OWL:
the Web Ontology Language

Alun Preece

http://www.csd.abdn.ac.uk/~apreece/foaf.rdf

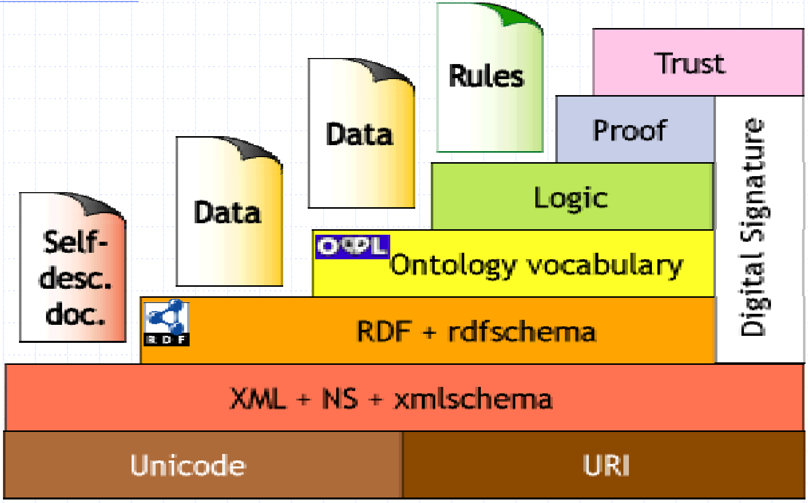
OWL: what?

- Core of the World Wide Web Consortium's Semantic Web activity
- In various senses a successor to previous work on "Web-friendly" knowledge modelling languages
  - RDF & RDF Schema
  - DAML-ONT
  - OIL / DAML+OIL
- W3C's Web Ontology Working Group are a "who's who" of the knowledge representation field
- Last Call Working Drafts issued in late March - closed on May 9 2003; final recommendation will then follow

OWL: why?

- Semantic Web apps:
  - portal Websites & intranets (information architecture)
  - multimedia digital libraries (rich metadata)
  - agents & Web services (interoperability, automation)
  - design documentation (complex, interlinked)
- Capabilities:
  - ontology sharing, evolution, interoperability
  - inconsistency detection
  - expressivity vs scalability
  - standards compliance

Semantic Web architecture



Rules

Trust

Data

Proof

Data

Logic

Self-desc. doc.

