A Discount Approach to the Semantic Web

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Abstract— **The frameworks underlying the Semantic Web have developed and matured greatly over the last years. However, uptake has been patchy, with the majority of SW use based around a small number of popular applications. User testing with SW–based projects highlights a number of issues that may contribute to this effect; principally, these relate to gaps between the user's mental model and formalism. Similar problems appear in non–SW developments with a strong reliance on a complex data model. Such problems include semantic drift and overload, and the provision of inaccurate or incomplete data. Working from a case study, this paper discusses difficulties with capturing real–world semantics in a large–scale collaborative environment. A preliminary model of user behaviour with respect to shared establishment of semantics, from socially shared cognition, is discussed. We conclude by discussing some possible features of a "discount" model of the Semantic Web, designed to accomodate diverse communities of users, with reference to examples taken from the "small–S" Semantic Web, microformats and free–text tagging.**

I. INTRODUCTION

The Semantic Web has recently gained a great deal in popularity. Many relevant standards are now available and in certain cases already widely used, whilst new drafts of old favourites are appearing on a regular basis. However, the use of the technologies is somewhat uneven, with a far greater uptake of RDF than many companion technologies [13]. There exist usability concerns to do with the current paradigm for RDF usage. The usability of the Semantic Web, for users and developers alike, is sometimes cast into doubt. Making use of user input within the framework of a relatively large or complex model frequently result in systems that do not make use of the user's intuition, but rely on their shared understanding of a sometimes complex abstract model. Moreover, the same is true of many metadata systems, such as the Dublin Core (DC). The popularity of folksonomic tagging demonstrates that reduction of the initial complexity of use of a system can dramatically increase its usability.

In this paper, we discuss a conception of the Semantic Web as a collaborative technology. We then suggest a possible model for understanding the requirements underlying the process of coming to a shared understanding of precise concepts, based around the ideas of socially shared cognition. Of principal importance to this is the suggestion that learning is a socially situated activity; the implications of this are discussed. We discuss the implications for a "discount" approach to the use of Semantic Web technologies — where the term is used in the sense that it is used in human–computer interaction research.

In HCI, the term "discount usability engineering" refers to an approach to usability engineering developed in response to the fact that HCI methods were seen as too time consuming and expensive, and that the techniques were often intimidating in their complexity [2], in [10]. In suggesting a similar approach be taken to Semantic Web engineering, the analogy is intended to recommend the use of methods that avoid the perception of excessive complexity in the use and development of SW–based systems and that showcase the benefits of the approach.

II. SEMANTIC WEB AS COLLABORATIVE TECHNOLOGY

As an ideal platform on which to build distributed databases of knowledge, the SW is designed to be a central technology for collaborative work. In this section, we discuss what this implies for the technology and the prerequisites for computer–supported collaborative work (CSCW) environments in general.

Prerequisites for successful CSCW

"Collaboration" is a term that has over the years acquired many meanings ; the phrase "collaborative learning" has suffered a similar fate. We argue that the establishment of a successful distributed collaborative workspace requires as a prerequisite that users have a shared understanding of the task at hand. For effective communication to take place, the participants must establish and share common ground. In effect, successful collaboration generally requires a preceding step, in itself a problem in collaborative learning ; the establishment of shared semantic and semiotic conventions for the purposes of the task. What does this mean in the context of applications centering around a complex data model? We describe a model within which to examine this process.

Establishing a framework

As a model for describing the process of establishment and reasoning across shared semantics, we propose a model based around the theory of social constructivism, from the perspective of socially shared cognition.

There are several theories of learning that could be used in collaborative learning systems [12]. Of these, of particular significance are the socioconstructivist and shared cognition approaches.

