

## Chapter 8.2

# Explaining Semantic Web Applications

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### ABSTRACT

In this chapter, we introduce the concept of explanation for Semantic Web applications by providing motivation, description, and examples. We describe the Inference Web explanation toolkit that provides support for a broad range of explanation tasks ranging from explaining deductive reasoning, to information extraction, to hybrid integrated learning systems. We argue that an explanation solution such as the one we endorse is required if we are to realize the full potential of hybrid, distributed, intelligent Web agents that users can trust and use.

### INTRODUCTION

Question answering on the Semantic Web (SW) typically includes more processing steps than database retrieval. Question answering can be viewed as an interactive process between a user and one or more intelligent software agents. Using queries, user preferences, and context, intelligent agents may locate, select and invoke services and, if necessary, compose these services to produce requested results. In other words, the web paradigm shifts from one where users mainly retrieve explicitly stated stored information to a paradigm where application results are answers to potentially complex questions that

may require inferential capabilities in addition to information retrieval. Web applications with question answering capabilities may still use information retrieval techniques to locate answers, but they may also need to use additional semantics such as encoded term meanings to support additional methods of information access (such as targeted database queries or knowledge base queries) along with information manipulations (such as reasoning using theorem provers, or inductive or deductive methods). Examples of this new, more complex reality include the automatic composition of web services encoded in OWL-S or semi-automatic composition of services as provided by workflows. Ontology-enhanced search is another example of how Semantic Web technology can provide and is providing new directions for a category of “smart” search applications. Many other SW applications are emerging with a common theme of increasing knowledge and autonomy. This new context generates an additional requirement for effective use of SW applications by typical users: *applications must provide explanation capabilities showing how results were obtained*. Explanations are quickly becoming an essential component in establishing agent credibility (e.g., Glass et al, 2008) and result credibility (e.g., Del Rio and Pinheiro da Silva, 2007) by providing process transparency, thereby increasing user understanding of how results are derived. Explanations can also identify information sources used during the conclusion derivation process. In the context of the SW, explanations should be encoded in a way that they can be directly or indirectly consumed by multiple agents, including both human users and software systems.

In this chapter we describe explanation as a special kind of pervasive SW functionality, in the sense that a SW application may need to provide transparency concerning its results. We first analyze some distinct application paradigms in the SW context, and for each paradigm we identify explanation requirements. We then describe a general framework, called Inference Web (IW)

(McGuinness and Pinheiro da Silva, 2004) that includes the Proof Markup Language (PML) (McGuinness, et al., 2007, Pinheiro da Silva, McGuinness, Fikes, 2006), a modularized ontology describing terms used to represent provenance, justifications and trust relations. IW includes a set of tools and methods for manipulating PML-encoded result justifications. Using Inference Web, and its PML interlingua, applications may provide interoperable and portable explanations that support intelligent, interactive application interfaces. After the description of the IW framework and the PML interlingua, we will exemplify how PML and IW have been used to explain the results and behaviors of a wide range of applications including intelligent personal agents, information extraction agents, and integrated learning agents.

## A CONCEPTUAL FRAMEWORK FOR EXPLAINING RESULTS FROM SEMANTIC WEB APPLICATIONS

We investigate the correspondence between SW application paradigms and their explanation requirements.

### Semantic Web Application Characterization

SW applications are geared to take advantage of vast amounts of heterogeneous data with potentially varying amounts of semantic markup. They concentrate on identifying and meaningfully combining available semantic markup in order to derive complex results. Below we briefly characterize the SW applications features considered important from an explanation perspective: collaboration, autonomy, and use of ontologies.

### Collaboration

Collaboration requires agents to interact and share knowledge with the common goal of solv-

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