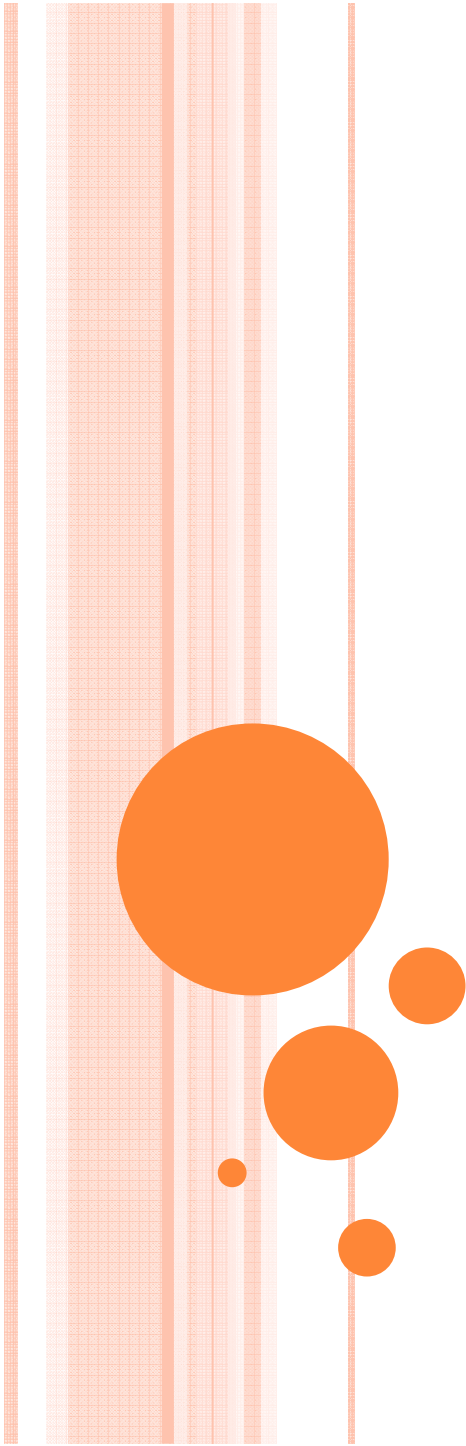




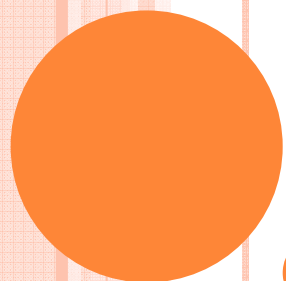
RDF AND RDF SCHEMA

Based slides from “RDF Data Model & How Linking Works” by Lalana Kagal from the Decentralized Information Group, CSAIL. I also used some slides/text from tutorial of Vagan Terziyan and Michal Nagy (University of Jyväskylä) which is based on tutorials and presentations of O. Lassila, R.R. Swick, J. Cowan, D. Brickley, R.V. Guha, W3C.

CONTENTS

- RDF
- RDF Schema



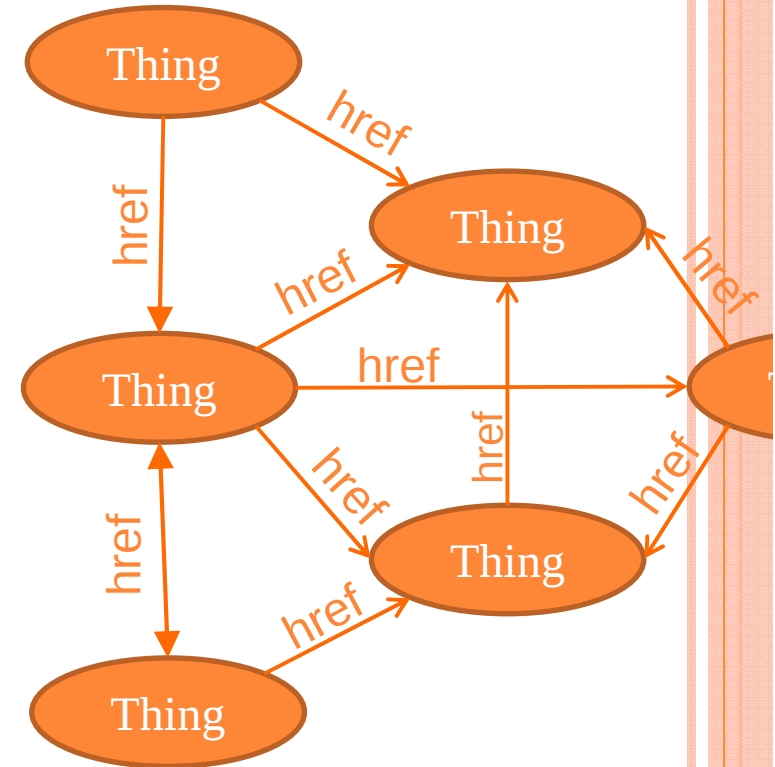
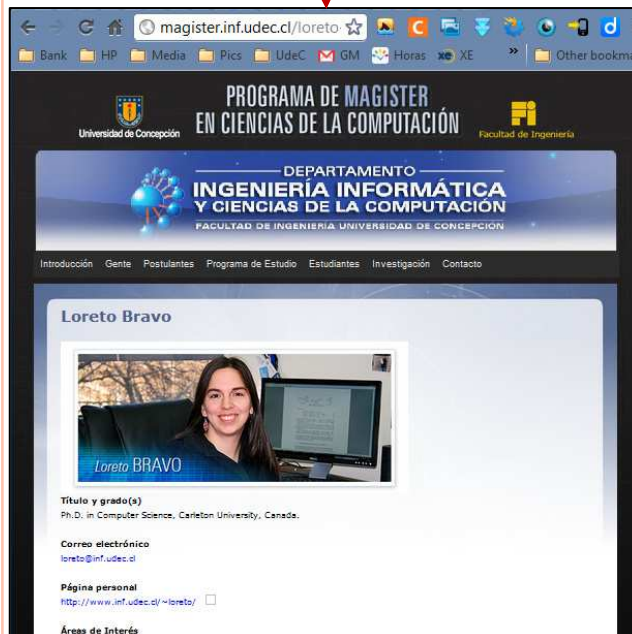


