

IMAGENOTION - Collaborative Semantic Annotation of Images and Image Parts and Work Integrated Creation of Ontologies*

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Abstract:

In this paper, we present the ImageNotion tool that allows for the semantic annotation of images and image parts together with the maturing of ontologies in a work integrated environment. The tool uses our ImageNotion methodology for ontology development.

Keywords Collaborative ontology engineering, image annotation, social software

1 Introduction

Currently, metadata about the content of images is largely based on the unstructured and non semantic tagging paradigm. E.g., also Flickr [Fli07] and Riya [Riy07], two popular systems for collaborative annotation of images, use this paradigm. Our current work aims to provide semantic search for image contents and also make easy navigation among images by simply clicking on their parts possible. This requires using domain specific ontologies for the annotation of images and image parts.

While tagging systems are user-friendly, ontology formalisms and development tools are too complicated for most users [FLGP02]. This fact normally leads to a separation of the ontology engineering process from the usage of ontology for the semantic annotation of resources. When the content of an image repository rapidly changes — and this is the case for most image repositories that are created collaboratively — this separation usually results in missing or obsolete concepts in the ontology. I.e., an adequate and user-friendly annotation of images is not possible any more. Moreover, using separated ontology editors and image annotation tools raises the need for continuous ontology import/export between them. This makes the whole process cumbersome, slow and expensive even for experienced ontology engineers and domain experts.

We identified three challenges that must be solved to change this situation. First, the ontology development process should be simple enough that even the average user without much ontology experience can contribute to the creation of a meaningful ontology.

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Second, the process of ontology development should be integrated into the process of semantic annotation. This work-integrated creation of the ontology eliminates the for the expensive communication among knowledge engineers and annotators (domain experts), and the need for importing/exporting ontologies. Work-integration allows the creation or adjustment of new ontology concepts exactly then, when the need for them arises during annotation: this makes ontology development well-motivated and intuitive. Finally, the ontology development process should also be collaborative so that users may profit from the work already done by their fellow users.

In this paper, we introduce our ImageNotion tool and methodology that allows for the collaborative, work-integrated development of ontologies and the semantic annotation of images and their parts. Thus, ImageNotion addresses all of the introduced challenges.

2 Related Work

The ideal solution for the collaborative, work-integrated development of ontologies would be a browser-based tool that is easy to use and follows an approach that allows both the development of ontologies and the semantic annotation of images (and their parts) in one integrated framework. Currently, we are not aware of any work that achieves this goal. Therefore we can only review works that address partial fields of our research.

Riya [Riy07] allows for a collaborative, browser based annotation of images and image parts with tags in a work-integrated environment. However, semantic annotation of images using ontologies is not possible. *Photostuff* [HWGS⁺06] is a stand-alone application that supports the semantic annotation of images with imported ontologies. Ontology development and collaborative work is not possible with this tool. Protégé [Pro07] is one of the most popular tools for ontology development. With an extension (Collaborative Protégé [TN07]), it also allows collaborative work. The problem of this tool is that it is difficult to use for non ontology experts. Semantic Wikis [VKV⁺06] are browser based and easy to use, but they are not suitable for the annotation of images.

A common drawback of all these tools is that a separate tool is required for semantic image annotation and therefore ontology development is no more work integrated. SOBOLEO [Bra07] is intended for non-ontology-experts, too, and allows the work-integrated maturing of ontologies. However, it is intended for the annotation of web pages and not for the annotation of images and especially image parts.

3 The ImageNotion Methodology

We tried to explain to our users (experienced in the area of tag based image annotation and thesauri) how to use the tools Protégé for the ontology development and PhotoStuff for the semantic image annotation. By using these tools, i.e., by separating the ontology building and semantic annotation processes, the semantic annotation of images was nearly

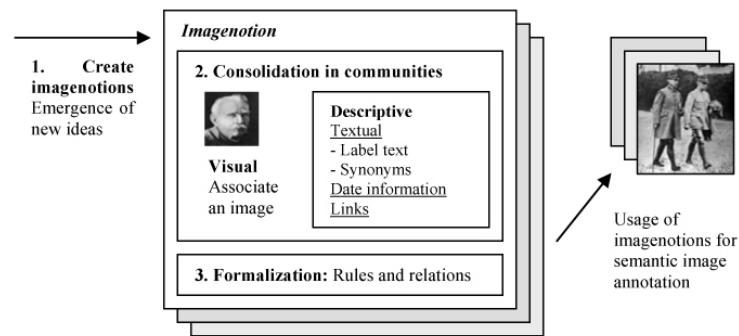


Figure 1: The ImageNotion methodology

impossible. The barriers were too high because of complexity tools, the complexity and formality of ontologies, and because of the cumbersome workflow for extending the ontology. This motivated our research for an approach more intuitive and more understandable for our users. The result is a methodology and a tool called ImageNotion.

