An investigation into a context filter for a real-time geospatial resource locator

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Abstract

This paper investigates three structures for frameworks for use as storage for contextual data, based on the requirements of a case study for a larger system, a real-time Geospatial Resource Locator. It discusses the strengths and weaknesses of these structures/frameworks.

The paper then addresses the implementation of the preferred system, Folksonomy, and discusses the practicalities of prototyping the system.

User testing results are discussed, and conclusions are drawn that show that a folksonomy structure is suitable, the paper does however suggest enhancements.

Further research topics are suggested that would further enhance the prototype system.

1. Introduction and Background

There is currently a project underway that is investigating the concept of a system that provides real-time contextual, location specific media to a mobile user. Part of this project requires a context filter to be put in place to remove unwanted results.

This research paper investigates the most appropriate structure to record context data and suggests the most appropriate way to implement a filter such as this, but also considers alternatives for more generic systems.

As humans, our minds naturally try to categorise things, as suggested by Kant's epistemology (study of knowledge), when things are in context, we can understand them better. This is apparent when you write a shopping list, prioritise tasks at work, home or university, even when planning an itinerary for a holiday.

In the physical world, this happens all of the time, we tend to do it sub-consciously.

This can also be true in the virtual or digital world. For example, computer file systems, message and bulletin boards, and search engines, tend to all be organised into lists and categories.

There are however, certain different types of lists and categorisations, this paper will discuss Taxonomy, Ontology and Folksonomy.

The data retrieved from the system is firstly, relevant to the user's location, and secondly in regards to extraction, relevant to them, based on their user profile. Uploaded

1.1 Case Study

Investigate a context system to describe media in a database. Describing the methods that should be used to develop a context filter for a Geospatial resource locator, which is a tool for users to upload media to and extract media from a central database.

The overall system can be seen in Figure 1, however this part of the system covers the part labelled Context/Location analyser.
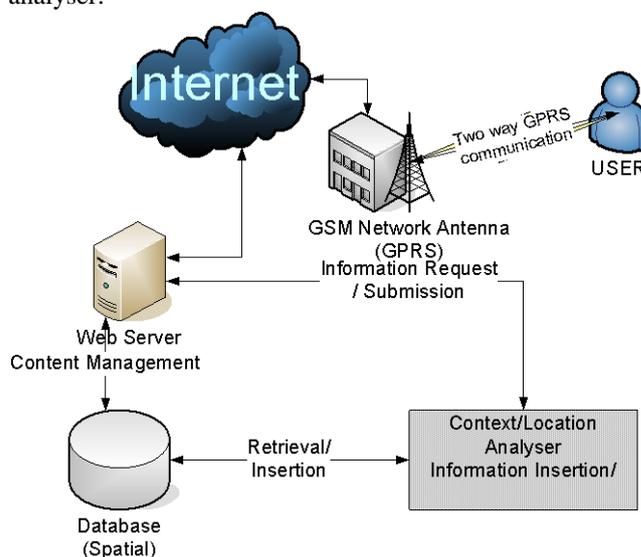

Figure 1 – Overall system structure

The concept behind the Geospatial Resource Locator is based on the current trend of mobile communications: more people than ever before have mobile devices, which are connectable in some way to the Internet. This system builds upon that premise, and suggests a new way for mobile communication, in the form of location based media, that is publicly available to people who may also be near that location, and who are interested in the same media. For example, you may be interested in a certain band, or genre of music, and when you walked past a pub that the band recently played in and recorded a short video clip, or some music, you may be alerted by your device, and be able to view and hear the clip. This paper concentrated on the contextual part of this scenario, what you are interested in.

media should also be suitably described in the same format that data is extracted. The context system must be easy to use and allow context information to be easily recorded and

retrieved by general users. The overall goal is to find the best recording structure, and suggest an implementation of this.

The system must be efficient, extendable and accurate, and be able to plug-in to the overall project.

In the overall project plan, this element sits in between the user and the server, it filters information from the server, based on a users preferences. A user will have a profile, which will already have been defined, giving hints as to what the user in interested in.

