Topic Maps Management in Spatial-Temporal Multimedia Blogs

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ABSTRACT: *Web-based blogging has entered the mainstream of society as an easy way to publish information, and it is exponentially increasing the data volume and its related complexity. Spatial-temporal information (Where and When contexts) contained inside multimedia postings needs to be better semantically handled by search engines or by end-users as current web blogs still lack semantic support. The semantic web community has promoted Topic Maps as a technology that reduces the lack of semantics regarding optimization of information creation, exchange, navigation, merging, and dissemination. This paper introduces a new layer that combines blogging standards (e.g. RSS and Atom) with the Topic Maps data model for semantic-augmented and interoperable information exchange support. In addition, the paper includes examples from the Isfahan Islamic Architecture DataBase (IIADB) project, the pilot user of the topic maps layer bridging the semantic gap of multimedia postings in a historical and architectural context.*

Categories and Subject Descriptors
I.2.4 [Knowledge Representation Formalisms and Methods]; Semantic networks: H.3.4 [Systems and Software]

General Terms
Semantics, Web blogs, Map Retrieval

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1. Introduction

With the advent of the Internet, dissemination of information has become one of the most important aspects of the web. Nowadays many enterprises, institutions, administrations, organizations, groups, families and individuals want their own web presence and want to participate in communities by quickly exchanging postings for sharing personalized information over the web. Weblogs, popularly known as blogs, provide a lightweight publishing paradigm for quick creation of web pages. Each individual is able to create a huge amount of user-centric information on different topics. These postings can be characterized by different patterns and organized according to categories. This helps in the subject-based creation of a large corpus of data about people, places, and times [1], and it does so in the retrieval phase, as has been shown by Bansal et al [22]. Blogs may be about specific topics including spatial data related to the physical world. Blogging [20] acts as *a collaborative online journal including links and postings in reverse chronological order*, in which the most recent posting appears at the top of the page. Multimedia blogs use images, audio, video, graphics, and animations which increase the volume and complexity of postings.

With this new opportunity to publish information easily over the web, the amount of spatial multimedia content is increasing tremendously, creating a difficulty for searching and retrieving specific posting content. In this context of the multimedia posting explosion, there is a need for a new semantic blogging layer to handle the increase in spatial data. Such a semantic layer is needed to improve effective discovery, automation, integration, and reuse of information across various applications, enterprise, and communities. In [2], the Semantic Web is seen as an extension of the current web in which information is given a well-defined meaning, better enabling computers and people to work in cooperation. Furthermore, the Semantic Web helps by defining machine understandable meanings for the published data over the web by associating formal descriptions so that relevant information can be easily retrieved when it is needed.

The semantic layer has to collect metadata including annotations in order to index posts accurately. Indeed, the blogging infrastructure supports annotation based on textual information. Annotations can be made from blog attributes such as topic of post, length of post, links to other resources, relationship between posts, and links or the placement of links in posts, blog rolls, comments, and trackbacks [3]. Even images and other multimedia documents attached to postings contain additional semantic about the target subject. The new layer should also bridge the semantic gap between multimedia postings by handling hidden semantics contained inside.

Topic Maps (ISO/IEC 13250:2000) is an emerging enabling technology for the Semantic Web [4]. Semantic blogging can be implemented using ontologies or topic maps as it acts as an information-modeling technique that allows conceptual maps to be represented, linked, and shared [4]. Topic Maps can also be used for content management, web application development, enterprise application integration, knowledge management, and indexed publications. Topic Maps improve the findability and manageability of information in a large body of information.

Many experts, individuals and organizations are involved in the creation of spatialtemporal data with heterogeneous representations and formats, creating difficulties in sharing data among end-users. In such a collaborative environment, topic maps enable the exchange of information by defining complex semantic relations and maintaining indexes of

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knowledge. Another interesting feature is that topic maps allow the merging of XTM (XML Topic Maps) documents by merging two topics with the same subject or topics with the same name in the same scope [6].

Different users may input different terms for the same subject or may differ in language. In such cases, a keyword-based search of the information may not be efficient or effective. Topic maps handle multilingualism, thanks to topic's base name associations allowing portions of the information overlay to be scoped based on the user language preference The identity and synonym problems are solved by using addressable and non-addressable subjects and multiple base names, respectively [7, 8]. In addition, semantic distances in topic maps can help to reduce the semantic gap by making a clear view of the semantic structures between topics [9].

