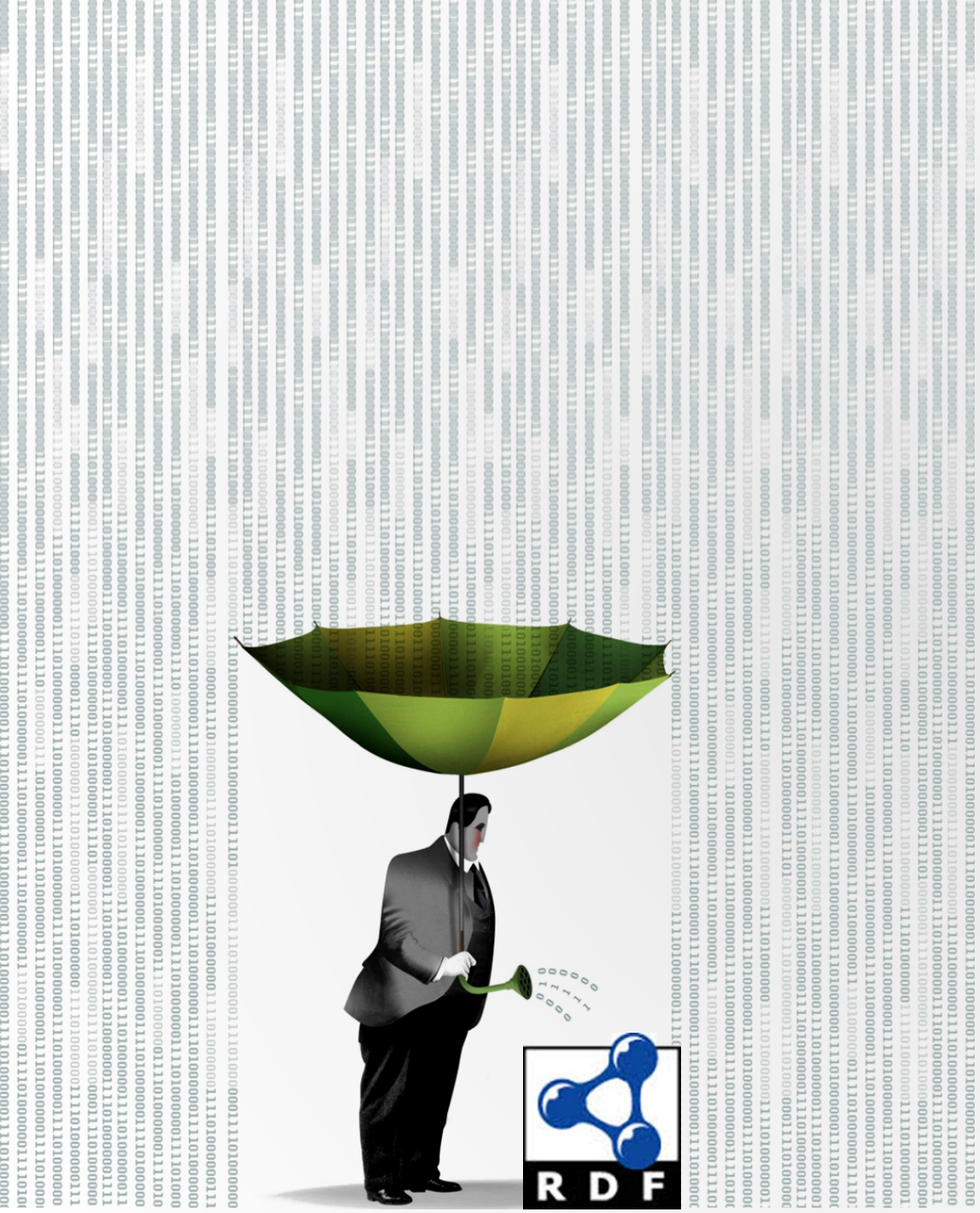


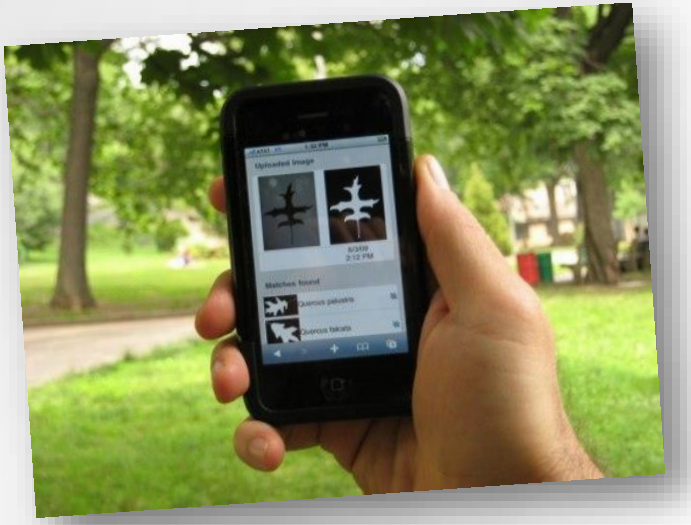
Integrating Heterogeneous Data Sources in the Web of Data

