Serving Linked Data

Principles – Solutions - ClioPatria

Four rules of Linked Data

1. Use URIs to identify things (**Resources**).

2. Use HTTP URIs so that these things can be referred to and looked up ("**dereference**") by people and user agents

3. Provide useful information (i.e., a **structured description - metadata**) about the thing when its URI is dereferenced.

4. Include **links** to other, related URIs in the exposed data to improve discovery of other related information on the Web.

www.w3.org/DesignIssues/**LinkedData**.html

So that means that

When I ask for a URI

dbpedia:Amsterdam

I want some data back, *describing* that resource

Content negotiation

Reply based on preference expressed in HTTP request response header (Accept:)

```
GET /resource/Amsterdam HTTP/1.1

Host: dbpedia.org

Accept: text/html;q=0.5, application/rdf+xml
```

I'm ok with HTML…

…but I really prefer RDF

text/html

```
body onload="init();" about="dbpedia:Amsterdam">
  <div id="header">
   <div id="hd_l">
       <h1 id="title">About: <a href="dbpedia:Amsterdam">Amsterdam</a></h1>
    <div id="homelink">
     <!--?vsp if (white_page = 0) http (txt); ?-->
    </div>
     <div class="page-resource-uri">
        An Entity of Type : <a href="http://dbpedia.org/ontology/City">city</a>,
        from Named Graph : <a href="http://dbpedia.org">http://dbpedia.org</a>,
        within Data Space : <a href="http://dbpedia.org">dbpedia.org</a>
    </div>
   </div> <!-- hd_l -->
   <div id="hd_r">
       <a href="http://wiki.dbpedia.org/Imprint" title="About DBpedia">
         <img src="/statics/dbpedia_logo.png" height="64" alt="About DBpedia"/>
    </a>
   </div> <!-- hd_r -->
  </div> <!-- header -->
  <div id="content">

   <p>Amsterdam is de hoofdstad en grootste gemeente van Nederland. De stad, in het Amsterdams ook Mokum genoemd, ligt
      in de provincie Noord-Holland, aan de monding van de Amstel en aan het IJ. De naam van de stad komt van de ligging bij een
      in de 13e eeuw aangelegde dam in de Amstel. De plaats kreeg stadsrechten rond 1300 en groeide tot één van de grootste
      handelssteden ter wereld in de Gouden Eeuw.</p>
```

text/html

dbpedia.org/page/Amsterdam

About: Amsterdam

An Entity of Type : city, from Named Graph : http://dbpedia.org, within Data Space : dbpedia.org

Amsterdam is de hoofdstad en grootste gemeente van Nederland. De stad, in het Amsterdams ook Mokum genoemd, ligt in de provincie Noord-Holland, aan de monding van de Amstel en aan het IJ. De naam van de stad komt van de ligging bij een in de 13e eeuw aangelegde dam in de Amstel. De plaats kreeg stadsrechten rond 1300 en groeide tot één van de grootste handelssteden ter wereld in de Gouden Eeuw.

Property	Value
dbpedia-owl:PopulatedPlace/areaMetro	1815.0
dbpedia-owl:PopulatedPlace/areaTotal	219.0
dbpedia-owl:PopulatedPlace/populationDensity	3506.0
dbpedia-owl:abstract	Amsterdam nebo též Amsterodam je hlavní město Nizozemska od roku 1808. Nesídlí v něm však parlament, vláda ani královská rodina, tyto instituce mají své sídlo v Den Haag. V současnosti je největším nizozemským městem, jeho finančním a kulturním centrem. Ve městě žije 761 395 obyvatel (sčítání lidu z 31. května 2009), kteří se hlásí ke 177 různým národnostem (duben 2009). Amsterdam je jedním z měst konurbace Randstad. Amsterdam er hovedstaden i Nederland. Den er landets største by og ligger i provinsen Noord-Holland. Til tross for at den er titulær hovedstad i landet, er ikke Amsterdam residensby for kongeparet og regjeringen. Amsterdam har en bykjerne med mange kanaler, og ble grunnlagt rundt en demning i elven Amstel, som også har gitt byen navn . Byens flyplass Schiphol, som ligger i nabokommunen Haarlemmermeer, er en av de viktigste i Europa. Amsterdam – największe miasto Holandii i jej stolica konstytucyjna. Wszystkie instytucje rządowe oraz przedstawicielstwa obcych państw znajdują się w Hadze. Amszterdam (Amsterdam) a Holland Királyság fő- de nem székvárosa (a királynő, a parlament, és a kormány székhelye Hága . Az Amstel folyó torkolatánál, az IJ partján fekszik. 1813 óta Hollandia fővárosa. Nevének jelentése: „gát az Amstelen". A várost a XVII-XVIII. századi iratok Amstelerdam néven említik. Amsterdam è la capitale e la maggiore città dei Paesi Bassi, nella provincia dell'Olanda Settentrionale. Il comune di Amsterdam ha 755.269 residenti di oltre 170 nazionalità, mentre la popolazione che risiede nell'area metropolitana è di circa 1.450.000 persone. L'area al centro della città circondata dai canali del XII secolo è dal 2010 Patrimonio dell'Unesco. アムステルダム（オランダ語:Amsterdam）は、オランダの北ホラント州の基礎自治体（ヘメーンテ）であり、憲法上に規定されたオランダの首都。オランダ語での発音は「アムスタダム」に近い。 政府、中央官庁、王室、国会など首都機能のほとんどはハーグにある。アムステルダムは商業および観光が中心である。 암스테르담은 네덜란드의 수도이다. 그러나 행정의 중심지는 암스테르담으로부터 약 50 킬로미터 떨어진 헤이그에 있다. 원래 한적한 마을이었다가, 12세기경 암스텔 강 하구에 둑을 쌓아 도시가 건설되었는데, 암스테르담이라는 지명은 여기에서 유래되었다. 16세기에는 무역항으로 유럽 굴지의 도시로 발전하였다. 지금은 네덜란드 최대의 도시이자 경제 문화의 중심 도시로 성장했다. 암스테르담 중앙역 건물은 도쿄 역 및 서울역 건물의 모델이 되었다고 한다. 관광 및 운하로 유명하며, 마약 합법화와 홍등가로 유명한 환락의 도시이다. 이 도시는 자전거를 타는 사람들이 유난히 많은 것으로 알려져 있다. 2008년 1월 1일 현재 인구는 136만명에 이르고 있다. Амстердам — столиця Нідерландів. Розташований в провінції Північна Голландія в гирлі річки Амстел. Амстердам сполучений з Північним морем каналом.

application/rdf+xml

```
<rdf:Description rdf:about="dbpedia:Amsterdam">  <rdf:type
    rdf:resource="http://schema.org/City" />
     <rdf:type rdf:resource="http://dbpedia.org/ontology/City" />
    <rdf:type rdf:resource=
    "http://dbpedia.org/class/yago/GeoclassCapitalOfAPoliticalEntity" />
    <rdf:type rdf:resource="http://dbpedia.org/ontology/Place" />  <rdf:type
    rdf:resource="http://dbpedia.org/class/yago/CitiesInTheNetherlands" />
    <rdf:type
    rdf:resource="http://dbpedia.org/class/yago/PortCitiesAndTownsInTheNet
    herlands" />
    <rdf:type rdf:resource=
    "http://dbpedia.org/class/yago/PortCitiesAndTownsOfTheNorthSea" />
    <rdf:type rdf:resource=
    "http://umbel.org/umbel/rc/Location_Underspecified" />
    <rdf:type rdf:resource="http://dbpedia.org/ontology/Settlement" />
…
```

application/x-turtle

<dbpedia:Amsterdam> <dbprop:/subdivisionName> "Amsterdam"@en .

<dbprop:/aprSun> "183"^^<http://www.w3.org/2001/XMLSchema#int> .

<http://www.w3.org/2000/01/rdf-schema#comment> "Amsterdam \u2013 najwi\u0119ksze miasto Holandii i jej stolica konstytucyjna. Wszystkie instytucje rz\u0105dowe …."@pl .

<http://dbpedia.org/ontology/timeZone> <dbpedia:Central_European_Summer_Time> .

<http://xmlns.com/foaf/0.1/name> "Amsterdam"@en .

<http://www.georss.org/georss/point> "52.37305555555555 4.892222222222222"@en .

<dbprop:/yearSun> "1662"^^<http://www.w3.org/2001/XMLSchema#int> .

<http://dbpedia.org/ontology/leaderTitle> "Secretary"@en .

….

