

RDF and the Semantic Web

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Semantic Web

- A way to build a model of information (knowledge)
 - Internet accessible
 - To overcome limits of current web
- A representation for the model *and* for the information
 - Schema versus data
 - Uses RDF and XML
- A labeling strategy
 - Everything has an identifier
 - Identifiers enable operations on models

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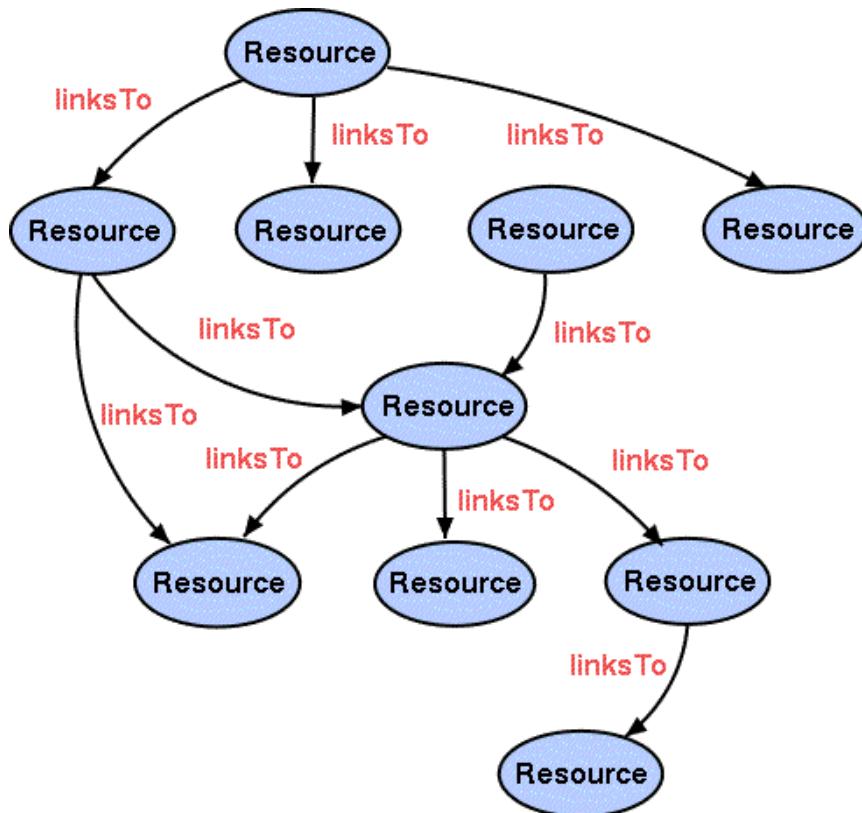
Resources

- Any piece of information
- Uniquely identified
 - Uses Uniform Resource Identifiers (URIs)
 - Need not be a web resource (ID, not a locator)

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Current Web

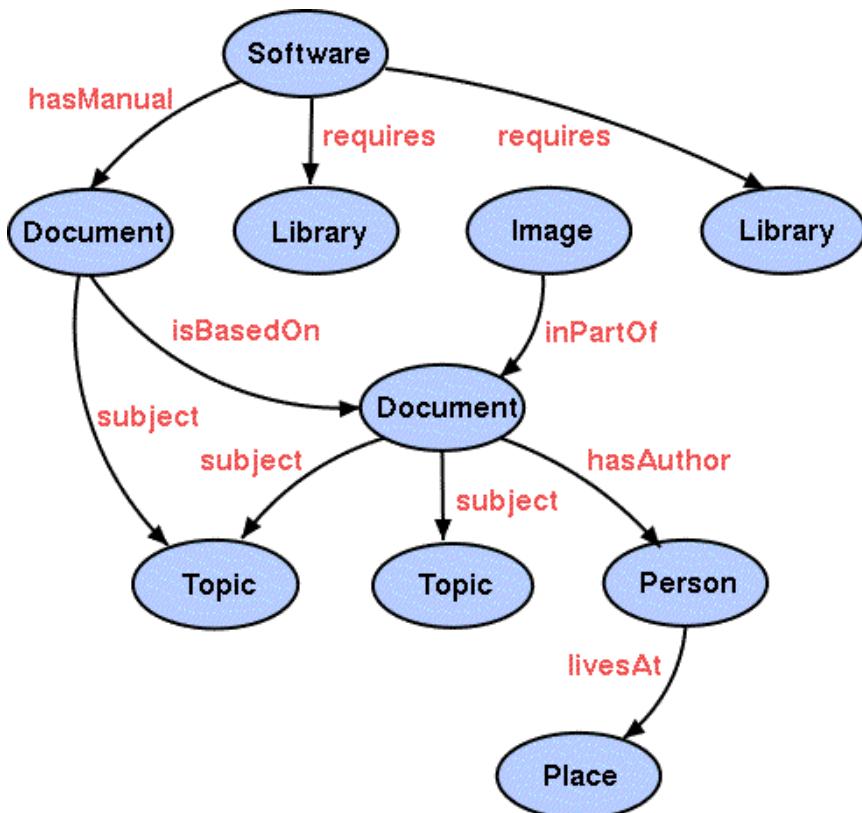
- Collection of documents (resources)
 - Fixed collections of types with specific document structure and semantics
 - Web page
 - Image
 - Known storage representation (document MIME type)
 - May know encoding (characterset)
 - Don't know anything else (no explicit or implicit model)
- Simple linking strategy
 - Links have no special meaning
 - Unidirectional