RDF

GROWTH OF INFORMATION IN THE WEB



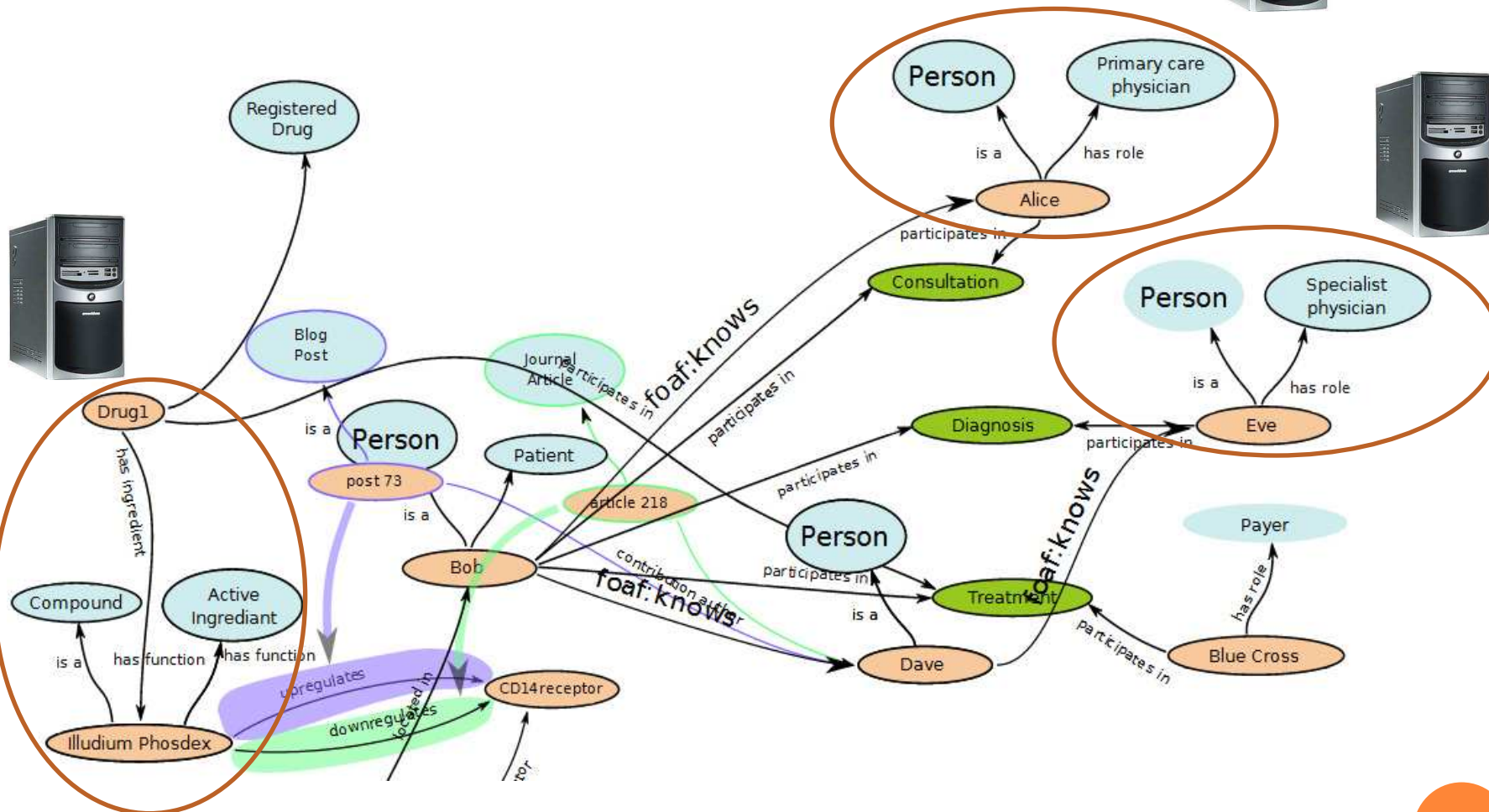
WHAT HUMANS AND COMPUTERS SEE



Idea of the diagram: “RDF Data Model & How Linking Works”. Lalana Kagal, MIT



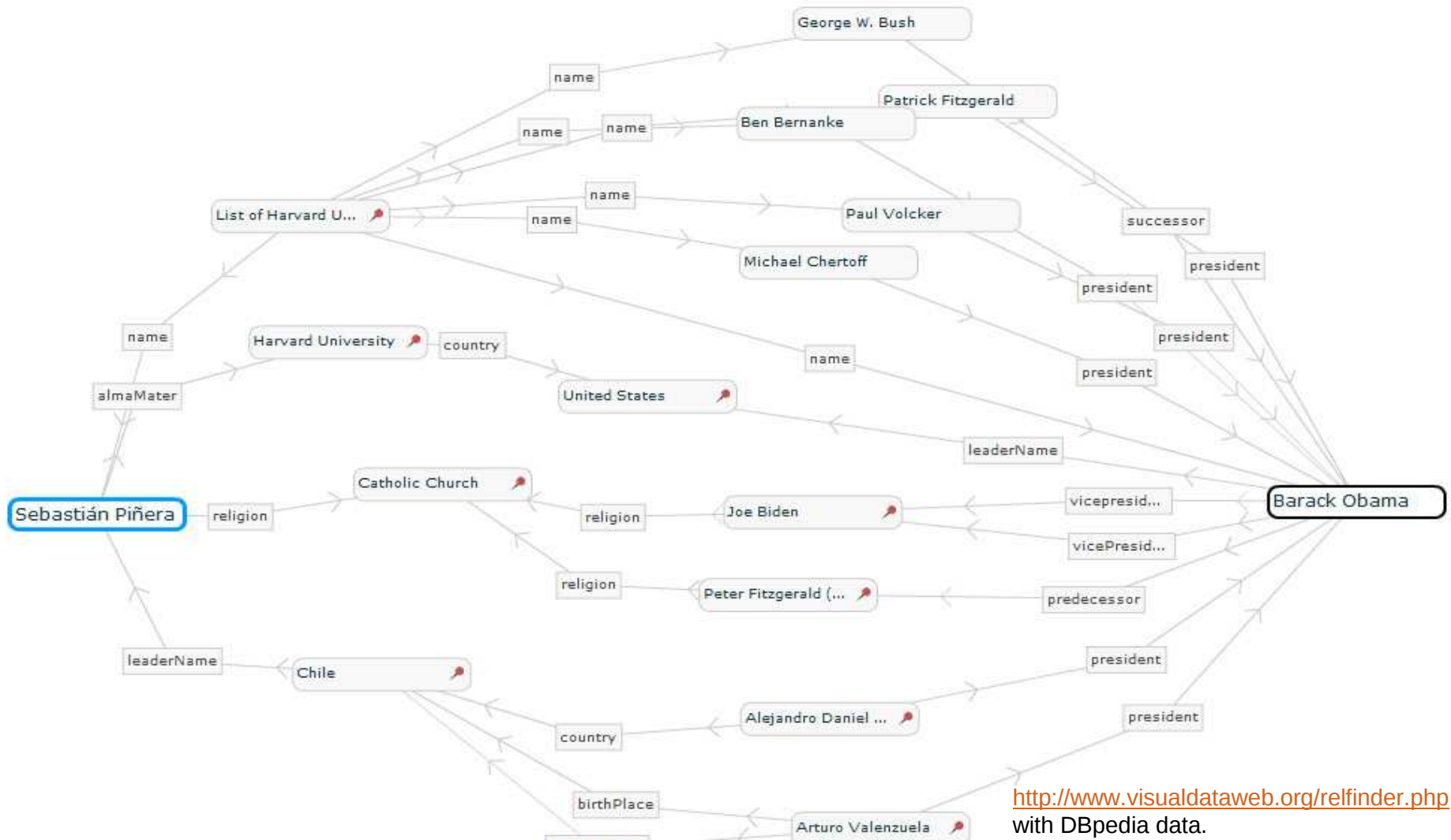
SEMANTIC WEB



Taken from *RDF geeking for Life Sciences*
 (<http://www.w3.org/2009/Talks/1005-jaoo-egp>)
 and W3C (<http://www.w3.org>)

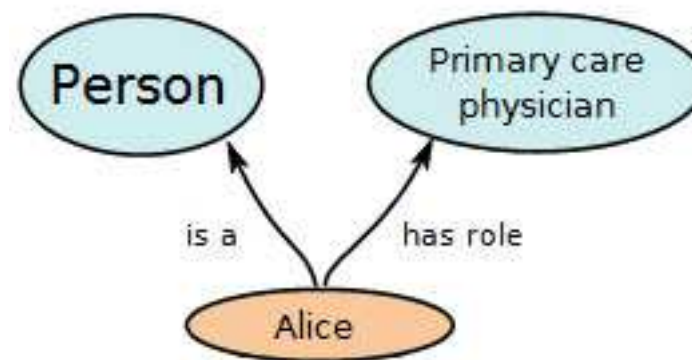
WHY IS LINKED DATA USEFUL?

- Whats the relationship between Sebastián Piñera and Barack Obama?



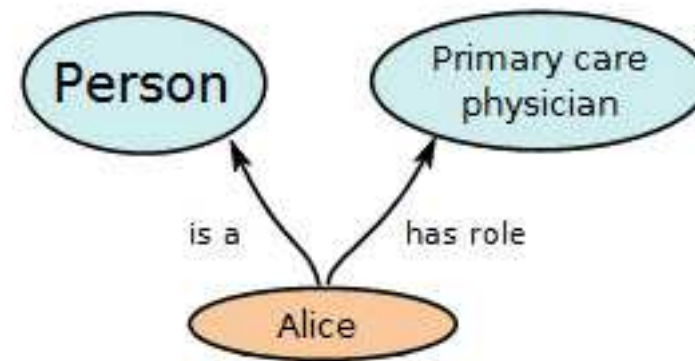
SEMANTIC WEB: RDF

- Resource Description Framework (RDF) is a foundation for processing metadata in the Web;
- It provides interoperability between applications that exchange machine-understandable information on the Web;
- RDF emphasises facilities to enable automated processing of Web resources;
- It is a mechanism for describing resources that makes no assumptions about a particular application domain.



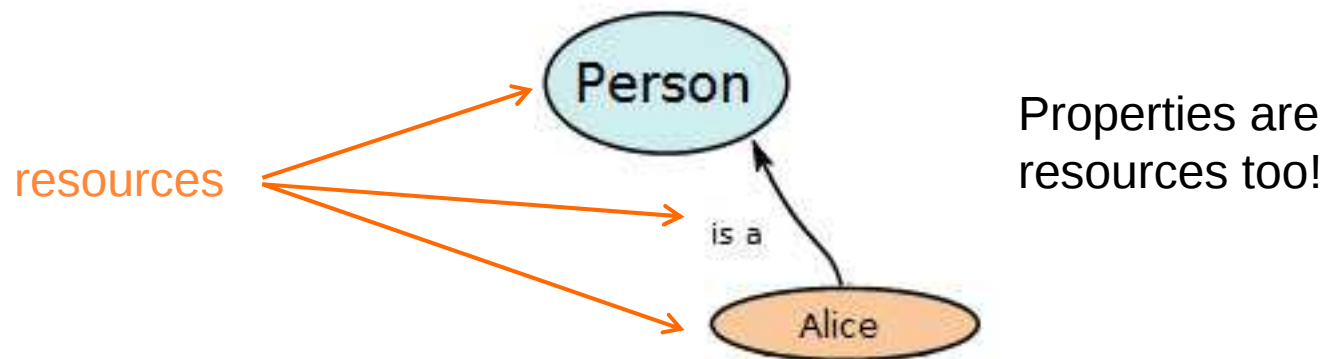
BASIC OBJECTS IN RDF DATA MODEL

- Resources
- Properties
- Statements



RESOURCES

- A resource can be anything that has identity:
 - entire Web page or part of a Web page (e.g. a specific XML element within a doc);
 - whole collection of pages (e.g. an entire Web site);
 - an object that is not accessible via the Web (e.g. a printed book, a person, a corporation).