What actually should happen

```
GET /resource/Amsterdam HTTP/1.1

Host: dbpedia.org

Accept: text/html;q=0.5, application/rdf+xml
```

```
GET /data/Amsterdam HTTP/1.1

Host: dbpedia.org

Accept: text/html;q=0.5, application/rdf+xml
```

```
HTTP/1.1 303 See Other

Location: http://dbpedia.org/data/Amsterdam

Vary: Accept
```

```
HTTP/1.1 200 OK
Content-Type: application/rdf+xml;charset=utf-8

<?xml version="1.0"?>
<rdf:RDF
   xmlns:units="http://dbpedia.org/units/"
   xmlns:foaf="http://xmlns.com/foaf/0.1/"
   xmlns:geon="http://www.geonames.org/ontology#"
   xmlns:rdfs="http://www.w3.org/2000/01/rdf-
```

The Treachery of Documents

http://en.wikipedia.org/wiki/Shanghai

Ceci n'est pas Shanghai

http://dbpedia.org/page/Shanghai

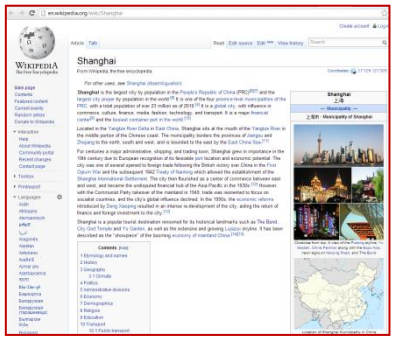
Ceci n'est pas Shanghai

http://farm1.staticflickr.com/225/474369474_b3f250bace.jpg

Ceci n'est pas Shanghai

photo: Flickr/Keith Marshall

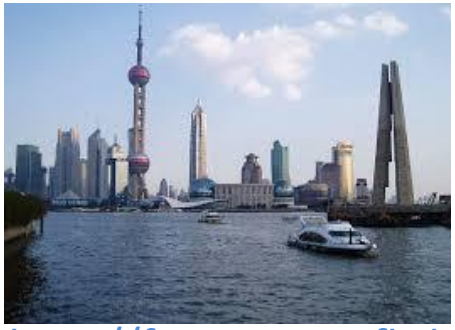
Information Resource vs non-Information resource



