# Ontology-based data integration in EPNet

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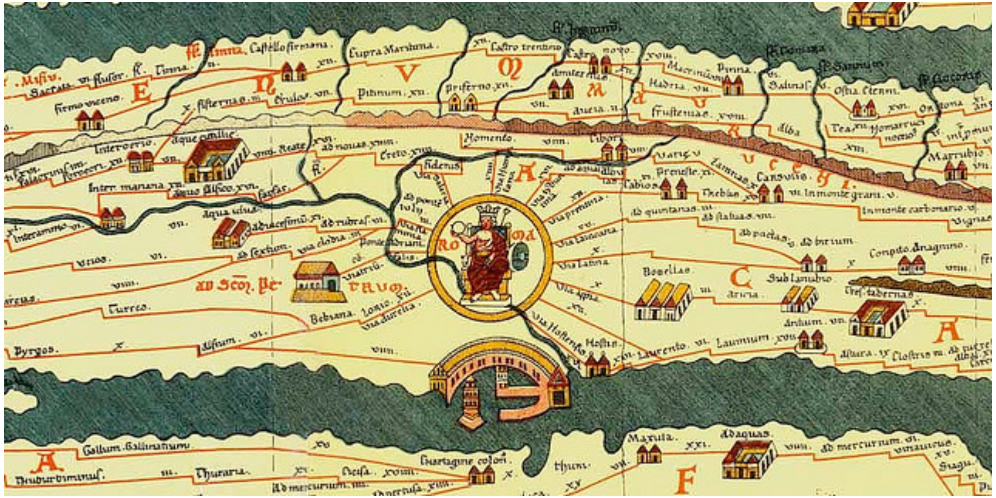
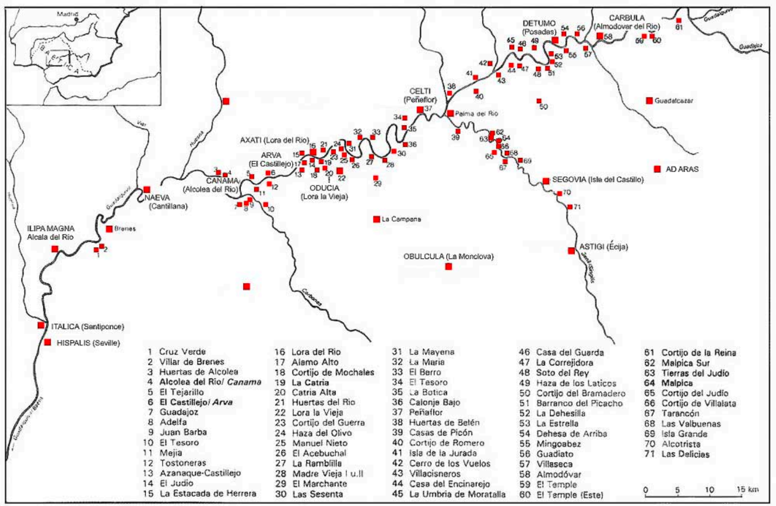
FAIR Heritage (Virtual meeting) - June 17, 2020

The Roman Empire trade system

# The first complex European trade network

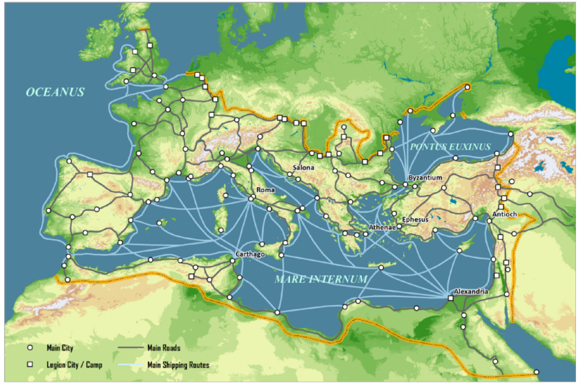


Tabula Peutingeriana
©Austrian National Library




Dressel 20 Kiln Sites @Lower Guadalquivir Valley (Remesal, 1997)

“An integrated network of interactions and interdependences between the Mediterranean basin and northern Europe”




The Roman Empire transport system (c.125 AD)
[http://people.hofstra.edu/](http://people.hofstra.edu/)

# The economy of the Roman Empire

## An ongoing debate!

- Traditionally, the study of the food distribution during the Roman Empire was focused on the life of the city of Rome and on the long distance trade. More recently, the food distribution to the Roman army also gained a primary role in the overall understanding of the Roman Empire trade system.

- It has been argued that the emperor and his circle managed the relationship between food and army in order to supervise and control the whole Roman territory and to strengthen and maintain their own political power.

- Periphery and regional food distribution then obtain the status of first-class citizens in the understanding of the whole system.

- Starting from this innovative idea, different models have been proposed.

House of Julia Felix @Pompeii

# Informal approaches are too informal...



- A plethora of unfalsifiable theories has been developed over the last couple of centuries to explain the organisation of the Roman Empire trade system.

- The ongoing debate remains exclusively speculative and often based on rhetoric.

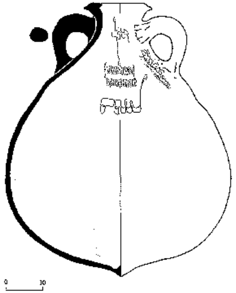
- Specialists from History and Archaeology do not even consider the possibility that their hypotheses can be formally expressed as theories that can be falsified[1] by analytical and computational methods.

[1] Popper, Karl, *The Logic of Scientific Discovery*, Basic Books, New York, NY, 1959

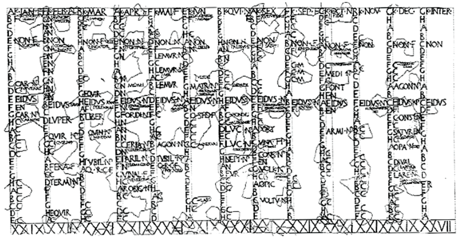
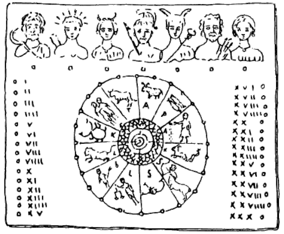
- A formal study of the mechanisms that have characterised the economic and political relations informing the Roman Empire trade system was still missing.

# The data landscape


Edible items: olive oil, wine, etc.

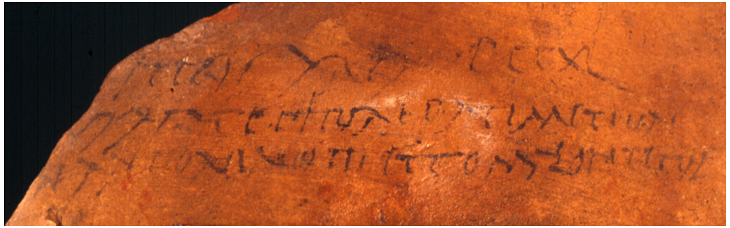


Containers

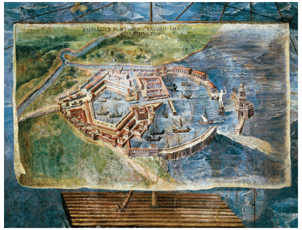
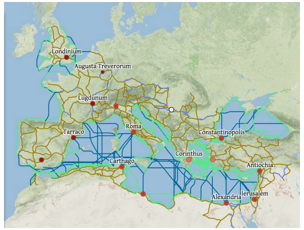
Temporal context: production, distribution, etc.

