On the broad applicability of Semantic Web technologies
(a personal journey)

Dr. Ora Lassila
Principal Technologist
Amazon Neptune
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
Semantic Web: a new vision of the Web?

Semantic Web: KR for the Web?

Why?

• metadata
• digital libraries
• better search results
• etc.
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.
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 sharing
- etc.
Semantic Web: a new vision of the Web?

Semantic Web: KR for the Web?

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”
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
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”*
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
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
My work after DAML-S

Semantic Web technologies as a means of better data integration between mobile devices and backend 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
My work after DAML-S

Semantic Web technologies as a means of better data integration between mobile devices and backend 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
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**
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”)
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!

**Email:** ora@amazon.com

**Twitter:** @oralassila