http://en.wikipedia.org/wiki/Shanghai

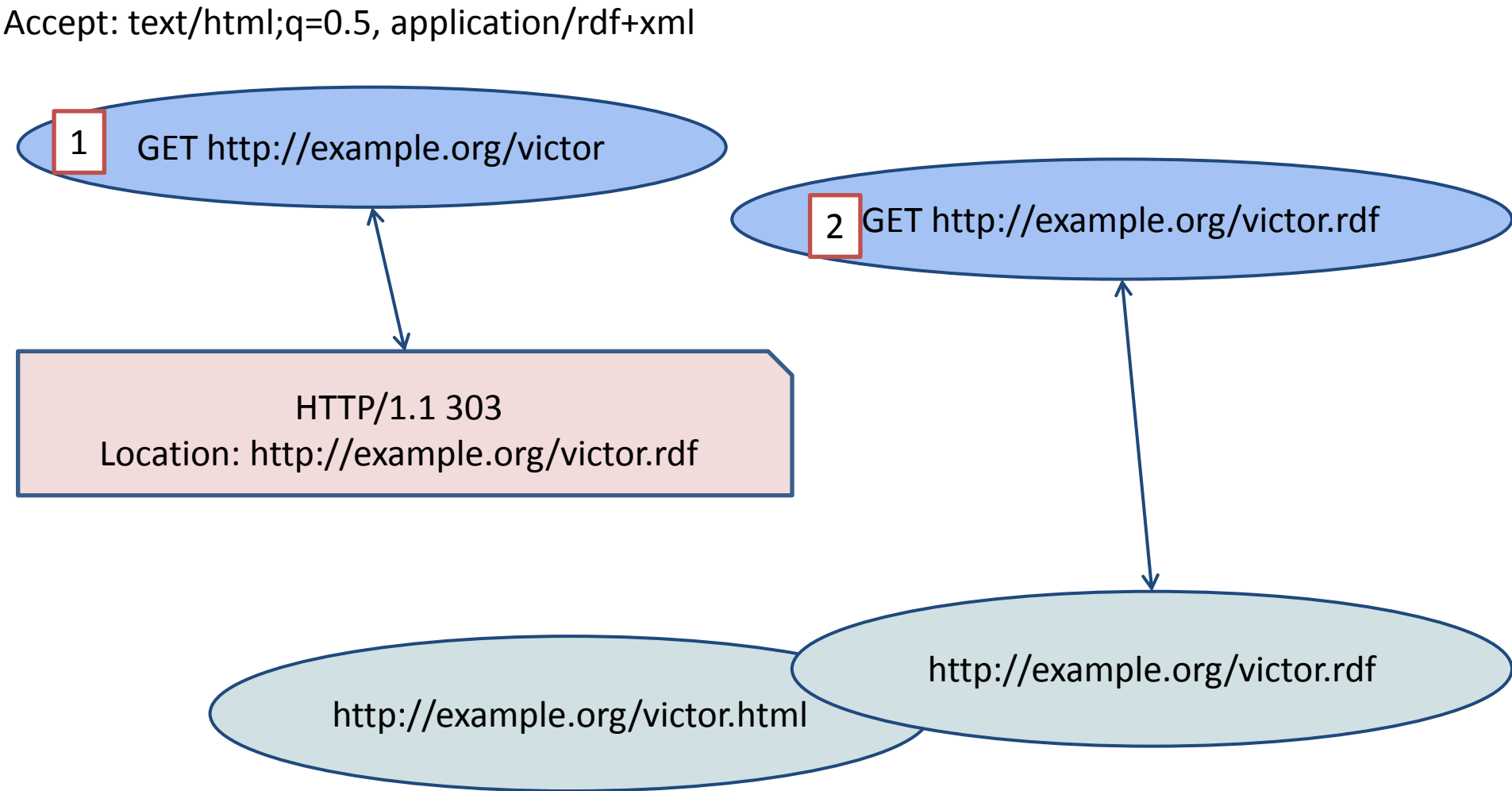
dbpedia:Shanghai

http://dbpedia.org/page/Shanghai

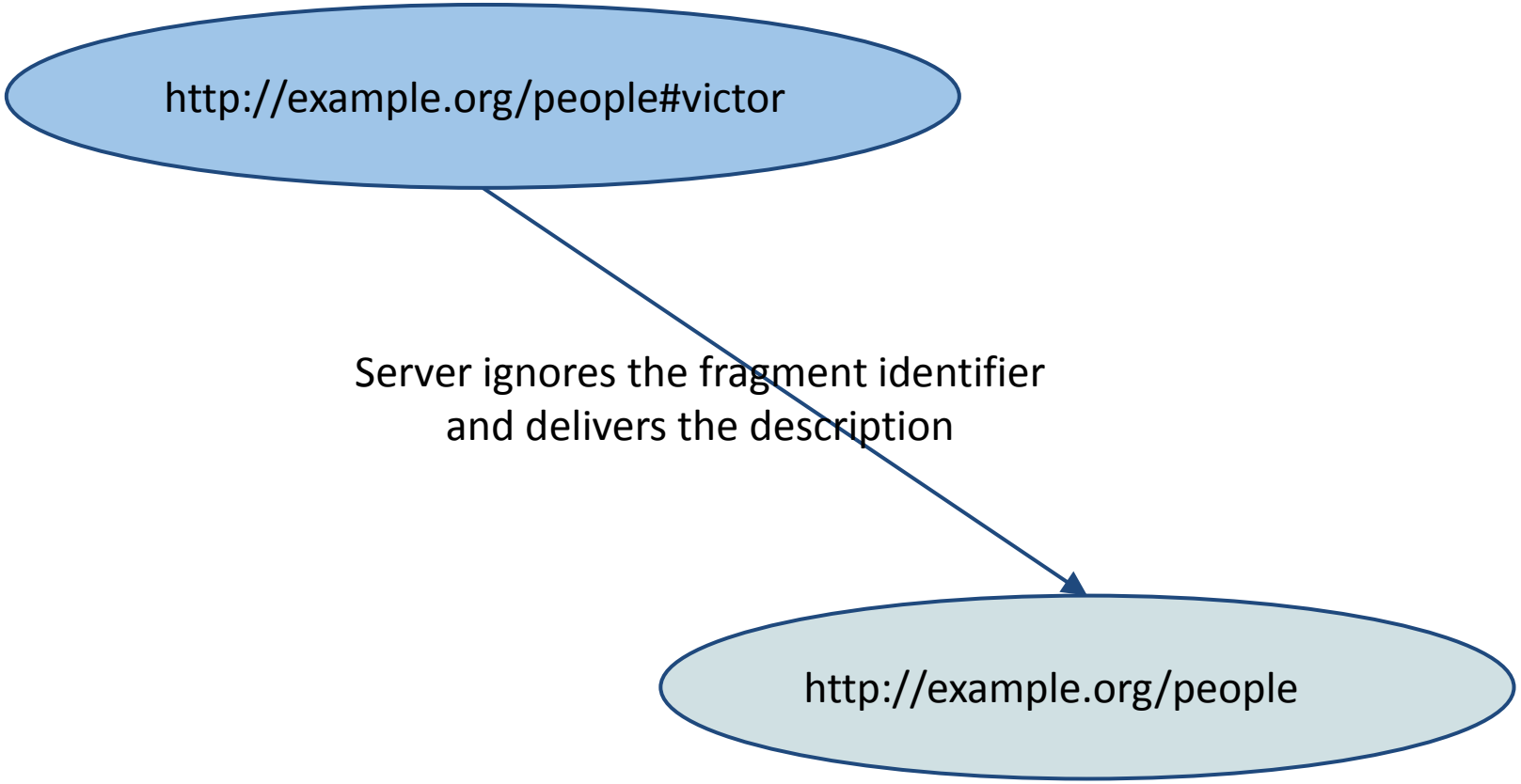


http://farm1.staticflickr.com/225/474369474_b3f250bace.jpg

Countermeasure: 303 redirect



Countermeasure: hash URIs



Hash vs. 303

303 require two HTTP requests

Hash retrieves entire document

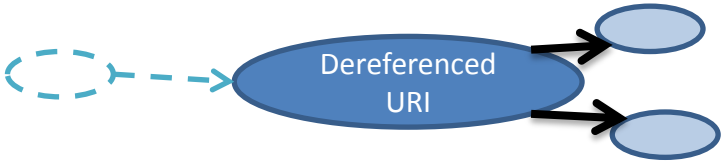
Hash better for smaller datasets and vocabularies

303 better for larger datasets

Which part of the graph?

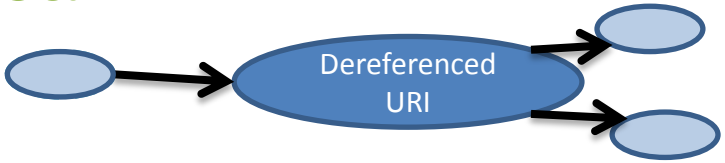
Concise bounded description

This notion is also known as "the bnode-closure of a resource“



Symmetric Concise bounded description

is similar to cbd, but includes triples with both URI as subject and object.



CBD vs SCBD

```
dbpedia:Amsterdam  dbprop:subdivisionName "Amsterdam"@en .
  dbprop:aprSun "183"^^<http://www.w3.org/2001/XMLSchema#int> .
  dbprop:timeZone dbpedia:Central_European_Sumer_Time .
  foaf:name "Amsterdam"@en .
  georss:point>"52.37305555555555 4.892222222222222"@en .
  dbprop:leaderTitle "Secretary"@en .
```

```
dbpedia:Johan_Cruyff dbpedia-owl:birthPlace  dbpedia:Amsterdam ;
                              dbpprop:cityofbirth     dbpedia:Amsterdam .
dbpedia:Heineken_International  dbpprop:location dbpedia:Amsterdam .
```

Publishing Linked Data

Recipes for publishing Linked Data

1. Serving Linked Data as Static RDF/XML Files
2. Serving Linked Data as RDF Embedded in HTML Files
3. Serving RDF and HTML with Custom Server-Side Scripts
4. Serving Linked Data from Relational Databases
5. Serving Linked Data by Wrapping Existing Application or Web APIs
6. Serving Linked Data from RDF Triple Stores

Tom Heath, Chris Bizer http://linkeddatabook.com/

1. Serving Linked Data as Static RDF/XML Files

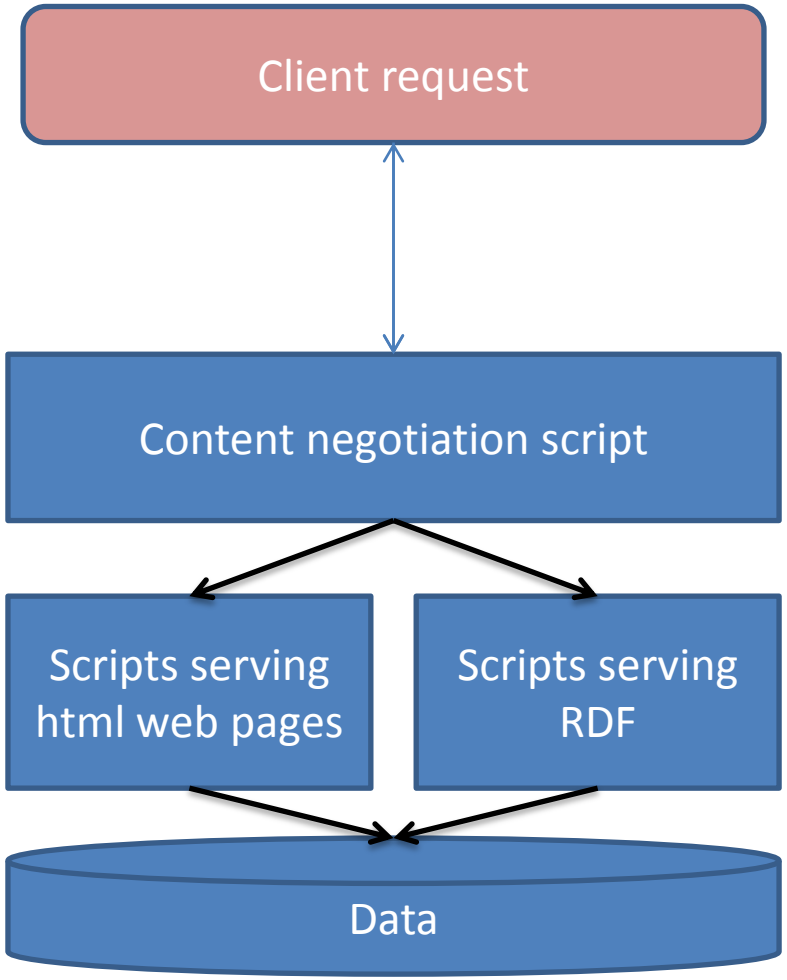
- “Just” host a .rdf file on your server, describing all of your RDF
  - Include correct MIME type

