

INF3580/4580 – Semantic Technologies – Spring 2018

Lecture 3: Jena – A Java Library for RDF

Martin Giese

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DEPARTMENT OF
INFORMATICS



UNIVERSITY OF
OSLO

Today's Plan

- 1 Repetition: RDF
- 2 Jena: Basic Datastructures
- 3 Jena: Inspecting Models
- 4 Jena: I/O
- 5 Example
- 6 Jena: ModelFactory and ModelMaker
- 7 Jena: Combining Models

Outline

- 1 Repetition: RDF
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Reminder: RDF triples

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- Expanded:
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`<http://www.w3.org/1999/02/22-rdf-syntax-ns#type>`
`<http://geo.example.com/#Country> .`

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- RFC 3987 says that “Simple String Comparison” is what you get comparing character-by-character. Like `String.equals()`.
- So: yes, case-sensitive.

Reminder: RDF graphs

Sets of RDF triples are often represented as directed graphs:

Berlin is a City in Germany, which is a country

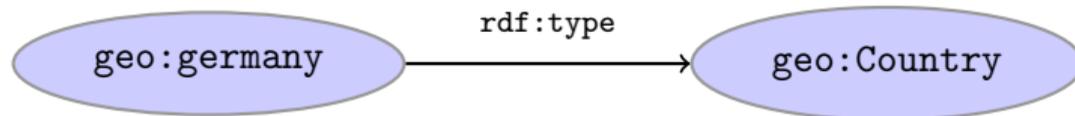
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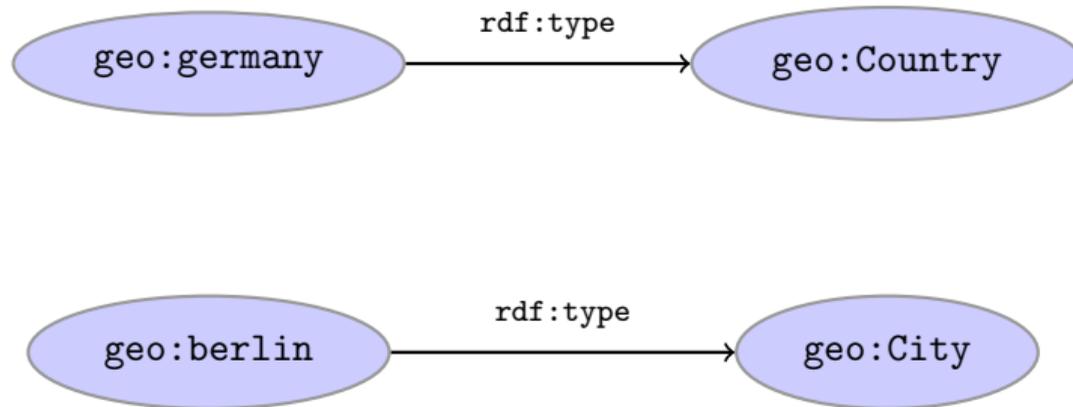
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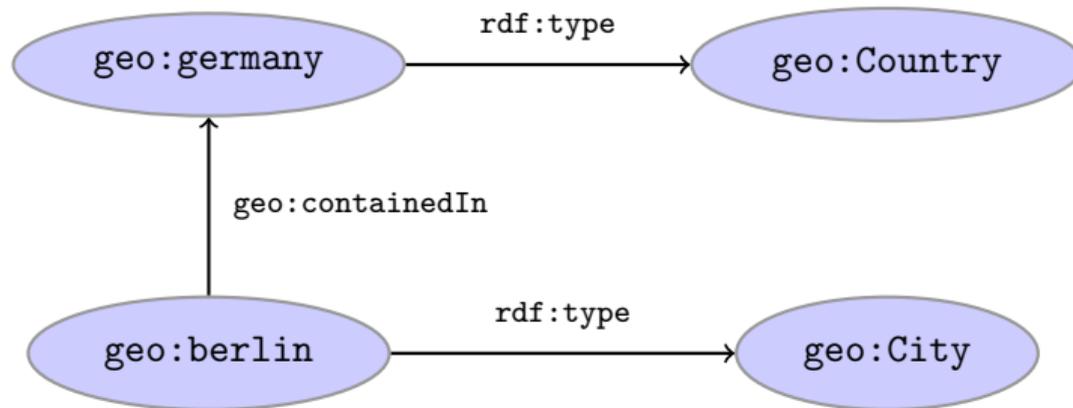