OWL Ontology vocabulary

Digital Signature

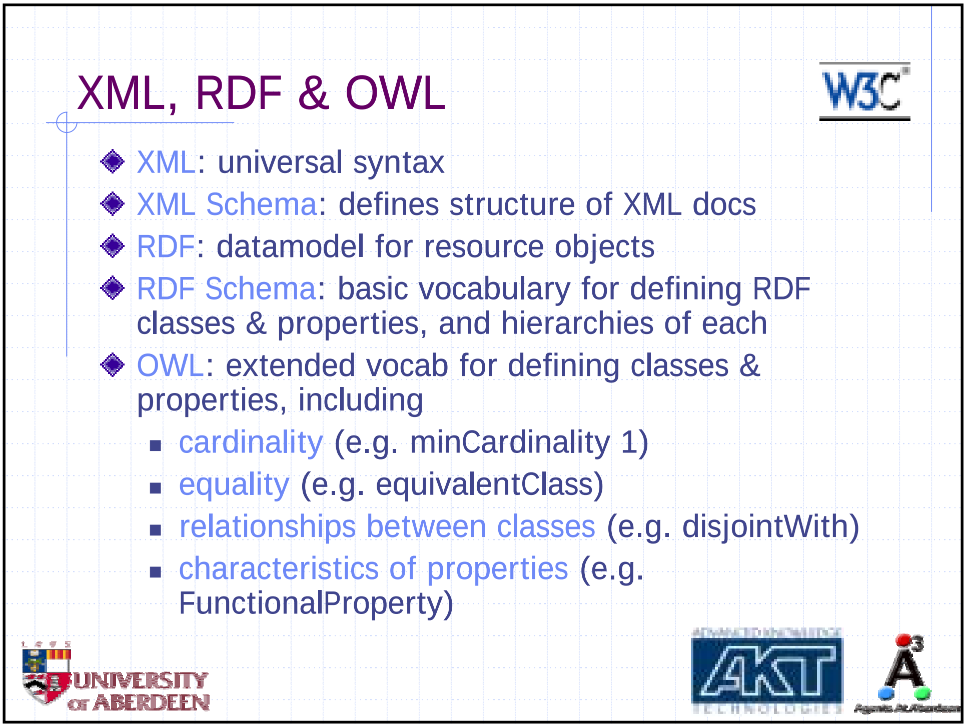
RDF RDF + rdfschema

XML + NS + xmlschema

Unicode

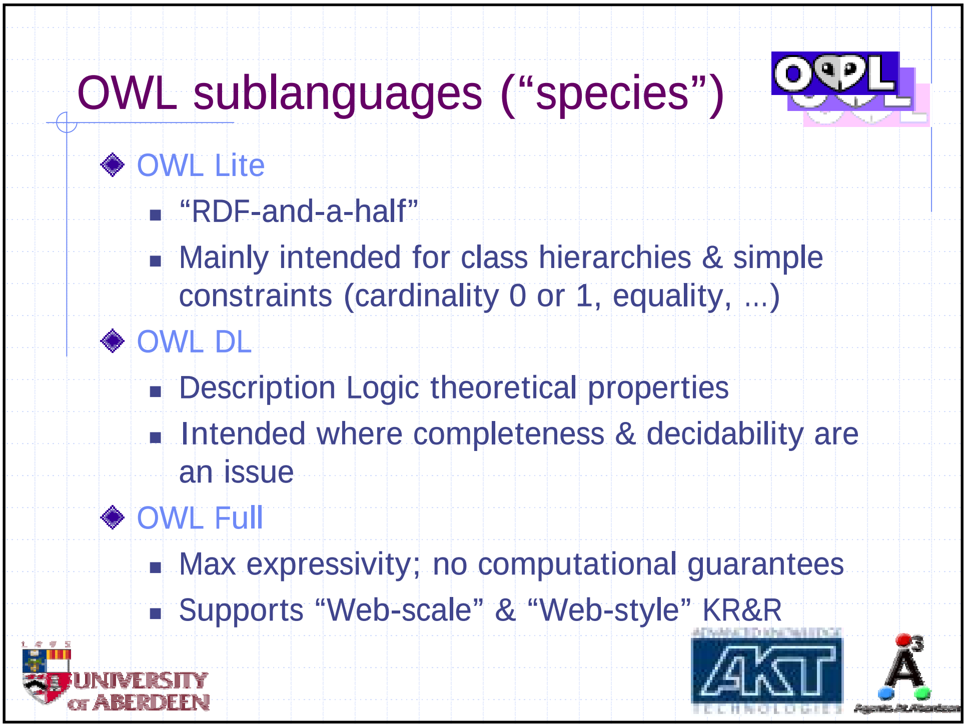
URI

[Semantic Web "layer cake" slide due to Tim Berners-Lee]



XML, RDF & OWL

- XML: universal syntax
- XML Schema: defines structure of XML docs
- RDF: datamodel for resource objects
- RDF Schema: basic vocabulary for defining RDF classes & properties, and hierarchies of each
- OWL: extended vocab for defining classes & properties, including
  - cardinality (e.g. minCardinality 1)
  - equality (e.g. equivalentClass)
  - relationships between classes (e.g. disjointWith)
  - characteristics of properties (e.g. FunctionalProperty)



OWL sublanguages (“species”)

- OWL Lite
  - “RDF-and-a-half”
  - Mainly intended for class hierarchies & simple constraints (cardinality 0 or 1, equality, ...)
- OWL DL
  - Description Logic theoretical properties
  - Intended where completeness & decidability are an issue
- OWL Full
  - Max expressivity; no computational guarantees
  - Supports “Web-scale” & “Web-style” KR&R

