

# Tag Disambiguation through Flickr and Wikipedia

Anastasia Stampouli<sup>1</sup>, Eirini Giannakidou<sup>1,2</sup>, and Athena Vakali<sup>1</sup>

<sup>1</sup> Aristotle University of Thessaloniki, Department of Informatics, 54124 Thessaloniki, Greece  
{astampou, eirgiann, avakali}@csd.auth.gr

<sup>2</sup> Centre of Research & Technology - Hellas  
Informatics and Telematics Institute  
6th km Harilaou - Thermi, 57001, Thessaloniki, Greece  
igiannak@iti.gr

**Abstract.** Given the popularity of social tagging systems and the limitations these systems have, due to lack of any structure, a common issue that arises involves the low retrieval quality in such systems due to ambiguities of certain terms. In this paper, an approach for improving the retrieval in these systems, in case of ambiguous terms, is presented that attempts to perform tag disambiguation and, at the same time, provide users with relevant content. The idea is based on a mashup that combines data and functionality of two major web 2.0 sites, namely Flickr and Wikipedia and aims at enhancing content retrieval for web users. A case study with the ambiguous notion “Apple” illustrates the value of the proposed approach.

**Keywords:** term disambiguation, flickr, Wikipedia, DBpedia project, mashup.

## 1 Introduction

With the development of social tagging systems a great amount of information was created in a relatively short time interval. This led a lot of researchers to think of various ways in which they could exploit this kind of information for various aims. However, an issue that emerges regarding this information that comes from many users is that it can be interpreted in many different ways because of its clearly subjective character. This subjective character is based on the fact that in most systems of such type users select the labels (i.e. tags) that they use, in order to characterize/describe digital objects, without any control over the procedure of choice through some concrete vocabulary.

An important issue that arises in such systems that the users have the possibility of selecting freely the tags that they use is the disambiguation of certain notions. The meaning of the tags may be obvious for the author but not for all the other users. Thus, because of the ambiguous character of tag information, a need was identified for combination of information from various sources of data, so that the information that is provided in the users has a more valid character and better quality results are produced in the various user queries. A solution towards that direction was the creation of mashups (i.e. concurrent use of information from multiple social data sources for users’ benefit). The applications that are based in mashups do not receive static

information but high quality processed elements that render the user information more useful. There are certain examples of tags that are used as a basis for the development of mashups which support in an efficient way the interconnection between the sources of information and operations concerning the management of their content [1].

The idea of creating customized applications (i.e. mashups) to use interlinked web 2.0 content and improve retrieval quality in social sites is often seen in various approaches [2]. Beyond this, there are also approaches that aim at resolving tag ambiguities and achieving better retrieval rates, by analyzing the tag space or using external resources [3, 4, 5].

In this paper, a mashup idea is presented that attempts to perform tag disambiguation and, at the same time, provide users with relevant content. The mashup combines data and functionality of two major web 2.0 sites, namely Flickr and Wikipedia and aims at enhancing content retrieval for web users. The rest of the paper is organized as follows. In the next section, a description of the “mashup” term is given, along with some indicative examples of successful and, currently, well adopted by users mashups that use either Flickr or Wikipedia. The proposed mashup framework is presented, in detail, in Section 3. Experimental results with real datasets follow and illustrate the value of the approach. Finally, the paper concludes with some conclusions and some ideas for future research.

## 2 Mashups

Mashups have recently gained special attention as concerns to the creativity that is included in their development and their functionality with regard to the users. Substantially, a mashup is a combination of data that are found in the World Wide Web via some processing. If we consider that the web is constituted by levels (the *physical* one that is referred to the equipment, the *logical* one that is referred to the communication protocols, the *data* level that is referred to the content and the *social* one that is referred to users and applications), then, the mashups are classified between the data level and the social one [6]. In this way, mashups achieve to change the way that the users are related to the content of web sites.

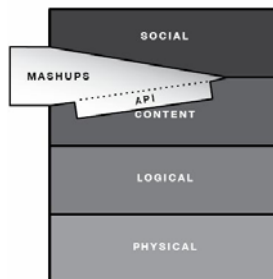


Fig. 1. Mashups in the web levels hierarchy ([6])

In web development the term mashup is defined as a web application which combines data that originate from more than one source in one functionally completed tool. The term mashup implies easy and quick incorporation which is realized mainly with access to APIs and to sources of data aiming at the production of more relevant results. The mashup developers use in a dynamic way data from a source and incorporate them in another application. This intra-application communication sparks interoperability concerns. Most developers of web 2.0 sites address these concerns by offering compatible technologies (e.g. APIs), web services and other tools that allow the users to create mashups [6].

