Semantic Web Technologies: The foundation for future enterprise systems

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Outline

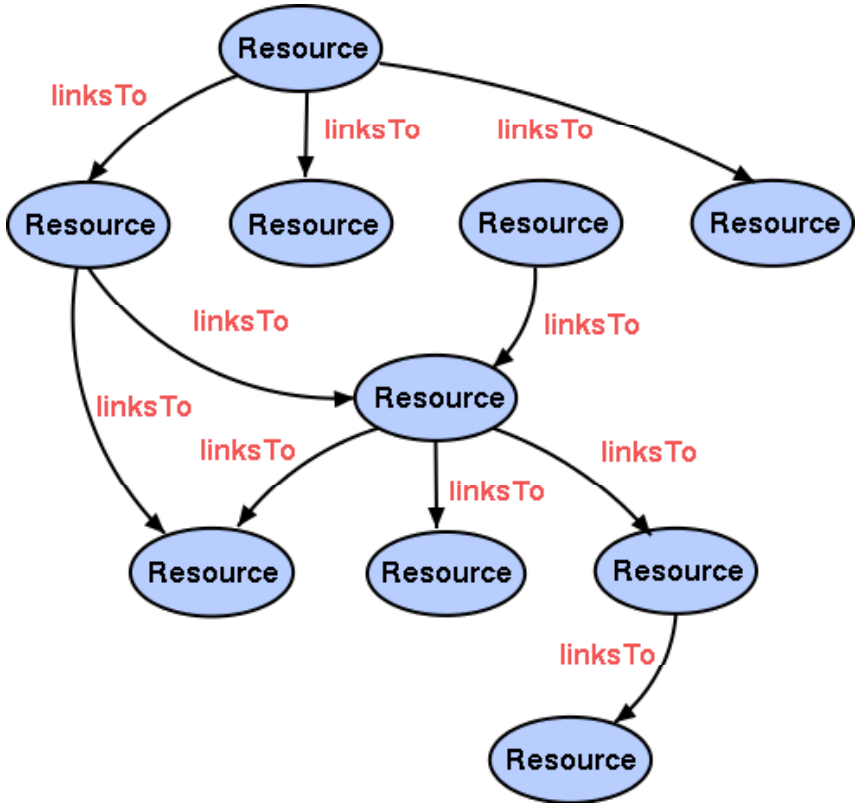
1. The Current Web and the Semantic Web
2. RDF and RDF Schema
3. Web Ontology Language OWL
4. Application areas for semantic web technology
5. Our reflections

Introduction

- In this talk we chose to look at the languages of the Semantic Web
  - Specifically RDF, RDF Schema and OWL
  - They are W3C recommendations
- We believe that as web developers, these languages are a necessary part of the skill set required of you

The Current Web

- Content is designed for human consumption.
- Main focus is on documents
  - a document or media can link to any other document (or different media).

