Integrating Data into an OWL Knowledge Base via the DBOM Protégé Plug-in

Olivier Curé, Raphaël Squelbut
Université de Marne-la-Vallée, France

9th International Protégé Conference
July 23-26, 2006
Stanford University, USA

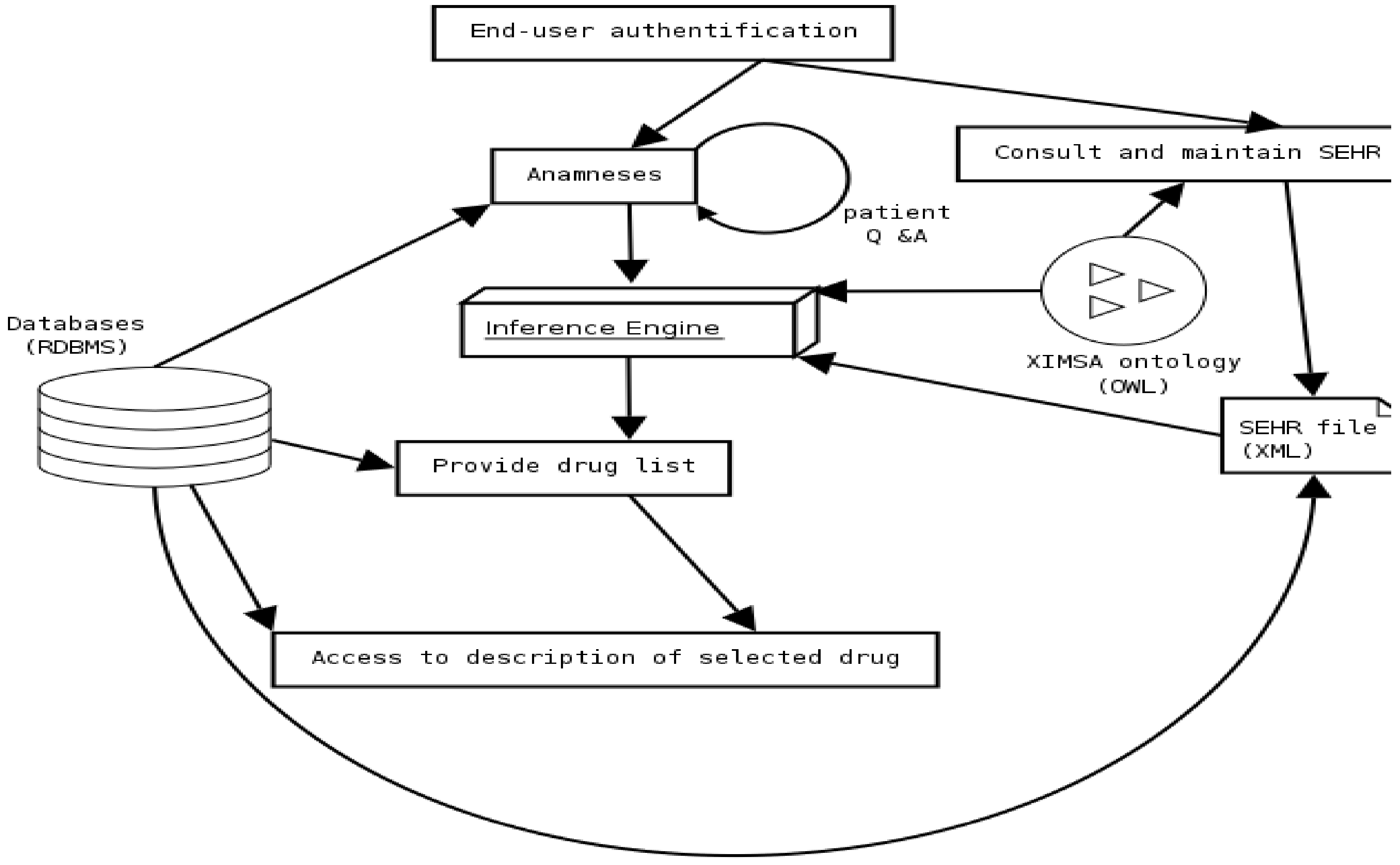
Main idea of this presentation

- Two facts
  - The Semantic Web needs ontologies.
  - Databases are everywhere
- Our approach
  - map databases to knowledge bases
  - provide a GUI (integrated into Protégé) to ease the creation of mapping files.

Motivating example

- Implementation of a system that helps patients to self-medicate safely.
- This application requires inferences on drugs and symptoms (contraindications, side-effects, posology, etc.).
- The system exploits the main DL reasoning tasks : ontology consistency, concept subsumption, concept satisfiability and instance checking.