We propose an innovative layer based on topic maps to enrich blog snippets with metadata and to extract semantic relationships between spatial-temporal multimedia information. Topic maps provide a new kind of knowledge structure for spatialtemporal data storage, data navigation, and visualization. Multimedia blog posts can be represented as a collection of topics with topic names and related variances. Topic maps enable the use of different names for the same topics, which can help to solve the problem of synonymy.

Section 2 describes the importance of semantics in spatial-temporal information. Section 3 describes how the semantic approach can increase the management of multimedia blogs. Section 4 introduces the architecture of the semantic-augmented layer for supporting spatial-temporal data. Section 5 describes the preliminary assessment results of a pilot study of our platform for the IIADB (Isfahan Islamic Architecture DataBase) project that was conducted in cooperation with the Institute of Oriental Studies of the University of Tokyo. Section 6 summarizes the paper and mentions future research.

2. Overview of the State of the Art

In studies on geospatial multimedia blogging management, semantic issues have been related to multimedia artifacts linked to temporal and/or spatial dimensions. Spatial semantics is a very active research field, and a review of it is available in [10, 18]. Layered semantics has also been identified as a key issue [19] for digital information systems. The upper-case "Semantic Web" research emerged in the past few years to address the issue that although the Web is in an easy way for humans to consume information it is not so easy for computing machines to use. On the other hand, supporters of the semantic web (the lower-case semantic web) adopt a totally different philosophy. They think the Web is for people, and that web semantic solutions should be aimed at practical problems for the people, not for computing machines. Multimedia spatial temporal data are becoming more and more real time as direct reflections of the geographic world. In this sense, they have various semantic interpretations within a large set of applications, as has been pointed out by the ECAI consortium's best practices[1]. As spatial temporal data are increasingly available over Internet, GIS software is acting more and more as a useful tool for understanding spatial and temporal dimensions of data for a wide range of disciplines. Google Earth[2] has gained popularity with its simple functions (e.g. Explore, Search and Discover) for end-users. This tool combines satellite imagery, maps, and the power of Google Search to put the world's geographic information into applications. Another example is TimeDrive that overlays semantic information and manages temporal information.

[1] http://www.ecai.org/

[2] http://earth.google.com/

Although the quality of its visualization function is good, Google Earth lacks analytical functionalities to deal with data semantics. Furthermore, it cannot be a substitute for professional GIS software unless it provides different statistical and analytical features. The Environmental Systems Research Institute (ESRI)[3] has come up with ArcGis Explorer, yet another free application with analytical and visualization capabilities allowing users to create virtual digital globe over the net. Various other GIS applications combining analytical strengths and visualization aids are emerging. One issue could be interoperability because Google Earth uses a proprietary data format. Regarding this, ESRI promised to provide compatibility by using the standardized data format issued by the Open Geospatial Consortium[4]. NASA provides a similar application called World Wind[5]. This open source application is designed to tailor the software to the needs of the end user. Its weak point as compared to Google Earth is that it consumes much more memory and CPU time [11].

Most applications discussed till now are single user/single machine. The Webbased applications are web-trend evolutions to provide search, retrieval and visualization functions to handle geographic-related multimedia (so called geomedia) information. There are a few solutions such as Virtualnyctour[6], which serves as the guide map for New York City. Another example is MapBuilder[7], a tool with a visual interface for building maps from different sites such as Google map or Yahoo Map and geo-coding and data import features. Besides these features, these applications [e.g. Google map, Yahoo Map] provide zooming in /out functions to locate target places on the map, geo-coding tools for location searches and quick navigation panels to view annotated descriptions about places.

In conclusion, the above systems are good at providing spatial information but do not stress the temporal side of the data. They lack a mechanism to deliver information with its changes in time because they don't have any adapted semantic layer to handle it. Furthermore, their valuable geospatial data lack the interoperability to be integrated with other data in formats such GXML or XTM. There is still a semantic gap between the available data as no method has been developed to explore the relationships among quantitative data.

