What is this thing called Linked Data?

Part II - Hands-on session

Manuel Atencia, Jérôme David and Philippe Genoud

DocEng 2015, September 8, Lausanne, Switzerland

Hands-on session

- Part I: From an Excel data file to linked open data
  - you will learn how to
    - create "cool" URIs
    - describe things with RDF
    - make links to other datasets
  - we will use the OpenRefine tool + RDF extension
- Part II: Querying linked data with SPARQL
  - you will learn how to make queries with SPARQL
  - we will use Apache Jena - ARQ command line applications

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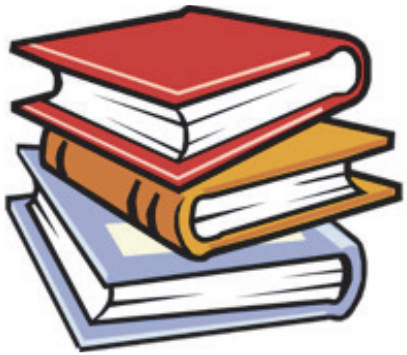
Part I: 14:00 – 15:30
Coffee break: 15:30 – 16:00
Part II: 16:00 – 17:30

Hands-on session

Case study: **Artemis Bookstore**

- Artemis owns a bookstore. She has heard of the Linked Data technologies, but she is not fully convinced of the benefits of using these technologies.
- Artemis has provided you with a sample of her data in an Excel file: `artemisBookstoreData.xlsx`
- Let's convince Artemis to join Linked Open Data!

Artemis Bookstore



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Hands-on session (I)

Artemis' bookstore data

- Let's have a look at `artemisBookstoreData.xlsx`
- There are two kinds of data: authors and books

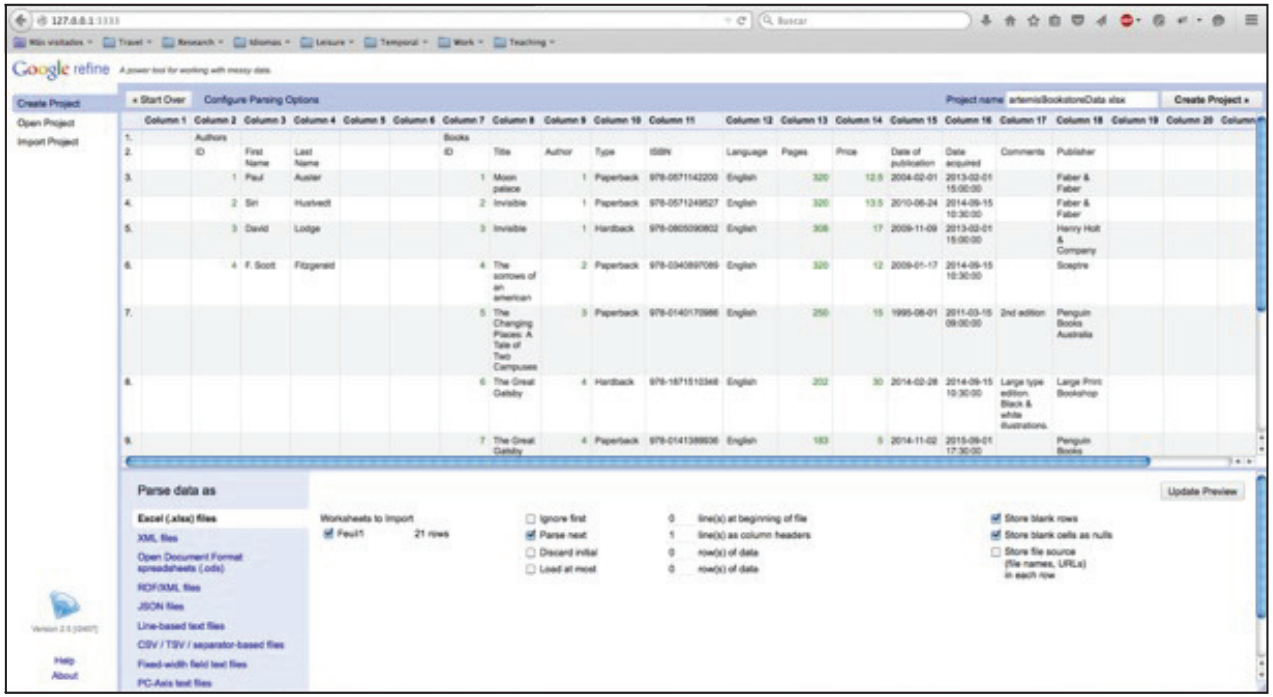
Authors		
ID	First Name	Last Name
1	Paul	Auster
2	Siri	Hustvedt
3	David	Lodge
4	F. Scott	Fitzgerald

Authors have an ID, a first name and a second name. Books have an ID, a title, author(s), a type, an ISBN, a language, pages, a price, a date of publication, a date of acquirement, comments and a publisher

Books										
ID	Title	Author	Type	ISBN	Language	Pages	Price	Date of publication	Date acquired	Comments	Publisher
1	Moon palace	1	Paperback	571142200	English	320	12.5	2004-02-01	2013-02-01 15:00:00		Faber & Faber
2	Invisible	1	Paperback	571249527	English	320	13.5	2010-06-24	2014-09-15 10:30:00		Faber & Faber
3	Invisible	1	Hardback	805090802	English	308	17	2009-11-09	2013-02-01 15:00:00		Henry Holt & Company
4	The sorrows of an american	2	Paperback	340897089	English	320	12	2009-01-17	2014-09-15 10:30:00		Sceptre
5	The Changing Places: A Tale	3	Paperback	140170986	English	250	15	1995-08-01	2011-03-15 09:00:00	2nd edition	Penguin Books Australia
6	The Great Gatsby	4	Hardback	1871510348	English	202	30	2014-02-28	2014-09-15 10:30:00	Large type e	Large Print Bookshop
7	The Great Gatsby	4	Paperback	141389936	English	183	5	2014-11-02	2015-09-01 17:30:00		Penguin Books
8	The Great Gatsby	4	Hardback	1857150193	English	176	15	1991-09-26	2011-03-15 09:00:00		Everyman's library

Hands-on session (I)

- Our goal is to convert Artemis' raw data into linked open data and for this we will use OpenRefine tool and its RDF extension developed by DERI
- Open OpenRefine and create a new project by uploading `artemisBookstoreData.xlsx`

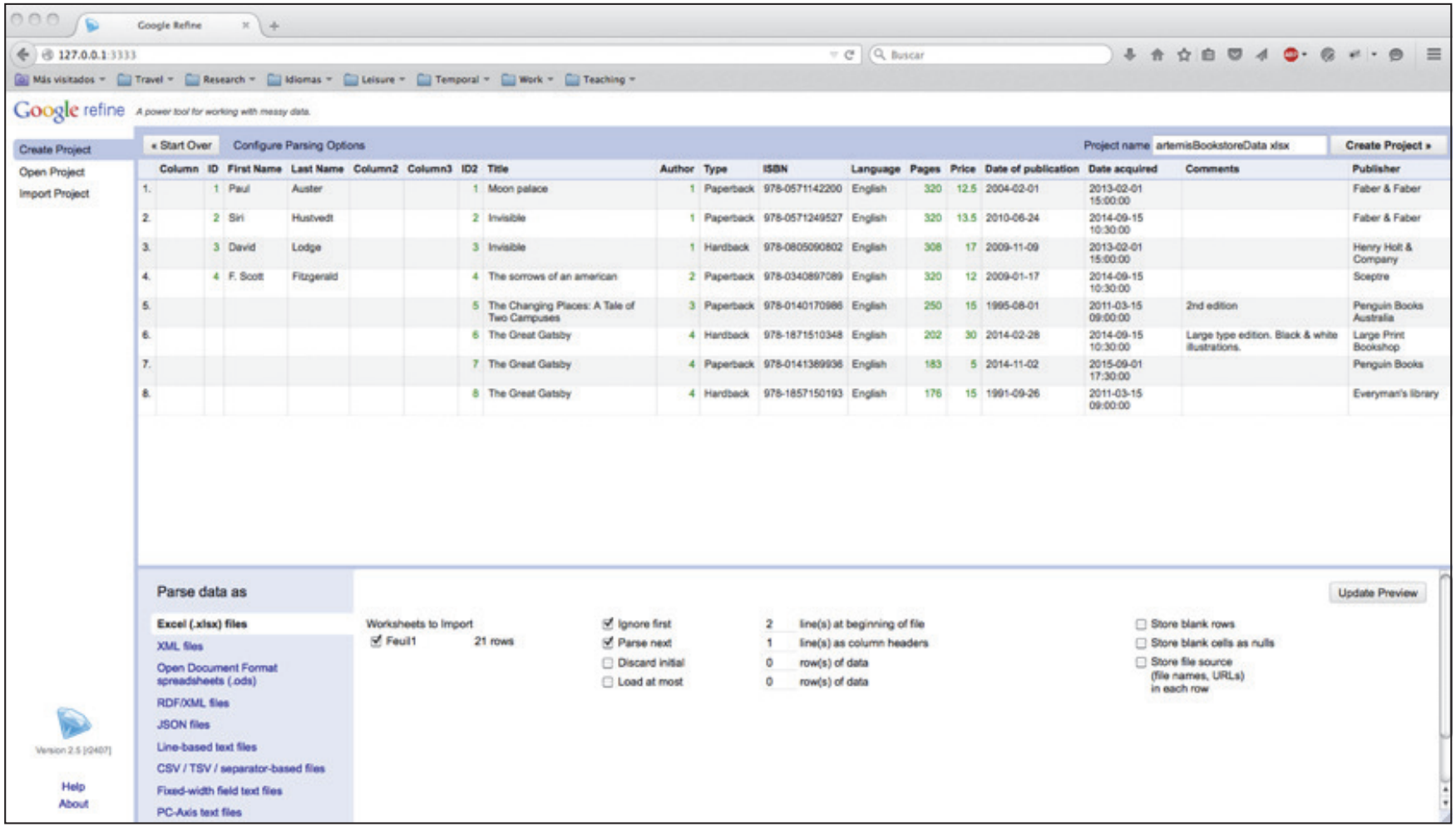


you can download OpenRefine at http://openrefine.org/download.html

Hands-on session (I)

OpenRefine
Preprocessing data

- Let's start by doing some preprocessing of the data



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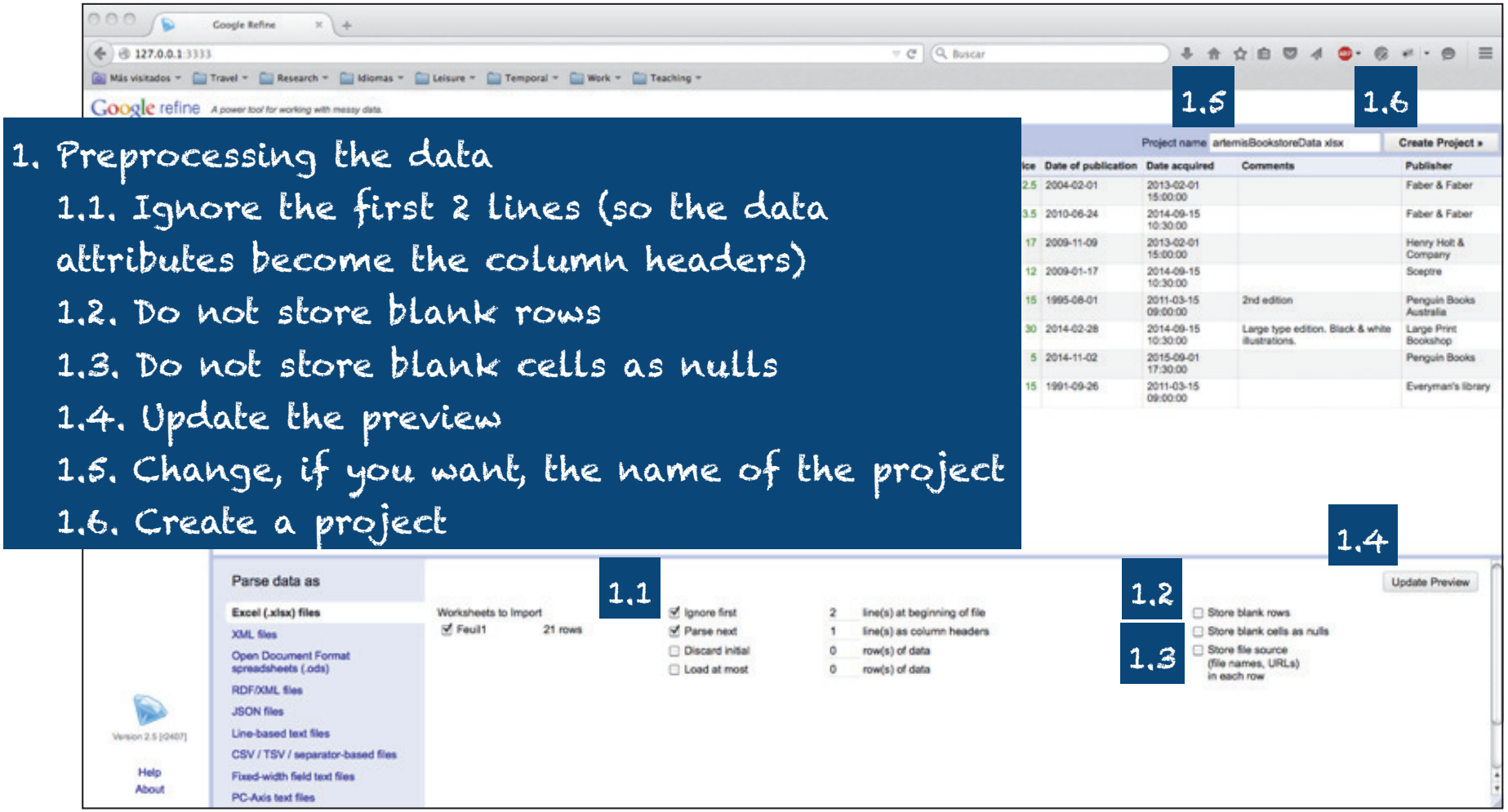

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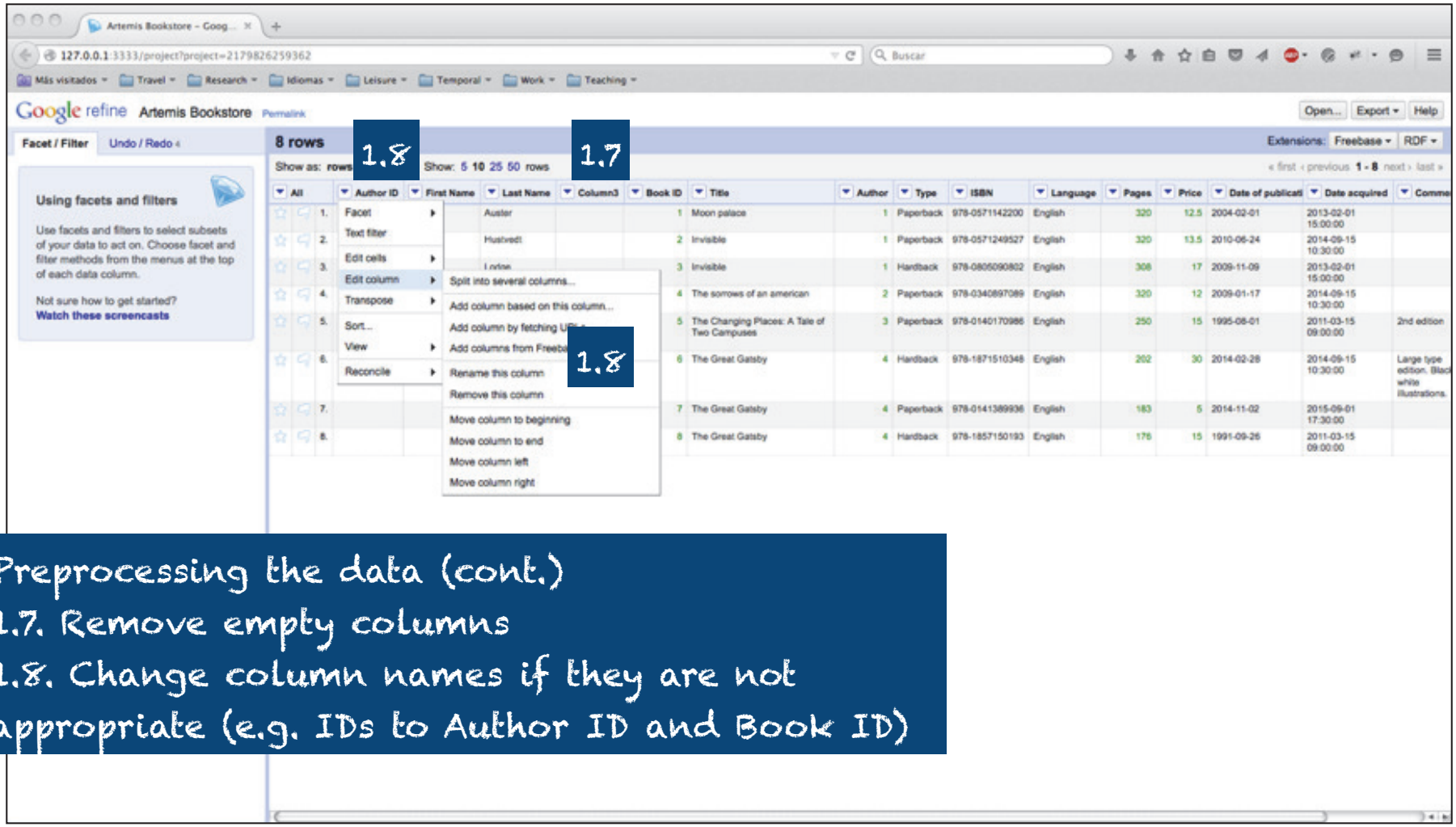

1. Preprocessing the data (cont.)
   1.7. Remove empty columns
   1.8. Change column names if they are not appropriate (e.g. IDs to Author ID and Book ID)

Hands-on session (I)

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- Now, let's create RDF data!

