MAPPING

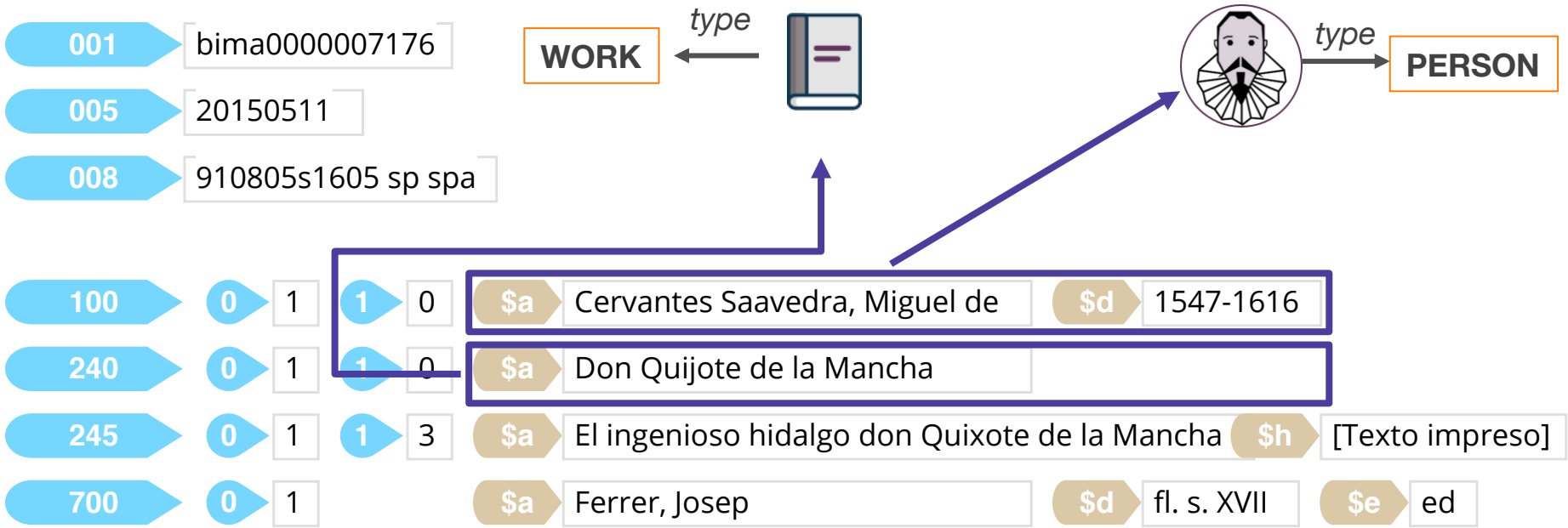
marimba-datamodel | **marimba-rml** | marimba-mapping

001	bima0000007176							
005	20150511							
008	910805s1605 sp spa							
100	0 1	1 0	$a	Cervantes Saavedra, Miguel de	$d	1547-1616		
240	0 1	1 0	$a	Don Quijote de la Mancha				
245	0 1	1 3	$a	El ingenioso hidalgo don Quixote de la Mancha	$h	[Texto impreso]		
700	0 1		$a	Ferrer, Josep	$d	fl. s. XVII	$e	ed

.

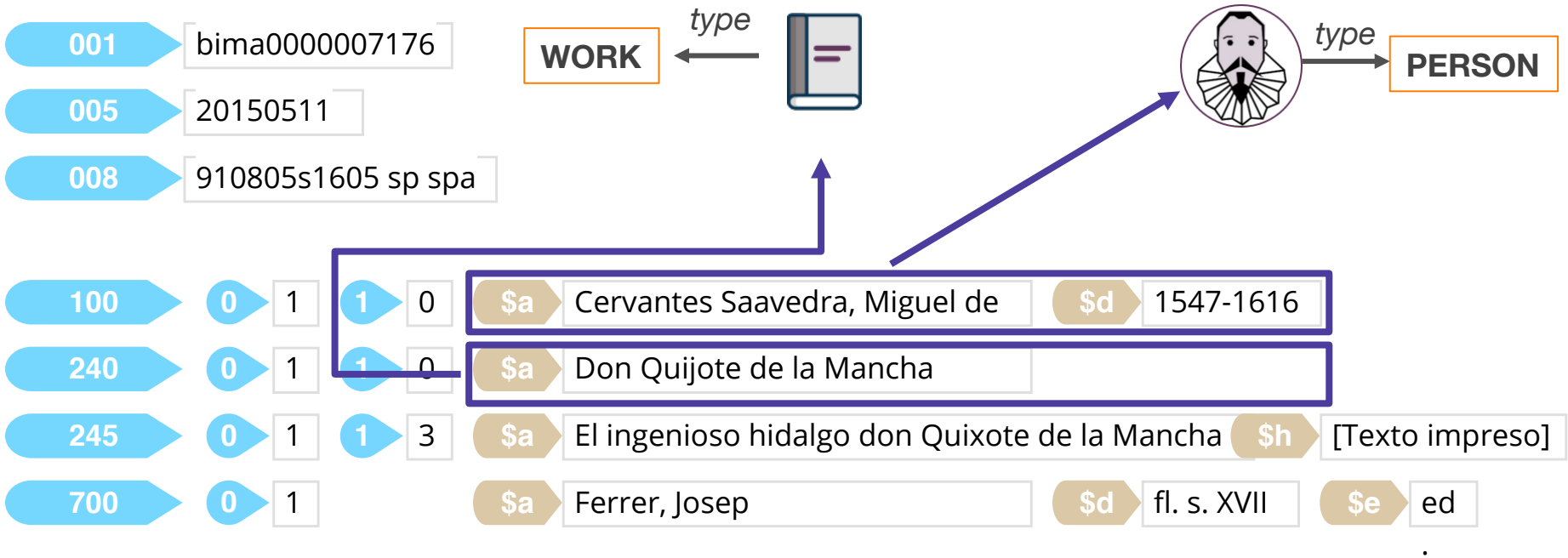
MAPPING

marimba-datamodel | **marimba-rml** | marimba-mapping



MAPPING

marimba-datamodel | **marimba-rml** | marimba-mapping



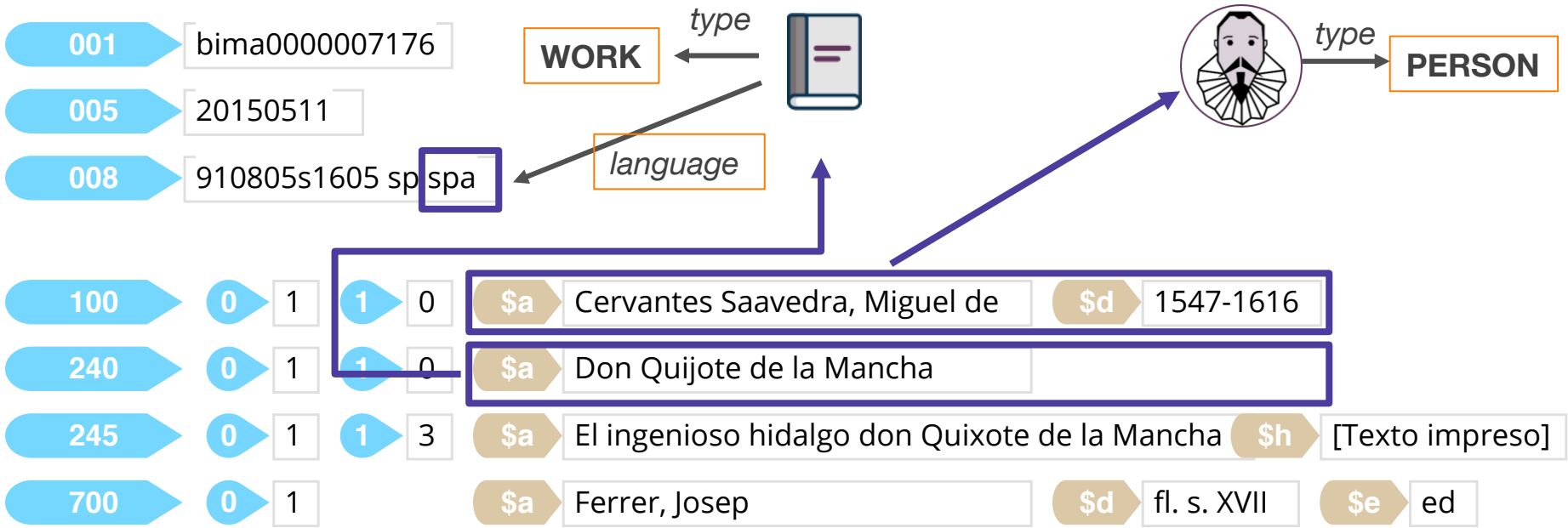
First modification of R2RML (*R2RML views)*

rr:sqlVersion → marimba-sql IRI

marimba-sql queries *for processing data in nested relations.*

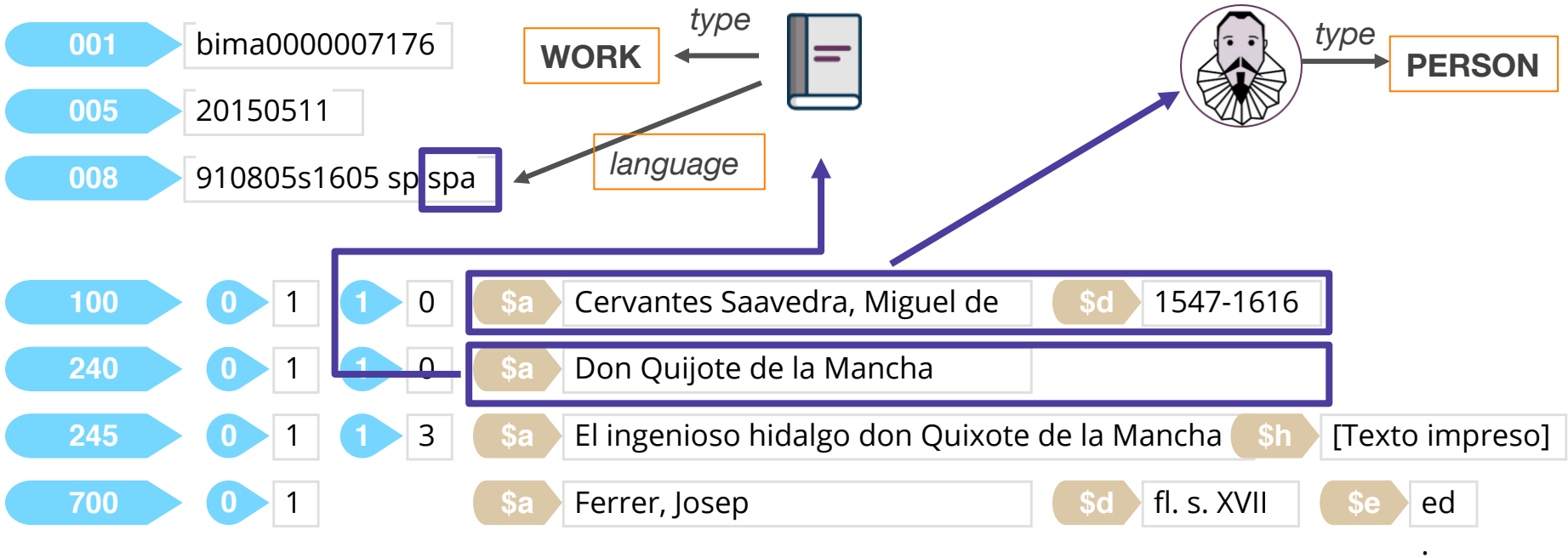
MAPPING

marimba-datamodel | **marimba-rml** | marimba-mapping



MAPPING

marimba-datamodel | **marimba-rml** | marimba-mapping



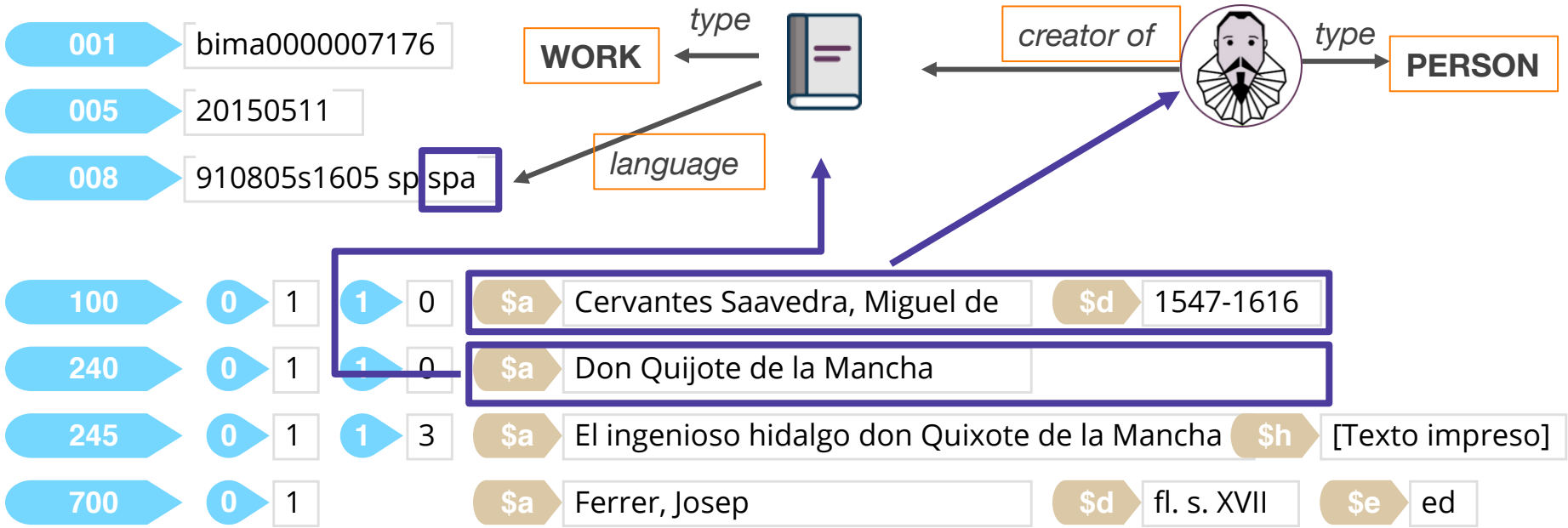
Second modification of R2RML *(rr:template and rr:column)*