A lot of users experiment with mashups using sources of information such as Microsoft, Google, eBay, Amazon, Flickr, Facebook and APIs of Yahoo [6]. As the majority of web users, in the past few years, have begun exploiting the services of the web in a way that approaches more their daily activities, a lot of mashups have been deployed towards this direction. Below we will report some of the basic mashups that have been created in the past few years, so that we can have a better view in reference to this phenomenon which is considered to be one of the technology trends that will shape the future web. Mainly, we focused on mashups that use Wikipedia, DBpedia and Flickr which are related immediately to our work.

**Wikipedia Mashups.** An example of such a mashup is Wikipedia Vision<sup>1</sup> that is a mashup in which for each wikipedia edit a box is displayed in a world map with the title of the article, the summary of the edit and other information such as geographical location of the Wikipedia user and the time the edit happened. The social resources utilized in this mashup are Wikipedia and Google Maps.

**Flickr Mashups.** It is observed that there are a lot of mashups that have been structured based on Flickr API. It should be placed emphasis on Flickr Wrapp<sup>2</sup> which is a mashup that combines data from DBpedia and Flickr that are two sources of information used in the development of the mashup, presented in this paper. Flickr Wrapp combines geographic information and assigns them in tags from Flickr and Wikipedia aiming at the favoring of pictures from Flickr which have high correlation with the notion that is relevant to the search of the user. Other examples of mashups that are based on Flickr are Flickr Mania<sup>3</sup>, Flickr Fight<sup>4</sup>, Feelimage<sup>5</sup>, Semapedia<sup>6</sup>, InSuggest<sup>7</sup>, Flicktionary<sup>8</sup>, etc.

**DBpedia mashups.** The basic idea in these mashups is to exploit the structured data offered by the DBpedia project. An example of such mashups is DBpedia Mobile that locates in the map locations that exist in DBpedia and gives the user the possibility of exploring relative information that exists for these places [7].

---

<sup>1</sup> Wikipedia Vision: <http://www.lkozma.net/wpv/>

<sup>2</sup> Flickr Wrapp: <http://www4.wiwiss.fu-berlin.de/flickrwrapp/>

<sup>3</sup> Flickr Mania: <http://www.flickrmania.com/>

<sup>4</sup> Flickr Fight: <http://flickrfight.net/>

<sup>5</sup> Feelimage: <http://www.feelimage.net>

<sup>6</sup> Semapedia: <http://en.semapedia.org/>

<sup>7</sup> InSuggest: <http://www.insuggest.com/>

<sup>8</sup> Flicktionary: <http://imagine-it.org/flickr/flicktionary.htm>

### 3 Framework Description

In this work we present a mashup that connects DBpedia with Flickr, in an effort to combine information that provides DBpedia with the information that is provided by the tags that are assigned to the photos of Flickr. This convergence aims at improving the retrieval quality and, thus, returning more relevant results to various user queries in Flickr site.

