Attention Metadata: Collection and Management

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ABSTRACT

This paper discusses how attention metadata enables collection of rich usage data. We use this attention to enhance users' models, predict usage patterns and feed personalization and recommender systems. We argue that attention metadata extends the information on user attention which can be derived from current log services. Furthermore, frameworks and schemas that enable tracking and merging rich and detailed user attention metadata in different applications are necessary to obtain a more complete picture on how the user handles digital content. We illustrate our approach by tracking user attention in learning systems as an example. For our application domain we want to collect large volumes of attention metadata, for statistical analysis that enables us to identify relevant learning paths.

1. INTRODUCTION

Current logging services, such as Apache (http://apache.org/), provide information about the digital content that users actually access in a repository, on the Web, and how they handle the content. We outline which attention metadata can be derived from logs and which limitations are imposed in section 2.

Attention metadata concerns collecting detailed information about the relation between users and the content they access. This information can be distributed over different applications. AttentionXML [2] is an open standard to track user attention in web applications such as news, blogs and wikis. This standard provides the base which we extend to describe more elaborate issues such as what a user likes, dislikes, reads, publishes, and listens to, whenever he pays attention to various kinds of content. For our purposes, AttentionXML does not provide all the facilities we need to merge attention metadata from different applications. We illustrate the advantages of AttentionXML and our proposed extension in the eLearning context in section 3.

In more concrete terms, we developed a generic attention schema and framework that enables tracking and merging detailed user attention metadata streams of different applications. In order to illustrate the occurring issues and our approach to solve them, we detail the schema and framework in section 4 using a simple example from the eLearning domain.

2. ATTENTION METADATA

2.1 What is Attention Metadata All About?

Attention metadata can be used to describe what a user likes, dislikes, reads, publishes and listens to whenever she or he pays attention to any kind of content, e.g. websites, movies, music, texts, chats, emails, blogs, wikis, to mention a few. Furthermore, attention metadata captures the information about the user's handling of digital content. The collected data includes information that enables to conclude on the user's preferences, context [5], dislikes, goals and interests [6]. The attention metadata term was introduced to the field of information technology by Steve Gillmore, the president of AttentionTrust (http://www.attentiontrust.org/) and co-author of AttentionXML [2] standard of tracking attention of users.

Attention metadata provides the ability to represent data about the activities of a user within a certain environment. Furthermore, it will allow systems to drop the rating button (I-like-this) by monitoring how users deal with the information provided.

2.2 Logs as Source for Attention Metadata

Logs usually capture information on the access or errors occurring in single systems. Such logs are designed to track what information users' access, which errors users make while using systems, or from which countries users originate. Some logs track additional information like the pages users have accessed, response code, cookies and html methods (GET and POST) used in the accessed websites. Logs are usually focused on a specific system. They often do not capture the handling of content within the system and certainly no across system borders.

Log files provide information on user activities within a single system. Such logs include information on which content was accessed, when and by whom. Thus, this data allows concluding on the general attention a user gives to some sort of content. Nevertheless, this data provides only very limited information on the intention of the user. The intention is derivable from correlating user's activities that arch over system borders and include the respective user context. Furthermore, it is necessary to monitor a large number of users to provide a data base on which conclusions about users' current interests and possible goals.

Attention metadata track rich information on the transaction between users and information they access through a variety of tools. It captures data, for example, about the last access time, number of visits, title, and duration spent on of each page a user may visit while searching and browsing the web. In addition, it records the context of usage, tags, descriptions, and annotations a user may provide while or after reading the pages.

Of course, logs can also be used as, for instance, a source to derive respective attention metadata of users or websites. Nevertheless, there are attention tracking mechanisms like FireFox extensions such as Slogger and StumbleUpon (http://firefox.org/). Also Flickr (http://flickr.com/) and del.icio.us (http://del.icio.us/) provide mechanisms to track rich attention [4] metadata in the form of tags.

By tracking detailed attention information about how users located specific web material (i.e., by tracking search terms) and how they handle it, we can provide users with efficient personalization and adaptation services such as the following examples will illustrate.