JDEV2017

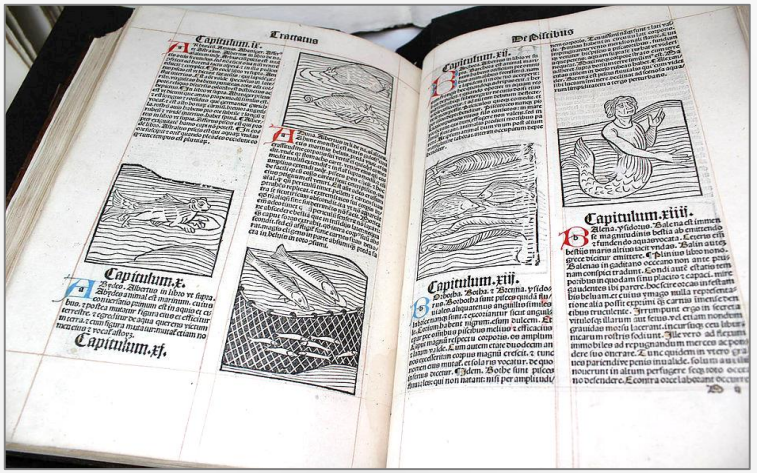
Franck Michel

UNIVERSITÉ CÔTE D'AZUR
cnrs
i3s sophia antipolis

More data sources ⇨ More opportunities



Example: study history of zoological knowledge



First Natural History Encycloedia, 1485.