RESOURCES

- Uniform Resource Identifiers (URI) provide a simple and extensible means for identifying a resource
 - "Uniform Resource Locator" (URL) refers to the subset of URI that identify resources via a representation of their location
 - Examples of URI:
 - urn:isbn:0-486-27557-4
 - <file:///home/username/RomeoAndJuliet.pdf>
 - fax:<phonenumber>
 - [telnet://<user>:<password>@<host>\[:<port>/\]](telnet://<user>:<password>@<host>[:<port>/])
 - <doi:10.1000/182>
 - dns://192.168.1.1/ftp.example.org?type=A
 - ftp://asmith@ftp.example.org
 - <http://www.reddit.com>



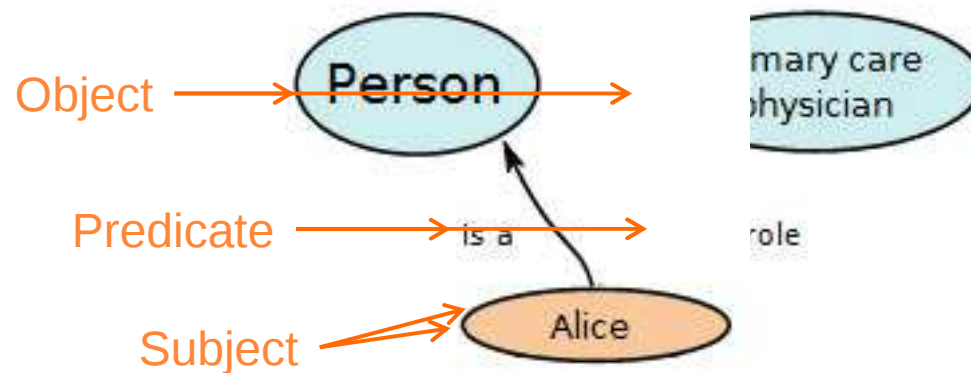
PROPERTIES

- A property is a specific aspect, characteristic, attribute, or relation used to describe a resource.
- Each property has a specific meaning, defines its permitted values, the types of resources it can describe, and its relationship with other properties.

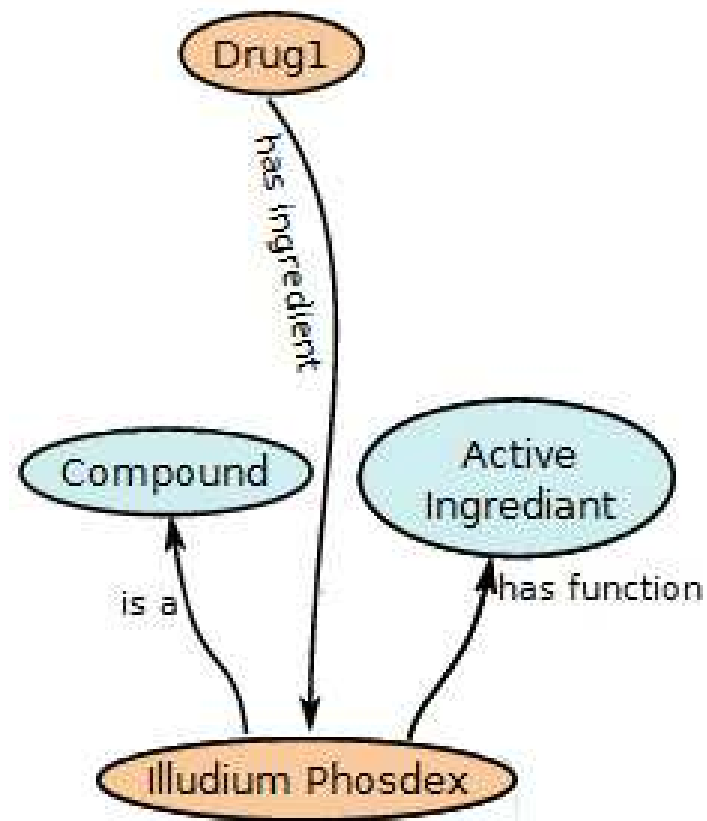


STATEMENTS

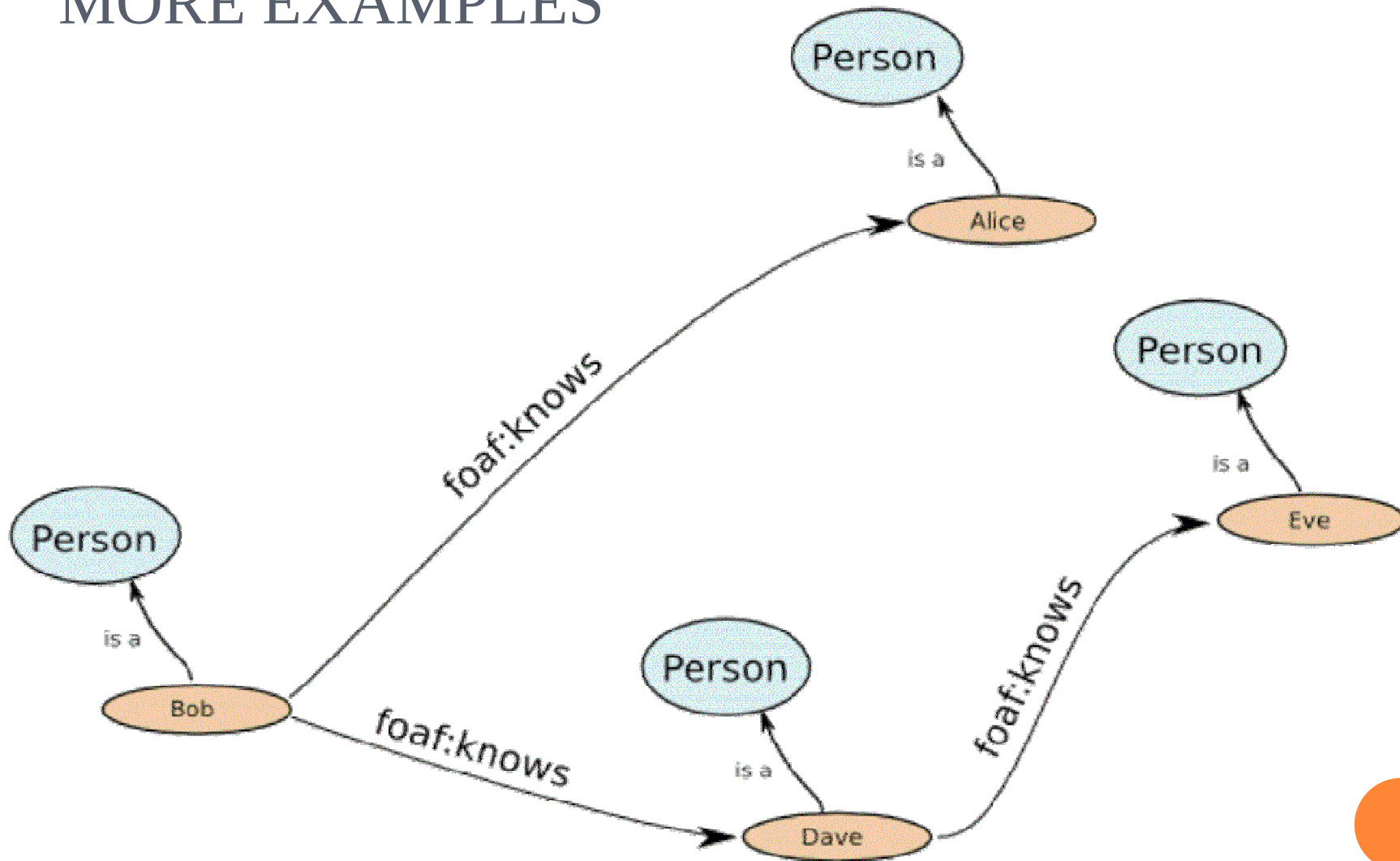
- A specific resource together with a named property plus the value of that property for that resource is an RDF statement.
- Triplet: (**Subject**, **Property**, **Object**)
 - **Subject** of an RDF statement is a resource
 - **Predicate** of an RDF statement is a property of a resource
 - **Object** of an RDF statement is the value of a property of a resource