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Semantic Web

- Collection of global resources
 - Each identified by a URI
- Collection of labeled links
 - Each link has a URI
 - Each link is a resource
 - Links thus have (limited) semantics

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RDF

- Resource Description Format
- A modeling language
- Resource -- anything identified with a URI
 - Uniform Resource Identifier (versus URL, URN)
 - ID is *uniform* or *universal* (with a known syntax)
 - Can be an ID for anything, not just network resources
- Everything in RDF is a resource
- Resources are linked
- Linking creates a *semantic web*

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Resource Statements

- *Subject* has a *property* with a *value*
- Everything in RDF is a resource, i.e., has a URI
 - Subject
 - Property (or predicate)
 - Value (or object)
- Resource (subject) has a property resource with an object resource
- Subject is linked to *object* (value) via a *predicate* (object)

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Resource Statement Representations

- Can be ad hoc in natural language
- Can be triples (subject, predicate, object)

- Can be a graph
- Can be informal RDF notation
- Can be encoded in XML

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Example Semantic Model: Natural Language

- Resource has *property* with value *value*
- *http://www.example.org/index.html* has a *creation-date* whose value is *August 16, 1999*
- *http://www.example.org/index.html* has a *language* whose value is *English*

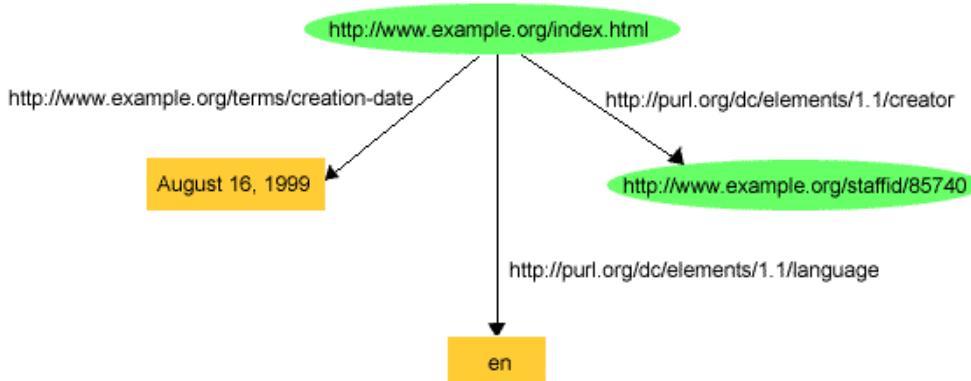
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Example Semantic Model: URI Triples

- <Resource URI> <Property URI> <Value URI>
- <<http://www.example.org/index.html>> <<http://purl.org/dc/elements/1.1/creator>>
<http://www.example.org/staffid/85740>
- <<http://www.example.org/index.html>> <<http://www.example.org/terms/creation-date>> "August 16, 1999"
- <<http://www.example.org/index.html>> <<http://purl.org/dc/elements/1.1/language>> "en"

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Example Semantic Model: Graph

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Example Semantic Model: Informal RDF Notation

```

ex:index.html dc:creator exstaff:85740
ex:index.html exterm:creation-date "August 16, 1999"
ex:index.html dc:language "en"