R2RML column → marimba-sql query

*Generate **values** from attributes in nested relations.*

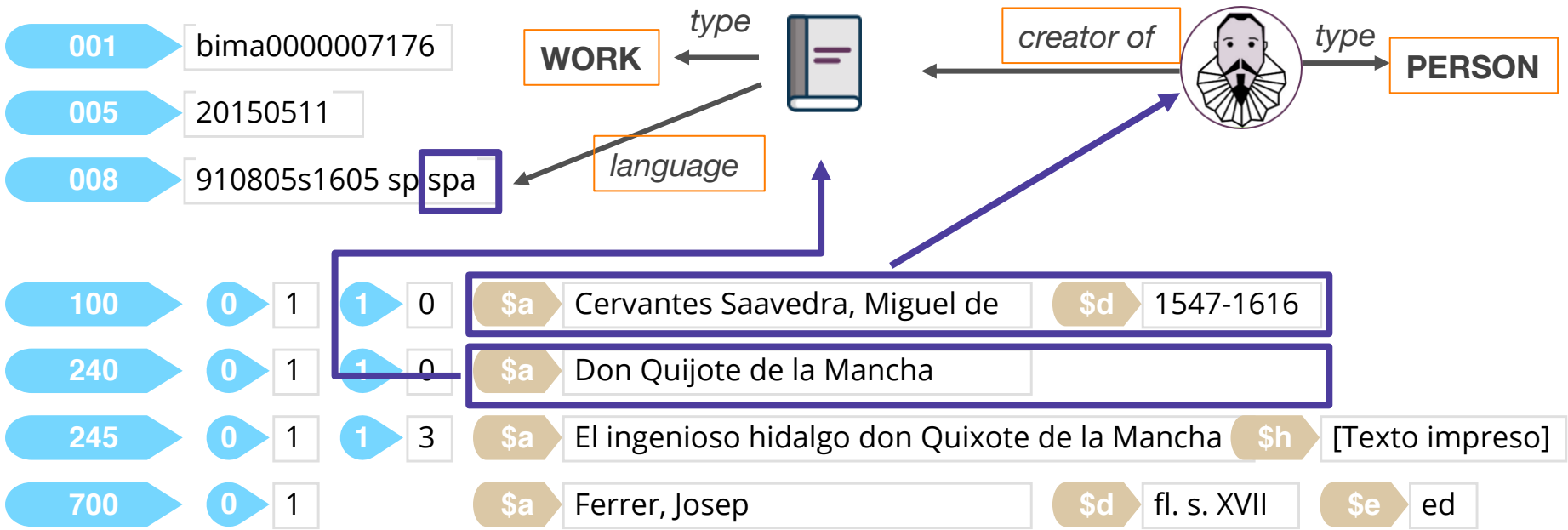
MAPPING

marimba-datamodel | **marimba-rml** | marimba-mapping



MAPPING

marimba-datamodel | **marimba-rml** | marimba-mapping



Third modification of R2RML *(rr:refObjectMap)*

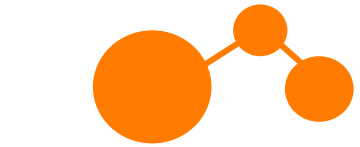
R2RML column → marimba-sql query

*Generate **joins** across nested relations*

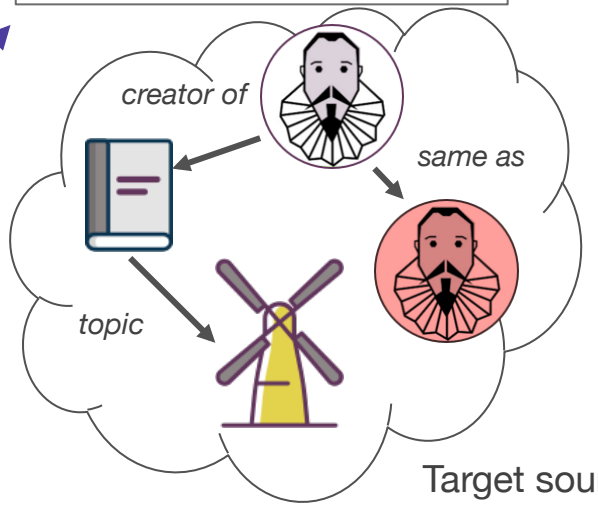
H2 Defined operational semantics
Three core modifications

marimba-mapping

P1
Mapping



GLOBAL SCHEMA



Target source
(RDF)

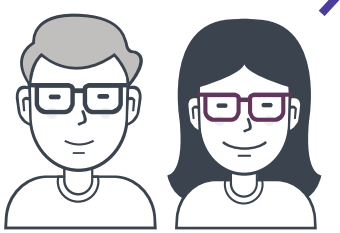
MAPPING

marimba-sql

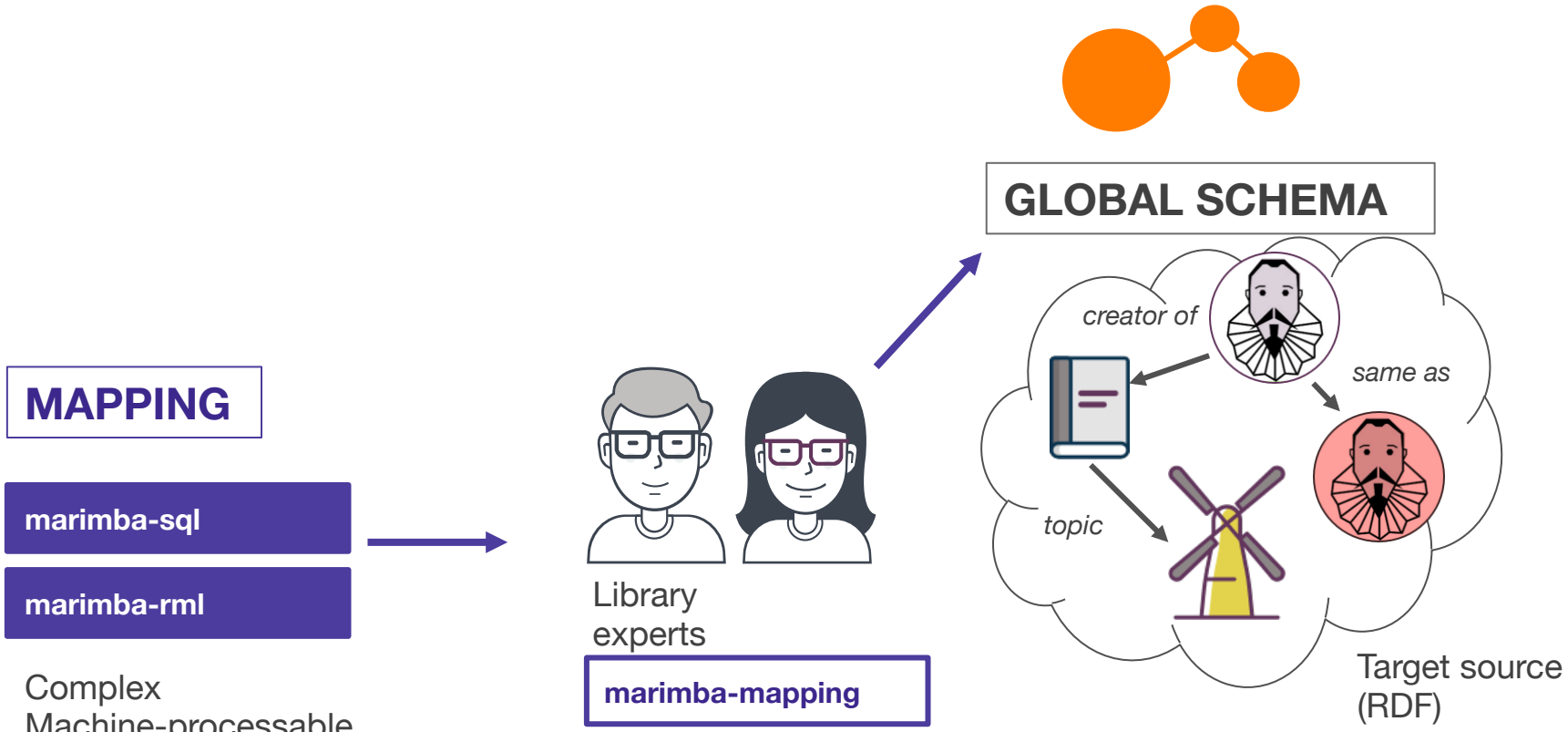
marimba-rml

Complex
Machine-processable

?



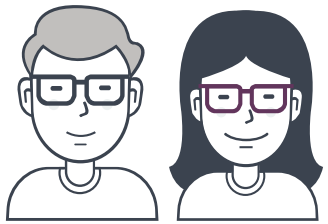
Library
experts


GLOBAL SCHEMA
creator of
same as
topic
Target source
(RDF)
MAPPING
marimba-sql
marimba-rml
Complex
Machine-processable
Library
experts
marimba-mapping

marimba-datamodel | marimba-rml | **marimba-mapping**

Generation of mapping templates

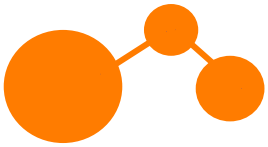
- Support the **mapping and ontology development process by library experts**
- **Full coverage** of data sources (e.g., at BNE more than 4,000 patterns)
- Library experts write simple mappings that are **translated into marimba-rml**



MARC 21 metadata	Record count	Class IRI
100adt	1,222,400	
100ad	999,789	
100adtl	567,534	
100ae	1,658	
100ac	20,768	

SCHEMA STATISTICS

OUTLINE



BNE ontology

marimba-topicmodel

marimba-modelling

MARC 21 metadata	Record count	Class IRI
100adt	1,222,400	
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P1
Mapping

P2
Ontology development process

P3
Library applications

Empirical studies

datos.bne.es

Library data sources

Ontology-based Library data (RDF)

Library online applications

BNE ontology

marimba-topicmodel

marimba-modelling

P2
Ontology development process

ONTOLOGY DEVELOPMENT

MARC 21 metadata	Record count	Class IRI
100adt	1,222,400	
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100adtl	567,534	
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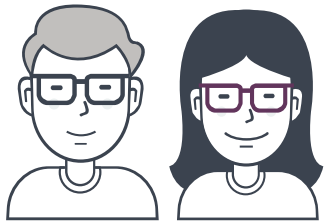
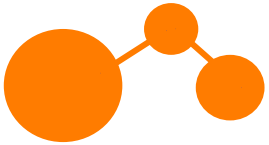
100ac	20,768	

Mapping templates



Library experts

?