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- Now, let's create RDF data!
- But before, let's recall the Linked Data principles:

1. Use URIs as names for things.
2. Use HTTP URIs, so that people can look up those names.
3. When someone looks up a URI, provide useful information using the standards (RDF, SPARQL).
4. Include links to other URIs, so that they can discover more things.

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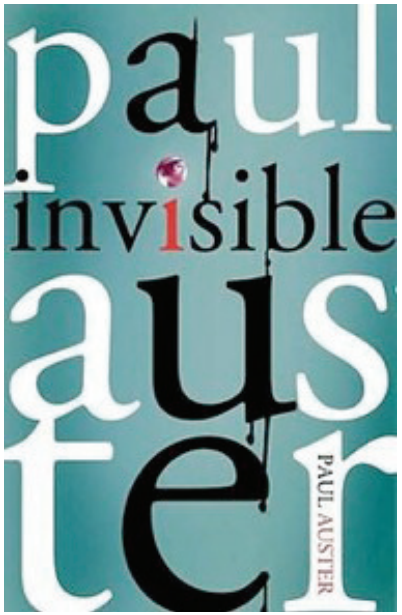
Hands-on session (I)

- Let's consider the paperback book "Invisible" written by Paul Auster. Can you find a cool URI for this resource?



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Creating RDF data
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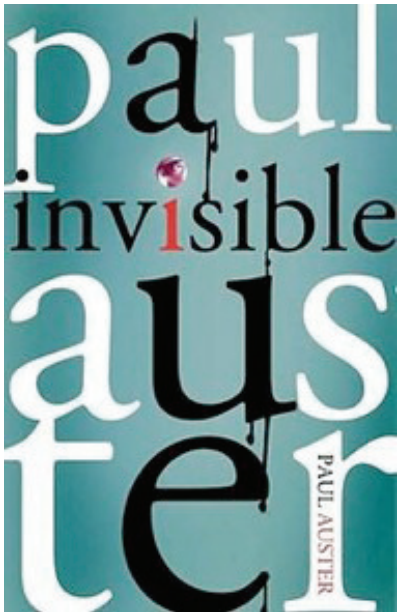

REMEMBER!
web document ≠ web resource
Actually, you should find
- A URI for the real object itself.
- A URI for the related information resource that describes the real-world object and has an HTML representation.
- A URI for a related information resource that describes the real-world object and has an RDF/XML representation.

Hands-on session (I)

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    more info at http://www.w3.org/TR/cooluris/

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Describing things with RDF

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  - triples describing related resources (e.g. the name of the resource's creator)

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  - triples describing the description itself (e.g. licensing terms)

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  - triples describing related resources (e.g. the name of the resource's creator)
  - triples describing the description itself (e.g. licensing terms)
  - triples about the broader dataset of which this description is a part

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  - triples that des
    resources, or *o*
  - triples describi
    resource's crea
  - triples describi
  - triples about th
    a part

and, for writing this description, you can use:
- terms from existing vocabularies
  - Dublin Core (e.g. dcterms:title)
  - FOAF (e.g. foaf:name)
  - ...
- your own defined terms
- RDFS (rdfs:comment and rdfs:label for annotations), OWL (owl:sameAs for links)

Hands-on session (I)

Reusing Existing Terms
FOAF vocabulary

- The FOAF ("Friend of a Friend") vocabulary can be used for describing persons, their activities and their relations to other people and objects.
- FOAF = RDF + Social Web
- namespace:

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

Hands-on session (I)

Reusing Existing Terms
FOAF vocabulary

- An example:

```
@base <http://exmo.inrialpes.fr/about> .
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix foaf: <http://xmlns.com/foaf/0.1/> .

<#jdavid>
  a foaf:Person ;
  foaf:name "Jérôme David"@fr ;
  foaf:nick "JD" ;
  foaf:mbox <mailto:jerome.david@inria.fr> ;
  foaf:homepage "http://exmo.inrialpes.fr/~jdavid/" ;
  foaf:depiction <http://exmo.inrialpes.fr/jdavid_img_small.jpg> ;
  foaf:knows <http://exmo.inrialpes.fr/about#matencia> ,
             <http://www.imag.fr/id/pgenoud> ,
             [ a foaf:Person ;
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<#jdavid>
  a foaf:Person ;
  foaf:name "Jérôme David"@fr ;
  foaf:nick "JD" ;
  foaf:mbox <mailto:jerome.david@inria.fr> ;
  foaf:homepage "http://exmo.inrialpes.fr/~jdavid/" ;
  foaf:depiction <http://exmo.inrialpes.fr/jdavid_img_small.jpg> ;
  foaf:knows <http://exmo.inrialpes.fr/about#matencia> ,
             <http://www.imag.fr/id/pgenoud> ,
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```
@base <http://exmo.inrialpes.fr/ab
@prefix rdf: <http://www.w3.org/19
@prefix rdfs: <http://www.w3.org/2
@prefix foaf: <http://xmlns.com/fo

<#jdavid>
  a foaf:Person ;
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  foaf:mbox <mailto:jerome.david@inria.fr> ;
  foaf:homepage "http://exmo.inrialpes.fr/~jdavid/" ;
  foaf:depiction <http://exmo.inrialpes.fr/jdavid_img_small.jpg> ;
  foaf:knows <http://exmo.inrialpes.fr/about#matencia> ,
             <http://www.imag.fr/id/pgenoud> ,
             [ a foaf:Person ;
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```

jdavid is a person, with the name of "Jérôme David" and the nickname of "JD", who has an email address of "jerome.david@inria.fr". His homepage is... He is depicted in the image... He knows... He also knows a person whose name is "Ewan David" and who is 5 years old.

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  foaf:mbox <mailto:jerome.david@inria.fr> ;
  foaf:homepage "http://exmo.inrialpes.fr/~jdavid/" ;
  foaf:depiction <http://exmo.inrialpes.fr/jdavid_img_small.jpg> ;
  foaf:knows <http://exmo.inrialpes.fr/about#matencia> ,
```

jdavid is a person, with the name of "Jérôme David" and the nickname of "JD", who has an email address of "jerome.david@inria.fr". His homepage is... He is depicted in the image... He knows... He also knows a person whose name is "Ewan David" and who is 5 years old.

Property: foaf:knows

knows - A person known by this person (indicating some level of reciprocated interaction between the parties).
Status: stable
Domain: having this property implies being a Person
Range: every value of this property is a Person

The knows property relates a Person to another Person that he or she knows.

from http://xmlns.com/foaf/spec/#term_knows

Hands-on session (I)

Reusing Existing Terms
The Dublin Core Schema

- The Dublin Core Schema is a vocabulary of terms that can be used to describe web resources (videos, images, web pages) and physical resources (books, publications, CDs).
- Dublin Core Metadata Initiative (DCMI)
- two namespaces:
  - Dublin Core Metadata Set version 1.1

    dc: <http://purl.org/elements/1.1/>
  - DCMI Metadata Terms

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- An example:

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@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix foaf: <http://xmlns.com/foaf/0.1/> .
@prefix dcterms: <http://purl.org/dc/terms/> .
@prefix ex: <http://www.example.org/> .

ex:myPaper a dcterms:BibliographicResource ;
           dcterms:title "What is this thing called Linked Data?" ;
           dcterms:creator ex:matencia, ex:jdavid , ex:pgenoud ;
           dcterms:subject "Linked Data", "Semantic Web" ;
           dcterms:issued "2015" ;
           dcterms:publisher "ACM Digital Library" ;
           dcterms:bibliographicCitation "Proceedings of the " .

ex:matencia a foaf:Person ;
            foaf:familyName "Atencia" ;
            foaf:givenName "Manuel" .

...
```

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           dcterms:creator ex:matencia, ex:jdavid , ex:pgenoud ;

ex:matencia                                                    .

...
```

Term Name: creator	
URI:	http://purl.org/dc/terms/creator
Label:	Creator
Definition:	An entity primarily responsible for making the resource.
Comment:	Examples of a Creator include a person, an organization, or a service.
Type of Term:	Property
Refines:	http://purl.org/dc/elements/1.1/creator
Refines:	http://purl.org/dc/terms/contributor
Has Range:	http://purl.org/dc/terms/Agent
Version:	http://dublincore.org/usage/terms/history/#creatorT-002
EquivalentProperty:	http://xmlns.com/foaf/0.1/maker

from http://dublincore.org/documents/2012/06/14/dcmi-terms/?v=terms#creator

Hands-on session (I)

- Which properties/classes could we use for describing Artemis' bookstore data?

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Creating RDF data
Reusing existing terms

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foaf vocabulary 

Classes: | Agent | Document | Group | Image | LabelProperty | OnlineAccount | OnlineChatAccount | OnlineEcommerceAccount | OnlineGamingAccount | Organization | Person | PersonalProfileDocument | Project |

Properties: | account | accountName | accountServiceHomepage | age | aimChatID | based_near | birthday | currentProject | depiction | depicts | dnaChecksum | familyName | family_name | firstName | focus | fundedBy | geekcode | gender | givenName | givenname | holdsAccount | homepage | icqChatID | img | interest | isPrimaryTopicOf | jabberID | knows | lastName | logo | made | maker | mbox | mbox_sha1sum | member | membershipClass | msnChatID | myersBriggs | name | nick | openid | page | pastProject | phone | plan | primaryTopic | publications | schoolHomepage | sha1 | skypeID | status | surname | theme | thumbnail | tipjar | title | topic | topic_interest | weblog | workInfoHomepage | workplaceHomepage | yahooChatID |

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Classes	Agent , AgentClass , BibliographicResource , FileFormat , Frequency , Jurisdiction , LicenseDocument , LinguisticSystem , Location , LocationPeriodOrJurisdiction , MediaType , MediaTypeOrExtent , MethodOfAccrual , MethodOfInstruction , PeriodOfTime , PhysicalMedium , PhysicalResource , Policy , ProvenanceStatement , RightsStatement , SizeOrDuration , Standard

Hands-on session (I)

Creating RDF data
Reusing existing terms

- Which properties/classes could we use for describing Artemis' bookstore data?

Author ID	First Name	Last Name	Book ID	Title	Author	Type	ISBN
1	Paul	Auster	1	Moon palace	1	Paperback	571142200
2	Siri	Hustvedt	2	Invisible	1	Paperback	571249527

Language	Pages	Price	Date of publicati	Date acquired	Comments	Publisher
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well... not so optimal

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Hands-on session (I)

Creating RDF data
User-defined vocabularies

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your own vocabulary/ontology

http://artemisBookstore.com/ontology#author
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use hash URIs for small datasets (e.g. ontologies)

Hands-on session (I)

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rdfs

rdfs:comment

your own vocabulary/ontology

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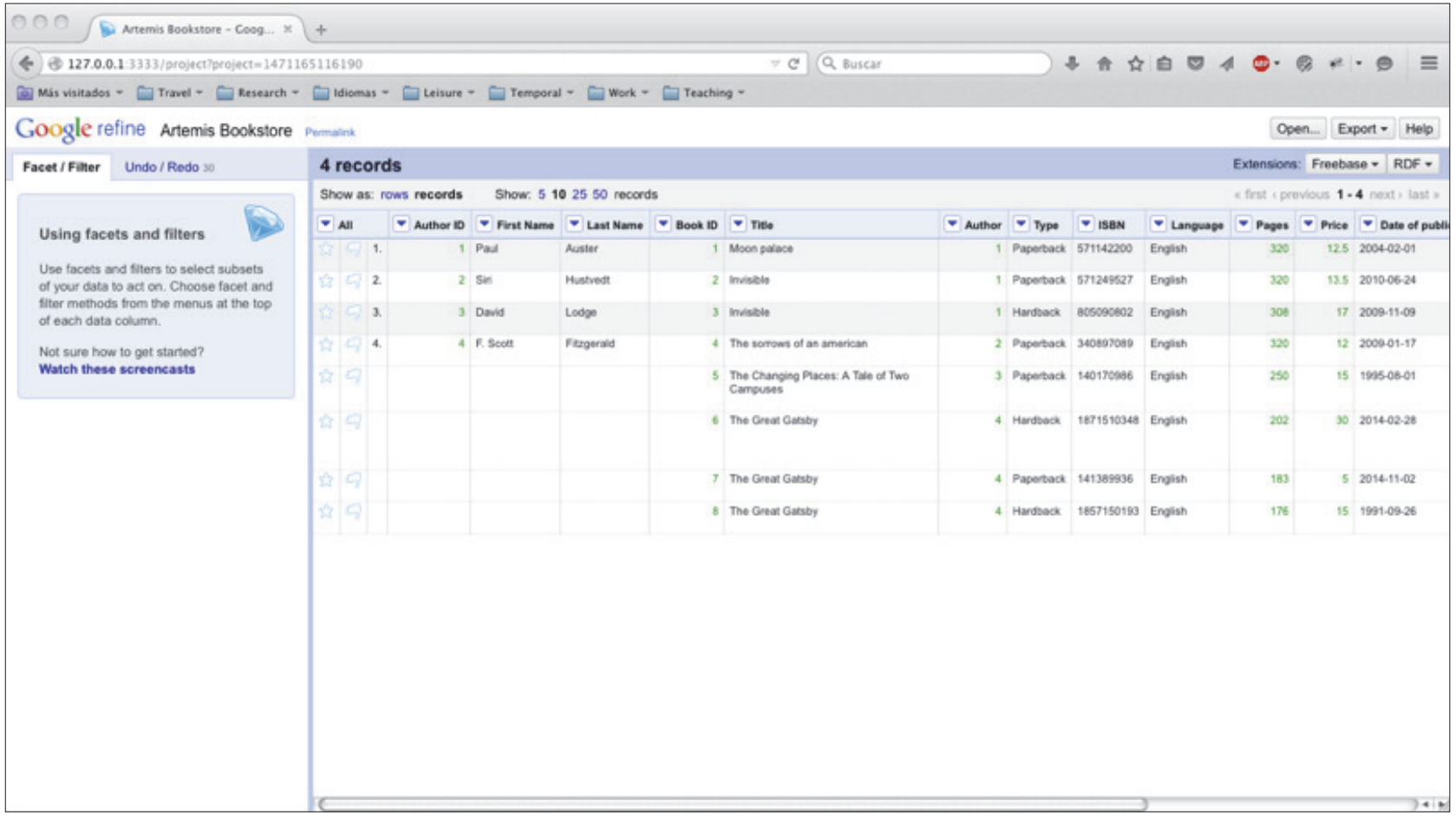
use hash URIs for small datasets (e.g. ontologies)

protégé out of scope

Hands-on session (I)

OpenRefine
RDF extension

- Let's create RDF data with OpenRefine + RDF extension (developed at DERI)



you can download OpenRefine RDF extension at http://refine.deri.ie/

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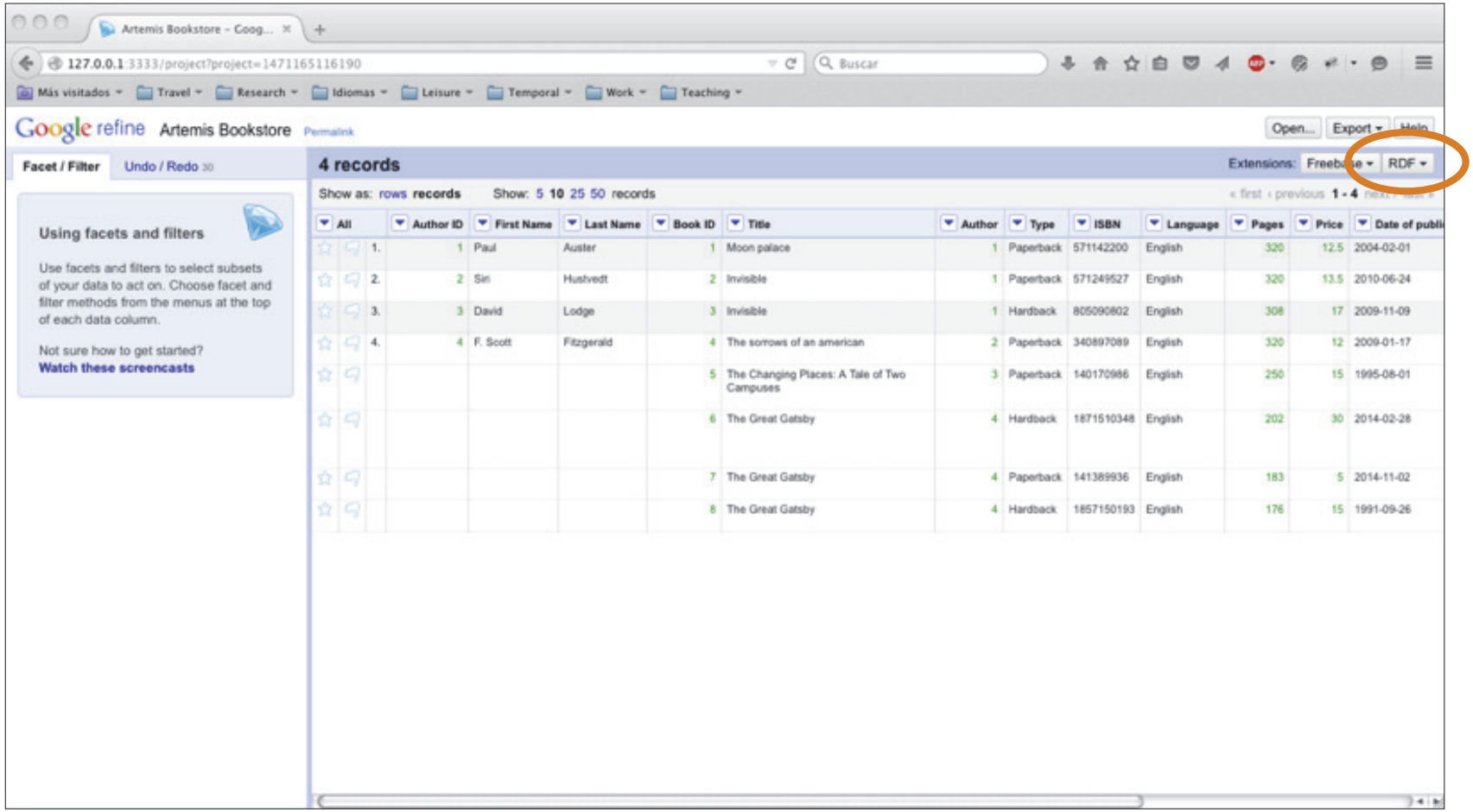

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Hands-on session (I)

- Let's create RDF data!

