

Semantic Web Technologies: The foundation for future enterprise systems

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Outline

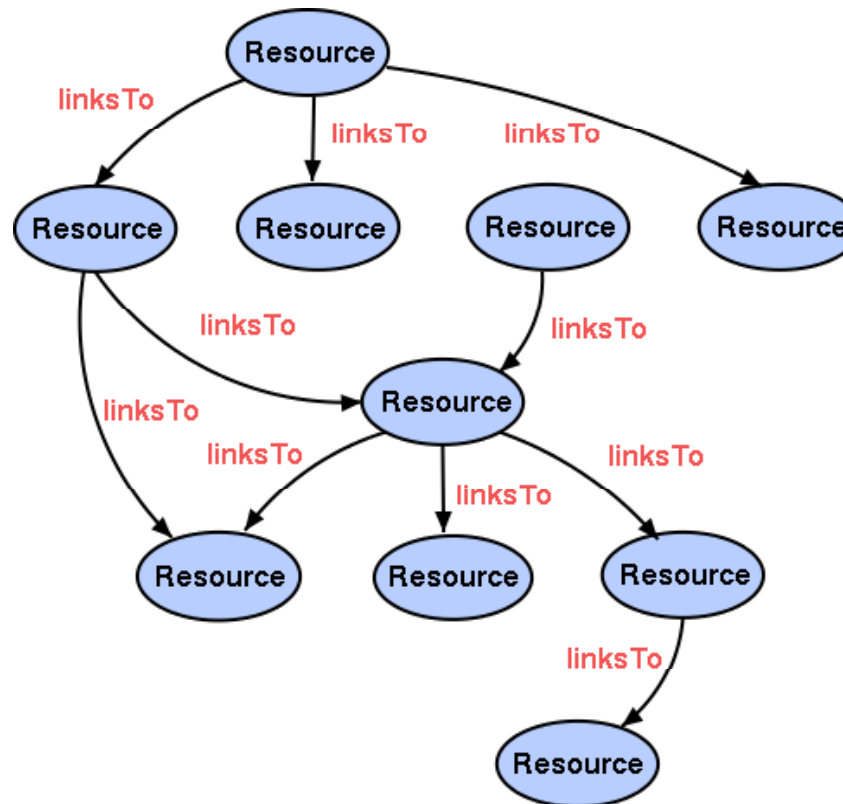
1. The Current Web and the Semantic Web
2. RDF and RDF Schema
3. Web Ontology Language OWL
4. Application areas for semantic web technology
5. Our reflections