MORE EXAMPLES

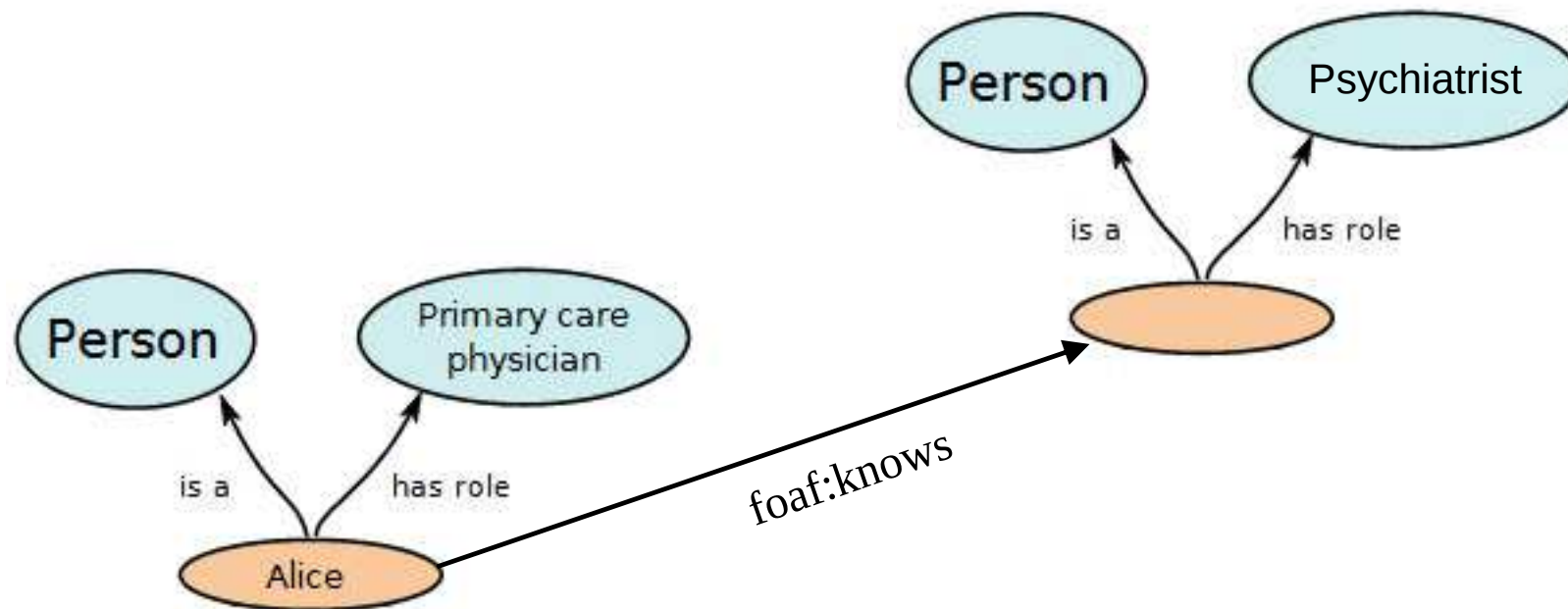


MORE EXAMPLES



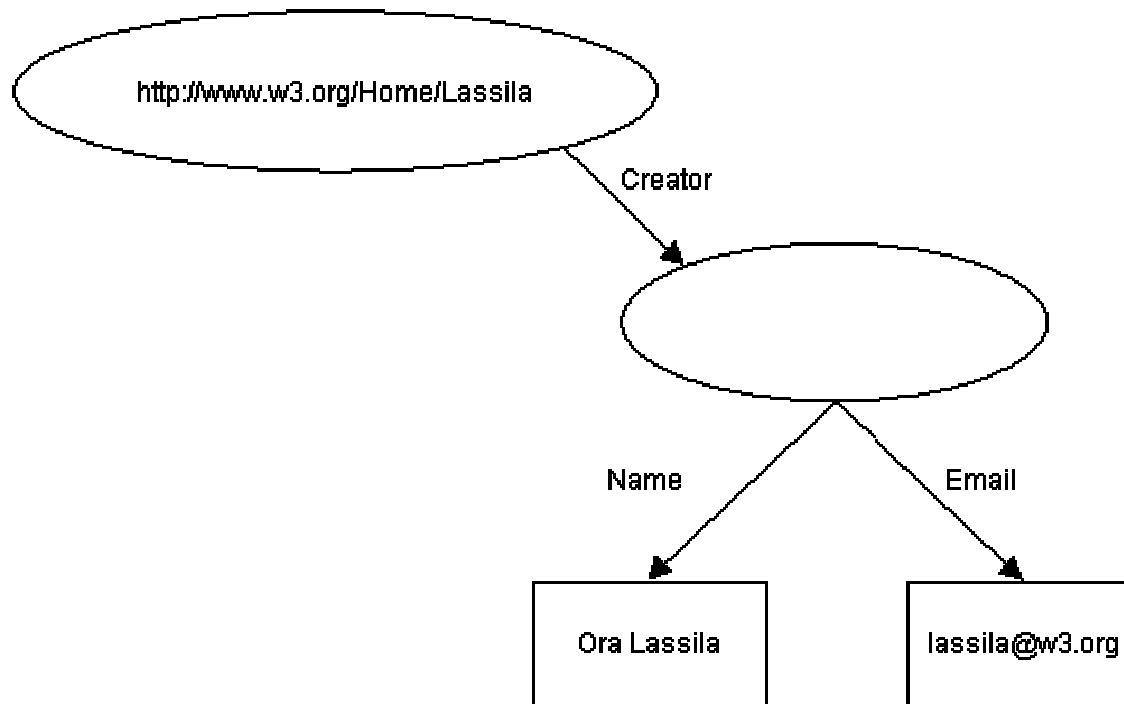
BLANK NODES

- “Alice has a friend who is a Psychiatrist”

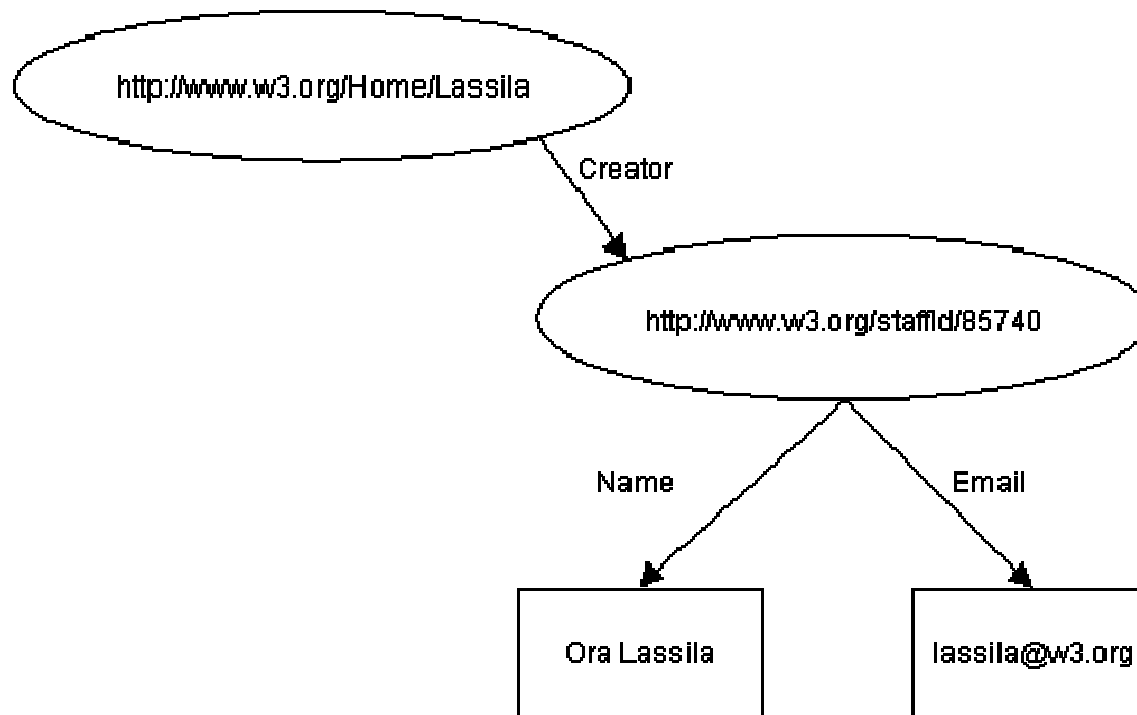


BLANK NODES

- “The individual whose name is Ora Lassila with email lassila@w3.org, is the creator of <http://www.w3.org/Home/Lassil>”



The individual referred to by employee id 85740 is named Ora Lassila and has the email address lassila@w3.org. The resource <http://www.w3.org/Home/Lassila> was created by this individual.