2. Serving Linked Data as RDF Embedded in HTML Files (RDFa)

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML+RDFa 1.0//EN"
   "http://www.w3.org/MarkUp/DTD/xhtml-rdfa-1.dtd">
<html xmlns="http://www.w3.org/1999/xhtml"
   xmlns:foaf="http://xmlns.com/foaf/0.1/"
   xmlns:dc="http://purl.org/dc/elements/1.1/"
   version="XHTML+RDFa 1.0" xml:lang="en">
 <head>
   <title>John's Home Page</title>
   <base href="http://example.org/john-d/" />
   <meta property="dc:creator" content="Jonathan Doe" />
   <link rel="foaf:primaryTopic" href="http://example.org/john-d/#me" />
 </head>
 <body about="http://example.org/john-d/#me">
   <h1>John's Home Page</h1>
   <p>My name is <span property="foaf:nick">John D</span> and I like
     <a href="http://www.neubauten.org/" rel="foaf:interest"
       xml:lang="de">Einstürzende Neubauten</a>.
   </p>
</body>
</html>
```

3. Serving RDF and HTML with Custom Server-Side Scripts

- PHP (ARC)
- Any other server-side scripting language

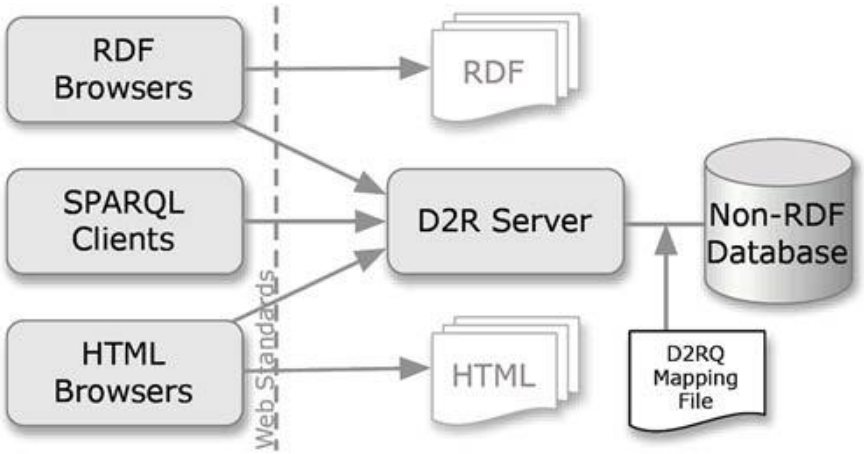


4. Serving Linked Data from Relational Databases

Some software mapping relational database tables to triples

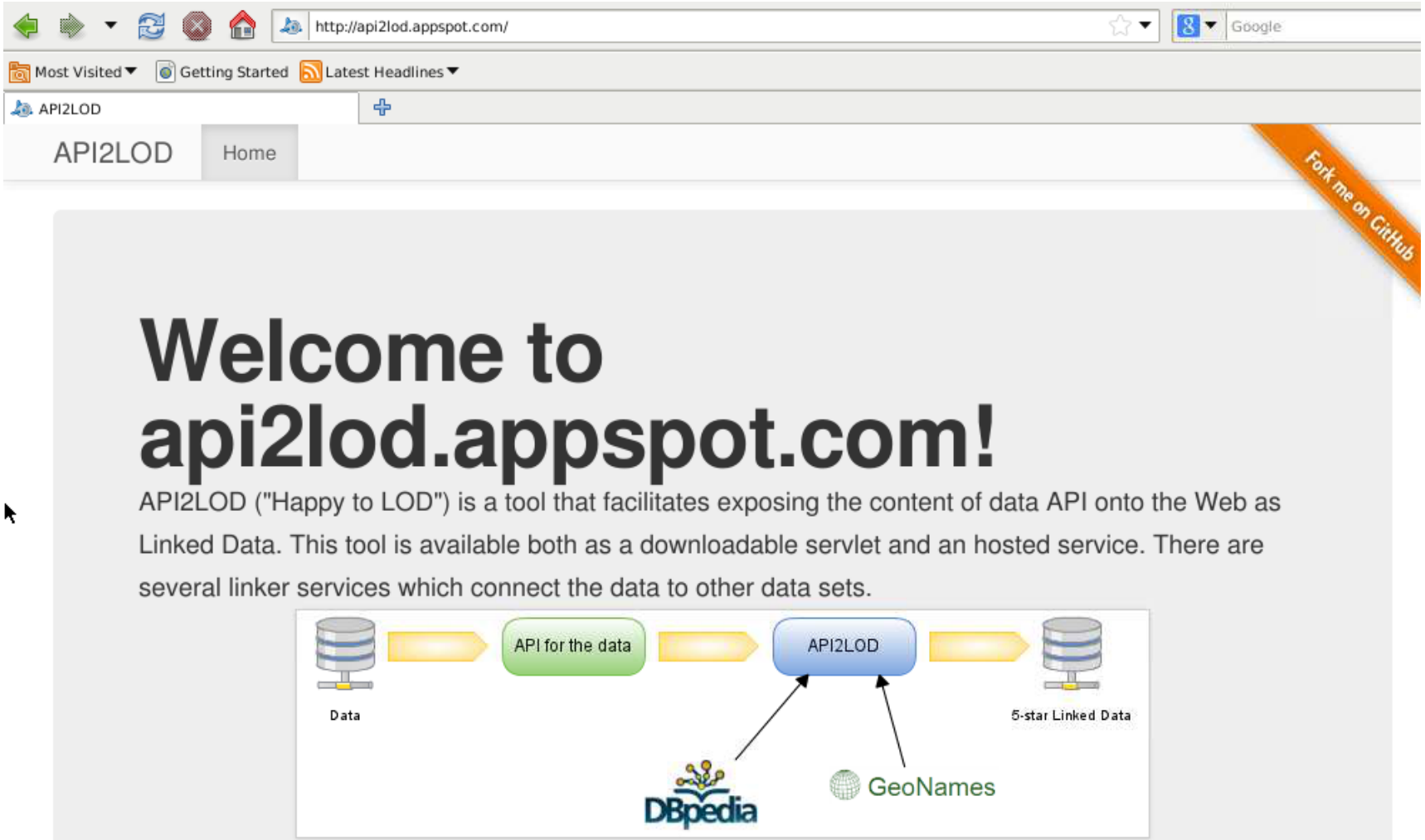
D2R, Triplify, Virtuoso

D2R



Tom Heath, Chris Bizer http://linkeddatabook.com/

5. Serving Linked Data by Wrapping Existing Application or Web APIs



6. Serving Linked Data from RDF *Triple Stores*

Sesame

Virtuoso

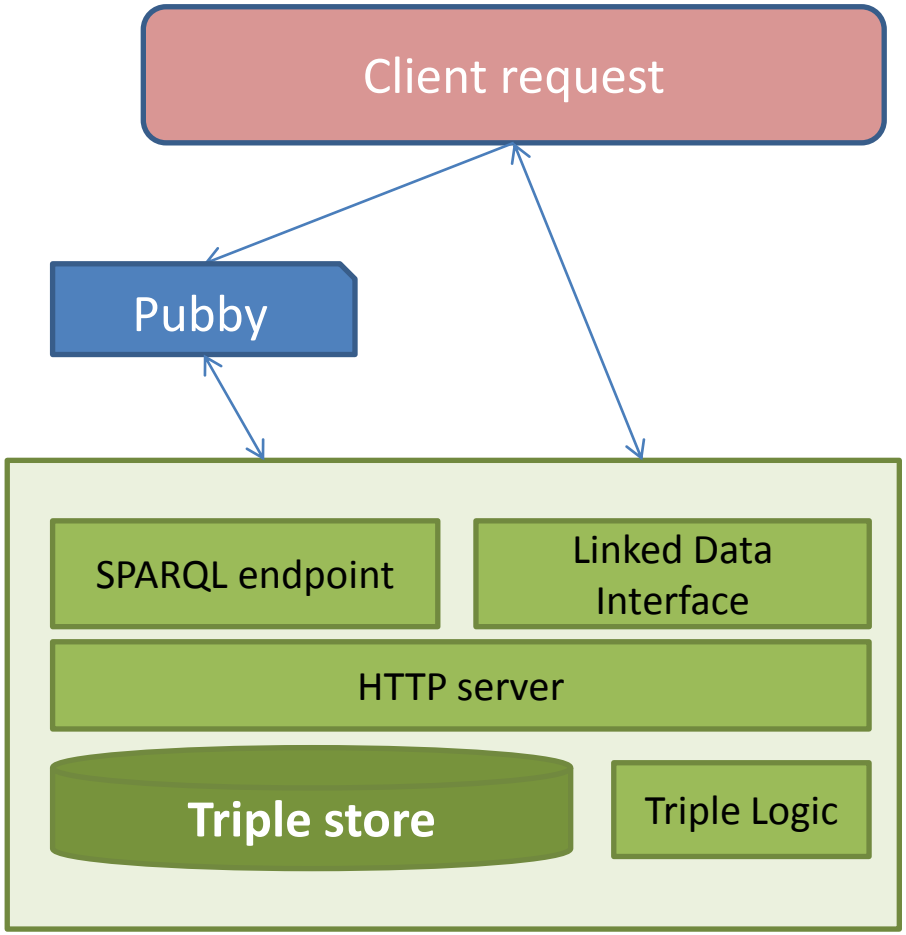
Apache Jena

Fuseki

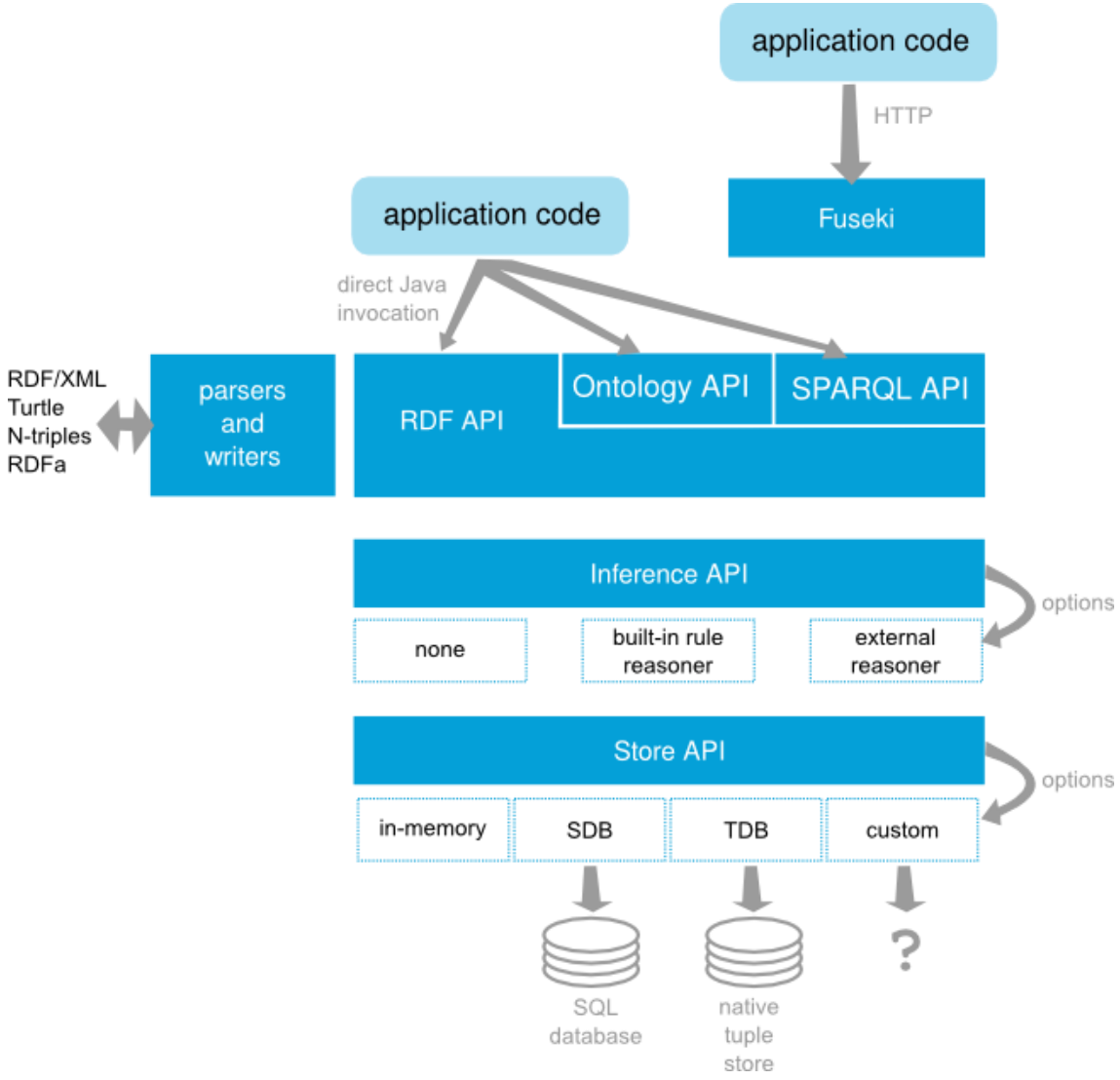
OWLIM

4Store

ClioPatria

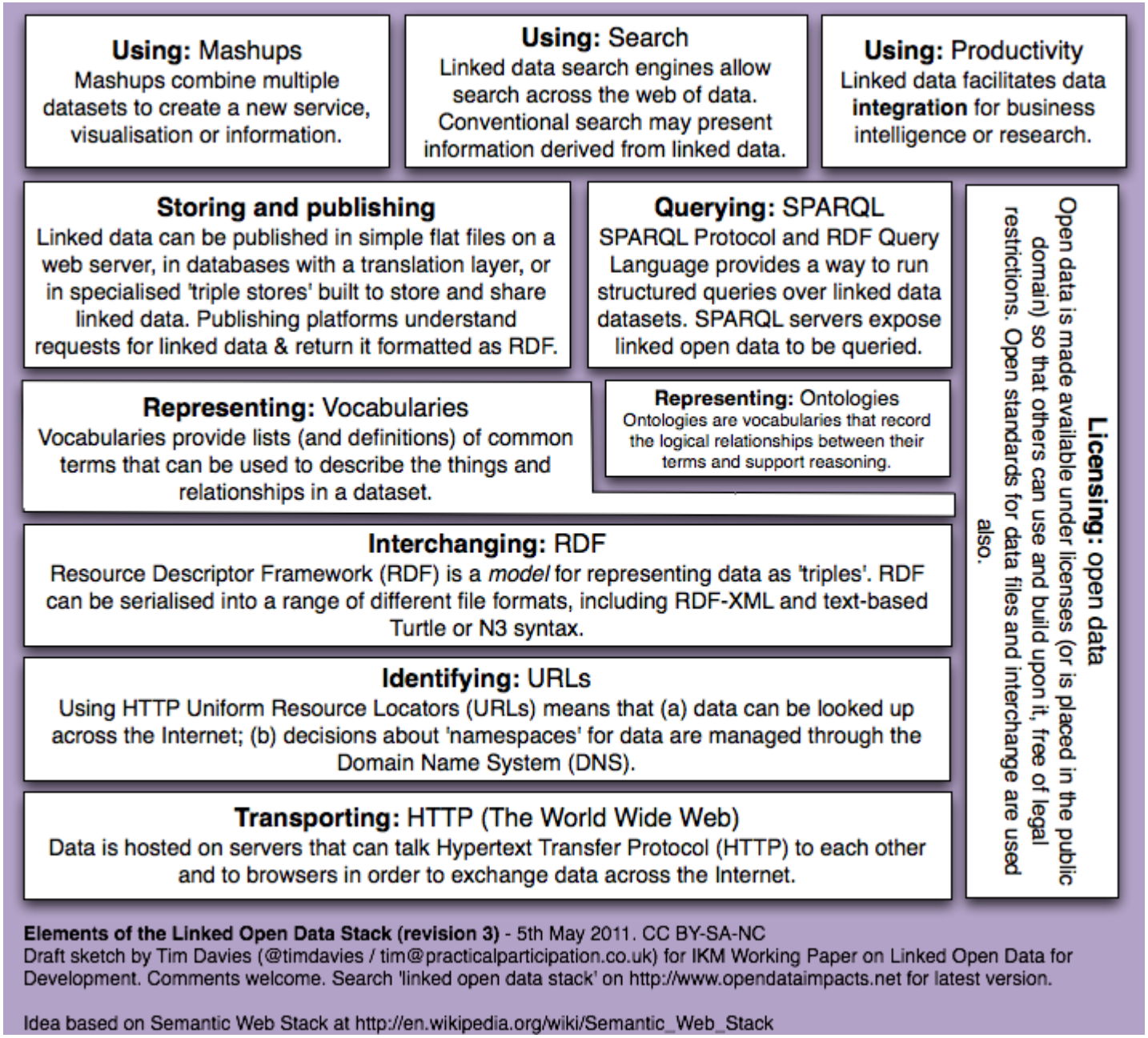


Apache Jena



http://jena.apache.org/about_jena/architecture.html

Elements of a Linked Open Data Stack



Elements of the Linked Open Data Stack (revision 3) - 5th May 2011. CC BY-SA-NC
Draft sketch by Tim Davies (@timdavies / tim@practicalparticipation.co.uk) for IKM Working Paper on Linked Open Data for Development. Comments welcome. Search 'linked open data stack' on http://www.opendataimpacts.net for latest version.