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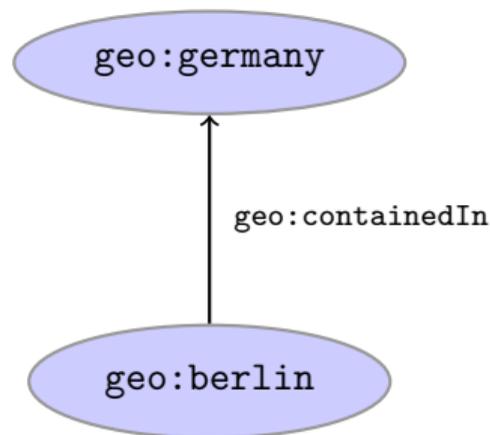
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geo:berlin geo:containedIn geo:germany .  
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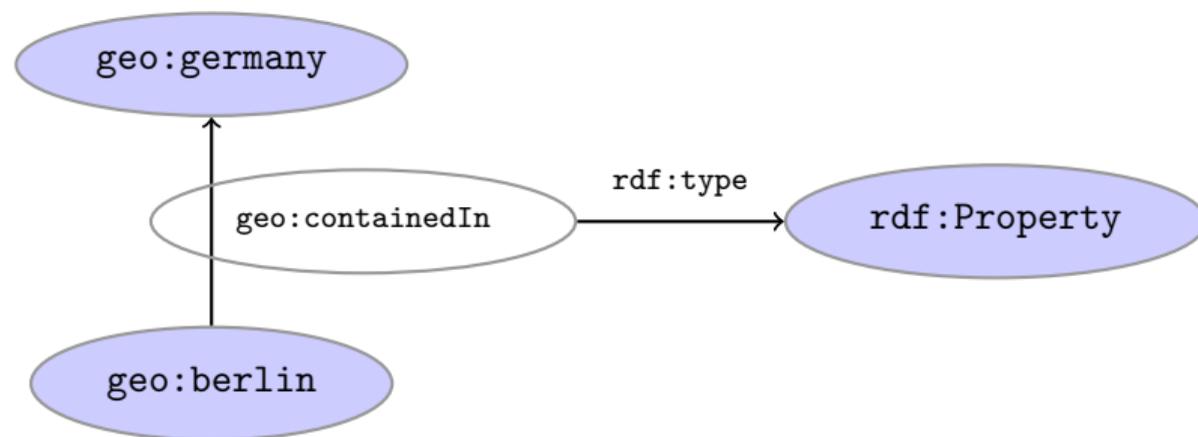


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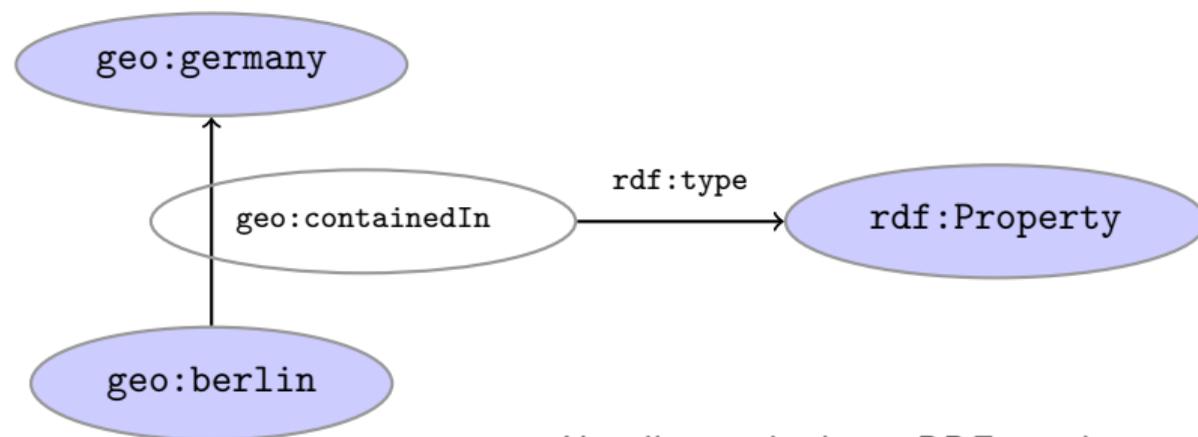


