The Semantic Web-on the respective Roles of XML and RDF

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What is this paper about?

- Give an introduction to the semantic web and the work that needs to be done over the RDF data model
- Sources.
  - w3.org
  - Ora Lassila's slides

How we are going to go today

- What is the semantic web?
- What is an ontology?
- XML
- RDF
- Why RDF is better than XML
- RDF alone is not enough..

What is the Semantic Web?

- Aims at machine processable information
- This means..
- Machine's ability to solve a well-defined problem by performing well-defined operations on existing well-defined data (not AI!)

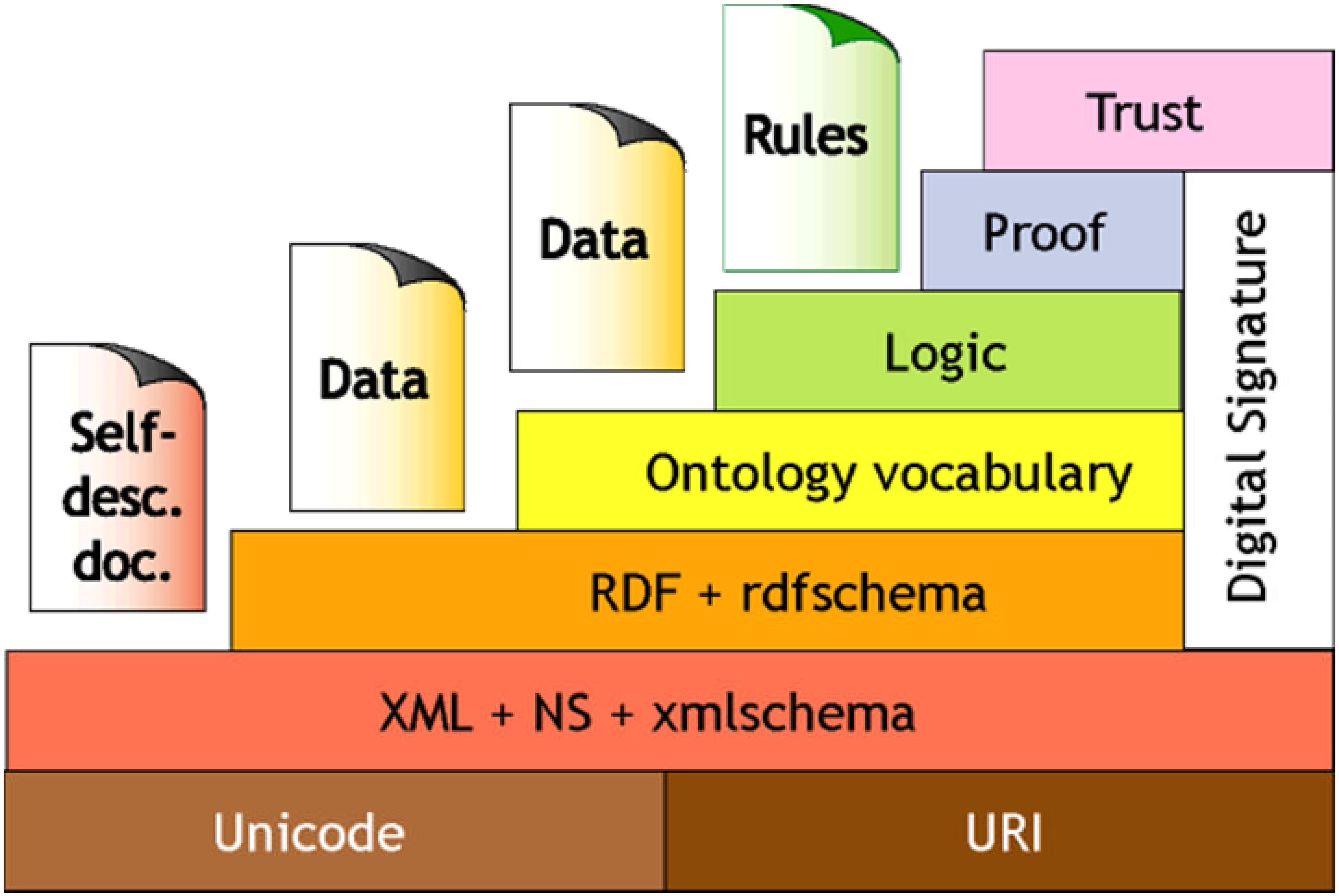
Why Semantic Web?