Conservation biology*

Archaeological excavation

*http://www.lynxeds.com/hmw/plate/family-delphinidae-ocean-dolphins

Example: study history of zoological knowledge

Knowledge formalizations

Controlled vocabularies,
taxonomies
domain ontologies, …

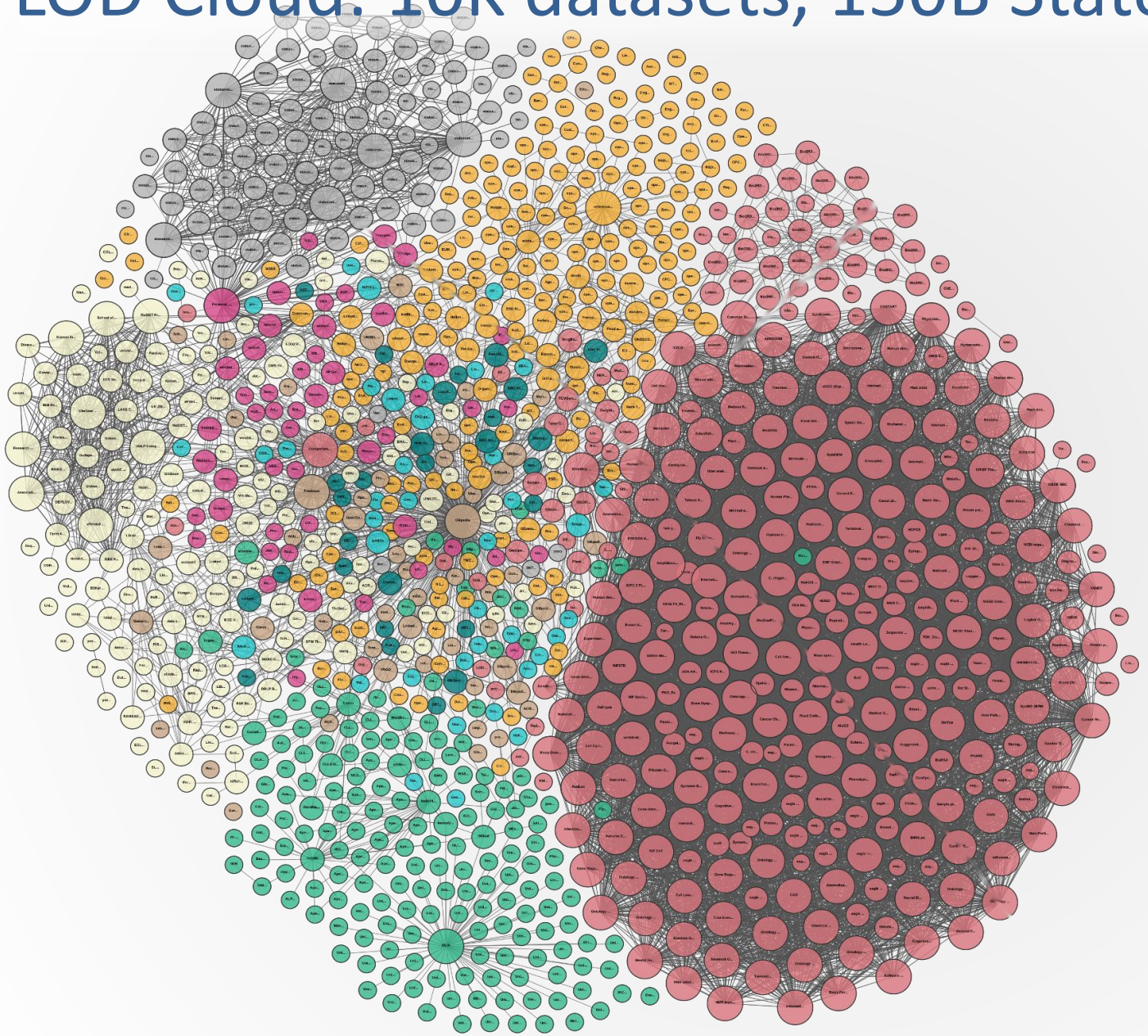
Conservation biology*

RDF

Archaeological excavation

*http://www.lynxeds.com/hmw/plate/family-delphinidae-ocean-dolphins

LOD Cloud: 10K datasets, 150B Statements

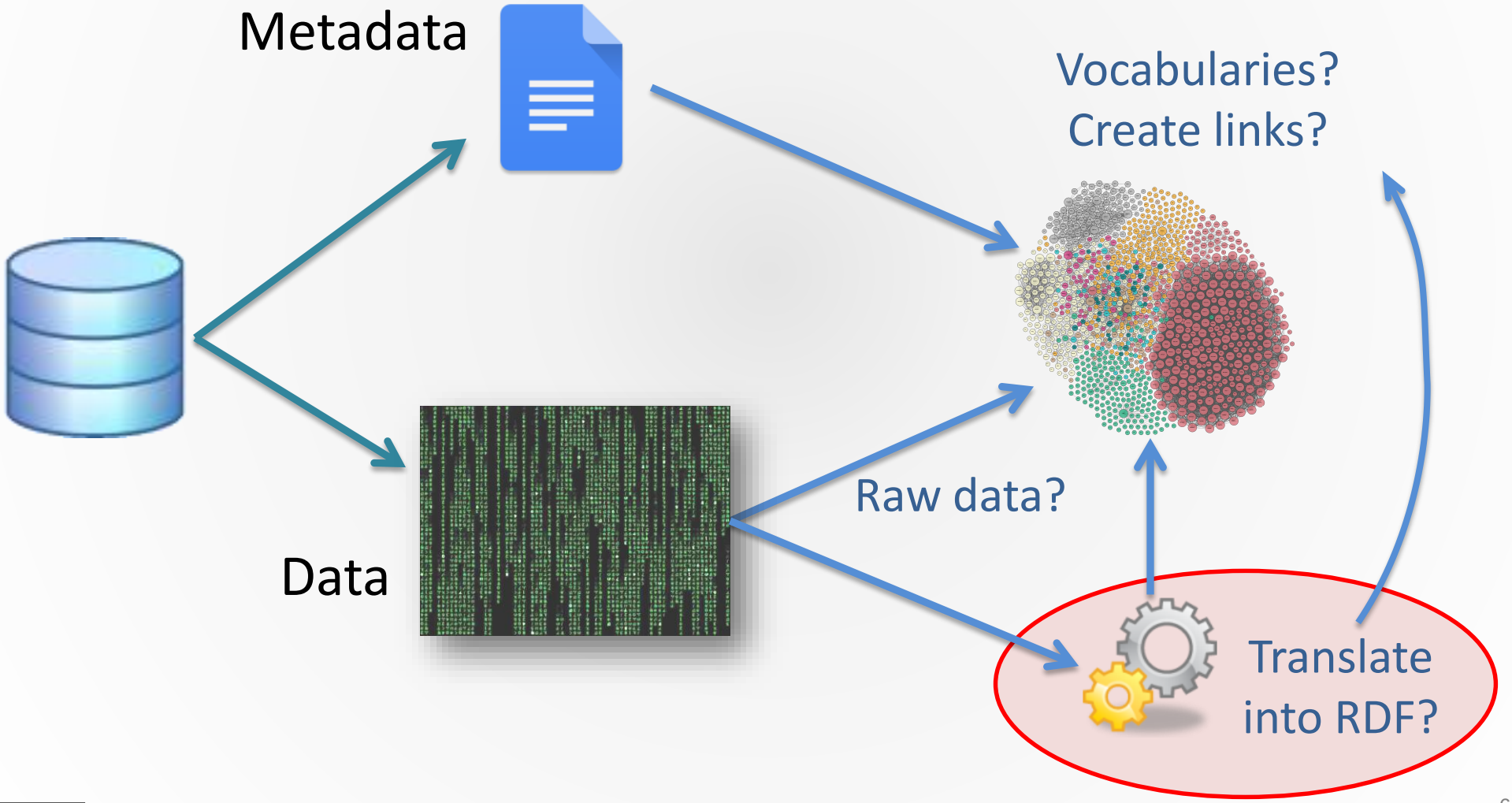


- ✓On the Web
- ✓In RDF
- ✓Under open licences
- ✓Interlinked

Cross Domain
Geography
Government
Life Sciences
Linguistics
Media
Publications
Social Networking
User Generated

Linking Open Data cloud diagram 2017. A. Abele, J.P. McCrae, P. Buitelaar, A. Jentzsch and R. Cyganiak. http://lod-cloud.net/

Publishing legacy data in RDF raises tricky questions



Agenda

Describe the translation of heterogeneous data into RDF

Choose vocabularies to represent RDF data

Access the RDF data produced

The key importance of metadata

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Data Sources Have Heterogeneous Data Models

Documents

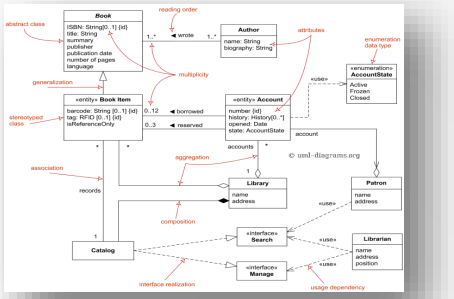
Relational DB

ID	NAME	

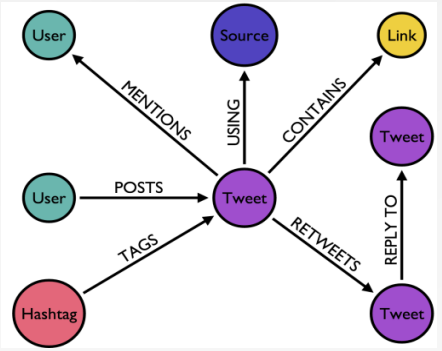
Native XML DBs

```
<Books>