3. Semantic Augmented Support using Topic Maps

An innovative semantic-augmented support has been created for the blogging infrastructure using topic maps. As part of this support, the system handles two categories of topic maps: (1) "structured" topic maps and (2) "content-based" topic maps. Structured topic maps are created from different syndication standard formats of blogs (e.g. RSS or Atom). These standard formats contain different elements (e.g. title, description, link, date), which give the blog message a finite structure. Moreover, these elements with the other taxonomy module enrich the blog message with metadata and provide semantically rich structured information. Each posting is a dialect of XML which is transformed into an occurrence of a

[3] http://www.esri.com

[4] http://www.opengeospatial.org/

[5] http://worldwind.arc.nasa.gov/

[6] http://www.virtualnyctour.com/

[7] www.mapbuilder.net

topic map. The *posting mapping-totopic- map* process is described in sub-section 4.2. Content-based topic maps are a collection of topics. “topic” subsumes both the ideas of “category” and “subject”. The topics are extracted from the elements of the structured topic maps and associated with other topics.

Before going through the semantic extraction process that is used to produce topic maps, let us review the formal definition of topic maps and related definitions.

Definition (1): A topic map is a triple G = (T *H*, *r*) where T is a set of topics, *G* is a graph representation of T, and r is a representation function.

The domain of *r* is a part of *H*. The range of *r* is T. If t is a topic in T, and x an element of *H*, t = *r*(x) means “t *is represented by* x” or “x *represents* t”

Definition (2): Spatial Temporal Topic Maps are Topic Maps that include topics whose type has either a discrete spatial (Where) or a temporal (When) representation.

For example, a spatial type is defined by a dual grid (G_p, G_s), following *Lema and Guting’s* approach [12], where G_p is the domain for points and G_s is the domain for segments. There are two related properties:

(1) The end point of any segment of G_s belongs to G_p.
(2) Any point intersection of two non collinear segments belongs to G_p.

A spatial temporal topic map has semantics in time and in space because postings are occurrences with different time spans and are from different places.

Semantic extraction to extend topic maps with additional semantics

The posting title is mapped as a new topic, and the posting content becomes an occurrence associated with the topic. Specific terms of the posting’s content are also extracted as new topics if they don’t exist already on the topic maps. The blog entry is associated to these topics.

Topic semantic extraction is done automatically in three steps (Figure 1). New topics and associations are extracted from the blog entry content. Each local topic map is semantically merged with the global topic map. If similar topics exist on the global topic maps, their occurrences and associations are updated; otherwise, new topics and new associations are added.

Metadata Extraction. Each posting (e.g. RSS or Atom) is mapped to a structural topic map as mentioned in the previous section. Each RSS posting is composed of channel elements and sub elements including the Dublin Core elements. These standard metadata elements with some domain-specific elements are mapped according to the Topic Maps Data Model (TMDM), creating a structural topic map. Other elements, such as latitude and longitude, will be included as part of the ECAI extension to Dublin Core metadata [23] to support geospatial data. This will enable us to add Time- Map visualizations as described in section 4.3. A metadata attribute acts as a topic name and resource files (document, image, audio or video) related to this topic are assigned as occurrences. Hence, each attribute (e.g. published date, author) gets mapped to a distinct topic. However, metadata provide contextual information about resources (e.g. creator, format of the content, date of creation), but cannot improve content-based retrieval by topic.

Textual Semantic Extraction. Even with a standard web document metadata such as Dublin Core, the metadata required to fulfill the semantic gap is still not sufficient. Useful metadata is hidden in other forms such as key words or in the message content itself. Latent semantic indexing (so called LSI) has been used to solve problems related to search and retrieval of information by overcoming the deficiencies of termmatching. The LSI approach addresses the two main problems of synonymy and polysemy by using singular value decomposition (SVD) [13, 14]. LSI techniques are used to extract more information about existing and new topics from blogs. The new topics and relationships are mainly extracted from title, key words, message content, blog rolls, permalinks, and comments on posts.

Image Semantic Extraction. Today’s digital cameras allow us to save an image in a JPEG (.jpg) format file with EXIF[8] (Exchangeable Image File) metadata describing the picture taken. The format is part of the DCF standard created by JEITA[9] (Japan Electronics and Information Technology Industries Association) to encourage interoperability between imaging devices. The metadata settings related to the camera with scenic metadata are stored in the image files themselves (see Figure 2).