Production places





Inscriptions: stamps and *tituli picti*


Distribution target places


Producers and Traders

# Multiple datasets, physically distributed

25701 Roma | 25700 Ostia Anti... | 15505 Bardon Mil... | 15505 Bardon Mil... | 15491 Corbridge

15492 Corbridge | 15493 Corbridge | 15494 Corbridge | 15495 London | 15495 London

## Baetis/Certis (river)

a Pleiades place resource

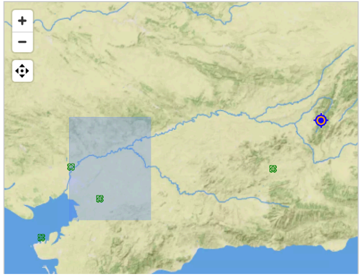
Creators: Jr., F.H. Stanley, R.C. Knapp
Contributors: R. Warner, R. Talbert, Sean Gillies, Tom Elliott, Jeffrey Becker

Last modified Jun 13, 2019 11:05 AM — History

**The Guadalquivir river is the fifth longest of the Iberian peninsula.**

**Canonical URI for this page:**
https://pleiades.stoa.org/places/256010

**Representative Point (Latitude, Longitude):**
37.969207, -2.910335



**Locations:**

- Barrington Atlas location (750 BC - AD 640)
- location of course of Baetis/Certis fl. (modern)

**Names:**

- *Baetis* (750 BC - AD 640)
- *Certis* (AD 300 - AD 640)
- *Perkes* (unspecified date range)

**Baetis/Certis (river) makes connections with:**

- Baetis/Certis (river) ➡ connection ➡ Atlanticus Oceanus (unspecified date range)

**Baetis/Certis (river) receives connections from:**

- Unnamed Bridge ➡ on ➡ Baetis/Certis (river) (30 BC - AD 300)
- Ligustinus L. ➡ connection ➡ Baetis/Certis (river) (unspecified date r
- Guadaíra (river) ➡ connection ➡ Baetis/Certis (river) (modern)
- Singilis (river) ➡ connection ➡ Baetis/Certis (river) (unspecified date r
- Ilipa Magna ➡ on ➡ Baetis/Certis (river) (30 BC - AD 300)
- Anatolikon Stoma ➡ connection ➡ Baetis/Certis (river) (unspecified c
- Baetis Aestuaria ➡ connection ➡ Baetis/Certis (river) (unspecified da

**Place type:**
river, drainage

## Dressel 20

previous amphora type | next amphora type

details | characteristics | pictures | drawings | petrology | specimens | bibliography | 3D models

**Variants of *Dressel 20*:**
[*Dressel 20 similis - Oliva 3*] [*Gauloise 14*]

**Distinctive Features**
This has a large globular body with thick, sharply bent or oval shaped handles; short neck often with an internally concave rim and a small basal knob. This form clearly developed from the Augustan prototype Oberaden 83 and eventually evolved into the smaller Tejarillo 1. A broad scheme for the evolution of the Dressel 20 rim has been suggested by Berni (1998), provided under 'Drawings'. This form is commonly stamped towards the summit of the handle, with the name in relief set in a rectangular frame. This is usually an abbreviated name of an individual, presumably the estate owner although place-names are also encountered (Remesal Rodríguez, 1986). It also includes complex painted inscriptions indicating amphora weights and individuals responsible for transport and control (Rodriguez Almeida, 1984). From the third century there is evidence of imperial ownership of some of these estates.
See characteristics

*Courtesy of Museu Arqueológico de Sevilla (Dr. Fernando Fernández Gómez) Simon Keay*

**Date Range**
The typical globular form was introduced by at least the Tiberian period (Xanten) and became established by the Claudian period (Colls *et alii*, 1977). Production continued up to the second half of the third century (Zevi, 1967, Blázquez Martínez & Remesal Rodríguez, 1999; 2001; 2003) (Monte Testaccio). In the western provinces it is the most common amphora from the late first to the early third centuries AD (Williams & Peacock, 1983, Remesal Rodríguez, 1986).
***Search:*** [1st century AD] [2nd century AD] [3rd century AD]

**Origin**
Along the banks of the river Guadalquivir and its tributaries between Seville and Córdoba in the Roman province of *Baetica* (Clark-Maxwell, 1899; Bonsor, 1931; Ponsich, 1974, 1979, 1991; Chic, 2001) in southern Spain, where kiln sites have been discovered (Click to map in Introduction). A graffito from Carlisle reads ESVRI (Vila Real de São Antonio) on the Algarve of Portugal (Mann, 1955), but the fabric is identical to the Spanish material. The vessel was imitated in Hispania *Tarraconensis*, along the coastal strip of *Baetica* and in *Germania* (Baudoux, 1996; Ehmig, 2003).
***Search:*** [North West Europe] [Spain] [Western Mediterranean]

HEIDELBERGER AKADEMIE DER WISSENSCHAFTEN
EPIGRAPHIC DATABASE HEIDELBERG

| number 1 | |
|---|---|
| HD no. | ↗ HD000165 (newer version at: ↗ EDR) |
| work status | checked with photo |
| province / Italic region | Etruria (Regio VII) |
| modern country | Italy |
| ancient find spot | Falerii (Novi), bei |
| modern find spot | |
| find spot (village, street, etc.) | |
| year | 231 AD – 300 AD |
| literature | AE 1982, 0274. (B)<br>AE 1983, 0059. (B)<br>I. Di Stefano Manzella, Supplt 1 (Roma 1981) 143-144, Nr. 21; Foto. - AE 1982.<br>L. Polverini, in: G. Barbieri (Hrsg.), Il lapidario Zeri di Mentana (Roma 1982) 104-105, Nr. 46; tav. 42. - AE 1983. |
| Transcription | D(is) M(anibus) s(acrum) / Aurelio Saturnino / militi torquato legionis / primes(!) Italic(a)e qui vix/sit(!) an(n)is XL messibus(!) VI / diebus X militavit / annis XIIII / Aurelius Arborius / fratri bene mer/enti fecit |

# The available datasets are heterogenous

(both conceptually and technically)