Hands-on session (I)

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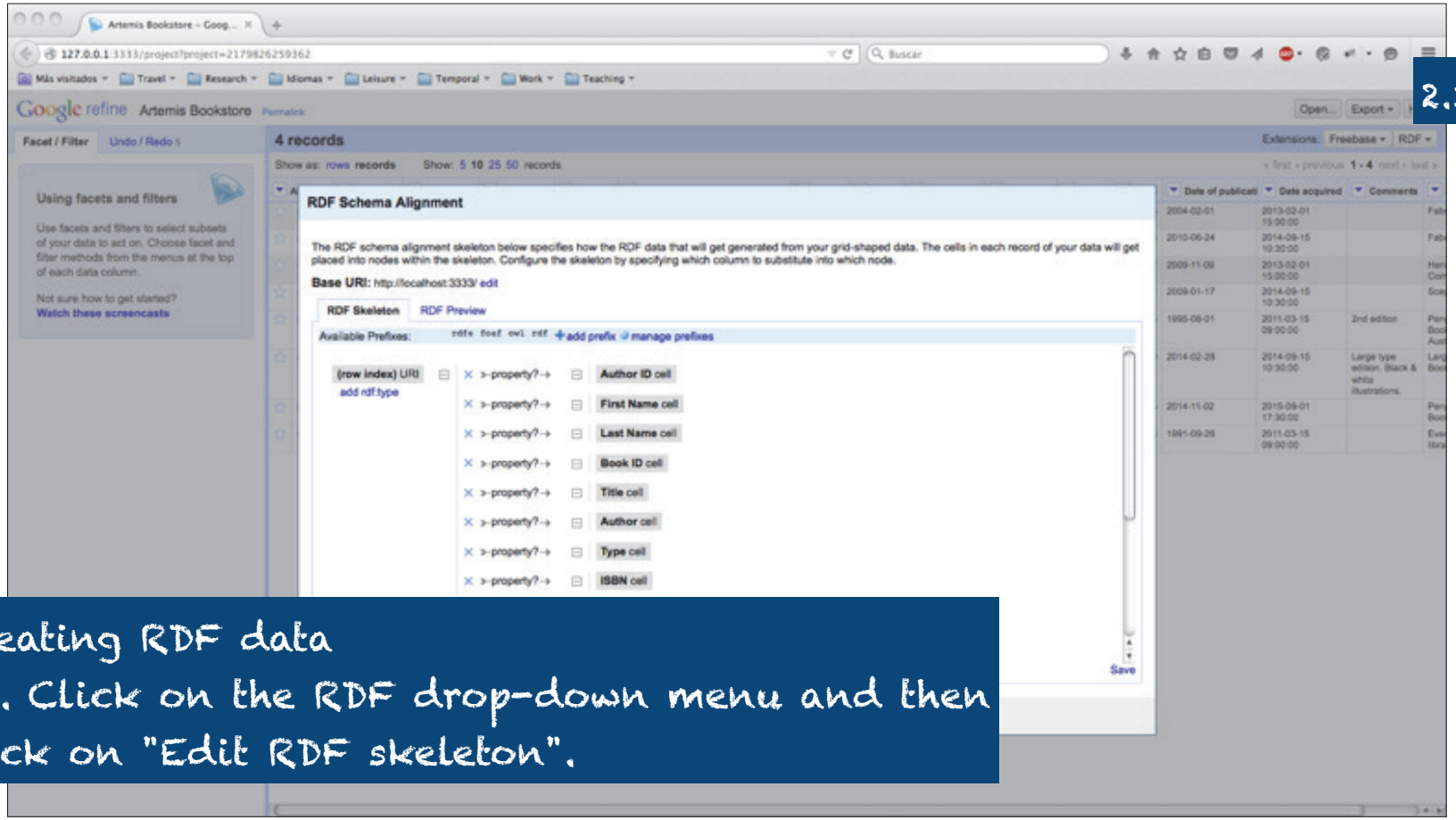
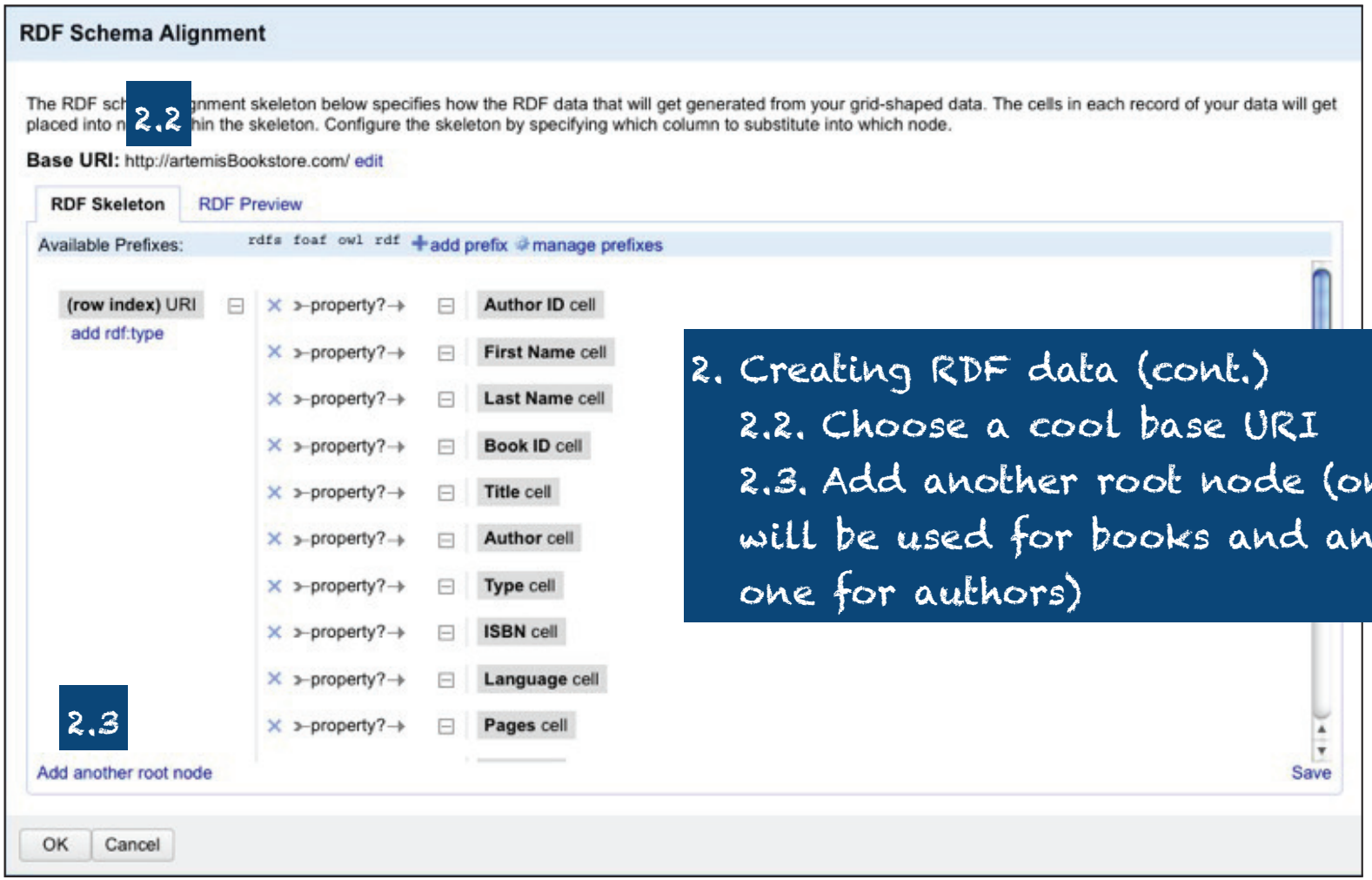


2. Creating RDF data
   2.1. Click on the RDF drop-down menu and then click on "Edit RDF skeleton".

Hands-on session (I)

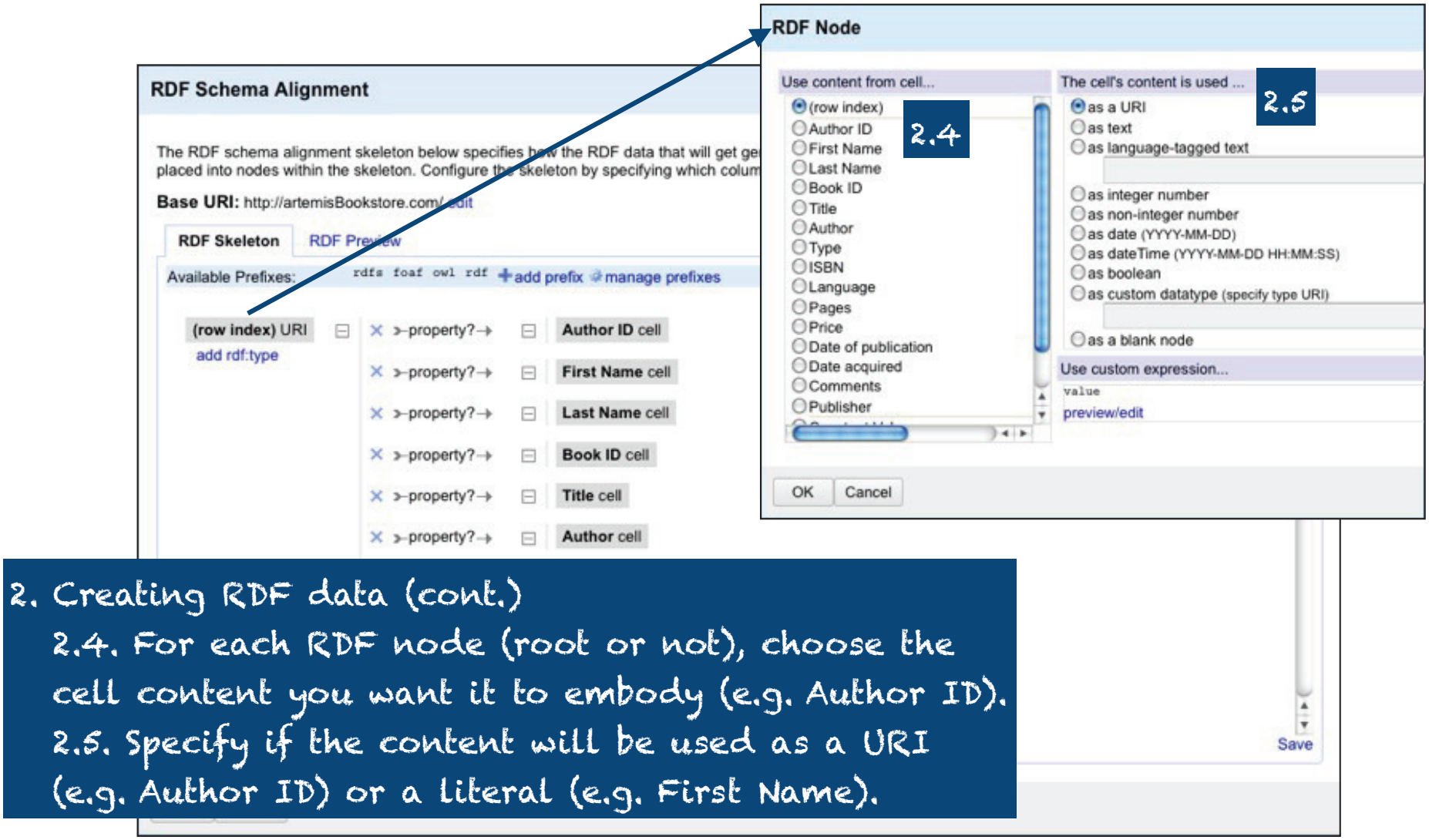
- Let's create RDF data!



2. Creating RDF data (cont.)
   2.2. Choose a cool base URI
   2.3. Add another root node (one will be used for books and another one for authors)

Hands-on session (I)

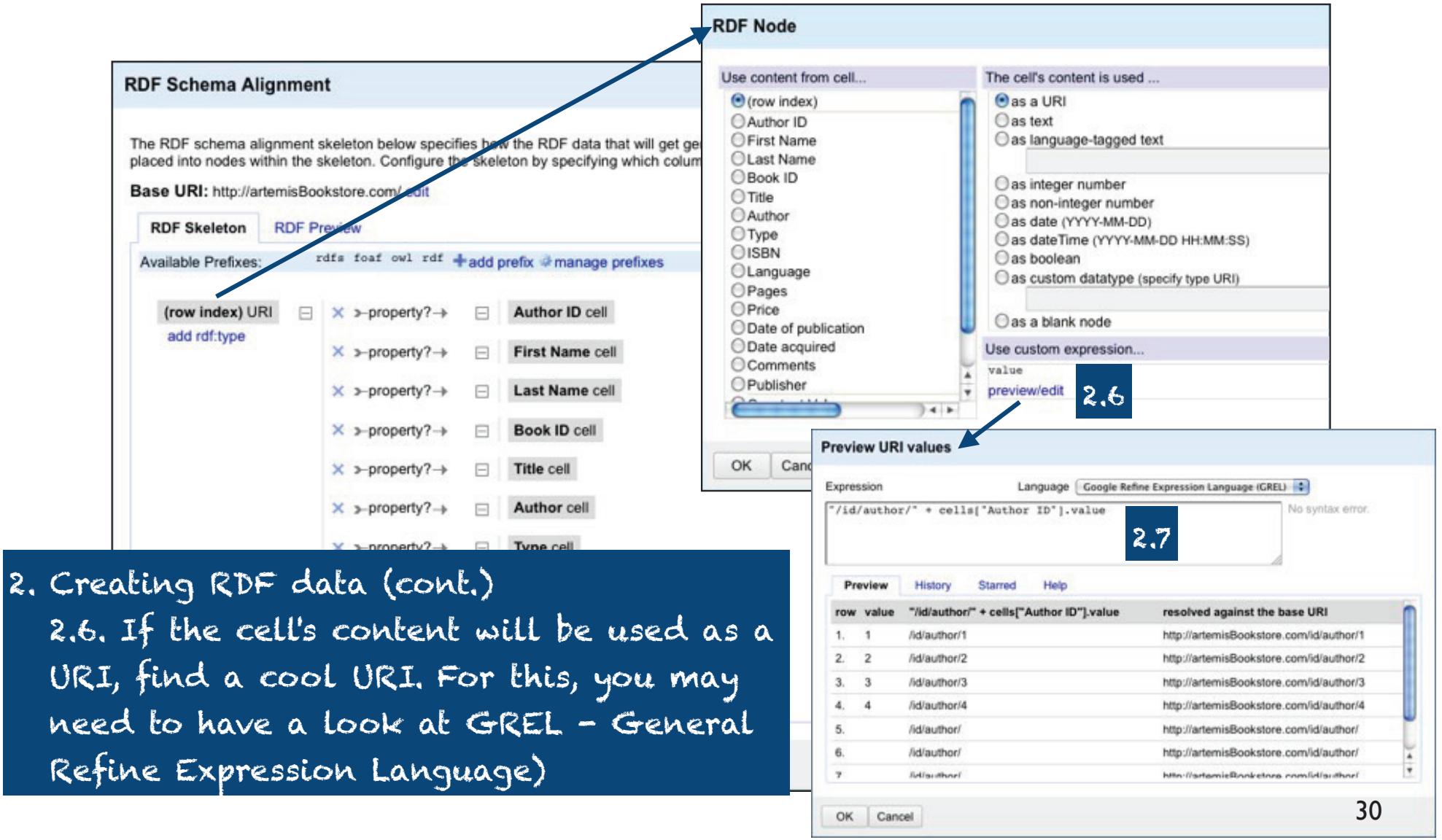
- Let's create RDF data!