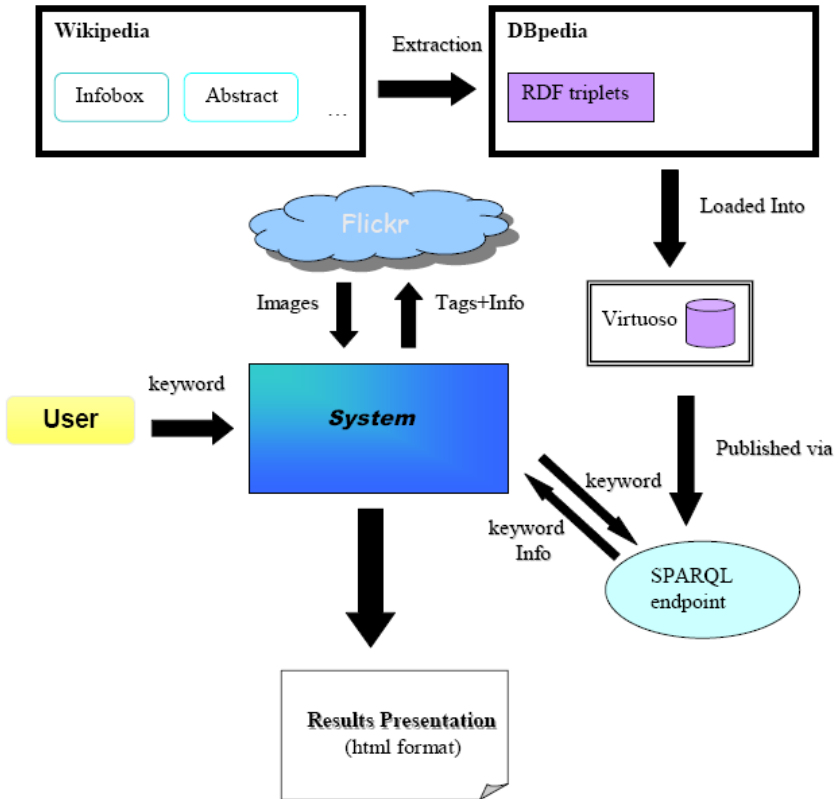


Fig. 2. Proposed framework overview

As it is widely known, Flickr constitutes one of the largest world sources of published photographs. It gives the opportunity to the users to characterize their photos with tags. Aiming at the facilitation of the user, there are not strictly determined rules for the potentially used tags. That is to say, there are no restrictions with regard to the name, the level of detail, as well as the relativity of tags. As a consequence, disambiguation may arise in cases, such as when certain photos are characterized with tags that are referred to general terms. To ensure better retrieval, users often use multiple related tags to describe a resource, which results in tag redundancy.

To the same extent with Flickr, as popularity is concerned, Wikipedia constitutes an enormous collection of semi-structured content from which the project of DBpedia.org extracts structured information. Here we will focus on a special functionality offered by Wikipedia, the so-called *term disambiguation*. With the term disambiguation in Wikipedia we refer to the activity of resolution of conflicts that result from the titles of articles in Wikipedia. These conflicts occur when a term is connected with more than one subjects, therefore this term is likely to appear in the title of more than one articles. In such cases, there must be a way that redirects the user in the page of a certain article that corresponds to the correct sense of the notion. What is reported above is widely known in Wikipedia as disambiguation. For example the term Texas appears to more than 20 different entities in Wikipedia such as university, musical album etc. The term disambiguation in Wikipedia enables the user to select the exact sense of Texas he/she is looking information for.

The system we present here materializes the interconnection of DBpedia and Flickr, in an effort to tackle the disambiguation issue that worsens the retrieval in Flickr. In Figure 2, the developed system is described graphically, along with the tools that were used in the proposed implementation. When the user performs a query at Flickr, a SPARQL query is executed via the DBpedia public SPARQL endpoint to the DBpedia data source. The DBpedia data source is hosted and published using OpenLink Virtuoso RDF Store. The SPARQL query returns the various senses of the user query terms. Then, an individual query is posed in Flickr for each different sense and the user gets Flickr photos grouped by the various senses. A more detailed description follows.

First of all, we will describe the way the Wikipedia data is represented in the DBpedia project. Each notion in DBpedia is found at a link of the form <http://dbpedia.org/page/Resource> where Resource is the name of the corresponding notion. In this particular page certain basic information that refers to the specific notion is included, in RDF triplets. More specifically, there is a column named “property” in which all predicates are recorded. With the term predicate we define the relation that exists between the basic notion and the values that are found in the right column of page. This way, the information that the DBpedia project extracts from Wikipedia for each notion exists in structured form. Therefore, the user is given the possibility of having access in these data via queries expressed in SPARQL.

As mentioned above, there is a term disambiguation page in Wikipedia for each basic notion, where there are links that redirect the users to pages describing each one of the ambiguous senses of the specified notion. The predicate (i.e. property) that is used to refer to the various senses of a notion, in the DBpedia project, is named `dbpprop:disambiguates`. In this property a list of disambiguations is included, that is substantially links that lead to the various senses of the particular senses.

Below, we quote a SPARQL query that returns the various senses of the notion Paris.

```
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
SELECT DISTINCT ?label ?disambiguates WHERE {
    dbpedia:Paris dbpprop:disambiguates ?disambiguates .
    ?disambiguates rdfs:label ?label.
    FILTER(lang(?label) = "en").
```

The results of the above SPARQL query include all the various ambiguous senses of the notion in question. More specifically, for each of these senses a list of related words that describe each particular sense is returned. Then, a preprocessing occurs that removes special characters from the returned words, such as parentheses and commas. Finally, each list contains labels that are supposed to characterize a photograph wrt a particular significance of the initial concept-notion. Such lists of words constitute tag lists that are given as input to the `flickr.photos.search` Flickr API function.