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Usually speak about *RDF graphs* anyway

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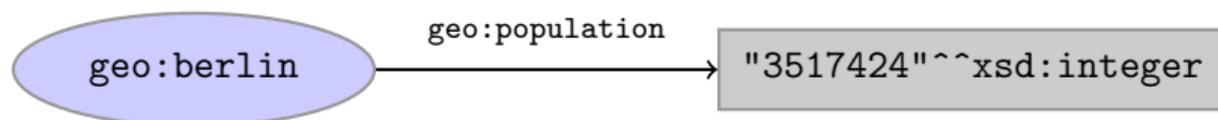
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 - `geo:germany geo:name "Deutschland"@de .`
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 - `geo:germany geo:name "Deutschland"@de .`
 - `geo:germany geo:name "Germany"@en .`
- Usually represented with rectangles:



Reminder: RDF Blank Nodes

Blank nodes are like resources without a URI

There is a city in Germany called Berlin

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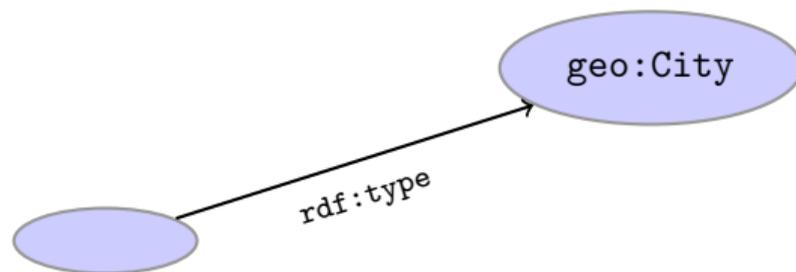


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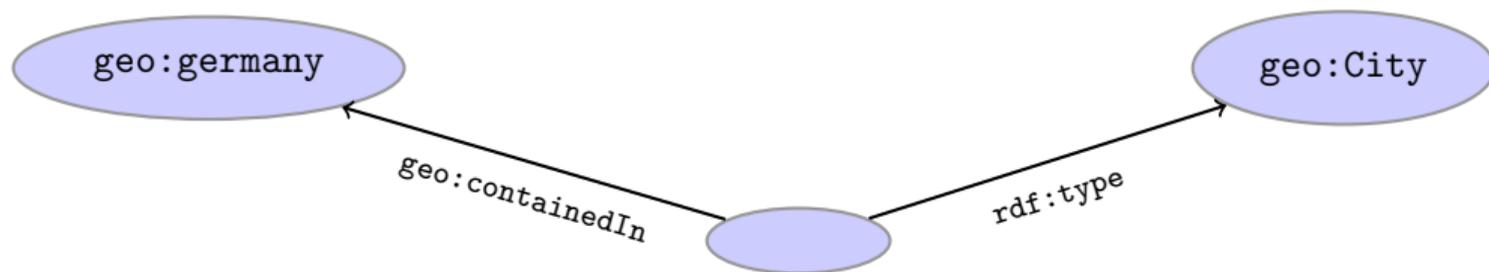