2. Creating RDF data (cont.)
   2.4. For each RDF node (root or not), choose the cell content you want it to embody (e.g. Author ID).
   2.5. Specify if the content will be used as a URI (e.g. Author ID) or a literal (e.g. First Name).

Hands-on session (I)

- Let's create RDF data!

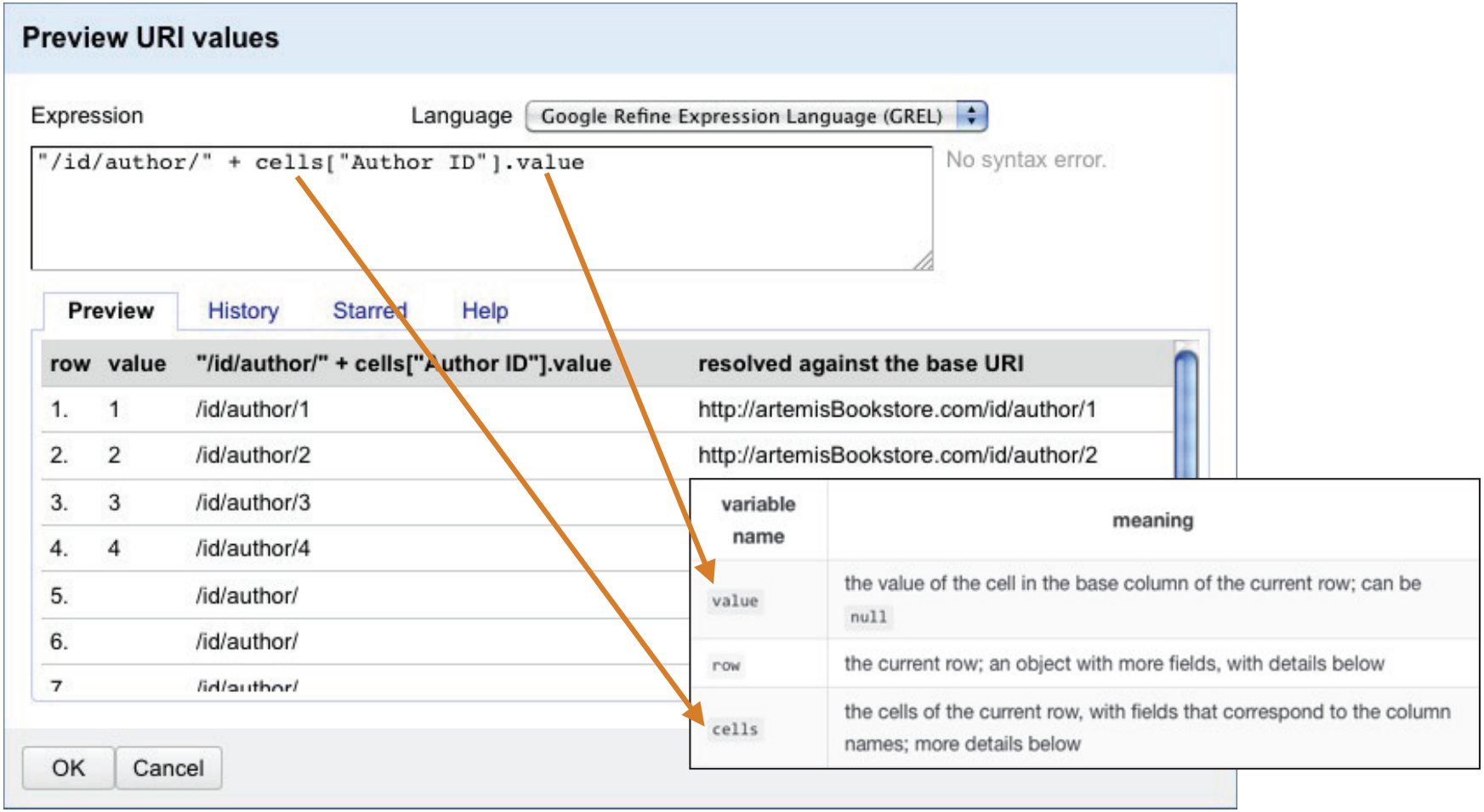


2. Creating RDF data (cont.)
   2.6. If the cell's content will be used as a URI, find a cool URI. For this, you may need to have a look at GREL - General Refine Expression Language)

Hands-on session (I)

OpenRefine
GREL

- General Refine Expression Language (GREL)



more info at https://github.com/OpenRefine/OpenRefine/wiki/Variables
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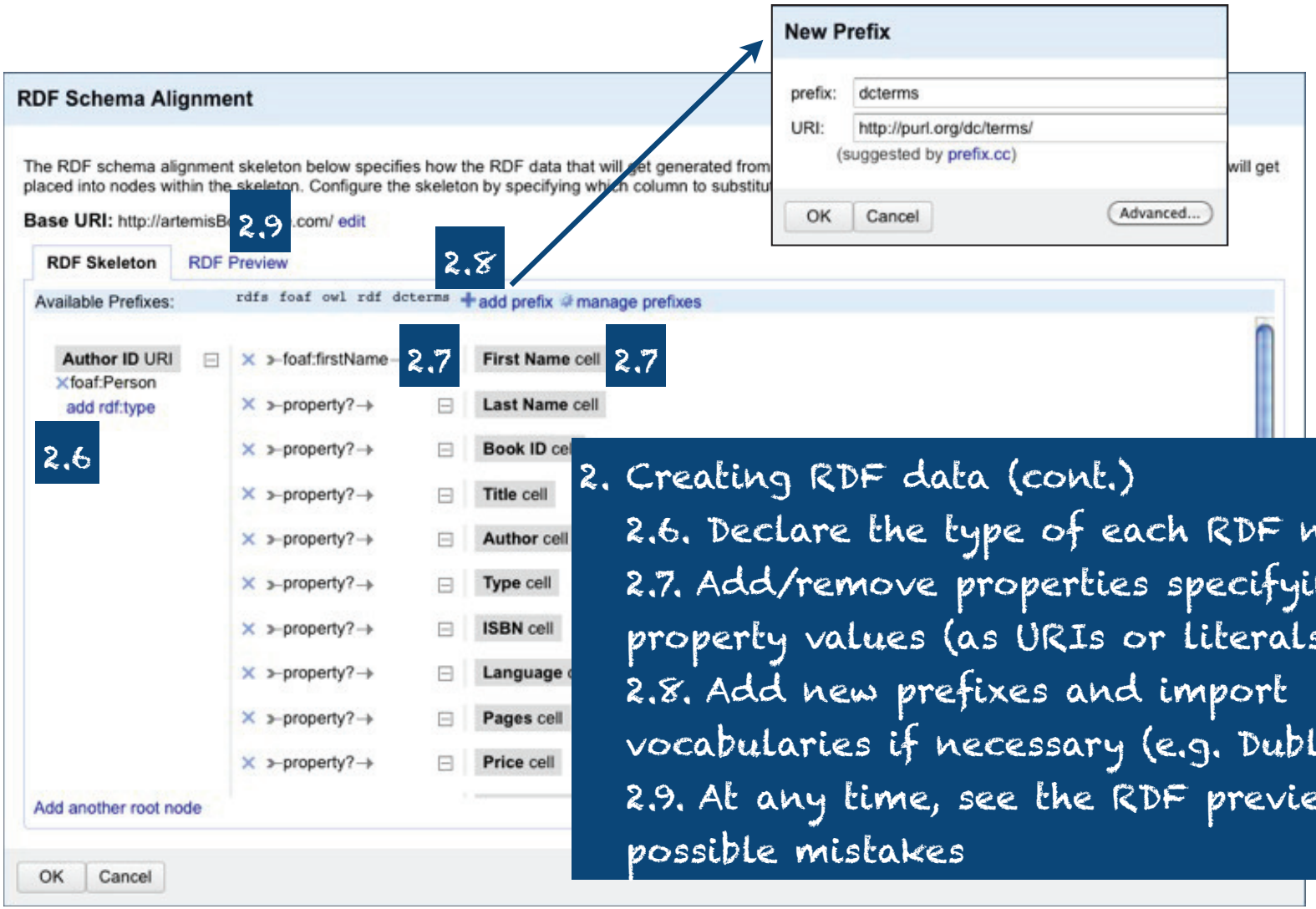
Hands-on session (I)

- Let's create RDF data!



Hands-on session (I)

- You should end up with something like this:

```
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix foaf: <http://xmlns.com/foaf/0.1/> .
@prefix owl: <http://www.w3.org/2002/07/owl#> .
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix abo: <http://artemisBookstore.com/ontology#> .
@prefix dcterms: <http://purl.org/dc/terms/> .


<http://artemisBookstore.com/id/author/1> a foaf:Person ;
        foaf:firstName "Paul" ;
        foaf:lastName "Auster" .

<http://artemisBookstore.com/id/book/571142200> a dcterms:BibliographicResource ;
        dcterms:title "Moon palace" ;
        abo:author <http://artemisBookstore.com/id/author/1> ;
        abo:bookType "Paperback" ;
        abo:isbn "571142200" ;
        abo:language "English" ;
        abo:pages "320"^^<http://www.w3.org/2001/XMLSchema#int> ;
        abo:price "12.5"^^<http://www.w3.org/2001/XMLSchema#double> ;
        abo:datePublication "2004-02-01" ;
        abo:dateAcquired "2013-02-01 15:00:00" ;
        dcterms:publisher "Faber & Faber" .

<http://artemisBookstore.com/id/author/2> a foaf:Person ;
        foaf:firstName "Siri" ;
        foaf:lastName "Hustvedt" .
```

Hands-on session (I)

Creating links to external datasets

- Now, let's create RDF data! But before
- Let's recall the Linked Data principles:
  1. Use URIs as names for things.
  2. Use HTTP URIs, so that people can look up those names.
  3. When someone looks up a URI, provide useful information using the standards (RDF, SPARQL).
  4. **Include links to other URIs, so that they can discover more things.**

Hands-on session (I)

- Data interlinking
  - Not an easy task
    - a large quantity of data
    - semantic heterogeneity
    - noisy data
  - Performed manually or (semi-)automatically
  - Key-based approaches vs similarity-based approaches
  - Data interlinking tools:
    - Silk - Link Discovery Framework
    - LiMES - Link Discovery Framework for Metric Spaces
    - Link Keys
    - OpenRefine + Reconciliation services

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Hands-on session (I)

- Reconciliation services based on SPARQL endpoints

Hands-on session (I)

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http://artemisBookstore.com/id/book/0571249527

Hands-on session (I)

OpenRefine
Reconciliation services

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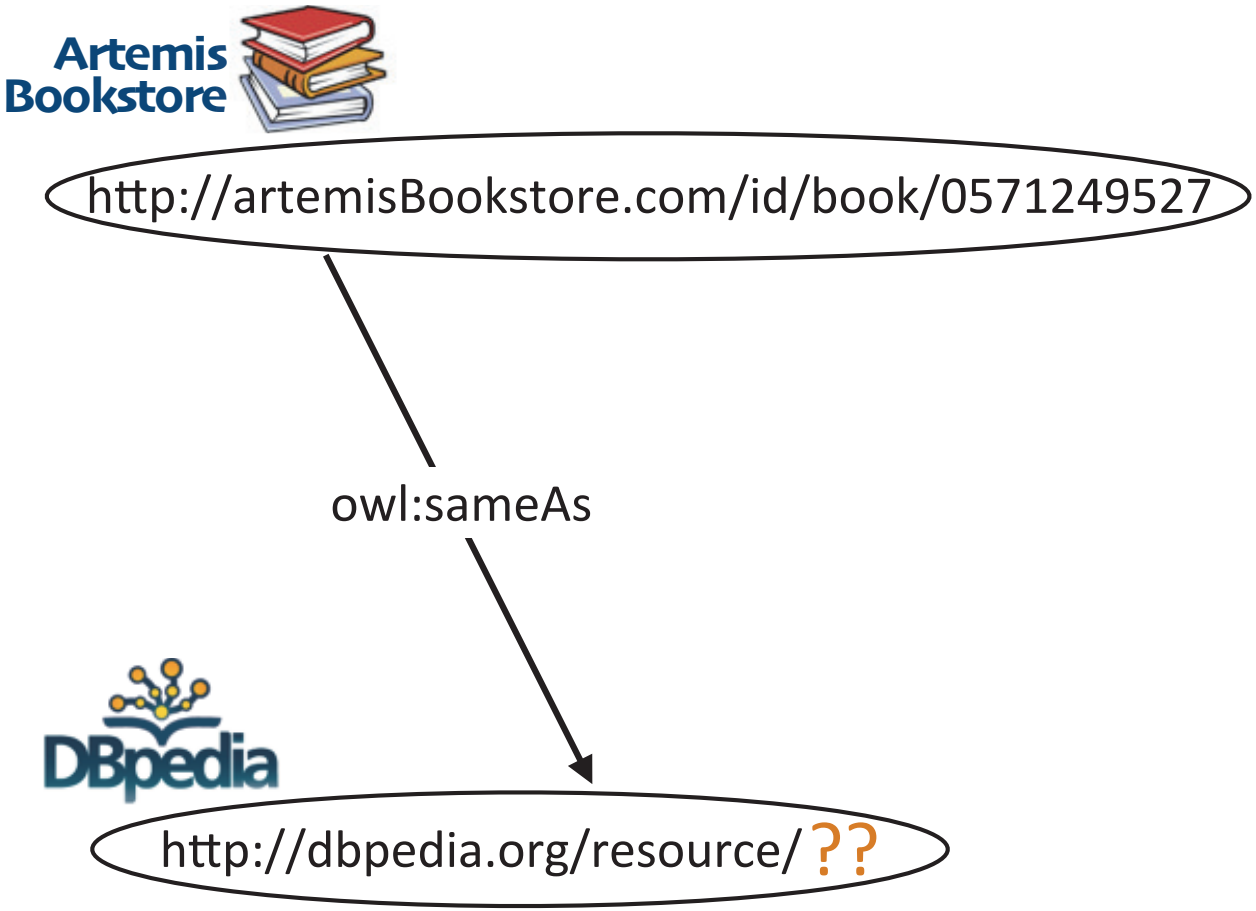
http://artemisBookstore.com/id/book/0571249527

http://dbpedia.org/resource/??