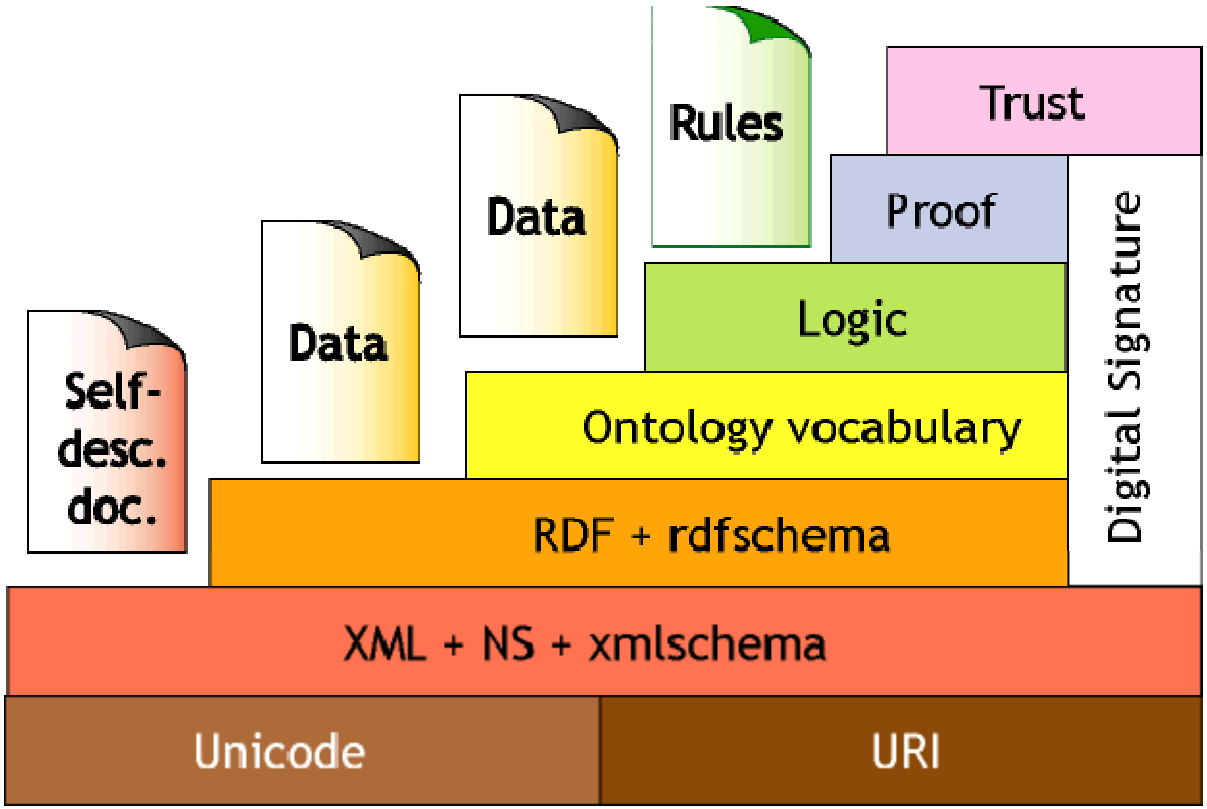


The Semantic Web

- An extension of the current web in which information is given a well defined meaning, better enabling computers and people to work in cooperation

The Semantic Web, Scientific American, May 2001

The Layer ‘Cake’



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Semantic Web Languages

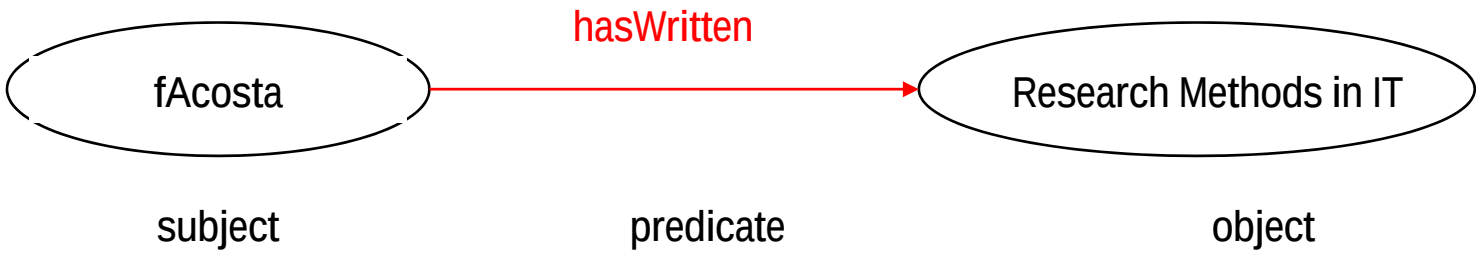
- Resource Description Framework (RDF)
  - RDF is a language (+ XML syntax + semantics) for representing metadata
  - for describing the semantics of information in a machine- accessible way
- RDF Schema (RDFS) extends RDF with "schema vocabulary"
  - Class, Property
  - type, subClassOf, subPropertyOf
  - range, domain
  - RDFS is a very simple ontology language

The RDF Data Model

Statements are (subject, predicate, object) triples:

(fAcosta, hasWritten, “Research Methods in IT”)

Can be represented as a graph:



Statements describe properties of resources. A resource is any object that can be pointed to by a URI:

Properties themselves are also resources (URIs)