OWL sublanguages cont'd

- Every legal OWL Lite ontology is a legal OWL DL ontology
- Every legal OWL DL ontology is a legal OWL Full ontology
- Every valid OWL Lite conclusion is a valid OWL DL conclusion
- Every valid OWL DL conclusion is a valid OWL Full conclusion

- The converse in each case does not hold

OWL Lite: essentials

Schema constructs

Class (i.e. owl:Class)
rdf:Property
rdfs:subClassOf
rdfs:subPropertyOf
rdfs:domain
rdfs:range
Individual

Property characteristics

inverseOf
TransitiveProperty
FunctionalProperty
InverseFunctionalProperty
SymmetricProperty

Equality constructs

equivalentClass
equivalentProperty
sameIndividualAs
differentFrom
allDifferent

Cardinality

minCardinality (0 or 1)
maxCardinality (0 or 1)
Cardinality (0 or 1)

Class intersection

intersectionOf

Headers

imports
priorVersion
backwardCompatibleWith
incompatibleWith

Property type restrictions

allValuesFrom
someValuesFrom

RDF datatyping

OWL DL & OWL Full: essentials

Class axioms

oneOf
disjointWith

Class expressions

equivalentClass
rdfs:subClassOf
unionOf
intersectionOf
complementOf

Property fillers

hasValue

Arbirtary cardinality

minCardinality
maxCardinality
Cardinality

When is a Class not a Class?

- Answer: in OWL Lite & OWL DL, when it's an Individual - DL restrictions (appparently) do not permit Classes to be treated as Individuals
- So, no "Class, an Individual class, being the Class of all Classes" (as in RDF)
- So, rdfs:Class cannot be used in OWL Lite or OWL DL
- owl:Class is defined as rdfs:subClassOf rdfs:Class
- (But, in OWL Full, they coincide!)
- Note that this means an RDF-processing agent can still use a lot of OWL, because it understands the triple: owl:Class rdfs:subClassOf rdfs:Class

Defining an owl:Class (I)

- By class identifier: Lite/DL/Full

```
<owl:Class rdf:ID="Lecturer">
  <rdfs:subClassOf rdf:resource="#Person" />
</owl:Class>
```

- By enumeration: DL/Full

```
<owl:Class rdf:ID="ComputingOfficer">
  <owl:oneOf rdf:parseType="Collection">
    <Academic rdf:about="#nmurray" />
    <Academic rdf:about="#jmartin" />
    <Academic rdf:about="#mritchie" />
  </owl:oneOf>
</owl:Class>
```

Defining an owl:Class (II)

- By property restriction: Lite*/DL/Full

```
    <owl:Class rdf:ID="Researcher">
  <rdfs:subClassOf>
    <owl:Restriction>
      <owl:onProperty rdf:resource="#activity" />
      <owl:someValuesFrom rdf:resource="#ResearchArea" />
    </owl:Restriction>
  </rdfs:subClassOf>
</owl:Class>
```

- By intersection/union/complement: DL/Full

```
<owl:Class rdf:ID="UniversityStaff">
  <owl:unionOf rdf:parseType="Collection">
    <owl:Class rdf:about="#Lecturer" />
    <owl:Class rdf:about="#Researcher" />
    <owl:Class rdf:about="#ComputingOfficer" />
  </owl:unionOf>
</owl:Class>
```

Properties in OWL

- Two types
  - ObjectProperty - relations between instances of classes
  - DatatypeProperty - relates an instance to an rdfs:Literal or XML Schema datatype

  (Both rdfs:subClassOf rdf:Property)

```
<owl:DatatypeProperty rdf:ID="name">
   <rdfs:domain rdf:resource="Person" />
   <rdfs:range rdf:resource=
        "http://www.w3.org/2001/XMLSchema/string" />
</owl:DatatypeProperty>
<owl:ObjectProperty rdf:ID=”activity">
   <rdfs:domain rdf:resource="Person" />
   <rdfs:range rdf:resource="ActivityArea" />
</owl: ObjectProperty>
```