```

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Example Semantic Model: RDF in XML

```

<?xml version="1.0"?>
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
           xmlns:dc="http://purl.org/dc/elements/1.1/"
           xmlns:exterm="http://www.example.org/terms/">

    <rdf:Description rdf:about="http://www.example.org/index.html">
        <exterm:creation-date>August 16, 1999</exterm:creation-date>
    
```

```

</rdf:Description>

<rdf:Description rdf:about="http://www.example.org/index.html">
  <dc:language>en</dc:language>
</rdf:Description>

<rdf:Description rdf:about="http://www.example.org/index.html">
  <dc:creator rdf:resource="http://www.example.org/staffid/85740"/>
</rdf:Description>

</rdf:RDF>

```

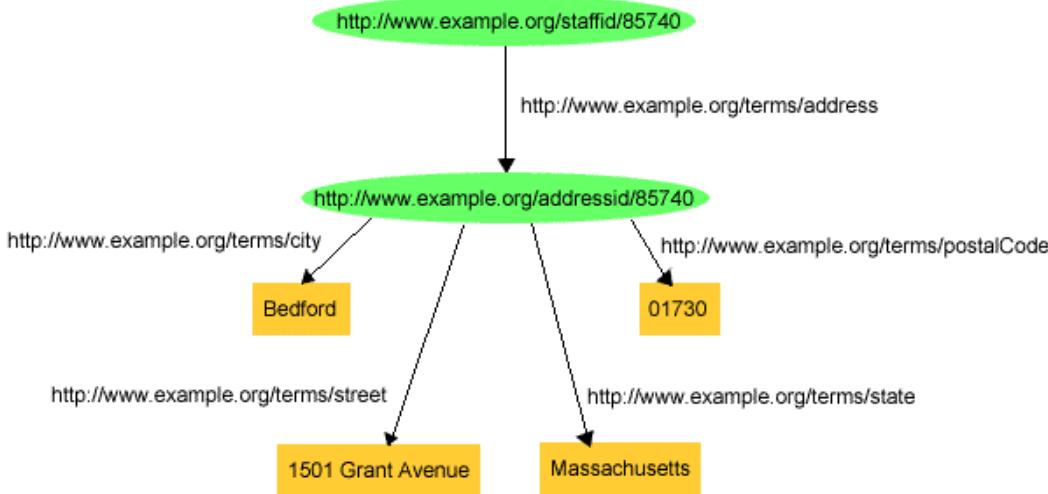
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Example Semantic Model 2: Informal RDF Notation

exstaff:85740	exterms:address	exaddressid:85740
exaddressid:85740	exterms:street	"1501 Grant Avenue"
exaddressid:85740	exterms:city	"Bedford"
exaddressid:85740	exterms:state	"Massachusetts"
exaddressid:85740	exterms:postalCode	"01730"
exstaff:85740	exterms:age	"27"^^xsd:integer (literal value)

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Example Semantic Model 2: Graph

