

Towards A Language Infrastructure for the Semantic Web

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1 Introduction

In recent years, the Internet evolved from a global medium for information exchange (directed mainly towards human users) into a “global, virtual work environment” (for both human users and machines). Building on the world-wide-web, developments such as *grid technology*, *web services* and the *semantic web* contributed to this transformation, the implications of which are now slowly but clearly being integrated into all areas of the new digital society (e-business, e-government, e-science, etc.) In particular, grid technology allows for distributed computing, web services for a distributed workflow, and the semantic web for increasingly intelligent and therefore autonomous processing.

In this, it is important to realize that the semantic web will function more and more as the man-machine interface of this “global, virtual work environment”. The underlying semantic web infrastructure of shared knowledge (ontologies) and markup of resources and services with such knowledge (ontology-based metadata) ensures that a common understanding will exist between the human user and the machine-based processes. However, as much

of human knowledge is and will be encoded in language, multilingual and multicultural aspects (culture as specific to countries, regions and nations, connected with language) will play an important role in establishing and maintaining such common understanding. Given these considerations, we emphasize the following two important issues in future semantic web development:

- **Making the semantic web accessible in many languages:** Authoring support for automatic knowledge markup should be available for many languages thereby avoiding that only documents in some languages will become part of the semantic web
- **Allowing the semantic web to represent many different cultures:** Ontologies should express concepts as used in different cultures, thereby avoiding that the semantic web would force an unnecessary semantic standardization. Therefore, tools for ontology adaptation and for mapping different ontologies should be an integral part of the semantic web infrastructure.

In both cases, there will be an important role for a combination of language technology, ontology engineering and machine learning, in order to provide text analysis for knowledge markup and text mining facilities for ontology mapping and learning. A growing integration of language technology tools into semantic web applications is therefore to be expected with the following characteristics:

- **Language Technology for the Semantic Web:** Language technology tools will be used for efficient, (semi-)automatic knowledge markup (based on information extraction) and ontology development (based on text mining), allowing web documents in many languages and from different cultural backgrounds to be integrated on a large scale within the semantic web.
- **The Semantic Web for Language Technology:** Semantic web methodologies (metadata, web services) and standards (RDF/S, OWL) will be used in the specification of web-based, standardized language resources – data (corpora, lexicons, grammars) and tools – allowing for a

distributed and widespread use of these resources in semantic web applications.

2 Language Technology for the Semantic Web

As human language is a primary mode of knowledge transfer, a growing integration of language technology tools into semantic web applications is to be expected. Language technology tools will be essential in scaling up the semantic web by providing automatic knowledge markup support (e.g. Amilcare, GATE, OntoMat, Melita, MnM) and facilities for ontology monitoring and adaptation (e.g. TextToOnto, OntoLearn, OntoLT). Obviously, it will then be of political and cultural importance that such authoring support for automatic knowledge markup will be available for many languages, thereby avoiding that only documents in some languages will become part of the semantic web.

Ontologies, as used in knowledge markup, are views of the world that tend to evolve rapidly over time and between different applications. Currently, ontologies are often developed in a specific context with a specific goal in mind. However, it is ineffective and costly to build ontologies for each new purpose each time from scratch, which may cause a major barrier for their large-scale use in knowledge markup for the Semantic Web. Creating ambitious semantic web applications based on ontological knowledge implies the development of new, highly adaptive and distributed ways of handling and using knowledge that enable existing ontologies to be adaptable to new environments. Besides time and place this also, quite importantly, includes adapting to different cultures, thereby avoiding an unnecessary process of semantic standardization.

3 Semantic Web Architecture for Language Technology

It is to be expected that semantic web methodologies (ontology-based metadata, web services) and standards (RDF, OWL) will be used in the specific action of web-based, standardized language resources – data (corpora, lexicons, grammars) and tools – allowing for a distributed and widespread use of these resources in semantic web applications. Therefore, platforms will be needed for the discussion, implementation and dissemination of semantic web standards and protocols for the syntactic and semantic interoperability of language tools and resources across languages, cultures and applications.

This work should build on and reinforce previous and ongoing national, European and world-wide projects and initiatives in this area within language technology, e.g. ENABLER (European National Activities for Basic Language Resources), ICWLR (International Committee for Written Language Resources), IMDI (ISLE Metadata Initiative), INTERA (Integrated European Language Data Repository Area), MILE (Multilingual ISLE Lexical Entry), ISO/TC37/SC4, LT-World, OLAC (Open Language Archives Community), OLIF (Open Lexicon Interchange Format), while taking into account emerging (semantic) web standards as specified within W3C or industry, e.g. RDF/S, OWL, TopicMaps, Web Services Choreography Group, DAML-S, JXTA.

5 Conclusions

Effective acquisition, organization, processing, sharing, and use of the knowledge embedded in multimedia content as well as in information- and knowledge-based work processes plays a major role for competitiveness in the modern information society and for the emerging knowledge economy. However, this wealth of knowledge implicitly conveyed in the vast amount of available digital content is nowadays only accessible provided that considerable manual effort has been invested into its interpretation and semantic annotation, which is possible only for a small fraction of the available content. Therefore the major part of the implicit semantic knowledge is not taken into account by state-of-the-art information access technologies like search engines, which restrict their indexing activities to superficial levels, mostly the keyword level.

Multilinguality and multicultural expression are important aspects of human society. Texts and documents are - and will be - written in various native languages, but these documents are relevant even to non-native speakers. We could imagine bypassing the multilingual problem by focusing directly onto knowledge itself, rather than on language, but in fact, human knowledge is and will be encoded in language, and multilingual and multicultural aspects (culture as specific to countries, regions and nations, connected with language) will play an important role in establishing and maintaining such common understanding. The Semantic Web must represent and structure concepts in multilingual and multicultural ontologies, which can be obtained only by linking conceptual nodes with the various language specific lexical realizations.

Given these considerations, we are proposing a global research and development effort on establishing a distributed, standardized and semantically inter-

operable infrastructure of language resources and tools, which would enable a widespread integration of multilingual analysis tools into semantic web services and applications.