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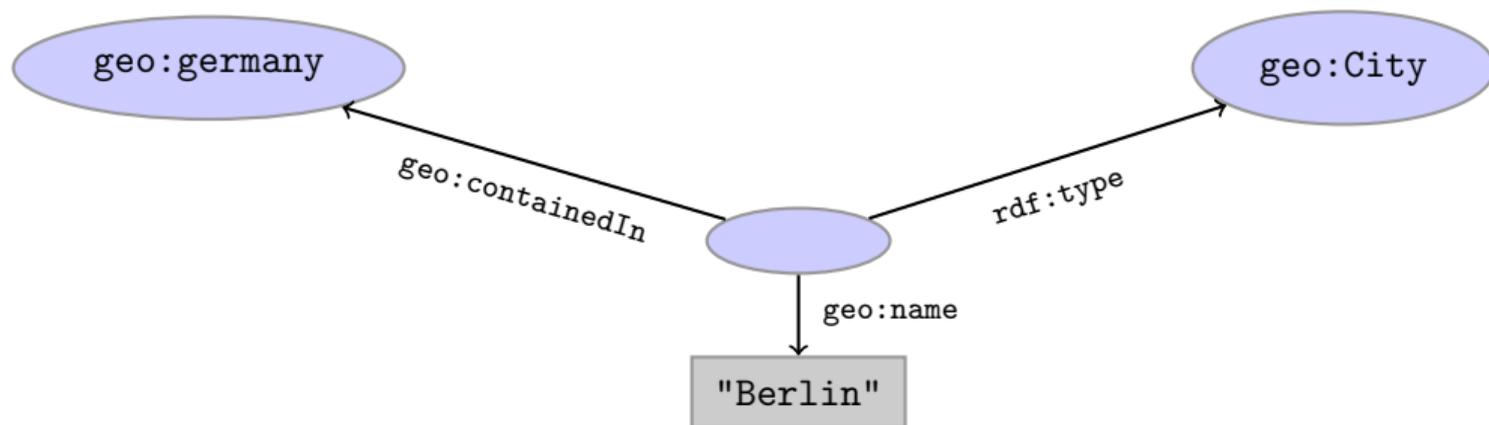


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Question

How many triples are represented here?

```
:norway :hasCapital [a :Place,:City; :name "Oslo", "Oslo"] ;  
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Answer: 8. Two different blank nodes, _:1, _:2:, but only one name each.

```
:norway :hasCapital _:1 .           :norway :hasCapital _:2 .
_:1 a :Place .                       _:2 a :Place .
_:1 a :City .                         _:2 a :City .
_:1 :name "Oslo" .                   _:2 :name "Oslo" .
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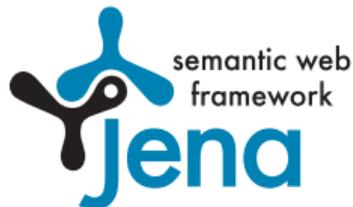


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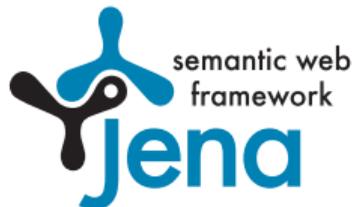


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- Probably a good idea to put namespaces in separate strings:

```
String geoNS="http://geo.example.com/#";
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```
String germanyURI=geoNS+"germany";
```

```
String berlinURI =geoNS+"berlin";
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- Beware: this is not usually what you want!



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- For a fresh blank node:

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- Subinterface of `Resource`
- Doesn't add anything important to `Resource`, but

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Data Representation: Properties

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- Jena defines a separate interface Property
- Subinterface of Resource
- Doesn't add anything important to Resource, but
 - a Property cannot be a blank node nor a literal
- To create a Property object:

```
Property name = model.createProperty(geoNS+"name");
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Data Representation: Literals

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String type = "http://www.w3.org/2001/XMLSchema#byte";  
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- Or, with a `org.apache.jena.datatypes.RDFDatatype`:

```
import org.apache.jena.datatypes.xsd.XSDDatatype;  
  
RDFDatatype type = XSDDatatype.XSDbyte;  
Literal n = model.createTypedLiteral("42", type);
```

Data Representation: Statements

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$$\langle s, p, o \rangle$$

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- Again, use the methods in Model:

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```
Resource berlin = model.createResource(geoNS+"berlin");  
Property name = model.createProperty(geoNS+"name");  
Literal b = model.createLiteral("Berlin");  
Statement stmt = model.createStatement(berlin,name,b);
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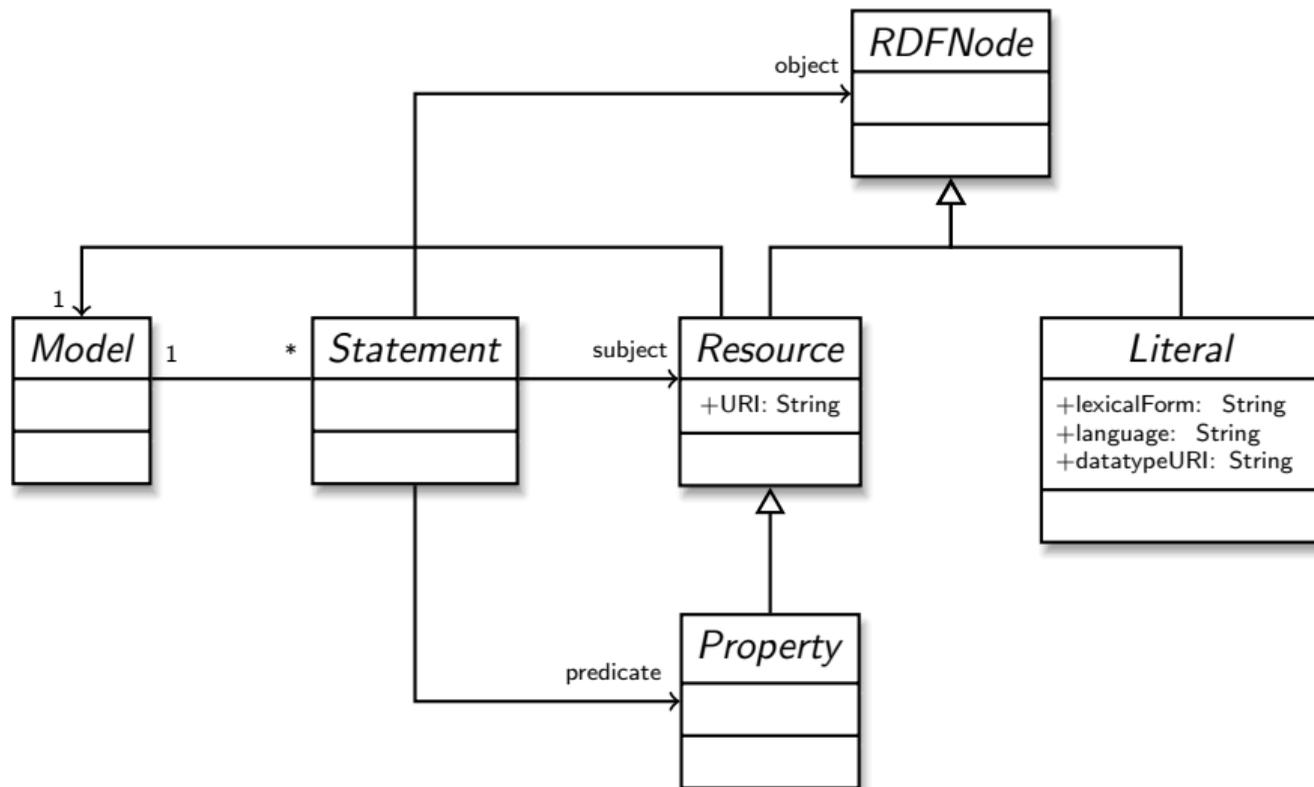
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- Not yet asserted in the model.
- To add this statement to the model:

```
model.add(stmt);
```

Overview



Convenience Methods in Resource

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- Given some properties and resources...

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Property name = model.createProperty(geoNS+"name");  
Property cont = model.createProperty(geoNS+"containedIn");  
Property pop = model.createProperty(geoNS+"population");  
  
Resource berlin = model.createProperty(geoNS+"berlin");  
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- ... we can write:

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berlin.addProperty(cont, germany);  
berlin.addProperty(name, "Berlin");  
germany.addProperty(name, "Tyskland", "no");  
berlin.addLiteral(pop, 3517424);
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 - Easy to implement
 - Classes Node, Triple, Graph
- We will be concerned only with the API!

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- 2 Jena: Basic Datastructures
- 3 Jena: Inspecting Models**
- 4 Jena: I/O
- 5 Example
- 6 Jena: ModelFactory and ModelMaker
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 - Via the Model

- Navigation through resources delegates to model, but sometimes more convenient



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```

- to find all statements with a particular predicate:

```
Property name = model.createProperty(geoNS+"name");  
Iterator<Statement> it = berlin.listProperties(name);
```

Retrieving Information from a Resource (cont.)

