Towards Web Usability: Providing Web Contents According to the Readers Contexts

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Abstract. Web usability has been considered as a key issue to the success of the Web. However, Web readers typically face difficulties since Web pages are presented according to the local contexts of Web authors. Web authors and readers follow their own local contexts to represent and interpret Web contents as they originate from different communities. Hence, there is a need to transform Web contents created according to the authors' contexts into the different contexts of their readers.

In this paper, we aim at presenting a solution that provides Web contents according to the reader's context. Our solution is based on an explicit representation of the authors' and readers' local contexts. We rely on RDFa to annotate contents with the author's context and we provide an adaptation process on the client-side that generates contextualized Web contents according to the readers' contexts. We validate our approach through a Firefox extension.

1 Introduction

Recently, the Web has successfully evolved into a "semantic" Web, where *Web authors* can describe Web contents with semantic information such that software applications (e.g., Web browser) can interpret them and hence handle *Web readers'* requests more effectively. For instance, a Web author may describe Web contents such as *events* with semantic information such as *starting date* and *ending date*, *location*, etc. Accordingly, a reader application can search, aggregate, or export any events with respect to a specific day or a location.

Open Data in XHTML is a bottom-up approach towards the semantic Web (called small-s semantic Web). small-s reuses the current Web as it is and relies on the authors to annotate their contents with semantic metadata, so that the former become machine interpretable. In this field, the main emerging technologies are RDFa and microformats [10]. Our previous work concluded that microformats are inextensible as they propose a finite set of specifications [8].

RDFa provides an abstract solution that aims at expressing RDF statements in XHTML documents. More precisely, RDFa provides a collection of XHTML attributes (reuses existing attributes such as *content* and *rel* and introduces new ones such as *about* and *property*) to embed RDF statements in XHTML, and provides processing rules to extract these statements.

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1.1 Web Usability and Local Context

The evolution of the Web raises new challenges, notably regarding *Web usability*. Our understanding of Web usability is derived from the ISO 9241-110:2006[1] specification. Web usability is defined as the effectiveness, efficiency, and satisfaction of the interaction between Web readers and Web pages. *Effectiveness* refers to the extent Web readers interpret Web contents accurately and completely. *Efficiency* refers to the efforts expended (e.g., time) to interpret Web contents effectively. *Satisfaction* refers to the readers' acceptance of the interaction.

In this sense, interactions between Web readers and Web contents are typically ineffective and inefficient. Indeed, authors and readers of Web contents originate from different communities. Web authors follow their local contexts for representing Web contents. This leads to an additional effort for the readers as they need to interpret these contents according to their own local contexts.

By *local context*, we mean a set of common knowledge shared by members of a community [11,2], like common language and common local or cultural conventions, such as measurement units, keyboard configurations and notational standards for writing time, dates, numbers, currency, etc. For instance, let us assume a French reader who needs to register to a summer school course on a Web site which is authored by a British author. In this context, the course price is in British Pound and follows the British currency format (e.g.: 1,234.50). As the French currency is Euro and uses a different format (e.g.: 1 234,50), the course price must be converted from British Pound to French Euro by the reader. Note that the situation can be even worse as the reader can misinterpret the attendance date of the course. For example, he could interpret the attendance date (e.g.: 07/08/2008) as the 7^{th} of August 2008 (following the French format) instead of the 8^{th} of July 2008 (following the British format).

1.2 Objectives

To enhance Web usability, we aim at resolving semantic discrepancies between contexts of Web authors and readers and at adapting context-sensitive contents (called adaptable Web contents) according to readers' contexts.

This paper is structured as follows. Section 2 presents our approach to annotate adaptable Web contents with authors' contexts and adapt them to readers' contexts. Section 3 discusses related works and Section 4 concludes the paper.

2 A Semantic Context-Based Approach with RDFa

This paper proposes a semantic context-based approach that relies on RDFa to annotate and adapt Web contents. This approach firstly introduces a set of adaptable concepts and a set of contextual attributes to specify the semantics of adaptable Web contents and the local contexts of Web authors and Web readers, respectively. Secondly, it exploits the idea of *semantic object*, which was detailed

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

in [9], to represent adaptable Web contents together with adaptable concepts and contextual attributes. Thirdly, it takes advantages of RDFa technology to annotate adaptable Web contents with these metadata. Finally, we propose an adaptation process implemented as a Firefox extension. This extension adapts the semantic objects according to the readers' contexts.

