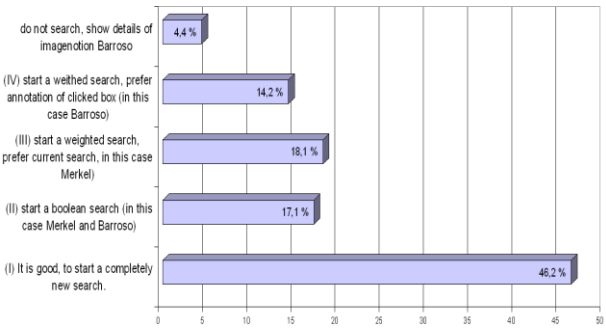

Fig. 12. Expected search when clicking on annotation boxes.

the users preferred starting a boolean search. An even higher number, 32.3%, preferred a weighted search mechanism and only 4.4% of the users prefer not to search but to see the background information of the "Manuel Barroso" imagenotion. Due to the irresolute nature of this voting, we see a need to implement all of these mechanisms in the future. A user must be able to choose the desired query refinement either dynamically for each click, or by preference in the user or session profile.

5.5. The effect of annotation boxes

The last part of the evaluation was concerned with the problem of having a large number of annotation boxes in an image see fig. 13. Currently, there are two annotation boxes per image on the average. With the completion of the annotation process of the image archive, we expect this number to increase significantly.

Since the number of annotation boxes in images can become very large, our idea to solve this problem is to filter the annotation boxes by topics or groups of interests [17]. For example, a group of annotators could create annotation boxes for politicians while the other group could create annotation boxes for airplanes. On images containing both airplanes and politicians, image searchers could then filter their respective group of interest to see only the annotations in those groups. This requires a slight extension in the collaborative model of image annotation to connect annotations with groups and a small change in the current user interface for image searchers to select groups for filtering the annotation boxes. We shared this idea with our evaluators and asked their opinion about it.

The majority of the users (53.4%) had a problem with the large number of annotation boxes see table 1. 87.9% of the users liked our idea to filter the annotation boxes see table 1. In the free text user feedback area, there were several proposals that if the number of annotation boxes exceeds a certain threshold, a filtering option should be automatically enabled.

6. Next steps

Based on the results of our evaluation we are confident that it is useful to implement our ideas about search refinement using image parts and filtering of annotation boxes

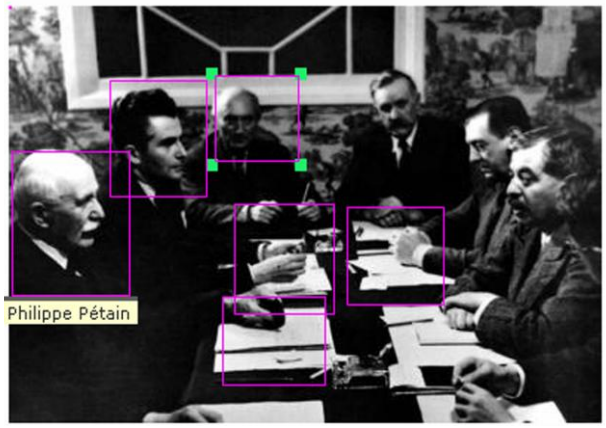

Fig. 13. Big number of annotation boxes in images.

in images. The next version of our system will contain these features. For example, if the if the current search request contains the imagenotion "Ferdinand Foch", after the user clicks on the face of "Philippe Petain", the system will be able to retrieve all images where the two generals appear together. As another example, the user will be able to display only persons (e.g., the two generals) in the image, and filter our annotations about airplanes or building that are also on the image.

The positive feedback about ontology relations (see also [10] for a more detailed evaluation of that point) motivates us to extend the visual search refinement feature of the system, and include also suggestion based on ontology relations. In this case, imagenotions that are connected with the imagenotion(s) of the current semantic query would be displayed. Similar to the previous techniques, the user can extend the query by simply adding one imagenotion from the suggested set. This technique would allow the formulation of complex search requests, such as "All Generals from France who participated in Battles of World War I". This query would return for example images showing "Philippe Petain" and "Ferdinand Foch" at the "Battle of Verdun".

7. Conclusions and outlook

In the ImageNotion project, we provide a rich combination of semantic techniques for the exploration of image archives. A key to the success of our project is to formulate ontology based queries, refine them and navigate through their result sets in a user friendly manner that is suitable even for image searchers without significant experience in semantic systems.

Our evaluation results show that using ImageNotion, semantic search is understandable and useful even for non-expert users. The manifold options that are opened for innovative visual search refinement and navigation techniques by using semantic technologies were appreciated by the evaluators. Especially the visual search refinement feature received a very positive feedback.

The user feedback helps us also to assess the potential extensions we already have in mind. Besides implementing these features, we want to encourage image annotators to extend their ontology formalism. Only then, we will be able to experiment with a richer set of predefined relations and also with user-defined relations. We will evaluate, however, each extension step. If the complexity of formalism reaches a limit where it is not understandable for non-expert users any more, we will opt for a less expressive, but understandable formalism.

We are also motivated to install our application for bigger communities to get further feedback on user experience. For this purpose, we plan a series of stress tests and performance analysis experiments.

Finally, in the IMAGINATION project, we will combine the ImageNotion methodology with automated processes to measure the benefit and time savings of automatic generation of semantic annotations. Good quality, automatic generated semantic annotations allow the economical transition of existing, text-based image archives to semantic systems, and thus the application of the visual methods that are presented in this paper.

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