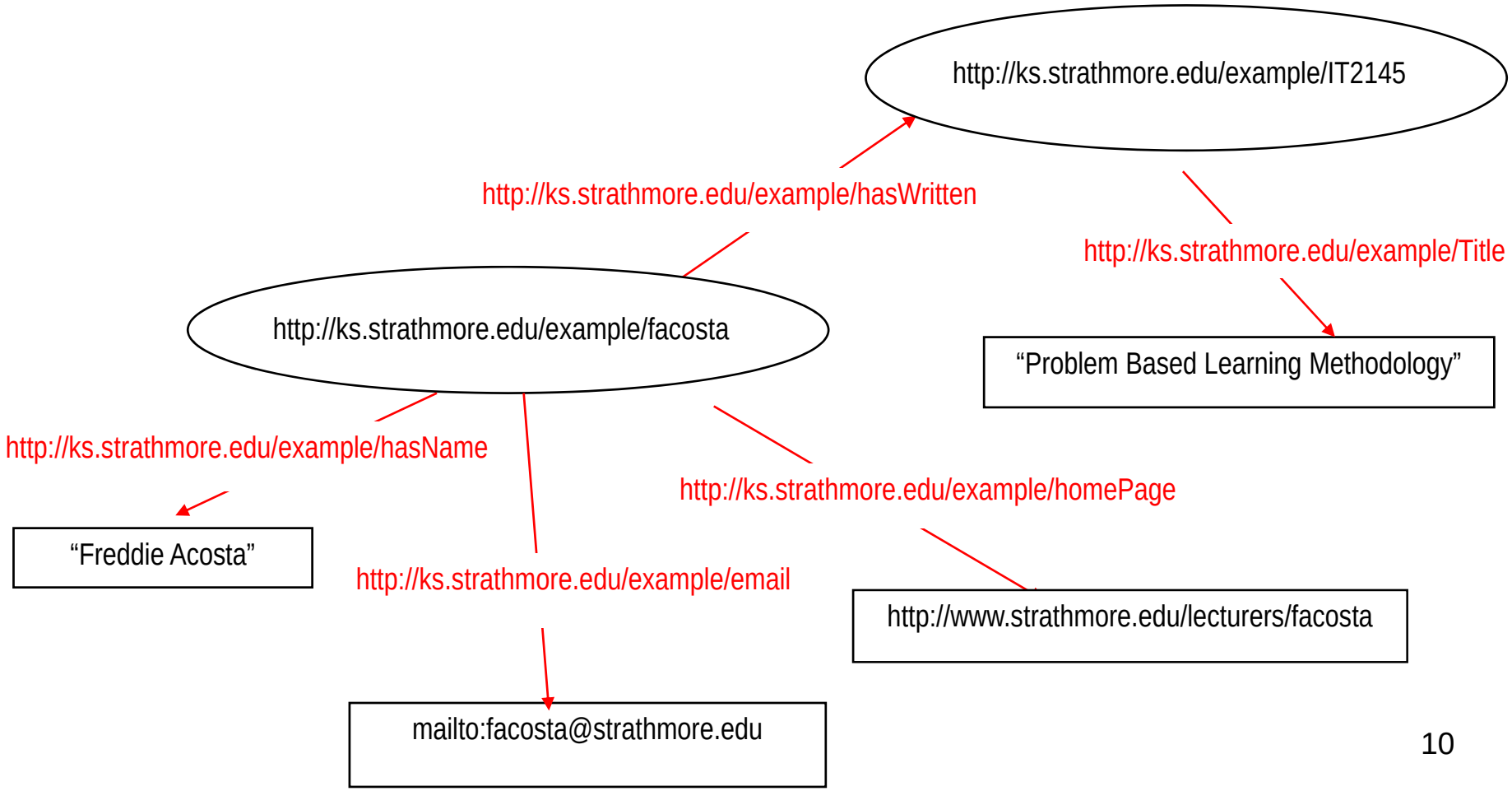
Uniform Resource Identifier - URI

- "The generic set of all names/addresses that are short strings that refer to resources"
  - URLs (Uniform Resource Locators) are a particular type of URI, used for resources that can be accessed on the WWW (e.g., web pages)
- In RDF, URIs typically look like “normal” URLs, often with fragment identifiers to point at specific parts of a document:
  - http://www.somedomain.com/some/path/file#fragmentID

- Example: http://ks.strathmore.edu/example/#facosta
  - Shorthand notation strath:facosta

Linking Statements

The subject of one statement can be the object of another
Such collections of statements form a directed, labeled graph



RDF Syntax

- RDF has an XML syntax
  - Every Description element describes a resource
  - Every attribute or nested element inside a Description is a property of that Resource