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).



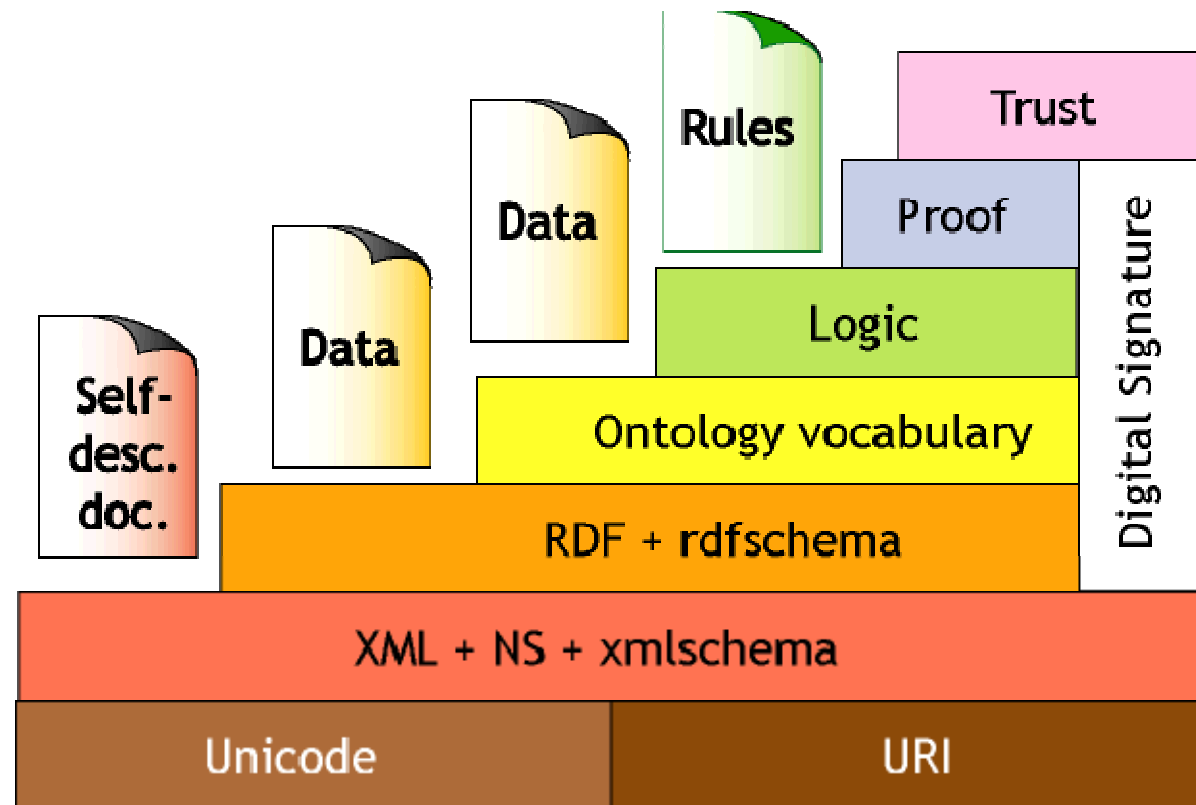
The Semantic Web

- 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'



Semantic Web Languages

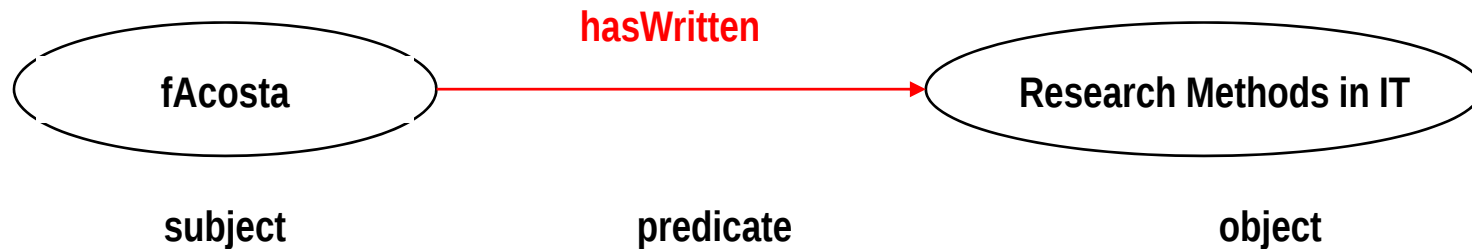
- Resource Description Framework (RDF)
 - RDF is a language (+ XML syntax + semantics) for representing metadata