1) Social constructivism: The theory of constructivism itself comprehends a set of assertions that, together, form a set of theories about learning. The originator of these was Piaget, whose work on theories of learning led to the assertion that each individual learns by a process of interaction, that each individual holds an internal model of the world that is progressively 'reframed' — revised — to fit new information and experiences. Social constructivism builds upon this framework with a series of further assertions arising from the statement that each learner has unique needs and backgrounds. In short, learning is a situated process that takes place and is influenced by a social and cultural environment. It follows from this that within this framework, knowledge itself to some extent is both socially and culturally constructed. Understanding and use of language are dependent on a variety of factors, including context.

2) Socially shared cognition: Within the framework of socially situated cognition, the recognition is made that motives and task representations are fundamentally social; that is, the social context within which a cognitive activity takes place is an integral part of an activity. To study an activity in a given environment may not provide generalisable results, therefore; Lave ([7], in [9]) suggests that learning may be viewed as "moving from relative incompetence to competence within a particular situation of practice". Understanding the result of learning requires understanding of how and within which context the learning process takes place. [9].

Socially situated cognition suggests that internalised thought is not immune to this effect. Thus, decontextualisation is a difficult feat, even within the sciences (see for example [8]). Theories, reasoning and argumentation all show a similar effect. Again, it is worth stressing that this concerns the manner in which individuals reason, and is to a certain extent intuitive. Many of us will recognise the existence of *discourse communities*, for example; communities in which certain standards of speaking and writing are promoted and rewarded [9].

3) Implications for CSCW: Language as a tool is incomplete without a shared grounding of participants in the discussion. This process is facilitated by the existence of a shared set of experiences. Many concepts are generally shared, at least within a culture. Other more abstract concepts — where little information is available or where the concept is a consequence of interpretation — are treated differently. The process of interpretation is itself dependent on cultural background.

Tasks that are dependent on shared understanding of a relatively complex model may be said to be at a particular disadvantage, especially if it is the case that the model is not directly analogous to a set of concepts that are likely to be shared by all participants. Each participant in such a task must negociate a shared understanding — a process that is greatly complicated by distance, asynchronicity of communication channels (meaning that no immediate feedback is received), and other confounding factors such as cultural, social and linguistic differences.

A relevant example of such a task set is the development, use and reuse of a shared metadata schema and underlying data model.

Human factors in semantic encoding

There are also consistency issues which are explicitly to do with inconsistencies in the understanding of the semantic nature of a term. These sometimes occur due to a conscious repurposing, but may also result from a user–level reinterpretation of the term in question.

Differing interpretations of use

Whilst the artifact may appear from the designer's perspective to have a very clear set of use cases, the user's interpretation of the tool's use may differ.

In practice, an artifact designed for use in a given context may be reused in many others; in each use a knowledge set is built around that artifact, yet each community may conceive of it differently. Promoting a shared understanding of the model is an absolute necessity in eliciting high–quality input from contributors to the system. Again, it is important to restate that this is neither a new problem nor resultant from the peculiarities of the semantic web; it is a problem resulting from the difficulties of distributed collaborative work in general.

III. The "discount" Semantic Web

Considering a couple of today's "small–S semantic web" applications with respect to the model described above provides some interesting evidence. Such applications are relatively simple. For example, collaborative tagging places no burden on the user to provide accurate or unambiguous information, leaving the system to interpret the semantics underlying the instances of use of a given term and to sort the wheat from the chaff when indexing and ranking searches. Microformats by contrast place a small burden on the user or developer to read and correctly use the markup provided, but are designed to closely fit a real–world situation — for example, the calendar specification allows events to be described. The date and time at which an event starts and end are a matter of no debate, since they are not in any sense interpretive. Similarly, the microformat draft describing news

items does not admit a great deal of ambiguity. Even so, however, there are clear differences between applications of the draft, suggesting that different implementations have been designed by individuals who interpreted the draft differently.

A. Collaborative tagging

Free–text tagging is, typically, entirely unstructured in nature. There is no attempt to disambiguate between homonyms or homographs; a tag is merely a short segment of plain–text data provided by the user. A brief review of the uses of free–text tags is available in [1] and [4]. Tagging in this manner is recognised as an activity with low cognitive cost [11] and widespread appeal. Nonetheless, there is considerable discussion about the failings of the free–text tag. Each individual — either alone or within a community — tag in an individualised way (a clue as to the underlying mechanisms can be found in experiments such as the work reported by Krauss and Fussell [6]). For this reason, tags vary widely in usefulness as part of a search and retrieval exercise.