Idea based on Semantic Web Stack at http://en.wikipedia.org/wiki/Semantic_Web_Stack

ClioPatria

What is ClioPatria 3.0?

- A Prolog RDF store
- A Prolog-based web-server
- With SPARQL endpoint
- With LOD (Linked Open Data) service
- With development tools
- With an extension mechanism (CPACK)
- ...

Next few slides by Jan Wielemaker

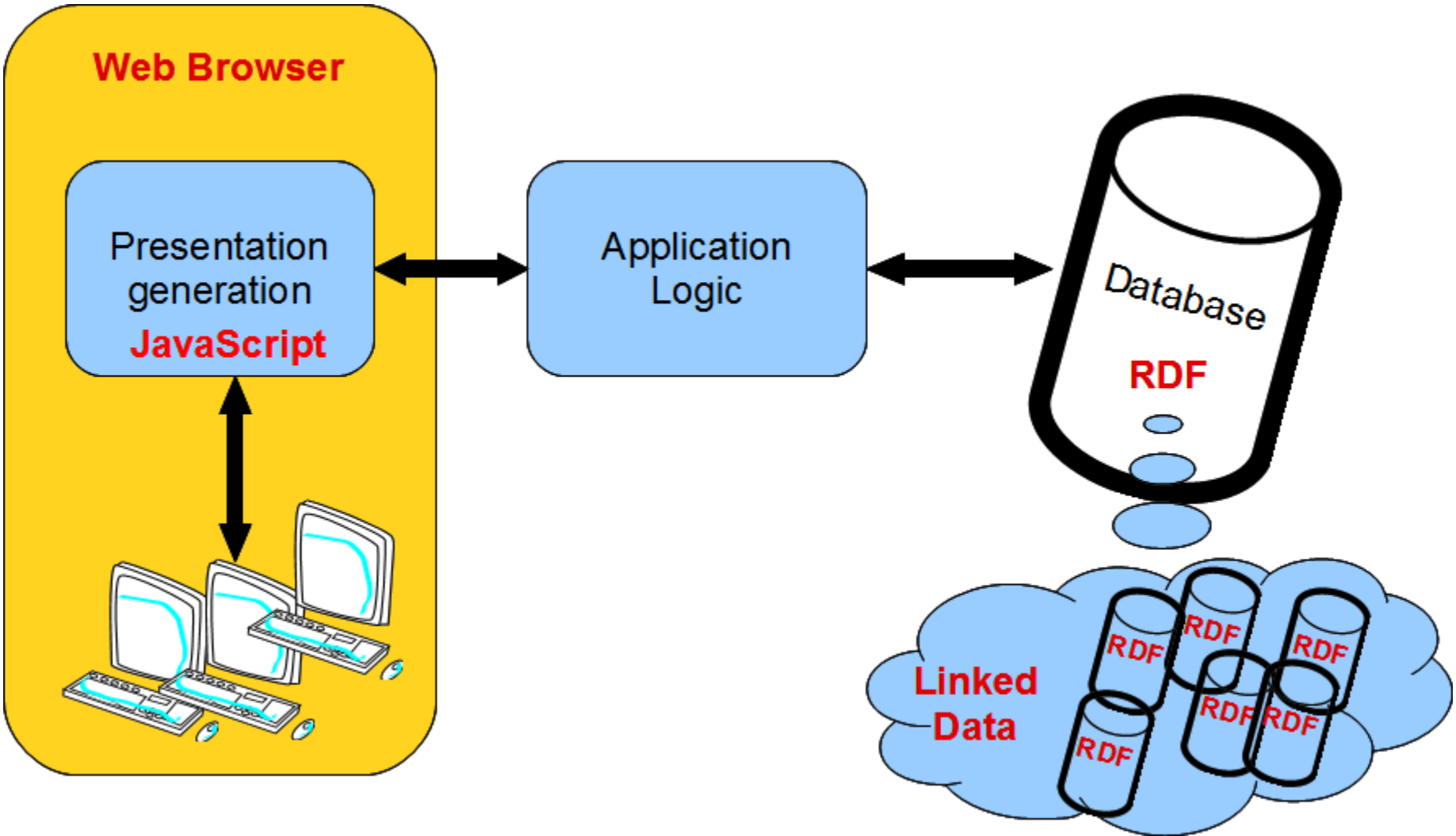
Aims of ClioPatria 3.0

- Provide an easy to use RDF platform
  - Simple installation
  - Simple exchange of extensions (CPACK)
  - Intuitive usage
    - Web front-end
    - Prolog interactive access
- Intended usage
  - Application development
  - Study

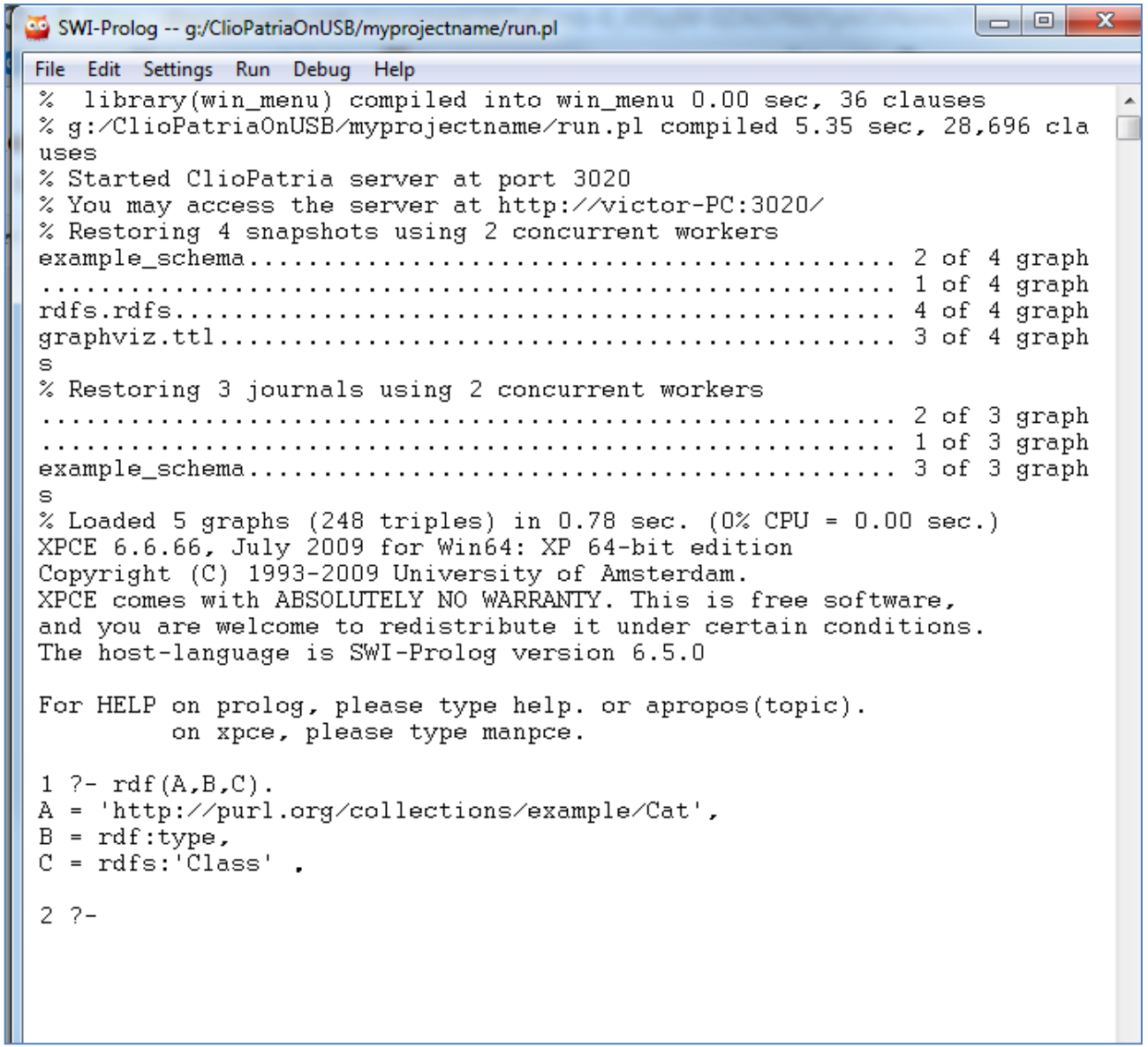
CPACKs

- Amalgame for vocabulary alignment
- XMLRDF for converting XML to RDF
- Prepackaged data and metadata sets
  - Provenance, SKOS, etc.
- UI packages
  - For specific web applications

ClioPatria model



RDF in SWI-Prolog



RDF/3 predicate