The context filter should have the ability to retrieve relevant information using the chosen context structure. In the overall system, this will be in relation to the users' geospatial location.

2. Research methods

This paper will discuss; Taxonomy, Ontology and Folksonomy in detail, and will go on to find which one is most appropriate context structure for this case study.

Once this has been established, it will discuss how such a system could be implemented for the case study, and discuss what processes are involved.

The effectiveness of the system for recording and filtering context will be tested by creating a simple prototype which will allow users to do two separate activities, firstly, add content to the system, with appropriate context identifiers, and secondly, to retrieve information from the system using the same system of identifiers.

3. Recording Structures

This section discusses different types of structures that could be used in the case study. Specifically: Taxonomy, Ontology and Folksonomy.

3.1 Taxonomy

Taxonomy can be described as a hierarchical structure that classifies its elements; its original form was to describe organisms in nature.

It is a system that has strict rules of classification and vocabulary, as items can only fit into the their correct place in the hierarchy, as described by the complete hierarchy to that place

For example the Carolus Linnaeus's scientific classification, see Figure 2:

Organism
Domain
Kingdom
Phylum
Class
Order
Family
Genus
Species
Etc.

Figure 2 – Example Taxonomy

Taxonomies are used throughout the scientific community to classify objects of the real world, not just organisms. These taxonomies have a strict structure and must have agreed rules about entries and alterations.

In the digital world data is often included in taxonomy like structure such as file systems. This is a simple taxonomy, as well as being a single parent structure; taxonomy can have nodes with multiple parents which a file system cannot.

One such example of a digital taxonomy structure is that of DMOZ (http://www.dmoz.org), which classifies subject areas by defining hierarchy of preceding disciplines e.g. for java programming, the root node is the DMOZ top node, Figure 3 shows the remainder.

Computers
Programming
Languages
Java
Figure 3

This gives a description of the subject at this level of the hierarchy and also gives options for 'travelling' down further into the 'Java' subject.

This particular system works well, as it is open and a person can add information (once verified) to the open database. This system, as with other taxonomies, is bound by strict rules as to how something can be classified. For example, Java Programming could not be classified under Java Coffee, as although is has the same name, it is not the same thing. This could be considered a drawback of the system when considering ease of use, as a user has to classify an entry location to find an item as touched on by Mathes when he said "[…]it would be impossible to get users of these systems to use a complex, hierarchical, controlled vocabulary[…]"[1].

But, for the same reason, some argue that it is a good thing to be more precise when classifying objects. There is a difference between taxonomy and an ontology (discussed in detail later) in that taxonomy maps an entire hierarchy, whereas an Ontology maps an object in its own right, and defines its in terms of itself. Adams [2], best describes the differences when she likens a Taxonomy to a librarian who is concerned with how patrons retrieve information with the aid of technologies:

'For librarians, taxonomies are a way to facilitate certain types of information-seeking behaviour.'
'Yet, as an overarching generalization, software developers focus on the role ontologies play in the reuse and exchange of data while librarians construct taxonomies to help people locate and interpret information.' *[2]*

3.2 Ontology

As mentioned before, ontology can be described as a subset of taxonomy. Also, it implicitly describes its data only in its own level of hierarchy. This differs from taxonomy which describes the classification route to the level in the hierarchy.

An example of an ontology system in the digital world is a system called WordNet (http://wordnet.princeton.edu/), which is an online lexical reference system. A user can search using a word, and will be presented with the meaning of the word, and its other possible meaning and associated words (like a thesaurus). For example, the word 'Java' gives the result in Figure 4

S: (n) Java (an island in Indonesia south of Borneo; one of the world's most densely populated regions)
S: (n) coffee, java (a beverage consisting of an infusion of ground coffee beans) *"he ordered a cup of coffee"*
S: (n) Java (a simple platform-independent object-oriented programming language used for writing applets that are downloaded from the World Wide Web by a client and run on the client's machine)
Figure 4 - Each of the entries is shown in its context.