2.1 Adaptable Concepts and Contextual Attributes

This section distinguishes between adaptable and non-adaptable Web contents. Adaptable Web contents refer to the contents that might be represented and interpreted differently from different authors and readers, according to their local contexts. In order to specify the semantics of adaptable Web contents, we identified in our previous work a list of adaptable concepts [8]. These concepts address the main concerns that rose up from our experience while browsing the Web. Here are some examples:

- **Date/time** are described in different formats, styles, and different time zones according to the user's language and country.
- **Price** are expressed in different formats, currencies[2], VAT rates, etc.
- **Measure units** are used to quantify the values of physical quantities (e.g., weight and length). Countries use different measure systems (e.g., Imperial and Metric systems), different unit prefixes, and different error percentages.
- **Telephone number** identifies telephone endpoint. Based on ITU[3] plan *E*.164, each country has a different *international call prefix* and *country calling code*. Also, each country uses a different telephone number format.

For these concepts, we propose a context ontology that attempts to identify a set of contextual attributes. These attributes make explicit the contexts of Web authors and Web readers. We do not aim at identifying an exhaustive list of contextual attributes, but we try to address the needs of the above adaptable concepts. In this sense, contextual attributes are mainly grouped into two broad categories: *country* and *language*. Each country has a set of local conventions such as currency, value added tax, measure system, etc. Also, each country has many cities, sometimes located in different timezones. The language attribute specifies the local natural language. One country may have one or more communities (e.g., French and Dutch speaking communities in Belgium). Each community usually uses a common natural language and a set of conventions related to that community (e.g., writing formats). Fig. 1 presents an excerpt of the proposed context ontology[4].

2.2 Semantic Object

In [9], *semantic objects* are used to annotate data objects exchanged between Web services with semantic metadata so that it enables automatic data mediation during Web service composition. In our approach, we use our own definition

[2] See ISO 4217 for used currency list.
[3] International Telecommunication Union: http://www.itu.int/
[4] Context ontology is designed using TopBraid composer™ modeling environment.

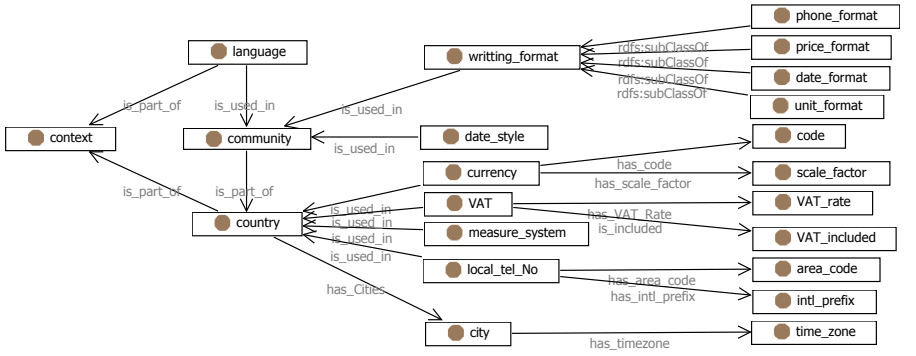


Fig. 1. An excerpt of the Context Ontology

of *semantic object* to annotate adaptable Web contents with a semantic concept and one or more contextual attributes to support automatic adaptation. A semantic object $SemObj$ is a 3- tuple represented as follows:

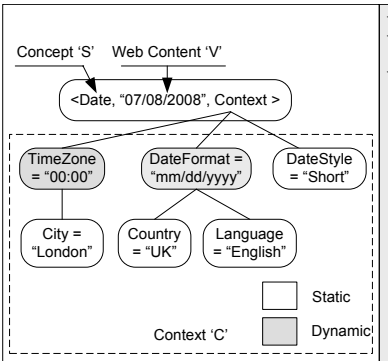
$$\boldsymbol{SemObj} = \langle S, V, C \rangle$$

Where S represents the adaptable concept that the $SemObj$ adheres to, V is the physical representation (the value) of the adaptable Web content. C specifies the local context of $SemObj$. This context is represented as a finite set of contextual attributes. In addition, contextual attributes themselves are represented as semantic objects, which may also have contextual attributes. This provides a recursive means for context description. Technically, adaptable concepts and contextual attributes are represented using RDF (See Fig. 2.B[5]).

For the needs of our approach, we categorize contextual attributes into two subsets: *static and dynamic*. Static attributes are the minimum contextual attributes that are used to describe the context of a semantic object and hence, their values must be specified explicitly. On the other hand, dynamic attributes, if they are not specified explicitly, can be inferred from other attributes (static or dynamic) that belong to that semantic object and its contextual attributes.