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            </layout>
        </layoutDesc>
    </objectDesc>
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            </dimensions>
        </handNote>
    </handDesc>
</physDesc>
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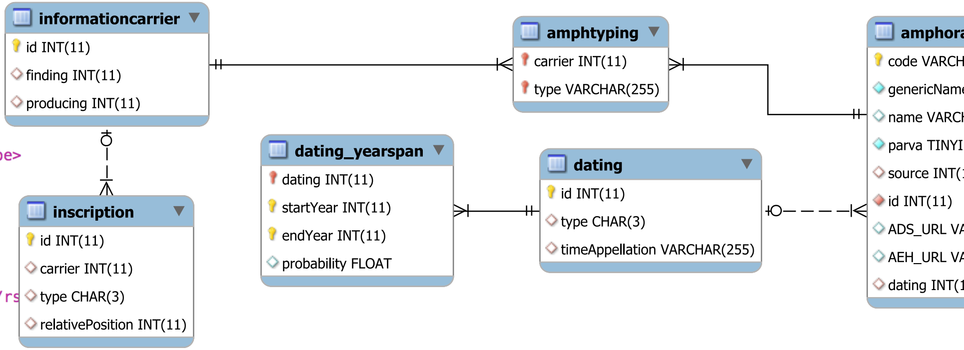
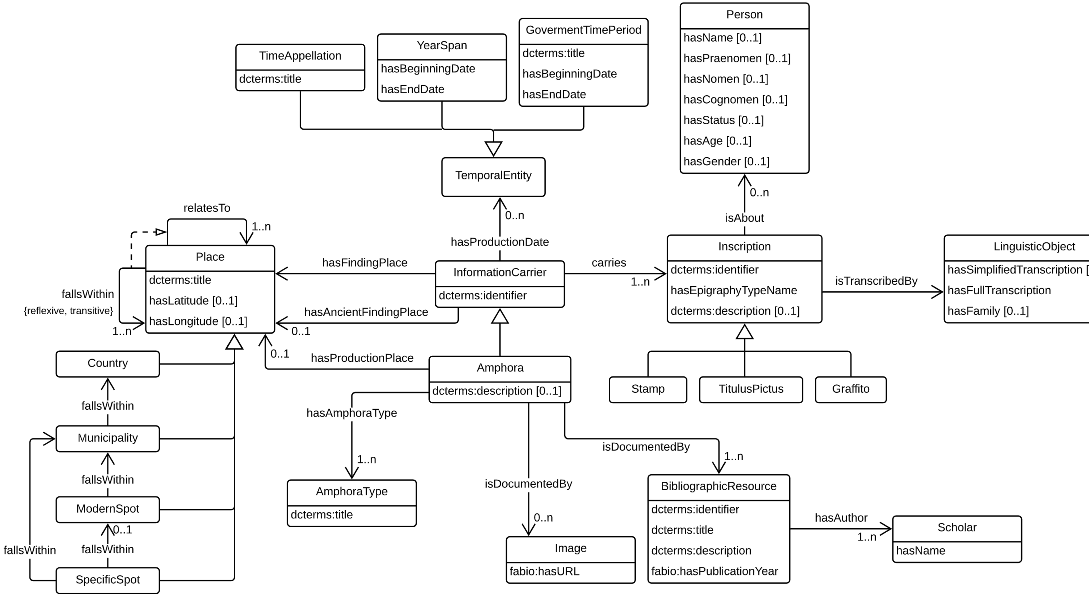
            placeName><placeName ref="http://www.trismegistos.org/place/014437">Cun
        <origDate notBefore-custom="0071" notAfter-custom="0130" datingMethod="http
            AD
        </origDate>
    </origin>
    <provenance type="found">

    <placeName ref="http://www.geonames.org/">Cuma, bei</placeName><placeName type=
        www.geonames.org/">Campania</placeName><placeName type="modernCountry" ref=
        placeName></provenance>
</history>
```



“I am looking for all the amphoras of type Dressel 20 (information carriers) produced in the settlement of Malpica, together with all the available information about their physical characteristics, dating and carried inscriptions, in all the available datasets. ”

# Relational model: Example

InformationCarrier

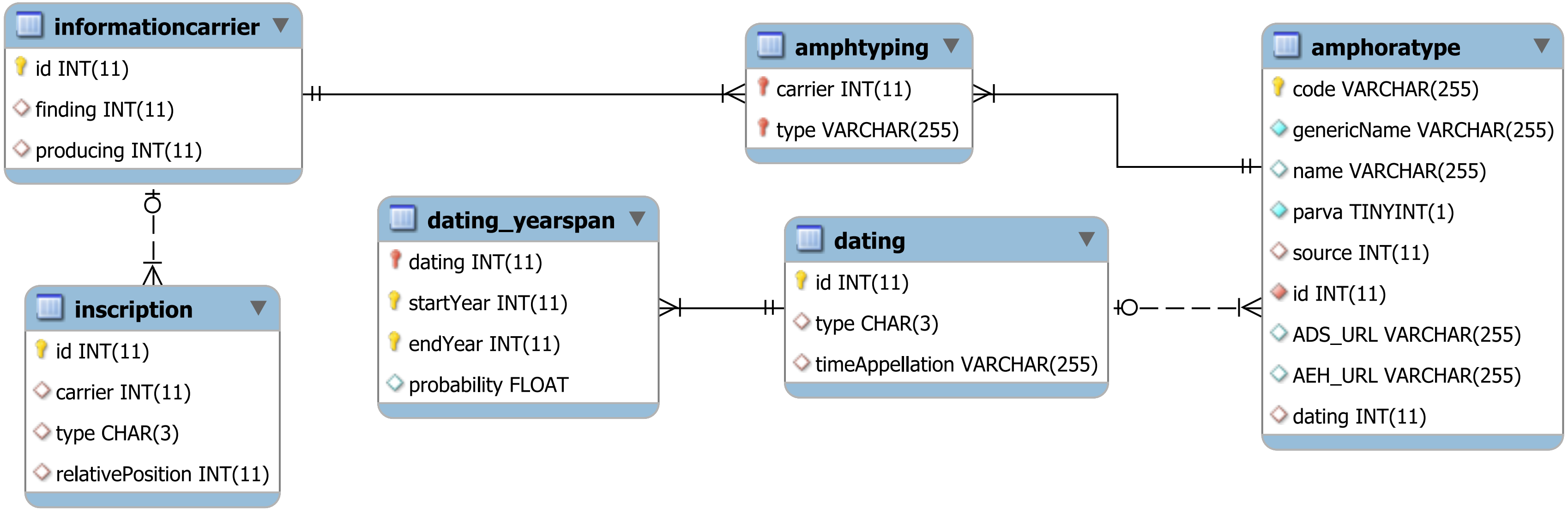
| carrierId | finding | producing |
|---|---|---|
| C234 | 'Monte Testaccio' | **null** |
| C678 | 'Hispalis' | 'Malpica' |
| C449 | **null** | 'Malpica' |

AmphTyping

| carrierId | finding |
|---|---|
| C234 | 'Monte Testaccio' |
| C678 | 'Hispalis' |
| C449 | **null** |

AmphoraType

| typeCode | genericName | name | source | … |
|---|---|---|---|---|
| T15 | Dressel | Dressel 20 | **null** | … |
| T09 | Africano grande | Africana 2C | S25 | … |



# SQL queries: Example

- SQL is the standard language for querying relational databases.
- The core of SQL corresponds to relational algebra, a well-studied formalism.

| | ic_id integer | d_id integer | sy integer | ey integer |
|---|---|---|---|---|
| 1 | 1 | 1 | -200 | -150 |
| 2 | 13 | 7 | 41 | 54 |
| 3 | 17 | 8 | 216 | 223 |
| 4 | 17 | 8 | 214 | 214 |
| 5 | 84 | 9 | 216 | 223 |
| 6 | 84 | 9 | 214 | 214 |
| 7 | 198 | 10 | 216 | 223 |
| 8 | 198 | 10 | 214 | 214 |
| 9 | 212 | 11 | 216 | 223 |

“Return the amphoras and the date when they were produced”

