IMAGE ANNOTATION USING VISUAL CONTENT AND OPTIMIZING OPEN KNOWLEDGE BASE

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Abstract

Open knowledge bases such as the Cyc and DBPedia contain rich knowledge sources for various applications. In the case of image annotation and retrieval applications, such knowledge can be tapped and exploited to semantically annotate poorly annotated images or even images which have not been annotated. We proposed an approach to annotate images by using the visual content of images and subsequently used such content to assign suitable seeds annotation to target images. These seeds annotation are then mapped to the open knowledge base in order to further enrich its semantic information.

1 Introduction

Open knowledge-bases such as Cyc [1], CUFTS [2] and DBPedia [3] offer numerous benefits to various applications and users. A few years back for example, the Linking Open Data Project became one of the main showcases for successful community-driven adoption of Semantic Web Technologies. It aims at developing best practices to opening up the "knowledge gardens" on the Web, interlinking open knowledge sets on the Web and enabling web developers to make use of that rich source of information. Such openness are not only useful for open web data, they also provide benefits to end users and at the enterprise at large [4].

This research aims to address the issues of how best to exploit such open knowledge bases in order to enhance image annotation and retrieval. The applications concerns with media annotation are huge as exhibited in the broadcasting industries [4], preservation of cultural heritage [5], social networking [6] and mobile applications [7]. The usual reason to annotate data (i.e. add metadata to it) is to simplify access to it. This is one of the key ideas behind the semantic web. The metadata added to documents or other medias allow for more effective searches. In the case of images, if they are completely described by a textual annotation, then many media searches can be done effectively by text search technique. Manual annotation done by experts although accurate but costly to be implemented. Social-based annotations which results in the creation of folksonomy although feasible but resulted in poor tagging due to the mood of the annotators and sometimes few images were left without being annotated.

2 Background and Related Research

Annotation means to add explanation and notes to a lot of things such as an artefacts, book and even medias with the intention of giving additional information [8]. Semantic annotation on the other hand is a specific metadata generation and usage schema, aiming to enable new information access methods and to extend the existing ones. The annotation scheme, offered here, is based on the conception that named entities constitute an important part of the semantics of the documents they are mentioned in. Moreover, via the use of different sorts of redundancy and external or background knowledge, those entities can be coupled with formal descriptions and thus provide more semantics and connectivity to the open environment. In a nutshell, semantic annotation is about assigning to the entities in the text links to their semantic descriptions. Automatic semantic annotations enable many new types of applications: highlighting, indexing and retrieval, categorization, generation of more advanced metadata, smooth traversal between unstructured text and available relevant knowledge [9].

Metadata can be specified using one or more of the following approaches, as reported in [10], listed in order of increasing structure:
  i. Free text descriptions: No pre-defined structure for the annotation is given.
  ii. Keywords: Arbitrary chosen keywords or keywords chosen from controlled vocabularies are used to describe the images.
  iii. Classifications based on ontologies: Ontologies – large classification systems that classify different aspects of life into hierarchical categories are used. This is similar to classification by keywords, but the fact that the keywords belong to a hierarchy enriches the annotations.

Various methods to support image annotation had been proposed [11]. However, little focus has been directed to annotate images which have no or little textual description or even to augment such annotations using open knowledge-bases. This proposed research sees the potential of exploiting such huge information available in the open knowledge base in annotating and augmenting such poor-descriptive medias.

DBpedia is one of such knowledge-bases which primarily aims to enhance intelligence of the Web and to support intelligent information reasoning. DBpedia extracts structured information from Wikipedia and make it available on the Web. As of March 2011, DBpedia knowledge base describes more than 3.5 million things, out of which 1.67 million are classified in a consistent ontology, including 364,000 persons, 462,000 places, 99,000 music albums, 54,000 films, 17,000 video games, 148,000 organisations, 169,000 species and 5,200 diseases. DBpedia data set features labels and abstracts in up to 97 different languages; 1,850,000 links to images and 5,900,000 links to external web pages; 6,500,000 external links into other RDF datasets, 633,000 Wikipedia categories, and 2,900,000 YAGO categories. DBpedia altogether consists of over 672 million pieces of information (RDF triples) out of which 286 million were extracted from the English edition of Wikipedia and 386 million were extracted from other language editions.