 - for describing the semantics of information in a machine- accessible way
- RDF Schema (RDFS) extends RDF with “schema vocabulary”
 - Class, Property
 - type, subClassOf, subPropertyOf
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



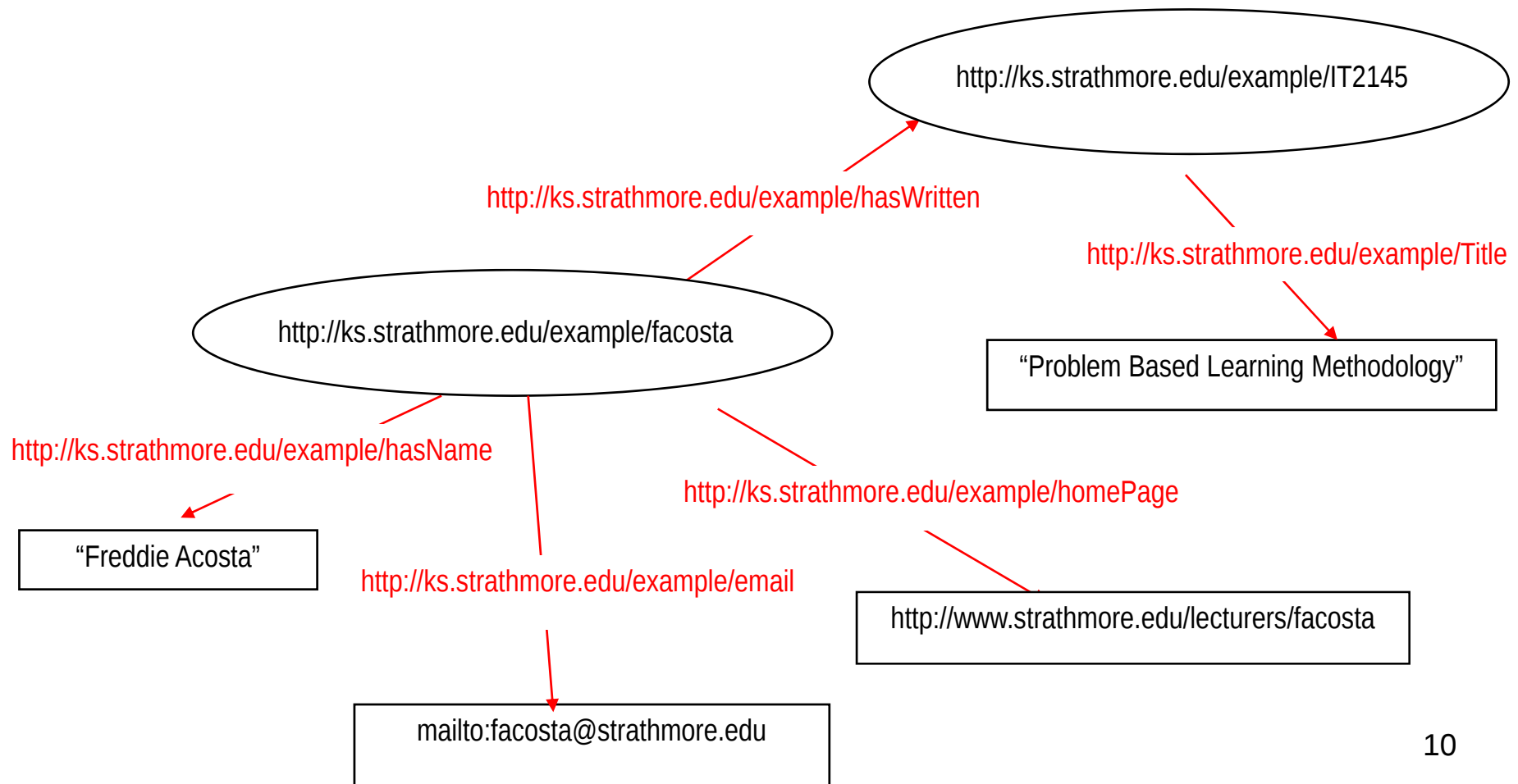