```
SELECT
    ic.id AS ic_id, d.id AS d_id, dys.startYear AS sy,
    dys.endYear AS ey
FROM
    InformationCarrier ic
    JOIN Producing p ON ic.producing = p.id
    JOIN Dating d ON p.dating = d.id
    JOIN DatingYearSpan dys ON dys.dating = d.id
```

# When can this go wrong?

To query this information and obtain the desired answers requires:

- To have a have deep understanding of the datasets.
- To create the proper queries that extract all information about each type of object from each dataset is a complex task even for experts.
- To merge the answers returned from each dataset, possibly filtering out undesired objects or undesired parts of the answers (e.g., the objects that were not produced in ‘Malpica’).
- To query multiple data sources, one can use a *data federation tool*, which exposes multiple data sources as if they were a single relational database (e.g., Teiid, Exareme) but…

Scholars can easily get lost!

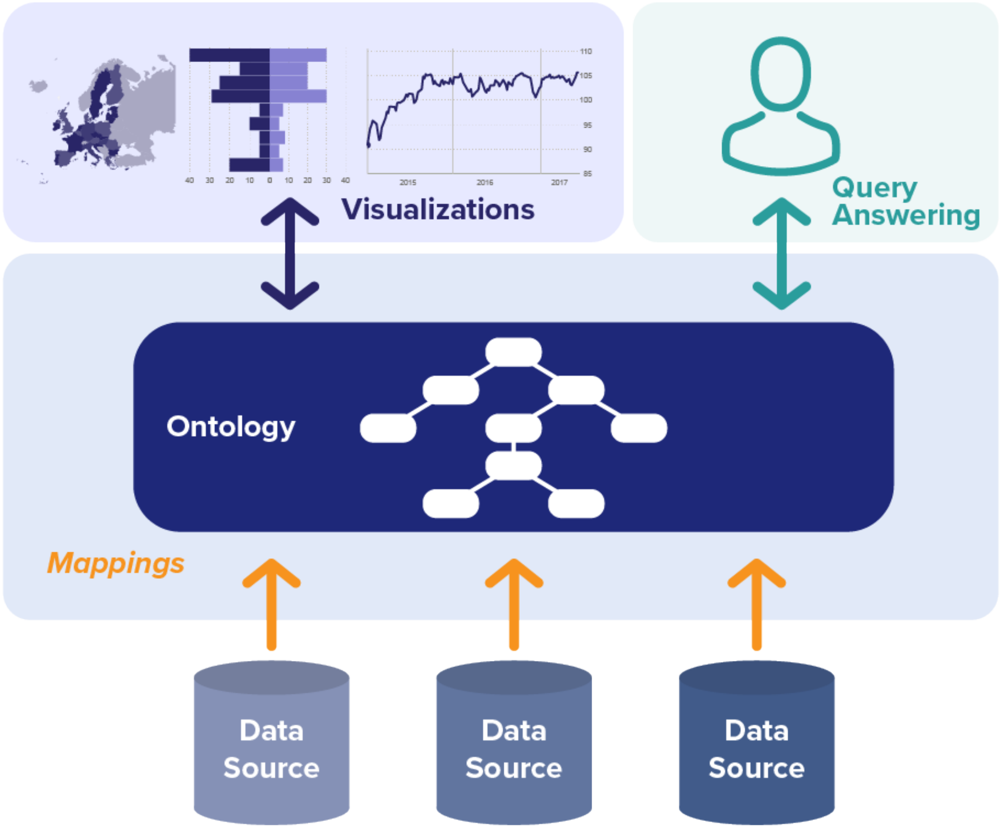
# The way we tackle the problem

- Exploit the knowledge that scholars have about the domain, and make this knowledge and its associated vocabulary explicit
  ↪ Ontology

- Provide a good understanding of the source data by connecting it to the domain knowledge
  ↪ Mappings

- Enable scholars to rapidly formulate intuitive queries using the ontology (which provides a familiar vocabulary and conceptualisations), and not the data sources.

# Ontology-based data integration (OBDI)




**Ontology**
provides a unified common vocabulary, and a conceptual view of the data.
- OWL 2 QL

**Mappings**
relate the terms in the ontology to the data in the sources by means of queries.
- R2RML

**Data sources**
are external and independent (possibly heterogeneous).
- Oracle, DB2, Postgres, MySQL, etc.

# Ontologies in Computer Science

Ontologies (in Computer Science):

- are used to represent a domain of interest in a way that is comprehensible to end users
- allow for efficient processing by machines, to infer new information from the one explicitly represented.

Ontology languages:

- Are grounded in mathematical logic, which makes them rigorous and not ambiguous.
- Are equipped with a formal syntax, which tells us how to write expressions in the languages:
  - logic based (e.g., $\exists carries^{-} \sqsubseteq Inscription$)
  - serialised and text-based (e.g., :carries rdf:range :Inscription)
  - diagrammatic/graphic.
- Have a formal semantics, usually provided in terms of logic.

In ontologies, the knowledge is structured into:

- Classes of objects (e.g., Inscription, Finding)
- Properties of class instances (e.g., name, startYear)
- Relationships between classes (e.g., hasShapeType between Stamp and ShapeType)
- Properties of relation instances

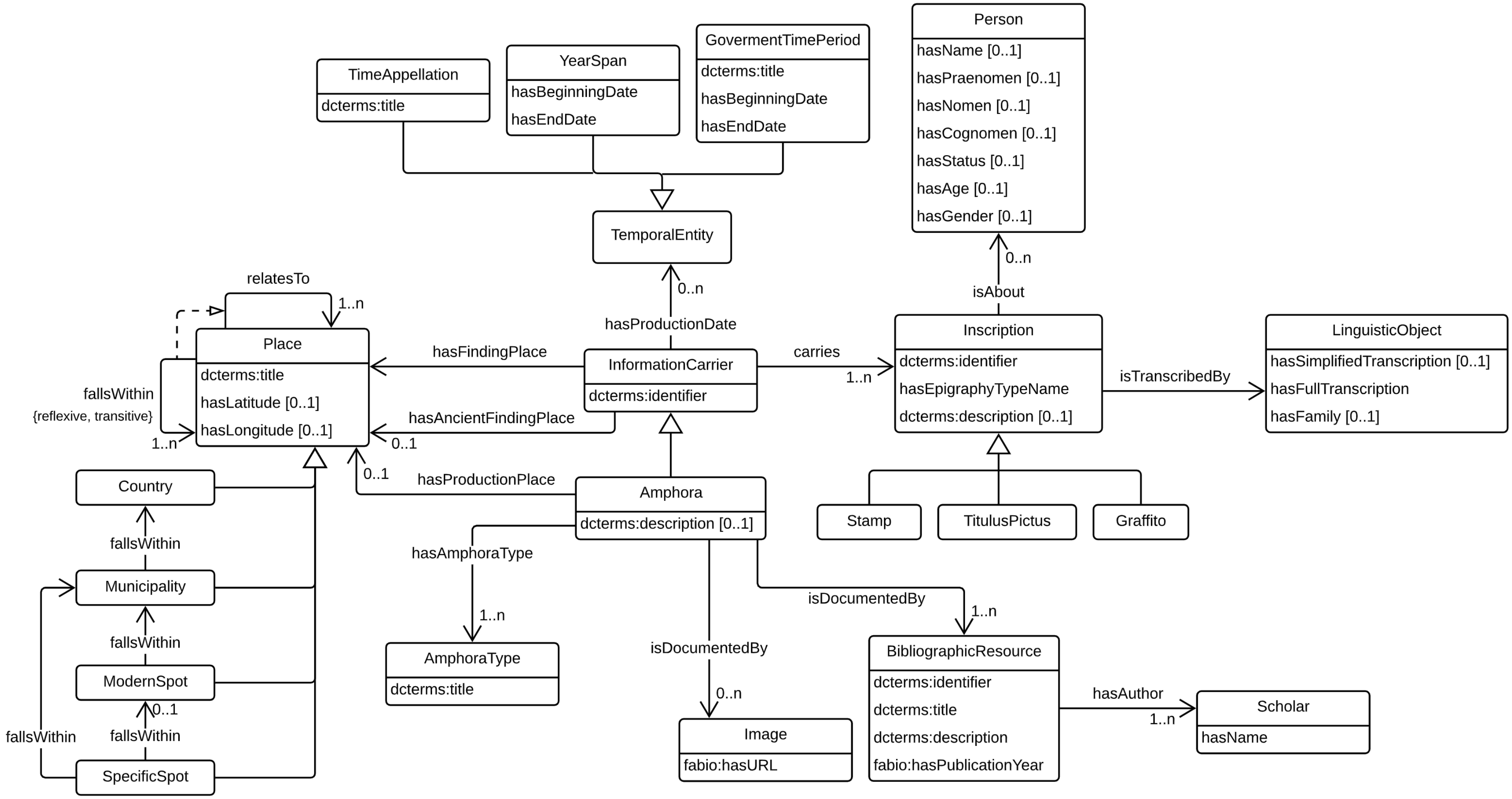
The knowledge about the domain is the stated by means of (logical) assertions.

# Ontology development in EPNet

In EPNet, the OBDI team working on the ontological modelling, has made use of this correspondence:

- They have developed the EPNet Conceptual Reference Model (CRM), an extensive conceptual model that *integrates* and *specialise* already existing ontologies and standards for the representation of historical data (e.g., CIDOC CRM, the EAGLE metadata model, and FaBiO).

- Using a domain-oriented vocabulary (made of terms like “inscription”, “stamp”, “simple” and “full transcription”, “grafito”, etc.), they have build a ontology expressed in the lightweight ontology language OWL 2 QL




https://romanopendata.eu/sparql/doc/index.html

