IN3060/4060 – Semantic Technologies – Spring 2020

Lecture 3: Jena – A Java Library for RDF

Martin Giese

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Department of Informatics

University of Oslo

DNV GL Summer Project 2020

- Summer internship with DNV GL, Høvik
- Interdisciplinary team of 8 fourth year MSc students
- Deadline 15 February
- Topics: artificial intelligence, machine learning, big data, IOT, augmented and virtual reality
- Application area in 2020: Wind Energy

`https://careers-dnvgl.icims.com/jobs/13576/dnv-gl-summer-project-2020/job`

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

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- Expanded:
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- So: yes, case-sensitive.

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Sets of RDF triples are often represented as directed graphs:

Berlin is a City in Germany, which is a country

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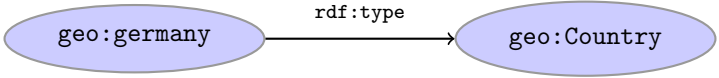

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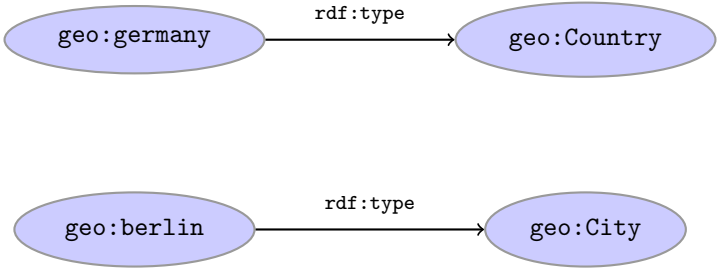

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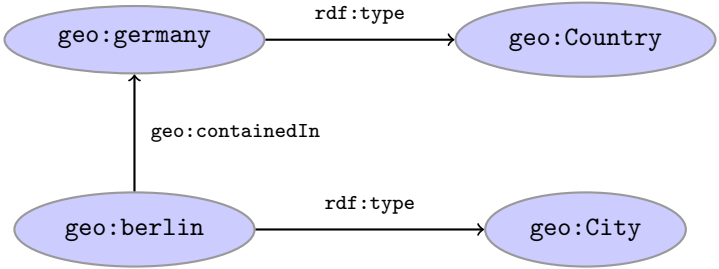

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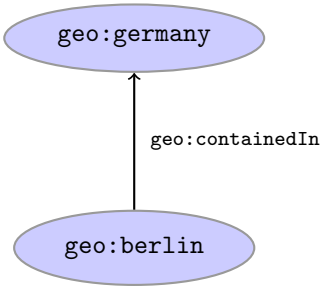

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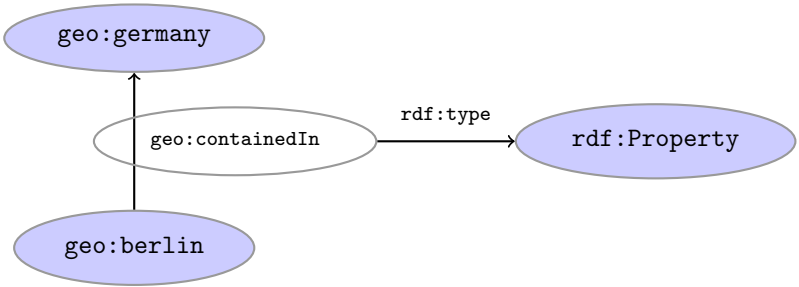

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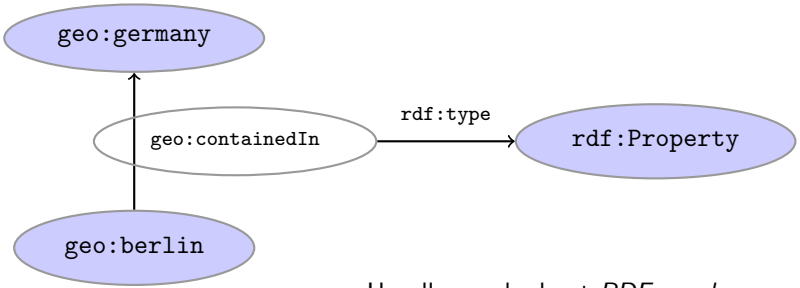