- To date, the World Wide Web has developed most rapidly as a medium of documents
- Information Overload
  - Information on the Web currently aiming at Human Consumption
- Search Engine fail more and more
  - Combined coverage is less than 42% of the HTML-Web
- Data interchange growing
  - Needs a common semantics

Why Semantic Web? Cont'd

- Make Web information practically processable by a computer
- Underlying this is the goal of making the Web more effective for its users (hotbot)
- Make a user's life easier by the aggregation and creation of new, trusted information over the Web

Tim Berners- Lee's Vision of Semantic Web



Relevance toDatabases

- Similar problems to Distrbuted Databases
- Well..not similar in the sense that we aren't worrying about sharing rows or duplicating copies..infact we are concerning ourselves with machine processable information
- BUT, similar issues as in we need a master ontology, we have issues with scaling. As of now, we have to assume co-operation and trust since these layers haven't been implemented yet.

We need: Syntactic Interoperability

Enabling heterogeneous components to interact.

- Bridge mismatches in:
  - Data formats.
  - Language mechanisms
  - i.e parse any data

And..Semantic Interoperability

- Ability to agree on the *meaning* of data and operations.

Ontologies

An ontology:

An 'Ontology' is an agreed on, shared, common understanding of a domain written as an explicit, formal specification.

Ontologies

- It is clear that a semantics based web in general will be very useful.
- Yahoo,hotbot are search engines based on semantics (metadata, i.e label)

An Example Ontology

```
class-def animal
class-def plant
    subclass-of NOT animal
class-def defined carnivore
    subclass-of animal
    slot-constraint eats
        value-type animal
```

XML

- To store, carry and exchange data.
- Case sensitive, nesting must be exact and attributes must have quotes.
- The legal building blocks are defined by DTDs. A valid XML is one that is validated against a DTD.
- XML Schemas should soon replace DTDs: can extend restrict types to form subtypes.

Uses of XML

- XML can make your Data more Useful
- With XML, your data is available to more users.
- Since XML is independent of hardware, software and application, you can make your data available to other than only standard HTML browsers.

XML and Semantics

- XML Documents do not have semantics
- One uses XML to define an XML language adhering to a particular DTD
- XML documents can have semantics only by convention
- Implicit Semantic agreement on paper within a community of users for a particular domain data

- author> <uri>page</uri> <name>Ora</name> </author> or
- <document href="page"> <author>Ora</author> </document> or
- <document> <details> <uri>href="page"</uri> <author> <name>Ora</name> </author> </details> </document>

So..