Library ontology

ONTOLOGY DEVELOPMENT

BNE ontology

marimba-topicmodel

P2
Ontology development process

MARC 21 metadata	Record count	Class IRI
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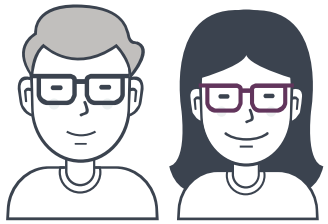
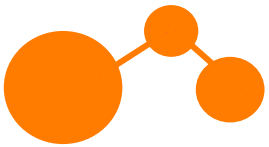
Mapping templates



Library experts

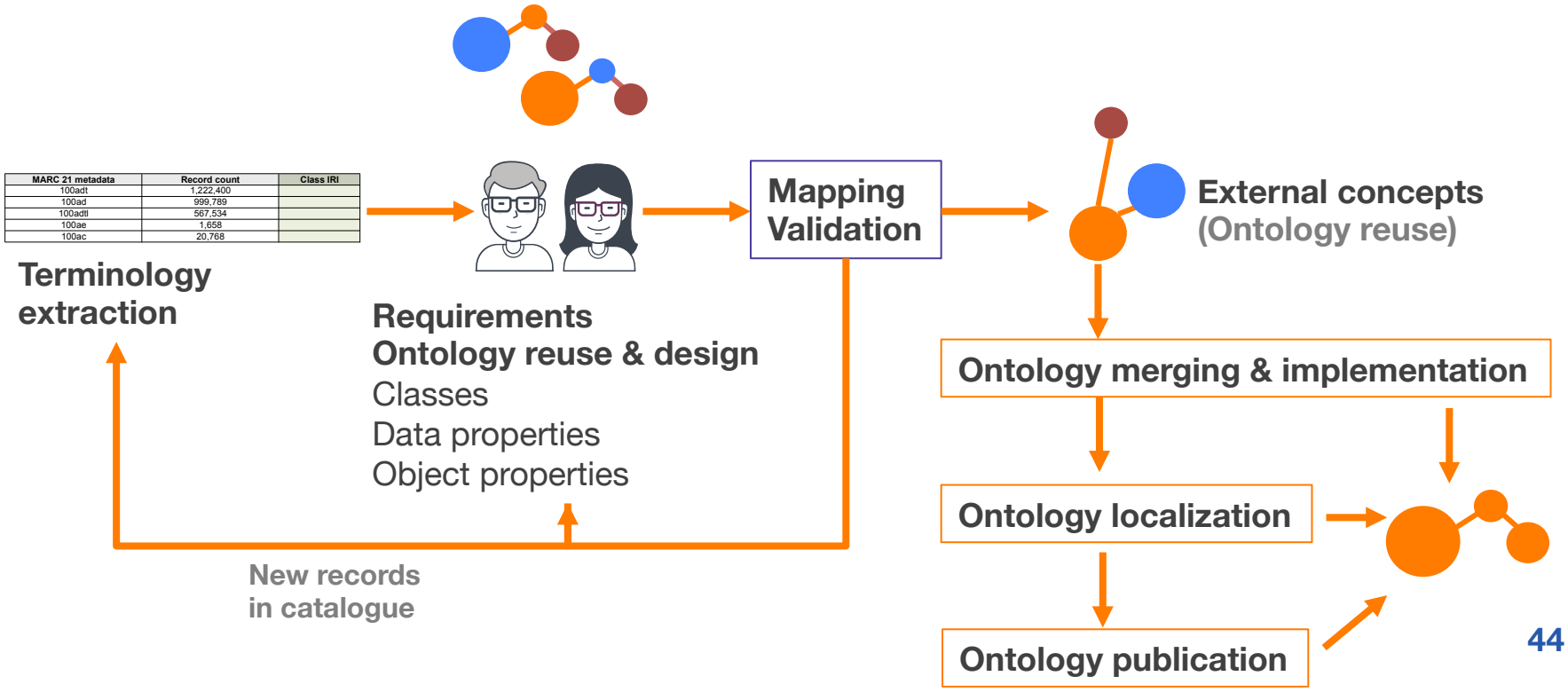
marimba-modelling



Library ontology

marimba-modelling | marimba-topicmodel | BNE ontology

- **Life-cycle model** based on **NeOn** methodology (Suarez-Figueroa et al. 2015).
- **Terminology extraction and ontology design activities** using **mapping templates**.
- **Ontology publication activity** added to NeOn.
- Two phases: **(1) Ontology reuse, and (2) ontology merging**



marimba-modelling | marimba-topicmodel | BNE ontology

ONTOLOGY DESIGN USING MAPPING TEMPLATES

MARC 21 metadata	Class IRI
100adt	frbr:C1001
100ad	frbr:C1005
100adtl	frbr:C1002
100ae	frbr:C1005
100ac	frbr:C1005

Classification template

CLASSES

WORK ← *type* 

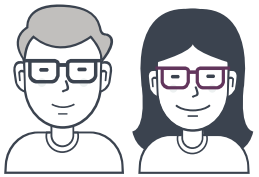
 *type* → PERSON

marimba-modelling | marimba-topicmodel | BNE ontology

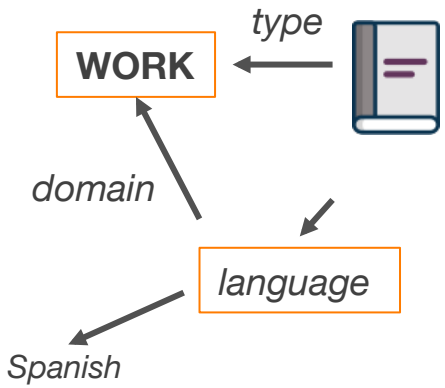
ONTOLOGY DESIGN USING MAPPING TEMPLATES

MARC 21 metadata	Datatype property IRI	Domain IRI
245n	isbd:P3033	frbr:C1003
321a	isbd:P3032	frbr:C1003
110a	frbr:P6001	frbr:C1006
400a	frbr:P5012	frbr:C1005

Annotation template



DATATYPE PROPERTIES
RDFS DOMAINS

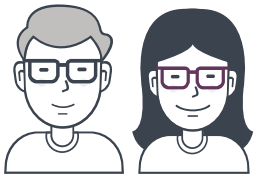


marimba-modelling | marimba-topicmodel | BNE ontology

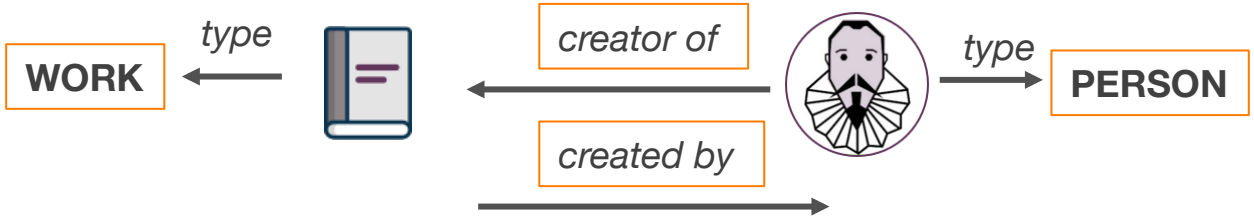
ONTOLOGY DESIGN USING MAPPING TEMPLATES

MARC 21 metadata	Object property IRI	Inverse property IRI	Domain IRI
t	frbr:P5001	frbr:OP1001	frbr:C1005
l	frbr:P1002	frbr:OP2002	frbr:C1001
n	frbr:OP1003	frbr:OP1004	frbr:C1001

Relation extraction template



OBJECT PROPERTIES
RDFS DOMAINS
INVERSE PROPERTIES

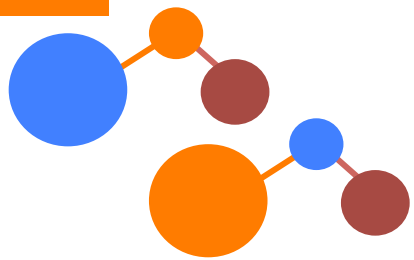


ONTOLOGY DEVELOPMENT

BNE ontology

marimba-topicmodel

P2
Ontology development process



?

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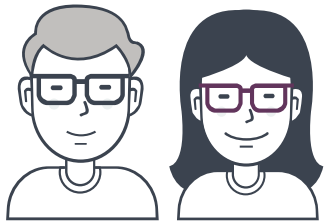
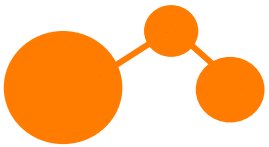
Mapping templates



Library experts

marimba-modelling

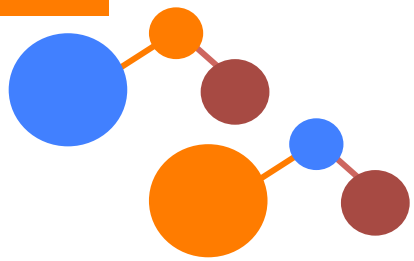


Library ontology

ONTOLOGY DEVELOPMENT

BNE ontology

P2
Ontology development process



marimba-topicmodel

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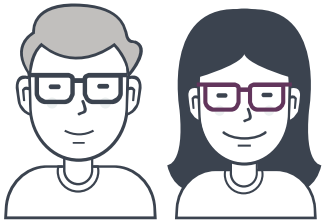
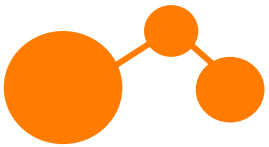
Mapping templates



Library experts

marimba-modelling

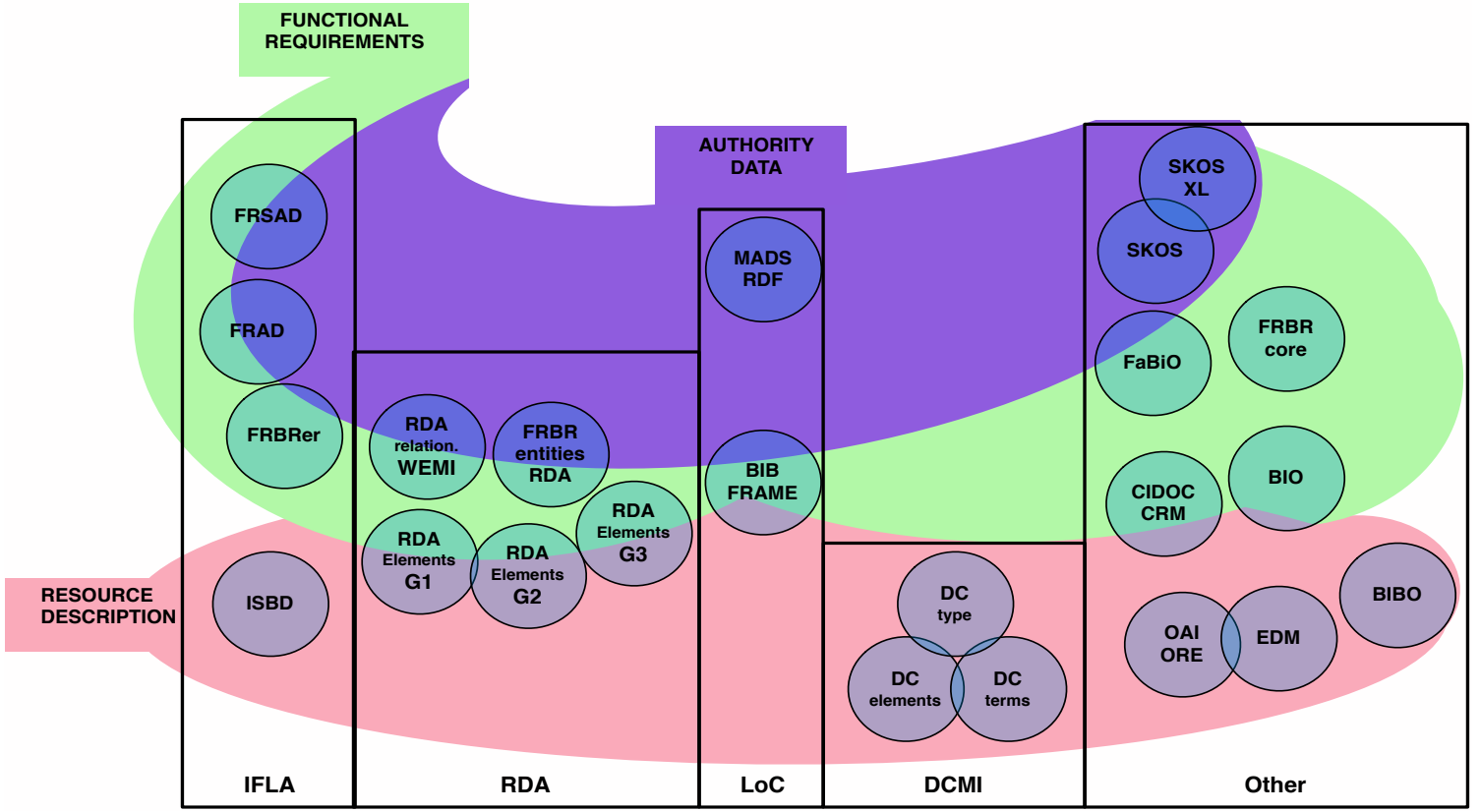


Library ontology

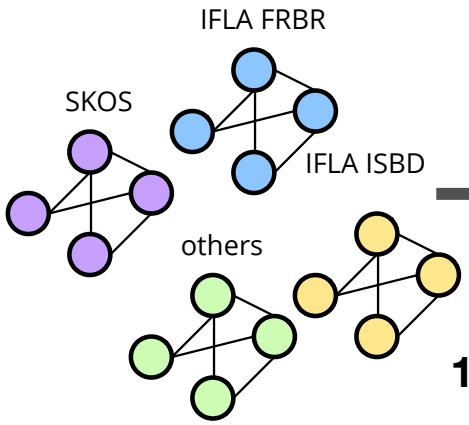
MOTIVATION: **MANUAL CLASSIFICATION OF LIBRARY ONTOLOGIES**

- Using **ontology repositories** (LOV and metadataregistry.org)
- Very **costly** and **not scalable** (e.g., new ontologies?)