The set of extracted metadata includes image size, date and time, thumbnail information, the spatial features (latitude and longitude) given by GPS, or the place at which the photo was taken. The EXIF data are extracted from the image in order to find relationships with textual information. These data also aid in management of image semantics for adding new topics and making associations related to image resources.

4. Semantic-augmented Layer Architecture

This section presents the overall architecture of our semantic augmented layer using topic maps. The high level architecture is represented in Figure 3.

We will overview three key components regarding the semantic-augmented layer implementation: (1) its blog/ metadata creation component, (2) its topic map storage component, and (3) the related semantic viewer.

4.1. Blog/Metadata Creation Component

Blog content and its metadata are created using the XML-based form interface. In such a geo-localization system, map localization is very useful for determining the place. It is efficient enough to click on the map and get the longitudinal and latitudinal value to annotate valuable information related to that place. Navigation and zooming of the map helps to find the exact position of the place or to find detailed information.

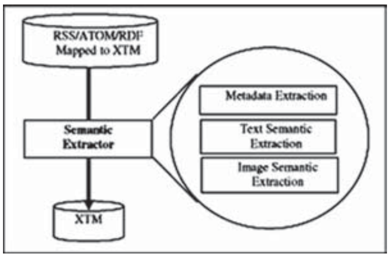

Figure 1. Semantic Extraction of Topic Maps

[8] http://www.exif.org
[9] http://www.jeita.or.jp

Figure 2. EXIF Metadata Profile

Textual descriptions of the place with its metadata information are added to make the blog content semantically rich. Besides the text, other kinds of files like images and audio video clips are uploaded using the drag and drop based multiple file upload applet. The EXIF data are extracted from the uploaded images and saved with the information that might be useful to find the relation between the uploaded images and the blog messages.

4.2. Topic Map Storage Components

Topic map merging is performed to integrate different topic maps with similar topics from various external environments. Topic maps are stored as mono-files in XTM format for simplicity in the current implemented version. Besides this, there is an option to store maps in different locations and relate them to external references. The current layer does not implement the storage of Topic Maps in the database because native Topic Map databases are unavailable and storing them in an RDBMS database may result in loss of semantic efficiency. This issue of storing Topic Maps in native databases has been left as the future work. The blogging infrastructure usually syndicates its contents in standardized format using different versions of RSS or Atom. The framework makes use of these standard formats for data exchange. Figure 4 shows the transformation and merging of documents following the different processing stages. The first step takes place through the transformation of an RSS file containing the blog message enriched with metadata into an XTM file using XSLT transformation. The XSL transformation is carried out by mapping RSS elements with the corresponding topic map elements. The RSS elements can be created as new topics or occurrences for the topics. Each RSS element <rss:title> is mapped as a base name element <baseNameString> of the topics and other elements <rss:description,dc:date> are mapped as the <resourcedata> elements of the <occurrence>.

The example XSL code below shows how the title element of RSS is mapped to an occurrence of Topic Maps.

```
<xsl:for-each select=”rss:title” >
  <xsl:element name=”occurrence”>
    <xsl:attribute name=”id”>
```

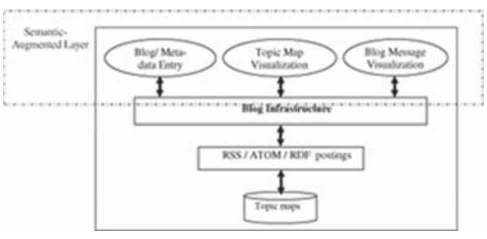

Figure 3. High-level Architecture of Semantic-augmented Blogs

```
      <xsl:number count=”rss:title” />
    </xsl:attribute>
    <xsl:element name=”instanceOf”>
      <xsl:element name=”subjectIndicatorRef”>
        <xsl:attribute name=”xlink:href”>
          http://www.nii.ac.jp/extm/extm.xtm#extm-title
        </xsl:attribute>
      </xsl:element>
    </xsl:element>
    <xsl:element name=”resourceData”>
      <xsl:value-of select=”.” />
    </xsl:element>
  </xsl:element>
</xsl:for-each>
```

After the transformation, the new XTM file contains the topic map structure of the blog postings including the different topics, association between topics, and related occurrences of resources. The XTM Schema file, provided by experts, contains the topics that define the relationships such as whole-part, class-instance, date-place, name-place, superclass-subclass, etc. For instance, the topic “Si-o-seh Pol - Bridge of 33 arches” relates to a bridge made up of a series of 33 arches built in 1602 by Shah Abbas is described. It can have a member relationship with “History”, a date-place relation with “1602”, or a name-place relation with “Shah Abbas,” where “History”, “1602”, “Shah Abbas” are other topics defined in the related topic map. Another example such as “Island” is an instance of class “Geography” but it is also the sub class of “Land”. In the second step, the schema file is merged with the created XTM file to mix topics and their occurrences with the global topic map or to create new topics if there is no topic related to that subject.