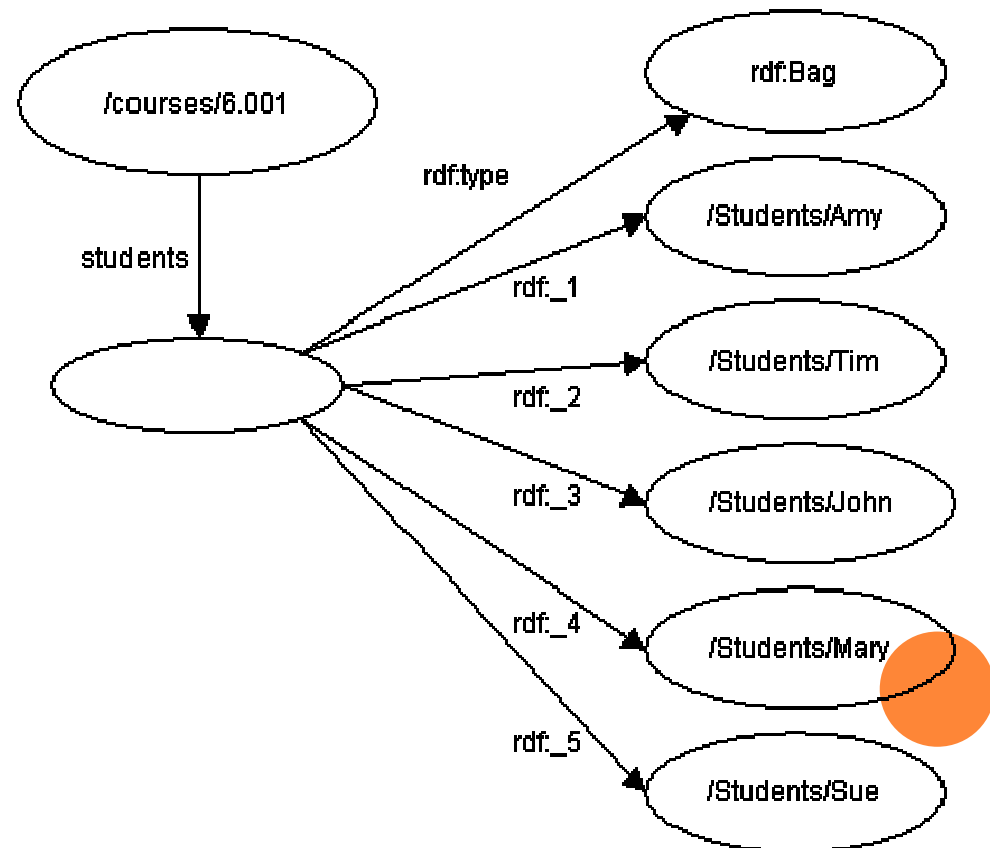
No blank node needed anymore



CONTAINERS

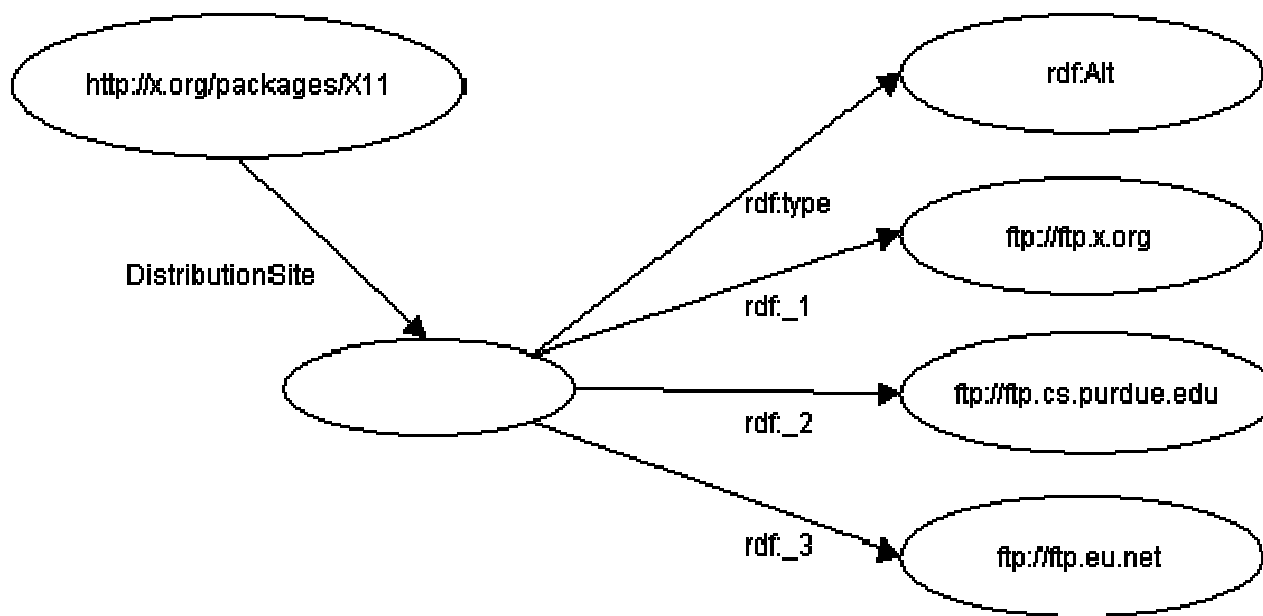
- Frequently it is necessary to refer to a collection of resources. RDF containers are used to hold such lists of resources or literals. There are three types of a container:
 - bag
 - sequence
 - alternative

Example: The students in course 6.001 are Amy, Tim, John, Mary, and Sue



EXAMPLE: ALTERNATIVE CONTAINER

The source code for X11 may be found at [ftp.x.org](ftp://ftp.x.org), [ftp.cs.purdue.edu](ftp://ftp.cs.purdue.edu), or [ftp.eu.net](ftp://ftp.eu.net)



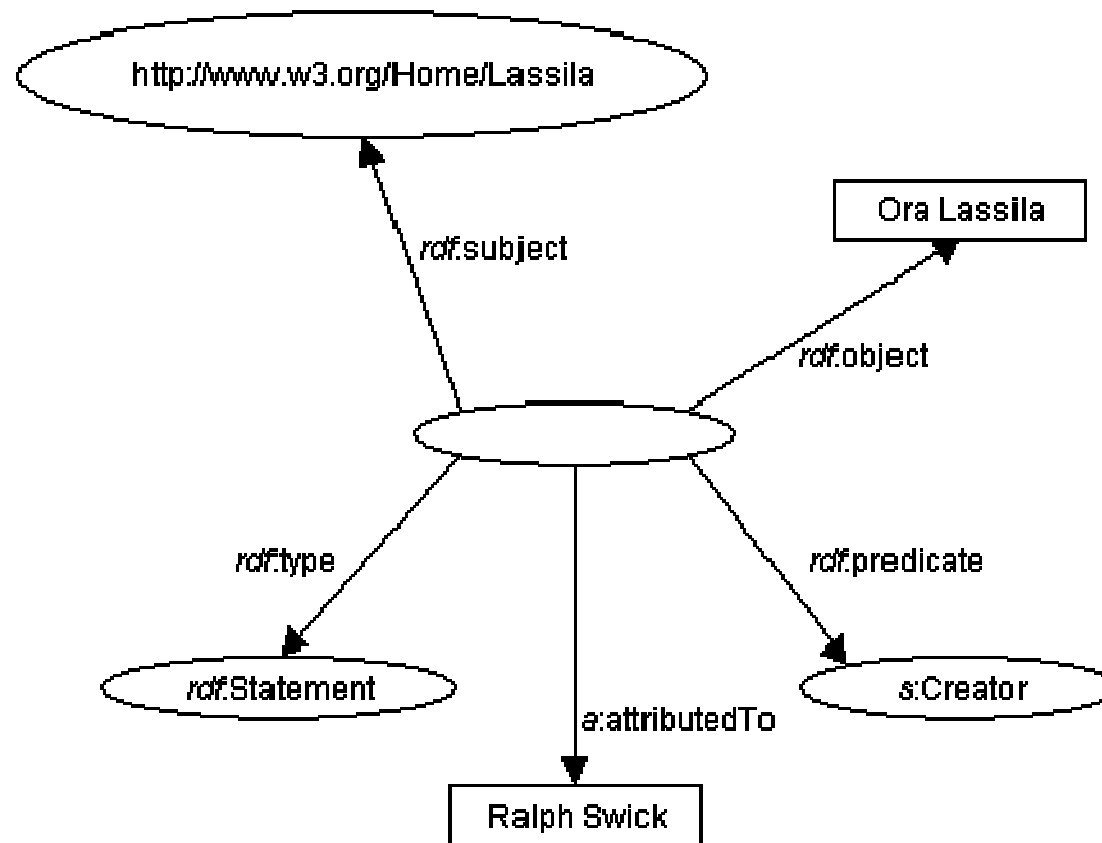
STATEMENTS ABOUT STATEMENTS

- For example, let us consider the sentence:
 - “Ora Lassila is the creator of the resource <http://www.w3.org/Home/Lassila>”.
 - RDF would regard this sentence as a fact.
- If, instead, we write the sentence:
 - “Ralph Swick says that Ora Lassila is the creator of the resource <http://www.w3.org/Home/Lassila>”
 - ... we have said nothing about the resource <http://www.w3.org/Home/Lassila>; instead, we have expressed a fact about a statement Ralph has made.
- How is this situation modelled in RDF?



