New Approaches to Semantic Web Service Discovery: Provenance, Annotations, and ESIP

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Abstract

Semantic web services utilize semantic markup to enable machine-readable service descriptions and automated discovery.

Despite the many advances in this research area there are still several open questions, especially in regards to e-Science applications.

We highlight some of these challenges and discuss our work in this area. Possible applications within ESIP and using the author's role as Student Fellow to evaluate this research are highlighted.

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Background

Web Service - application that can be used automatically by a computer on behalf of a user.

Web Services "provide a standard means of interoperating between different software applications, running on a variety of platforms" *

* W3C, 2004 - http://www.w3.org/TR/ws-arch/

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Background

- XML-based standards of web services encode only syntactic representation of what is expected
- Using only syntax is intractable for computers. Web Services leave a number of manual tasks for developers and users (Kopecky and Simperl, 2008)

Semantic Web Service – web service that applies semantic markup such that the meanings of service components is machine understandable

Semantic Annotations for WSDL and XML Schema (SAWSDL)

- recent W3C standard (2007)
- annotates WSDL file with links to semantic markup

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Background

Prominent Semantic Web Service Research

- Web Service Modeling Ontology (WSMO, Lausen et al., 2005)
- OWL-S (Ankolenkar et al., 2002)
- Semantic Web Services Framework (SWSF, Battle et al., 2005)
  - SWSF never developed any implementations or tool support (Herold, 2008) and is expected to remain only a theoretical contribution (Fensel et al., 2006)

OWL-S vs. WSMO

- OWL-S is a description language
- WSMO is a complete framework
- Both are currently being augmented to work with SAWSDL as they predate SAWSDL's release

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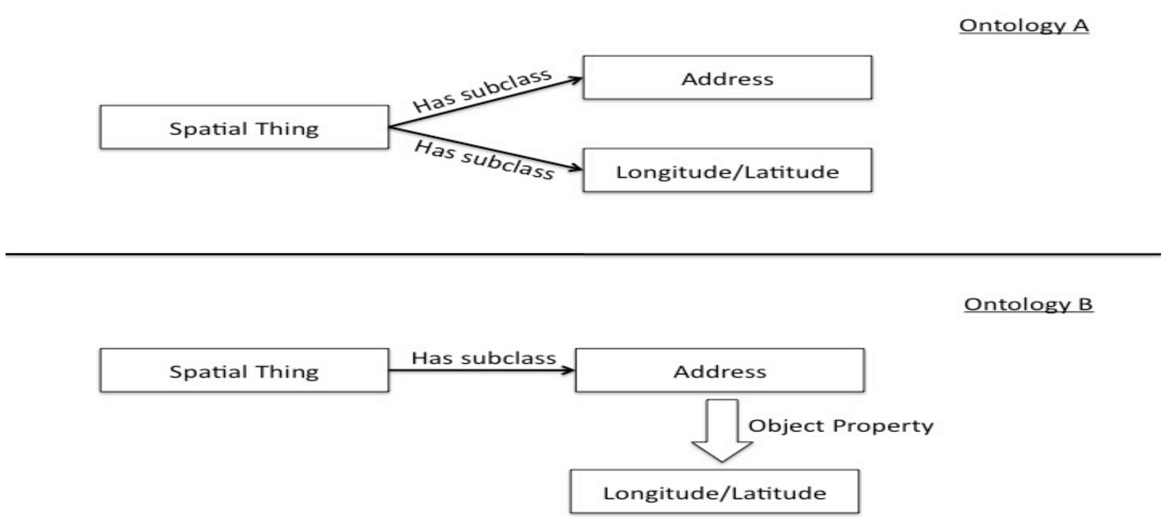
Background

Discovery Algorithms – OWL-S

- OWL-S implementations use variations of the Zaremski and Wing (1997) algorithm
- Hybrid approaches extend this with information retrieval techniques (Klusch et al., 2005; Mikhaiel and Stroulia, 2006)
- Algorithm is susceptible to ontology design



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Background

Discovery Algorithms – WSMO

- WSMO used its own language that allowed the writing of formal logic statements (Keller et al., 2004)
- Allowed more expressive queries than the Zaremski and Wing (1997) algorithm
- Used an automated deduction system (theorem prover) to compare queries against service descriptions
- WSMO is now evolving toward SAWSDL methodology (Kopecky and Simperl, 2008)

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Limitations

- Neither OWL-S nor WSMO fully address how a service operates – focus is primarily on inputs and outputs
- There is a need to better describe what a service is doing (Chen and Jiao, 2006)
  - “Discovery” is often a two-step process with second-step being manual inspection of capabilities (Stollberg, 2008)
  - Lack of such information can easily lead to using different algorithms and settings that generate results of varying quality (Chen and Jiao, 2006)
  - Lack of provenance information in web applications has been linked to distrust (Li et al, 2010)
- Semantics are becoming a part of science (Fox and Hendler, 2009; McGuinness et al., 2009)
- There is a need for user supplied feedback to web service – annotations (Chen and Jiao, 2006)
- User evaluations have shown (Toch et al., 2011) that Zaremski and Wing (1997) method is not how humans view service similarity

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Proposed Solution

Service Provenance - the information required to fully understand a web service. This includes applications invoked, methodologies used, actions and settings invoked, and any assumptions and hypothesis involved.