# Query answering over ontologies

- When a query is posed over the ontology, the OBDI system can reason over the knowledge in the ontology to provide more answers.
- This is achieved by rewriting the query posed by the user into a new query, that is then further processed.
- This new query incorporates the knowledge provided by the ontology (the ontology is compiled into the query).

**Query answering by rewriting**

# Query answering by rewriting: Example

Query: $\mathsf{q}(x) \leftarrow \mathsf{worksFor}(x, y), \mathsf{Project}(y)$

Data: $\mathsf{worksFor}(\mathtt{jose}, \mathtt{epnet})$ $\mathsf{Coordinator}(\mathtt{jose})$
$\mathsf{worksFor}(\mathtt{martin}, \mathtt{ontop})$ $\mathsf{Coordinator}(\mathtt{diego})$

# Query answering by rewriting: Example

Ontology:

$$\mathsf{Coordinator} \sqsubseteq \mathsf{Researcher}$$
$$\mathsf{Researcher} \sqsubseteq \exists\mathsf{worksFor}$$
$$\exists\mathsf{worksFor}^{-} \sqsubseteq \mathsf{Project}$$

Corresponding rules:

$$\mathsf{Coordinator}(x) \rightarrow \mathsf{Researcher}(x)$$
$$\mathsf{Researcher}(x) \rightarrow \exists y(\mathsf{worksFor}(x, y))$$
$$\mathsf{worksFor}(x, y) \rightarrow \mathsf{Project}(y)$$

Query: $\mathsf{q}(x) \leftarrow \mathsf{worksFor}(x, y), \mathsf{Project}(y)$

Perfect rewriting:

$$\mathsf{q}(x) \leftarrow \mathsf{worksFor}(x, y), \mathsf{Project}(y)$$
$$\mathsf{q}(x) \leftarrow \mathsf{worksFor}(x, y), \mathsf{worksFor}(\_, y)$$
$$\mathsf{q}(x) \leftarrow \mathsf{worksFor}(x, \_)$$
$$\mathsf{q}(x) \leftarrow \mathsf{Researcher}(x)$$
$$\mathsf{q}(x) \leftarrow \mathsf{Coordinator}(x)$$

Data:

$\mathsf{worksFor}(\mathtt{jose}, \mathtt{epnet})$ $\mathsf{Coordinator}(\mathtt{jose})$

$\mathsf{worksFor}(\mathtt{martin}, \mathtt{ontop})$ $\mathsf{Coordinator}(\mathtt{diego})$

# Query answering by rewriting: Example

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Corresponding rules:

$$\mathsf{Coordinator}(x) \rightarrow \mathsf{Researcher}(x)$$
$$\mathsf{Researcher}(x) \rightarrow \exists y(\mathsf{worksFor}(x, y))$$
$$\mathsf{worksFor}(x, y) \rightarrow \mathsf{Project}(y)$$

Query: $\mathsf{q}(x) \leftarrow \mathsf{worksFor}(x, y), \mathsf{Project}(y)$

Perfect rewriting:

$$\mathsf{q}(x) \leftarrow \mathsf{worksFor}(x, y), \mathsf{Project}(y)$$
$$\mathsf{q}(x) \leftarrow \mathsf{worksFor}(x, y), \mathsf{worksFor}(\_, y)$$
$$\mathsf{q}(x) \leftarrow \mathsf{worksFor}(x, \_)$$
$$\mathsf{q}(x) \leftarrow \mathsf{Researcher}(x)$$
$$\mathsf{q}(x) \leftarrow \mathsf{Coordinator}(x)$$

Data: $\mathsf{worksFor}(\mathtt{jose}, \mathtt{epnet})$ $\quad$ $\mathsf{Coordinator}(\mathtt{jose})$
$\mathsf{worksFor}(\mathtt{martin}, \mathtt{ontop})$ $\quad$ $\mathsf{Coordinator}(\mathtt{diego})$

Evaluating the perfect rewriting over the ABox (seen as a DB) produces as answer $\{\mathtt{jose},\ \mathtt{martin},\ \mathtt{diego}\}$.

unibz

# Query answering by rewriting: Example

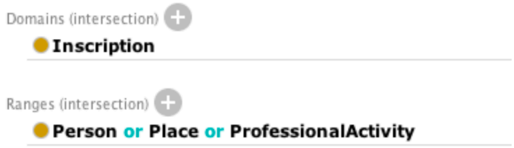
Suppose we want to query the Inscriptions in our database:

Select ?p WHERE { ?p rdf:type :Inscription .}

And our ontology says....

Subclasses of Inscription


Property `:isAbout`




*Suppose* that we only have mappings for `Stamp` and the property `IsAbout`

Without Reasoning there is no Answer!!!!!

# Query answering by rewriting: Example

- By looking at the mappings, we know that the original query returns no answer.
- By looking at the ontology we know that:
  - every stamp is an inscription
  - every element in the domain of `IsAbout` is an inscription.

So we can rewrite the original query as:

```
Select ?p WHERE {
{ ?p rdf:type :Stamp . }
UNION
{ ?p :isAbout ?y . }}
```

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# Mapping the data sources to the ontology

In an OBDI system, the mapping $\mathcal{M}$ encodes how the data $\mathcal{D}$ in the sources should be used to populate the elements of the ontology.

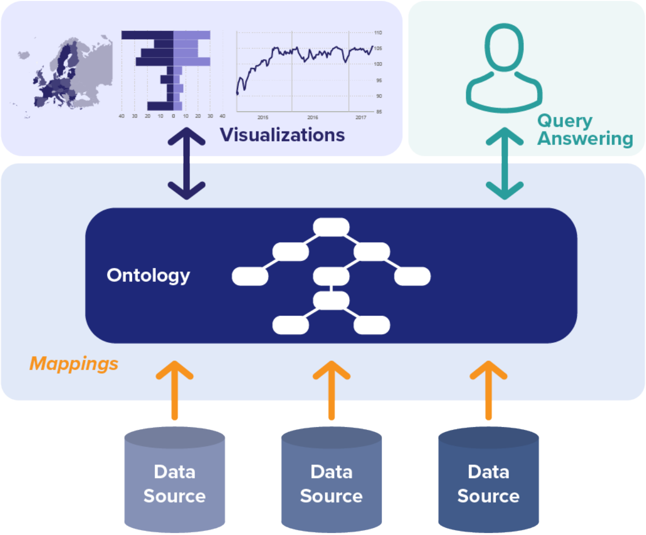
## Concrete mapping languages

- Several proposals for languages to map a relational DB to an ontology have been made:
- They assume that the ontology is populated in terms of triples of the RDF data model.
- Some template mechanism is used to specify the triples to instantiate.

**Virtual data layer**

The data $\mathcal{D}$ and the mapping $\mathcal{M}$ define a virtual data layer $\mathcal{V} = \mathcal{M}(\mathcal{D})$

- Queries are answered w.r.t. the ontology and $\mathcal{V}$.
- We do not really materialize the data of $\mathcal{V}$ (it is virtual!).
- Instead, the intensional information in the ontology and the mapping is used to translate queries over the ontology into SQL queries formulated over the sources.



# Virtual RDF graph

## The extensional counterpart of an ontology

In RDF, all data are represented by means of triples of the form: <subject, property, object>

- These triples form a so-called RDF graph, which is what the user actually queries.
- The mappings specify how to construct this virtual RDF graph from the data sources and the mappings .

$$\text{t}: \mathcal{L}(\text{t}(\boldsymbol{x})) \leftarrow \text{s}: \mathcal{Q}(\boldsymbol{x})$$

---

$C(t_1(\mathbf{x_1}))$, $p(t_1(\mathbf{x_1}), t_2(\mathbf{x_2}))$, or $d(t_1(\mathbf{x_1}), t_2(\mathbf{x_2})) \leftarrow$ **SQL** query over the DB schema

Through the mapping, each result row returned by the SQL query in the right-hand side generates a triple in the virtual RDF graph according to the triple template.

# Virtual RDF graph: Example

AmphoraT

| amId | place | inscription |
|---|---|---|
| A24 | 'Monte Testaccio' | ‘PNN' |
| A52 | 'Hispalis' | ‘ARVA' |

Mappings:

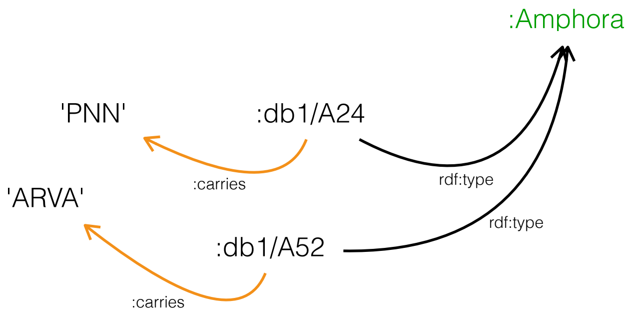
(:db1/{id}, rdf:type, :Amphora) ← `SELECT amId AS id FROM AmphoraT`

(:db1/{id}, :carries, {inscription}) ← `SELECT amId AS id, inscription FROM AmphoraT`

# Virtual RDF graph: Example

AmphoraT

| amId | place | inscription |
|---|---|---|
| A24 | 'Monte Testaccio' | ‘PNN' |
| A52 | 'Hispalis' | ‘ARVA' |




Mappings:

(:db1/{id}, rdf:type, :Amphora) ← `SELECT amId AS id FROM AmphoraT`

generates the triples: (:db1/A24, rdf:type, :Amphora),
(:db1/A52, rdf:type, :Amphora)

(:db1/{id}, :carries, {inscription}) ← `SELECT amId AS id, inscription FROM AmphoraT`

generates the triples: (:db1/A24, :carries, 'PNN')
(:db1/A52, :carries, 'ARVA')

# Using the mappings in OBDI: “Entity linking” Example

Suppose that we want now to extract the place of amphoras from a different data source:

- We need to combine the answers coming from different data sources.
- The different data sources might adopt different identifiers for data representing the same objects.

AmphoraT

| amId | place | inscription |
|---|---|---|
| A24 | 'Monte Testaccio' | ‘PNN' |
| A52 | 'Hispalis' | ‘ARVA' |

PlaceT

| amphId | place |
|---|---|
| pl-A24 | 'Monte Testaccio' |
| pl-A52 | 'Hispalis' |

Generating the same URI (i.e., RDF identifier):

(:db1/{id},:hasPlace, :db3/{place}) ← `SELECT` *`stringOp`*`(amphId) AS id, place FROM PlaceT`

where *stringOp* is a suitable string operation that, e.g., deletes the ’pl-’ prefix from the amphora identifier.

The mappings can be used to link the entities extracted from the different data sources, so that at the level of the ontology they can be recognised as representing the same object.

# Using the mappings in OBDI: Example

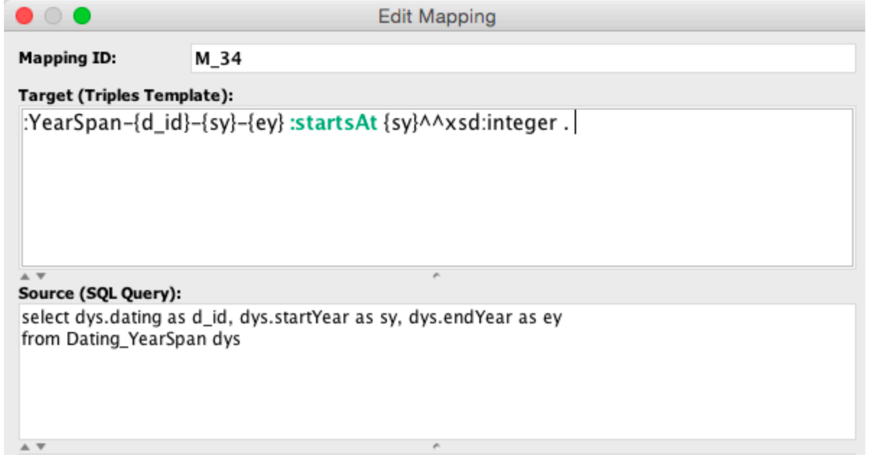