STATEMENTS ABOUT STATEMENTS

- Ralph Swick says that Ora Lassila is the creator of the resource <http://www.w3.org/Home/Lassila>



RDF FORMATS

- Graphs can be “serialized” or represented in a textual format.
- Serialization formats:
 - Based on Triples:
 - **NTriples**: triples with no abbreviations
 - **Turtle**: Ntriples + abbreviations
 - **Notation3** (N3): Turtle + RDF rules
 - RDF/XML (W3C recommendation)
 - RDFa for webpages (W3C recommendation)



SERIALIZATION

Triple: (Subject Predicate Object)

- Each **subject** and **object** is represented as:
 - a blank node
 - Example: “_2”
 - a literal value: “value”^^type where type is some URI, that defines a data type
 - Example “21”^^:age
 - a URI
 - Example: <http://fake.host.edu/smith>



SERIALIZATION

Triple: (Subject Predicate Object)

- Each **predicate** is represented as one of the following:
 - a URI,
 - Example: <http://fake.host.edu/contact-schema#fav>
 - abbreviated URI
 - Example: example:age which represents a URI that will be expanded by substituting a value for the string “example”.

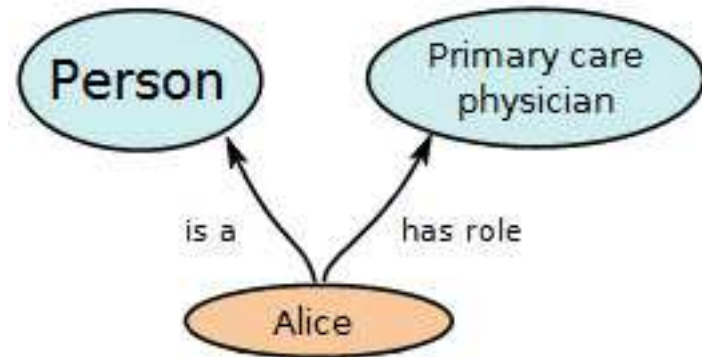
If the specified URI is dereferenceable to a URL, that URL may identify a text file that defines the meaning (or semantics) of the predicate.



NTRIPLE

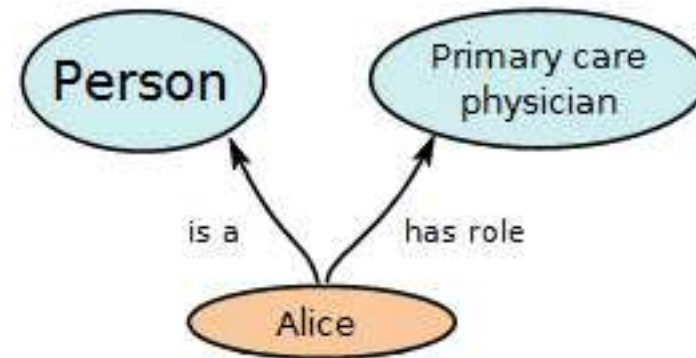
- Plain text format for RDF
- Each triple ended by a period.
- <http://www.w3.org/2001/sw/RDFCore/ntriples/>
- Example:

```
<http://dig.csail.mit.edu/2010/LinkedData/testdata/alice#Alice>  
<http://www.w3.org/1999/02/22-rdf-syntax-ns#type>  
<http://dig.csail.mit.edu/2010/LinkedData/testdata/example#Person>.  
<http://dig.csail.mit.edu/2010/LinkedData/testdata/alice#Alice>  
<http://dig.csail.mit.edu/2010/LinkedData/testdata/example#role>  
<http://dig.csail.mit.edu/2010/LinkedData/testdata/example#PrimaryCarePhysician>.
```



TURTLE

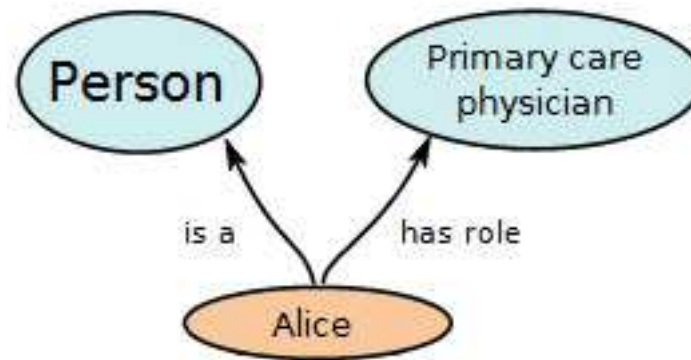
- Textual syntax for RDF that allows RDF graphs to be completely written in a compact and natural text form, with abbreviations for common usage patterns and datatypes
- Example:



```
alice:Alice rdf:type ex:Person .  
alice:Alice ex:role ex:PrimaryCarePhysician .
```



TURTLE



@prefix ex: <http://dig.csail.mit.edu/2010/LinkedData/testdata/example#> .

@prefix foaf: <http://xmlns.com/foaf/0.1/> .

@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .

@prefix : <http://dig.csail.mit.edu/2010/LinkedData/testdata/alice#> .

:Alice rdf:type foaf:Person.

:Alice ex:role ex:PrimaryCarePhysician.



N3

- is a compact and readable alternative to RDF's XML syntax, but also is extended to allow greater expressiveness (such as rules)
- <http://www.w3.org/DesignIssues/Notation3>
- Turtle + rules + builtins
- Some notations
 - prefix notation same as Turtle
 - no default “:” and `rdf:type` is replaced by “a”
 - Example: **JoeLamba a Person.**



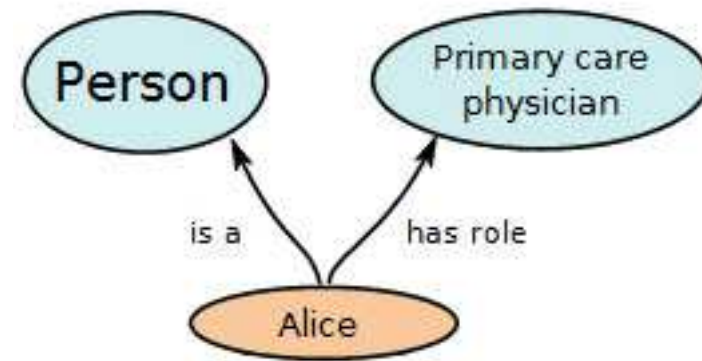
TURTLE/N3: SHORTHAND NOTATIONS

- multiple property-value pairs of same instance can be combined:
 - `<subject> <predicate1> <object1>; <predicate2> <object2>; <predicate3> <object3>.`
 - Example `:Alice rdf:type ex:Person; ex:role ex:PrimaryCarePhysician .`
- multiple values for same properties
 - Example `:Alice rdf:type ex:Person, ex:Female.`
- anonymous/blank node (no identifier)
 - `[ rdf:type ex:Person, ex:Female ].`
 - Example `:Alice foaf:knows [ foaf:name "Carol Nobody" ].`



RDF/XML

- XML syntax for RDF
- W3C Recommendation
- <http://www.w3.org/TR/REC-rdf-syntax/>



```
<rdf:Description rdf:about="http://dig.csail.mit.edu/2010/LinkedData/testdata/alice#Alice">
```

```
  <rdf:type>
```

```
    <rdf:Description rdf:about="http://dig.csail.mit.edu/2010/LinkedData/testdata/example#Person">
```

```
    </rdf:Description>
```

```
  </rdf:type>
```

```
</rdf:Description>
```

```
<rdf:Description rdf:about="http://dig.csail.mit.edu/2010/LinkedData/testdata/alice#Alice">
```

```
  <ex:role>
```

```
    <rdf:Description rdf:about="http://dig.csail.mit.edu/2010/LinkedData/testdata/example#PrimaryCarePhysician">
```

```
    </rdf:Description>
```

```
  </ex:role>
```

```
</rdf:Description>
```