Usually speak about *RDF graphs* anyway

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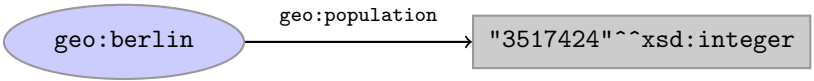
- Usually represented with rectangles:



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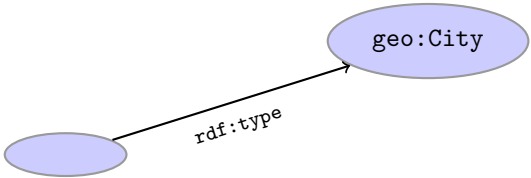

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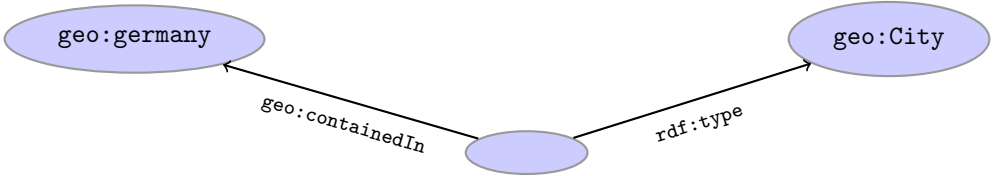

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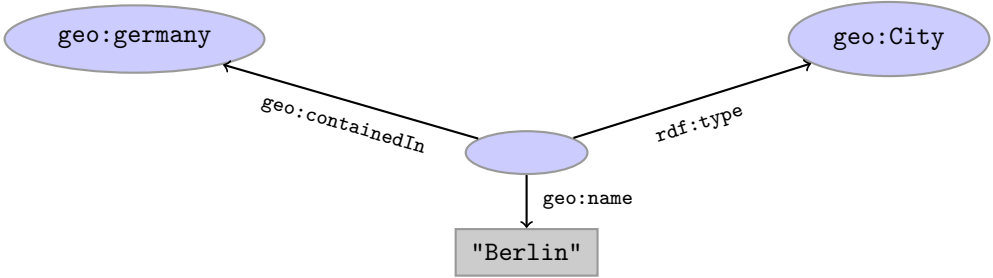

Question

How many triples are represented here?

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Answer: 8. Two different blank nodes, `_:1`, `_:2`:, but only one name each.

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

```
:norway :hasCapital _:2 .
_:2 a :Place .
_:2 a :City .
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- Probably a good idea to put namespaces in separate strings:

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

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- Beware: this is not usually what you want!

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- Also deals with reading & writing various formats

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- ...and a URI...

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- For a fresh blank node:

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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);
```

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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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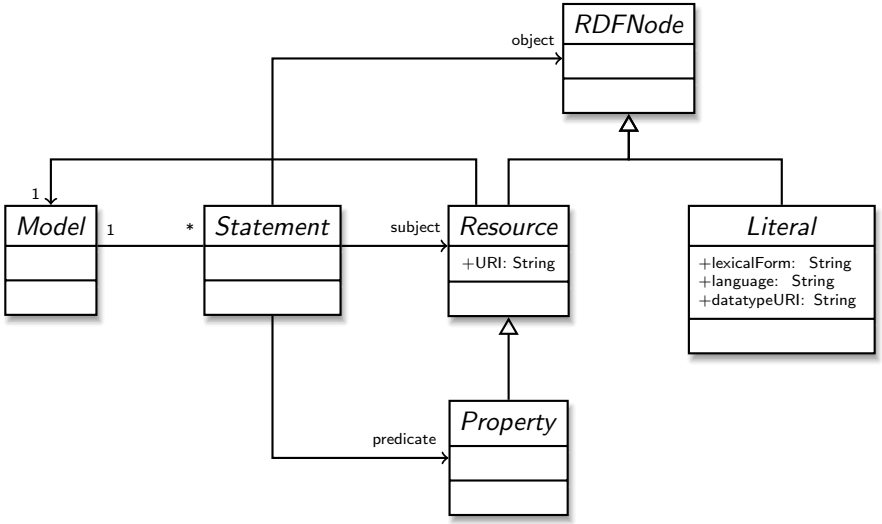
- Not yet asserted in the model.
- To add this statement to the model:

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

Overview


RDFNode
object
1
Model
1
*
Statement
subject
Resource
+URI: String
Literal
+lexicalForm: String
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predicate
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- We will be concerned only with the API!