The user may define the number of the pictures that he/she wants to be returned for each of the disambiguations. The results are stored in an xml file that includes information for all the photographs that are returned from the search in Flickr and fulfill certain criteria that are defined by the user and concern the certain sense of the initial word (notion). Moreover, these photographs are stored in jpeg format at a certain user-defined path, and they are also presented in thumbnail format at html pages, grouped by each sense. In that way the user has the complete monitoring of the returned results.

## 4 Experimentation

To study the retrieval quality of our proposed approach, we tested with various ambiguous notions, such as paris, jaguar, apple, bush and many others. The results were satisfying, as the script returned photos grouped by sense. Here, we demonstrate a case study, where user wants to discover the possible disambiguation of the word Apple. The DBpedia page for the particular notion is <http://dbpedia.org/resource/Apple>. In Figure 3, the various senses extracted from Wikipedia and related to Apple notion appear<sup>9</sup>.

```
dbpprop:disambiguates
  ■ dbpedia:Apple_%28automobile%29
  ■ dbpedia:Apple_Corps
  ■ dbpedia:Apple_River
  ■ dbpedia:Apple_%28band%29
  ■ dbpedia:Apple_Inc.
  ■ dbpedia:Apples%2C_Vaud
  ■ dbpedia:Apple_%28album%29
  ■ dbpedia:Apple_Cup
  ■ dbpedia:Apple_Daily
  ■ dbpedia:Apple_Records
  ■ dbpedia:Apple_Store_%28online%29
  ■ dbpedia:Apple_Valley
  ■ dbpedia:Apple_Bank
  ■ dbpedia:Apple_Store_%28retail%29
  ■ dbpedia:Apple_Brook
  ■ dbpedia:Apple_Inc.%5D%5D_since_1976'
```

**Fig. 3.** Values of DBpedia `dbpprop:disambiguates` property for the word Apple

<sup>9</sup> Some of them it is likely not to have the property `rdfs:label` therefore they will not be presented in the results in the html page.

After the processing of the `dbprop:disambiguates` property values (as described in the previous section), we perform one query to Flickr for each different sense of the word Apple. In Figure 4, the Flickr results for these queries are given, that is to say the photographs that were returned as relevant for each different sense.

**Apple (automobile)**



**Apple Corps**



**Apple River**



**Apple (band)**



**Apple Inc.**



**Apples, Vaud**



**Fig. 4.** Flickr photos related to "Apple" grouped by sense meaning, after DBpedia information exploitation (no further processing)

**Apple (album)**



**Apple Cup**



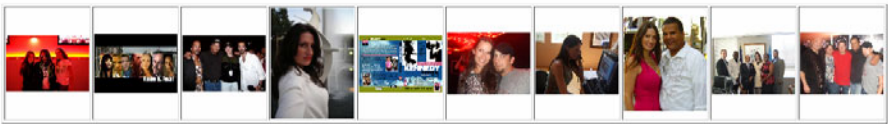
**Apple Daily**



**Apple Records**



**Apple Store (online)**



**Apple Valley**



**Fig. 4. (continued)**

These results were returned when the search for the relevant photographs in the site of Flickr is conducted with criterion each photograph to be characterized with the total of the tags that corresponds in each sense. It is observed that for certain senses the photographs that are returned from Flickr are highly relevant with the subject, such as Apple (automobile), Apple (band), Apples, Vaud etc. However for certain senses the photographs that are returned are not highly relevant with the real meaning of the particular sense. Some cases of this kind of search are Apple Daily, Apple Cup and Apple Inc. For example, in the case of “Apple Daily” which is a newspaper that is



published in Hong-Kong, the search that was conducted in Flickr for photographs that would be characterized with both tags (Apple and Daily) did not return any relevant results. This happened because these two tags are possible to be assigned in photographs that depict other relevant things. As an example for the above case might be a photograph that depict the fruit apple and it has been also assigned with the tag “daily” while it could depict a daily moment from the life of person.