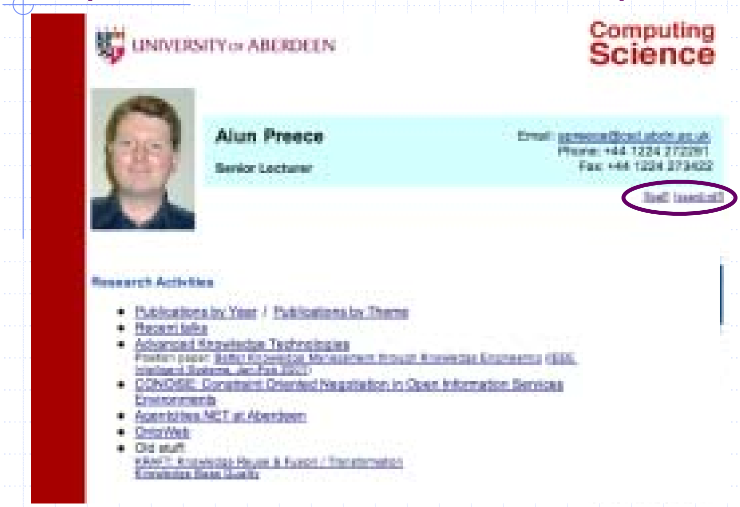
Individual axioms (“facts”)

- OWL is not only a language for defining ontologies - it is used to define their instances (Individuals)
- Example:

```
<Lecturer rdf:ID="apreece">
   <name>Alun Preece</name>
   <activity rdf:resource="#AgentsResearch" />
   <activity rdf:resource="#WebTeaching" />
</Lecturer>
<ResearchArea rdf:ID="AgentsResearch”/>
<TeachingArea rdf:ID=”WebTeaching”/>
```

(Notice how individual **apreece** follows the definition of Lecturer given earlier)

An example: http://www.csd.abdn.ac.uk/~apreece



UNIVERSITY OF ABERDEEN

Computing Science

Alun Preece

Senior Lecturer

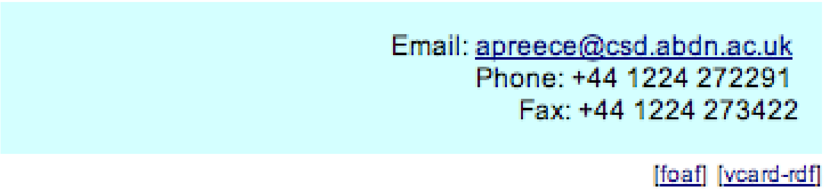
Email: apreece@csd.abdn.ac.uk
Phone: +44 1224 272291
Fax: +44 1224 273422

[foaf] [vcard-rdf]

Research Activities

- Publications by Year / Publications by Theme
- Recent talks
- Advanced Knowledge Technologies
  Position paper: Better Knowledge Management through Knowledge Engineering (IEEE Intelligent Systems, Jan/Feb 2001)
- CONOISE: Constraint Oriented Negotiation in Open Information Services Environments
- Agentcities.NET at Aberdeen
- OntoWeb
- Old stuff
  KRAFT: Knowledge Reuse & Fusion / Transformation
  Knowledge Base Quality