As an example of a semantic object, Fig. 2.A represents the attendance date of the summer course presented in Section 1.1. *Date* refers to the Date/Time adaptable concept. 08/07/2008 is the value of the attendance date. Finally, $Context$ represents the set of contextual attributes. Here, the date $SemObj$ has $DateStyle$ as *static* attribute; $DateFormat$ and $TimeZone$ as *dynamic* attributes. The other part of context further describes the context of other semantic objects ($DateFormat$, $TimeZone$). The value of $DateFormat$ is inferred from the *country*, *language* and *dateStyle* and the value of $TimeZone$ is inferred from the *country* and *city*. Fig. 2.B presents the summer course XHTML excerpt annotated with the Date semantic object using RDFa syntax[6].

[5] The *namespaces*, inside html tag, represent the URL references of the RDF.
[6] More information available on http://www.w3.org/TR/rdfa-syntax/




```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML+RDFa 1.0//EN"
   "http://www.w3.org/MarkUp/DTD/xhtml-rdfa-1.dtd">
<html xmlns:ns="http//www.example.org/" xmlns:cxt="http://localhost/context"
      xmlns:dc="http://purl.org/dc/elements/1.1/" >
 <head>. . .</head>
 <body>
   <div about="ns:SummerCourse" >
     <h2 property="dc:title">knowledge is the power</h2>
     <h3>Attendance Date
        <span rel= "{#attendance-date}">
          <span property="dc:Date"> 07/08/2008 </span>
          <span property= "cxt:dateStyle" content="Short" />
          <span property= "cxt:language" content="English"/>
          <span property= "cxt:country" content="UK"/>
          <span property="cxt:city" content="London"/>
        </span>
     </h3>
     <h3>Course Price<span property="ns:price"></span>£1,234.50 </span>...</h3>
   </div>...
 </body>
```

B: XHTML and Annotated Date Web Content

Fig. 2. An excerpt of annotated XHTML Code and Date Semantic Object

2.3 Adaptation of Semantic Objects

Representing Web contents as semantic objects provides a way to adapt a *SemObj* from one local context C to another local context C' (and vice versa). To this end, we specify a conversion function F as follows:

$$\boldsymbol{F}\ (<S,\ V,\ C>,\ C') = <\ S,\ V',\ C'>$$

F for instance can adapt the above date semantic object (e.g., D) from the British author's context to the French reader's context (e.g., $D1$) as follows.

D *=<Date, 07/08/2008, Timestyle=short, City=London, Country=UK, Lang=EN>*

D1 *= <Date, 08/07/2008, Timestyle=short, City=Paris, Country=FR, Lang=FR>*

We implemented an adaptation engine as a Firefox extension. This engine enables the reader to describe his local context and adapts the semantic objects from author's to reader's contexts. In addition, this provides a way to adapt semantic objects from several server-side contents. More details can be obtained at the following address: `http://perso.fundp.ac.be/~maljabar/RDFa/`.

3 Related Work

Space limitations allow us to only discuss some major works related to Web usability, Web adaptation, and semantic contents' annotations. Firstly, enhancing Web usability has been acknowledged as an important issue in many works. However, most initiatives propose practical studies [2] or design guidelines to help enhancing Web usability [11,6]. Secondly, our approach describes the contexts of both Web authors and readers explicitly and adapts the presentation of Web contents according to the reader's contexts. However, most adaptation approaches

acquire and aggregate users' contexts into context models, mostly based on assumptions derived from Web authors (e.g., stereotyping), and provide different contents to different readers accordingly [5,4,11]. Also, the adaptation process in most of these approaches is deployed on the server-side. Server-side deployment can only adapt contents hosted on the server-side itself. Finally, several works have used semantic annotation and/or proposed client-side extensions such as transcoding (e.g., SADIe [3]) and semantic aggregators (e.g., Kalpana [7] and Piggy Bank [1]). However, they do not address Web usability and local context. Transcoding approaches aim at restructuring annotated Web contents, based on a transcoding ontology, to make them accessible to visually impaired readers. Semantic aggregators aim at aggregating personal information in RDF form and enable server-side and/or client-side applications to query that information.

Finally, to our best knowledge, there is no approach that uses RDFa to annotate Web contents with contextual information as defined in this paper.

4 Conclusion

This paper presents an approach to enhance the Web usability for Web readers. We explicitly describe the contexts of Web authors and readers with a solution that relies on the notion of semantic object, which includes a tree-structured set of context attributes. Then, we use RDFa to annotate adaptable Web contents with metadata (concepts and context attributes). Hence, Web contents can be adapted into different readers' contexts. We implement an adaptation engine as a Firefox extension. Our future work aims at evaluating Web usability by testing the readers' satisfactions. In addition, we aim at extending our approach to enhance the Web usability of Web authors when they annotate Web contents.

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