Statements describe properties of resources. A resource is any object that can be pointed to by a URI:
Properties themselves are also resources (URIs)

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

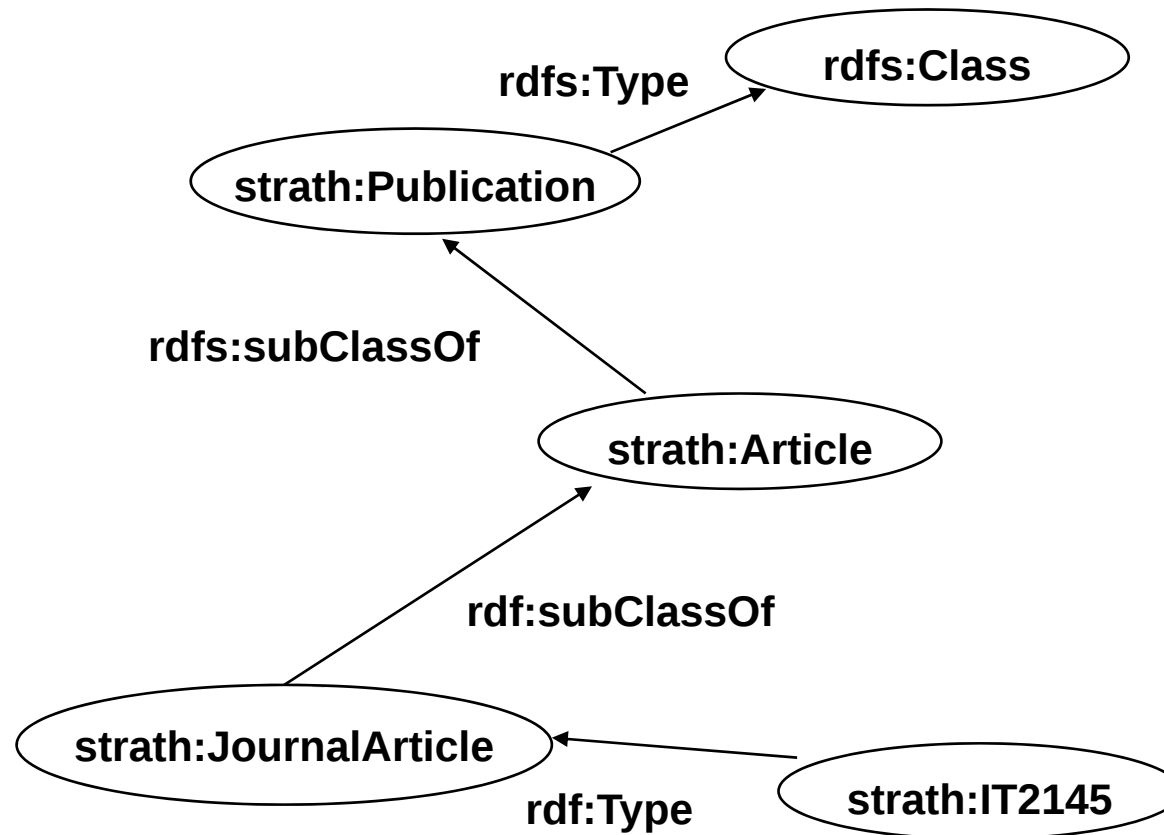
```
<rdf:Description rdf:about="http://ks.strathmore.edu/example/facosta">  