4.3. Semantic Viewer Function

Topics and associations provide a structured semantic graph above geomedia information resources. In the following, we overview the visualization functions provided by our platform to display the semantic layer efficiently, which is a critical issue as Topic Maps may contain millions of topics and associations.

Map Visualization. The “map visualization” function visualizes the geomedia places on maps. This kind of visualization allows the user to click on the map to get the geographical position of the place along time. Also, the tool provides a zooming feature to view higher resolution positions.

Say we post some information about “Madrasa Chahar Bagh Royal Theological College”. It is possible to use the zoom and navigation functions provided by our semantic layer to point out the site we are looking for in the map. We are able to get the longitudinal and latitudinal location of the place clicking on the map. The next step will be to create blog entry inputting information about the target place with additional resources as such as images, audio/video, or any other document genre

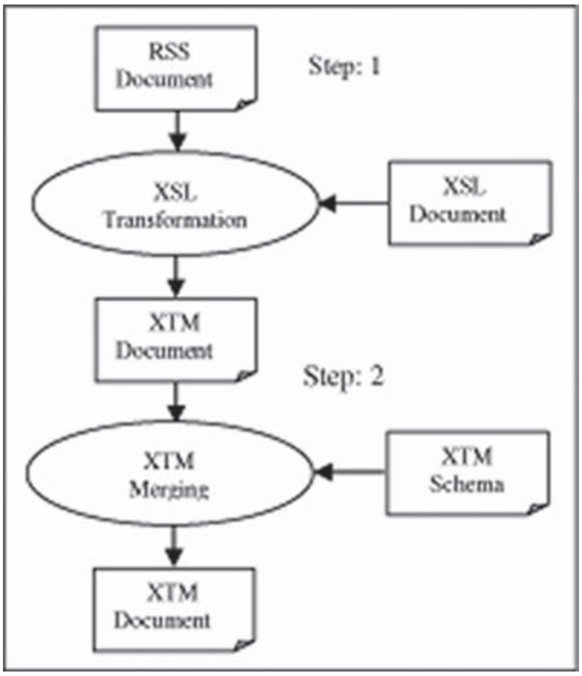

Figure 4. Overall Process of Creating XTM Files

using the xml based form shown in Figure 5. The triangular mark pointing out the target site visualizes the annotated information within the map.

BlogMap visualization. As explained in [15], a Treemap point of view is a 2D spaceconstrained visualization of hierarchical structures. We extended this approach to blogs and called it BlogMap. This kind of visualization can show hierarchal categorizations as structural summaries in our semantic-augmented layer according to multi- dimensional topics such as size, time, and space. Also, using different color, size, and pattern schema improves the visualization. In Figure 6, the Blogmap shows the hierarchal structure of blogs posted under different categories (e.g. Geography, History and Education). The size metric of one block can have three different values: (1) length of content of blog message, (2) number of blogs messages associated with that specific topic, and (3) number of accesses to this topic. As an example, another dimension of viewing the blog content may be the color of the block assigned to each category of the blogs. For instance, in Figure 6, History is one category which has green background color to distinguish it from other blog messages. In the same way, the intensity of the color of each blog gives temporal information visualizing the time elapsed from the published date. A tool tip with the details of the blog message is displayed when a mouse is moved on the top of it.

We can visualize the above posted information under the Education category (purple) by showing the hierarchical categorization of blog messages. The size variation indicates the priority compared with other blog messages: the largest size corresponds to the most popular message. In a similar way, darker color indicates that the message was posted later than other content. Basically, in our implementation, the Blogmap function provides a mechanism to navigate inside the topic map belonging to specific communities by zooming into specific categories as part of the hierarchy. Within the same category, different subjects can be compared in terms of type of blog, size of content, date/time of post, or most accessed messages. Furthermore, the statistics of blog messages in different categories can be analyzed in a visual way.