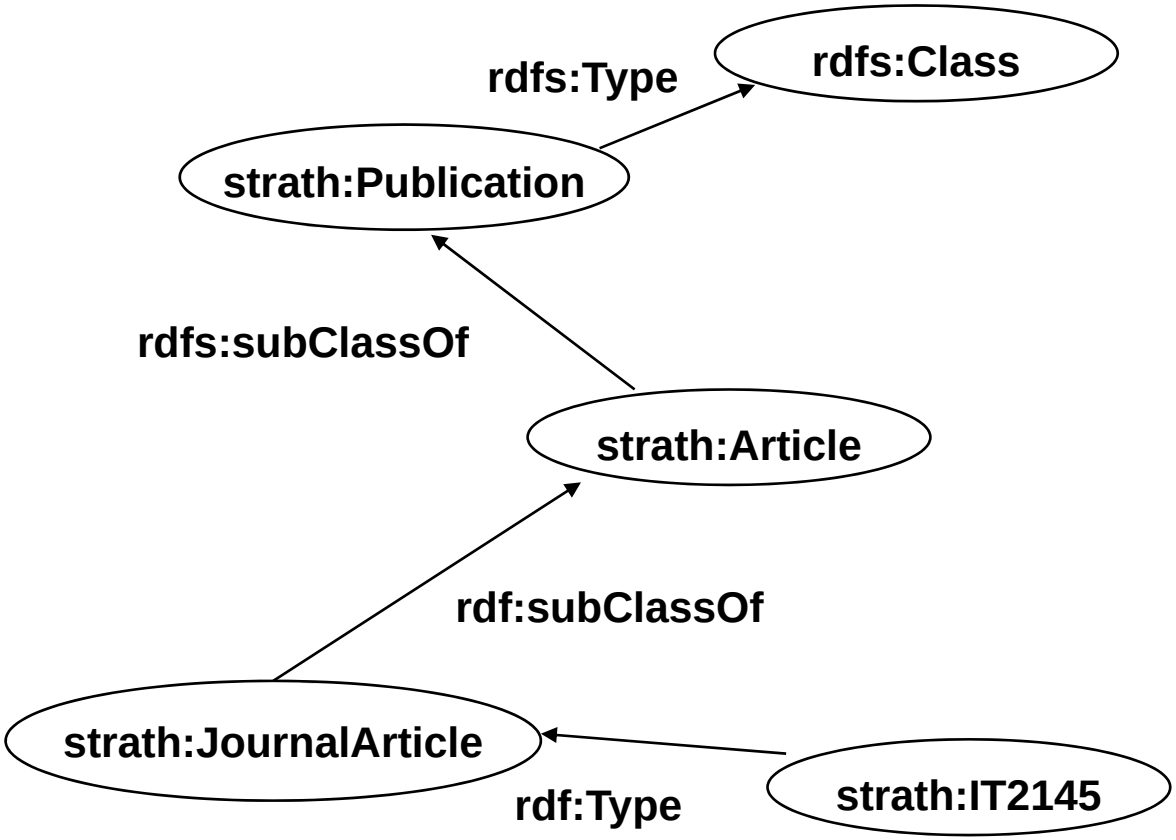
```
<rdf:Description rdf:about="http://ks.strathmore.edu/example/facosta">
   <homePage rdf:resource="http://www.strathmore.edu/lecturers/facosta"/>
   <hasName>Freddie Acosta</strath:hasName>
   <email rdf:resource="mailto:facosta@strathmore.edu"/>
   <hasWritten rdf:resource=“strath:IT2145"/>
</rdf:Description>

<rdf:Description rdf:about="http://ks.strathmore.edu/example/IT2145">
   <Title>Problem Based Learning Methodology</Title>
</rdf:Description>
```