  <homePage rdf:resource="http://www.strathmore.edu/lecturers/facosta"/>  
  <hasName>Freddie Acosta</strath:hasName>  
  <email rdf:resource="mailto:facosta@strathmore.edu"/>  
  <hasWritten rdf:resource="strath:IT2145"/> 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

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

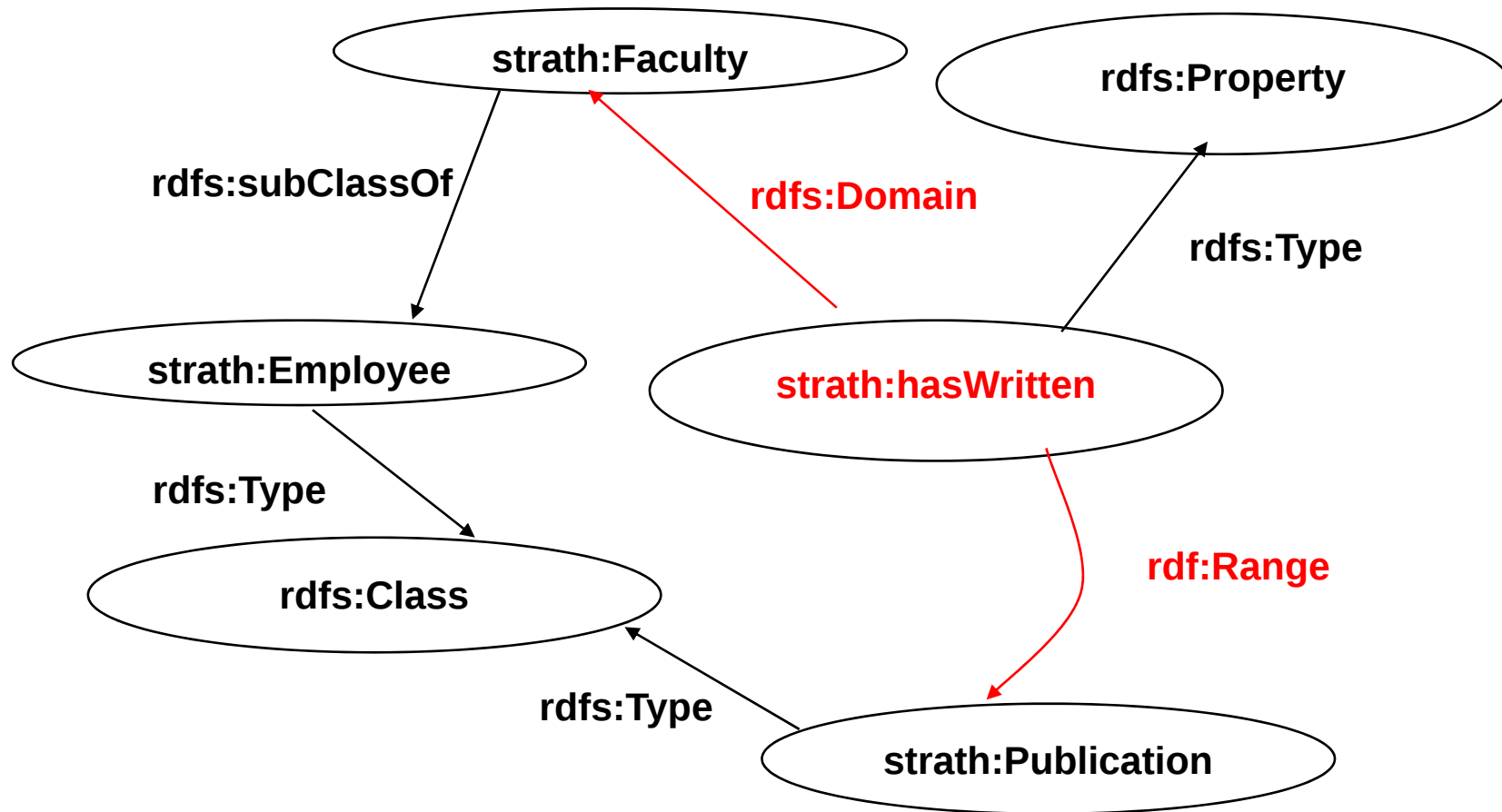
