Laying the foundation for the next-generation Web

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The Semantic Web lies at the heart of Tim Berners-Lee's vision for the future of the Web, enabling a wide range of intelligent services. Thanks to the development of the infrastructure needed for the large-scale deployment of ontologies as the bedrock of the Semantic Web, that vision is much closer to reality.

Ontologies provide the lifeblood of the Semantic Web by defining shared and common domain theories, and allowing people and machines to communicate more effectively. They also play a crucial role in enabling content-based access, interoperability and communication across the Web.

In the three years since the WonderWeb IST project began, it has managed to meet – and in some cases exceed – all of its key objectives. These achievements include standardisation of the OWL ontology language, the development of the KAON ontology-engineering environment, the development of the WonderWeb ontology library and the development of an ontology modularisation framework.

Significant results above and beyond the stated objectives of the project have also been achieved, according to project coordinator Professor Ian Horrocks. These include the development of techniques for the semi-automatic annotation of dynamic websites and the investigation of alternative reasoning techniques.

Towards standardisation

One of the more important contributions of WonderWeb to the ongoing development of the Semantic Web is the standardisation of the OWL ontology language, which is now a fully-fledged recommendation of the World Wide Web Consortium (W3C).

Explaining the significance of OWL, Ian Horrocks described it as a "Description Logic-based knowledge representation language," with the typical advantages of such languages. Among its benefits, OWL:

· supports modelling of the structure of the domain (the schema, or ontology) as well as the details of some particular situation (the data);

· is very powerful and allows for detailed and precise domain models (ontologies) to be captured;

· supports powerful data and schema level queries, e.g. find all men working at Manchester University whose boss is a woman (data) or is it possible for a man working at Manchester University to have a woman as a boss (schema);

· allows implicit information to be derived from explicitly stated facts about the schema and the data, e.g. a man working at Manchester University who is married to his boss could be inferred to be an answer to the above query even if the gender of the boss isn't explicitly stated (provided the schema (ontology) tells us that men can only be married to women).

"The important thing that OWL provides is a common standard for such a language with a precise formal specification," adds Ian Horrocks. "OWL is to knowledge management systems what SQL is to database management systems. This allows tool and ontology interoperability,

facilitates the rapid development of tools and infrastructure and gives users the confidence to devote major efforts to using OWL," he said.

An engineering toolkit

In terms of tools and services, an important result of the project has been the development of KAON, an ontology-engineering environment, which has been downloaded by over 14,000 users, and the integration of a wide range of software components such as editors and reasoners. A completely new inference engine has also been developed in order to improve reasoning services for OWL applications. The result is a powerful and extensible ontology development environment.

Complementing KAON and tools is the WonderWeb ontology library, a rich collection of foundational ontologies and domain specific extensions. The library includes the DOLCE, OCRE and BFO foundational ontologies, as well as extensions covering areas such as Web services, plans, and descriptions and situations. An influential review of the current state-of-the-art in ontology design methodologies has also been produced.

Underpinning further research

While acknowledging the technical difficulties that are part-and-parcel of any such project, Ian Horrocks said that it was gratifying to see so much of the fundamental research underpinning WonderWeb finding its way into other initiatives.

"This was a basic research project so feeding results through to applications involves the usual technology transfer problems such as tool building, scalability and developing 'industrial strength' infrastructure from research prototypes. This is already happening, however, with

ontology building tools such as Protege, which owes a lot to our pioneering work on the ontology editor OilEd, and commercial offerings such as those from Network Inference, which owes a lot to our work on reasoning infrastructure," he said.

WonderWeb has also exercised considerable influence on current EC-funded FP6 projects, with the Descriptive Ontology for Linguistic and Cognitive Engineering, DOLCE, being used by aceMedia, Metokis, Semantic Mining and SmartWeb, among others. Many projects are also using the KAON environment and tools.

Although WonderWeb has now officially run its course, the technologies brought to life by the project are very much alive and kicking.

"OWL is already very widely accepted and used, even in commercial offerings, and is the de facto standard in many domains, such as e-Science for example, that are not directly related to the Semantic Web," notes Ian Horrocks. "There are several extensions being discussed by W3C, and working groups have and are being established to take the work forward. For example there is a 'best practices' working group looking at application of OWL and RDF and a 'data access' working group looking at query languages and there is also going to be a W3C workshop on rules extensions to OWL in April with a view to starting up another working group," he said.

As for the Semantic Web, Ian Horrocks is optimistic that the vision is moving slowly but surely towards reality.
"The Semantic Web is still a research project, but the development of OWL and OWL-based infrastructure is seen as a huge success for Semantic Web research. This is now a major research community, and huge amounts of work are going into further developments," he said.

Source: IST Results

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