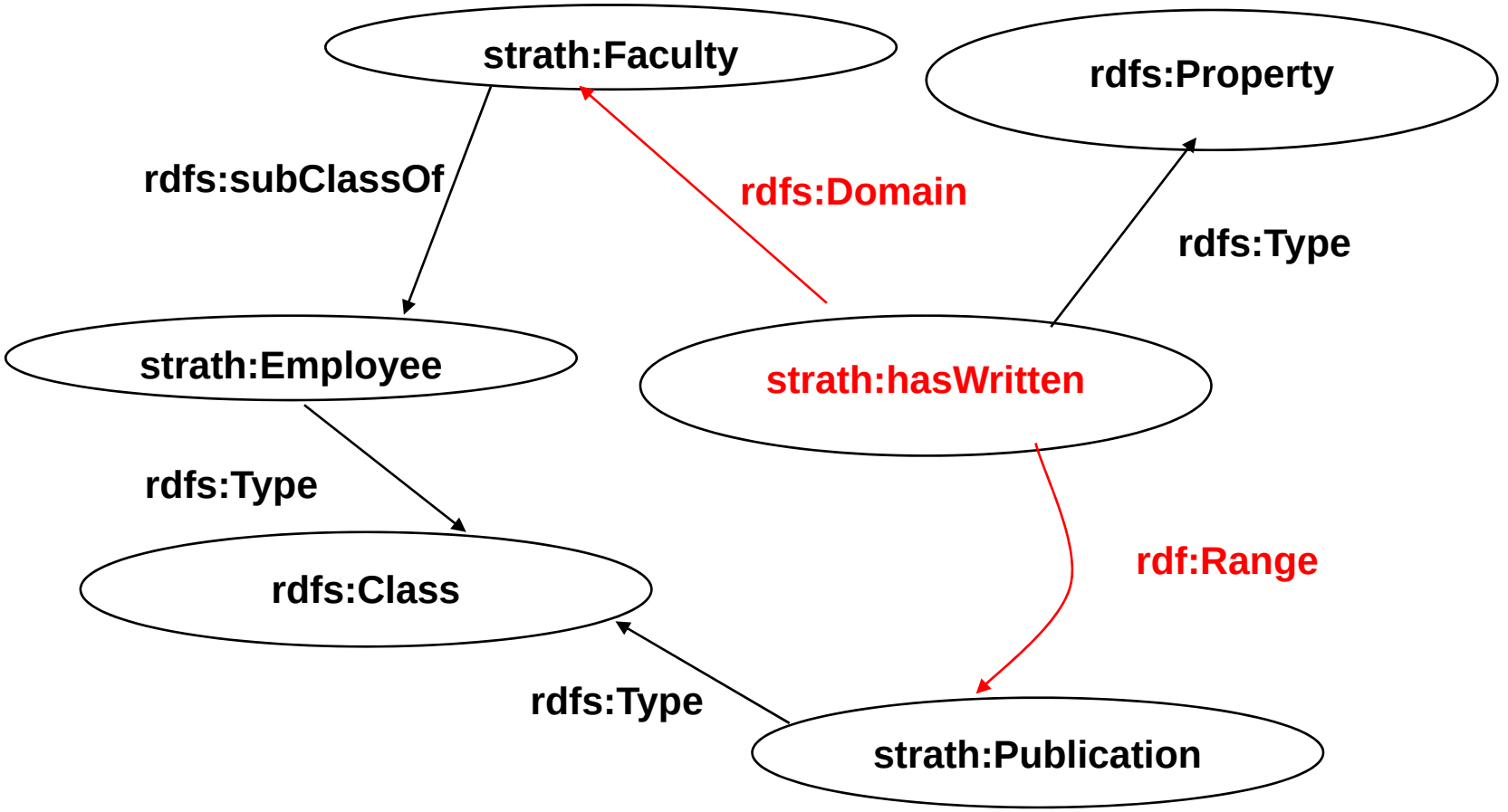
RDF Schema

- RDF gives a language for meta data annotation, and a way to write it down in XML, but it does not provide any way to structure the annotations
- RDF Schema augments RDF to allow you to define vocabulary terms and the relations between those terms
  - it gives “extra meaning” to particular RDF predicates and resources
  - e.g., Class, subClassOf, Property, domain, range
- These terms are the RDF Schema building blocks (constructors) used to create vocabularies

RDF Schema - Classes



RDF Schema - Properties



RDF Summary

- RDF - The Resource Description Framework allows us to describe resources by specifying their properties and property values.
  - RDF Statements are triples of the form (Subject, Predicate, Object)
  - A set of RDF triples forms an RDF Graph
- RDF Schema semantically extends RDF by providing a means to describe RDF Vocabularies.
- RDF and RDF Schema provide basic capabilities for describing vocabularies that describe resources.

Problems with RDF Schema

- RDFS too weak to describe resources in sufficient detail
  - No localised range and domain constraints
    - Can’t say that the range of hasChild is person when applied to persons and elephant when applied to elephants
  - No existence/cardinality constraints
    - Can’t say that all instances of person have a mother that is also a person, or that persons have exactly 2 parents
  - No transitive, inverse or symmetrical properties
    - Can’t say that isPartOf is a transitive property, that hasPart is the inverse of isPartOf, or that touches is symmetrical
  - Need to extend RDFS to provide better support for ontologies
- Difficult to provide reasoning support

Ontology

- Borrowed from philosophy - the study of “The nature of being”
- “An ontology is a formal, explicit specification of a shared conceptualization specification of a conceptualization” (Gruber, 1993)
- In general, an ontology provides a mechanism to capture information about the objects and the relationships that hold between them in some domain of interest.

An Ontology Language for the Semantic Web

- Create a richer ontology language for the Semantic Web
- Desirable features identified for Web Ontology Language:
  - Extend existing Web standards
    - Such as XML, RDF, RDFS
  - Easy to understand and use
  - Formally specified
- Possible to provide automated reasoning support