Can we do this analysis **automatically**?



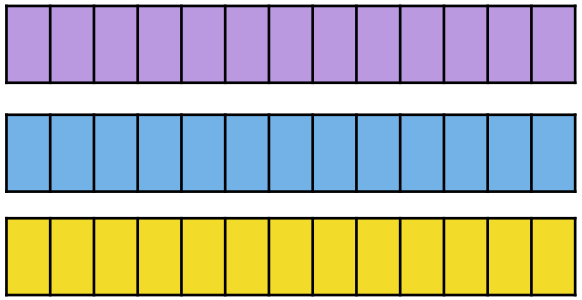
MARIMBA-TOPICMODEL: **OVERVIEW**



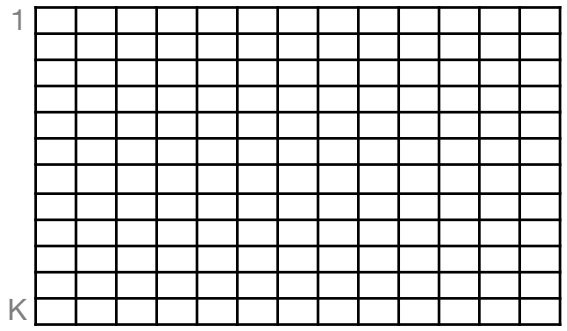
Corpus of ontologies

marimba-topicmodel

1. **Ontology documents** from textual descriptions
2. **Annotate** with **external word senses**
3. Train a **probabilistic topic model**



Ontologies as probability distributions over **K** topics



K topics as probability distributions over **S** word senses

Topic-based ontology similarity measures:

JSD: Jensen-Shannon Divergence

JSM: Jensen-Shannon Metric

marimba-topicmodel | Evaluation | Application

LOD resources
(e.g., DBpedia categories)

BabelNet sense URI	*Word(s)*
bn:s00046705n	*info*
bn:s00025314n	*data*
bn:s00029345n	*email*
bn:s00046516n	*person*
bn:s00049910n	*language*
bn:s00023236n	*Country, nation*

TOPIC EXAMPLE: PERSONAL INFORMATION

HIGH PROBABILITY: FOAF, BIBO, FABIO

EXPERIMENT 1: **TOPIC COHERENCE**

1. **External senses** improve the **coherence** of topics?
2. **Short-text oriented** topic models produce **more coherent** topics than **classical topic models**?

Measure: Mimmo et al. [2011]

METHODS

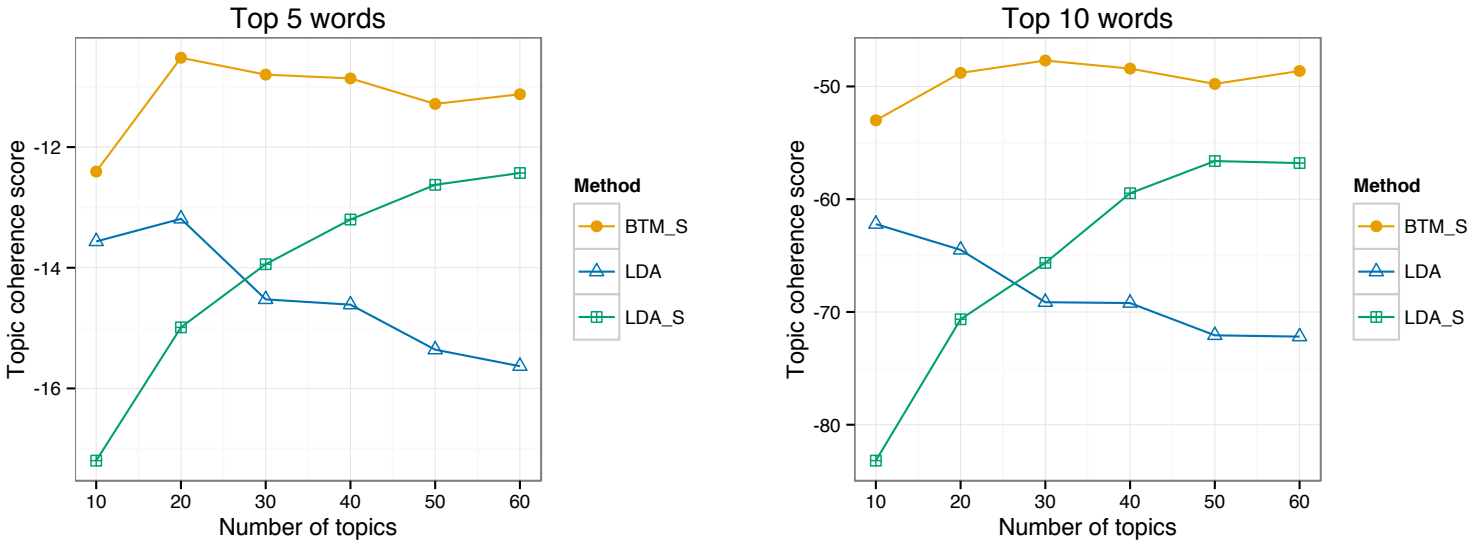
Classical LDA (Latent Dirichlet Allocation)

LDA_S: LDA with sense-annotated documents

BTM_S (marimba-topicmodel): BTM with sense-annotated documents

EXPERIMENT 1: **TOPIC COHERENCE**

1. **External senses** improve the **coherence** of topics?
2. **Short-text oriented** topic models produce **more coherent** topics than **classical topic models**?



1. Annotation with **senses increase topic coherence** (BTM_S > LDA_S >LDA)
2. **Short-text topic models increase coherence**

   (**BTM_S** consistently outperforms LDA and LDA_S).

EXPERIMENT 2: **ONTOLOGY CLUSTERING EXPERIMENT**

Does **marimba-topic model** produce **more precise clustering** than classical search methods?

- **How to measure?**
  - **H-score: IntraCluster** distance **<** **Intercluster** distance

- **Methods with different distance measures and metrics:**
  - **2 TF-IDF:** Baseline method (Cosine and Euclidean distance)
  - **2 Marimba-topicmodel** (JSD and JSM)

- **Gold-standards** (annotated by humans)
  1. **LODTHEMES:** LOD cloud themes
  2. **LOVTAGS:** Topic tags of LOV repository

marimba-topicmodel | **Evaluation** | Application

EXPERIMENT 2: **ONTOLOGY CLUSTERING EXPERIMENTAL RESULTS**

	tf-idf cosine	marimba-cosine	marimba-jsd
LOVTAGS	0.924	0.861	**0.859**
LODTHEMES	0.842	0.722	**0.683**

	tf-idf eucli	marimba-jsm
LOVTAGS	0.808	**0.998**
LODTHEMES	0.723	**0.741**

* **Lower** values mean **better precision** (low intracluster, high intercluster)

Does **marimba-topic model** produce **more precise clustering** than classical search methods

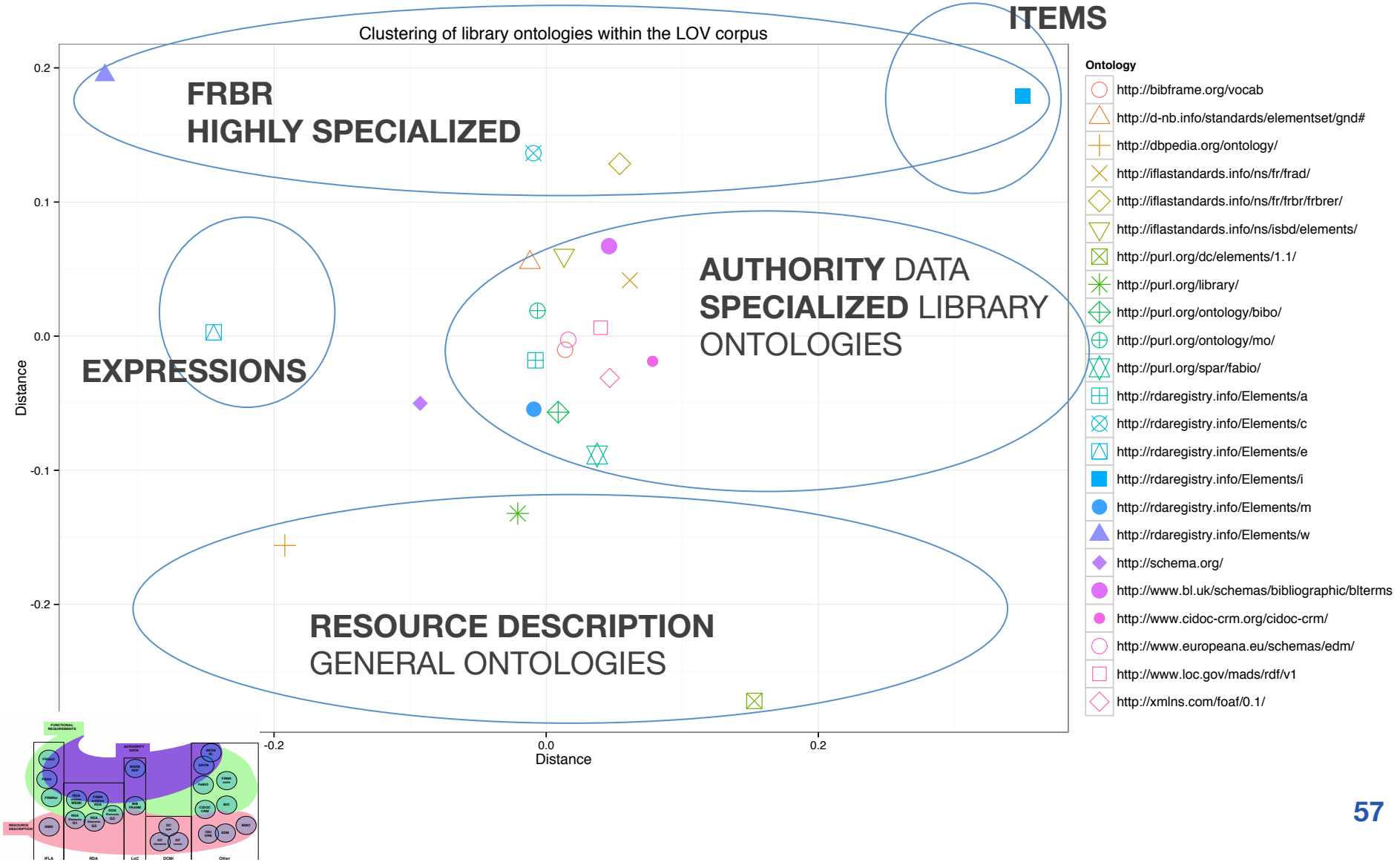
H4 **Topic-based ontology similarity measures perform better** than existing methods used in ontology search for **clustering widely used LOD ontologies** (LOV repository and LOD cloud).

But, what about **library ontologies** and **more qualitative results**?