- To get *some* statement, without iterating:

```
Property pop = model.createProperty(geoNS+"population");  
berlin.getProperty(pop)
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- `hasProperty`,
- `hasLiteral`,

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- To get all resources with a statement for a given predicate:

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- To get all resources that are subject of some statement:

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Iterator<Resource> rit = model.listSubjects();
```

- To get all resources with a statement for a given predicate:

```
Iterator<Resource> rit = model.listResourcesWithProperty(name);
```

- ...with a given value for a property:

```
Iterator<Resource> rit = model.listResourcesWithProperty(cont, germany);
```

Simple Pattern Matching

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- where subj, pred, obj can be null to match any value ("wildcard")



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- ... use

```
Iterator<Statement> sit = model.listStatements(subj, pred, obj);
```

- where subj, pred, obj can be null to match any value ("wildcard")
- e.g. to print everything contained in Germany:

```
Iterator<Statement> sit = model.listStatements(null, cont, germany);  
while (sit.hasNext()) {  
    System.out.println(sit.next().getSubject());  
}
```



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- More about this next week!

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- Example: Load Martin Giese's FOAF file from the 'net:

```
Model model = ModelFactory.createDefaultModel();
model.read("http://heim.ifi.uio.no/martingi/foaf");
```

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 - Used to make some URIs relative in the output.

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 - Format defaults to RDF/XML
 - Variants with `format (lang)` parameter exist
- Can write to `OutputStream` or `Writer`.
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Writing RDF

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- Can write to `OutputStream` or `Writer`.
- Some write variants take a “base URI”.
 - Used to make some URIs relative in the output.
 - Absolute URIs are a better idea.
- Example: write `model` to a file:

```
try {  
    model.write(new FileOutputStream("output.rdf"));  
} catch (IOException e) {  
    // handle exception  
}
```

Prefix Mappings

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Question

What's the difference in effect between this code snippet:

```
norway=model.getResource("http://...");  
name=model.getProperty("http://...");  
model.createStatement(norway,name,"Norway");
```

and this:

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norway=model.getResource("http://...");  
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Answer: they create the same statement,
but only the second snippet adds it to the model.

Outline

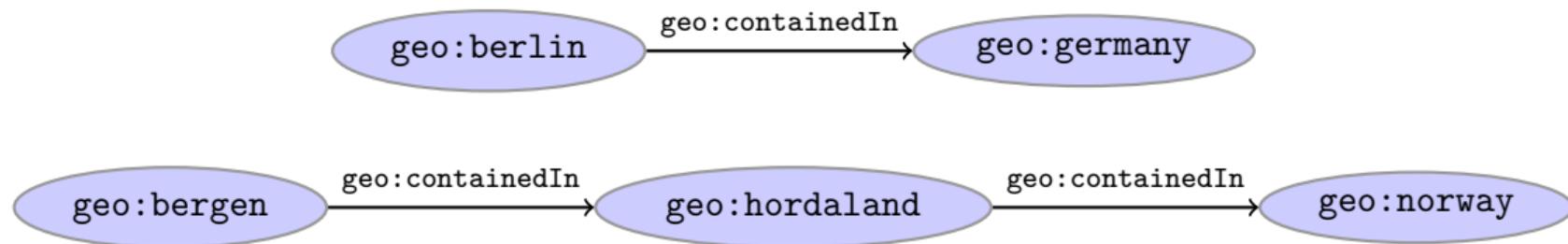
- 1 Repetition: RDF
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A Containment Example

Given an RDF/XML file with information about containment of places in the following form:

Geographic containments

```
geo:berlin geo:containedIn geo:germany .  
geo:bergen geo:containedIn geo:hordaland .  
geo:hordaland geo:containedIn geo:norway .  
...
```