RDF Schema

- 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

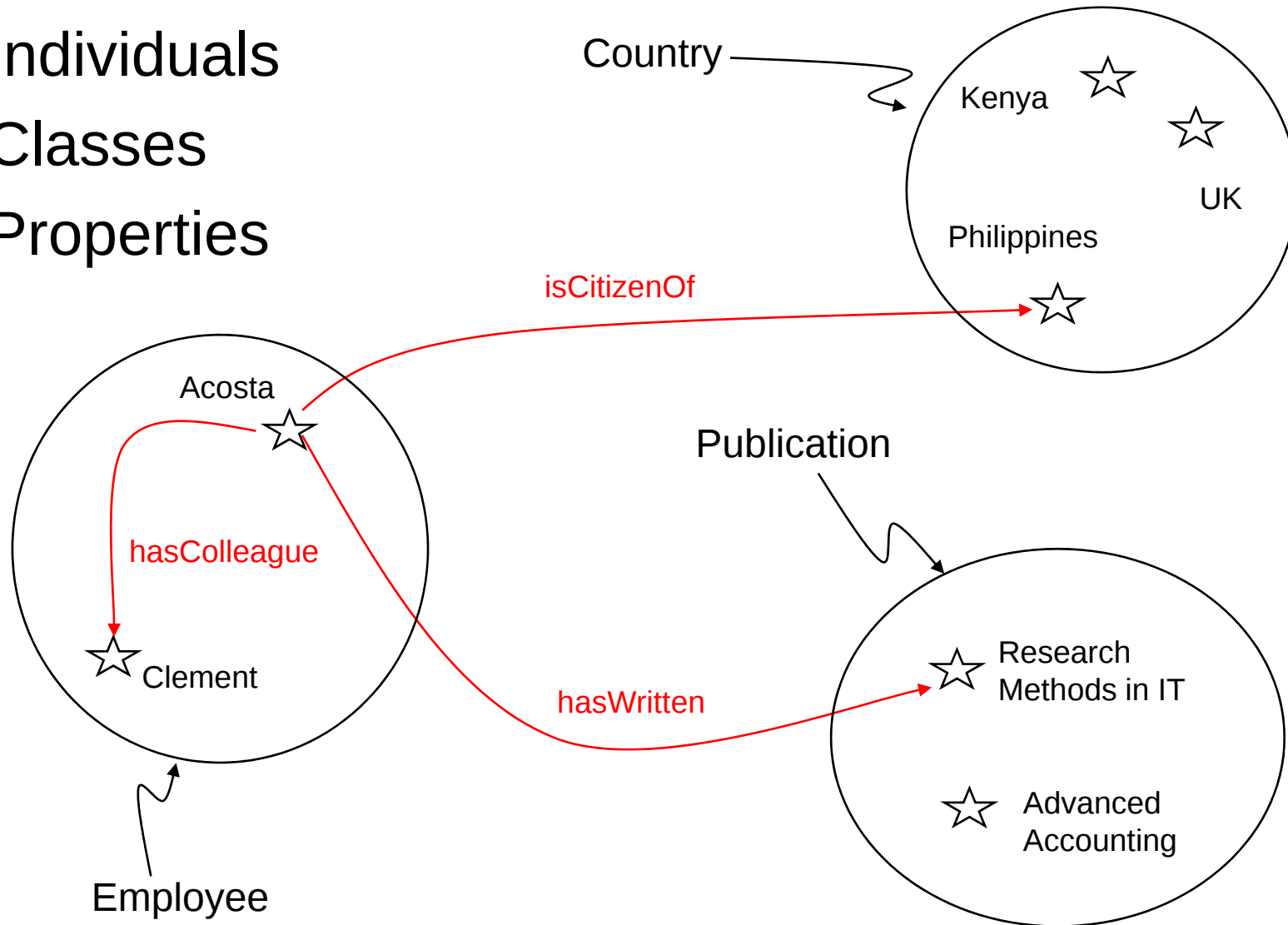
OWL Overview

- 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



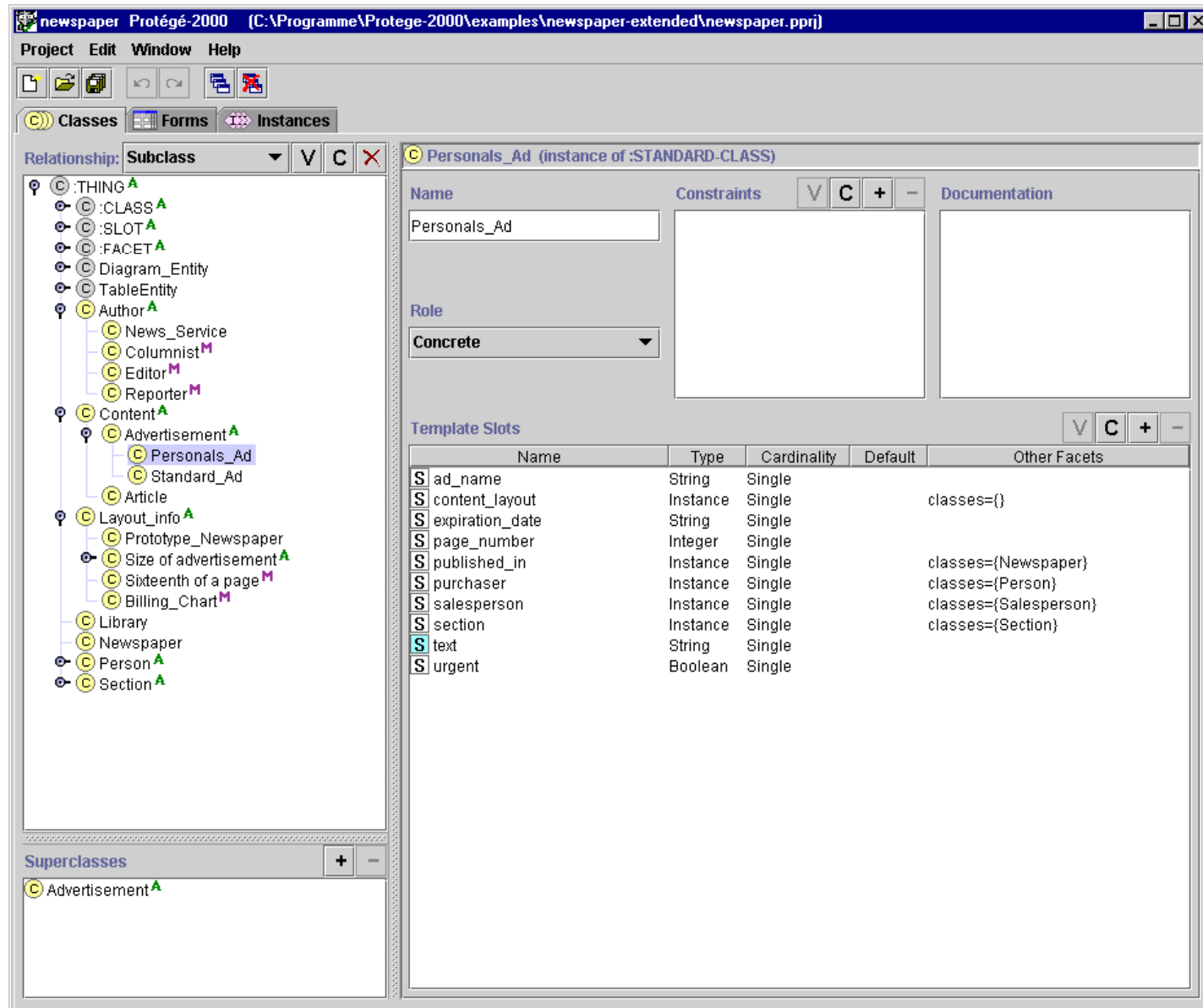
The Three Species of OWL

- 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