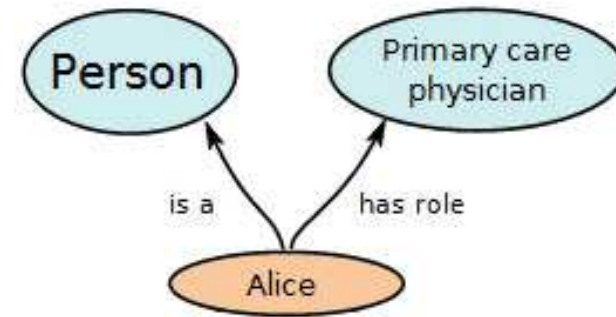


RDF/XML

- Starting and ending tags
 - `<rdf:RDF> ... </rdf:RDF>`
- Namespaces
 - `xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"`
 - `xmlns="http://dig.csail.mit.edu/2010/LinkedData/testdata/alice#"`
- Prefixes
 - `http://www.w3.org/1999/02/22-rdf-syntax-ns#type => rdf:type`
- Subjects defined using
 - `<rdf:Description rdf:about=uri of subject ></rdf:Description>`
- Properties of subjects defined inside `rdf:Description` of the subject using start and end tags
 - `<rdf:type></rdf:type>`
- Objects defined inside property tags using `rdf:Description`



RDF/XML



```
<rdf:RDF xmlns="http://dig.csail.mit.edu/2010/LinkedData/testdata/alice#"
  xmlns:ex="http://dig.csail.mit.edu/2010/LinkedData/testdata/example#"
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#">
```

```
<rdf:Description rdf:about="http://dig.csail.mit.edu/2010/LinkedData/testdata/alice#Alice">
```

```
<rdf:type>
```

```
<rdf:Description rdf:about="http://dig.csail.mit.edu/2010/LinkedData/testdata/example#Person">
```

```
</rdf:Description>
```

```
</rdf:type>
```

```
</rdf:Description>
```

```
<rdf:Description rdf:about="http://dig.csail.mit.edu/2010/LinkedData/testdata/alice#Alice">
```

```
<ex:role>
```

```
<rdf:Description rdf:about="http://dig.csail.mit.edu/2010/LinkedData/testdata/example#PrimaryCarePhysician">
```

```
</rdf:Description>
```

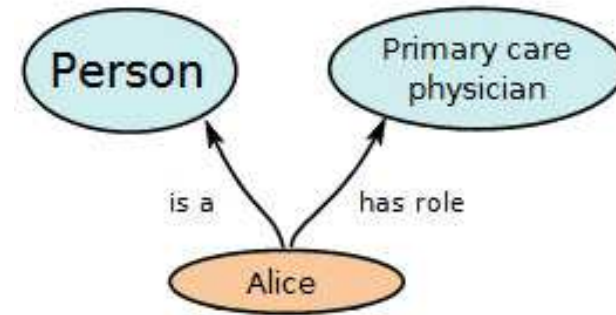
```
</ex:role>
```

```
</rdf:Description>
```

```
</rdf:RDF>
```



RDF/XML: SUMMARIZED



```
<rdf:RDF xmlns="http://dig.csail.mit.edu/2010/LinkedData/testdata/alice#"
  xmlns:ex="http://dig.csail.mit.edu/2010/LinkedData/testdata/example#"
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#">
  <rdf:Description rdf:about="http://dig.csail.mit.edu/2010/LinkedData/testdata/alice#Alice">
    <rdf:type rdf:resource="http://dig.csail.mit.edu/2010/LinkedData/testdata/example#Person" />
    <ex:role
rdf:resource="http://dig.csail.mit.edu/2010/LinkedData/testdata/example#PrimaryCarePhysician" />
  </rdf:Description>
</rdf:RDF>
```