Ontologies in the ImageNotion methodology consist of *imagenotions*. An imagenotion (formed from the words image and notion) graphically represents a semantic notion through an image. Our motivation was the ancient observation that “a picture worth a thousand words”. Furthermore, similarly to many existing ontology formalisms, it is possible to associate descriptive information with an imagenotion. A part of the descriptive information is textual: labels in different languages (such as English or German). For each language, one of these synonymous labels is selected as the main label of the imagenotion. Other labels are termed synonyms. Additionally, date information (exact date or time interval) attached to the imagenotion allows for temporal queries on images. Further, it is possible to add links to web pages for an imagenotion. Links provide additional background information for the users of the ontology. On the one hand, this makes imagenotions easier to comprehend. On the other hand, it is easier for the users to extend the description of the imagenotion based on this background information, i.e., to mature the imagenotion. In addition to descriptive information, relations among imagenotions are also possible. Currently we support hierarchical relations (broader and narrower imagenotions). All other relations are termed “unnamed relations”.

3.1 The Phases of the ImageNotion Methodology

The aim of the ImageNotion methodology (see Fig. 1) is to guide the process of visually creating an ontology that contains imagenotions and relations among them. The main steps of this methodology are based on the ontology maturing process model that we have described in [BNS⁺06]. Step 1 is the creation of new imagenotions, step 2 is the consolidation of imagenotions in communities and step 3 is the formalization of imagenotions with rules and relations. Imagenotions from each maturing grade may be used for semantic image annotation.



Figure 2: Creation of new imagenotions

3.2 Social Aspects of ImageNotion

The usual separation of ontology development and ontology usage leads to problems in practice, such as having outdated elements in the ontology ([Hep07]). Ontology maturing, i.e., the development of ontologies, is a social and collaborative process. This process should be supported by a user-friendly methodology that allows the needed collaboration. In ImageNotion, users can modify the underlying ontology¹ of a semantic application themselves and at once when the need arises. They also see the changes that are made by their fellow users. This approach, motivated by constructivist views on learning (see also [AMR06]), allows a community the creation of required ontologies that fit their needs as well as possible.

4 The ImageNotion Tool

We will now describe how the ImageNotion methodology is implemented in our tool. A demo version of the tool is accessible at www.imagenotion.com/demo.

Creating and Editing Imagenotions: Images with new ontology elements require the creation of new imagenotions. In Fig. 2, a user has new images of “Joseph Joffre” (french general in World War I). Since the ontology contains so far no concept (or instance, respectively) for Joffre, a new imagenotion is required that allows for the annotation of this new image. The user chooses one image in the archive showing Joffre and drags this image to the area that allows the creation of new imagenotions (see Fig. 2). Now she can enter a label in her preferred language and the new imagenotion is created. To add relations, the tool first allows searching for existing imagenotions. Then, it is possible to add these imagenotions as relations or to create a new imagenotion and relate it with the current one. E.g., in the example of “Joffre”, relations to “France” or to “World War I” may be added (see Fig. 3).

¹add new ontology elements or modify existing ones

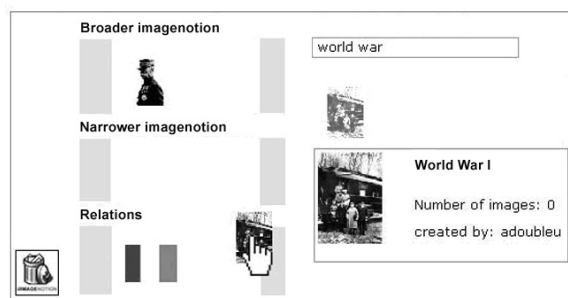


Figure 3: Adding relations between imagenotions

Annotation of Images and Image Parts: The annotation of images is possible with every available imagenotion. The tool allows searching for imagenotions and bookmarking the preferred ones as “my imagenotions”. With drag and drop, a user can annotate images or image parts very easily. For image parts, the user can also specify the correct position of the image annotation box (see Fig. 4).



Figure 4: Semantic annotation of image parts

5 Conclusion and Future Work

The ImageNotion tool allows for the creation and maturing of ontologies for the semantic annotation of images and image parts. It is accessible via a standard web-browser and allows collaborative work in a work integrated environment. Our next work steps include implementing exporting possibilities for the the created ontologies, further elaborate on the issue of relations among imagenotions, and evaluating the system with experienced users in the area of image annotation within the EU project IMAGINATION². In this project, we implement an expert-based version of the system, where only experts may annotate the images. Our vision is, however, the creation of a Flickr-like collaborative environment where imagenotions are used for the semantic search and annotation of image contents.

²<http://www.imagination-project.org>

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