## Customising the data access


We classify the time periods by *imperial dynasties*.

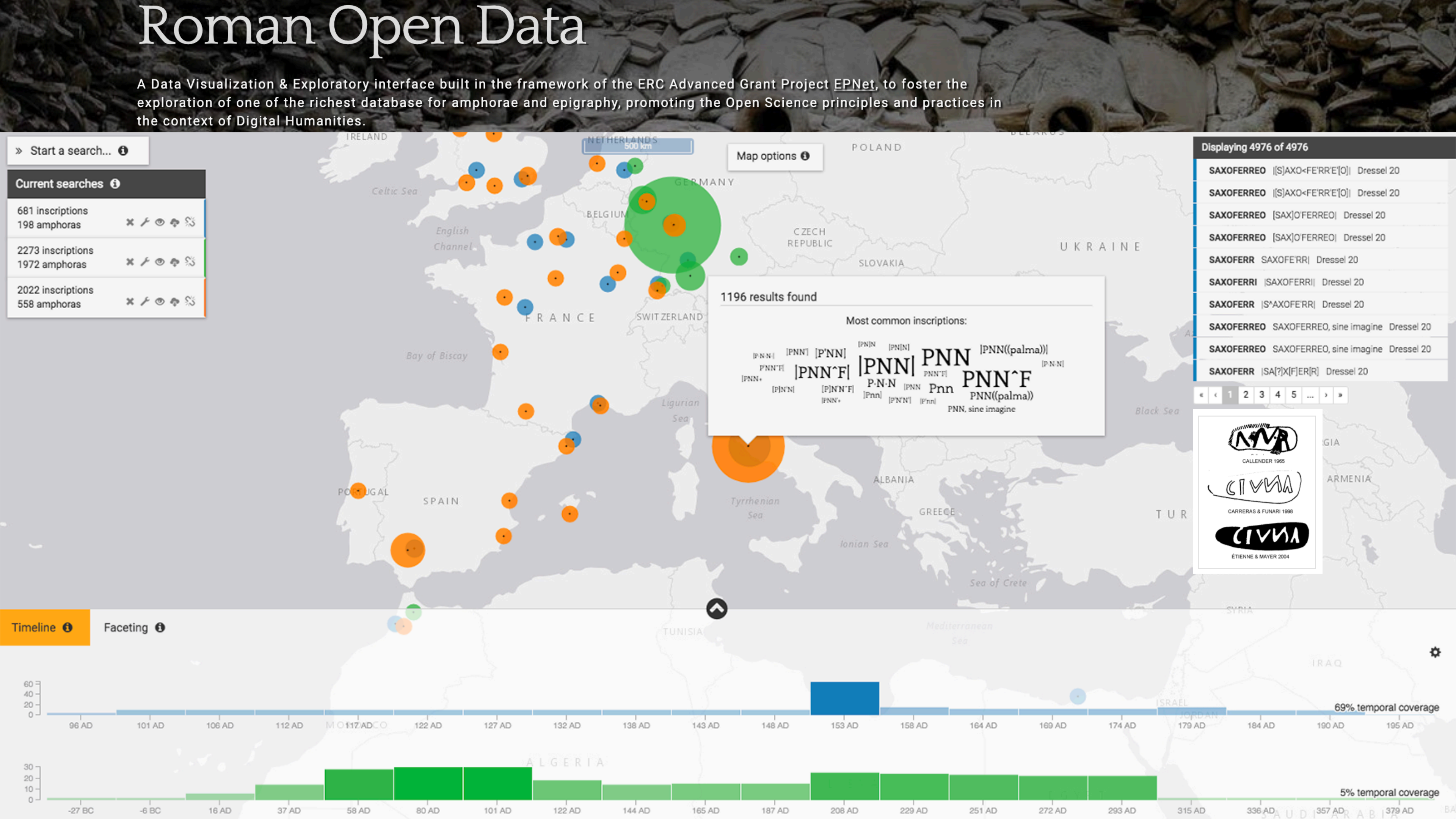
- For instance, Caligula-Government is defined as (startYear >= 37 and endYear <= 41).

Now, we can query a government instead of integers.

## Homogenising data




We homogenise all the *dates* in the different databases: integer, strings, or date, etc.


Roman Open Data
A Data Visualization & Exploratory interface built in the framework of the ERC Advanced Grant Project EPNet, to foster the exploration of one of the richest database for amphorae and epigraphy, promoting the Open Science principles and practices in the context of Digital Humanities.
Start a search...
Current searches
681 inscriptions
198 amphoras
2273 inscriptions
1972 amphoras
2022 inscriptions
558 amphoras
Map options
Displaying 4976 of 4976
SAXOFERREO |[S]AXO<FE'R'R'E'[O]| Dressel 20
SAXOFERREO |[S]AXO<FE'R'R'E'[O]| Dressel 20
SAXOFERREO |[SAX]O'FERREO| Dressel 20
SAXOFERREO |[SAX]O'FERREO| Dressel 20
SAXOFERR SAXOFE'RR| Dressel 20
SAXOFERRI |SAXOFERRI| Dressel 20
SAXOFERR |S^AXOFE'RR| Dressel 20
SAXOFERREO SAXOFERREO, sine imagine Dressel 20
SAXOFERREO SAXOFERREO, sine imagine Dressel 20
SAXOFERR |SA[?]X[F]ER[R]| Dressel 20
1196 results found
Most common inscriptions:
|PNN| PNN PNN^F |PNN^F| |PNN((palma))| PNN((palma)) PNN, sine imagine Pnn P·N·N
CALLENDER 1965
CARRERAS & FUNARI 1998
ÉTIENNE & MAYER 2004
Timeline
Faceting
69% temporal coverage
5% temporal coverage
96 AD 101 AD 106 AD 112 AD 117 AD 122 AD 127 AD 132 AD 138 AD 143 AD 148 AD 153 AD 158 AD 164 AD 169 AD 174 AD 179 AD 184 AD 190 AD 195 AD
-27 BC -6 BC 16 AD 37 AD 58 AD 80 AD 101 AD 122 AD 144 AD 165 AD 187 AD 208 AD 229 AD 251 AD 272 AD 293 AD 315 AD 336 AD 357 AD 379 AD
IRELAND
NETHERLANDS
POLAND
GERMANY
BELGIUM
CZECH REPUBLIC
SLOVAKIA
UKRAINE
FRANCE
SWITZERLAND
SPAIN
PORTUGAL
ALBANIA
GREECE
Celtic Sea
English Channel
Bay of Biscay
Ligurian Sea
Tyrrhenian Sea
Ionian Sea
Black Sea
Sea of Crete
ARMENIA
TUNISIA
ALGERIA

CEIPAC Dataset Explorer | Map view | Table view | Gallery view | SPARQL Endpoint

» Start a search...

Current searches

681 inscriptions
198 amphoras

2273 inscriptions
1972 amphoras

2022 inscriptions
558 amphoras

Browsing 24 images so far.
Scroll down to fetch more images, if any


SimplifiedTranscription
SAXOFERREO

FullTranscription
[SAX]O'FERREO|



SimplifiedTranscription
SAXOFERREO

FullTranscription
SAXOFE'[RREO].


SimplifiedTranscription
SAXOFERRI

FullTranscription
|SAXOFERRI|


SimplifiedTranscription
SAXOFERREO

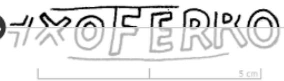
FullTranscription
|sA!XOFERREO|

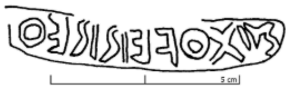

SimplifiedTranscription
SAXOFERR

FullTranscription
|S^AXOFE'RR|


Ponsich (1982)


SimplifiedTranscription




SimplifiedTranscription
SAXOFERREO

FullTranscription
|S^AXOFERREO|

Add Propert

Timeline | Faceting

| AmphoricTypeTitle | AreaTitle | FindingPlaceTitle | SimplifiedTranscription |
|---|---|---|---|
| Africana 1A pic. | Aachen | (Fund-Nr.70/3) | ((PALMA)) |
| Amphora incerta | Abernethy | (PS Moseler) | ...A... |
| Augst 17 | Adenau | (bei Kanalbau) | ...A...... |
| Augst 33 | Agde | - 6m; 15.2.1905 | ...A?... |
| Beltrán 2A | Alcolea del Río | -3,5m; 2.12.1939. | ...AGE?... |
| Brindisian amphora | Alexandrie | -5-6 m..; 21.2.1905. | ...AL?... |
| Dressel 1 | Alise-Sainte-Reine | -6m; a. 14.2.1905. | ...ARPL...?... |
| Dressel 10 | Altenstadt | 0004/141 (13-7-1994) | ...CCL... |
| Dressel 2-4 | Altkalkar | 0004/321 (22-7-1994) | ...CPRIS?... |
| Dressel 2-4 Baetican | Alzey | 0006/503 (22-5-1995) | ...DIM?... |
| Dressel 2-4 Catalan | Amiens | 004/160 | ...DV...... |
| Dressel 2-4 Loire Basin | Angers | 10.11.1904 | ...FEK... |
| Dressel 20 | Ardèche (Alba) | 12.3.1961. | ...FSS... |

EPNet Production and Distribution of Food during the Roman Empire: Economic and Political Dynamics