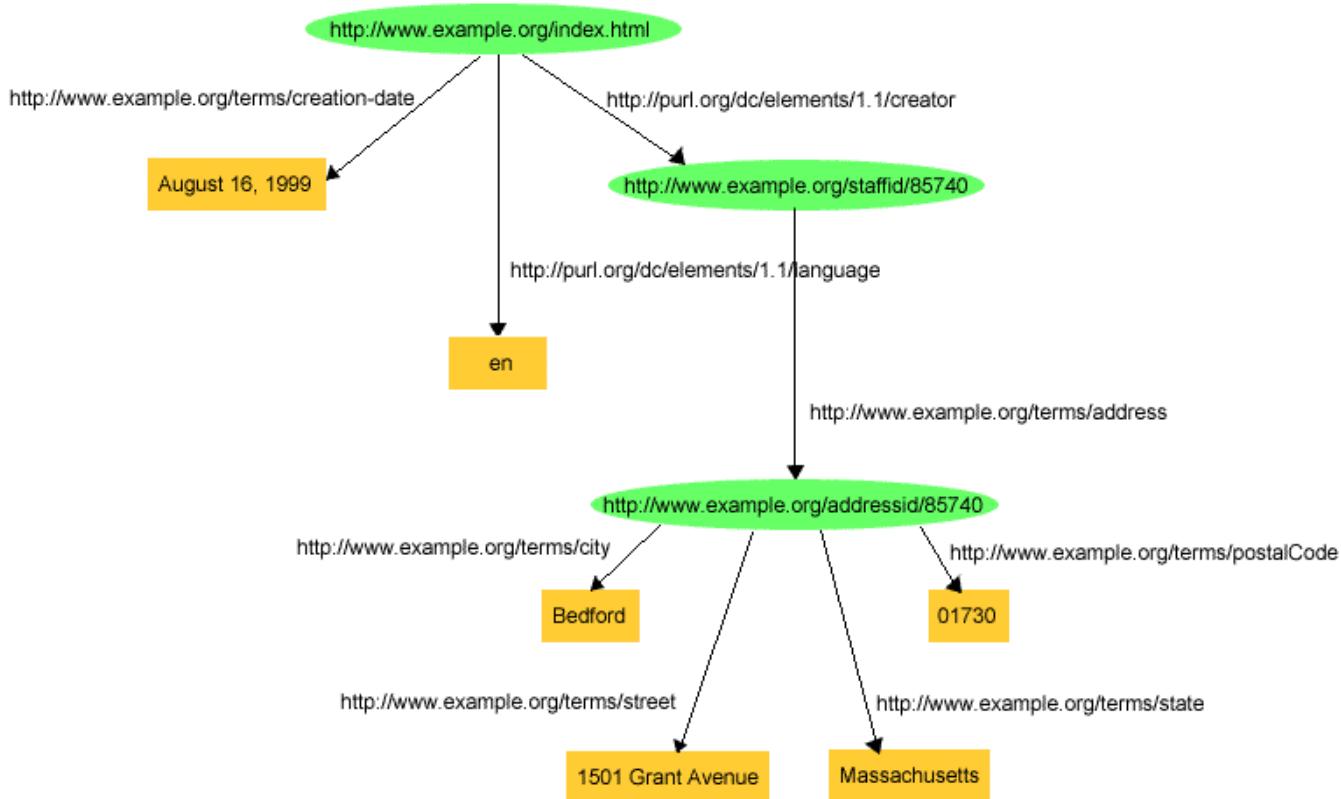
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Richer Semantic Models

- Since ids are *universal* you can use them to combine concepts

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Example Combined Semantic Model: Graph

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Reification

- RDF is defined in RDF
- Can write RDF statements about RDF

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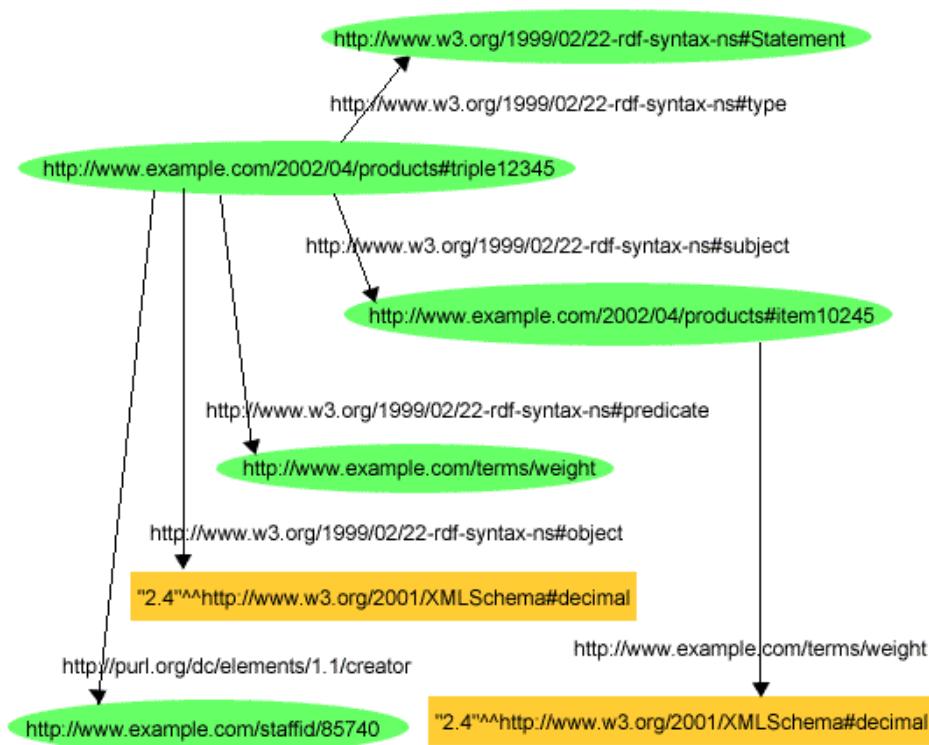
Example RDF in RDF: Informal RDF Notation

```

exproducts:triple12345 rdf:type      rdf:Statement
exproducts:triple12345 rdf:subject    exproducts:item10245
exproducts:triple12345 rdf:predicate  exterm:weight
exproducts:triple12345 rdf:object     "2.4"^^xsd:decimal
  
