Services and the Web of Data: an unexploited symbiosis

Services and the Web of Data: An Unexploited Symbiosis*

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Abstract

The Web of Data is certainly a great success for data publication but the state of the art of the applications processing linked data is however not that outstanding. In this paper we highlight an unexploited symbiosis between Semantic Web Services and the Web of Data that could give birth to new families of highly advanced Web applications.

Background and Motivation

Over the past decade there has been considerable research activity in the area of Semantic Web Services (SWS). A number of ontology-based frameworks for describing services have been created (Martin et al. 2004; Fensel et al. 2007; Farrell and Lausen 2007). Up until now the impact of SWS on the Semantic Web has been minimal. In the Web context semantics are used to mark up a wide variety of data-centric resources but are not used to annotate online functionality in any form in significant numbers. The reasons for this are two-fold. Firstly, SWS research has for the most part targeted WSDL/SOAP-based Web services (Erl 2007) which are not prevalent on the Web (Davies et al. 2009). Secondly, due to the inherent complexity required to fully capture computational functionality, creating SWS descriptions has represented an important knowledge acquisition bottleneck and has required the use of rich semantic languages and complex reasoners.

In parallel, much research on the Semantic Web has lately been devoted to creating what is referred to as the Web of Data. The Web of Data is based upon a set of linked data principles and provides publicly large amounts of interconnected data across a wide range of topics described in terms of lightweight ontologies (Bizer, Heath, and Berners-Lee 2009). Despite the outstanding evolution so far, most linked data applications solely gather data from different sources and display it alongside each other (Bizer, Heath, and Berners-Lee 2009).

We believe that SWS and the Web of Data can mutually alleviate some of the current limitations hampering each other. In this short paper we highlight the potential benefits from integrating both worlds and where appropriate, we outline how we are currently addressing these aspects.

Services in the Web of Data

A fundamental tenet of Service-Oriented Architectures is the notion of service repositories for programmatic access and discovery of suitable services. Enhancing repositories with semantics has been one of the key issues of SWS research (Sycara, Paolucci, and Srinivasan 2003). However, the largest public SWS repository is probably still OPOSSum, a test collection with less than 3000 service annotations. It provides programmatic access to its content solely through direct access to the database management system (Küster and König-Ries 2008).

Before any significant uptake of SWS technology can happen, proper mechanisms for publishing SWS must be in place. In this respect, the evolution of the Web of Data shows that i) lightweight ontologies together with the possibility to provide custom extensions prevail against more complex models; ii) linked data principles are an appropriate means for publishing large amounts of semantic data, both for human and machine consumption; iii) links between publicly available datasets are essential for the scalability and the value of the data exposed.

We believe that publishing SWS descriptions should follow the successful principles that drive the Web of Data. So far, our work builds upon lightweight RDF(S) ontologies, namely WSMO-Lite (Vitvar et al. 2008) and MicroWSMO (Maleshkova, Kopecký, and Pedrinaci 2009). WSMO-Lite extends SAWSDL with a simple vocabulary for describing semantic annotations for services such as preconditions, effects, functional classification, and non-functional properties. MicroWSMO provides a microformat-like mechanism for annotating Web APIs and RESTful services.

Alongside WSMO-Lite and MicroWSMO we have developed iServe[1], a platform for publishing SWS as linked data, no matter their original format. Currently iServe supports the publication of SAWSDL, WSMO-Lite, MicroWSMO, and partially OWL-S service annotations as linked data after (partial) transformation into RDF. iServe adopts linked data principles to enable humans and machines to discover and use services via a Web API and a SPARQL endpoint.

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[1] See iserve.kmi.open.ac.uk

Since knowledge-acquisition has been a significant bottleneck for SWS technologies, we are devoting much effort to creating tools that support users in the annotation of services by leveraging the Web of Data as a source of background knowledge (e.g., the Web API annotation tool SWEET (Maleshkova, Pedrinaci, and Domingue 2009)). The acquisition of service annotations is in this way simplified while at the same time links between service annotations and the Web of Data are established, paving the way for linked data application developers to locate interesting services in a simple manner (e.g., based on the input and output types of services).

Services for the Web of Data

Services as well-defined, independent and distributed pieces of functionality are a very powerful means for developing distributed systems (Erl 2007), which, when it comes to an environment like the Web, appears as a highly appropriate (if not necessary) construct. Services can contribute to the Web of Data in two fundamental ways. First, services can enable the provisioning of additional linked data dynamically by exposing legacy systems. For instance, there is a large body of information behind RESTful services, or offered by sensors that still remain within controlled silos and expressed in formats that do not follow linked data principles. Execution frameworks based on annotations of existing Web APIs and WSDL services would enable a new means for unleashing valuable data on demand. Second, we previously highlighted the fact that most linked data applications are essentially providing integrated views of distributed data without exploiting the deeper value of the Web of Data. Application developers could conveniently combine services at runtime to carry out computations as simple as unit transformations, more complex as deriving similarities between things based on the reviews published by different users on Revyu.com, or even more advanced as envisioned for the Semantic Web from the very beginning. These services, however, should be able to consume RDF data, carry out the concrete activity they are responsible for, and return the result in RDF as well. In this respect, the languages and technologies presented in the previous section provide a solution for annotating, exposing, and discovering this kind of services easily. In a sense, we propose an activated realization of semantic mash-ups (Phuoc et al. 2009) with the difference that services may range from RDF-specific manipulation up to highly complex processing beyond data fusion, and they can in turn be published, shared and reused.

Conclusions and Discussion

The Web of Data is certainly a great success in terms of data publishing, however, the state of the art of the applications processing linked data is not that outstanding. We believe that there is an unexploited symbiosis between SWS and the Web of Data that could give birth to new families of highly advanced Web applications. The Web of Data currently represents the most appropriate environment for the annotation, publication and exploitation of SWS. Conversely, SWS can provide the appropriate constructs better allowing the development of advanced linked data applications. The vision sketched herein has been further refined and discussed in (Pedrinaci, Domingue, and Krummenacher 2009) including ideas from prior research on Knowledge Engineering and Artificial Intelligence, and additional architectural concerns such as the need for supporting data updates and notifications have to be investigated. These are in our opinion essential features for the systematic engineering of complex intelligent systems over the Web of Data.

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