RDF about Alun Preece



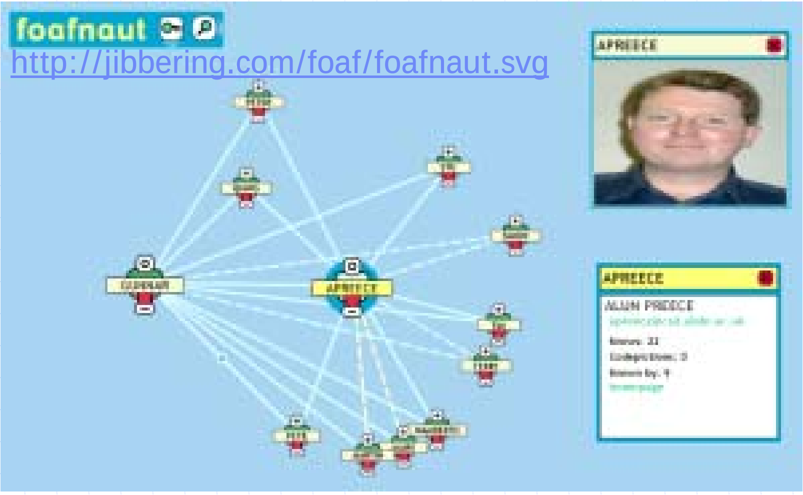
Email: apreece@csd.abdn.ac.uk
Phone: +44 1224 272291
Fax: +44 1224 273422

[foaf] [vcard-rdf]

Friend-of-a-Friend (FOAF) resource data:
http://www.csd.abdn.ac.uk/~apreece/foaf.rdf

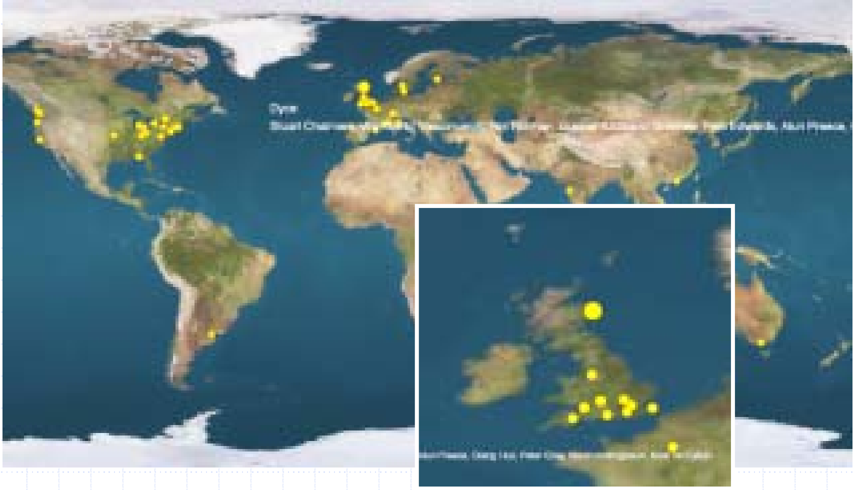
vCard resource data:
http://www.csd.abdn.ac.uk/~apreece/apreece.rdf

Visualising FOAF data



http://jibbering.com/foaf/foafnaut.svg

World Wide FOAF



The FOAF ontology

- FOAF is defined using RDF(S) and OWL http://xmlns.com/foaf/0.1/
- OWL’s InverseFunctionalProperty is used to state that particular properties unambiguously identify unique people:
  - mbox
  - homepage
  - weblog
  - dnaChecksum (joke)
- So, in the FOAF model, non-personal email addresses (say, info@conoise.org) can’t be used to ID a person

OWL for ontology alignment

- There are overlaps between the ontologies for
  - FOAF - http://xmlns.com/foaf/0.1/
  - vCard - http://www.w3.org/2001/vcard-rdf/3.0
- OWL can articulate equivalences, for example:

```
<rdf:Property
 rdf:about="http://www.w3.org/2001/vcard-rdf/3.0#EMAIL">
      <owl:equivalentProperty
       rdf:resource="http://xmlns.com/foaf/0.1/mbox" />
</rdf:Property>
```

- An OWL reasoner could use this equivalence to derive a value for some resource’s vcard:EMAIL if it can find a value for foaf:mbox

OWL: implications

- OWL is potentially the most important knowledge representation language we’ve yet seen
- (Hendler claims DAML already is, in terms of numbers of statements asserted)
- It could be the “last word” in KR similar to how HTML came to dominate the field of hypertext markup
- Implications:
  - If you’re doing KR research, you will need to situate yourself in relation to OWL
  - If you’re building KBS, OWL will be your first choice of KRL
  - There are enormous challenges ahead in creating effective OWL reasoners/processors