Requires pre-arranged agreement

Only feasible for closed collaboration

- agents in a small & stable community
- pages on a small & stable intranet

not for sharable Web-resources

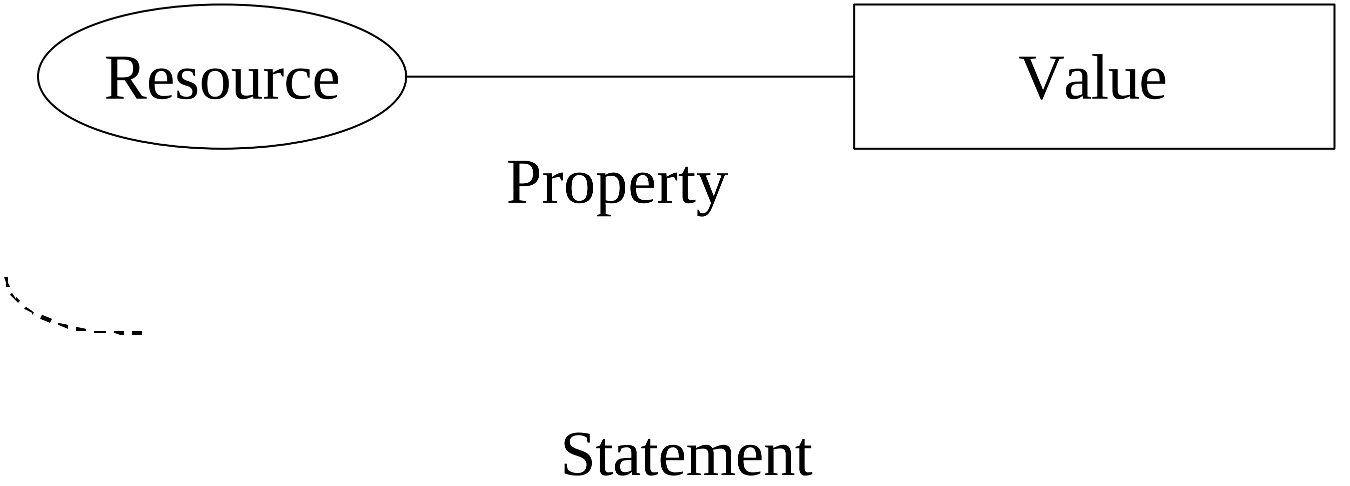
RDF

- RDF is a data model
  - the model can be viewed as directed, labeled graphs or as an object-oriented model (object/attribute/value)
  - the specification provides an encoding (in XML) of the model
  - RDF data model is an abstract, conceptual layer independent of XML

RDF

- The RDF structure is based on the three main concepts: a **resource**, a **property**, and a **statement**.
- A resource is any web page that can be identified with the URI.
- A property is a resource with a name, such as **Title**.
- A statement is a resource, a property, and a value.

RDF Model Primitives



Example

- *Ora Lassila is the creator of the resource http://www.w3.org/Home/Lassila.*
  - Subject(Resource): http://www.w3.org/Home/Lassila
  - Predicate (Property): Creator
  - Object (literal/value): "Ora Lassila"

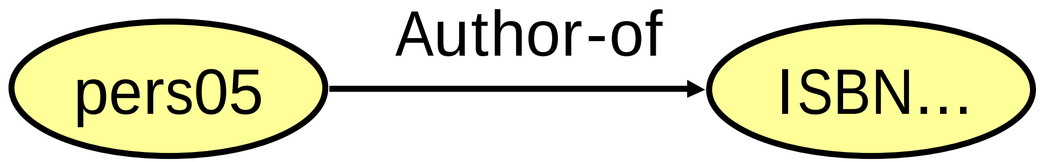
More examples

Resource (Subject)	Property (Predicate)	Value (Object)
"War and Peace"	Author	"Leo Tolstoy"
http://www.ccil.org/~cowan	MIME Type	"text/html"
http://www.ccil.org/~cowan/XML	Parent	http://www.ccil.org/~cowan

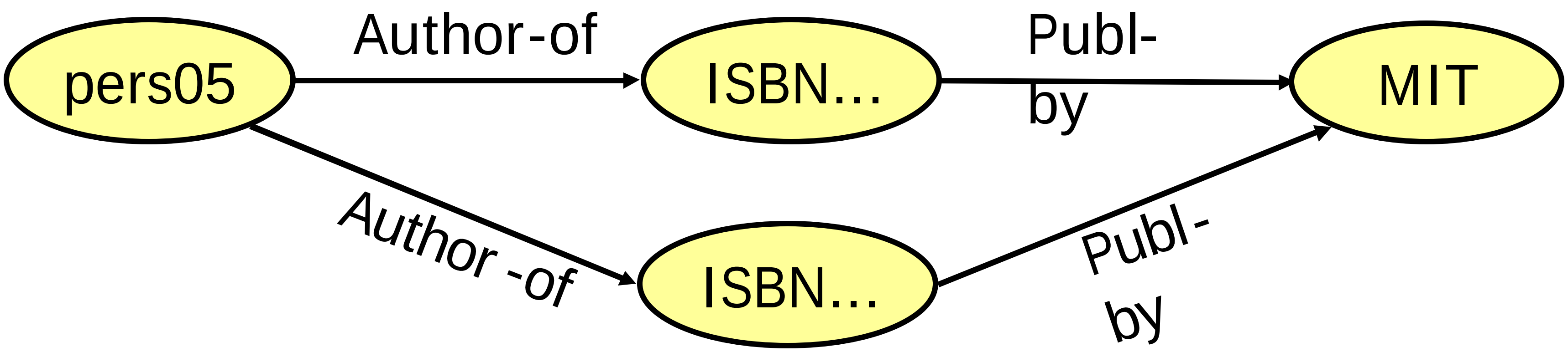
Also as OO

- RDF provides metadata about Web resources
- Object -> Attribute-> Value triples