Hands-on session (I)

- Reconciliation services based on SPARQL endpoints



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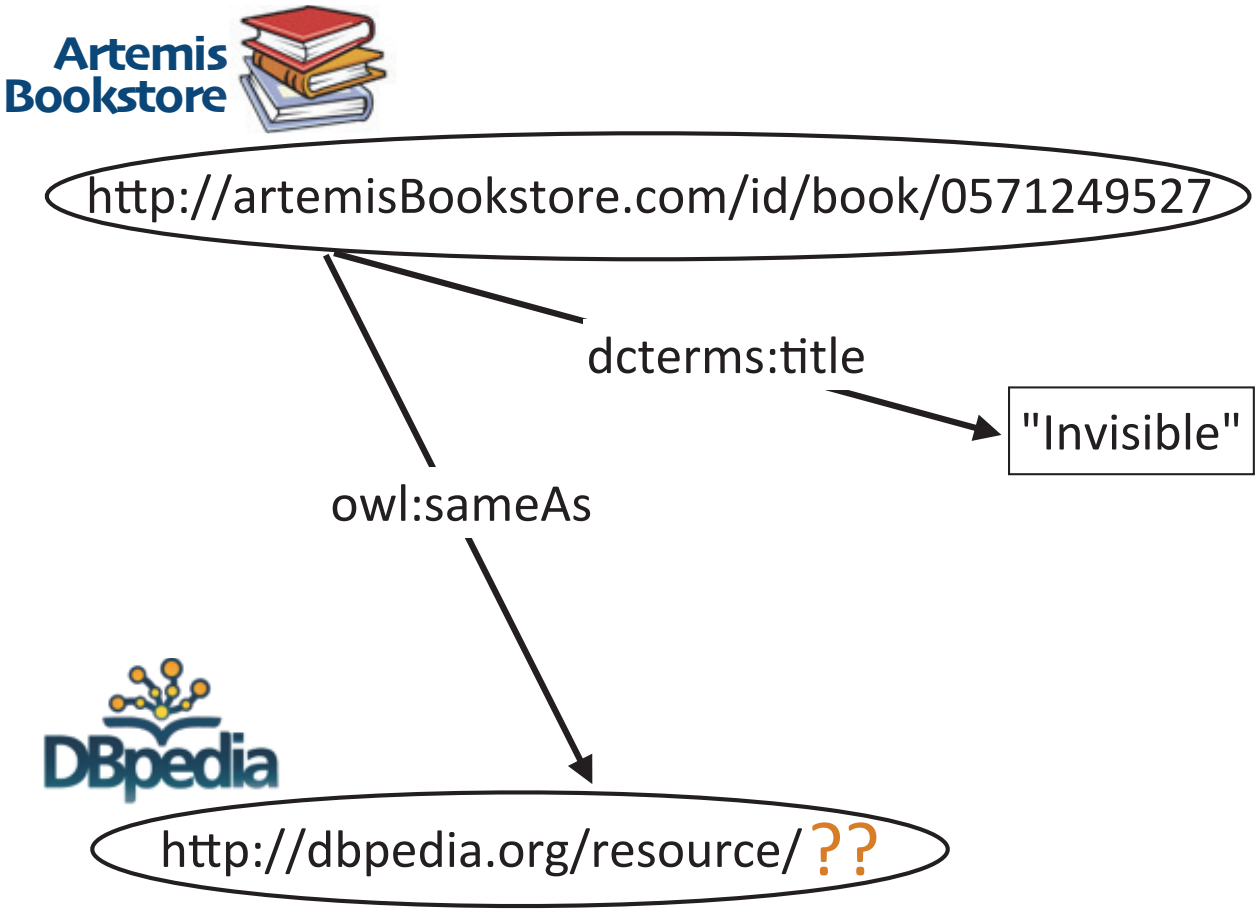

Hands-on session (I)

OpenRefine
Reconciliation services

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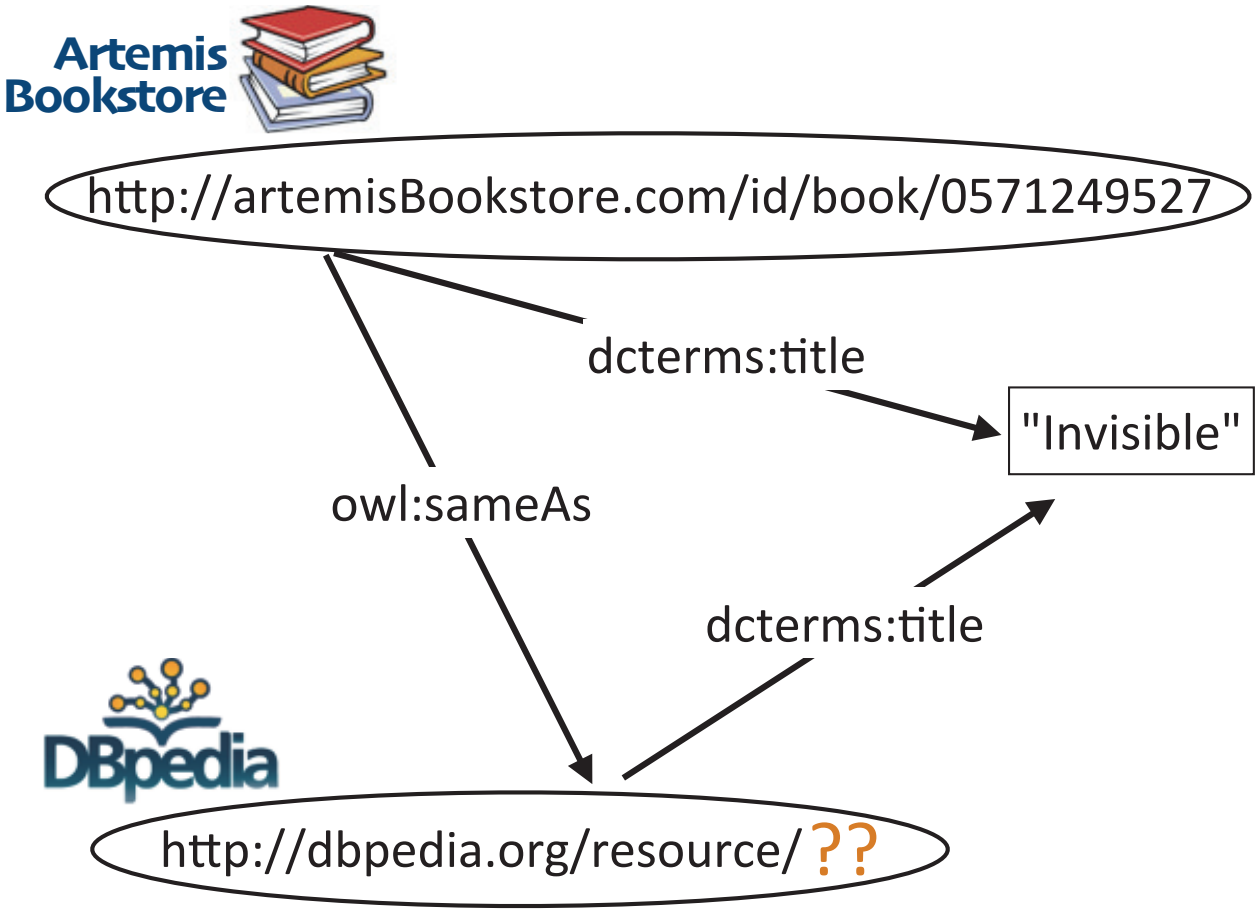

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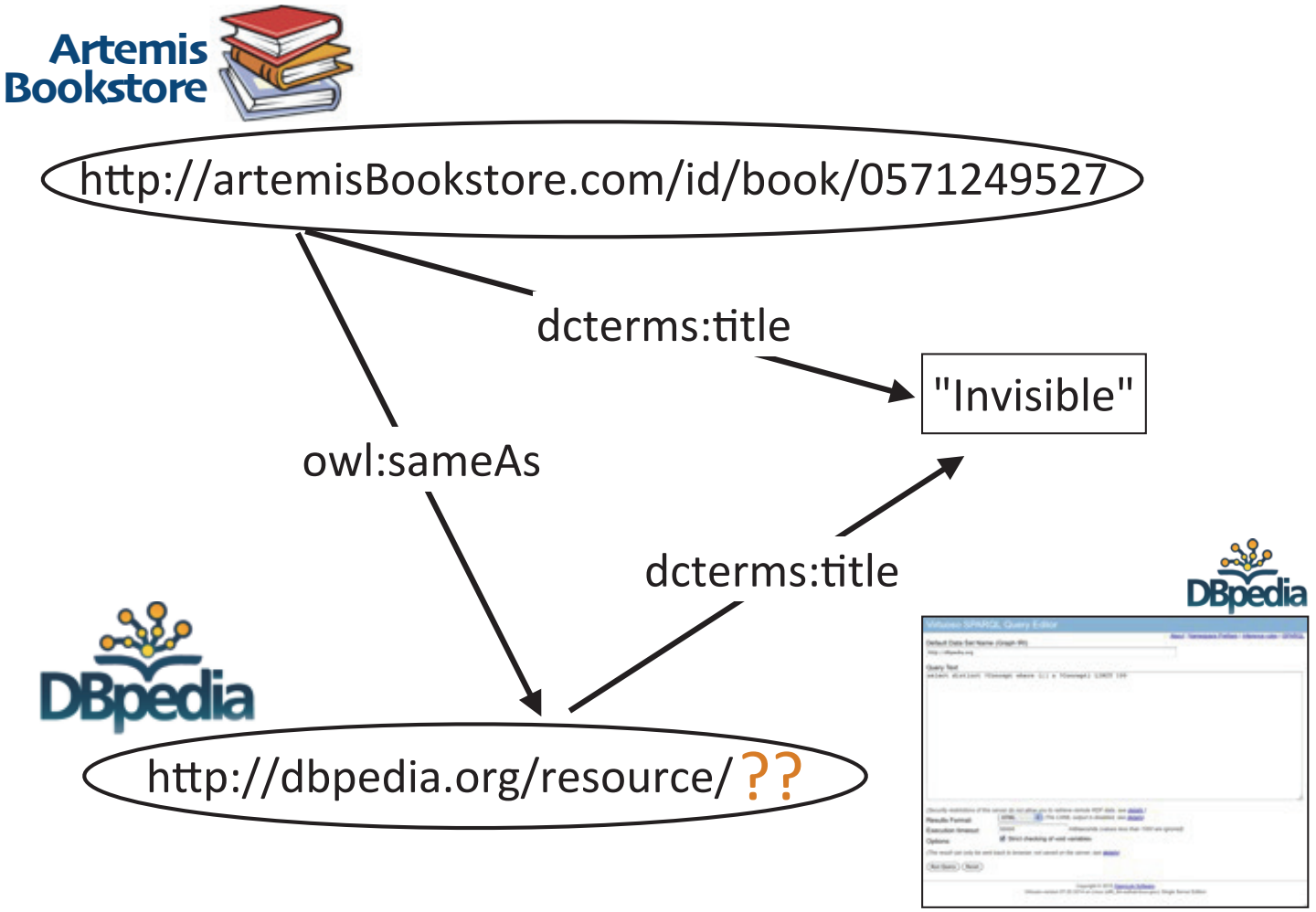

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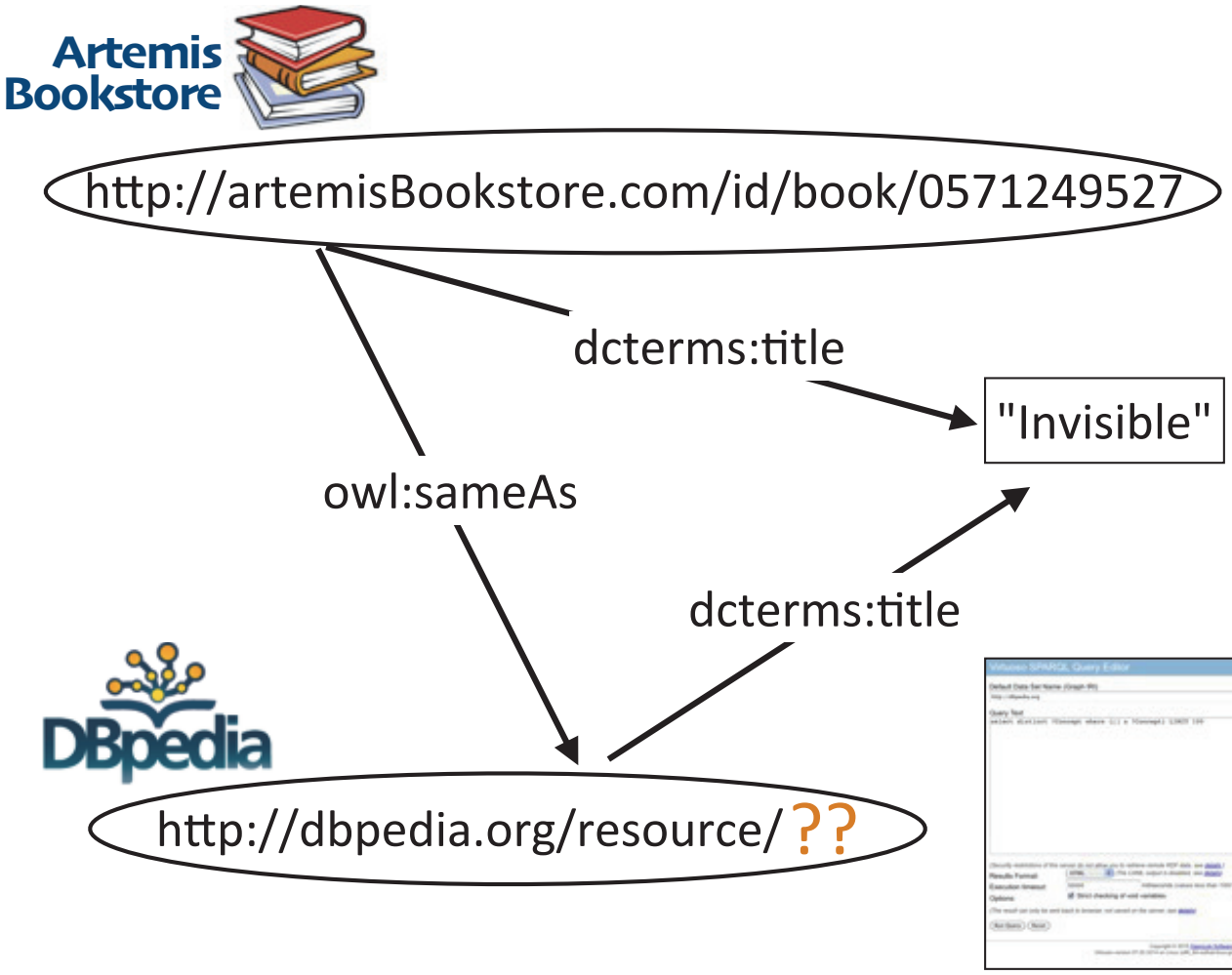

find DBpedia resources having "Invisible" as a value for the property dcterms:title

Hands-on session (I)

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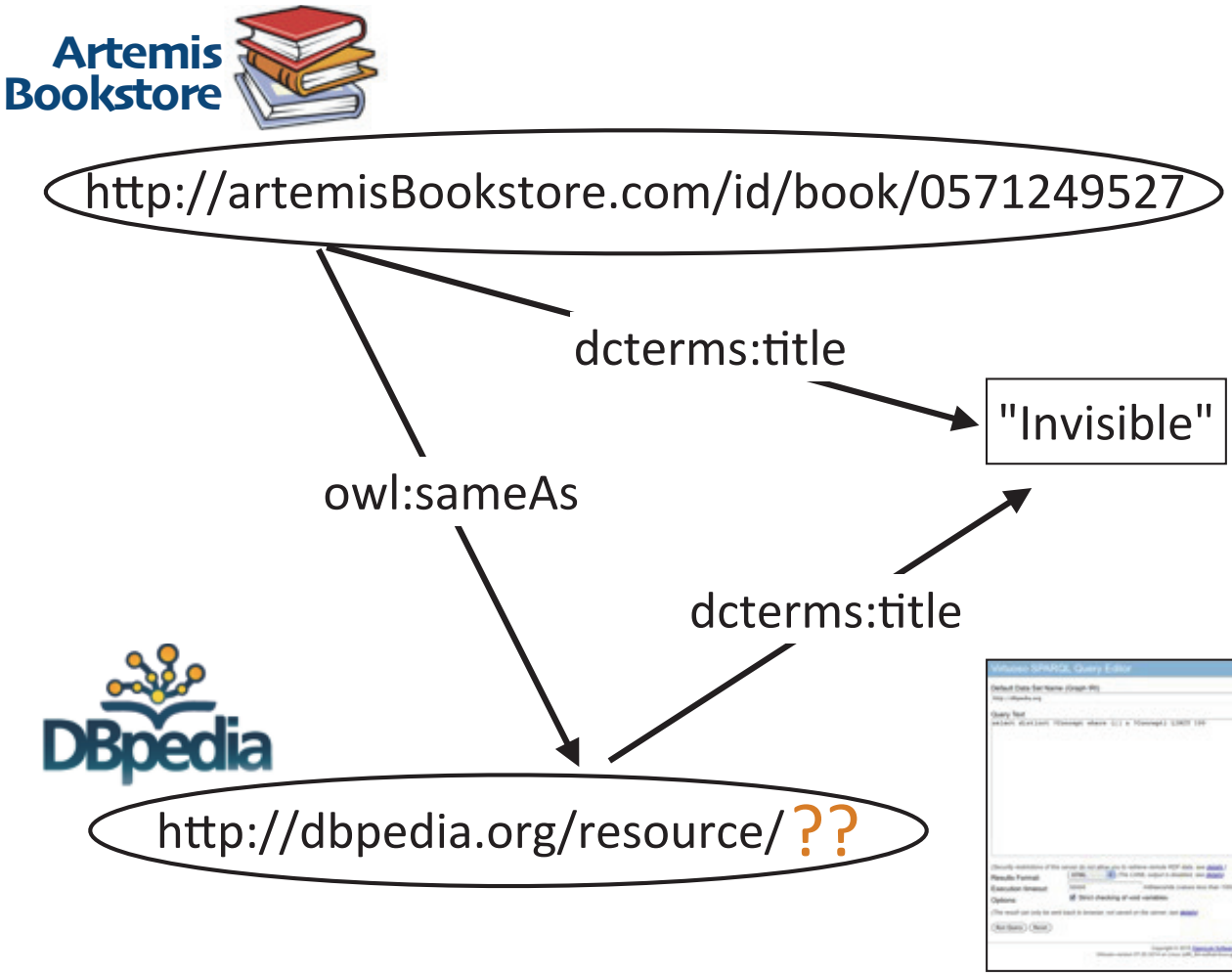
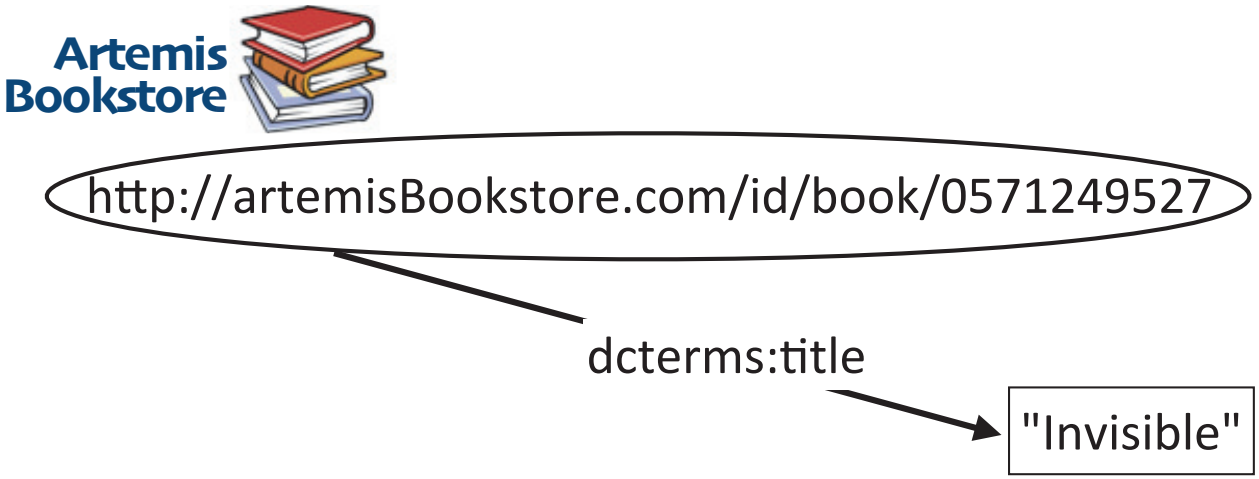


we can refine our search:
-or dc:title, rdfs:label...
-similar to "Invisible"
-resources of type dbo:Book

find DBpedia resources having "Invisible" as a value for the property dcterms:title