This is an extension of traditional data provenance

We hypothesize that capturing service provenance, and using it in the discovery process, leads to a better understanding of service functionality by end users and increased decision quality.

Proposed Solution

Service Provenance Ontology =
PML Ontology + W7 Model

Proof Markup Language (PML) – provenance ontology that provides justification capabilities

W7 Model – a provenance model designed to describe the history of data

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Proposed Solution

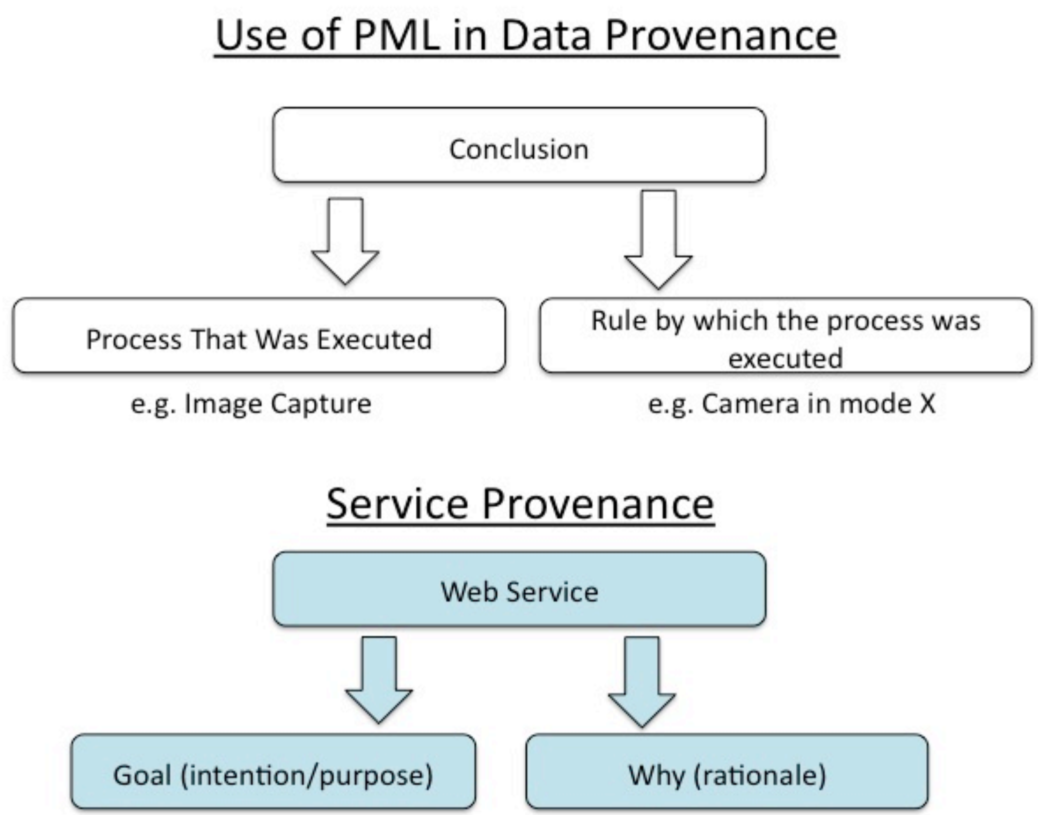
Why a new ontology?

- Existing provenance ontologies only cover a portion of required service provenance capabilities

- OWL-S has no standard means of querying over quantities that are not inputs/outputs (SPARQL vs. SWRL)

- WSMO criticized for being too heavy-weight. New WSMO-Lite has no discovery mechanism