Application areas of attention metadata are, for example, the extension/enrichment of user models [7]: Attention metadata, for instance, can help give information that informs the user model about the language of the user. Similar data improves those models by describing the real user behavior [9]. In other words, such metadata at the intersection of learner and content enables to build successful learner models.

Furthermore, attention metadata can be used to enable support systems for administration decisions. Attention can provide organizations with information on the development of their employers and how their expertise matches with their functions. Furthermore, by analyzing attention metadata, systems will be able to provide insights into the user's learning behavior thus enabling management to recognize needs and potential savings (e.g. cheaper learning material) earlier.

In addition, attention metadata provides information for recommendation systems. Attention metadata can be a rich source of information for recommender systems because it describes the past user experience with learning objects. For example, when searching for suitable learning objects, the user gets a ranked results list presented with the ranking basing on the user attention so far. Another example is a recommender system that helps the user to identify the most suitable learning object for her context, e.g. an automatic suggestion of related learning objects following the style of Amazon's "users who have bought this book also bought". In other words, the process of matching relevant content is transformed from searching through keywords in huge repositories to the "information finding".

3. ATTENTION METADATA SCHEMAS

3.1 AttentionXML Specification

AttentionXML is a specification that was introduced to track what read, look at or listen to in RSS feeds and Blogs.

Post/Item/Page	Blog/Feed/Site
- Title	- Title
- GUID/identifier	- url
- Type (mime type)	- Alt url
- Etag	- Etga
- Last updated	- Last updated
- Last read	- Date added
- Duration	- Date removed
- Followed links	- Last Read
- Rel/vote link	- User feed title
- Tags	- Rel/XFN and vote link
- Read times	- Tags

Figure 1. AttentionXML schema

Figure 1 explains the basic elements of AttentionXML specification. It is apparent from the figure that AttentionXML provides basic elements to describe the attention metadata. Nevertheless, it is missing attribute data, such as: Information about user activities: e.g., downloading, viewing or editing learning objects. Applications Information: e.g., browsers, mail clients, etc. Context where objects were used: e.g., building a course material, reading a news item.

3.2 Extending AttentionXML

In order to be able to collect and manage rich and detailed attention metadata, we need to:

- Track attention information about applications and context of usage (e.g., building a course in a LMS). We need several sources to be able to generate a more complete dataset on the user experience and behaviour [5].
- Track the type of tasks and actions that users are involved in. For example, such data will enable us to measure the relationships between user tasks and the time spent with the digital content [6].
- Track user information, working sessions, search activities and results obtained. This data is needed to identify the attention of specific user, successful sessions of that user and related actions that happened in same sessions. Session here describe the whole process a user has to perform to achieve a certain goal.
- Track data about user ratings and annotations for content they access. This data allows us to determine the relevance of content, and also provides information about what users like, dislike and their interests.

Representing the above tracked data with Attention.XML is not possible. In order to be able to collect large data volumes of attention metadata overarching system boundaries, we need to extend AttentionXML. In addition, this extended AttentionXML specification will facilitate merging attention streams of different tools.

In our application domain, we need to collect large volumes of attention metadata to be able to statistically analyze it to identify relevant learning paths. Based on the identification of a learning path, e.g. by applying simple pattern matching algorithms, we will be able to predict the next step of a learner within a learning system based on what many other learners in the same situation with a related goal have done before. This approach to learning path identifications bases on the assumption that existing learning path modeling techniques capture real learning paths only partially. We aim to identify learning paths based on the actual behavior of learners within learning scenarios involving a large number of heterogeneous and possibly non-compatible systems. We therefore need a schema to capture attention metadata within different system while being able to merge this data to provide a complete data set on users.

In the next sections, we present our Contextualized Attention Metadata schema (CAMs) and framework (CAMf) that facilitate the collection and management of user rich attention metadata from a variety of learning tools.

4. Contextualized Attention Metadata

Users usually interact with a wide variety of tools while using learning objects:

– Learning Object Repositories (LORs) -like MERLOT, EdNa, ARIADNE- are used to search, download and/or upload relevant learning objects.
– Learning Management systems (LMSs)-like Blackboard, WebCT and Moodle- students and teachers may use LMSs to learn and manage their courses.
– Internet Browsers: Users view and download relevant learning objects from different sources on the internet such as the ones found using Google or within a LOR or LMS.
– Authoring tools: Examples of such tools are word processing suites such as MSWord, OpenOffice and MSPowerpoint that are used to create new learning resources by re-aggregating existing ones, by authoring new contents and by modifying existing ones.