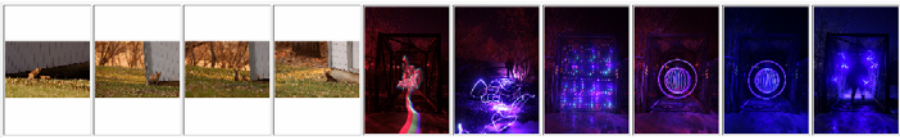
**Apple (automobile)**



**Apple Corps**



**Apple River**



**Apple (band)**



**Apple Inc.**



**Apples, Vaud**



**Fig. 5.** Flickr photos related to "Apple" grouped by sense meaning, after DBpedia information exploitation (**with** further processing)

**Apple (album)**



**Apple Cup**



**Apple Daily**



**Apple Records**



**Apple Store (online)**



**Apple Valley**



**Fig. 5. (continued)**

After the preprocessing that we applied that concerns the removal of special characters and the joint use of words that describe one sense as a single tag in the Flickr query, we get the results that appear in Figure 5. The difference in the retrieval between the two cases is observed especially in senses that the words that describe them are separated from each other with a void. For example, in the case of “Apple Cup”

sense, in the first case where the search was conducted with two tags ('Apple' and 'Cup') the results do not approach at all the real meaning of the concept Apple Cup. Apple Cup is the annual football's game between the two biggest universities in the United States. In the second case is observed that after the code modification that result in a search with only one tag ('Apple Cup') the results correspond completely in the actual meaning of "Apple Cup" according to DBpedia. The described case study illustrates that the proposed framework achieves high retrieval quality in terms of grouping together really relevant Flickr photos, in case of ambiguous terms.

## 5 Conclusions

Given the popularity of social tagging systems and the limitations these systems have, due to lack of any structure, we presented in this paper an approach for improving the retrieval in these systems, in case of ambiguous terms. The developed system may also contribute in familiarizing the user with various senses of a given notion, as they are described in Wikipedia, and may be used in order to inform users for a particular sense of the word. It can also be used as a presentation tool that describes each sense of an ambiguous term with optical means via the relevant photographs from Flickr. Furthermore it could be used as a recommendation system which will be embedded in a site such as Flickr, and it would help users in the choice of relevant tags by proposing tags relative with the various senses of a certain word.

As ambiguities are bound to happen very often in non-structured text, the proposed approach may, also, be used in the text processing domain, to resolve ambiguities of particular terms. For as long as natural language terms are used, without any formal or other representation that embeds structural linkage between terms, term disambiguation remains an issue. Our future work towards this aim involves testing with other sources, apart from DBpedia, for gaining information about various senses of ambiguous terms. Furthermore, we plan to extend the current framework to an approach that renders structure and semantics to data from social sites, stepping, thus, towards the direction of Web 3.0.

## References

1. Hagemann, S., Vossen, G.: ActiveTags: Making Tags More Useful Anywhere on the Web. In: Proc. of the Twentieth Australasian Database Conference (ADC 2009), New Zealand (2009)
2. Bizer, C., et al.: DBpedia - A crystallization point for the Web of Data. *Journal of Web Semantics: Sci. Serv. Agents World Wide Web* (2009), doi:10.1016/j.websem.2009.07.002
3. Au Yeung, C.M., Gibbins, N., Shadbolt, N.: Understanding the Semantics of Ambiguous Tags in Folksonomies. In: Proc. of the International Workshop on Emergent Semantics and Ontology Evolution (ESOE 2007) at ISWC/ASWC, South Korea (2007)
4. Giannakidou, E., Koutsonikola, V., Vakali, A., Kompatsiaris, I.: Co-clustering Tags and Social Data Sources. In: Proc. of the 9th International Conference on Web-Age Information Management (WAIM 2008), China, pp. 317–324. IEEE Computer Society, Los Alamitos (2008)

5. Giannakidou, E., Kompatsiaris, I., Vakali, A.: SEMSOC: SEMantic, SOcial and Content-based Clustering in Multimedia Collaborative Tagging Systems. In: Proc. of the 2nd IEEE International Conference on Semantic Computing (ICSC 2008), CA, USA, pp. 128–135. IEEE Computer Society, Los Alamitos (2008)
6. Palfrey, J., Gasser, U.: Mashups Interoperability and eInnovation. Berkman Publication Series (2007)
7. Becker, C., Bizer, C.: DBpedia Mobile: A Location-Enabled Linked Data Browser. In: Proc. of the Linked Data on the Web (LDOW 2008), China, (2008)