Architecture of the self-medication application



SEHR : Simplified Electronic Health Record

Data sources

- Problem :
  - Need to integrate all drugs sold in France (more than 10.000 drugs) with complete information (Summary of Products Characteristics).
  - Most french drug databases are incomplete and are usually not available on-demand.
  - Many standards need to be integrated : ATC (Anatomical Therapeutic Chemical classification) and DDD (Defined Daily Dose) from the WHO, EphMRA, etc..

DBOM
DataBase Ontology Mapping

- Objective : design, instantiate and maintain a knowledge base (KB) from multiple relational databases (DBs).
  - Design the TBox using the DBs schemas.
  - Instantiate the ABox with the tuples of the data sources w.r.t. the mapping.
  - Maintain the ABox using the mapping (from DBs to KB), a set of automatically created triggers and Java methods.

DBOM (2)

- DBOM is related to the exchange and integration of data.
- The DBOM system is a triple (S,O,M) with
  - S, a set of sources
  - O, an ontology formalized in a Description Logic (DL) that can be as expressive as SHOIN(D), syntactically equivalent to OWL DL.
  - M the mapping in a language over S and O

Characteristics of DBOM

- Main characteristics of DBOM :
  - Mapping exploits the GAV (Global As View) approach : the elements of the target are expressed in terms of the sources (opposed to LAV -Local As View).
  - Mapping file is serialized in XML.
  - The target is materialized (because on-demand querying may not be possible) and is an OWL document.

Characteristics of DBOM (2)

- Main operations of DBOM
  - Instantiation (at mapping processing time)
  - Maintenance (whenever a tuple of a source is updated)
  - both operations adopt the possible answer semantics (opposed to certain answers in data integration and data exchange).

DBOM members

- DL Members = DL concepts + DL roles
- In DBOM, we distinguish abstract to concrete members.
- Approach is similar to Object-Oriented Programming :
  - abstract members serve to design a hierarchy and are not instantiated. They are created with the owlClasses and Properties tabs of Protégé.
  - SQL queries are associated to concrete members to enable instantiation from tuples of the sources. They are created with the DBOM Protégé plug-in.

Dealing with inconsistencies

- Because of the adoption of possible answers with multiple sources, inconsistencies can emerge from redundant data.

Source DB1

cip	name	price	reimb	atc	rate
3311692	TUXIUM 30 mg	2.32	0	R05DA09	18

Source DB2

cip	name	price	reimb	atc
3311692	TUXIUM 30 mg	3.32	35	R05DA09

Source DB3

cip	name	price	reimb	atc
3626651	DIMETANE Sirop Sans Sucre	2.94	35	R05DA08
3311692	TUXIUM 30 mg	2.05	65	R05DA08

Source DB4

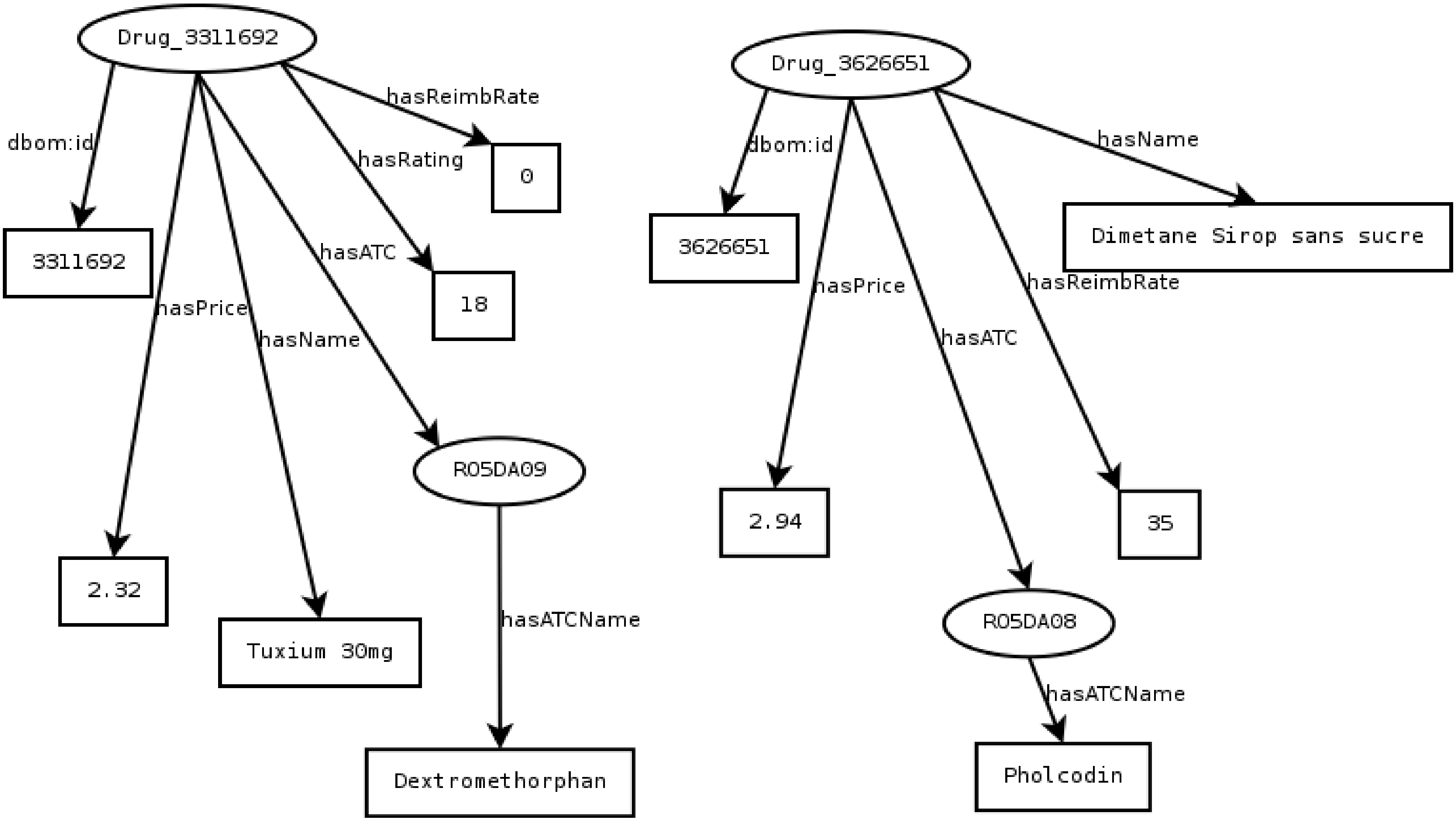
code	name
R05DA08	Pholcodin
R05DA09	Dextromethorphan