- Object --Attribute-> Value triples



- objects are web-resources
- Value is again an Object:
  - triples can be linked
  - data-model = graph



RDF example

RDF ~ set of (Resource, Property, Value)

"The Author of
http://scom.hud.ac.uk/scomtlm/Artform/planning.html
is Lee McCluskey."

IN RDF:

<rdf:Description about=
http://scom.hud.ac.uk/scomtlm/Artform/planning.html'>
<Author> Lee McCluskey </Author>
</rdf:Description>

Resource, Property, Values can all have URI's

We need an RDF Schema

- What *vocabulary* should we use ("Contains", "ChartType", etc)?
- Add traditional datatypes to RDF
  - the value of the property labeled should be a boolean *in the mathematical sense*
- Use RDF Schemas for the basic vocabulary
  - what properties can be used?
  - what resources the properties can be applied to?

RDF Schema

- So, RDF :
  - (very small) commitment to modeling primitives
  - but: no commitment to domain vocabulary

⇨ **RDF Schema**

- Define vocabulary for RDF
- Organize this vocabulary in a typed hierarchy
  - **`Class, SubClassOf, type`**
  - **`Property, subPropertyOf,`**
  - **`domain, range`**

RDF and RDFS Properties

Property name	Comment	domain	range
rdfs:isDefinedBy	Indicates the namespace of a resource	Resource	Resource
rdf:subject	The subject of an RDF statement.	Statement	Resource
rdf:predicate	the predicate of an RDF statement.	Statement	Property
rdf:object	The object of an RDF statement.	Statement	Not specified
rdf:type	Indicates membership of a class	Resource	Class
rdfs:member	a member of a container	Container	Not specified
rdfs:subClassOf	Indicates membership of a class	Class	Class
rdf:value	Identifies the principal value (usually a string) of a property when the property value is a structured resource	Resource	Not specified
rdfs:subPropertyOf	Indicates specialization of properties	Property	Property
rdfs:comment	Use this for descriptions	Resource	Literal
rdfs:label	Provides a human-readable version of a resource name.	Resource	Literal
rdfs:domain	A domain class for a property type	Property	Class
rdfs:range	A range class for a property type	Property	Class
rdfs:seeAlso	A resource that provides information about the subject resource	Resource	Resource

RDFS and RDF

- <rdfs:Class rdf:ID="Teacher"> <rdfs:comment>Teacher Class</rdfs:comment> <rdfs:subClassOf rdf:resource="#Person"/> </rdfs:Class>

- <teacher> <Teacher rdf:ID="jp"> <name>John Punin</name> </Teacher>

- Usually, schema link to
- http://www.w3.org/2000/01/rdf-schema#

RDF & RDFS

- Provide a data model and syntax convention for representing the semantics of data in standardized interoperable manner
- Describe relationships among resources
- RDFS – Minimal ontology modeling language, object oriented type system

Comparitive XML Schema drawbacks

- XMLS can extend/restrict types to form subtypes but still no concept of inheritance
- A union of possible types for an element is possible with the <*union*> tag , and this is not possible in RDF. However, RDF uses bags which allow for unordered collections. Moreover, the higher levels (like OWL) support unions.