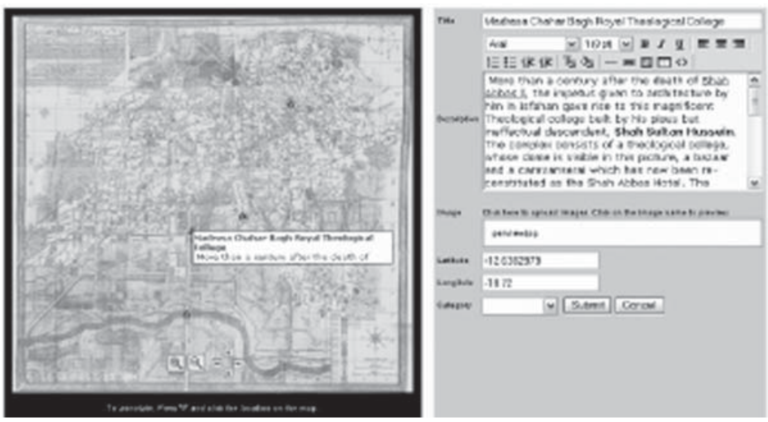

Figure 5. Map Visualization of Geospatial data

Figure 6. Blogmap Visualization of Blogs

Graph based Visualization. The graph-based visualization function is useful to show the global structure of topic maps and the associations between different nodes in a 3D visual space [16]. The graph viewer provides a better global understanding of the content by exploring it through graph nodes and associations. This kind of intuitive visualization enables browsing through all the topics and relationships defined in the topic maps. The graph can be moved and restructured along with its topological and scope view according to the user's need and navigation.

Figure 7 shows the implementation of the highlighted element pointing out the current context and its relationship with other topics in the topic map. The topic "extm" has a whole-part relationship with four other topics (religion, education, history and geography). The information about the "Theological College" that was posted using the geo-localization map-applet also has a whole-part relationship with the "Education" topic. Furthermore, this kind of visualization tool helps us to understand the semantic relationship between topic maps.

TimeMap based Visualization. The spatial and temporal data may contain images, maps, or videos that are generated and used by people around the world. These map grids are converted into geospatial formats, latitude, longitude and time coordinates, for search purposes. The search can be carried out either using a single latitude, longitude, time coordinate, a series of spatial foot prints, and between certain time ranges. As the semantic layer supports ECAI metadata, our framework has been extended to support TimeMap[10] developed by the University of Sydney. TimeMap enables the spatial searches of any resource which falls within the defined search area in the map (Figure 8). It provides map layering to display information created in different time ranges. The time bar control highlighted with a dotted block can be used to set time range from years to seconds. The map shown in the figure can be linked to any web resource or live feed [17].

Everyday huge amounts of spatial information are published in personal or community blogs. The information about the same place is posted at different time intervals by different users of the blog server. TimeMap provides an easy mechanism for spatial searches of these multimedia blogs at different time intervals. Using topic maps, the data about these places published at different time periods can be associated in various ways. Thus, the framework provides a unique way for visual semantic based searches of geospatial information over different time spans. It's an intuitive method of combining map data, and the time dimension ranging in scale from millions of years to seconds gives new ways to visualize historical data, environmental changes, and much more.