The above list illustrates that attention metadata, generated from all these sources needs to be combined to provide a more complete set of information on the user. Figure 2 presents the CAM (Contextualized Attention Metadata) framework that we have developed to exchange and manage attention metadata regarding the users and their interaction with learning objects.

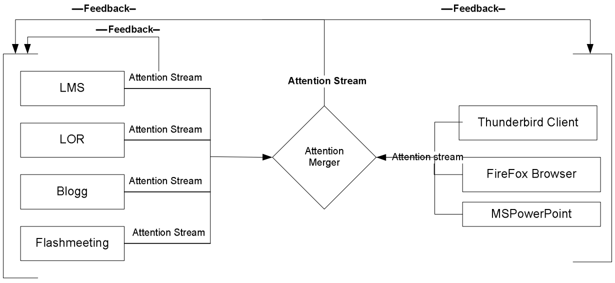

Figure 2. The CAM framework

Our framework is intended to publish attention metadata related to each tool in a separate extended AttentionXML stream. Afterwards, the set of those Attention streams are merged into one extended AttentionXML stream.

The Contextualized Attention Metadata schema (CAMs) that we developed (see figure 3) captures information about the user in the various systems and environments. Tracking the user over system boundaries requires a strong identity management. In this respect, we rely on research projects to provide solutions to the identity issue (e.g. liberty alliance; http://www.projectliberty.org/).

CAMs uses the full set of elements of AttentionXML (see figure 1) and extends this with a number of additional elements required to capture user activities in various systems. In order to broaden the scope of AttentionXML to facilitate our approach, we extend the schema at the item element level. We provide the full set of extensions at: http://ariadne.cs.kuleuven.ac.be/empirical/attention.php. We extend the AttentionXML schema by adding the highlighted event container element, as shown in figure 3, to enable the representation of data related to the user-driven action or event in.

The three of the major elements that we propose to use to extend AttentionXML are:

The **Action** element provides information on the *action type* that the object was involved in (e.g. if it was downloaded, inserted, viewed, etc.). In case of a query, this element also stores information on the query terms used to locate learning objects. In case of an insertion of an object, it also holds information on the metadata schema used to index the learning object.

The **Application** element groups information related to the tool used by the user to carry out actions, e.g. search, use or integrate learning objects. Information hold includes the name of the tool, its URI and the type of the tool, e.g. LOR or LMS. Information collected in this element allows the identification and combination of attention information collected from different applications.

The **Session** element holds the information that is needed to identify the different working sessions that the user engages within the systems. However, this element is not intended to hold the session of a user across multiple system boundaries. Instead, it only captures session information per system.

In order to describe a session that spans across multiple system boundaries and varies timelines, attention metadata provides a sound database on attention metadata. Still, further research is needed to provide the right analyzing algorithms to describe such a session which a learning object is involved in.