Confidence values

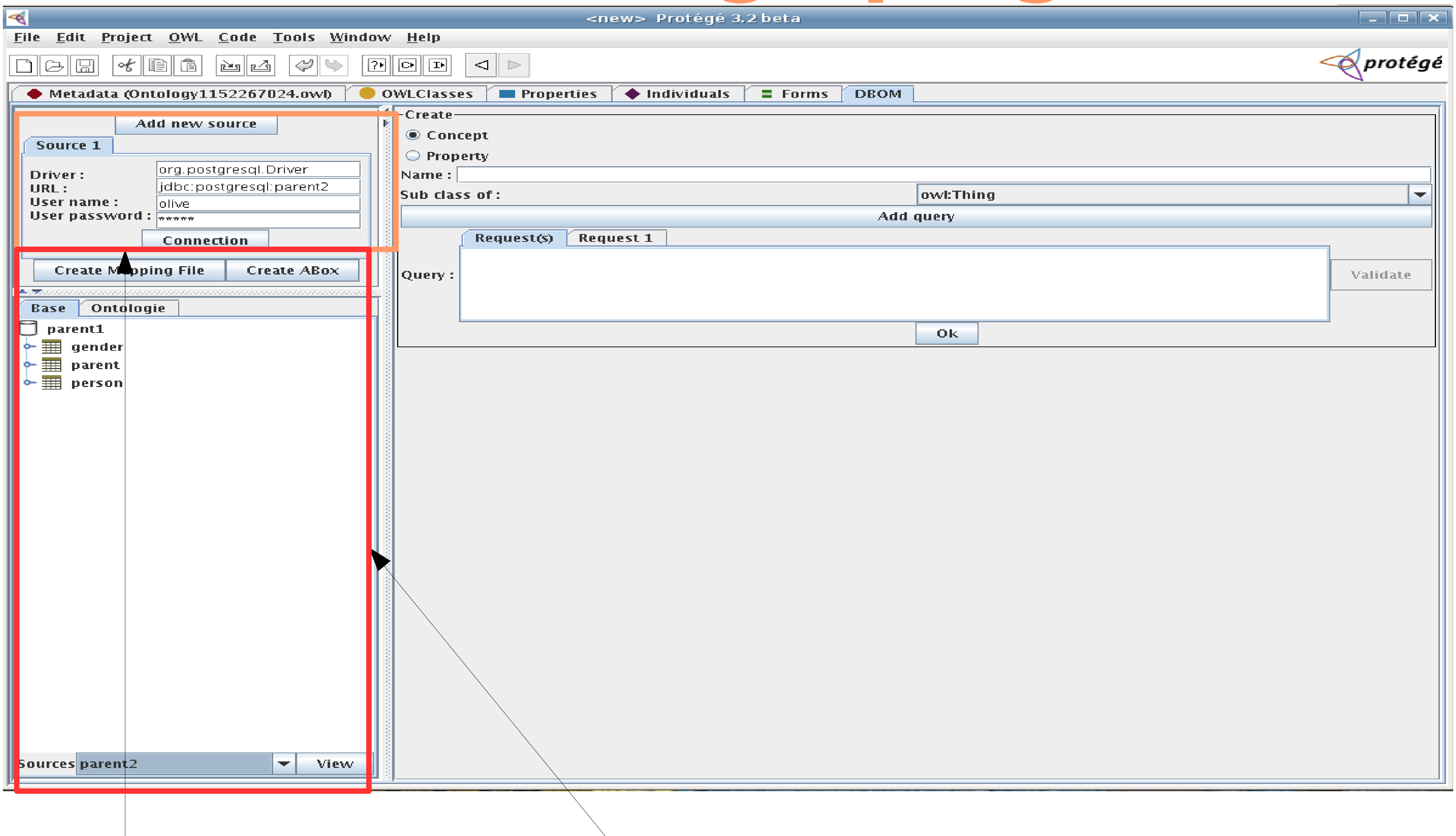
- The end-user has the ability to set a confidence value (real value in [0,1]) for each member's view. Intuitively defines the reliablility of the view from the designer's point of view. [Mendelzon et al, Greco et al, De Giacomo et al].
- In cases of several views for a given member, it defines a partial order on the views.
- Mapping example using conjunctive queries :

```
Drug ≡ {(U,V,W,X,Y,Z) | DB1.drug(U,V,W,X,Y,Z)}
 conf=0.8
Drug ≡ {(U,V,W,X,Y) | DB2.drug(U,V,W,X,Y)}
 conf=0.6
Drug ≡ {(U,V,W,X,Y) | DB3.drug(U,V,W,X,Y)}
 conf=0.5
```