ONTOLOGY DEVELOPMENT

Ontology Engineering Group

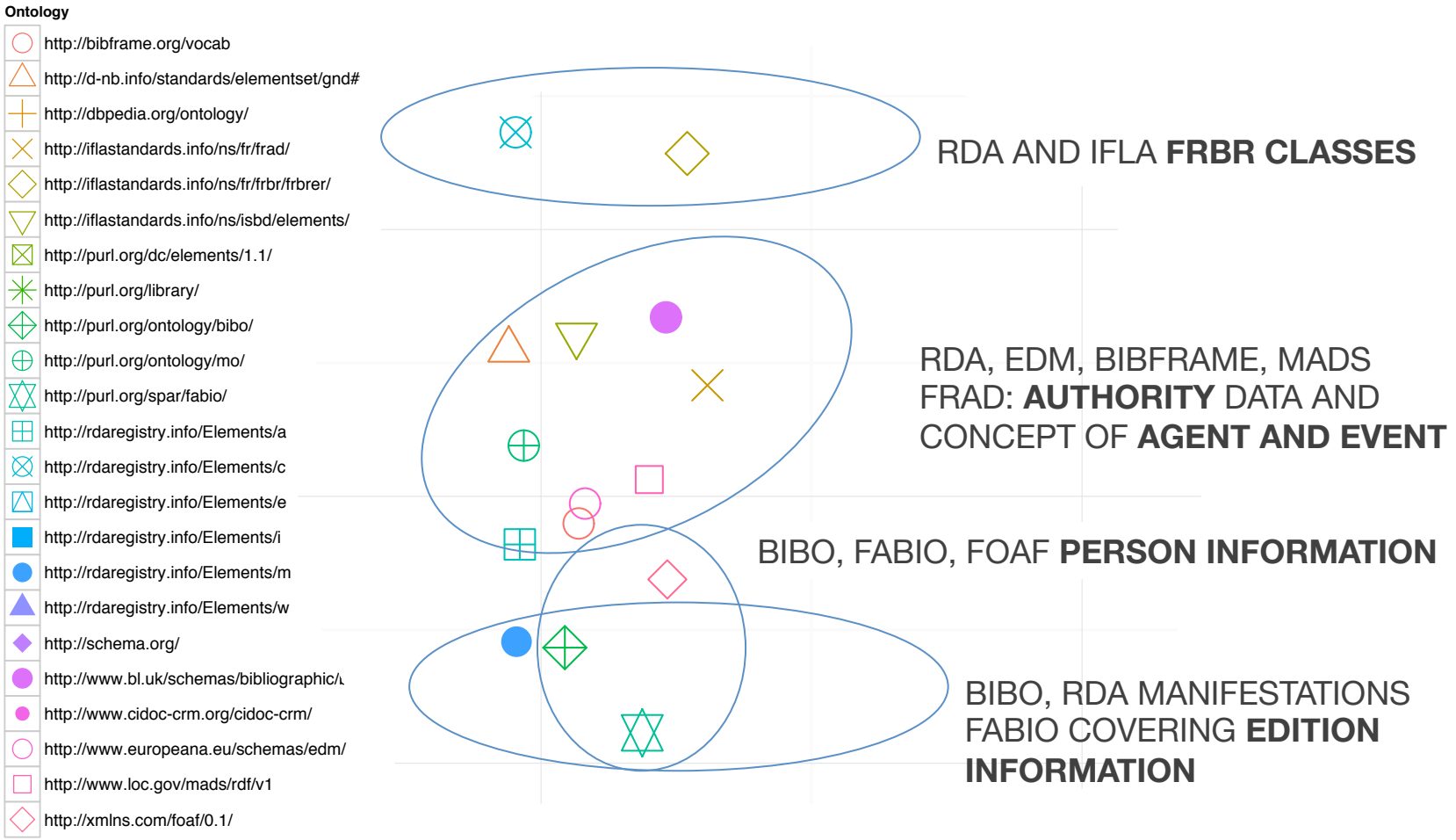
marimba-topicmodel | Evaluation | Application



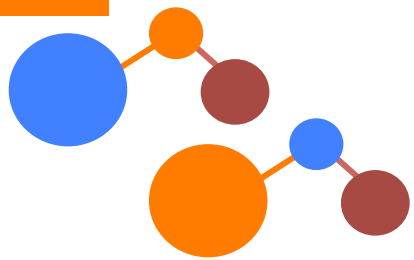
ONTOLOGY DEVELOPMENT

Ontology Engineering Group

marimba-topicmodel | Evaluation | **Application**



P2
Ontology development process



marimba-topicmodel

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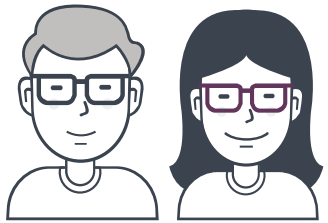
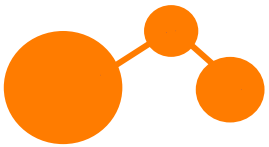
Mapping templates



Library experts

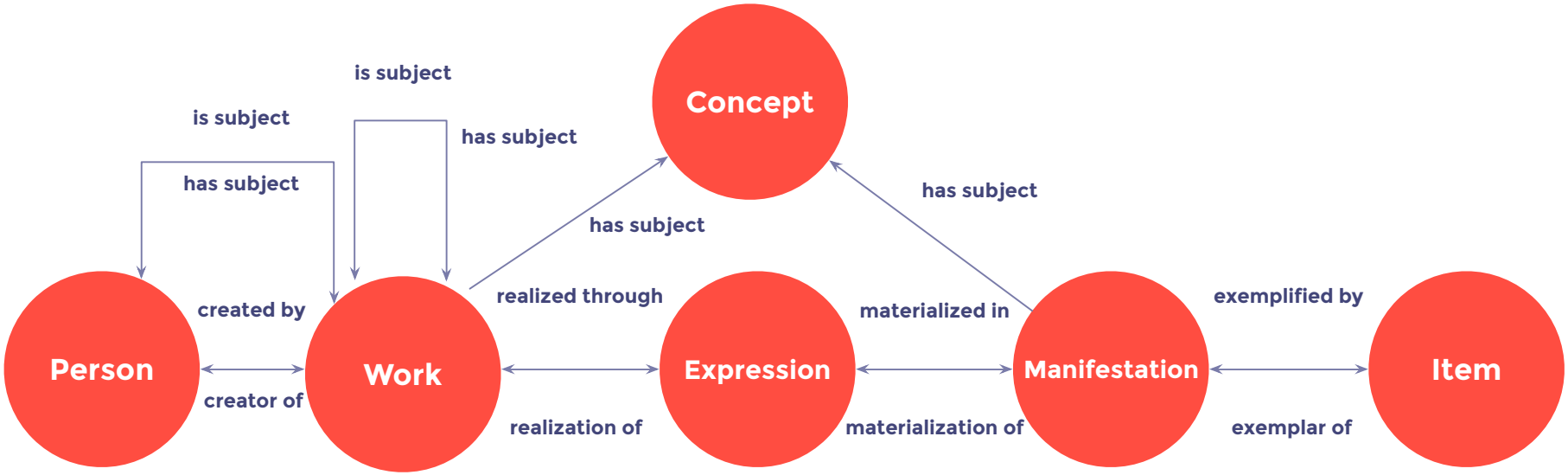
marimba-modelling



Library ontology

BNE ontology

marimba-modelling | marimba-topicmodel | **BNE ontology**



- Includes **alignments** to library ontologies (ISBD, IFLA FRBR, RDA)
- **6** classes, **33** object properties, **200** datatype properties
- **Ontology localization**: Spanish and English
- **Ontology publication**: HTML doc, RDF formats

marimba-modelling | marimba-topicmodel | **BNE ontology**

H3 Analytical data and the feedback of library experts can be used to develop a library **ontology** with sufficient **quality** with respect to **state of the art evaluation metrics.**

Evaluation from two perspectives:

1. **Topology based**: *OOPS!* (Poveda-Villalón et al. [2014]):

   0 critical pitfalls, only 3 important.

2. **Application-based:** Task-based experiment with 72 participants.

OUTLINE

Empirical studies

datos.bne.es

P1
Mapping

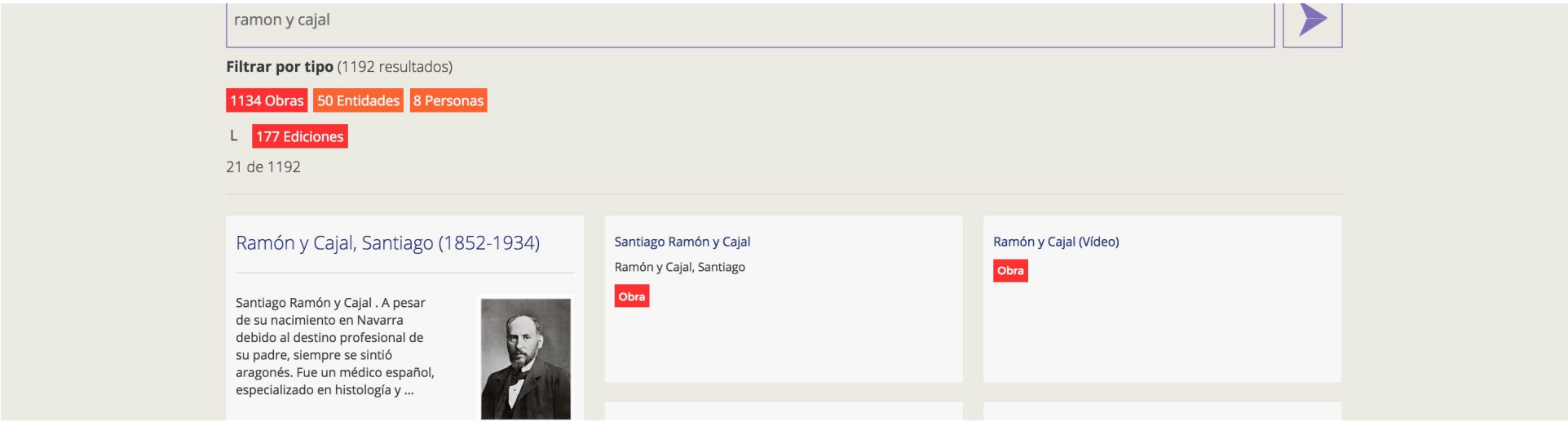
P2
Ontology development process

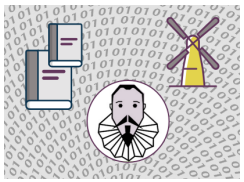
P3
Library applications

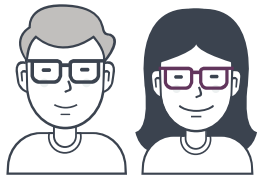
Library data sources

Ontology-based Library data (RDF)

Library online applications







marimba-rml
mappings

marimba-tool

Methodology

RDF
generation

Publication
Exploitation

datos.bne.es

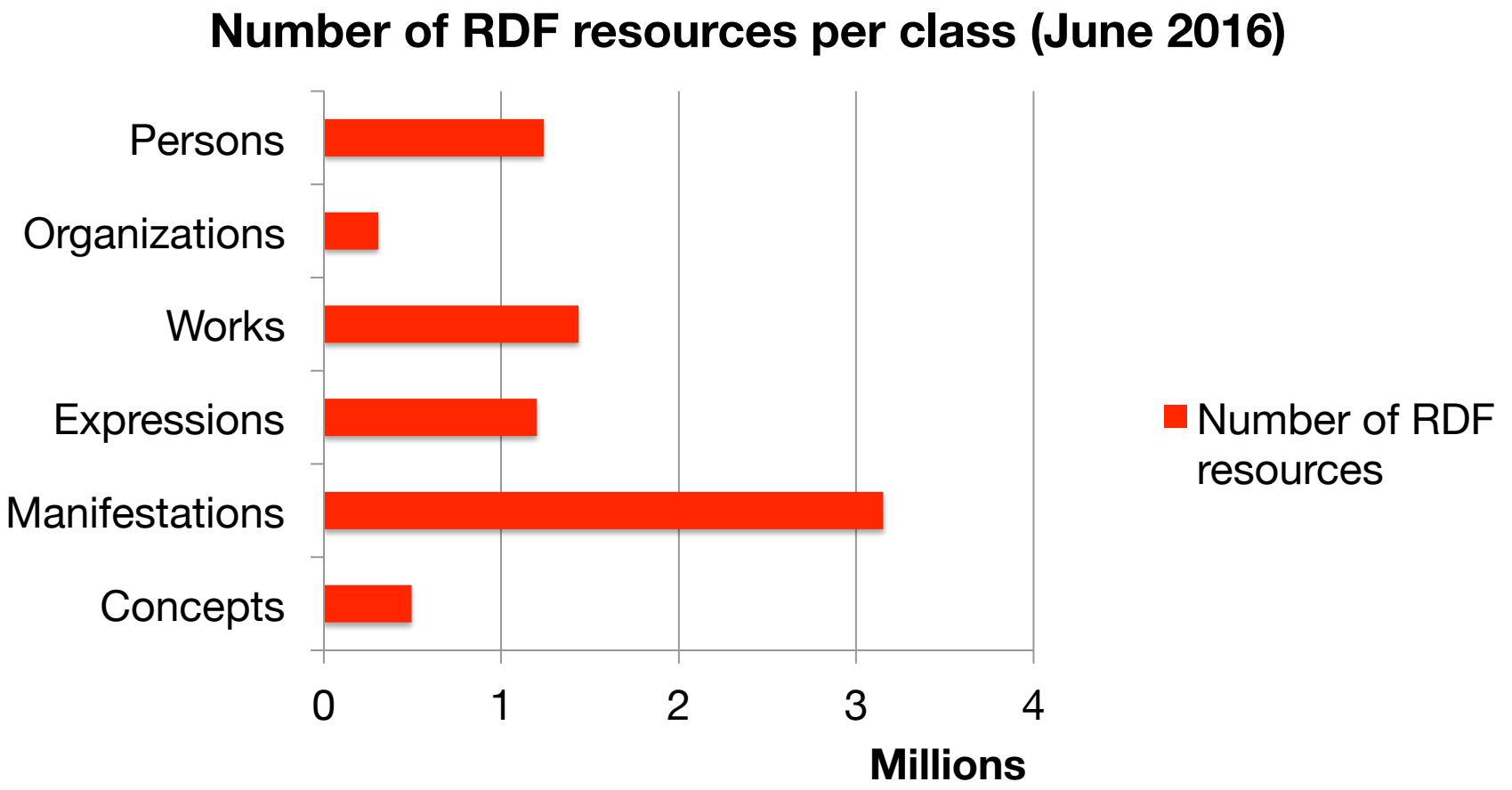
Library
data sources

Ontology-based
Library data (RDF)

Library
online applications

datos.bne.es | Empirical studies | Task-based experiment | Usability study

PUBLICATION: **+7 MILLION** RDF RESOURCES, **+1M SAMEAS** LINKS



LIBRARY ONLINE APPLICATIONS

datos.bne.es | Empirical studies | Task-based experiment | Usability study

DATOS·BNE·es *beta

Inicio Personas Entidades Obras Temas Ayuda

BIBLIOTECA NACIONAL DE ESPAÑA BNE

1. MULTILINGUAL SEARCH

aristoteles

Filtrar por tipo (663 resultados)

654 Obras | 7 Personas | 2 Entidades

907 Ediciones

21 de 663

2. ONTOLOGY ENTITIES

3. GRAPH-BASED RANKING

4. DATA **ENRICHMENT**

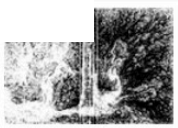
Aristóteles

Aristóteles, en griego antiguo Ἀριστοτέλης Aristotélēs, fue uno de los más influyentes filósofos de la antigüedad, de la historia de la filosofía occidental y considerado por muchos como ...

