On the broad applicability of Semantic Web technologies

(a personal journey)

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Speaker background

Co-author of the original RDF specification (1999) and the seminal article on the Semantic Web (2001)

Elected member of W3C's Advisory Board 1998-2013

Research interests:

- KR for agents, ubiquitous computing (IoT), context-awareness
- graph queries and reasoning
- software abstractions and patterns for KR and graphs

Education: Helsinki University of Technology

- M.Sc on frame-based KR (resulting software flew on NASA "Deep Space 1")
- Ph.D on path queries and reasoning in RDF

Semantic Web: a new vision of the Web?

Why?

- original Web facilitated sharing of documents, but not really sharing of data

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~~Semantic Web: a new vision of the Web?~~

Semantic Web: KR for the Web?

Why?

- metadata
- digital libraries
- better search results
- etc.

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~~Semantic Web: a new vision of the Web?~~

~~Semantic Web: KR for the Web?~~

Semantic Web: KR using Web technologies!

Why?

- well understood, lots of software support, widely deployed
- “networking friendly” (HTTP goes through firewalls, etc.)
- prevailing mindset of distributed systems
- etc.

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Semantic Web: KR using Web technologies!

Represents a different take on standardization

- semantics: specify “how to say it”, not “what to say”

The key aspect of the Semantic Web is serendipity

- solution for use cases yet to be articulated
- “delayed semantic commitment”

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DAML-S

A. Ankolekar, M. Burstein, J. Hobbs, O. Lassila, D. Martin, S. McIllraith, S. Narayanan, M. Paolucci, T. Payne, K. Sycara, and H. Zeng: "**DAML-S: Semantic Markup for Web Services**", SWWS'01

Part of the DARPA Agent Markup Language (DAML) effort

- DAML (the program) was DARPA's take on the Semantic Web
- DAML (the language, later DAML-ONT) was the predecessor of OWL
- DAML-S ("DAML for Services") was later renamed OWL-S

Ontological modeling of (Web) Services to enable automatic

- service discovery
- service composition
- service invocation & monitoring

Process models, pi-calculus, temporal reasoning, …

Also: autonomous agents

My team's work at Nokia Research (1998-2005)

Focus: applying Semantic Web technologies to mobile & ubiquitous computing

DAML-S & our main hypothesis:

1. expose device functionality as services
2. describe these services using ontologies and DAML-S
3. perform service discovery and service composition

Result: **device collaboration and orchestration**

Use cases and experiments:

- *ad hoc* device connectivity in ubiquitous computing environments
- reactive reconfiguration of devices in case of failures/outages

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Problems with DAML-S/OWL-S (my take)

Devil's Advocate view: *This is just WSDL with a different syntax…*

- DAML-S descriptions were verbose and complex
- at Nokia, we designed a simplification of DAML-S called "DAML-S Lite"

Describing the semantics of any functionality is a difficult issue

- DAML-S called this "service profiles"
- we anticipated the emergence of a classification taxonomy for services

Generally, WSDL/SOAP/WS-* was a disaster

- incredibly complex stack of specifications

Why are Semantic Web technologies attractive?

1. Data semantics not defined by code & applications
2. Self-describing data with accessible semantics
   - remember: **accessible data = physical bits + semantics**
3. Procedural → declarative
4. Serendipity
5. Graph-based representation is intuitive
   - (“I can explain this to a 7-year old”)

NB: Outside popular non-symbolic AI methods, the Semantic Web technologies are the embodiment of what we wanted to do before the “AI winter”

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My work after DAML-S

Ontology-based policy description, application in untraditional domains

- policies as a descriptions of “desired behavior”
- “do not disturb” → access control policy for user attention, etc.

Context-awareness cast as a DL classification problem

- contexts as classes

Also: combine symbolic reasoning with non-symbolic methods for detecting context

Smarter, less intrusive mobile devices

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My work after DAML-S

Semantic Web technologies as a means of better data integration between mobile devices and back-end services

- separating applications from data
- applications as a manifestation of "user intent"

Ontological description of data (Big Data datasets)

- capture semantics
- "democratization of data"
- privacy [Oliver 2014]
- housekeeping, ETL, provenance, …

Better management of data for mobile devices and mobile services

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data catalog

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Better management of data ~~for mobile devices and mobile services~~

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Better management of data?

Modern enterprise data practice is messy

None of the mainstream solutions will actually get us out of the mess

We need a unifying logical representation for data (and semantics)

Semantic Web technologies have the potential of being that representation

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What is still difficult? (20+ years into all this…)

Software abstractions and access patterns for graphs and ontologies

- “the trouble with triples”
- supporting ontologies in your code
- queries (yes, really)

Data expressiveness vs. user interface expressiveness

Graph as a logical representation vs. graph as a data structure

RDF vs. LPGs confusion

- RDF-star?
- in the Neptune team we are working on mitigating this (project “OneGraph”)

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What is still missing?

Enterprise knowledge graphs have arrived, but…

What about personal knowledge graphs?

- management of notes, bookmarks, etc.
- recording ”associations”
- generally, easier access to your data (as a whole)
- why did the “semantic desktop” effort fail?

Tight integration between RDF data and code

Better ways to combine symbolic and non-symbolic reasoning

- can we generalize on the idea of reasoning?

Thank you!

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