Resulting ABox

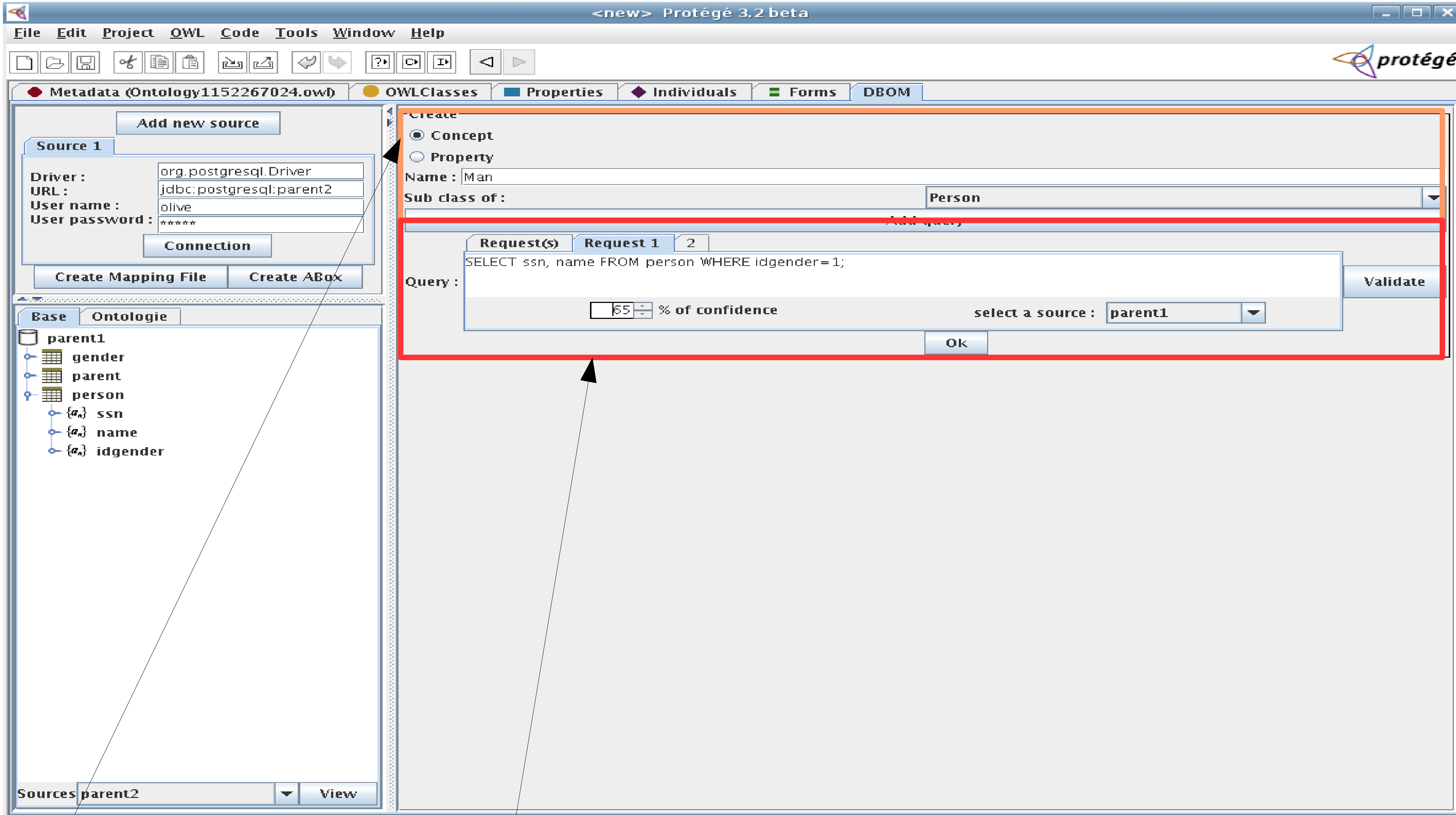


DBOM Protégé plug-in (1)