```
6 ?- rdf(A,B,C).
A = 'http://purl.org/collections/example/Cat',
B = rdf:type,
C = rdfs:'Class' .

7 ?- rdf(A, 'http://purl.org/collections/example/likes', B).
A = 'http://purl.org/collections/example/victor',
B = 'http://purl.org/collections/example/truffel' .

8 ?- rdf(A, B, literal(L)).
A = 'http://purl.org/collections/example/Cat',
B = rdfs:label,
L = 'Cat' .

9 ?-
```

More predicates

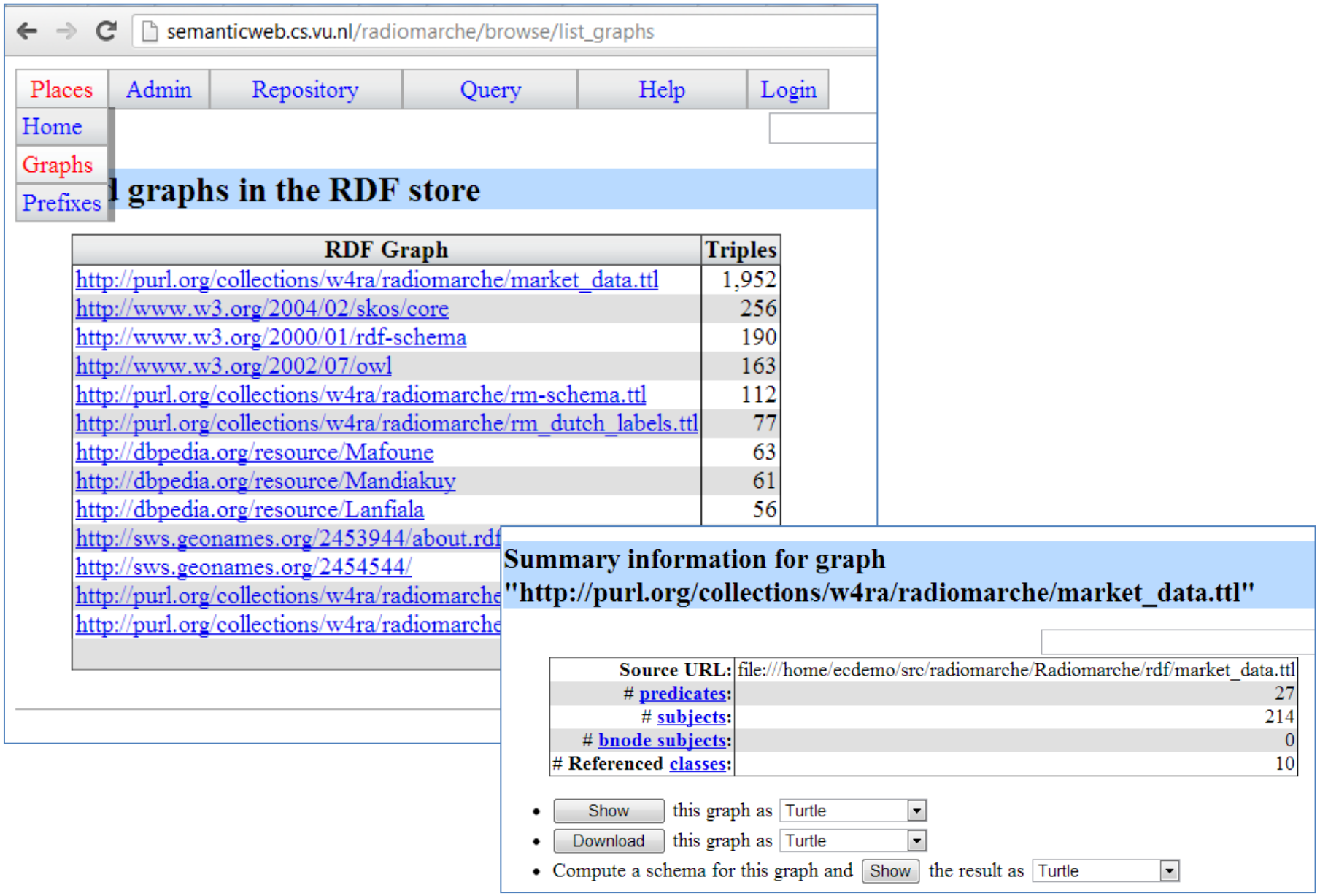
```
rdf_load(FileOrURI).
```

