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An approach to Semantic Content Based Image Retrieval using Logical Concept Analysis. Application to comicbooks.

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Abstract. In this paper, we present an ongoing work aiming to improve content based image retrieval performance with the help of logical concept analysis. Domain semantic is formalized and used instead of classical CBIR visual features. This is being applied to comicbooks using Sewelis.

Keywords: Comic Books, Description Logics, Semantic, Logical Concept Analysis, Content-Based Image Retrieval.

1 Introduction

Web search engines usually give poor results when searching in multimedia databases since they use the contextual web page, or the meta information attached to the multimedia objects. The semantic meaning that the user usually attaches to the content of the document is often very different from the text used for indexing the image (semantic gap). Content Based Image Retrieval (CBIR) has been proposed to search into huge unstructured image databases by giving an example of what the user is looking for instead of describing the concept it represents. Classically, visual features are extracted from the images and then compiled into a signature [1]. To perform the retrieval, a similarity function is computed to compare the index of the query to those of the collection. A ranking of the results is produced according to the similarity and shown to the users. To improve the quality of the retrieval, an interaction with the user, called relevance feedback [2], can be added. These techniques work pretty well in the context of searching visually similar images in unstructured image databases.

In this article, we are interested in CBIR in the context of comicbook databases. In this case, databases cannot be considered as unstructured anymore since images can be grouped in terms of panels, pages and volumes which are themselves associated with metadata concerning the author or the series they belong to. We would like to benefit both from the search facilities given by CBIR techniques with feedback and semantic information embedded in the structure of the comicbooks documents. To do such a thing, Logical Concept Analysis (LCA), an extension of Formal Concept Analysis (FCA) [3], is used through the Sewelis implementation [4]. We will first go through the presentation of our comicbook model and its transcription into LCA. Then we will explain how we can mix classical CBIR and LCA techniques together to enhance retrieval relevance.

2 Semantic Content Based Image Retrieval

2.1 Model description

Comicbooks have a natural hierarchical structure that can be formalized. They are made of pages which contain panels. These panels can eventually be gathered in strips[1] and contain different kind of objects, such as speech balloons, characters, free text, etc. Balloons can be of many kinds (dialogue, thoughts etc.).This knowledge can be used to deduce more information such as pieces of the storyline. Fig. 1 illustrates the model we propose to formalize the comicbooks domain. It has been described with more details in [5].

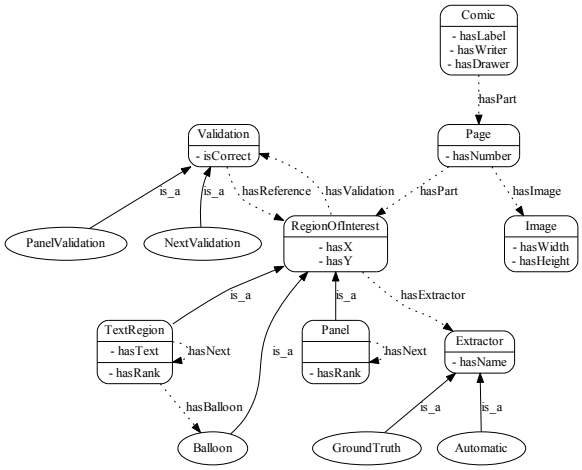

Fig. 1. Part of our model concepts hierarchy and their properties.

2.2 Heterogeneous and complex data integration

Some works [6–8] already enhanced the classical CBIR techniques with an ontology approach. The modelling was mainly focused on the description of segmented areas though. We would like to go further and use the full power of description provided by description logics.Indeed, the model presented previously is expressive enough to allow the retrieval of similar panels considering different characteristics like low-level image features, spatial relations or semantic information.

An input picture, picked from the database, being given, the system will not only be able to retrieve similar pictures based on the classical image characteristics (colors, shapes, textures...), but also based on the associated semantic and the knowledge that could have been learnt previously. Considering that the query is a Panel instance, the search can focus on:

(1) The panel's characteristics (i.e. data properties of a Panel object). This could be its rank, its shape, its size, its position, its shot type, its view angle,

[1] A strip is defined as an horizontal sequence of panels. Traditionally, a strip is made of 1 to 6 panels and a page can contain up to 4 stacked strips.

etc. Images of a *very close shot of a character's face* or a *landscape picture of a valley being at the top of a page* can be examples of queries.

(2) The panel's relations (i.e. object properties). Properties of objects related to the query panel can be used as well as its own characteristics. Therefore, there are two directions to look at from a panel point of view.

- The search can focus on what is *inside* the panel, like similar amount of objects in a scene (a dialogue between two characters for instance) or related text content. The retrieval process can also rely on objects contained in the panel, whether they are identified or not. Assume that the query picture contains an identified character A whose visual signature is defined by the set of features X. The system will not only look for panels containing an instance of A, but also for those showing a spatial region matching X.
- Outside: the search can focus on panels sharing page's or comic's characteristics (such as author, style, etc.)

These kinds of retrieval angles are not mutually exclusive and it is very possible to combine two or more of them in order to narrow the result set. The search possibilities are only limited by the completeness of the description.

2.3 Sewelis integration

In databases, information retrieval is classically performed by request queries expressed in a specific request language, as SQL for example. However, the more refined is the search, the more sophisticated is the request. Some information retrieval systems offer a simpler search refinement by navigation in a predefined static data structure, where each navigation step proposes to the user a more refined query answer. For example, file systems can be considered as an information retrieval system where data is organized in a static tree structure. A new approach of information retrieval, both by request and by navigation in a Galois lattice structure [9], has been proposed in [10, 11].

The concept lattice is a rich and flexible navigation structure automatically derived from data, and can therefore be considered as a dynamic and complete space search enabling data description while preserving its diversity. Querying and navigation can be freely combined: to each user request corresponds a concept of the lattice as answer ; the user can then improve its search either by amending its request, or by on-line browsing around the concept in the lattice structure. Such an approach was already proposed, for example in [10] with the logical information systems (LIS) and has been implemented in Sewelis [4].

Sewelis is used to load the comics' ontology and to create a bound between the model and a concept lattice. The objects of the lattice match the classes of the model, the attributes are their properties and each concept stands for a set of classes' instances sharing the same properties. It is then possible to navigate all the way to any concept, using the flexible navigation structure provided by the concept lattice.

2.4 Application

Let us illustrate this with a simple example. Let say we have a query panel and we want to retrieve the strip it is coming from. While it only takes a quick look

to a human being to find the answer, it is not something obvious for a machine, the *strip* concept not even being part of the model. Classical CBIR methods, based on a similar visual features criterion, are helpless in that case. However, if the knowledge related to the panels and their inside/outside relatives is used, it becomes possible to return results that can be justified by the system and iteratively refined with the relevance feedback brought by the user. Concerning this request, the page number of the panel will first be considered (outside panel's relation) in order to focus on panels coming from the same page. Then, the y-axis value of its centroid will be selected and only panel's whose centroid corresponds to the same y-value, within a predefined delta, will be kept. Finally, the *hasNext* [5] relation can be used to sort output panels in order to rebuild the strip.

3 Conclusion and perspectives

This paper has presented an ongoing work about a Semantic Content Based Image Retrieval system applied to comic books. The final aim would be to provide a complete system that would be able to (1) retrieve resources similar to a query, based on the amount of mutual properties they share and the significance of these properties guided by the user relevance feedback, and (2) explain to the user why a returned resource is considered to be relevant to the query.

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