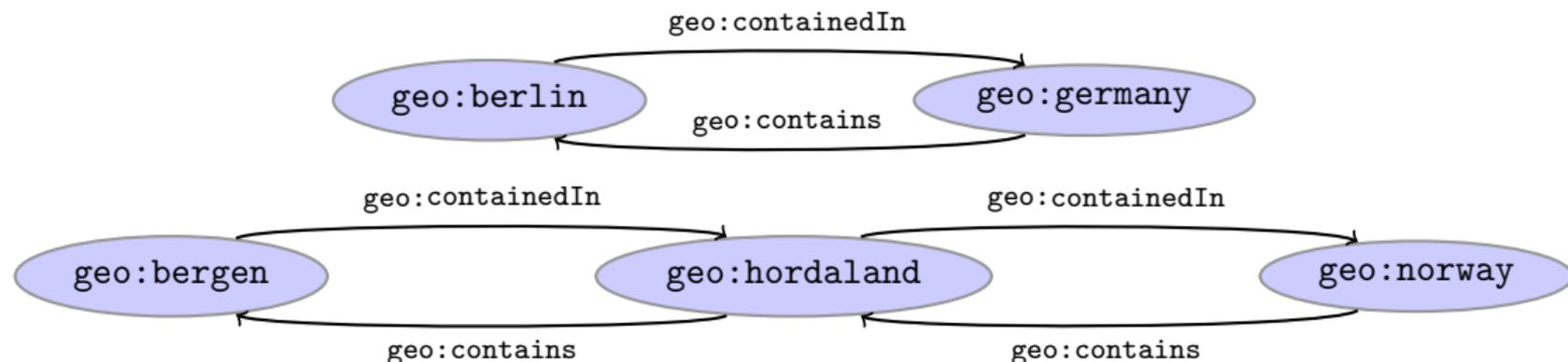


A Containment Example (cont.)

Add inverse statements using property `geo:contains`:

Inverted Containment Statements

```
geo:germany geo:contains geo:berlin .  
geo:hordaland geo:contains geo:bergen .  
geo:norway geo:contains geo:hordaland .  
...
```



Solution: Creating the Model, Reading the File

```
import java.io.*;
import java.util.*;
import org.apache.jena.rdf.model.*;

public class Containment {

    public static String GEO_NS = "http://geo.example.com/#";

    public static void main(String[] args) throws IOException {
        Model model = ModelFactory.createDefaultModel();
        model.read(new FileInputStream("places.rdf"), null);

        Property containedIn = model.getProperty(GEO_NS+"containedIn");
        Property contains = model.getProperty(GEO_NS+"contains");
    }
}
```

Solution: Adding Statements, Writing a File

```
Iterator<Statement> it =
    model.listStatements((Resource)null, containedIn, (Resource)null);
while ( it.hasNext() ) {
    Statement st = it.next();
    model.add((Resource)st.getObject(), contains, st.getSubject());
}

model.write(new FileOutputStream("output.rdf"));
} // main()

} // class Containment
```

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- ...a relational database:

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IDBConnection conn = new DBConnection(DB_URL,DB_USER,DB_PASSWD,DB_TYPE);
```

```
ModelMaker mm = ModelFactory.createRDBModelMaker(conn);
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- See book or documentation for examples of creating a DBConnection!

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- All models are stored as tables in one RDB, files in one file system directory, etc.

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 - adding/removing statements in `u/i/d` does not affect `model1/model2`
- Typically a fresh memory model holding all data.

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- Union model delegates storage to other models

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 - `http://dbpedia.org/ontology/PopulatedPlace`
 - `http://dbpedia.org/ontology/Country`
 - `http://dbpedia.org/property/subdivisionName`

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 - The same types are identified by different URIs
 - Similar properties are identified by different URIs
- Need some way to “align” the vocabularies
 - Say that `geo:oslo` equals `dbpedia:Oslo`.
 - Say that a `geo:City` is a kind of `dbpedia-owl:PopulatedPlace`.
 - Say that subdivisions are contained in each other.
- You will learn how to do this later in the course...

The Alignment Problem (cont.)

- We can now construct the union of both information sources
- But the union will not be very useful :-(
 - The data is not linked!
 - The same entities are identified by different URIs
 - The same types are identified by different URIs
 - Similar properties are identified by different URIs
- Need some way to “align” the vocabularies
 - Say that `geo:oslo` equals `dbpedia:Oslo`.
 - Say that a `geo:City` is a kind of `dbpedia-owl:PopulatedPlace`.
 - Say that subdivisions are contained in each other.
- You will learn how to do this later in the course...
- ...but to get it right, some theory is needed!

Outlook

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Lecture 5: Mathematical Foundations

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Lecture 6: Intro to Reasoning

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Lecture 8: Model Semantics

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- All this will be explained with examples

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- All this will be explained with examples
- There will be practical exercises

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- All this will be explained with examples
- There will be practical exercises
- But there are some theoretical concepts to grasp!

Oblig

- New oblig to be published today, after the lecture.

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- Deadline: 23:59 07.02.2018.