Proposed Solution

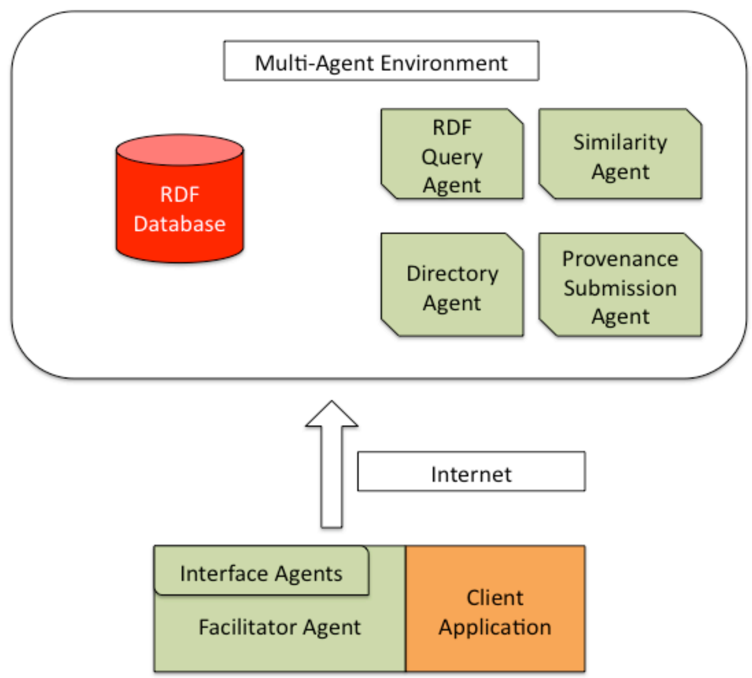


Proposed Solution

- Service Provenance Ontology will be utilized in a multi-agent system that becomes part of informatics infrastructure

- Provides service registration and discovery functionality

- Social nature of agents would facilitate the communication and coordination needed for user applications



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Proposed Solution

Adding a social component - Annotations

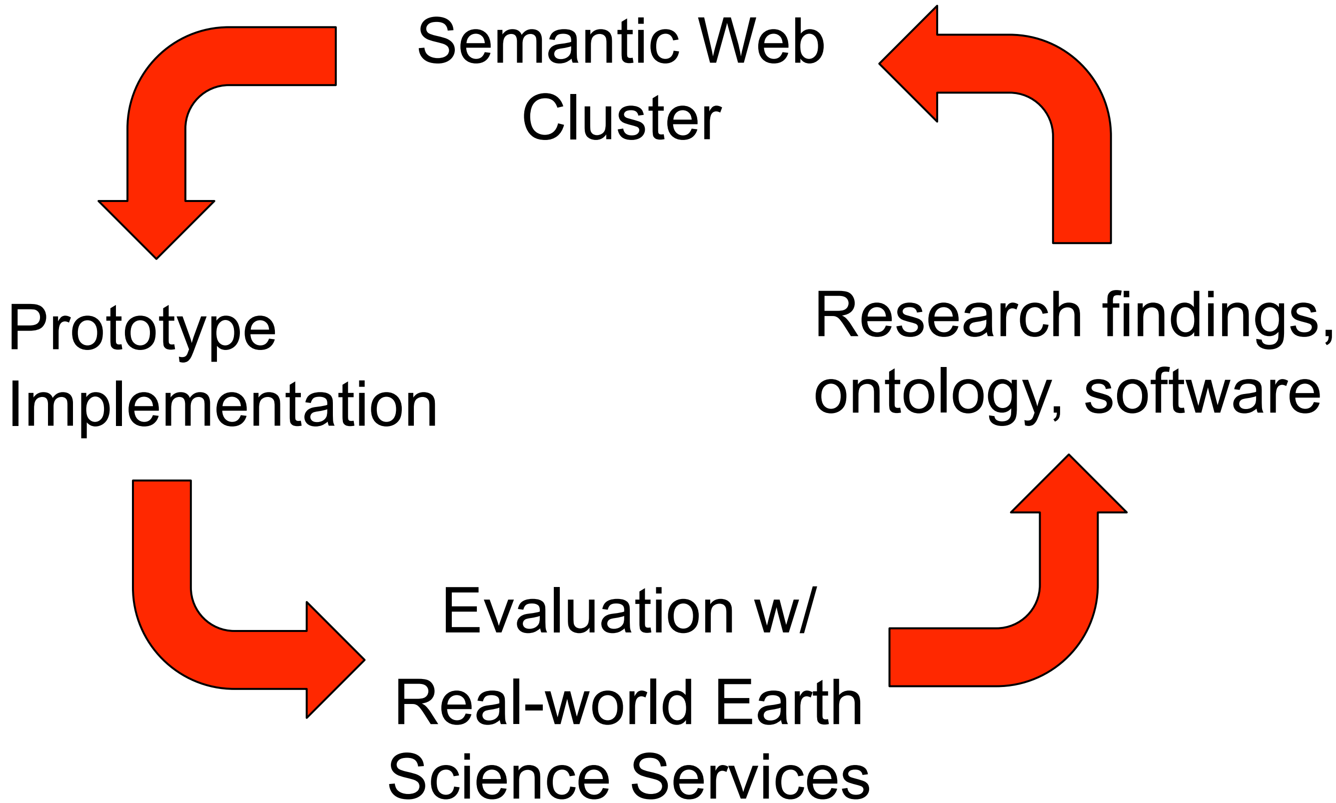
- Web service discovery could benefit from allowing user feedback (Chen and Jiao, 2006)

- This has not yet been explored in-depth

- We would like to utilize the PML-A ontology being developed at RPI to allow users to semantically annotate web service descriptions.

ESIP

How I’d like to use Student Fellowship role
with Semantic Web Cluster



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