B. Microformats

There are as of the present time several microformat drafts. They are not as yet very widely used; however, there is a great deal of interest shown in their development. It is reasonable to spend a few moments examing the ideas behind microformats and the characteristics that add to the appeal of the specifications.

The microformats.org web site states the design philosophy clearly as "for humans first, and machines second". By this, it is meant that microformats are principally designed for ease of use. In reality, microformat specifications simply specify markup by which simple semantics in certain domains can be encoded within standard HTML web pages. Microformat drafts exist encoding a number of familiar specifications : hCalendar, based on iCalendar; hCard, a representation of the vCard standard; hAtom, based on a subset of the Atom syndication format, and so forth. It is notable in browsing these specifications that several are based around physical objects or familiar tasks or events. Microformats are designed according to the following philosophy [5], "Rather than creating schemas and formats based on a theoretical or idealistic view of how people should be publishing on the Web, with microformats we prefer to observe and standardize on common, emergent behavior."

IV. Usability Recommendations

A "discount" approach to the Semantic Web, then, is one that successfully marries the aims of the SW with acceptable usability of the resulting applications and artifacts. The above examples provide us with some idea of what such an approach might resemble. The designer of a system making use of user input or manipulation of semantically rich data is faced with a difficult trade–off; cognitive cost, confusion and inconsistency versus excessively contextualised and muddled data. The use of machine learning techniques and (traditional) semantic tagging on user input permits such data to be reused. The penalty for this may be the need for occasional interactions for repair, or for the elicitation of additional information. The result, however, is an interface that — at least to some extent — can be said to 'speak the user's language'.

There are a number of general heuristics that can be said to underly the design of discount, "small–S" semantic web technologies. These include the following :

A. Reduce cognitive load/cost

One outcome of the experiment described by Krauss and Fussell [6] is the suggestion that, in performing a task for oneself alone, one is required only to consider one's own underlying knowledge. Writing for others requires one to build up — or at any rate to utilise — a representation of the shared knowledge available to all participants. This implies that the latter may be a more complex process, and one with a higher risk of failure.

B. Use clear, unambiguous semantics

Clarity in modelling is difficult to achieve and maintain over time. The way in which we think about processes, tasks and artifacts may change over time. Models (statistically derived or overtly descriptive) generally require periodic revision. Examining real–world examples of uses of DC metadata, such as that of Dushay and Hilman [3], shows that certain elements in DC metadata appear to be more consistently applied than others. Eliciting the presence — and operation — of such apparently stable elements within the framework of a given task is part of the process of design and maintenance in a user–centred approach to development of user–facing SW applications.

C. Graceful handling of imperfect data

User input is often inaccurate or incomplete. Handling the tradeoff between accuracy and quantity of data is a design requirement that can often be built into the model at an early stage.

Handling data that is available, but in some way suspect — for example, it does not validate according to the relevant schema, or appears to be incorrectly formed according to evaluation by use of a relevant machine learning technique — can be accomplished by the use of markers explicitly built into the data model. This recommendation could be said to be largely equivalent to the use of a sandbox, as is used in wikis and elsewhere to provide a safe environment for users to take their first steps with the technology.

V. Conclusion

The uptake of Semantic Web technologies is limited by a number of factors, some real, some perceived. By application of a model based around the ideas of socially shared cognition, we have identified certain key difficulties faced by users in the use of a certain class of application, which intersects with the span of Semantic Web–based projects. However, by considering successful applications in other fields and examining popular related technologies, certain key similarities in approach may be identified. Examination of these provides a number of heuristics for development of SW applications, which share a reassuring similarity with a weighted subset of existing heuristics and practices designed to promote usability within a user–centred development process.

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