In order for this system to work, the system must explicitly describe each data element in the system, which as with Taxonomy, requires strict rules and vocabulary.

3.3 Folksonomy

'"Taxonomy" is from the Greek *taxis* and *nomos*. *Taxis* means "classification", and *nomos* (or *nomia*) means "management". "Folk" is from the Old English *folc*, meaning people. So "folksonomy" literally means "people's classification management"' Wikipedia, 2005

Folksonomy is the concept of categorisation, not in the strict sense of taxonomies and Ontologies which have a set of rules for *classification*, but where categorisation is managed by the users of the system, who are using their own vocabulary to collectively describe the same piece of information (Vander-Wal[8], Wikipedia[3]).

Butterworth [9] suggests that a Folksonomy is 90% of the value of a proper taxonomy, but 10 times simpler.

However, Mathes [1] discounts this as vastly overstated, but goes on to say:

'Non trivial and important metadata are captured through these Folksonomies, The comparisons are almost irrelevant as it would be impossible to get users of these systems to use a complex, hierarchical, controlled vocabulary' - Mathes 2004 [1]

This neologism 'Folksonomy' was 'coined' by Ted Vander Wal, when explaining the nature of public information sharing websites such as Flickr (http//www.flickr.com) and Delicious (http://del.icio.us/), which both use a Folksonomy type of categorisation.

The method behind a Folksonomy is generally implemented as a flat namespace hierarchy, in that there is exactly one level of hierarchy, which are keywords. These keywords are used to describe data, and are therefore meta-data.

In the case of Flickr, which is a photograph storage and sharing service, the keywords are used to describe images that are in the system. Which can be shared with others, and in fact, other can add keywords to those images themselves.

Delicious is a social book-marking service, where users record their browsing 'bookmarks' on the website, along with descriptive (or not) keywords about that link.

These systems then categorise the recoded data into keyword categories. These categories can then be searched by keyword and relevant results returned.

With Delicious, the most popular bookmarks can be seen, similarly with Flickr, the most popular tags can be viewed. With both Flickr and Delicious, it is possible to supply a keyword, and see every (public) image or bookmark that is associated with that keyword.

Flickr is quite clever in that when it shows results for a particular keyword, it also shows related keywords, based on the other keyword that were used to describe the image. As an example, several different users may tag separate images with the words 'Java', 'coffee' and 'cup'. This would suggest that it was an image of a cup of java coffee.

Another user may simply add the tag 'Java' to an image, which is ambiguous, but acceptable in this free-tagged, unrestricted system, however, the user who added this image may be disappointed when the image does not show up in its correct context.

In this way, the user in encouraged to add more tags to the image, to make it more contextual. Adding the keywords 'java', 'Indonesia', 'island' and 'holiday', gives the impression that it is a holiday snap from the island of Java in Indonesia.

Udell [10] describes this as a tight feedback loop, as the user us encouraged (by not seeing his image in the correct community) to correctly categorise his data.

Mathes [1] suggests that where some authors refer to this process as classification, it is in fact categorisation. The data is not being determined by its tags, but merely its relevant categories.

Drawbacks of this system are that the tags could be ambiguous, and a lack of sufficiently descriptive tags could effectively invalidate the community system, as all the tags would yield results that were poor in context.

However, as is evident with Flickr, which has a large user community, it seems to be possible to avoid this.

3.4 Conclusion

All of these structures have their strengths and weaknesses, and are often used in the digital world; however, the keyword based structure of the Folksonomy fits best with the case study. It lends itself to the community nature of the Geo-Resource Locator project.

One of the case study requirements is that the system be easy to use by general users. Taxonomies and Ontologies require specialist abilities to classify objects using strict rules, but a keyword based system requires a user to give

his or her description of an object. This seems most apt in this case study.

The hierarchical structure of a Taxonomy is too inefficient in this scenario when it comes to general classification of objects, as a media file would have to be implicitly classified as to its content. This would create a large overhead to determine where it should be classified. Similarly, Ontology requires precise information about an object to correctly model it, making the job of recording the meta-data a comparatively lengthy process. The keyword based system of a Folksonomy provided an easy if less accurate method by which to describe a media object, although it maybe slightly hit and miss, it is dependant upon the community who uses it to make it more accurate.