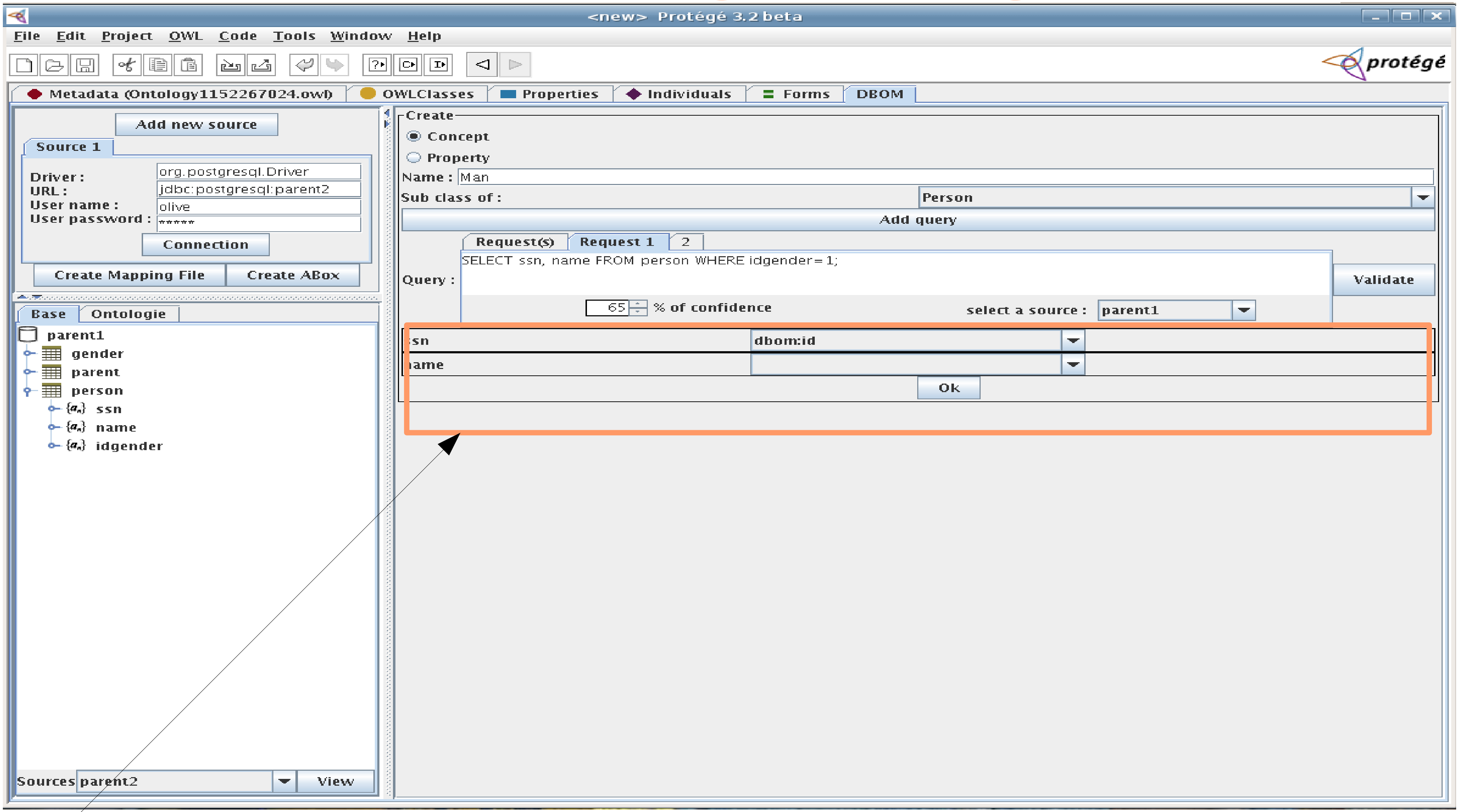
- Loading DB sources
- Visualization of the DB schemas

DBOM Protégé plug-in (2)