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

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```

- to find all statements with a particular predicate:

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

Retrieving Information from a `Resource` (cont.)

- To get *some* statement, without iterating:

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Property pop = model.createProperty(geoNS+"population");
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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);
```

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```
Iterator<Statement> sit = model.listStatements(subj, pred, obj);
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- 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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  - Usually not needed: absolute URIs are a better idea.

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- `read` does not create a new `Model` object.
  - First create a model, then add statements with `read`.
  - Can call read several times to accumulate information.
- Available formats: RDF/XML, N-triples, Turtle, RDF/Jason, TriG,...
  - Get format from HTML content type, then file name extension
  - Variants with format (`lang`) parameter exist
- Can read from `InputStream` or `Reader`, or directly from a `URL`.
- Some `read` variants take a "base URI".
  - Used to interpret relative URIs in the document.
  - Usually not needed: absolute URIs are a better idea.
- 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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- 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
}
```

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Question

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

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

and this:

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Answer: they create the same statement,
but only the second snippet adds it to the model.

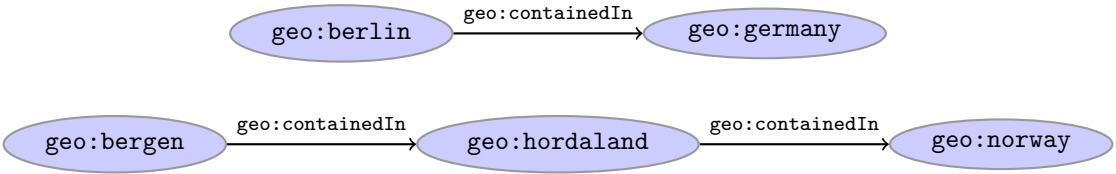
Outline

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 .
...
```

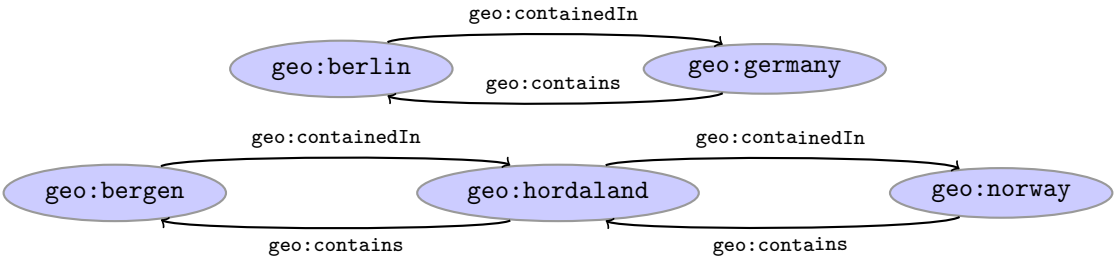


A Containment Example (cont.)

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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- 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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- Union model delegates storage to other models

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    `http://geo.example.com/#germany`
  - Expressed in terms like
    `http://geo.example.com/#City`
    `http://geo.example.com/#Country`
    `http://geo.example.com/#containedIn`
- Now we discover `http://dbpedia.org/` with
  - information about resources like
    `http://dbpedia.org/resource/Oslo`
    `http://dbpedia.org/resource/Germany`
  - Expressed in terms like
    `http://dbpedia.org/ontology/PopulatedPlace`
    `http://dbpedia.org/ontology/Country`
    `http://dbpedia.org/property/subdivisionName`

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  - Say that subdivisions are contained in each other.

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- ...but to get it right, some theory is needed!

Outlook

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Lecture 5: Mathematical Foundations

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- But there are some theoretical concepts to grasp!

Oblig

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- Deadline: 23:59 07.02.2020.