History

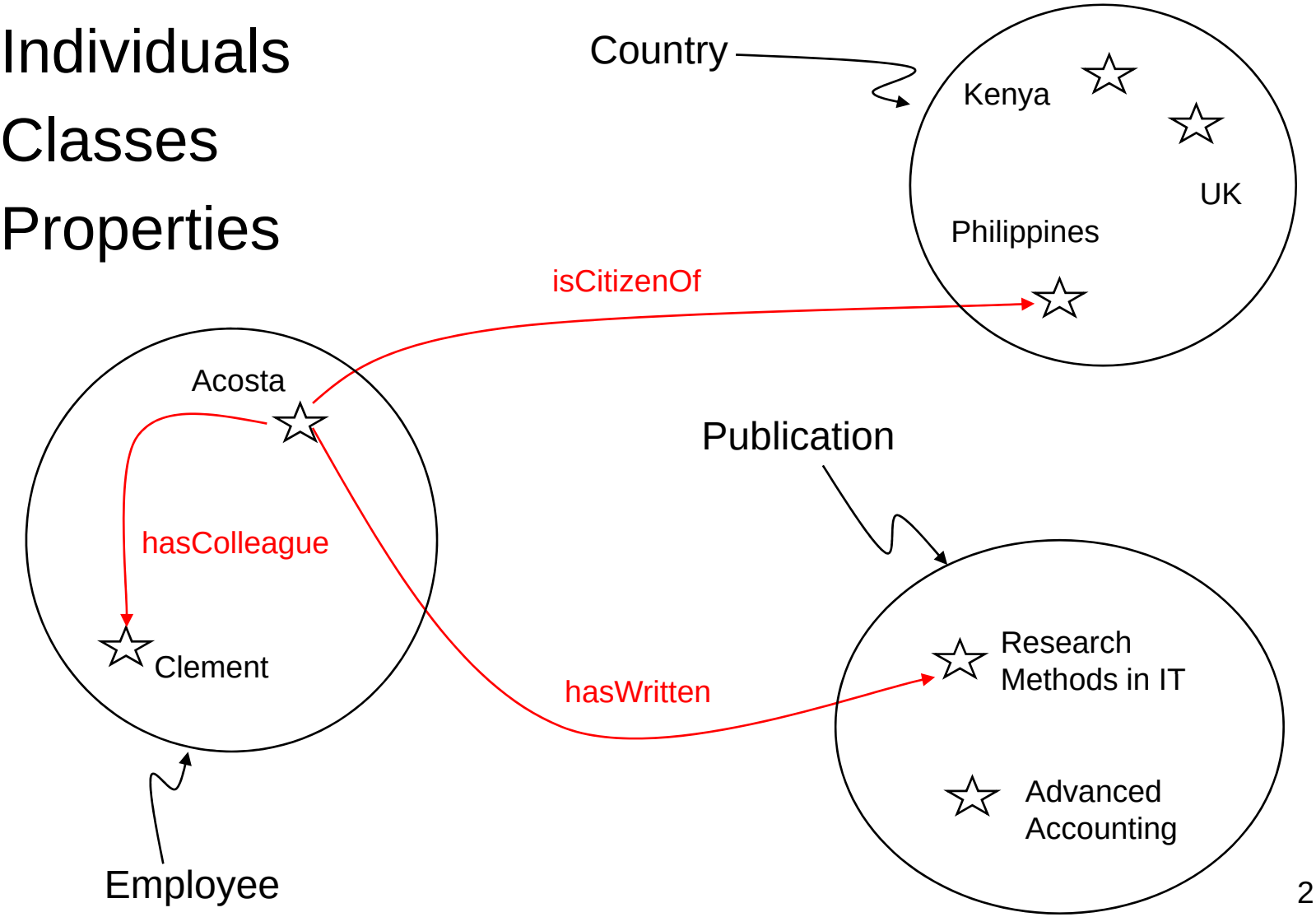
- Two languages were developed to satisfy above requirements
  - OIL: developed by group of (largely) European researchers
  - DAML-ONT: developed by group of (largely) US researchers
- Efforts merged to produce DAML+OIL
  - Done by a “Joint EU/US Committee on Agent Markup Languages”
- DAML+OIL was submitted to W3C as basis for standardization
  - Web-Ontology (WebOnt) Working Group developed OWL language based on DAML+OIL
  - OWL language now a W3C Recommendation

OWL Overview

- OWL is an ontology language, based on ideas from Description Logics
- Well defined semantics
- OWL extends the expressive power of RDFS
  - Can talk about defined properties of classes