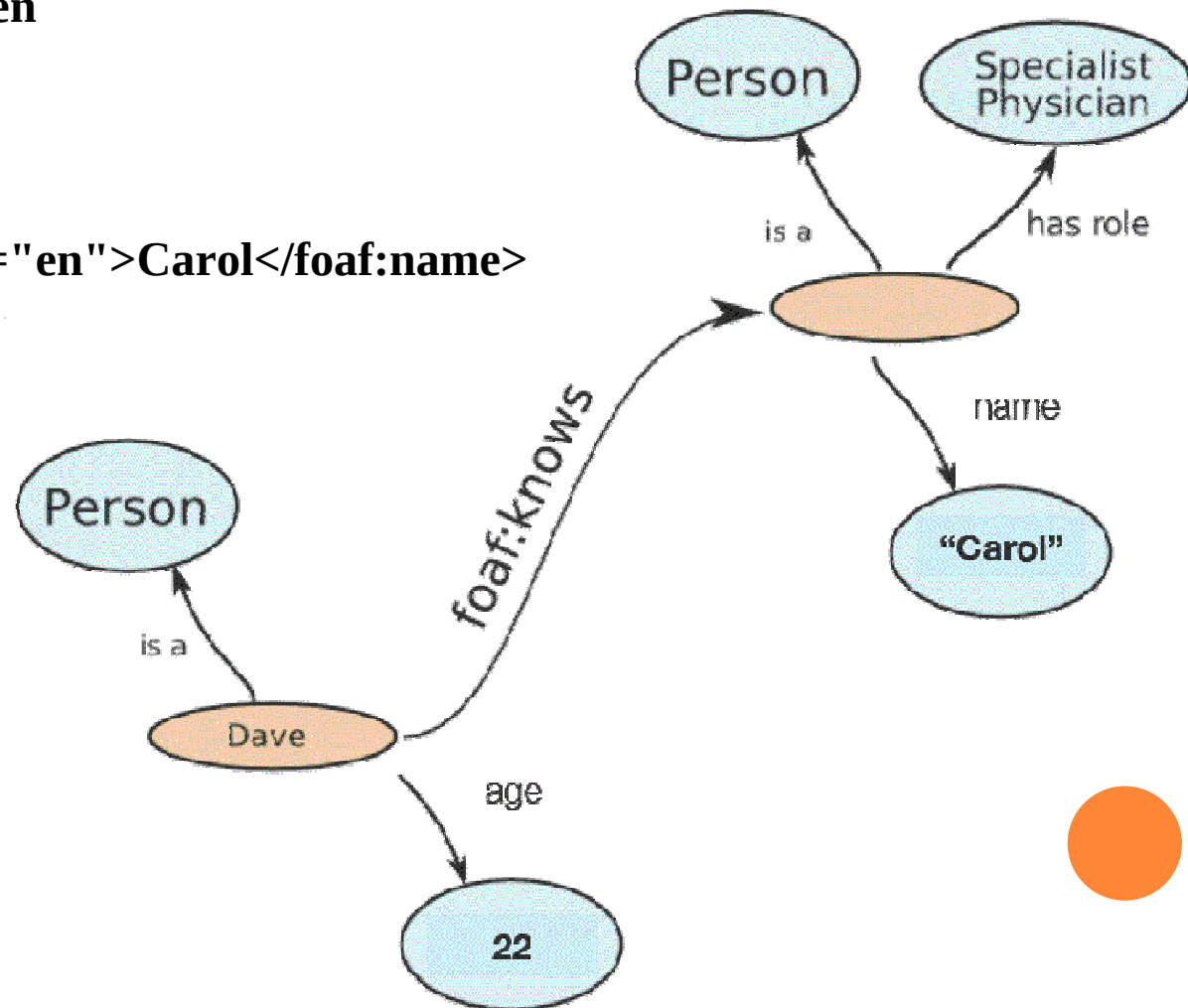
LITERALS

- N3

- **foaf:name "Carol"@en**

- RDF/XML

- **<foaf:name xml:lang="en">Carol</foaf:name>**



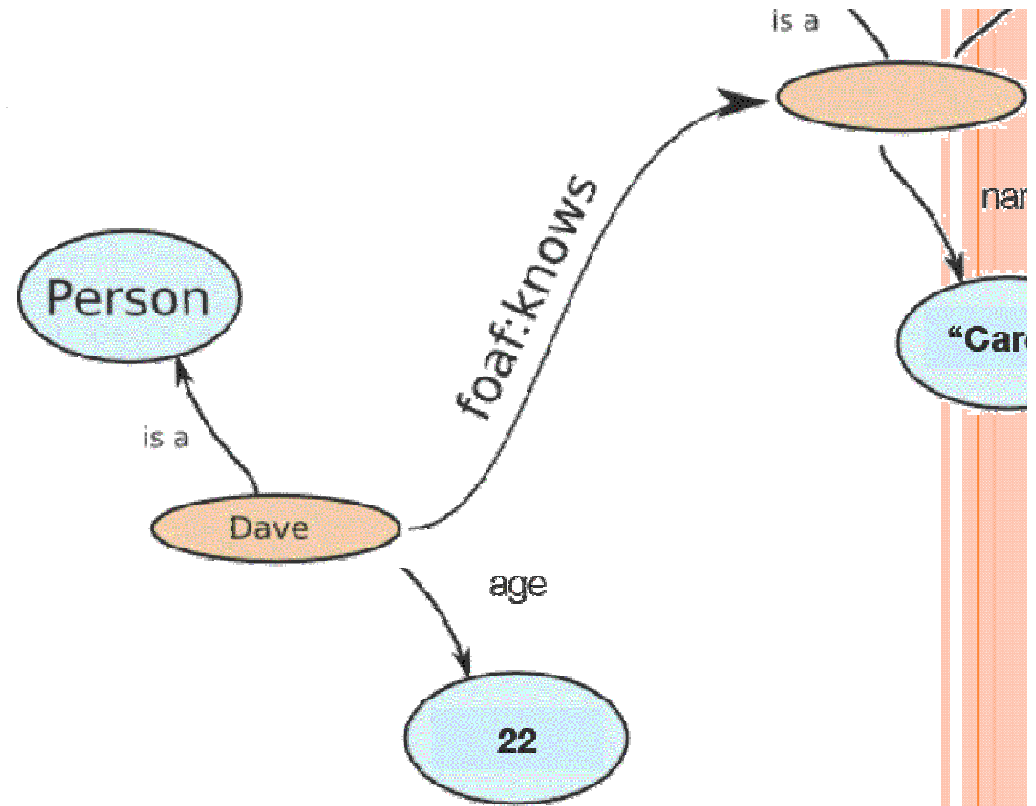
DATA TYPES

○ N3:

- `foaf:age "22"^^xsd:int;`

○ RDF/XML:

- `<foaf:age rdf:datatype="http://www.w3.org/2001/XMLSchema#int">22</foaf:age>`



RDF DATA

- Are graphs consisting of triples
 - triples consist of <subject> <predicate> <object>
- Can be represented:
 - Pictorially using circles and arrows diagrams
 - Via serializations
 - NTriples, N3, RDF/XML
- RDF Standard:
<http://www.w3.org/RDF/>
- Web RDF validator:
 - <http://www.w3.org/RDF/Validator/>
- Can be embedded into xHTML
 - RDFa

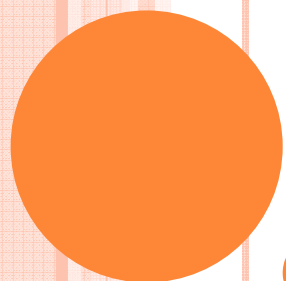


REFERENCES

- N3, <http://www.w3.org/DesignIssues/Notation3>
- RDF/XML, <http://www.w3.org/TR/REC-rdf-syntax/>
- Comparing formats: <http://www.w3.org/2000/10/swap/doc/formats>
- Converting between formats
 - <http://www.mindswap.org/2002/rdfconvert/>
 - <http://www.w3.org/2000/10/swap/doc/cwm.html>
- RDFa validators
 - <http://check.rdfa.info/>
 - <http://validator.w3.org/>
- Rich Snippet Tester: <http://www.google.com/webmasters/tools/richsnippets>

Most of the slides in this talk are modifications of the talk “Publishing Linked Data” by Lalana Kagal (<http://csail.mit.edu/~lkagal>). The original slides can be found in <http://dig.csail.mit.edu/2010/Courses/6.898/resources/lk-sep28-session1.pdf>





RDF SCHEMA

RDF SCHEMA (RDFS)

- RDF describes resources with classes, properties, and values.
- RDF also need a way to define application-specific classes and properties.
 - RDF Schema!
- RDF Schema:
 - does not provide actual application-specific classes and properties.
 - provides the framework to describe application-specific classes and properties.

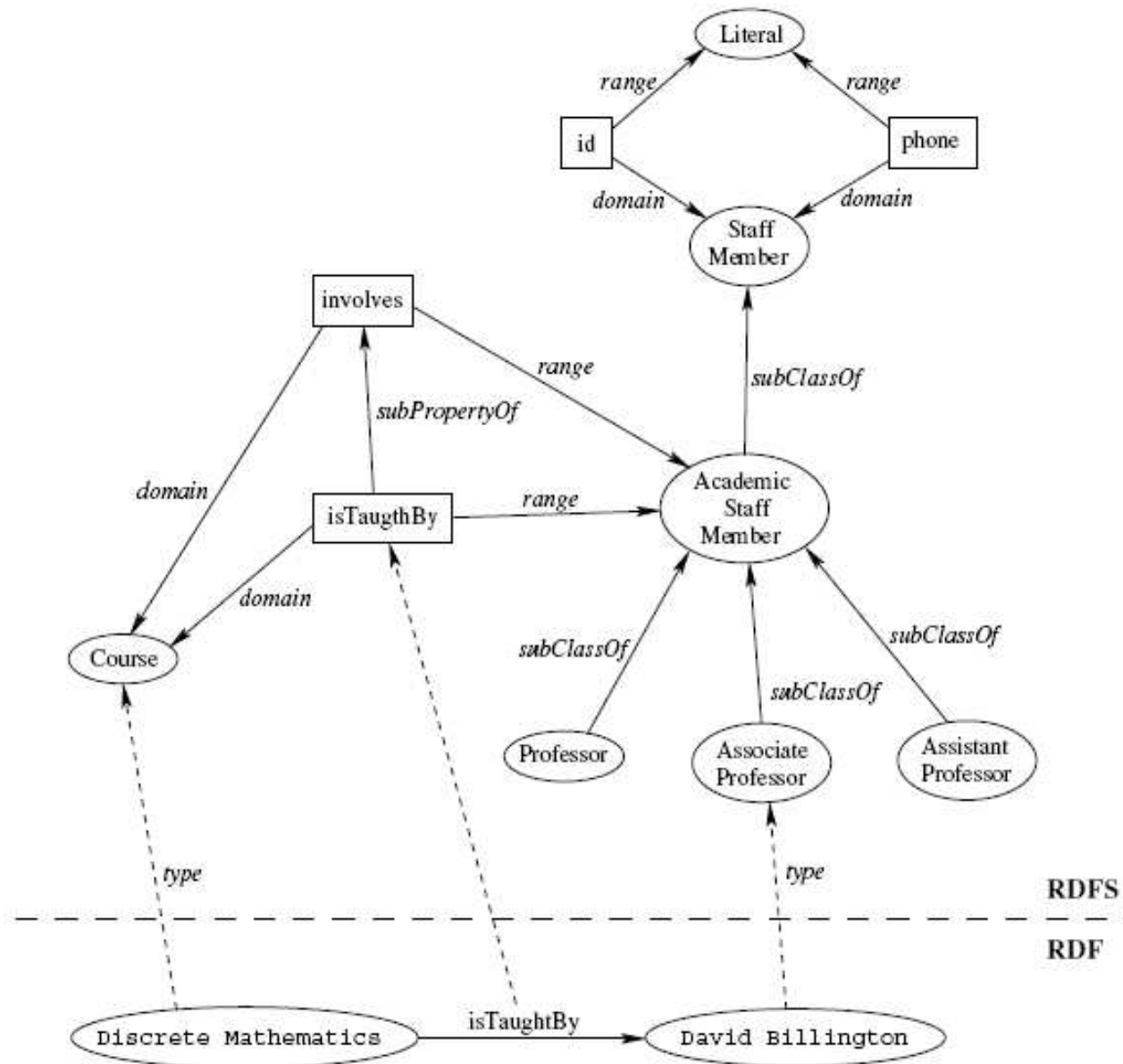


WHAT IS RDFS ?

- The RDF Schema is a collection of RDF resources that can be used to describe properties of other RDF resources.
- The core schema vocabulary is defined in a namespace informally called '**rdfs**', and identified by the URI reference:
<http://www.w3.org/2000/01/rdf-schema#>.
- Specification also uses the prefix '**rdf**' to refer to the core RDF namespace: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>.



RDF & RDFS EXAMPLE (BY EMILY CHEN)



SCHOOL EXAMPLE

- School RDFS
- School RDF



WHERE TO LOOK NEXT

- RDF:
<http://www.w3.org/RDF/>
- RDF Schema:
<http://www.w3.org/TR/rdf-schema/>