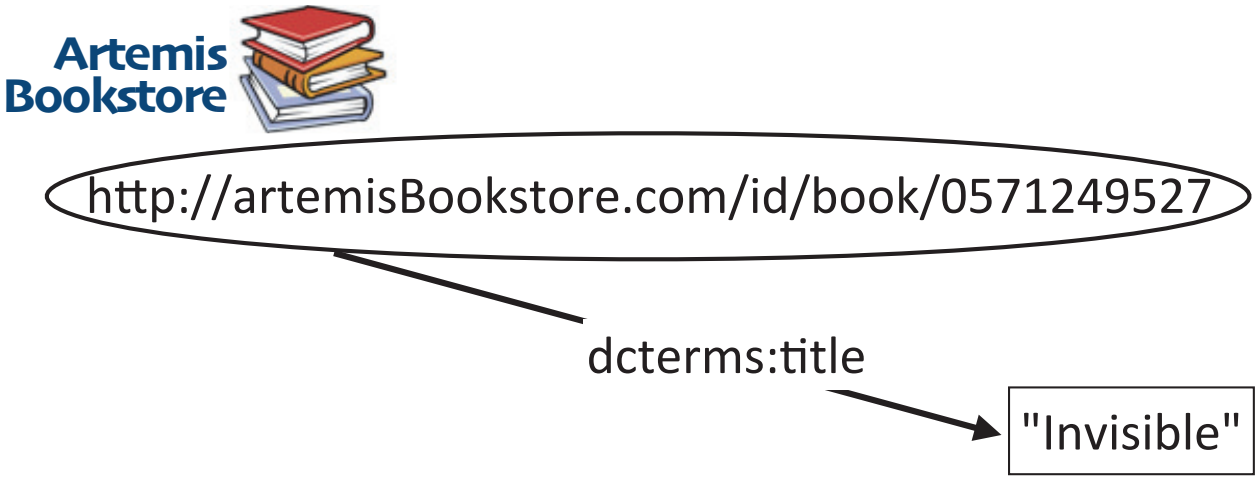
Hands-on session (I)

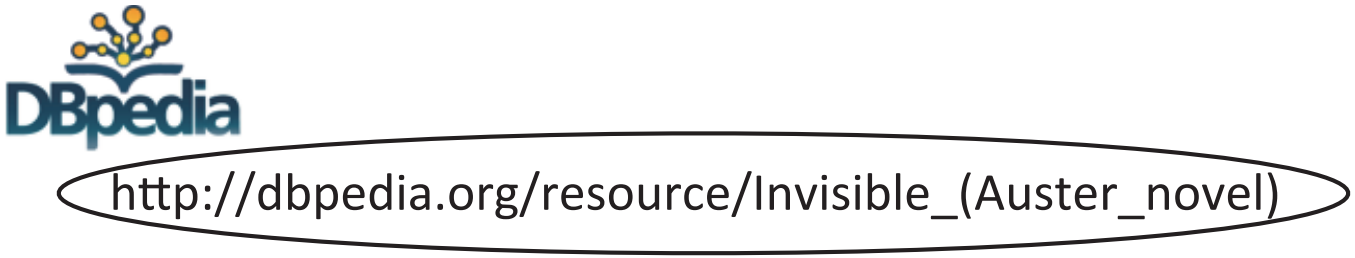
- Reconciliation services based on SPARQL endpoints



Hands-on session (I)

- Reconciliation services based on SPARQL endpoints

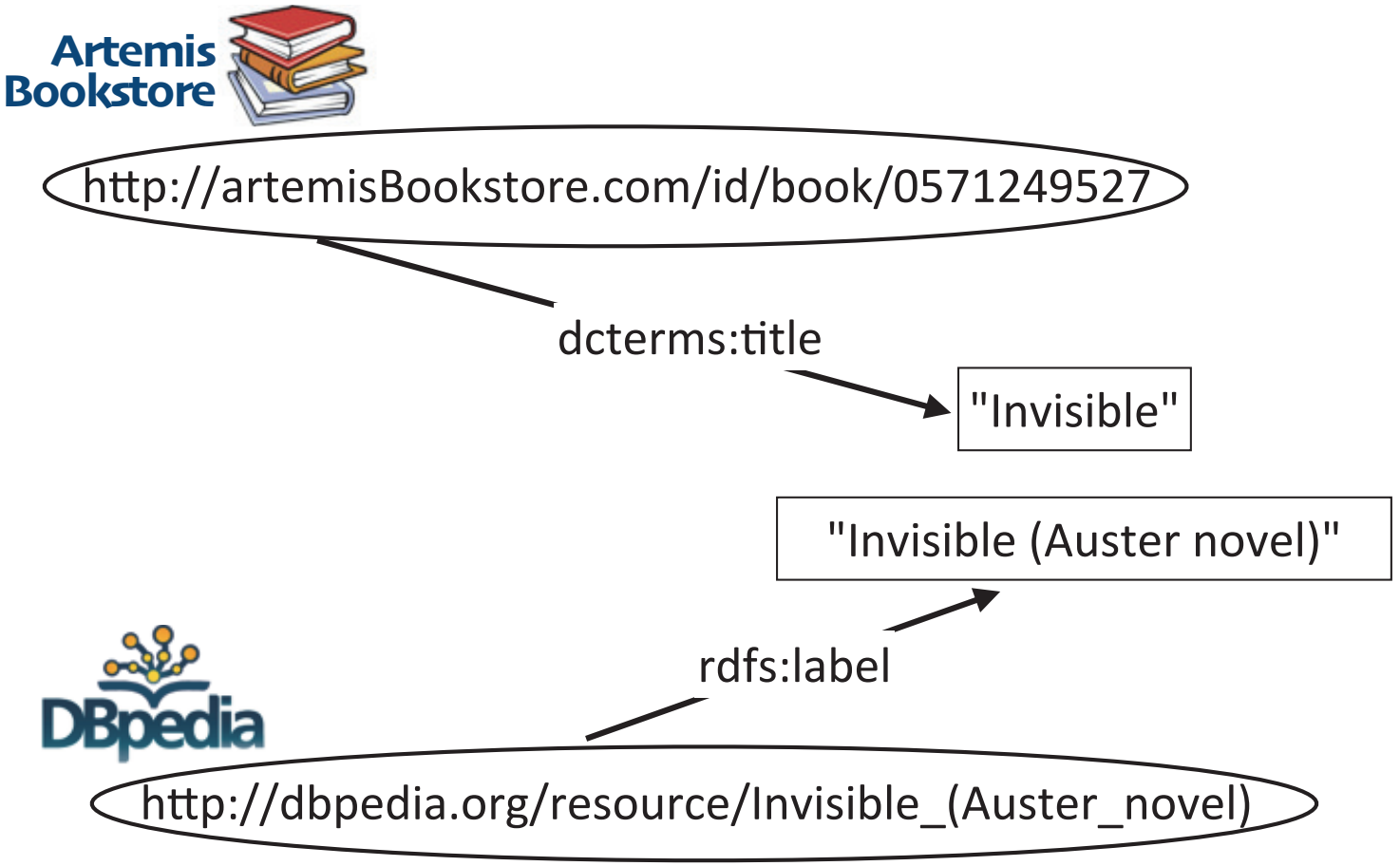




Hands-on session (I)

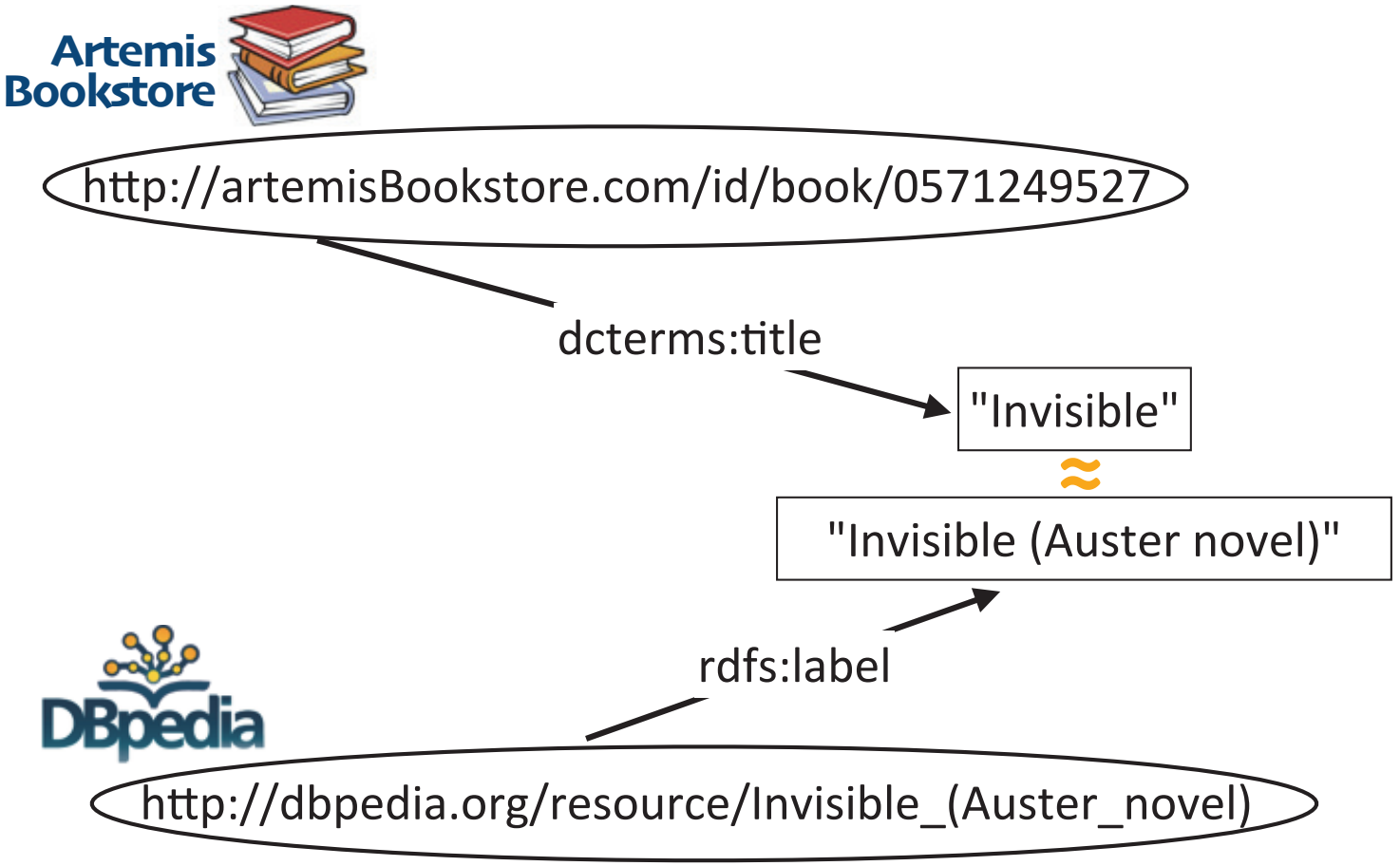
OpenRefine
Reconciliation services

- Reconciliation services based on SPARQL endpoints



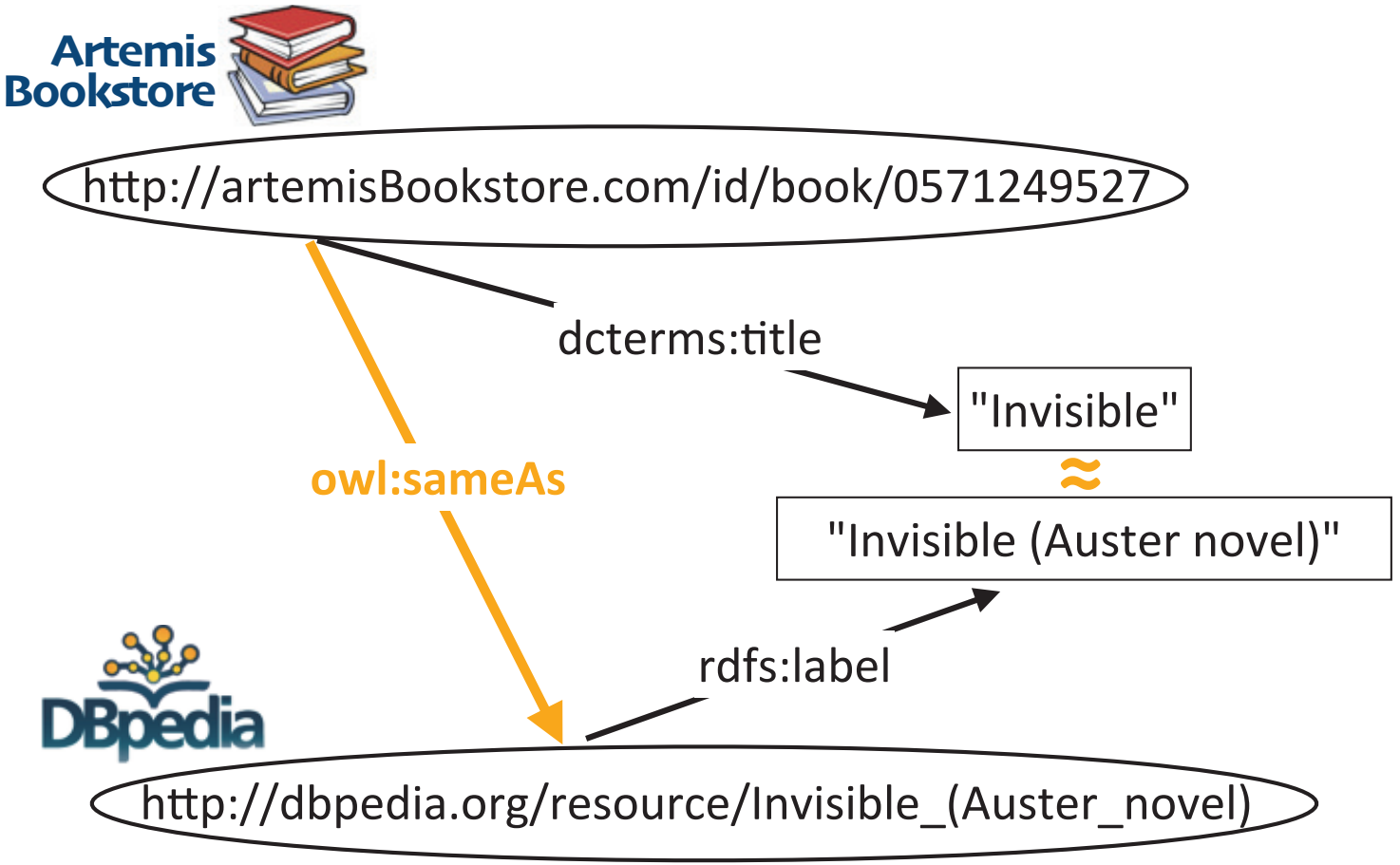
Hands-on session (I)