Obras destacadas

Poética
Ética a Nicómaco
Política
Metafísica

Aristóteles
Obra Disponible en digital



Ética a Nicómaco
Aristóteles
Obra Disponible en digital

Política
Aristóteles
Obra Disponible en digital

Metafísica
Aristóteles
Obra Disponible en digital

Main questions:

H5

1. Do semantic technologies increase **user satisfaction** and **efficiency?**
2. **Holistic evaluation** of contributions in the thesis

Comparing 2 large-scale services of BNE:

1. Online Public Access Catalogue: **catalogo.bne.es**
2. Linked data-based service: **datos.bne.es**

Two experiments:

1. **Task-based experiment:** 72 participants
2. **Usability and user satisfaction study**: 36 participants

EXPERIMENTAL SETTING

- **Between-group** experiment:

  72 participants of library and information sciences.

- User's goal: Complete an information retrieval **scenario of 10 tasks.**

- **Scenario:**
  Documentation about **Spanish scientist** "Santiago Ramón y Cajal"

  – **Designed** with **professors of Library and information sciences**
  – **Realistic tasks** reproducing a documentation scenario.
  – **Tasks: interrelated and with different levels of complexity. E.g.,:**

  "Find dates related to the author",
  "Find the title of three works",
  "Find works by topic"

LIBRARY ONLINE APPLICATIONS

datos.bne.es | Empirical studies | Task-based experiment | Usability study

EVALUATION APPLICATION

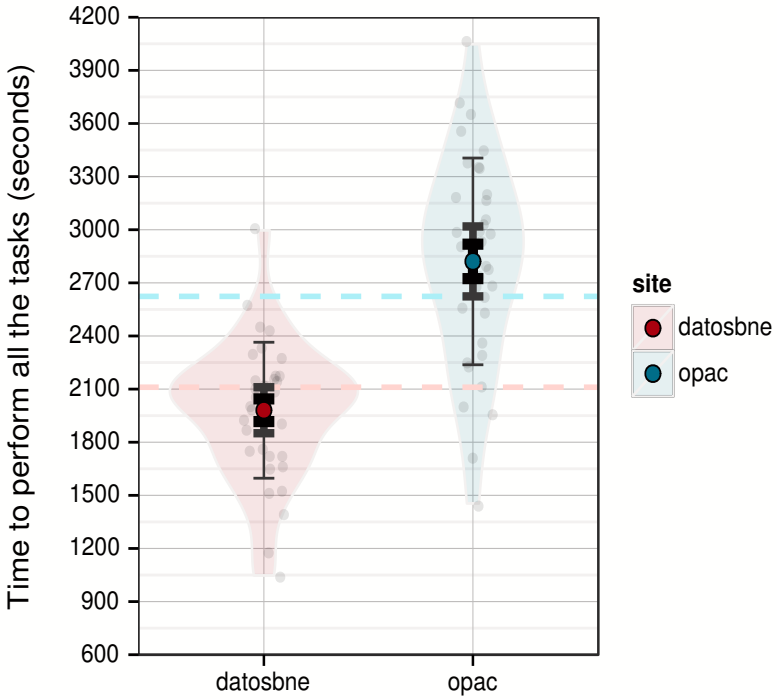
datosbne

OPAC

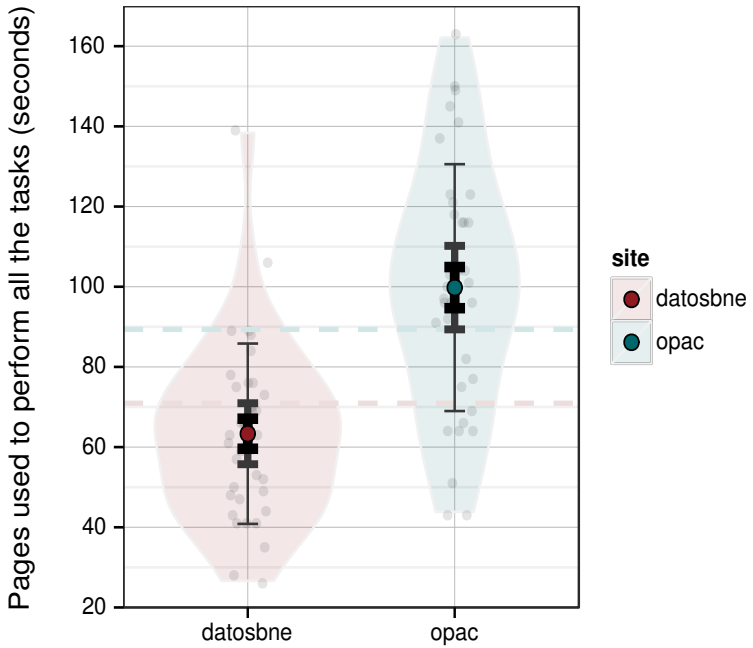
- **Measures:**
  - Task **completion time** (Kelly [2009])
  - **Visited pages** (Su [1992])
  - **User satisfaction** (1-5 scale) (Brooke [2013])

Efficiency

- **32% less time** on avg. to complete scenario (**>15 min**)



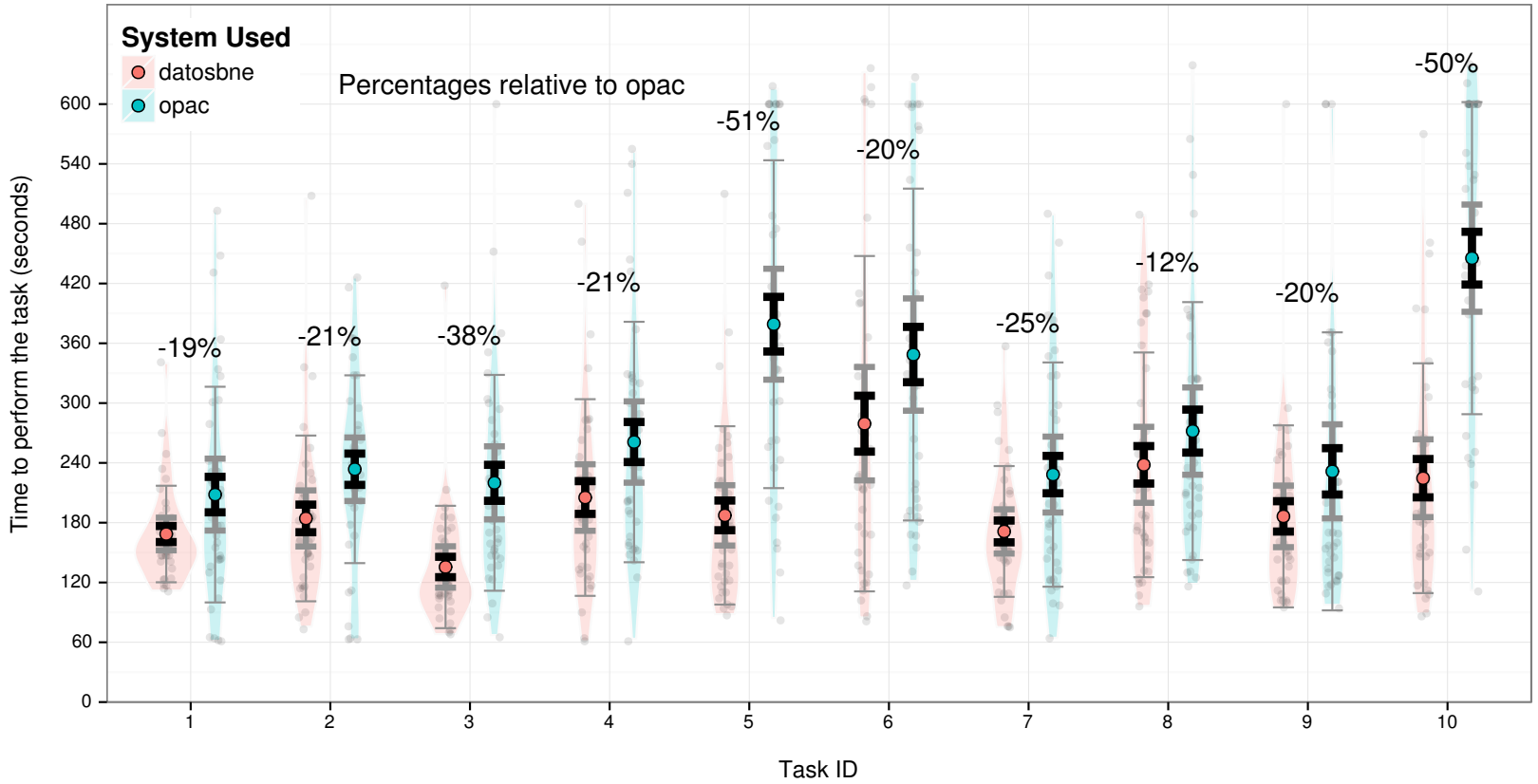
- **40% less pages** on avg. to complete scenario (**>40 pages**)



H5

Users are significantly more **efficient** in completing **information retrieval tasks**.

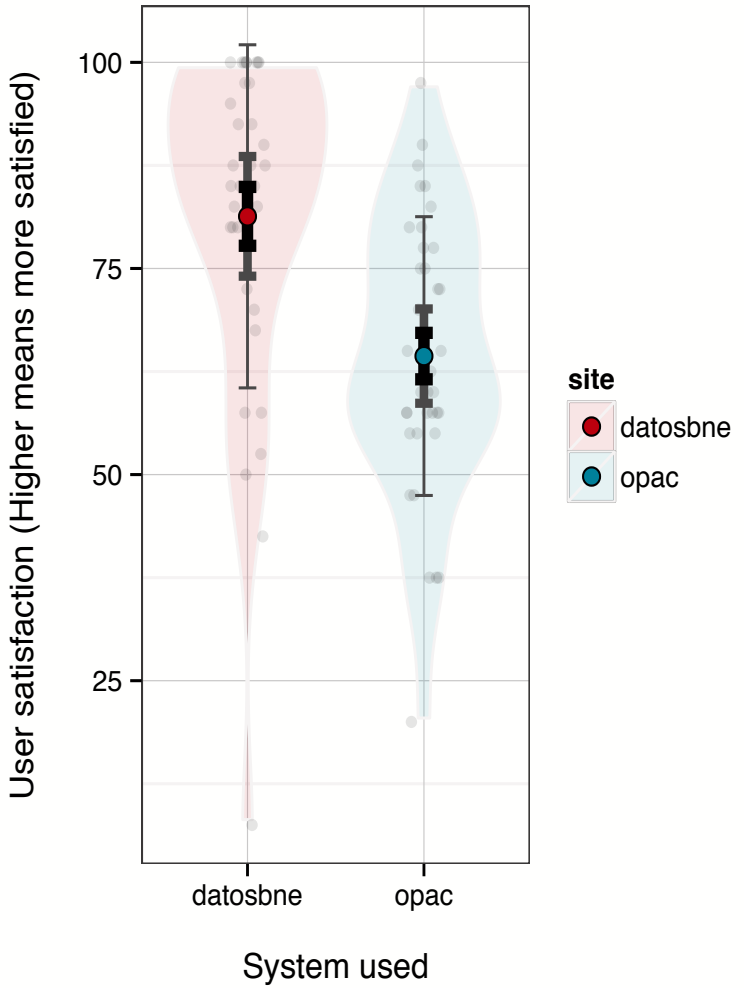
Time completion per task



- **More complex tasks: difference > 50% → Complex navigation of ontology**
  - Finding the **title** of a **translation** into English (Task 5)
  - Finding the **topic** and **author** of a work (Task 10)

