Towards Effective Usage-Based Learning Applications: Track and Learn from User Experience(s)

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Abstract

In this paper we propose a schema and framework for recording and managing attention metadata. This framework is intended to capture, manage, and re-use data about attention users give to learning objects in different applications. Capturing attention allows us to track what objects people use and how they use them.

1. Introduction

Nowadays-learning systems that support learning need a concise and detailed user profile to be able to provide personalized services targeted to a user. Instead of basing personalization on stereotypes, such systems utilize detailed information about the single user including observations on the handling of learning objects and the attention a user gives to them to conclude on the user's aims and goals [4][5]. For example, if a user spends a certain time on searching for and integrating learning objects dealing with an "Introduction to Java Programming", it is most likely that he is working on a course with the topic "Java Programming."

In this paper we propose a framework for recording and managing metadata that captures and describes attention. For example, in the case of searching for learning objects the captured information include the login process to the system, the search and the search terms used, the results displayed, the learning objects viewed, etc. We argue that this type of attention metadata lies at the intersection of metadata about the learning objects, the user and the systems involved.

Our aim is to capture the attention metadata about the user's actions across system boundaries to enable better targeted personalization of learning services. This framework is based on the exchange of information that uses an extended version of AttentionXML [1] metadata as outlined in section 2. Section 3, presents our attention metadata schema and framework. Section 4 concludes the paper.

2. Attention Metadata

In educational settings various types of users such as learners, learning object authors, etc. employ a vast number of different systems (e.g. learning systems, websites, chat, blogs, wikis, emails, etc.) to pursue their goals. These systems usually already provide a vast amount of data, for instance in the form of log files, either from proprietary formats like Apache webserver (http://httpd.apache.org) or from standards as used in digital libraries [2] or about the user e.g. IMS LIP [7] and IEEE PAPI [3]. On the client-side, applications like AttentionTrust and FireFox extensions like Slogger and StumbleUpon capture data related to the user's attention, usually in proprietary formats.

As such, provided log data is targeted to the system, as it tries to capture all activity that takes place within the environment without going beyond its borders [2]. Metadata about attention on the other hand focuses on the user and his usage of systems and learning objects within, so that it describes the intersection relation between users and learning objects. Both paradigms are close to each other but do not overlap, log files, for example, provide only few data on the process of which and how learning objects are handled in the system. Data about the attention that a user has given includes the log information from various systems, information about the users handing of learning resources in his environment, data about the user, etc.

The recently introduced AttentionXML standard sets out to capture attention of users in terms of attention metadata. As an open specification, AttentionXML provides applications with a schema to describe data on tracking, prioritizing and sharing how people use digitally provided information, e.g. what people are reading, looking at or listening to. It is used to capture and share information on the attention that users spend on web pages, news feeds and blogs. Figure 1 lists the elements that the AttentionXML schema provides.

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

Figure 1: AttentionXML schema

It is apparent from figure 1 that AttentionXML provides basic elements to describe the attention metadata. Nevertheless, it is missing elements to capture the wealth of information provided in logs, on the user or captured through monitoring how the user works with learning objects within systems. For example, the schema does not allow capturing the information about users' activities such as downloading, viewing or editing learning objects and applications and contexts where objects were used.

3. Attention Metadata for Enhanced Learning

3.1. Attention metadata for learning

As mentioned in the previous section, attention metadata provides us with detailed information how users handle specific learning objects. For example, it captures information on the context in which objects were used, how long users spent with them and how users located those objects. It also indicates which specific user is interested in which objects, based on their attention given to certain learning objects. This attention metadata is not covered by current learning metadata specifications (i.e. IEEE LOM [8]) or by user information models (i.e. PAPI). Attention metadata is especially useful in the context of learning to improve the technologies that enable learning experiences with multiple contemporary technologies:

- **Enrich metadata about learning object:** (manually/semi-automatic) generating content metadata is one of the challenges content providers are facing. Attention metadata provides rich metadata about learning content based on the attention it receives. Users seldom provide accurate data about themselves or their interests, thus automatically derived attention metadata can be used to improve the learning experience by better target personalized offers. They use objects in a certain context and they provide tags and descriptions for objects they pay attention to. This data forms a rich source of information to be used to update learning object metadata records in Learning Object Repositories (LORs). In addition, it can be used to update user profiles (i.e, in LORs and LMSs) with recent information about users' interest and attention.
- **Support recommendation systems**: attention metadata is a very good 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's attention so far. Another example is a recommender system that helps the user to identify the most suitable learning object for his/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…"