```
PREFIX :↔
SELECT ?ceipacNumber ?transcription ?findingPlace ?findingSpot ?country
WHERE {
    ?amph a :Amphora .
    ?amph dcterms:identifier ?ceipacNumber .
    ?amph :carries ?inscription .
    ?inscription :isTranscribedBy ?linguisticObject .
    ?linguisticObject :hasFullTranscription ?transcription .
    ?amph :hasFindingPlace ?findplace .
    ?findplace :fallsWithin ?cou .
    ?cou a :Country .
    ?cou dcterms:title ?country .
    FILTER (?country = "Spain")
    ?findplace :fallsWithin ?mun .
    ?mun a :Municipality .
    ?mun dcterms:title ?findingPlace .
    optional {
        ?findplace :fallsWithin ?msp .
        ?msp a :ModernSpot .
        ?msp dcterms:title ?findingSpot .
    }
}
ORDER BY ?findingPlace ?findingSpot
LIMIT 100
```

Table | Response | Pivot Table | Google Chart | Geo | Execute & Download CSV

Showing 1 to 50 of 100 entries (in 2.473 seconds)

Search: Show 50 entries

| | ceipacNumber | transcription | findingPlace | findingSpot | country |
|---|---|---|---|---|---|
| 1 | "12585"^^xsd:int | \|T^H\| | Alayor | Alcaidús d'en Flaquer | Spain |
| 2 | "12585"^^xsd:int | \|F'\| | Alayor | Alcaidús d'en Flaquer | Spain |
| 3 | "41452"^^xsd:int | \|P\| | Alayor | Binialmesc | Spain |
| 4 | "12574"^^xsd:int | \|M·C·N\| | Alayor | Cotaina | Spain |
| 5 | "12581"^^xsd:int | \|PRI\| | Alayor | Cotaina | Spain |

## What we have seen today

- Ontologies and mappings provide a vocabulary to formulate the queries, enrich them, and find the answers in (possibly) multiple heterogenous data sources.

- Ontologies and Semantic Web Technology can help to handle the problem of accessing and integrating data sources, also in the Cultural Heritage domain.

  Diversity:
  - Using ontologies describing particular domains allows to hide the *storage complexity*.
  - Agreement on data identifiers allows for *integration* of multiple datasets.

  Understanding:
  - Agreement on a domain-oriented vocabulary allow to better define your data and allows for easy information exchange.

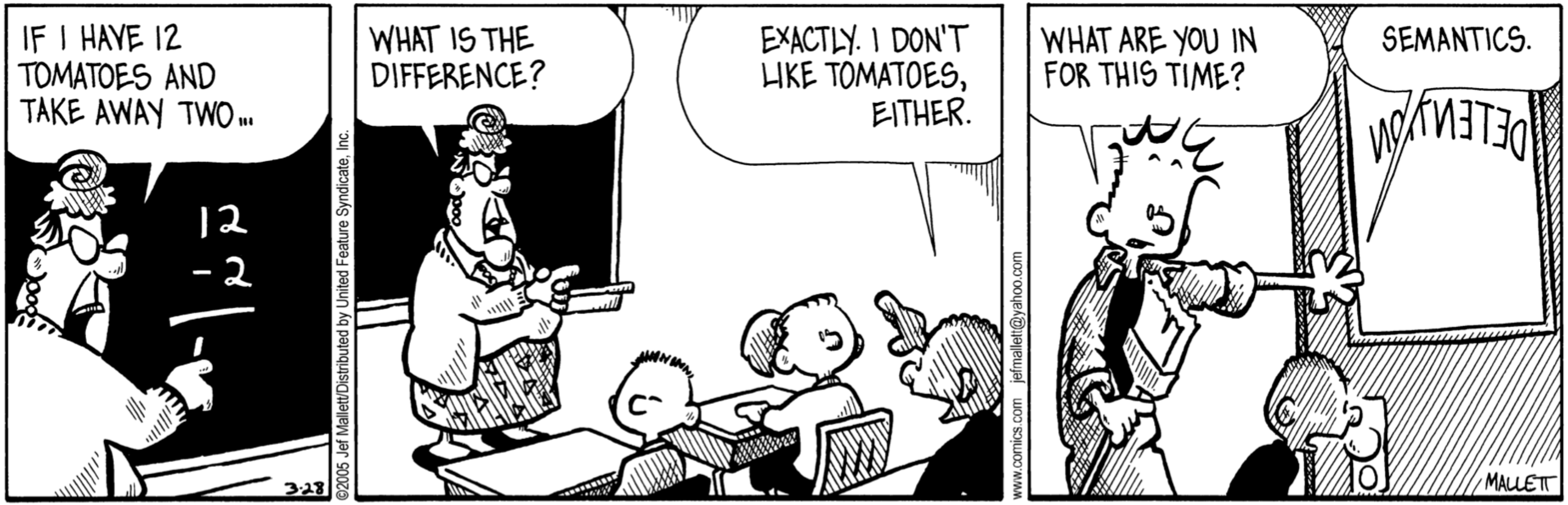
## What we left outside

- Semantic Query Optimisation, SPARQL-based querying, Performance Evaluation, Aggregates and bag semantics, no-SQL repositories, … *Tons of theory*.

Thank you for your attention!

https://romanopendata.eu/

Questions?

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