[10] http://www.timemap.net

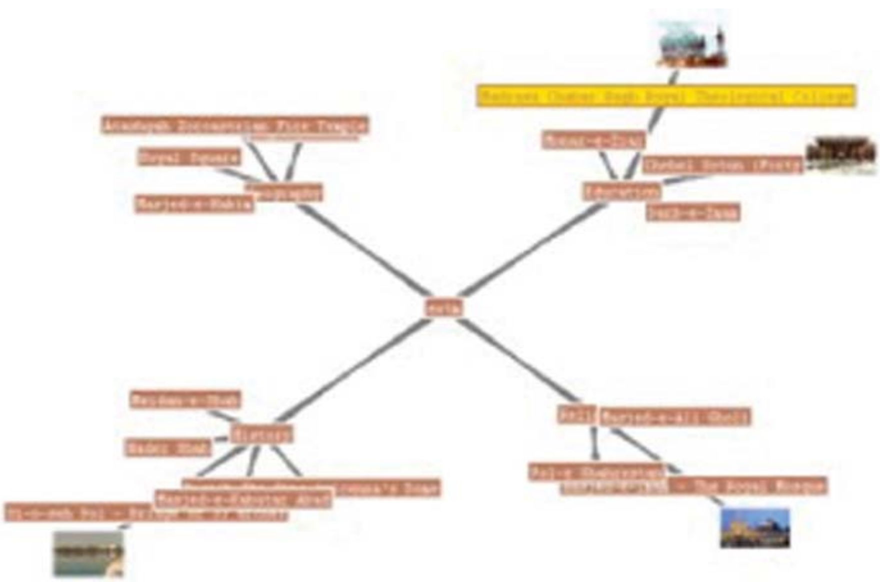

Figure 7. Touch Graph Visualization of Topic Maps about History/ Geography/Religion/Education of Isfahan

5. Case study and preliminary functional Assessment

The IIADB Project (Isfahan Islamic Architecture DataBase) is a pilot project for the TMblog platform that has been carried out by the Institute of Oriental Studies of the University of Tokyo. It targets Isfahan, a UNESCO world heritage site. Islamic architectural styles of buildings dating from the 11th century (C.E.) to the 19th century are an important research issue along the time dimension of our semantic-augmented layer. The data set includes 1863 annotated photos categorized according to architectural objects such as minarets, mosques and shrines, palaces and bridges, roads, and bazaar. There are various functions (e.g. economic, religious) to categorize the buildings. The assessment follows three steps: (1) geo-localization and additional end-user metadata interface assessment, (2) photo uploading and interoperability mechanism assessment, and (3) navigation, search, and visualization assessment. The self-assessment has started, and the assessors found that in a number of respects, their goals have already been achieved. Their goals will be extended with additional requirements regarding video and summary processing. The final report of the team of experts will be a best practices guideline.

Thanks to our implementation, a large number of researchers around the world are able to do research about this town. Our collaborative platform will improve cooperation and the quality of discussions between research groups.

6. Conclusion and Perspectives

The key result of our semantic augmented layer is to enrich multimedia blogs with semantic metadata. The implementation demonstrated the need for geospatial semantics associated with the temporal dimension to improve accesses in multimedia blogs. In this paper, we pointed out:

- The essence of the semantic web in the field of geo-localization information system
- The applicability of Topic Maps for semantic-augmented layers.
- An automatic semantic extraction of metadata from text and images to enrich blog snippets.
- Semantic metadata enabling richer view, navigation, and query mechanisms.
- That Topic Maps helps when deriving relations among the different blog entries and when developing collaborative spatial- temporal information networks.
- That XTM document merging is useful in a collaborative environment where information is dispersed among researchers, experts, and students.
- That visualization tools for blogging based on Topic Maps can help us to acquire deeper knowledge about the subject matter.

The case study on Isfahan in Iran and the functional assessments were done in cooperation of the University of Tokyo. They illustrated the benefit of our approach in the short term regarding spatial temporal classification of multimedia data and in the long term regarding collaborative research on architectural history.

This layer needs to be extended to better support accessibility, sharing, and rendering of spatial data (maps, images, and vector data) through the implementation of a mapping server that provides services conforming to the recommendation (e.g. GML, G-XML) of the Open Geospatial Consortium. The current implementation is limited to file-based storage of Topic Maps that can be extended by the use of native XML/RDBMS databases. To extend the collaborative uses of Topic Maps, the implemented layer needs to be enriched with mobile blogging functionality.

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References

[1] Gruhl, D., Liben-Nowell, D., Guha, R., Tomkins, A (2004). Information diffusion through blogspace. SIGKDD Explor. Newsl. 6, 2, 43-52.

[2] Berners-Lee, T., Hendler, J., Lassila, O (2001). The Semantic Web. Scientific American (2001).

[3] Bar-Ilan, J (2004). An outsider's view on "topic-oriented blogging". *In*: Proceedings of the 13th International World Wide Web Conference on Alternate Track Papers Posters New York, NY, USA, (May 19 - 21, 2004). WWW Alt. ACM Press, New York, NY, 28-34.