3.2. Contextualized Attention Metadata framework (CAMf)

Users usually interact with a wide variety of tools while using learning objects in one way or another. We provide here a none-exhaustive list that exemplifies the large number of tools and possible interactions within:

- Learning Object Repositories (LORs) like MERLOT, EdNa, ARIADNE and SMETE.
- Learning Management systems (LMSs) like Blackboard, WebCT and Moodle are used to learn and manage their courses.
- Authoring tools like MS Office amd OpenOffice are used to create new learning resources by re-aggregating existing ones.

The above list clearly 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 framework that we are developing to exchange and manage attention metadata regarding the users and their interaction with learning objects.

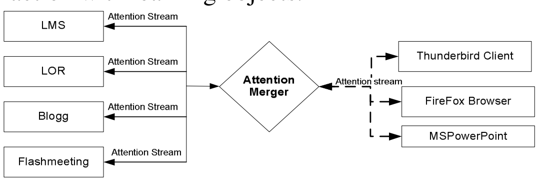

Figure 2: The CAM framework

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 merge process bases on the usage of our proposed extension to AttentionXML in which we attempt to capture information about the user in the various systems and environments.

Our framework provides the merged extended AttentionXML streams to participating LORs, LMSs, recommendation and adaptation systems to enable advanced and personalized services. Thus, we propose a Contextualized Attention Metadata schema (CAMs) and framework (CAMf) to facilitate the collection and management of user rich attention metadata from a variety of learning tools.

3.3. Contextualized Attention Metadata schema (CAMs)

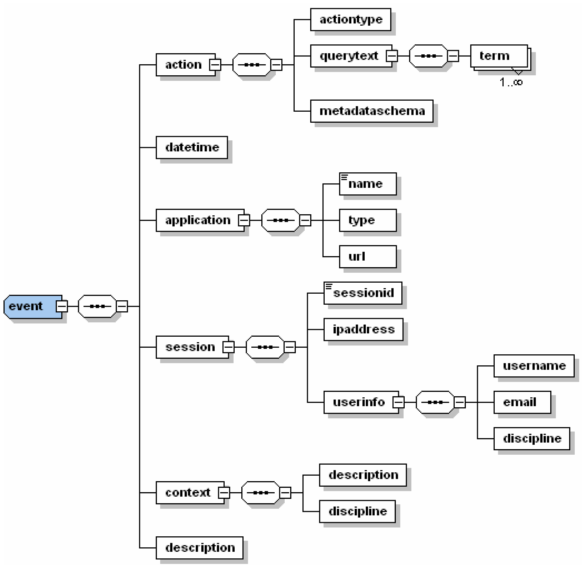

Figure 3: The event element in CAMs

Using the Contextualized Attention Metadata framework (CAMf) to capture the above elaborate data, we furthermore propose Contextualized Attention Metadata schema (**CAMs**). CAMs includes the full set of elements of AttentionXML (see figure 1). Additionally, we include a number of additional elements required to capture user activities in various systems. The conventional AttentionXML schema allows for tracking the attention of one user in respect to RSS feeds, blogs and wikis. In addition to that, as outlined in section 3.2, we need to capture the user's attention in many different systems. In order to broaden the scope of AttentionXML to facilitate our approach, we extend the schema at the item element level. In the following, we will exemplify our extensions. We provide the full set of the schema and extensions at: http://ariadne.cs.kuleuven.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 events in which a learning object is involved in.

We will now describe three of the major elements that we propose to use to extend AttentionXML and that are grouped by the event element in the following.

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.

4. Conclusions and Future Work

We propose a framework and schema for recording and managing rich and detailed sets of data about user attention given to learning objects in different applications [6]. Future work includes the collection of vast amounts of attention metadata from several applications to form a rich and large base of attention metadata about users. We will use advanced technologies to facilitate efficient merging of attention metadata. We also plan to develop a prototype that exemplifies the capabilities and the importance of attention metadata in improving learning services.

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