- Reconciliation services based on SPARQL endpoints



Hands-on session (I)

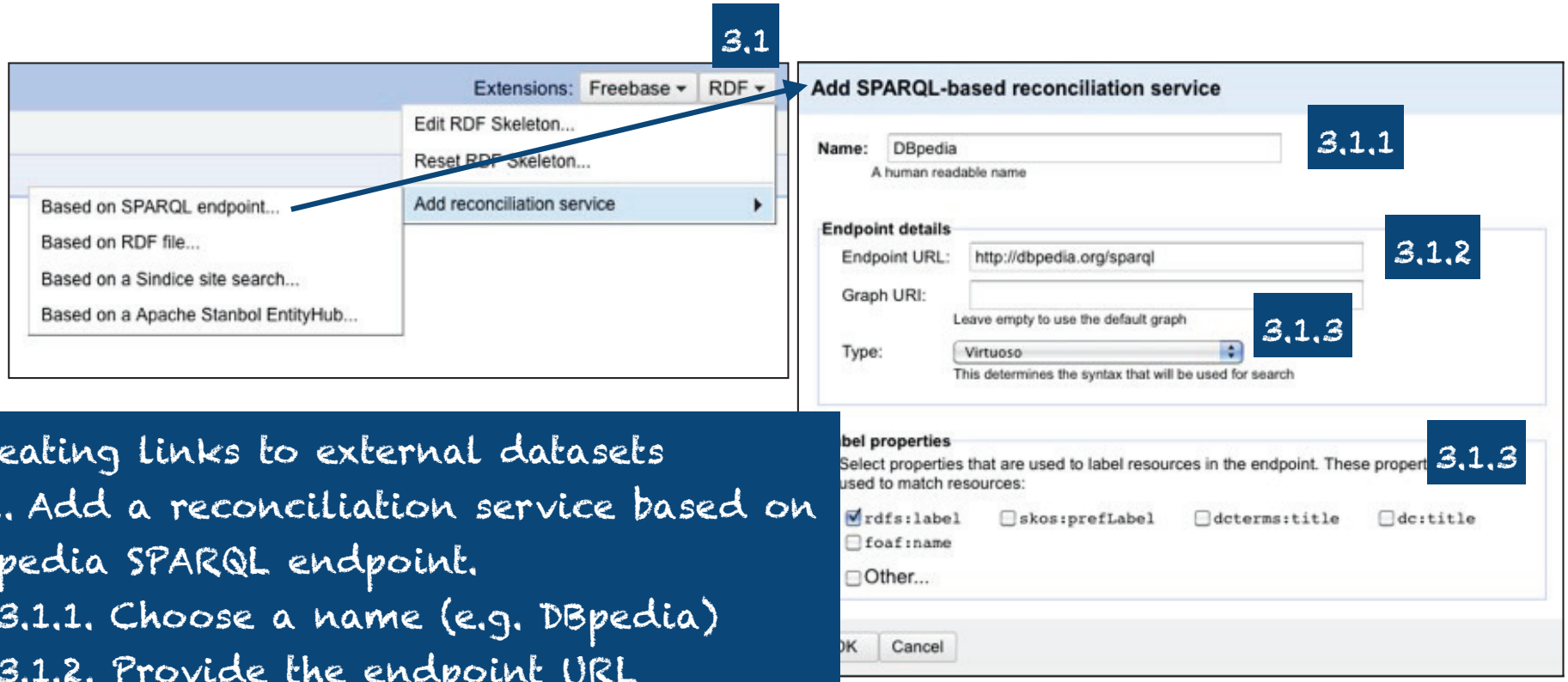
- Reconciliation services based on SPARQL endpoints



Hands-on session (I)

Creating links to external datasets

- Let's create links to DBpedia!

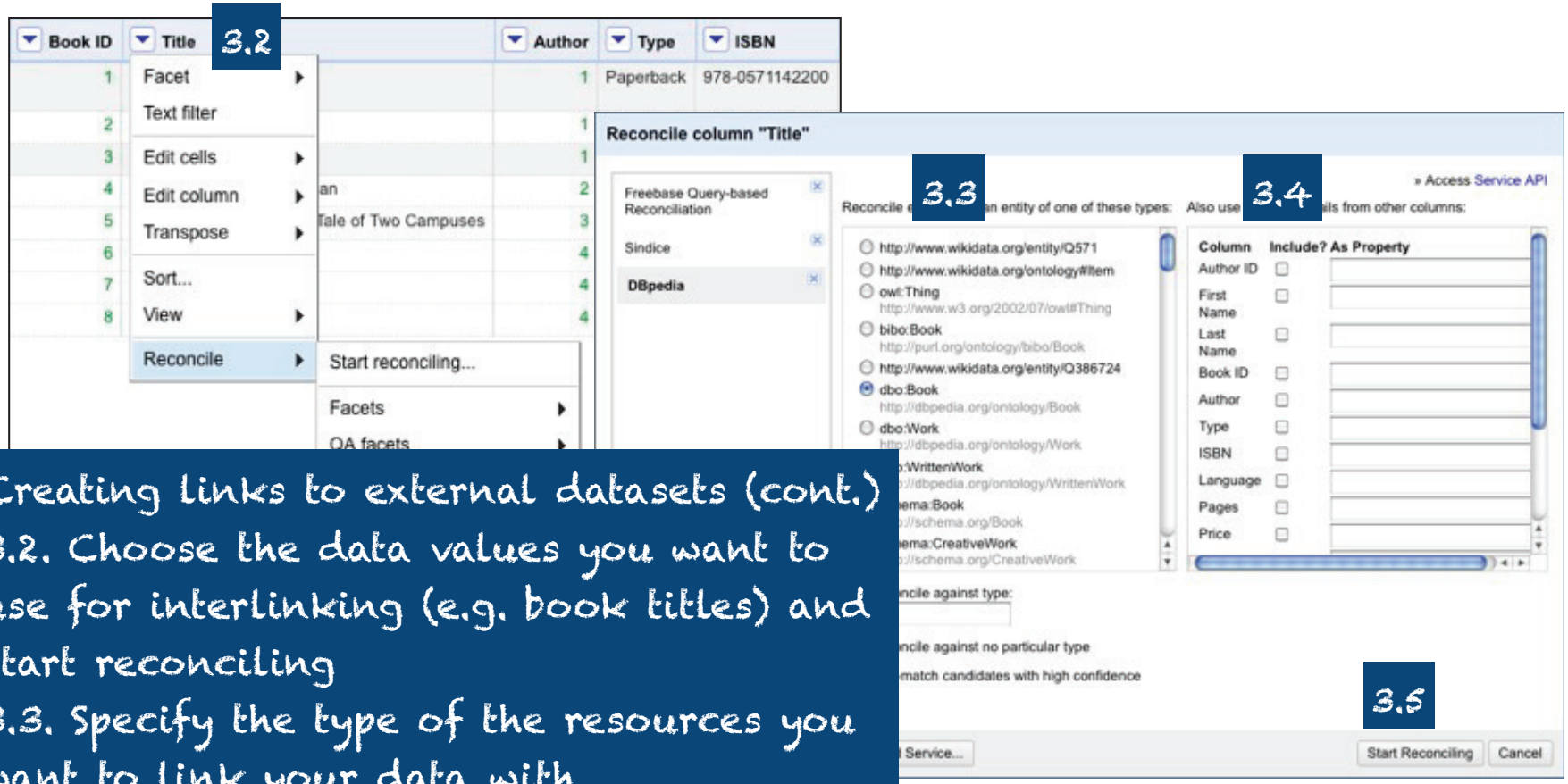


3. Creating links to external datasets
   3.1. Add a reconciliation service based on DBpedia SPARQL endpoint.
      3.1.1. Choose a name (e.g. DBpedia)
      3.1.2. Provide the endpoint URL (http://dbpedia.org/sparql)
      3.1.3. Select the type virtuoso
      3.1.4. Select the properties that will be used to match resources (e.g. rdfs:label)

Hands-on session (I)

Creating links to external datasets

- Let's create links to DBpedia!

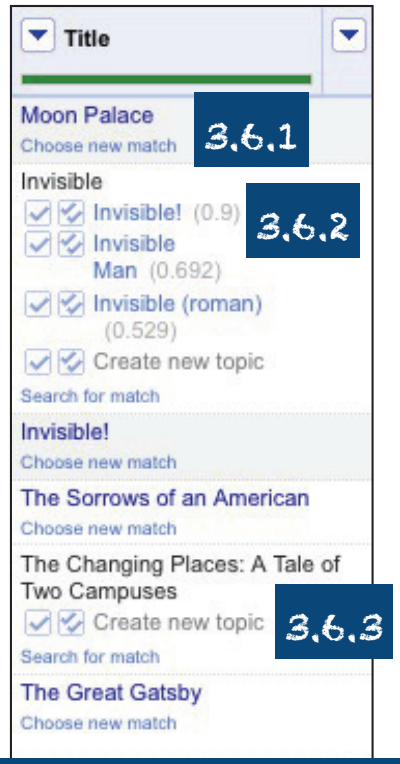


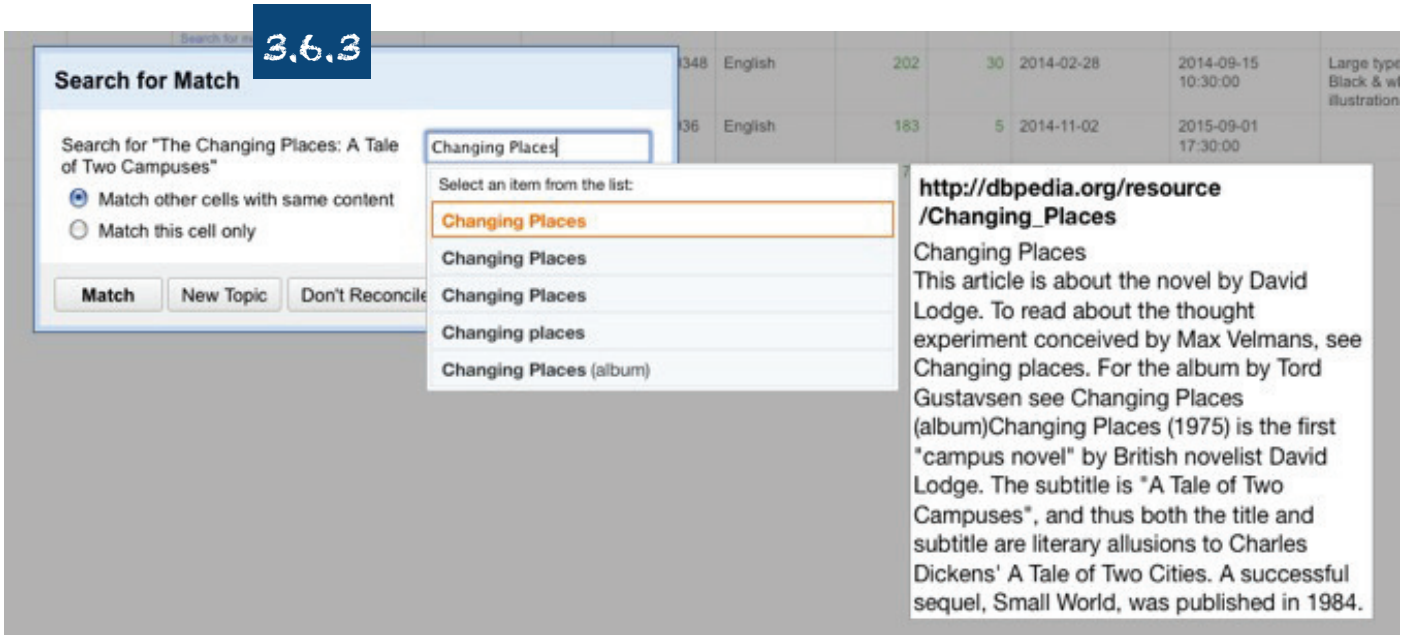
3. Creating links to external datasets (cont.)
   3.2. Choose the data values you want to use for interlinking (e.g. book titles) and start reconciling
   3.3. Specify the type of the resources you want to link your data with
   3.4. You also can select other properties. to be used for interlinking
   3.5. Start reconciling!

Hands-on session (I)

Creating links to external datasets

- Let's create links to DBpedia!



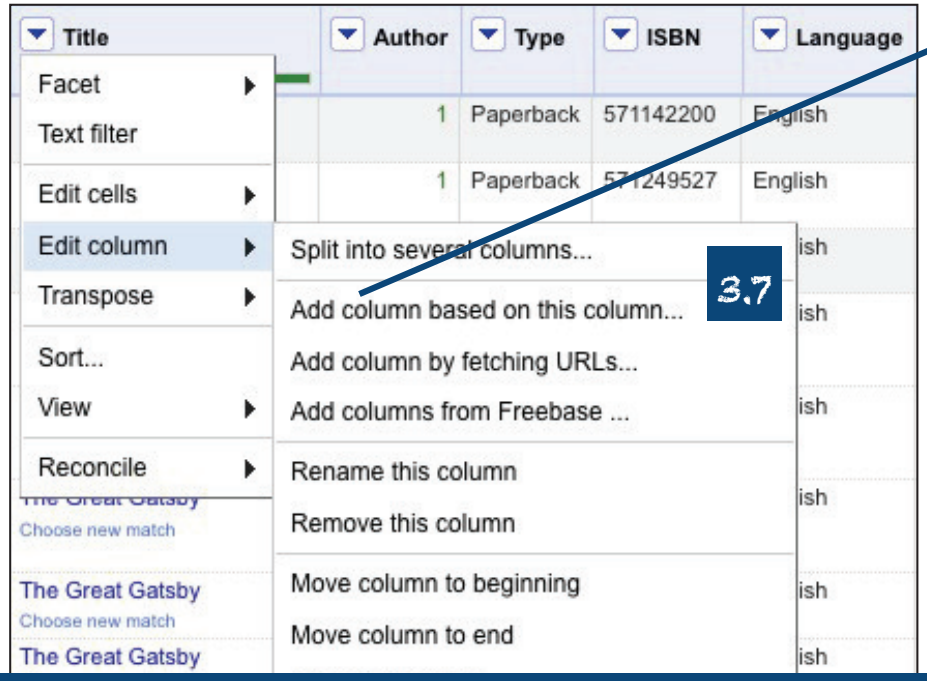


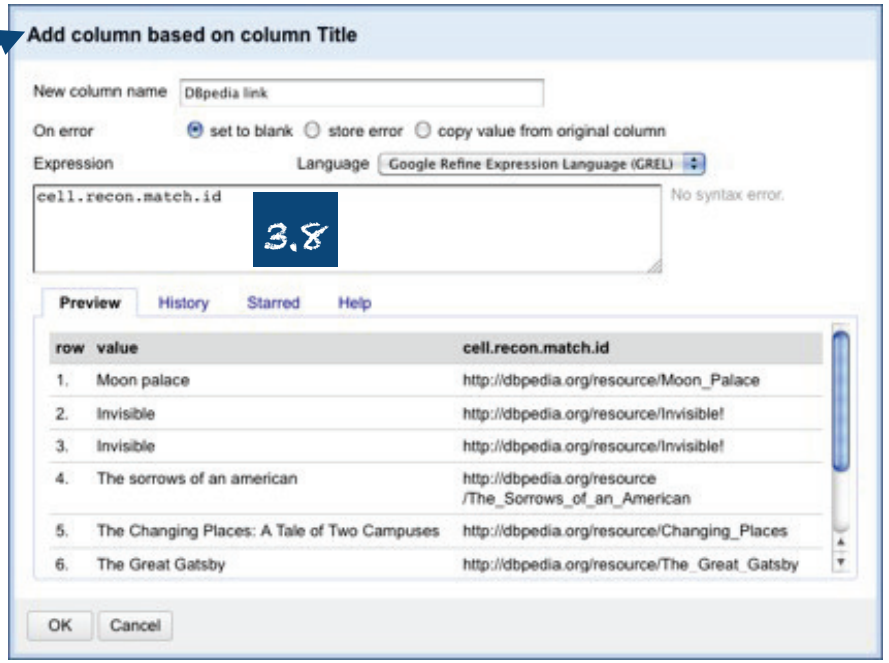
3. Creating links to external datasets (cont.)
   3.6. Once the reconciliation process is finished
      3.6.1. Some links will be correctly found, but
      3.6.2. You may need to validate other links, and
      3.6.3. You may need to find links manually

Hands-on session (I)

Creating links to external datasets

- Let's create links to DBpedia!