[4] International Organization for Standardization (ISO) (1998). ISO 639:1998 Code for the representation of names of language, (1998).

Figure 8. TimeMap Applet Visualization of Geospatial Temporal Postings

[5] Garshol, L. M (2003). Living with Topic Maps and RDF. In: Proceedings of XML Europe (2003), organized by IDEAlliance, London, UK.

[6] Pepper, S., Moore, G (2001). XML Topic Maps (XTM) 1.0 TopicMaps.Org Specification. (2001), http://www.topicmaps.org/xtm/

[7] Garshol, L. M (2004). Metadata? Thesauri? Taxonomies? Topic Maps! Making sense of it all. Ontopia. (26 October 2004).

[8] Rath, H. H (2003). The Topic Maps Handbook. Empolis GmbH, Gutersloh, Germany. http://www.empolis.com/downloads/empolis_TopicMaps_Whitepaper20030206.pdf

[9] Naito, M., Andres F (2005). Application Framework based on Topic Map,Application Framework Based on Topic Maps, LNCS, Volume 3873, Feb 2006, p. 42 - 52, Charting the Topic Maps Research and Applications Landscape: First Int. Workshop on Topic Map Research and Applications, TMRA 2005, Leipzig, Germany, October 6-7, 2005, Revised Selected Papers Editors: Lutz Maicher, Jack Park ISBN: 3-540-32527-1.

[10] Rodríguez, A., Cruz, I. , Egenhofer, M., Levashkin, S. (ed.) (2005). GeoSpatial Semantics. *In*: the Proceedings of the 1st International Conference on GeoSpatial Semantics Lecture Notes in Computer Science, Vol. 3799, Springer, New York, (2005).

[11] Butler, D (2006). The web-wide world. Nature Publishing Group, Vol. 439, 16 February.

[12] Lema, J. A. C., Guting, R. H (2002). Dual Grid : A New Approach for Robust Spatial Algebra Implementation. GeoInformatica Volume 6, Number 1. Springer, Netherlands 57-76.

[13] Zhao, R., Grosky, I. W (2002). Bridging the Semantic Gap in Image Retrieval, Distributed Multimedia Databases: Techniques and Applications, Idea Group Publishing, Hershey, Pennsylvania (2002) 13-36 http://www.cs.sunysb.edu/~roz/publications/SemanticGap.pdf

[14] Andres, F., Naito M (2005). Dynamic Topic Mapping Using Latent Semantic Indexing. IEEE International Conference on Information Technology and Applications Sydney (4th-7th July, 2005) 220-225, ISBN 0-7695-2316-1.

[15] Shneiderman, B (2005). Treemaps for space-constrained visualization of hierarchies. HCIL, University of Maryland. (2005).

[16] Grand, L. B., Soto, M (2002). Visualisation of the Semantic Web: Topic Maps Visualisation. Sixth International Conference on Information Visualisation (IV'02) London, England. (2002) 344.

[17] Johnson, I (2005). Indexing and Delivery of Historical Maps Online Using TimeMap. National Library of Australia Magazine. (January 2005).

[18] Fonseca, F., Egenhofer, M. , Agouris, P., Câmara, G (2003). Using Ontologies for Integrated Geographic Information Systems. In: Transactions in GIS 6 (3) 231-257.

[19] Gong, Z., Zhang, J (2003). Layered Semantic Architecture of Multimedia Data. *In*: *Proceedings of the IASTED International*Conference on Internet and Multimedia Systems and *Applications*, Honolulu, USA. (August 13-15, 2003) ACTA Press. (2003) 275-280.

[20] Maxymuk J (2005). Blogs, The Bottom Line: Managing Library Finances, Emerald Group Publishing Limited (18-1) 2005, 43 – 45.

[21] Tseng, C., Ng, P (2007). Precisiated information retrieval for RSS feeds, Information Management & Computer Security, Emerald Group Publishing Limited, V. 15 (3) 184-200.

[22] Bansal, N., Koudas, N (2007). BlogScope: spatio-temporal analysis of the blogosphere. *In*: *Proceedings of the 16th international Conference on World Wide Web* (Banff, Alberta, Canada, May 08 - 12, 2007). WWW '07. ACM Press, New York, NY, 1269-1270.

[23] ECAI Metadata Manual http://www.ecai.org/documentation/ecai_metadata_standard.html.