Task User Satisfaction

- **datos.bne.es** average score = **81**
- **17% higher** than catalogo.bne.es



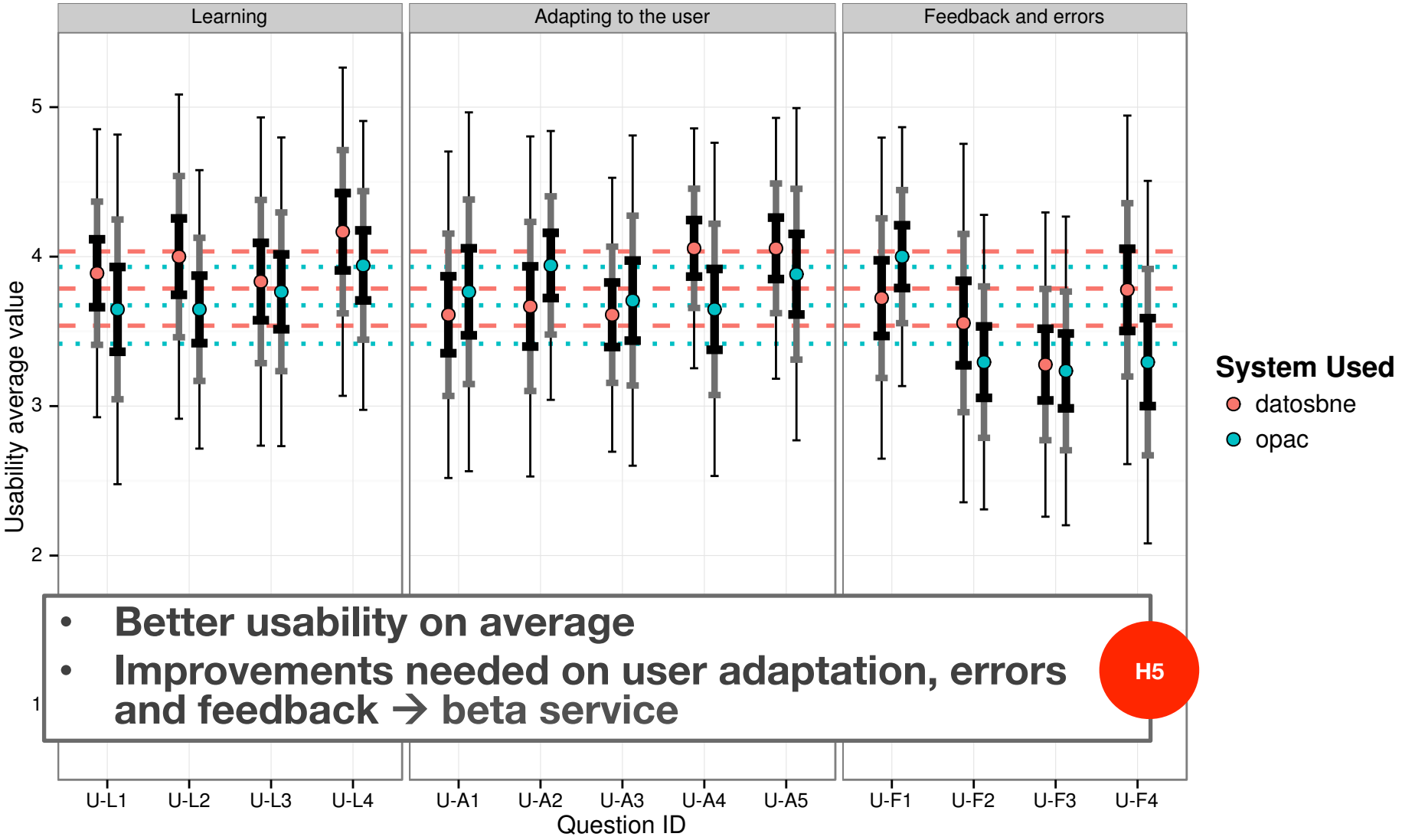
H5 Significant increase in **user satisfaction** for information retrieval tasks

USABILITY STUDY: **EXPERIMENTAL DESIGN**

- **36 participants** (18 for each system)
- **No** time measurement and **constraints**
- **No task solving**
- Usability test “Practical Heuristics for Usability Evaluation” (Perlman [1997])

LIBRARY ONLINE APPLICATIONS

datos.bne.es | Empirical studies | Task-based experiment | **Usability study**



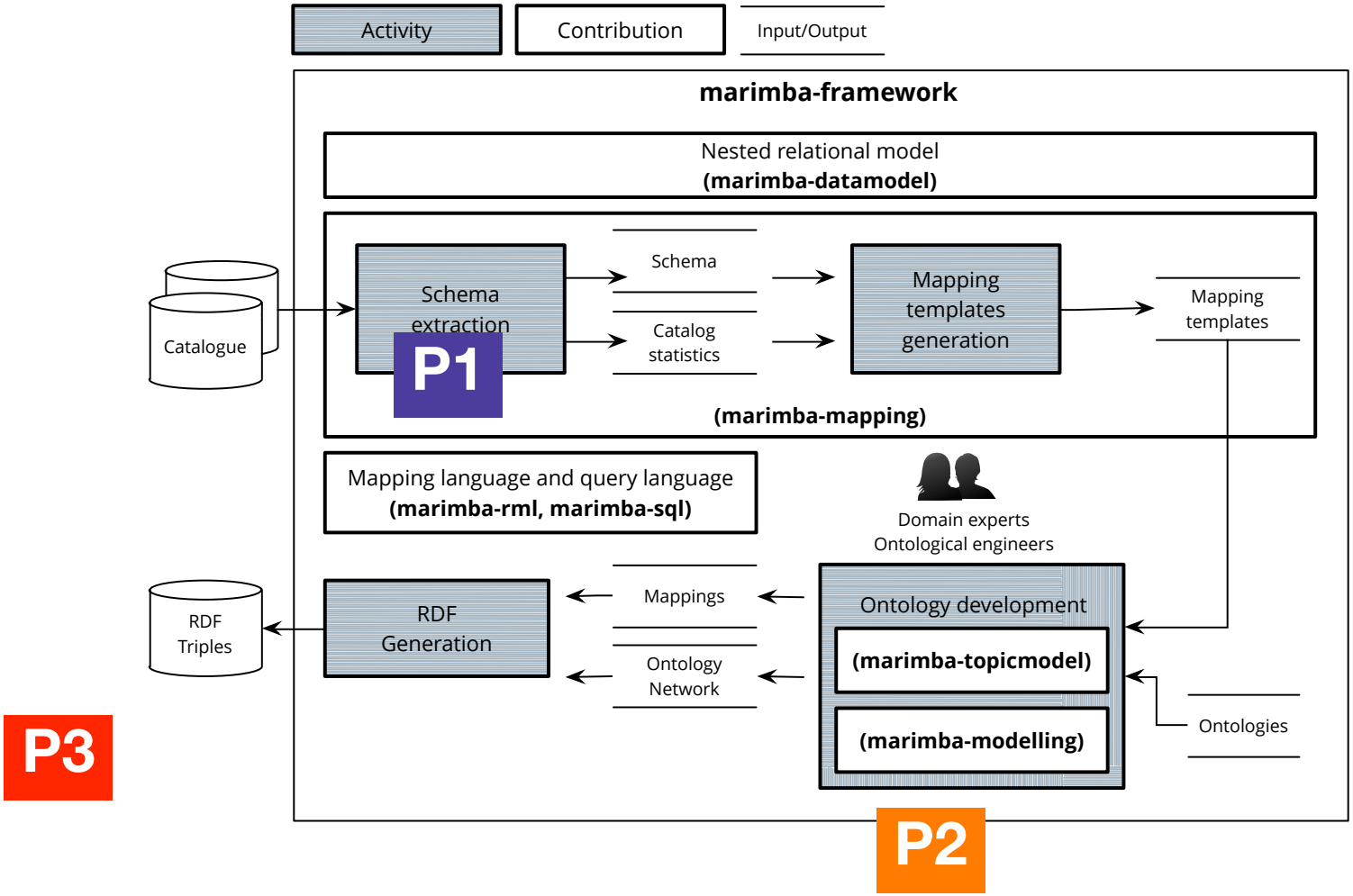
- **Better usability on average**
- **Improvements needed on user adaptation, errors and feedback → beta service**

H5

CONCLUSION AND FUTURE DIRECTIONS

THEORETICAL, TECHNOLOGICAL AND EMPIRICAL RESULTS

End-to-end solution for ontology-based library data generation, access and exploitation



OTHER RESULTS

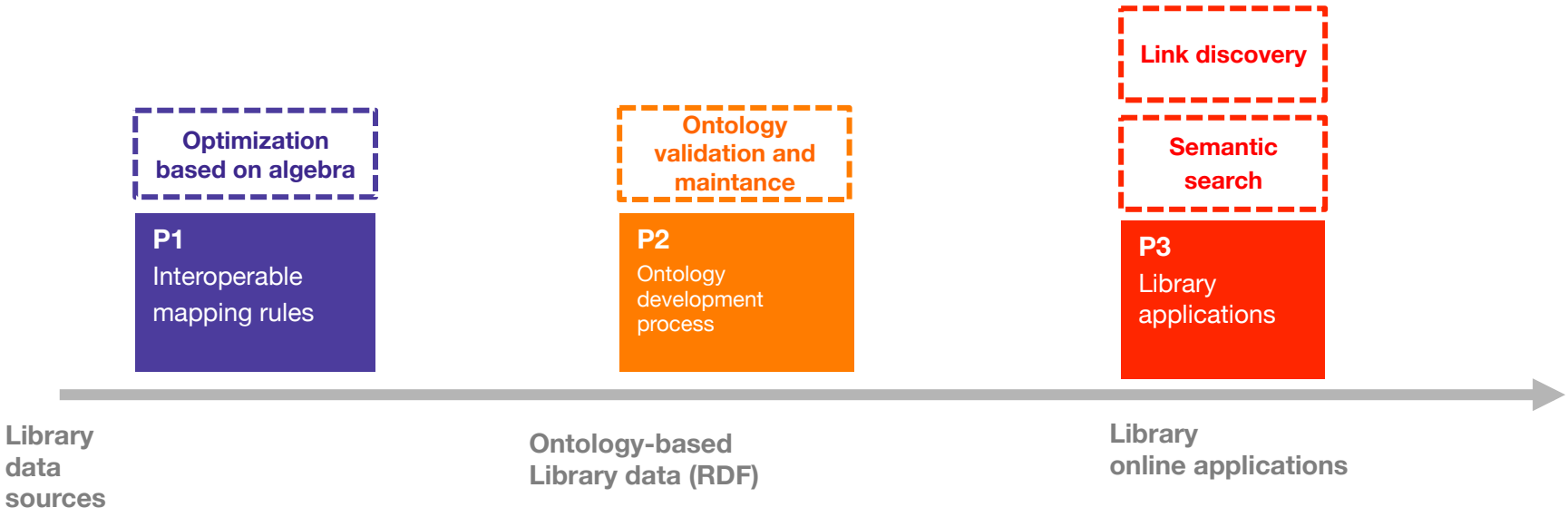
DATOS·BNE·es *beta

- **Discoverability**:
  - **45,000 visitors/month,** +1M visitors,
  - **Access** through **search engines to BNE catalogue has doubled**. Specially "**long-tail" queries**
- **Reusability**:
  - Used by **+10 third-party library projects**
  - **Wikidata**
  - **Street detective:** Fujitsu Laboratories of Europe Innovation Award 2015
- International **reference library LOD implementation**
- Library science **courses at Universities.**