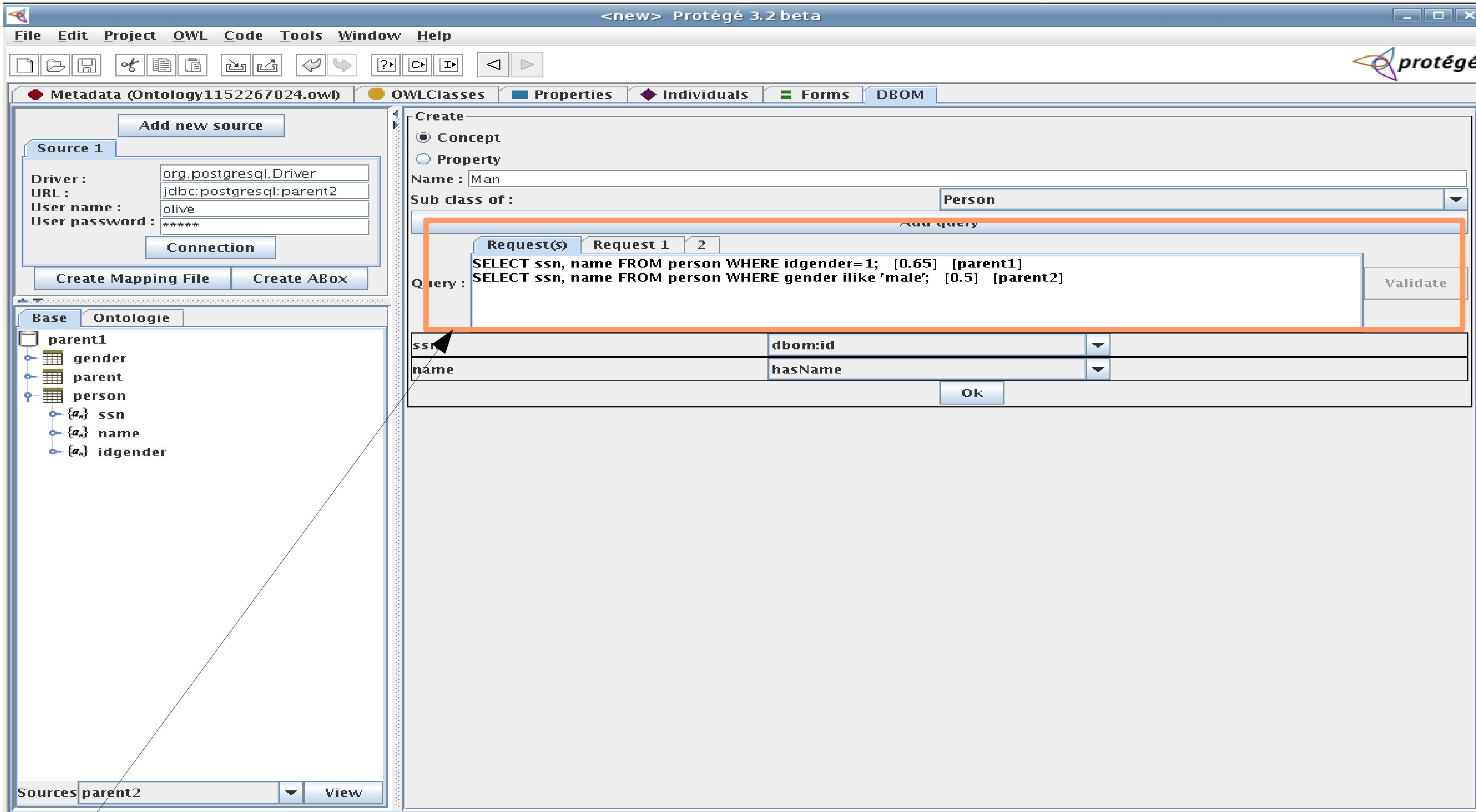
- Concept definition
- Association of SQL queries to this concept, with confidence values.

DBOM Protégé plug-in (3)