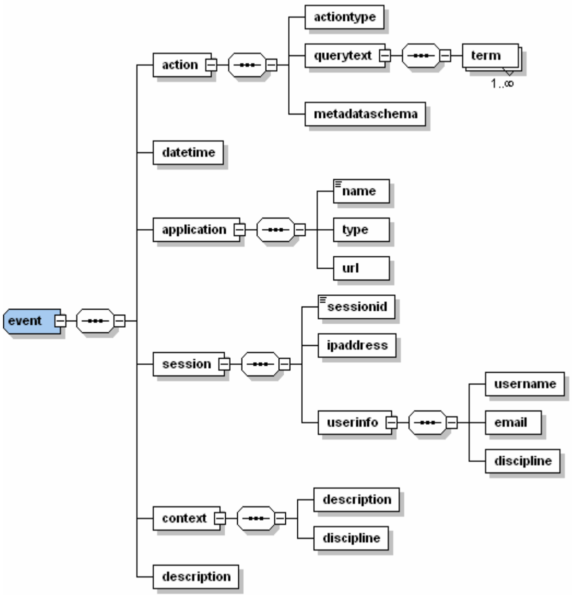

Figure 3. The event element in CAMs

As a case study, figure 4 shows the output of a simple tool based on an attention metadata file of one user from three sources: Ariadne [1] search and indexation tool (SILO) [8], Moodle (http://moodle.org) learning management system and the FireFox browser. This example includes the metadata about attention given to the same learning object (same object identifier) in SILO and Moodle, and also the attention given to different learning objects viewed in the browser. We applied XSLT to transform SILO logs (stored in XML format) into a SILO CAMs attention stream. In SILO, we were able to track the item title, guid, url, read times, action type, datetime, session and user information, search terms (used to locate the objects) and application information. We also developed an XSLT to transform FireFox Slogger logs (stored in XML format) into CAMs attention stream. We were able to collected title, guid, datetime, read times, tags and a description provided by users after reading objects and application information. In Moodle, user activities are tracked using [3], and user activities are stored in an object oriented data base. Work on a transformation tool is currently carried out. After investigating the Moodle tracking system, we found that we can collect the same attention data that was collected in SILO. Furthermore, we were able to acquire and store information on the context in which each object was used as well as a user-driven ranking measure (I-Like-It or Not-for-Me) of object relevance to this specific user.

We are also working on merging the different attention metadata streams into one general attention stream for each user. Moreover, we are also working on collecting attention metadata for other tools. In this way, we expect to build large repositories of attention metadata to provide a stable base to analyze the data and possible be able to identify statistically relevant information, i.e. identify the learner’s learning path.

```
<group>
 <title>Ariadne learning tools_attention</title>
 <feed> .........
     <item>
      <title>G3 Session 7: Web search and usability</title>
<guid>http://ariadne.cs.kuleuven.ac.be/silo2004/silo.jsp?ID=BLKLKP1625</guid>
       <readtimes>2</readtimes>
       <events>
           <event>
             <actiontype>Downloaded</actiontype>
             <querytext>
                 <term>ppt duval</term>
                 <term>usability</term>
             </querytext>
             <datetime>2005-05-31 14:51:44</datetime>
             <session>
                 <sessionid>2005-05-31-14</sessionid>
    <ipaddress>134.58.40.132</ipaddress>
    <userinfo><username>E_Duval</username></userinfo>
             </session>
             <application><name>SILO</name>
                     <type>search tool</type>
<url>http://ariadne.cs.kuleuven.ac.be/silo2004/</url>
             </application>
            </event>
           <event>
             <actiontype>Integrated</actiontype>
              <application><name>Moodle</name>
              <type>LMS</type></application>
```


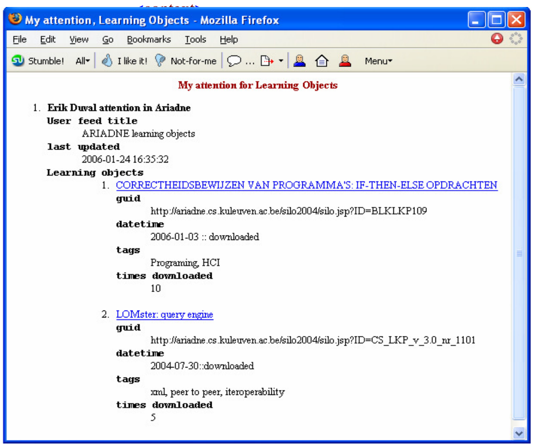

Figure 4: XML fragment of user attention metadata with screenshot of attention metadata generator

5. Conclusion

In this paper we discuss the notion of attention metadata in cross-system scenarios. In general, we argue that attention metadata lies at the intersection of metadata about the content, contexts and users. As such, it provides a vast amount of data that can be used to deduce the aims and goals of users. We illustrate the benefits of using attention to add to and enrich user models, predict usage patterns and feed personalization and recommender systems. We present some of the limitations of current logging services and a way to overcome them. We also present a schema and framework that we have been developing to collect and merge attention metadata of users from different tools.

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ACKNOWLEDGMENTS

We like to thank Riina Vuorikari, Xavier Ochoa and Julien Broisin for the fruitful discussions that enabled this work. We also like to thank the PROLEARN project and Belgian Technical Cooperation (BTC) for their support.