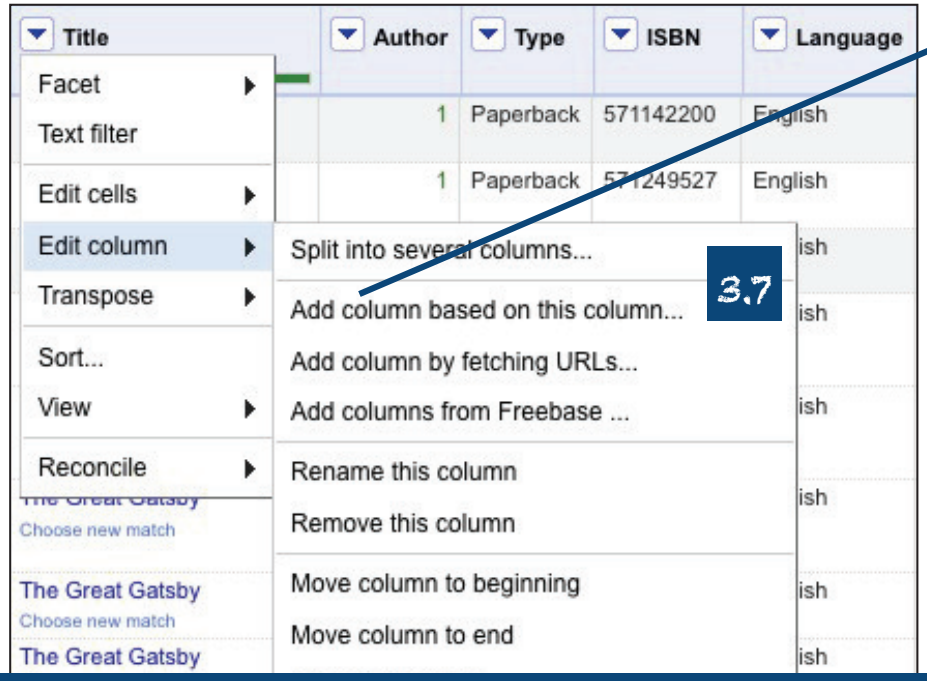


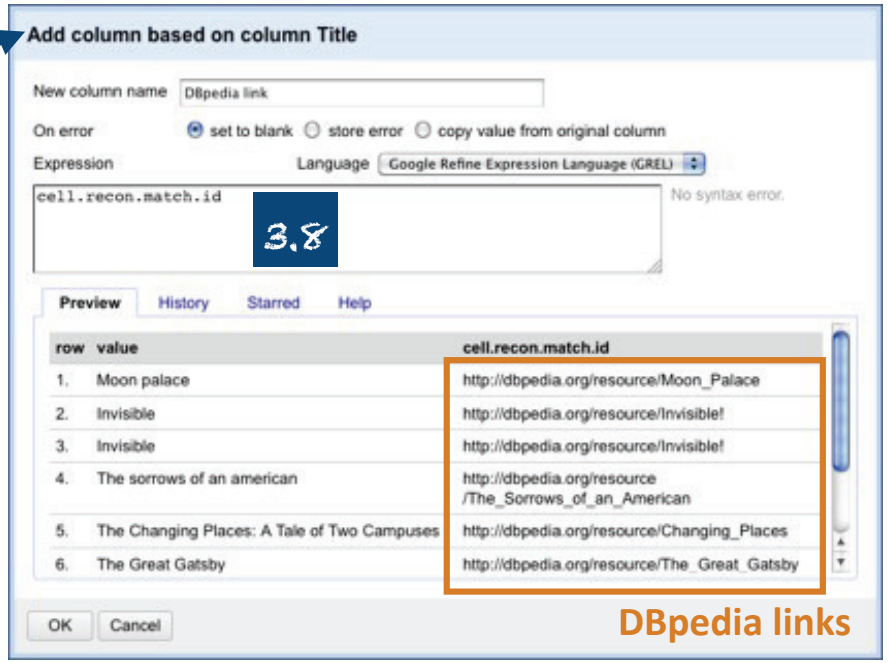
3. Creating links to external datasets (cont.)
   3.7. Add a new column based on the column used for interlinking.
   3.8. Retrieve the links found using GREL.

Hands-on session (I)

Creating links to external datasets

- Let's create links to DBpedia!



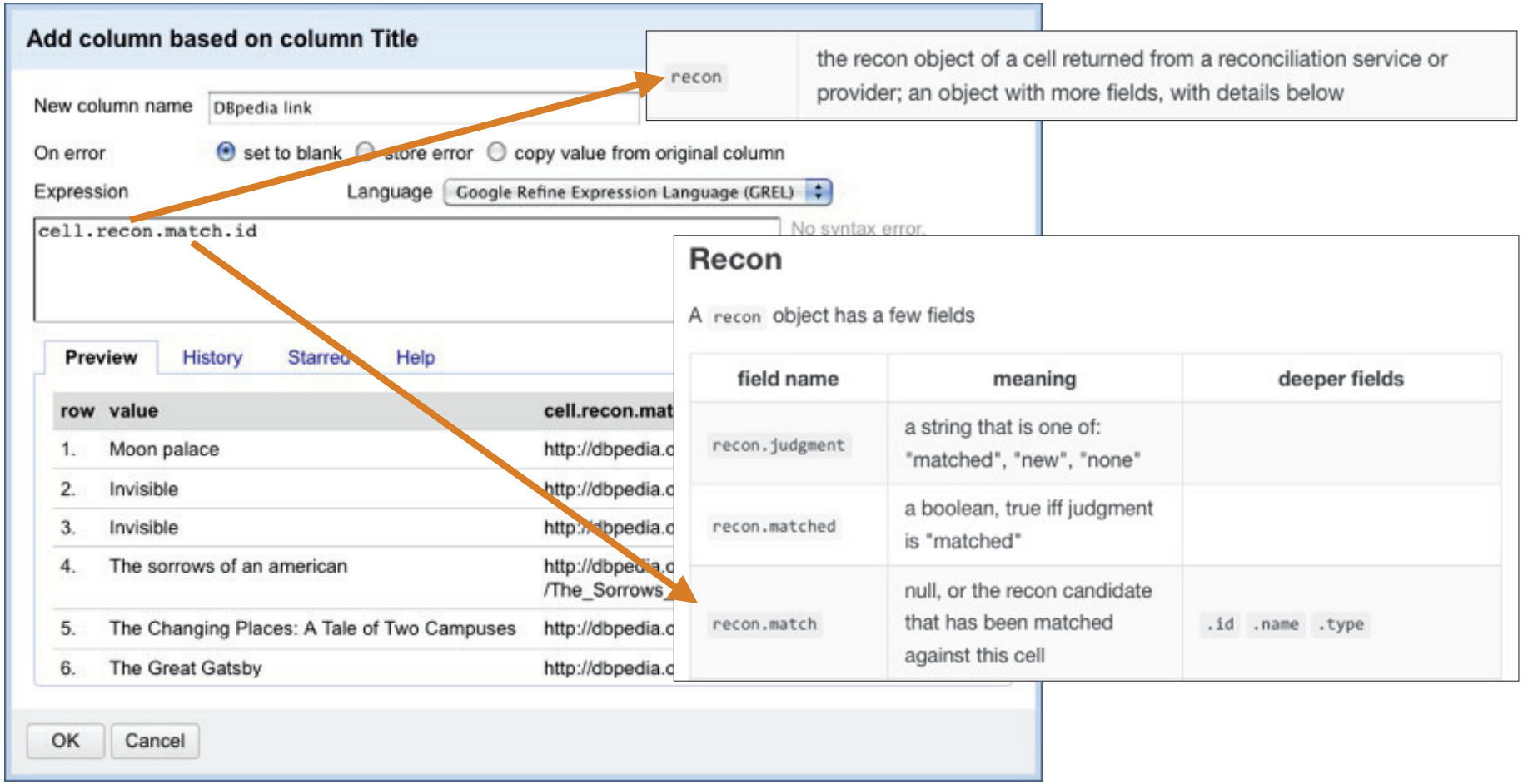


3. Creating links to external datasets (cont.)
   3.7. Add a new column based on the column used for interlinking.
   3.8. Retrieve the links found using GREL.

Hands-on session (I)

OpenRefine
GREL

- General Refine Expression Language (GREL)

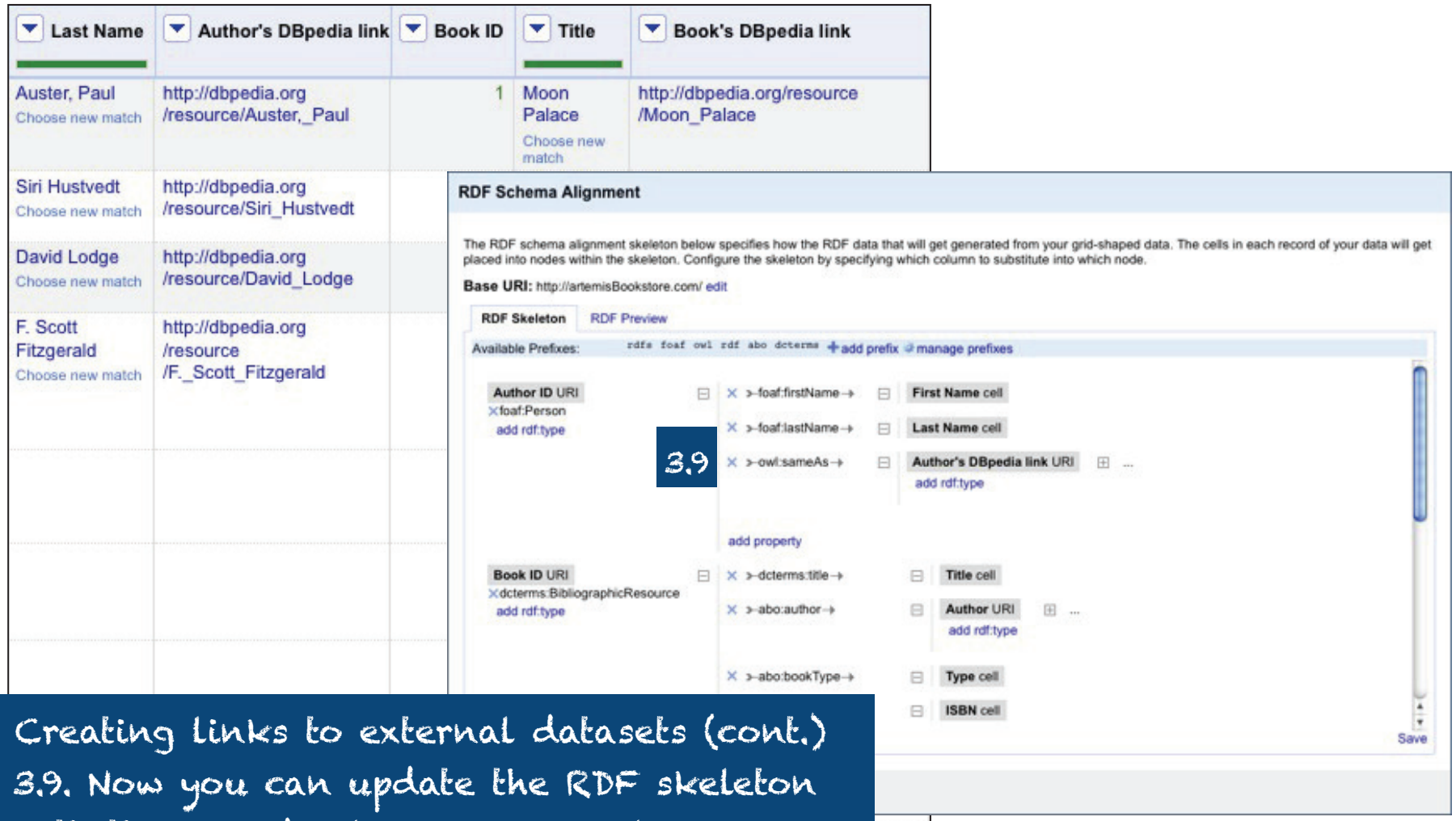


more info at https://github.com/OpenRefine/OpenRefine/wiki/Variables
https://github.com/OpenRefine/OpenRefine/wiki/General-Refine-Expression-Language

Hands-on session (I)

Creating links to external datasets

- Let's create links to DBpedia!



3. Creating links to external datasets (cont.)
   3.9. Now you can update the RDF skeleton with the DBpedia links using owl:sameAs.

Hands-on session (I)

Creating links to external datasets

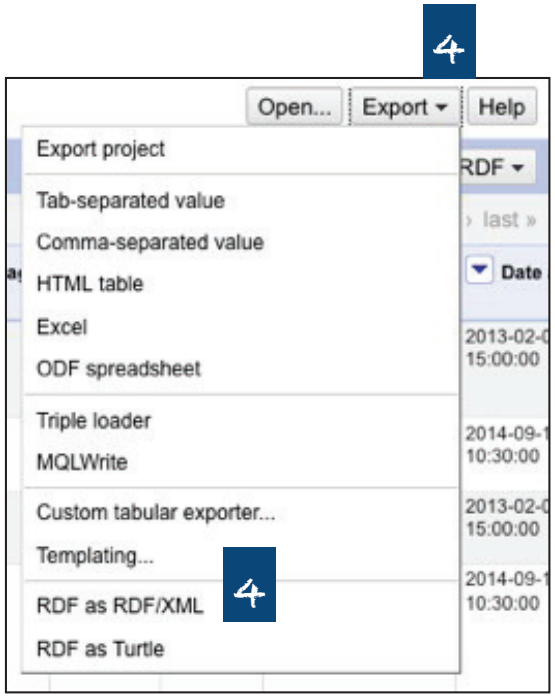
- You should end up with something like this

```
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix foaf: <http://xmlns.com/foaf/0.1/> .
@prefix owl: <http://www.w3.org/2002/07/owl#> .
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix abo: <http://artemisBookstore.com/ontology#> .
@prefix dcterms: <http://purl.org/dc/terms/> .


<http://artemisBookstore.com/id/author/1> a foaf:Person ;
        foaf:firstName "Paul" ;
        foaf:lastName "Auster" ;
        owl:sameAs <http://dbpedia.org/resource/Auster,_Paul> .

<http://artemisBookstore.com/id/book/571142200> a dcterms:BibliographicResource ;
        dcterms:title "Moon palace" ;
        abo:author <http://artemisBookstore.com/id/author/1> ;
        abo:bookType "Paperback" ;
        abo:isbn "571142200" ;
        abo:language "English" ;
        abo:pages "320"^^<http://www.w3.org/2001/XMLSchema#int> ;
        abo:price "12.5"^^<http://www.w3.org/2001/XMLSchema#double> ;
        abo:datePublication "2004-02-01" ;
        abo:dateAcquired "2013-02-01 15:00:00" ;
        dcterms:publisher "Faber & Faber" ;
        owl:sameAs <http://dbpedia.org/resource/Moon_Palace> .

<http://artemisBookstore.com/id/author/2> a foaf:Person ;
        foaf:firstName "Siri" ;
        foaf:lastName "Hustvedt" ;
        owl:sameAs <http://dbpedia.org/resource/Siri_Hustvedt> .
```

Hands-on session (I)

Artemis' RDF data

- Artemis' data is now available in RDF. Well done!




```
<rdf:RDF>
  <rdf:Description rdf:about="http://artemisBookstore.com/id/author/1">
    <rdf:type rdf:resource="http://xmlns.com/foaf/0.1/Person"/>
    <foaf:firstName>Paul</foaf:firstName>
    <foaf:lastName>Auster</foaf:lastName>
    <owl:sameAs rdf:resource="http://dbpedia.org/resource/Auster,_Paul"/>
  </rdf:Description>
  <rdf:Description rdf:about="http://artemisBookstore.com/id/book/571142200">
    <rdf:type rdf:resource="http://purl.org/dc/terms/BibliographicResource"/>
    <dcterms:title>Moon palace</dcterms:title>
    <abo:author rdf:resource="http://artemisBookstore.com/id/author/1"/>
```

```
<http://artemisBookstore.com/id/author/1> a foaf:Person ;
        foaf:firstName "Paul" ;
        foaf:lastName "Auster" ;
        owl:sameAs <http://dbpedia.org/resource/Auster,_Paul> .

<http://artemisBookstore.com/id/book/571142200> a dcterms:BibliographicResource ;
        dcterms:title "Moon palace" ;
        abo:author <http://artemisBookstore.com/id/author/1> ;
        abo:bookType "Paperback" ;
        abo:isbn "571142200" ;
        abo:language "English" ;
        abo:pages "320"^^<http://www.w3.org/2001/XMLSchema#int> ;
        abo:price "12.5"^^<http://www.w3.org/2001/XMLSchema#double> ;
        abo:datePublication "2004-02-01" ;
        abo:dateAcquired "2013-02-01 15:00:00" ;
        dcterms:publisher "Faber & Faber" ;
        owl:sameAs <http://dbpedia.org/resource/Moon_Palace> .

<http://artemisBookstore.com/id/author/2> a foaf:Person ;
        foaf:firstName "Siri" ;
        foaf:lastName "Hustvedt" ;
        owl:sameAs <http://dbpedia.org/resource/Siri_Hustvedt> .
```

4. You can export Artemis' RDF data as RDF/XML or Turtle.

Hands-on session

- Part I: From an Excel data file to linked open data
  - you will learn how to
    - create "cool" URIs
    - describe things with RDF
    - make links to other datasets
  - we will use the OpenRefine + RDF extension
- Part II: Querying linked data with SPARQL
  - you will learn how to make queries with SPARQL
  - we will use Apache Jena - ARQ command line applications