EMPOWERING DISABLED USERS THROUGH THE SEMANTIC WEB

The Concept Coding Framework an application of the Semantic Web

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Abstract: The World Wide Web offers many services from typical textual web content to shopping, banking and educational services, for example, virtual learning environments. These technologies are inherently complex to use, but in their very nature offer many benefits to the disabled person. The traversal of the web relies upon the cognitive skills of the user. You need to know what you want to do. You need to understand what the site is allowing you to do, and you need to be able to complete the task by interacting with the website. The emergence of the semantic web offers the potential to reduce the cognitive burden of understanding what the site can do and how to complete a task, whilst also offering new solutions to typical accessibility issues. In this paper, we aim to present how the semantic web can be used to enhance accessibility. Firstly we'll give some examples of what is currently possible. Secondly we'll motivate some research initiatives to enhance user independence for the disabled person, particularly those that use Augmentative and Alternative Communication (AAC) systems and/or are Learning Impaired.

1 INTRODUCTION

The World Wide Web offers many services from typical textual web content to shopping, banking and educational services, for example, virtual learning environments. These technologies are inherently complex to use, especially when navigated through alternative devices (Huang & Sundaresan, 2000; Sloan, et al, 2000), but in their very nature offer many benefits to the disabled person.

Disabled users of the web are more common than many might believe with one in three families in the world touched by disability (Theofanos & Redish, 2003). Their article, *Bridging the Gap* continues to make some critical points, i. the number of people with disabilities and disposable incomes is likely to increase; ii. users with disabilities spend more time logged on than non-disabled users; and iii. the internet opens up many barriers and provides enhanced independence freedom for people with disabilities.

The internet is currently a web of links, the traversal of which relies upon the cognitive skills of the user. That is, they need to know what they want to do, they need to understand what the site is allowing them to do, and they need to be able to complete the task by interacting with the website.

The current focus of web accessibility is that of the interaction problem, i.e. the navigation of a site. The emergence of the semantic web offers the potential to reduce the cognitive burden of what the site can do and how to complete a task, whilst also offering new solutions to typical accessibility issues.

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The semantic web is a framework for data to be reused across different applications and boundaries. It is an extension of the current web that provides machine-readable information whose meaning is well-defined by standard protocols. (Berners-Lee, 2003). Much of the semantic web research and development is focused on either the business opportunities, on knowledge management, or test environments to explore ideas and tools, for instance, "Friend of a Friend" (FOAF). Little so far has been explored that focuses on the end the user, particularly the disabled user. In this paper, we aim to present how the semantic web can be used to enhance accessibility, firstly with what is currently possible, and secondly to motivate the research to enhance user independence for the disabled person, particularly those that use Augmentative and Alternative Communication (AAC) systems and/or are Learning Impaired.

2 BACKGROUND

Augmentative and Alternative Communication (AAC) users are persons with a speech impairment that is a result of a congenital (eg. Cerebral Palsy) or acquired dysfunction (eg. Multiple Sclerosis, or Aphasia following a stroke). People with these kinds of disabilities have a range of impairments that are usually a combination of sensory, physical, cognitive and speech problems. (Edwards, 1995).

A typical task that adults do, for example, organising travel can be very complicated for a disabled person. They need to know about physical access to the hotel, disability friendly amenities and the flight arrangements will need to accommodate their special needs. Could the semantic web make the burden of arranging this trip much simpler? We could envisage a time when the disabled user should be able to tell a search engine, "I want to attend the ISAAC conference in Brazil" (International Conference of 2004 on Augmentative and Alternative Communication). The user's agent / browser would then return options ready to purchase with the flights, hotel arrangements, and all special requirements already filtered based on a user profile that, for example, takes into account their physical or dietary needs. The architecture of the semantic web is intended to do just that. The user's agent will be able to ask intelligent questions of a website. The solution will be provided from the rules and the ontologies that the website uses, and these can bridge different domains, all interoperating seamlessly. This is currently a vision of the future, an anticipated result of the emergence of the semantic web. For now though, we can exploit the semantic web with applications of it in constrained domains to address access issues previously neglected.

The AAC user needs a communication aid to interact with others in everyday situations. These systems may be populated with a variety of symbolic representations of language concepts (abstract entities / meanings). For instance, the sequence of concepts, "I, belly, yesterday, (to) hurt" could be interpreted as "I had a sore belly yesterday". This form of communication is common for symbol users and each of the concepts could be represented as a symbol on the users' device as shown in Figure 1, where four different symbol sets, Bliss, PCS, Pictogram and Beta are used (in rows, top-to-bottom) to show how they would each portray the same message.