Therefore, a prototype will be developed to test the effectiveness of this structure type, and evaluate it against the requirements of the case study.

4. Prototype for testing

This section will discuss the thoughts that went into making the prototype, and justify the decisions made during implementation.

4.1 Concept

In order to make this system, there are certain parts that are required, as shown in this diagram, Figure 5:
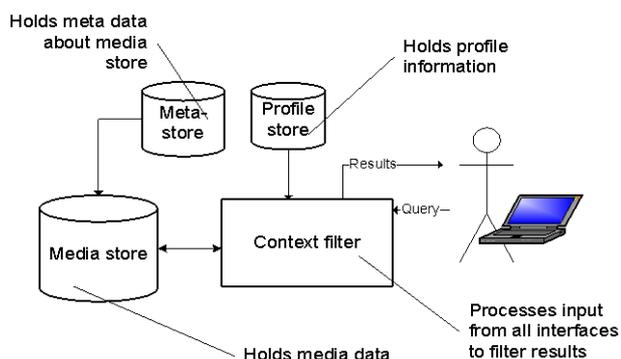

Figure 5 – System elements

As the diagram shows, the context filter can be thought of as the middleware part of the system, connecting the Front-end and backend interfaces.

4.1 Software Platform

This prototype is being developed as a web based system. The open source Apache web server (Version 2) platform has been chosen, firstly due to its widespread use, and secondly due to its ease of installation and low cost. Alternate systems were considered: IIS, a Microsoft product and JIGSAW which is developed by SUN Microsystems.

A server side technology is also required to add dynamics to the system, PHP (Version 5) was chosen, for the same reasons as the web-server choice, also because the author has some knowledge of this technology already.

Lastly, a database system is needed, and in this case, MySQL (Version 1.41) was chosen, again due to its popularity, ease of use and easy installation.

This software was all installed onto a PC Running Windows XP Professional, but the author also has access to a remote web server, running Free BSD (Version 4.11), MySQL (Version 1.4) PHP (Version 4.3).

4.2 Prototyping

The main concept for the prototype was to be simple, yet functional. It should encompass the requirements of the case study, in that it should be easy to use by general users. It should also meet the functional requirements, by allowing users to enter, categorise and retrieve media.

The first step was to create a relational database schema that would encompass the required aspects of the system: Media, Keywords. The simple schema is shown in Figure 6
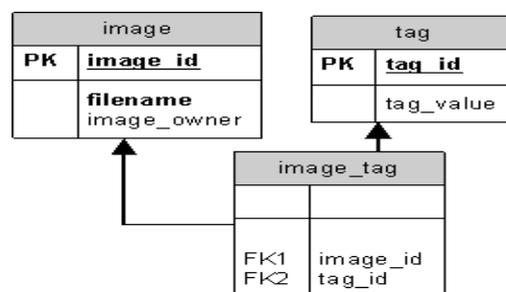

Figure 6 database schema

The two main tables; image and tag are joined by the tag_image table. This table links the two together, thus associating keywords to images in this conceptual database.

After creating this database, a simple web interface was devised, firstly, data entry. The Screen shot in Figure 7 shows its simplicity.

The user simply uploads an image and associates keywords to that image. This upload form feeds into a script that adds the information to the database, linking the image and tags together.

The next logical step is to retrieve the information from the database in the manner in which it was entered, as detailed in the requirement.

The user merely enters the keyword and searches for matching images. This uses SQL inner joins to collate the data from the various database tables.

The actual user profile part of the specification is abstracted to the users search terms. In a practical application of the context filter, a user may be presented with options for specifying separate profiles of interest, that would consists of a number of keywords together, which form their interest profile.

The location search part of the filter is also not shown in this prototype, as the location could be thought of a keyword itself, but would be applied separately. The completed system would need a mechanism for getting the range limits for matching resources and filtering results

based on the distance from the current location to resource location.