Components of an OWL Ontology

- Individuals
- Classes
- Properties



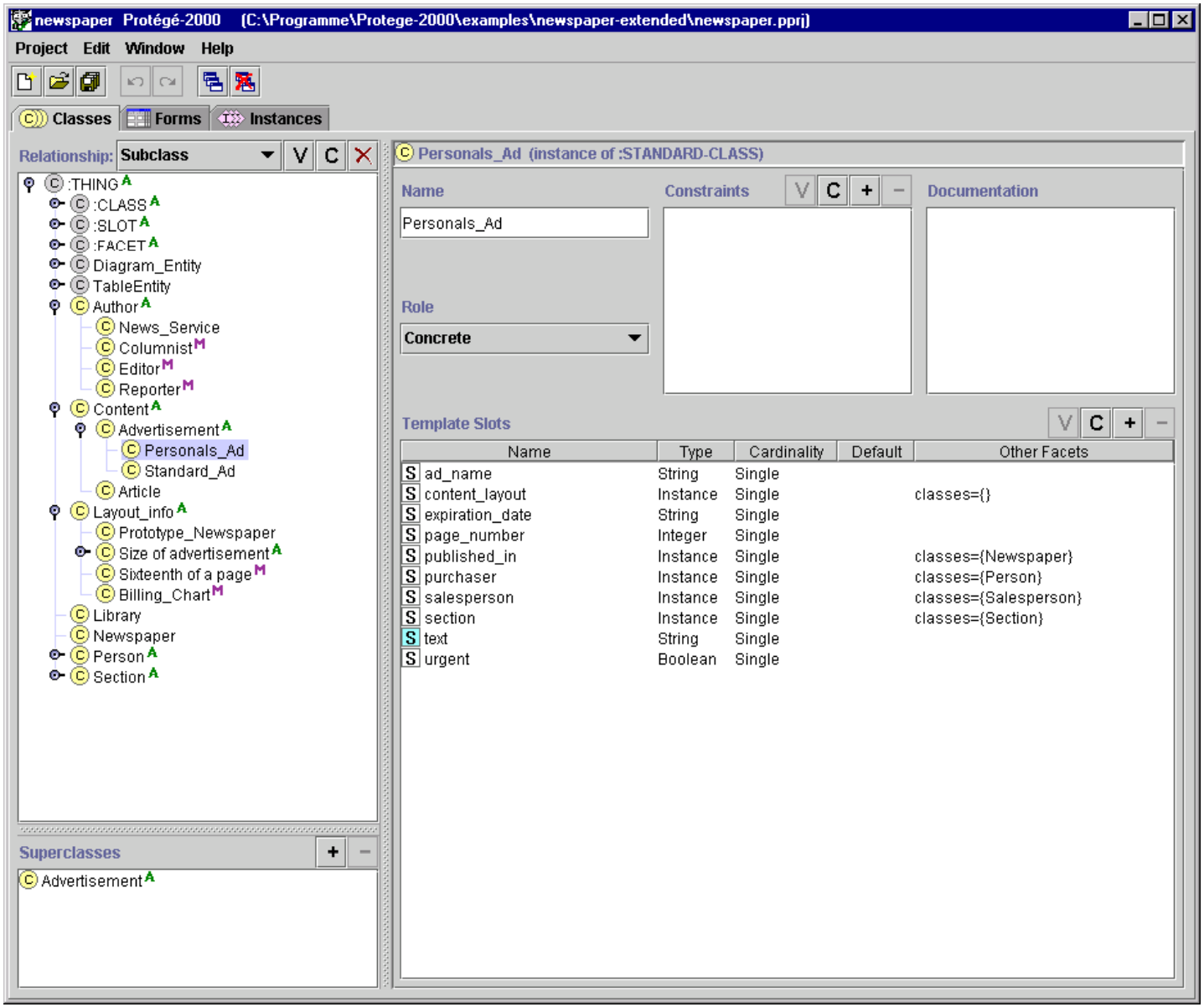
The Three Species of OWL

- OWL-Full - No restrictions on how/where language constructs can be used. The union of OWL and RDF Schema OWL-Full is not decidable.
- OWL-DL - Restricted version of OWL-Full. Corresponds to a description logic. Certain restrictions on how/where language constructs can be used in order to guarantee decidability.
- OWL-Lite - A subset of OWL-DL. The simplest and easiest to implement of the three species.

OWL Summary

- OWL is the latest standard in ontology languages.
- It is layered on top of RDF and RDFS, and has a rich set of constructs.
- There are three species of OWL: OWL-Lite, OWL-DL and OWL-Full.
- We can perform automated reasoning over ontologies that are written in OWL-Lite and OWL-DL.
- Tools to build Ontologies exists e.g. Protégé