```
rdf_assert(Subject, Predicate, Object).
```

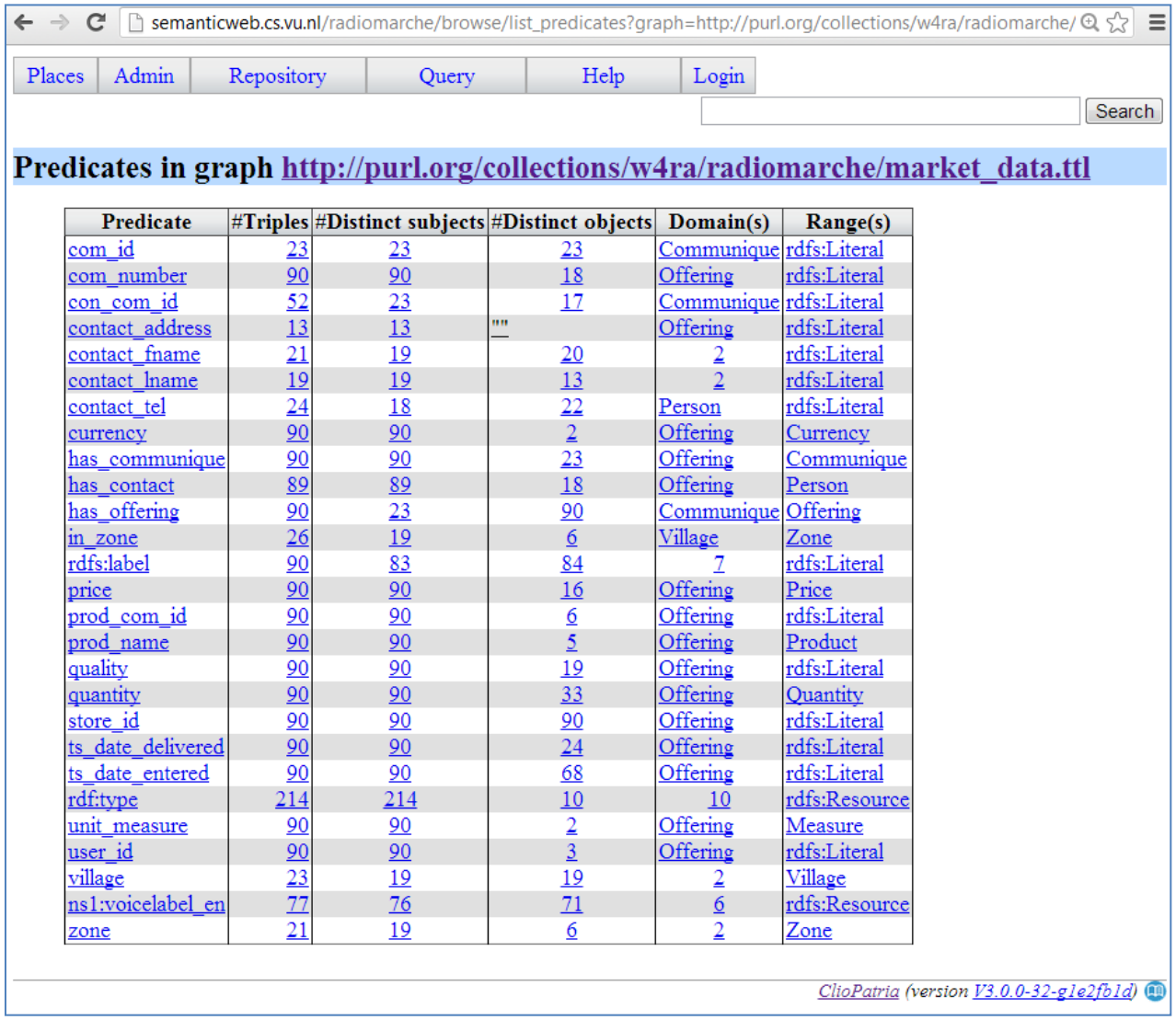
```
rdf_retractall(S,P,O).
```

ClioPatria UI

Statistics: Named Graphs



Statistics: predicates in a Named Graph



semanticweb.cs.vu.nl/radiomarche/browse/list_predicates?graph=http://purl.org/collections/w4ra/radiomarche/

Places | Admin | Repository | Query | Help | Login

Search

Predicates in graph http://purl.org/collections/w4ra/radiomarche/market_data.ttl

Predicate	#Triples	#Distinct subjects	#Distinct objects	Domain(s)	Range(s)
com_id	23	23	23	Communique	rdfs:Literal
com_number	90	90	18	Offering	rdfs:Literal
con_com_id	52	23	17	Communique	rdfs:Literal
contact_address	13	13	""	Offering	rdfs:Literal
contact_fname	21	19	20	2	rdfs:Literal
contact_lname	19	19	13	2	rdfs:Literal
contact_tel	24	18	22	Person	rdfs:Literal
currency	90	90	2	Offering	Currency
has_communique	90	90	23	Offering	Communique
has_contact	89	89	18	Offering	Person
has_offering	90	23	90	Communique	Offering
in_zone	26	19	6	Village	Zone
rdfs:label	90	83	84	7	rdfs:Literal
price	90	90	16	Offering	Price
prod_com_id	90	90	6	Offering	rdfs:Literal
prod_name	90	90	5	Offering	Product
quality	90	90	19	Offering	rdfs:Literal
quantity	90	90	33	Offering	Quantity
store_id	90	90	90	Offering	rdfs:Literal
ts_date_delivered	90	90	24	Offering	rdfs:Literal
ts_date_entered	90	90	68	Offering	rdfs:Literal
rdf:type	214	214	10	10	rdfs:Resource
unit_measure	90	90	2	Offering	Measure
user_id	90	90	3	Offering	rdfs:Literal
village	23	19	19	2	Village
ns1:voicelabel_en	77	76	71	6	rdfs:Resource
zone	21	19	6	2	Zone

ClioPatria (version V3.0.0-32-g1e2fb1d)

Local view of a resource

Local view for "http://purl.org/collections/w4ra/radiomarche/product-Beurre_de_karite"

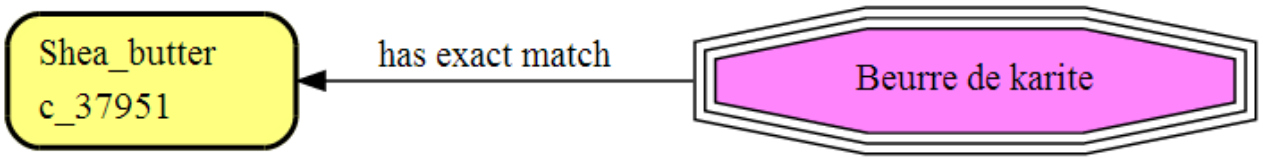
Predicate	Value (sorted: default)
rdfs:label	"Beurre de karite"[2]
rdf:type	Product[2]
skos:has exact match	<http://aims.fao.org/aos/agrovoc/c_37951>[1] <http://dbpedia.org/resource/Shea_butter>[1]
ns1:voicelabel_en	<http://semanticweb.cs.vu.nl/amalgame/voicestest/VXMLtest/audio/Beurre_de_karite_en.wav>[2]
ns1:voicelabel_nl	<http://semanticweb.cs.vu.nl/amalgame/voicestest/VXMLtest/audio/Beurre_de_karite_nl.wav>[3]

Named graphs describing this resource:

[1] http://purl.org/collections/w4ra/radiomarche/alignments.ttl
[2] http://purl.org/collections/w4ra/radiomarche/market_data.ttl
[3] http://purl.org/collections/w4ra/radiomarche/rm_dutch_labels.ttl

The resource appears as object in 37 triples

Context graph



Get external RDF data from the Linked Data Cloud

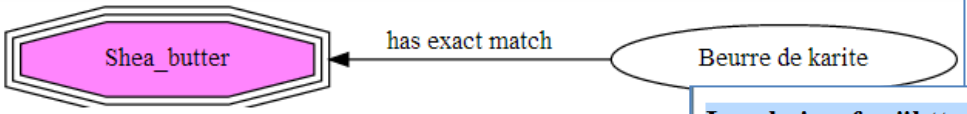
Local view for "http://dbpedia.org/resource/Shea_butter"

No triples for this URI. Would you like to Query the Linked Data cloud ?

The resource appears as object in one triple:

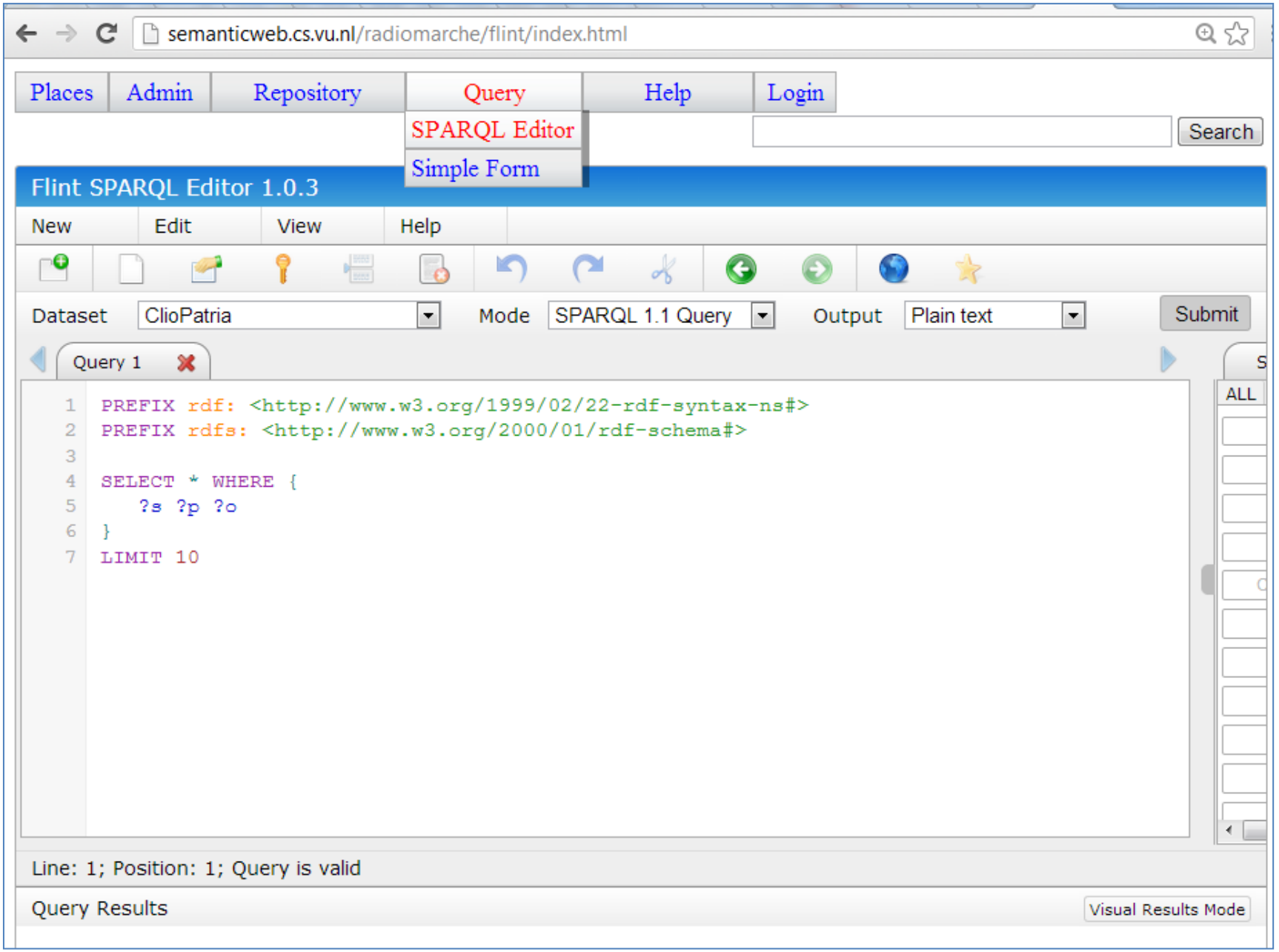
{ Beurre de karite, skos:exactMatch, <http://dbpedia.org/resource/Shea_butter> }

Context graph



Local view for "http://dbpedia.org/resource/Shea_butter"

Predicate	Value (sorted: default)
rdfs:label	"Shea butter"@en
rdf:type	<http://dbpedia.org/class/yago/CookingFats> <http://dbpedia.org/class/yago/CropsOriginatingFromAfrica> <http://dbpedia.org/class/yago/VegetableOils>
rdfs:comment	"Shea butter is a slightly yellowish or ivory-colored fat extracted African shea tree (Vitellaria paradoxa). It is widely used in cosme moisturizer, salve or lotion. Shea butter is edible and may be use preparation. Occasionally the chocolate industry uses shea butter oils, as a substitute for cocoa butter, although the taste is differen "shea" comes from s'i, the tree's name in the Bamana language o "Karitevoi, tai myös Sheavoi on kasvirasva, jota saadaan karitepu paradoxa) pähkinästä. Sitä käytetään laajasti kosmetiikan raaka-a "Le beurre de karité, ou beurre végétal, est une substance comes fruits du karité, un arbre poussant dans les savanes arborées de l' et dont le nom signifie « vie » en langue mandingue. Le beurre d consommé dans la cuisine traditionnelle ou utilisé dans l'industrie substitut au beurre de cacao. Il est surtout connu pour ses propri comme hydratant et assouplissant de la peau."@fr "参照のこと]] シアバター（英: shea butter）はアカテツ科のシ 子の胚から得られる植物性脂肪。シアーバターとも表記される "시어버터는 강력한 항염효과를 지닌 식물성 오일이다. 학명 Butyrospermum parkii (부티로스퍼멈 파키)이다. 시어버터는 고 있는 지방산 추출물로 가공되지 않은 상태의 시어버터는 25%~30% 가 항산화 (Phenolics) 성분으로 구성되어 있고, 국


semanticweb.cs.vu.nl/radiomarche/flint/index.html
Places
Admin
Repository
Query
Help
Login
SPARQL Editor
Simple Form
Search
Flint SPARQL Editor 1.0.3
New
Edit
View
Help
Dataset
ClioPatria
Mode
SPARQL 1.1 Query
Output
Plain text
Submit
Query 1
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
SELECT * WHERE {
?s ?p ?o
}
LIMIT 10
ALL
Line: 1; Position: 1; Query is valid
Query Results
Visual Results Mode

So let’s get our RDF in a triple store!