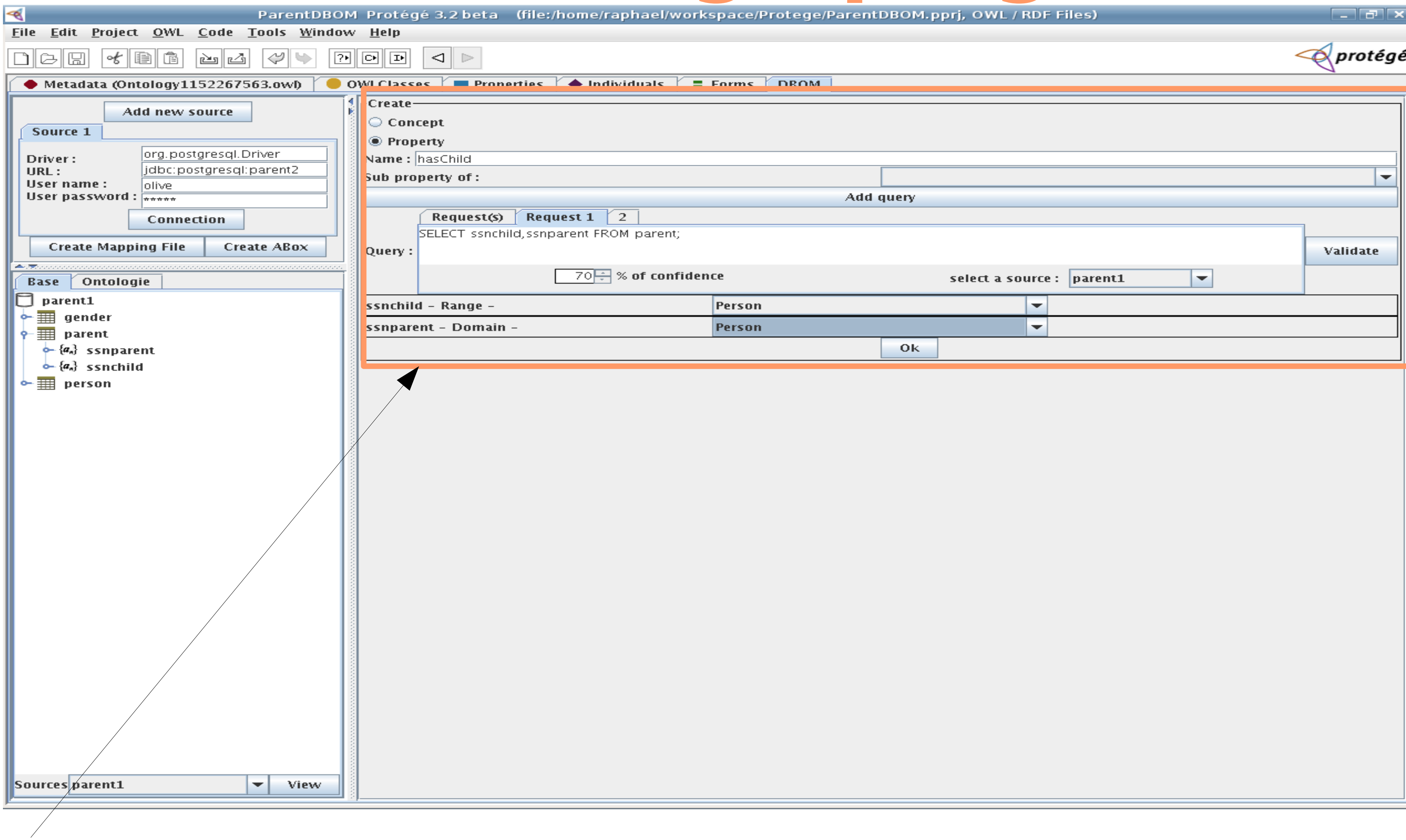
- Associate a datatype property to each attribute of the SELECT clause.

DBOM Protégé plug-in (4)



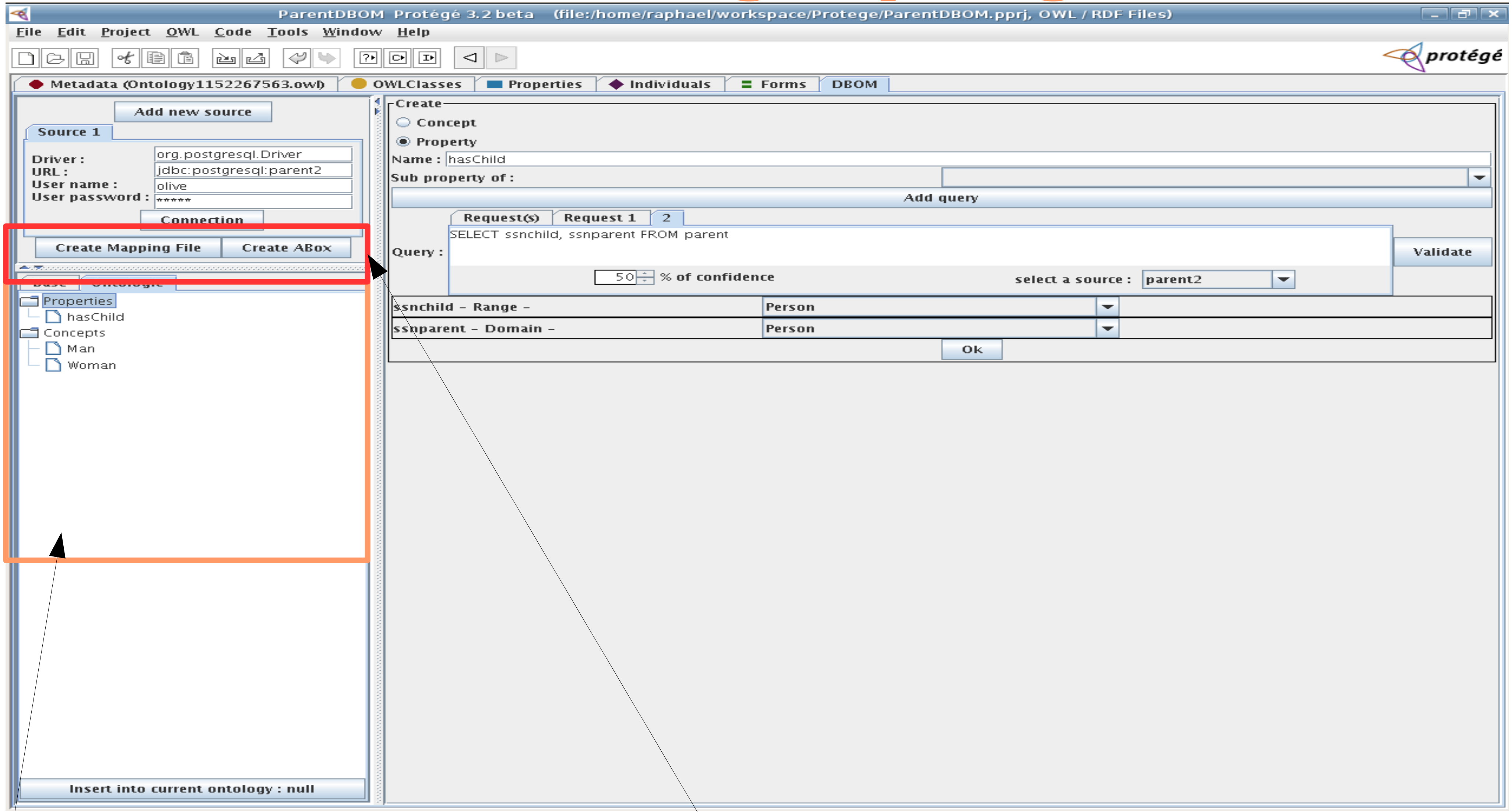
- Visualization of all the queries associated to a Concept.