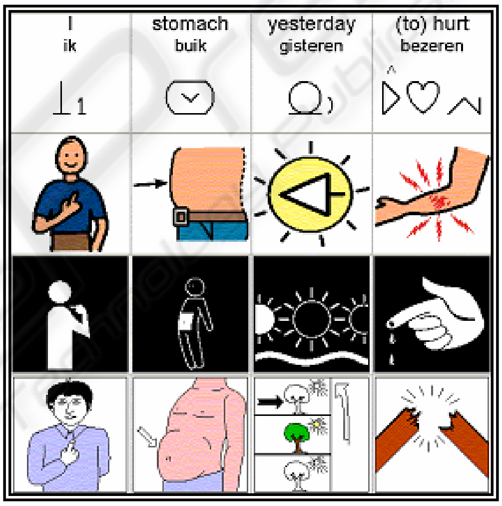

Figure 1: "I had a sore belly yesterday", represented in Bliss, PCS, Pictogram and Beta.

Referencing to and exchanging between proprietary, symbols encoded messages, becomes problematic in Internet environments. For example, if Andy constructs a message using his English PCS symbol vocabulary and sends it via email to his friend Mats, a person who uses Bliss and lives in Sweden, then Mats may wish to read the message in Swedish Bliss representation, that is his personal graphic symbol and language preference. Such translation on a concept-by-concept basis presents a number of problems for the user. For instances, Mats' replacement symbol language, Bliss may not include equivalent representations of the PCS concepts used by Andy, or may have two or more representations of the same concept. These difficulties are caused by a lack of common practices in the definition of concepts for graphic symbol systems in general, and concept encoding schemes in particular. The development of a Concept Coding Framework (CCF) intends to change that.

The CCF is designed as an application of the Semantic Web. It will offer AAC users enhanced accessibility of the Internet and will remove barriers for message exchange. The Semantic Web as a whole potentially offers these same users more support and independence. This all sounds great in theory, but developing such solutions is very complicated, and will be a rather long-term commitment. This is clear from the rate of progress with the Semantic Web itself. Development started with Tim Berners-Lee's road map in 1998, by February 2001 we had an Activity Statement from the World Wide Web Consortium (W3C) Semantic Web Initiative and in February 2004 we saw the Resource Description Format (RDF) and Web Ontology Language (OWL), (the backbone to the Semantic Web) become standard technologies of the W3C.

3 REPURPOSING CONTENT

Users of AAC systems experience significant difficulties when interacting in the text-rich Internet environment. Web accessibility experts feel Internet users with learning difficulties present an especially complex challenge (Seeman, 2002; Clark, 2003). The existing Web Content Accessibility Guidelines (WCAG) from the W3C, WCAG 1.0 clearly focus on the visual impaired users, but the emerging guidelines, WCAG 2.0 are certainly taking more notice of the other groups of users, as more groups of accessibility experts focus or specialise, for instance, in Learning Difficulties (LDWeb). Existing solutions or recommended techniques say amongst other things, "use plain language", but even this idea is vague and how this could be achieved is still debated in many accessibility forums and discussion threads. With the emergence of new technologies as part of the Semantic Web Initiative we now have the capabilities and potential to start to address the issues of web accessibility for persons with learning difficulties (Seeman, 2004). With time, we should see user agents that can fulfil the vision of simpler travel as outlined above.

Jakob Nielsen's Alertbox article "Alternative Interfaces for Accessibility" (Nielsen, 2003) describes the conflict between practical and ideals when implementing a perfectly usable design. Neilsen states that the practical solution chosen through cost and maintenance is to provide a "single design for multiple audiences"; where as the ideal is to provide "separate designs optimized for each of main access modalities". This ideal is achievable through the technique of separating content from presentation; hence the prolific development of Cascading Style Sheets (CSS), whose power in terms of accessibility is driving many online accessibility communities to deliver beautiful and highly accessible content.

The Concept Coding Framework is a new potential solution that is being specifically developed to provide a mechanism for repurposing content into preferred symbolic representations through the use of semantic web technologies for the AAC user. This is an opensource and international initiative that resulted from the pan-European WWAAC project, which aimed to enhance access to the World Wide Web for the AAC user through various routes (Lundälv, et al, 2003; Poulson & Nicolle, 2003; Magnuson & Hunnicutt, 2003).

Concept coding offers an extra level of separation - that of the actual meaning of the content from its representation. So in addition to the text in the HTML paragraphs, RDF annotations are provided that map the words in the text to their generic concepts. It is then the responsibility of the user-agent, for example, the user's web browser, to parse the annotations and thus repurpose (on the fly) the textual content into their preferred language, and if necessary symbolic representation. Lisa Seeman of UB-Access is also investigating the use of the Semantic Web to repurpose material into an accessible form suitable to users via a system known as the Semantic Web Accessibility Platform (SWAP). SWAP uses a proxy server to translate content into a form that suits the users' profile, however, it does not look at the AAC user.