Such a huge knowledge base is seen potential to be exploited for supporting semantic annotation and augmentation of images. However, to automatically annotate images is not a straightforward process. Initial 'good' annotations (or seed terms) are required. This can be achieved by analysing textual content associated with the media if there is any. However, for media with no associated text or little textual description, other alternatives may be considered. One of the possible ways is to exploit low level features (such as colour) and find other similar images which have been annotated or contain rich textual description and use such information to annotate the images. Linking of these initial annotations to the huge DBpedia knowledge base is also another important research area. Proper strategy needs to be crafted as linking and querying DBpedia knowledge base require appropriate SPARQL statement in order to get the correct component of the entities.

3   Proposed Approach

Our proposed approach to image annotation is as illustrated in Figure 1. Features database will be made available by careful selection and extraction of tagged Flickr images. Social media sharing websites like Flickr offers rich annotations that can be taken advantage of. Features database will present visual along with textual features for various classes of images. These features are used to assign suitable seeds annotations for target images by means of some similarity measures. Target images catered for in this research are images without any annotation. Concepts of image classification, aforementioned, are chosen manually based on popular and distinctive visual characteristics. In this case, we will explore various feature descriptors and classifiers as well as suitable feature similarity measures will be proposed.

Tags (or annotation) of images that are very similar with the target image are used as seeds or initial annotation for the latter. This is done by first computing the feature of both target image and annotated images, and then searching is done to find visually similar images via a similarity measure technique. Annotations associated to these similar images are appointed as initial annotation to the target image. As there can be more than one similar image, a suitable strategy for merging such annotations is necessary. Furthermore as Flickr social based annotation is sometimes prone to 'junks' further refinement is non-trivial. It is at the refinement stage whereby the annotations are mapped to the open knowledge base such as the DBPedia in order to further enrich its semantic meanings. The automatic mapping of these annotations will be a challenging task as the open knowledge base contains huge information and its content is frequently unknown to annotators.
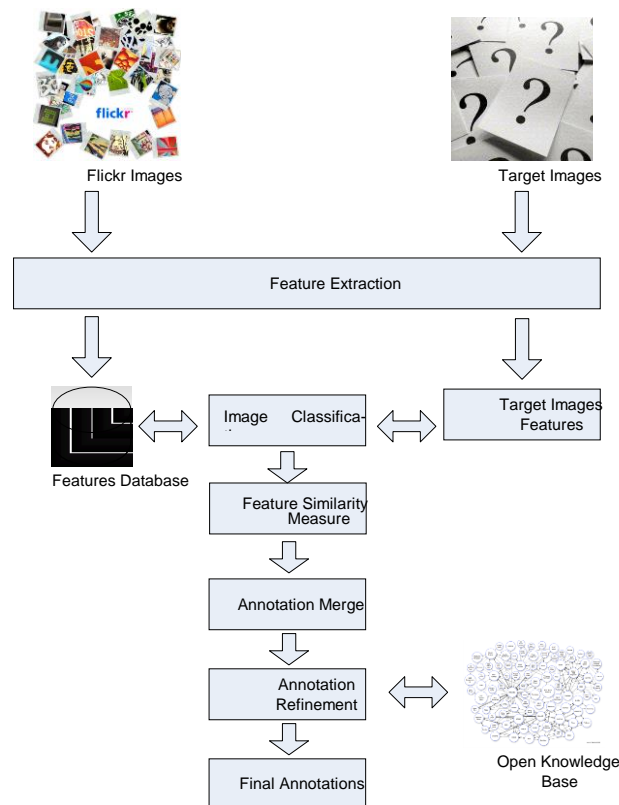
Figure 1 : Proposed approach to semantic image annotation

4   Conclusion

This study proposed an alternative to enhance image annotation and retrieval by exploiting open knowledge base. In the proposed approach existing tagged images are used to provide initial seed annotations. These seeds annotation are subsequently refined and mapped with the open knowledge base such as the DBPedia. The proposed approach aims to semantically annotate images which are not being described by any textual description.

We hope that this research will be able to answer the following research questions:
- *What features and approaches are useful to automatically generate annotations for images?*
- *What are the approaches and mechanisms to exploit open knowledge bases for augmenting semantic media annotation and retrieval?*

Evaluation of the effectiveness of the proposed approach will be based on the conventional precision and recall measures. We proposed to evaluate from two perspectives. First, is based on the accuracy of the annotations by comparing the results with the ground-truth images or benchmarks. The second is based on the information retrieval system (IR) perspectives whereby a prototype IR system will developed and effectiveness is based on the quality of relevant images being retrieved from the system.

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