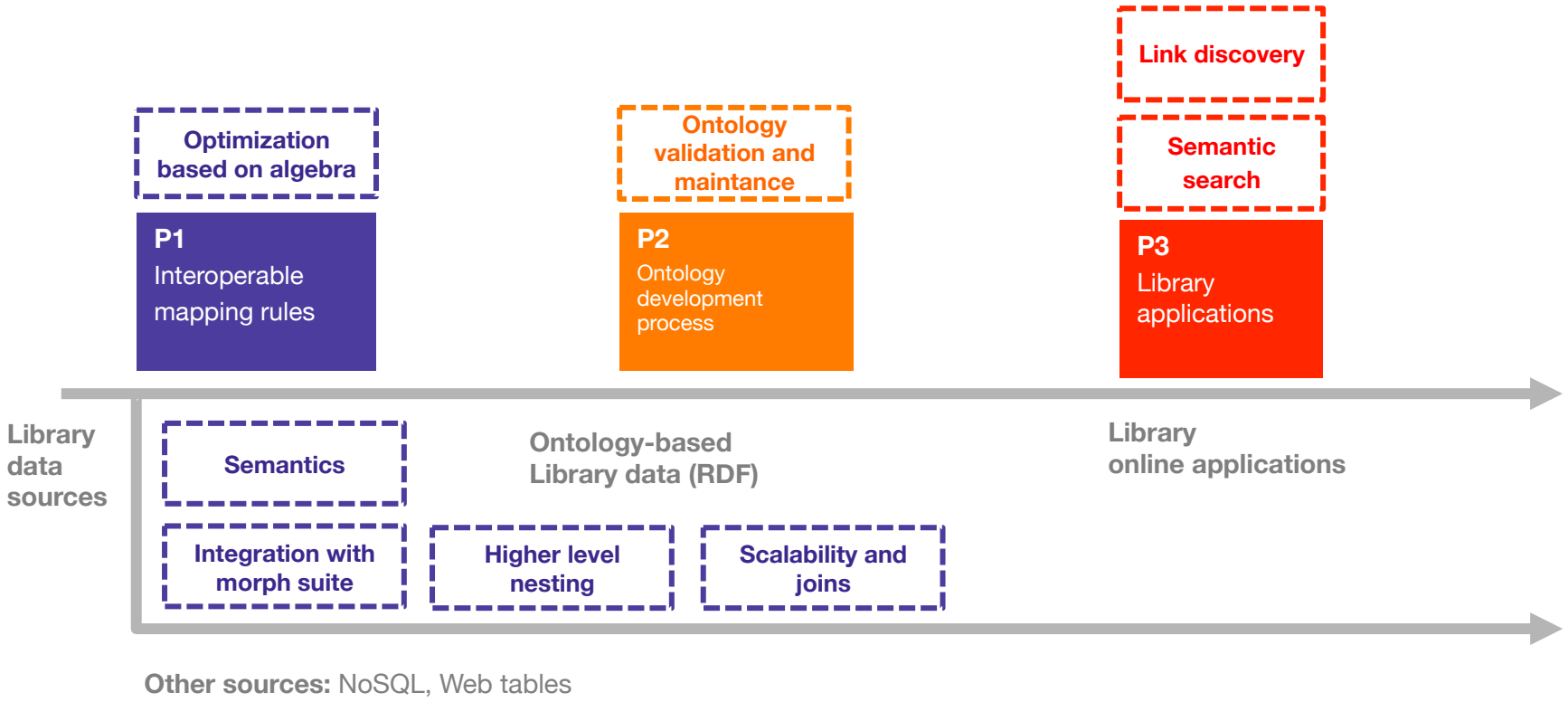
OTHER RESULTS

- **Technology transfer:**
  - **Commercial product:** deployed and licensed to BNE.
  - Requested by +**20 libraries world-wide.**
  - **Diploma** to one of the **best business ideas UPM 2016** (ActuaUPM).
- **Scientific value:**
  - Reference **methodological guidelines**.
  - Topic of **+10 invited talks** and **keynotes** at major library events (e.g., LODLAM summit, EuropeanaTech, SWIB 2012 and 2015).

FUTURE DIRECTIONS



FUTURE DIRECTIONS



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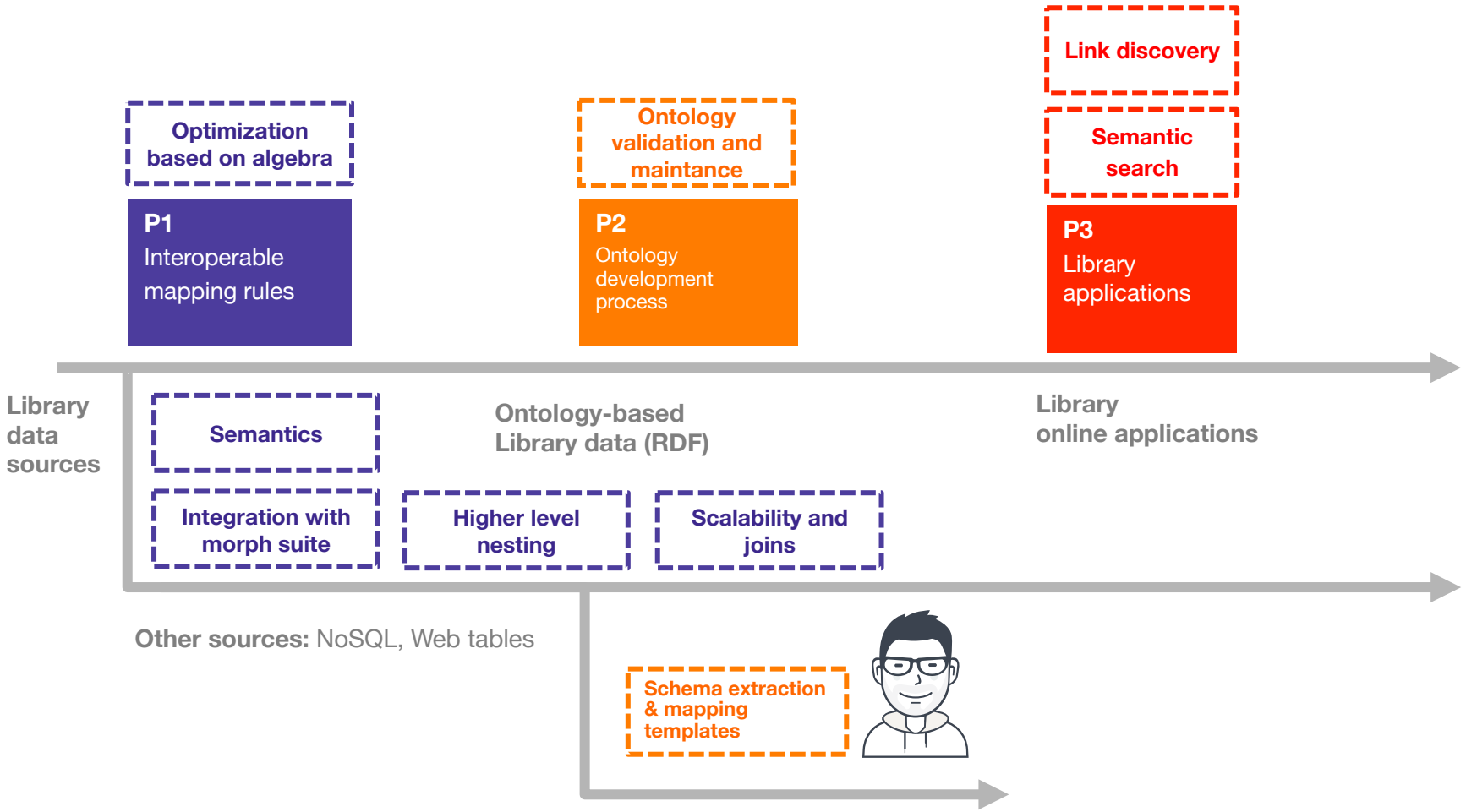

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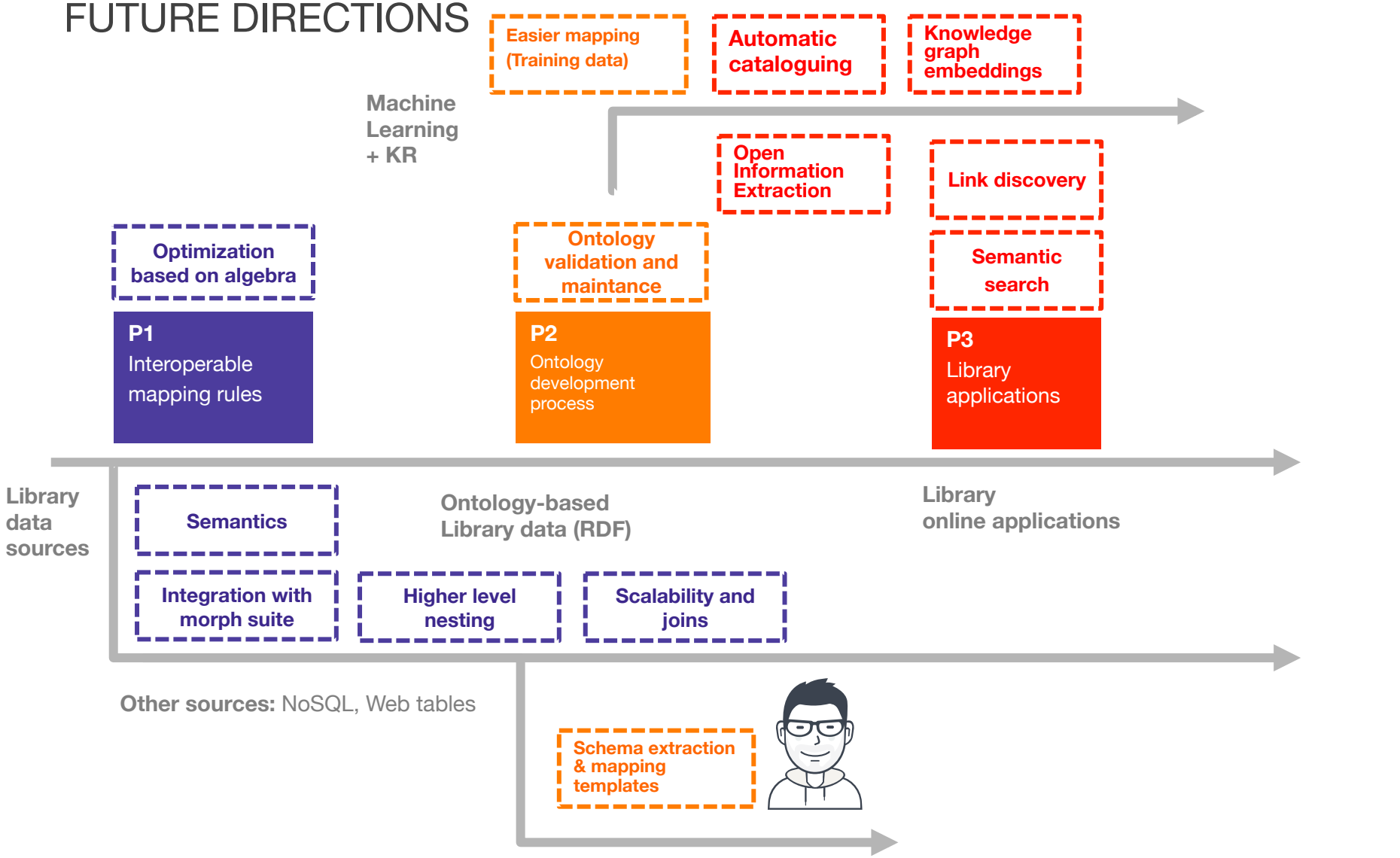

SELECTED PUBLICATIONS

- **JOURNAL ARTICLES**
  - **Daniel Vila-Suero** and Asunción Gómez-Pérez. datos.bne.es and marimba: an insight into library linked data. Library Hi Tech, 31(4):575–601, 2013.
  - **Daniel Vila-Suero**, Boris Villazón-Terrazas, and Asunción Gómez-Pérez. datos.bne.es: A library linked dataset. Semantic Web Journal, 4(3):307–313, 2013.
- **INTERNATIONAL CONFERENCES**
  - Ricardo Santos, Ana Manchado, and **Daniel Vila-Suero**. Datos.bne.es: a LOD service and a FRBR-modelled access into the library collections. In IFLA World Library International Conference. Cape Town, South Africa, 2015.
  - **Daniel Vila-Suero**, Víctor Rodríguez-Doncel, Asunción Gómez-Pérez, Philipp Cimiano, John McCrae, and Guadalupe Aguado-de Cea. 3ld: Towards high quality, industry-ready linguistic linked linguistic data. European Data Forum 2014, 2014.
  - Asunción Gómez-Pérez, **Daniel Vila-Suero**, Elena Montiel-Ponsoda, Jorge Gracia, and Guadalupe Aguado-de-Cea. Guidelines for multilingual linked data. In 3rd International Conference on Web Intelligence, Mining and Semantics, WIMS '13, Madrid, Spain, June 12-14, 2013, page 3.
- **OTHER**
  - **Daniel Vila-Suero**, Asunción Gómez-Pérez,Elena Montiel-Ponsoda, Jorge Gracia, and Guadalupe Aguado-de-Cea. Publishing linked data on the web: The multilingual dimension. In Paul Buitelaar and Philipp Cimiano, editors, Towards the Multilingual Semantic Web, pages 101–117. Book chapter. Springer Berlin Heidelberg. 2014
  - **Daniel Vila-Suero**. W3C Library Linked Data Incubator Group: Use cases Report. 2011.

RESEARCH STAYS

- **INRIA** 2012 (3 months) and 2013 (2 months)
- **Knowledge Management Institute, Open University, UK:** 2012, 1 month working on linked data applications

A FRAMEWORK FOR ONTOLOGY-BASED LIBRARY DATA GENERATION, ACCESS AND EXPLOITATION

Daniel Vila Suero

Advisors:
Prof. Dr. Asunción Gómez-Pérez and Dr. Jorge Gracia del Río

PhD in Artificial Intelligence,
Defense, Madrid, 27th of July 2016