3.1 Concept Coding Framework

Many AAC systems use some kind of graphical symbols to represent a limited vocabulary of basic concepts. However, there is a lack of widely accepted standards for the language, concept, symbol, and encoding schemes of these vocabularies. This then means that translation between the different vocabularies and text is difficult.

The CCF provides a foundation for, and a bridge between, current and future proprietary AAC systems, by supporting effective graphic symbol usage, exchange and maintenance in the context of standard Internet information sharing. To be acceptable as mechanism for exchanging messages, concept codes should be:

- Clearly defined, harmonising where possible, with the emerging principles for general concept management in the Internet.

- Non-Proprietary and publicly accessible.
- Exchangeable over the web.
- Culture and language independent.
- Simple and straightforward to implement.
- Provide clear benefits for end-users.

As with any other language, symbol sets are dynamic entities, families and professional carers supporting AAC users are likely to need or want to understand the technical complexities of such a system. Therefore, there is a requirement for mechanisms to support the framework, such as, a facility for the addition of new concepts, and the maintenance of the ontologies (a database of terms used to describe and represent an area of knowledge, in this case language.

To achieve this, the proposed CCF must rely on a stable foundation of concepts with unique IDs referring to one or more Reference Ontologies where the concepts are clearly defined – including their relations to other concepts. It is strategically essential that there is a rich and thoroughly defined natural language ontology at the root of this construction.

The Base Reference Ontology (BRO) contains around 4000 - 12000 concepts that are a subset of WordNet, an electronic lexical reference system (Fellbaum, 1999), supported by a small Complementary Reference Ontology (CRO) of about 200 - 1000 common function words and specialized concepts not covered by WordNet. Figure 2 illustrates the structure of the proposed framework. The CCF is built up of 3 parts connected by a Bridge. These are:

1.
2. The Concept Code Definitions (CCD) acts as a controlled vocabulary of concepts currently supported by the CCF. Each concept is defined by its own unique ID, and through references into the Reference Ontologies.
3. The Base Reference Ontology (BRO), which contains the concepts and their definitions, including relevant parts of the hierarchy, relations and some linguistic information. This resource is currently derived from WordNet, but alternative or complementary ontologies may potentially be utilised.
4. The Complementary Reference Ontology (CRO), which contains the concepts currently not found in WordNet (primarily around 200 common function words, such as pronouns, prepositions, and question words). These concepts are grouped in simple hierarchies, with other relational and linguistic information corresponding to that of the BRO.

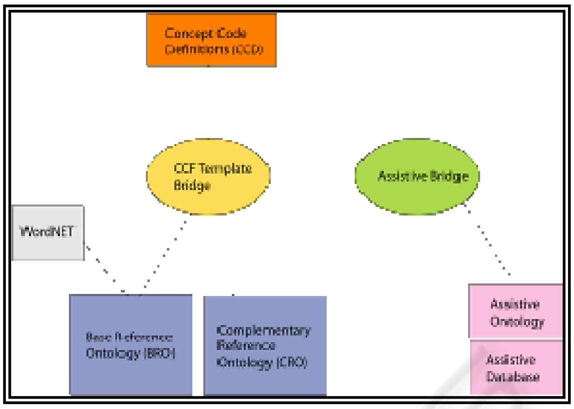

Figure 2: Concept Coding Framework Structure Overview

Each proprietary ontology owner who wants their users to benefit from the CCF will have to take on the responsibility to create a mapping between the concepts in their own ontology and the concept codes in the CCD, the entry point into the framework. The APIs and a CCF Template Bridge are being developed as part of the Framework to support the mapping process.

An alternative view of CCF is a nerve spine, with each proprietary system tapping in & out of it (See Figure 3).

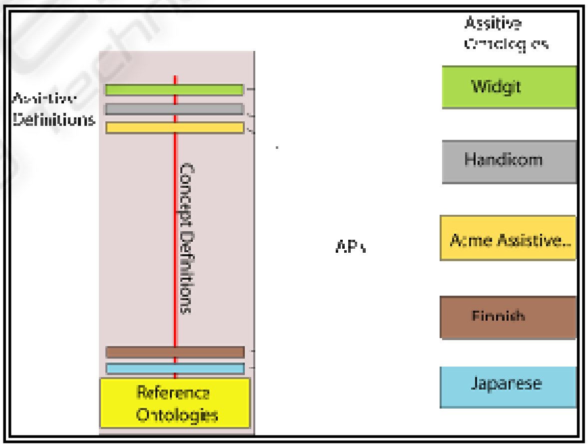

Figure 3: Concept Coding Framework Spine Visualisation

The large column on the left is the CCF. The CCD is the nerve stem running down the spine to the BRO coupled with CRO that form the base of the column. Vendors (e.g. Widgit and Handicom) then create a mapping from their respective Assistive Ontology onto the CCD. These Assistive Ontologies are then linked into the CCF, allowing requests to be routed between them (e.g. between Widgit and Handicom concepts).

