Resource Description Framework (RDF)
Web Ontology Language (OWL)

Need for OWL

- To extend the expressiveness of RDF Schema (for classes and properties)
- To bring expressive and reasoning power of description logic to the semantic web
- Adds constructs of Description Logics (DL) to RDF
- Description Logics are a set of Knowledge Representation languages
- It has formal semantics that maps to First Order Logic (FOL)
- Trade-off between expressivity of language and efficiency of reasoning
- OWL has well-known Description Logic with tractable reasoning algorithms

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- Everything from RDF cannot be expressed in DL
- E.g. the classes of classes are not permitted in the (chosen) DL, some triple expressions
- OWL can be only syntactic extension of RDF/RDFS
- To partially overcome this problem, layering within OWL with three species of OWL
- Web Ontology Language is a set of three languages with increasing expressiveness: OWL Lite, OWL DL and OWL Full

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(*OWLLite ⊆ OWLDL ⊆ OWLFull)*

•every legal OWL Lite ontology is a legal OWL DL ontology

•every legal OWL DL ontology is a legal OWL Full ontology

•inverses of these relations do not hold

•Also, every OWL ontology is a valid RDF document (i.e., DL
expressions are mapped to triples)

•But not all RDF documents are valid OWL

Contd...

- *OWL Lite* can be used to express taxonomy and simple constraints, such as 0 and 1 cardinality

- *OWL DL* supports maximum expressiveness while retaining computational completeness and decidability

- *OWL Full* has no expressiveness constraints, but also does not guarantee any computational properties

– (full OWL vocabulary, does not impose any syntactic constrains, so that full syntactic freedom of RDF can be used)

Comparision of RDF/OWL Vs UML

- UML used in requirement and design phase of middle tier of application
- UML and RDF(S)/OWL differs in the modelling scope
- Modelling primitives of UML are specific to objects
- UML primitives of objects characterized by static attributes, associations, dynamic behavior
- Significant overlap in expressiveness of OO models and ontological models

Unique features of RDF/OWL

- Modelling of RDF is less constrained than UML (more primitives, no equivalent in UML)
- OWL allows to describe defined classes, instance can be a member of class
- RDF/OWL Properties are global: they do not belong to any class
- Properties defined as subproperties of other properties
- Classes can be treated as instances, allowing for meta-modelling

Contd...

- RDF reification is more flexible than the association class mechanism of UML
- All non-blank RDF resources are identified with a URI (ID not in UML)
- Instances can and usually have multiple types

Unique features of UML

- UML has the notion of relationship roles
- Two common types of part-whole relations are available in UML (aggregation and composition)
- UML makes a distinction between attributes and associations (different from the distinction between datatype and object-properties in OWL)
- Comparision of UML class models and RDF/OWL models is difficult (as UML close world, RDF/OWL open world)
- Required generate the object model from an existing ontological model or vice versa – e.g.code generators from RFS to java object model

E/R Model, Relational Model Vs UML, RDF/OWL

- Entity/Relationship (E/R) model used in information modelling in data storage layer of applications
- It maps to relational model for defining data structures in RDMS
- Relationships characterized by arity, entities cardinality and dependency
- Similar reification in RDF,UML - E/R model allows attributes to relationship, relationships in other relationships

Contd...

- Entity sets is less of a concern to the E/R model
- Only predefined relationship type between entity sets is generalization
- Semantics of this construct is limited to attribute inheritance
- Ex. lower level entity sets have all the attributes of the higher level entity sets.
- Unlike UML/RDF Generalization between relationships is not allowed

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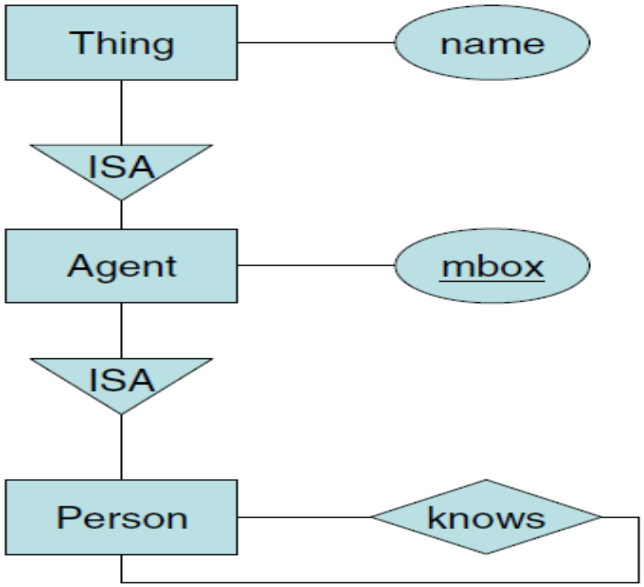
- E/R model has the notion of keys of entity sets (set of attributes value together identify an entity)
- E/R also has notion of weak entities – also take into relations to other entities
- Example (Weak enitiy): the unique identification of a room depends on the identification of the building
- Keys of single attributes can be modelled in RDF by making the given property functional

Contd...

- E/R diagram does not allow to represent instances
- RDF Solves this every resource has an inherent identifier



Person

name	mbox
Rembrandt	rembrandt@example.org
Saskia	?

knows

mbox1	mbox2
rembrandt@example.org	?

E/R models and ontologies

- specific storage facilities based on the RDF model available as extension to object and relational model
- Commonly data stored in RDBMS and exposed via web interface as RDF
- But automated mapping of relational schemas to ontologies is difficult
- E/R diagrams mapped in multiple ways for much simpler relational model
- So relational model post-processing and enrichment needed to arrive at an accurate model of the domain

XML and XMLSchema Vs RDF/OWL

- XML - a directed, ordered tree, e.g. Text document -> paragraphs → subsections -> sections ->chapters

- RDF more relaxed data model based on arbitrary directed graph (single edges between the nodes representing classes or instances)

- Best suited for conceptual domain models rich in cross-taxonomical relationships (difficult in hierarchical)

- Like RDF, XML is a conceptual model with its own vocabulary

- XML schema languages defines types of elements, their attributes and prescribe syntax (used to validate XML doc)

Contd...

- RDF impose constraints on interpretations of metadata to check consistency of an RDF/OWL model
- Different Xml representation produce different results for same data in XML tools
- So, xml need agreement on both syntax and semantics
- RDF – only kind of agreement needed to exchange RDF documents need representation of individual statements (simple sub-pred-obj model)

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- Legacy of XML compelled W3C to adopt it as a notation for RDF and OWL
- More tools are available for XML
- Semantic Web itself is build over XML, URIs and Unicode
- RDF/XML documents are valid XML (can be written out to XML and validated using XML editors)
- Re-representation of XML schemas and data using RDF is difficult
- XML schemas, however, have not been designed to conform with striped syntax of RDF

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- No way to automate the process of XML to RDF conversion
- But possible for particular schemas thru XSLT transformations
- Use RDF/XML in a constrained way for new formats (ex.RSS1.0)
- Transforming XML Schema documents into RDF/OWL vice versa difficult (ordering, integrity constraints of key cannot expressed in RDF/OWL)
- RDF/OWL are more flexible, more expressive and conceptually cleaner languages than XML

Comparison of the E/R, UML, XML and RDF/OWL languages

	Origin	Application domain	Primitive	Expres-sivity	Dis-tributed represen-tation	Formal semantics
E/R	1976	Relational databases	Relation	•	no	no
UML	1995	OO software	Object	••	no	yes[33]
XML	1998	Text markup and data exchange	Entity	••	yes	no
RDF/OWL	2004	Resource markup and data exchange	Resource	• - • • •	yes	yes