Protégé


newspaper Protégé-2000 (C:\Programme\Protege-2000\examples\newspaper-extended\newspaper.pprj)
Project Edit Window Help
Classes Forms Instances
Relationship: Subclass
:THING
:CLASS
:SLOT
:FACET
Diagram_Entity
TableEntity
Author
News_Service
Columnist
Editor
Reporter
Content
Advertisement
Personals_Ad
Standard_Ad
Article
Layout_info
Prototype_Newspaper
Size of advertisement
Sixteenth of a page
Billing_Chart
Library
Newspaper
Person
Section
Superclasses
Advertisement
Personals_Ad (instance of :STANDARD-CLASS)
Name
Personals_Ad
Constraints
Documentation
Role
Concrete
Template Slots
Name Type Cardinality Default Other Facets
ad_name String Single
content_layout Instance Single classes={}
expiration_date String Single
page_number Integer Single
published_in Instance Single classes={Newspaper}
purchaser Instance Single classes={Person}
salesperson Instance Single classes={Salesperson}
section Instance Single classes={Section}
text String Single
urgent Boolean Single

SW Application Areas

- Application Areas
  - Knowledge Management
    - Focus of our research group: Knowledge Systems group
  - Enterprise Data Integration
  - Web services, to support
    - E-Commerce (B2C and B2B)
  - Context based search
  - E-Government
  - E0learning
- … many more

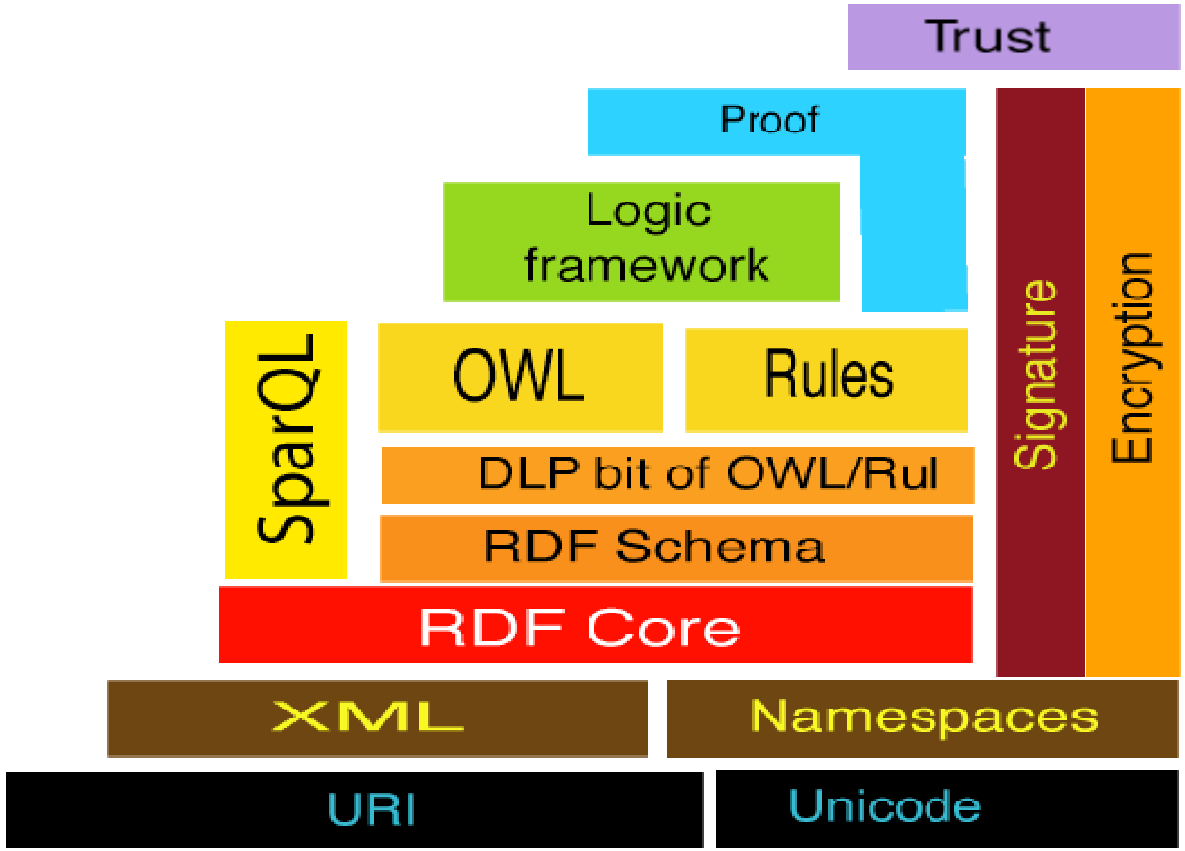
Take Home Ideas

- Semantic web is an idea that will be with us
- Standards have already be set by W3C
- Tools are available for this

Questions?

Layer Cake - Revised

W3C Semantic Web Language Layer Cake
revised version, Tim-Berners-Lee 2005



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