In a similar manner different natural language lexicons, providing additional text representations, may be related as Assistive Ontologies. Note: The English one is already present as part of the BRO/CRO.

3.2 Concept Coded Documents

We will not define a new document format or specify one to use as that would go against all principles of the web and steer us into proprietary formats. Instead, we suggest the use of RDF (W3C, RDF) coupled with other technologies, namely OWL (W3C, OWL), XPointer (W3C, XPointer) and Ruby Annotation (W3C, Ruby Annotation) as a means to provide concept coding to existing document formats. For example, imagine a very simple webpage that just contains the text "I want a cup of coffee". One way, and probably the tidiest for adding concept codes, is to link in a mapping file of the concept codes and representation references from the document header.

```
<link rel="ConceptCoding" href="mapping.ccf">
```

The linked, RDF/XML file contains the concept code references for the text in the html, after some initial declarations of namespaces, each word or phrase would be mapped by an XPointer to its concept code in the CCD, and possibly some alternative representations, for instance Bliss, as shown in the following "coffee" RDF example snippet.

```
<rdf:Description
           rdf:about="#xpointer('coffee')">
  <ccf:conceptCode
           rdf:resource="&ccd;CC-COFFEE-
1000"/>
  <ccf:representationItem
           rdf:resource="&iso-bliss;13373"/>
</rdf:Description>
```

The Standard Bridge is then used to map this definition to entries in the BRO and/or the CRO. Then, for instance, the Reference Ontology would contain an entry that has a text representation of the concept and possibly refers back to the original WordNet ontology. In this example there would also be a Bliss extension of the Bridge that maps the concept code to a code in the Bliss Assistive Ontology.

4 ENHANCED INDEPENDENCE

Everyday tasks such as shopping for groceries may be a complex and tiring rigmarole for the disabled person. Online shopping may provide many benefits to this user group, but using these services is still very complex and hard work. This Christmas, online spending was expected to include 43% of consumers in the UK (BBC News, 2004). There is a move from the high street to eRetailers. There is also a move of shoppers from eRetailers with the cheapest product to eRetailers with better service, websites and customer reviews. Indicating that some customers, according to individual preferences and prerequisites, in some instances are beginning to prefer shopping online to traditional shopping. It also indicates the need for eRetailers to improve the accessibility to their services – for customers in general and for disabled users in particular.

The Aurora (Huang & Sundaresan, 2000) system was a proxy facility to address the issues of comprehension and navigation as faced when using, for example, an auction site like eBay. However, their system was developed pre Semantic Web. They relied upon manually made custom profiles of sites to allow each facility to be successfully re-purposed.

The Semantic Web can potentially reduce barriers of understanding and provide enhanced user independence. But this is still a long way off, and poses "the grand challenge for the current generation of computer technology" (Embley, 2004).

The CCF will form the basis of a number of new research and opensource development initiatives that will take concept coding to another level of sophistication and flexibility. A demonstrator exists that allows you to explore a test framework, which includes a facility for composing simple messages that can translate to different symbol sets.

Eight million disabled European citizens with language disability (about 20% of the current total disabled population) are not, or are in only a very limited manner able to make use of the possibilities that modern information technology provides. The challenge of the WWAAC project has been to make the Internet more accessible, thereby increasing the quality of life for this target group of users.

With the help of European Community funding it has been possible to start to develop an open source standard. The CCF can through standardisation enable users to be more active members of the society. The CCF when matured will assist their education, independence, and employability.

5 FUTURE WORK

The developments of the Concept Coding Framework show that it is possible to create a common bridge between various graphic symbol systems and textual languages. This is definitely a step in the right direction as a solution to providing understandable content. The CCF can bridge between different technologies and products developed for AAC users and also between Assistive Technologies (AT) and the mainstream technologies of today. In the future, assistive devices employing CCF technologies will be able to exploit the Semantic Web in numerous ways. For instance, their user agents could roam the web on a mission to perform sophisticated tasks, like a organising a trip, for them in an automated manner.

Future work of the CCF Interest Group is focused on the delivery of tools and plug-ins for the development and support of the framework. Particularly, the objective is to develop and evaluate a full-scale vocabulary (CCD), supported by a large-scale repository of ontologies (BRO, CRO and Assistive Ontologies). It is vital that this work is performed in co-operation with key vendors and stakeholders of the field.

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