```

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Example RDF in RDF: Graph

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Example RDF in RDF: RDF in XML

```

<?xml version="1.0"?>
<!DOCTYPE rdf:RDF [ <!ENTITY xsd "http://www.w3.org/2001/XMLSchema#"> ]>
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
           xmlns:dc="http://purl.org/dc/elements/1.1/"
           xmlns:externms="http://www.example.com/terms/"
           xml:base="http://www.example.com/2002/04/products">

<rdf:Description rdf:ID="item10245">
    <externms:weight rdf:datatype="&xsd;decimal">2.4</externms:weight>
</rdf:Description>

<rdf:Statement rdf:about="#triple12345">
    <rdf:subject rdf:resource="http://www.example.com/2002/04/products#item10245"/>
    <rdf:predicate rdf:resource="http://www.example.com/terms/weight"/>
    <rdf:object rdf:datatype="&xsd;decimal">2.4</rdf:object>
</rdf:Statement>

<dc:creator rdf:resource="http://www.example.com/staffid/85740"/>
</rdf:Statement>

</rdf:RDF>
  
```

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RDF Vocabulary Example: Informal RDF Notation

ex:MotorVehicle	rdf:type	rdfs:Class
ex:PassengerVehicle	rdf:type	rdfs:Class
ex:Van	rdf:type	rdfs:Class
ex:Truck	rdf:type	rdfs:Class
ex:MiniVan	rdf:type	rdfs:Class
ex:PassengerVehicle	rdfs:subClassOf	ex:MotorVehicle
ex:Van	rdfs:subClassOf	ex:MotorVehicle
ex:Truck	rdfs:subClassOf	ex:MotorVehicle

ex:MiniVan rdfs:subClassOf ex:Van
ex:MiniVan rdfs:subClassOf ex:PassengerVehicle

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RDF Drawbacks

- No builtin type system
- Very simple schema and vocabularies

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Overcoming the Drawbacks

- Need to create a richer semantic model
- Model *ontologies*
- *OWL* Web Ontology Language

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OWL

- Schema definition
 - class
 - subclass
 - property
 - subproperty
 - domain
 - range
- (In)Equality
 - equivalent class or property
 - same
 - different
 - distinct members
- Restrictions
 - values from set
 - minimum and maximum cardinality
- Property definitions
 - inverse
 - symmetric
- Versions
- Intersections definitions
 - complement
 - union
 - intersection
- Annotations
- Datatypes
 - from XML Schema

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Semantic Web Representation Stack

- XML
 - Syntax for structured documents
 - Does not provide semantics or constraints on document meaning

- XML Schema
 - Adds data types, structures and limited constraints to XML
 - Used to define simple semantic model for individual documents
 - Built on XML
- RDF
 - Data model for resources
 - Model for relations between resources
 - Provides for simple semantics of a network of resources
 - XML syntax, XML Schema data types
- RDF Schema
 - Vocabulary for hierarchies of RDF resources
 - Adds classes and properties to RDF
- OWL
 - Extended vocabulary -- relations (disjointness, equality), cardinality, more types

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Using the Semantic Web

- RDF and OWL provide a way to model information
- Data instances are created that belong to the models
- Programs process using data and model
- Development of common behaviors (services) is underway

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Semantic Web versus XML and Web Services

- Large investment in XML schema models and web services
- Scalability
- Common features of semantic processing stack and web services stack
- When are IDs actionable (URI yields a URL)

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Information Resources

- [RDF Primer W3C Recommendation, February 10 2004](http://www.w3.org/TR/rdf-primer/)
<http://www.w3.org/TR/rdf-primer/>
- [OWL Web Ontology Language Overview W3C Recommendation, February 10, 2004](http://www.w3.org/TR/owl-features/)
<http://www.w3.org/TR/owl-features/>

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