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

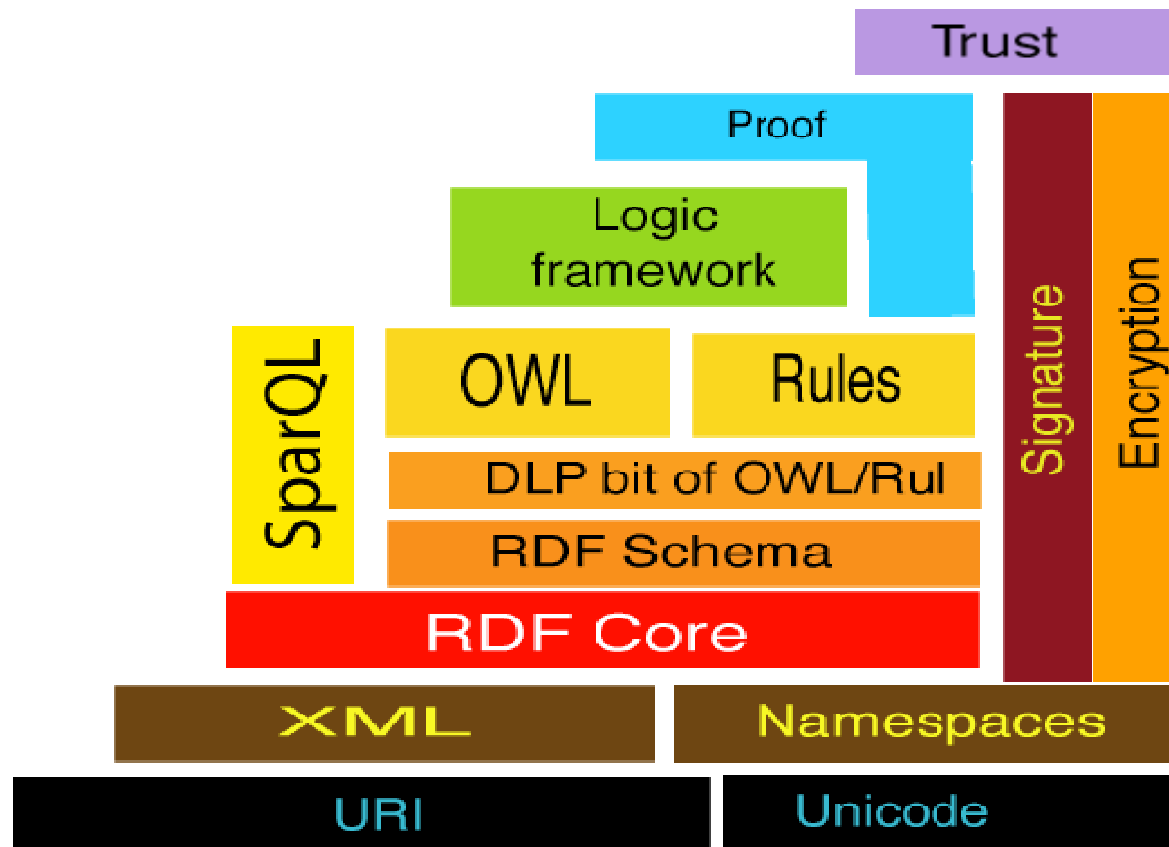
- Semantic web is an idea that will be with us
- Standards have already be set by W3C
- Tools are available for this

Questions?

Layer Cake - Revised

W3C Semantic Web Language Layer Cake

revised version, Tim-Berners-Lee 2005



[Back to](#) 2000 Version