Why RDF(S) Is Not Enough

- Expressive inadequacy
  - Only range/domain constraints (on properties)
  - No equivalence, disjointness, coverings etc.
  - No necessary and sufficient conditions (for class membership)

Extending RDF Schema

Goal

- make RDFS useable as ontology language
  - give RDF(S) precise semantics
  - extend RDF(S) with additional modeling primitives

Procedure

- formulate ontology language as RDF Schema document
  - using existing primitives as much as possible
  - placing additional primitives in the hierarchy of RDFS primitives

Ontology Inference Layer (OIL)

- Sponsored by European Union IST programme for Information Society Technologies

How DAML+OIL Builds ON RDFS

- Extends expressive power
  - Constraints (restrictions) on properties of classes (existential/universal/cardinality)
  - Boolean combinations of classes and restrictions
  - Equivalence, disjointness, coverings
  - Necessary and sufficient conditions
  - Constraints on properties

OIL (now DAML+OIL)

- Similar to RDFS in providing infrastructure to allow machines to make inferences

  Given

  ```
  (motherOf subProperty parentOf)
  (Mary motherOf Bill)
  ```

  when stated in OIL, allows you to conclude

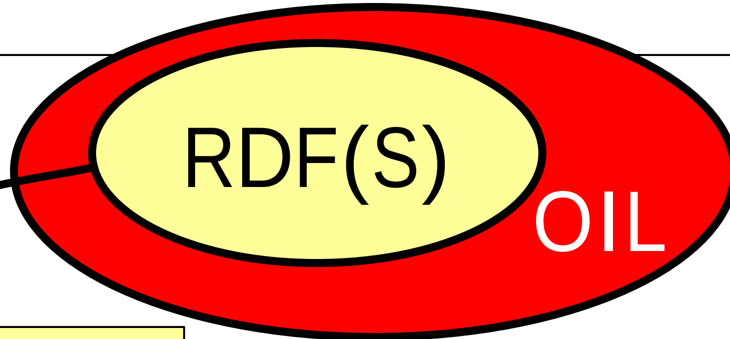
  ```
  (Mary parentOf Bill)
  ```

- RDFS is limited in expressiveness that OIL addresses

How does OIL translate to RDF

- Simply map OIL to RDF vocabulary

OIL	RDF
Class-def	rdfs:Class
Subclass-of	rdfs:Subclass
Slot constraint	Subclass expressions in RDF-OIL
AND, ","	oil:AND
Has – value	Oil:has - value



- class-def
- subclass-of
- slot-def
- subslot-of
- domain
- range

- class-expressions
  - AND, OR, NOT
- slot-constraints
  - has-value, value-type
  - cardinality
- slot-properties
  - trans, symm

Language Feature Comparison

	XML DTD	XML Schema	RDF(S)	DAML+ OIL	RDF(S) 2002
bounded lists				X	X
cardinality constraints	X	X		X	
class expressions				X	
data types		X		X	?
defined classes				X	
enumerations	X	X		X	
equivalence				X	
extensibility			X	X	X
formal semantics				X	X
inheritance			X	X	X
inference				X	
local restrictions				X	
qualified constraints				X	
reification			X	X	X

What did we get?

- Any RDF agent can
  process OIL instances
- Any RDF-S agent can
  process OIL ontologies
- Any OIL-aware agent can
  exploit semantics & reasoning

Conclusion..proof and trust!?

- **Logic**
  - **I am an employee of UMBC.**
    UMBC is a member of W3C.
    UMBC has GET access to http://www.w3.org/Member/.
    I (therefore) have access to http://www.w3.org/Member/.
- **Proof**
  - **UMBC's document employList lists me as an employee.**
    W3C'c member list includes UMBC.
    The ACLs for http://www.w3.org/Member/ assert that employees of members have GET access.
- **Trust**
  - **UMBC's document employList is signed by a private key that W3C trusts to make such assertions.**
    W3C'c member list is trusted by the access control mechansim.
    The ACLs for http://www.w3.org/Member/ were set by an agent trusted by the access control mechanism.

Latest..OWL=OIL+DAML

- OWL adds more vocabulary for describing properties and classes: relations between classes (e.g. disjointness), cardinality (e.g. "exactly one"), equality, richer typing of properties, characteristics of properties (e.g. symmetry), and enumerated classes.

Comments:

- Remember that the paper isn't saying RDF is better than XML. It is just saying that RDF is better for the semantic web.

Conclusion

- Meta-data should be given lots of importance in the semantic web
- Work needs to be done on establishing trust and security.