DBOM Protégé plug-in (4)



- Same mechanism for roles but we associate DL concepts to attributes of the SELECT clause (domain and range).

DBOM Protégé plug-in (5)



- Visualization of the concrete members

- Process the serialization of the mapping and creation of the ABox

Serialization of the mapping

```
<?xml version="1.0" encoding="iso-8859-1"?>
     <map xmlns:dbom="http://www.univ-mlv.fr/~ocure/dbom/1.0#">
<namespaces prefix="owl" namespace="http://www.w3.org/2002/07/owl
#"/>

<dbConnect dbDriver="org.postgresql.Driver"
dbNamePrefix="jdbc:postgresql" dbName="parent1" dbUser="olive"
dbPwd="***"/>

<dbom:map xmlns:dbom="http://www.univ-mlv.fr/~ocure/dbom/0.1#">
<dbom:class className="Man">
  <dbom:instanceUnion>
   <dbom:instance dbSrc="parent1" query="SELECT ssn, name FROM
person WHERE idgender=1;" confidence="0.65">
   <dbom:id> <dbom:field value="1"> </dbom:id>
   <dbom:data>
      <dbom:field value="2" datatypeProperty="hasPersonName"/>
   </dbom:data>
   </dbom:instance>
   ...
  </dbom:instanceUnion>
</dbom:class>
...
</map>
```

Benefits of the Protégé plug-in approach

- A user-friendly graphical user interface
- Exploits the end-user's Protégé expertise : use OWL tabs to create abstract members and datatype properties, add restrictions to concepts, etc..
- Possibility to enrich an existing ontology with concrete members.

Future works on DBOM

- Integrate a Query By Example (QBE) approach to facilitate the declaration of SQL queries attached to concrete members.
- Exploit the mapping to enable
  - data synchronization : maintain the ABox according to updates on available data sources.
  - schema synchronization : adapt the TBox according to some modifications on the source schemata.

Future works on DBOM (2)

- Considering XML documents as data sources.
- Propose a mapping methodology.
- In cases of data synchronization, infer on the KB to validate updates at the sources.

Inference example

- Scenario : An authorized end-user logs in the database administration web site and records a new drug : D1 with RINN 'dextromethorphan' and therapeutic class 'antidepressive'.
- The tuple is recorded in the database.
- A trigger fires the ABox synchronization.

Inference example (2)

- Searching the KB graph.
- Result : no relationship exists between the RINN and the therapeutic class.
- A new entry is recorded in the maintenance log file. This record contains
  - the id of the user
  - the tuple that caused the problem
  - a problem description (RINN-therapeutic class problem).

Inference example (3)

- A solution to this problem can either be :
  - A new relation between the RINN and the therapeutic class can be validated by the end-user.
  - The RINN for that drug is false and the system can propose valid RINN for anti-depressive (for example iproniazide)
  - The therapeutic class is false and valid a therapeutic class will be proposed according the RINN (i.e. Antitussive).
  - All information are false.

Summary

- Using existing databases to design ontologies, instantiate and maintain knowledge bases.
- DBOM is application-independent and can be used when databases are available and covering a domain.

Thank you

Questions ?