5. Testing and results

Testing the prototype system required some user input to gauge the usability of the system with respect to the requirements generated by the case study.

In order to determine whether a keyword system was appropriate for this case study, the system needed to be easy to use. Users needed to be able easily add keywords to the images they uploaded, they also needed to be able to intuitively search for their image, based on their keywords, and finally needed to be able to easily find other images in the system.

Users were asked to perform 3 tasks using the system, firstly to add at least one image with appropriate keywords, secondly to search for their image using their keywords and finally to search for any images using any keywords.

They were then asked to complete a short survey about the experience, which gauged the ease of use and accuracy they felt they experienced.

Most users found the interface easy to use or at lest OK. All users apart from 1 entered at least three keywords for their keywords on average. Most images were found to appear with other similar images when searched for, and users mostly felt that the images were accurately described by their keywords. All but one left feedback in the comments box. Mostly requested extra functionality to the system; including: more keyword information when displaying images and hints for keywords to search for. There were also suggestions regarding cosmetic aspects of the site.

6. Analysis and conclusion

User testing has highlighted a number of areas that would need to be thought about. Spurious words could be removed such as: a, in, of, the, is, on. These words have no descriptive relevance in this system, and so could be ignored. Also punctuation and case can be safely ignored, as this would cause problems when searching.

One use of preserving case would be if multiple word keywords were implemented, for example 'JavaCoffee' could be used to give a better description of an image. Problems ay arise if descriptive words are spelt incorrectly, as this invalidates the system.

Users should also be given the opportunity to amend the keywords that they have entered, as discussed earlier, users are encouraged to change their keywords if they are not descriptive enough, and indeed users should have the option to remove their uploaded media if they wish.

Overall, it would appear that the results to users searches was accurate, and the keywords used to describe the images were mostly accurate, however, some images were uploaded with irrelevant tags, or tags that described the event at which the image was captured, rather than the content of the image.

Overall, the test users found the system to be easy to use, both when inserting images and keywords, and when retrieving images based on keywords. The users received accurate results in most cases, suggesting the system was intuitive to use.

In conclusion, it seems that a folksonomy structure would be most appropriate for this context filter system, however some thought needs to be given towards enhancing the standard keywords system with some category control structure, at least whilst the system is small scale with a small community.

7. Further work

After some thought about the context analysis, it would appear that a mixture between an ontological structure and a keyword based structure could be employed to greater effect. This could be implemented by having a user specify a general category in which to place the image, and then specifying keywords that further describe the image.

Also, a description of the image could be used to add the extra information about an image that could not be conveyed in keywords.

Further areas to be considered: Associating keywords with other keywords, Adding AND and NOT constraints. Statistical analysis functions.

8. References and Bibliography

[1] Mathes, A, "Computer Mediated Communication", Graduate School of Library and Information Science, University of Illinois, December 2004.

[2] Katherine Adams, "The Semantic Web: Taxonomies vs. Ontologies", Volume 5, Number 2 (February 7th 2000)

[3] "Folksonomy", Wikipedia
http://en.wikipedia.org/wiki/Folksonomy

[4] Tom Gruber, "What is an ontology", Stanford university, http://www-ksl.stanford.edu/kst/what-is-an-ontology.html.

[5] "Taxonomy", Wikipedia, 24 Oct 2005
http://en.wikipedia.org/wiki/Taxonomy,

[6] Tom Coates, "Two cultures of fauxonomies collide…" *plasticbag.org,* June 2005

[7] "Taxonomy vs. Ontology vs. Controlled Vocabulary vs. Topic maps", *tripledogs.com,* May 2005

[8] Thomas Vander Wal, "Folksonomy Definition", *vanderwal.net,* November 2005 (and others).

[9] Butterfield, Stewart. "Sylloge.", August 4, 2004. http://www.sylloge.com/personal/2004/08/folksonomy-social-classification-great.html

[10] Udell, Jon. "Collaborative knowledge gardening." InfoWorld. August 20, 2004.