    <Book ISBN="0553212419">
        <title>Sherlock Holmes: Complete Novels...
        <author>Sir Arthur Conan Doyle</author>
    </Book>
    <Book ISBN="0743273567">
        <title>The Great Gatsby</title>
        <author>F. Scott Fitzgerald</author>
    </Book>
    <Book ISBN="0684826976">
        <title>Undaunted Courage</title>
        <author>Stephen E. Ambrose</author>
    </Book>
    <Book ISBN="0743203178">
        <title>Nothing Like It In the World</title>
        <author>Stephen E. Ambrose</author>
    </Book>
</Books>
```

Object-Oriented



Graph



NoSQL

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RDFa: RDF in HTML attributes

https://www.w3.org/TR/rdfa-core/

http://devlog.cnrs.fr/

```
<body vocab="http://schema.org/">
 <div resource="/jdev2017" typeof="Event">
  <h2 property="title">JDEV 2017</h2>
  <p>Date: <span property="startDate">2017-07-04</span></p>
  ...
  <p>T2 - Ingénierie et web des données.
     <a property="url“href="http://devlog.cnrs.fr/jdev2017/t2">More…</a>
  </p>
 </div>
</body>
```

```
prefix sch: <http://schema.org/>
<http://devlog.cnrs.fr/jdev2017>
  rdf:type sch:Event ;
  sch:title "JDEV 2017";
  sch:startDate "2015-10-20" ;
  sch:url <http://devlog.cnrs.fr/jdev2017/t2> .
```

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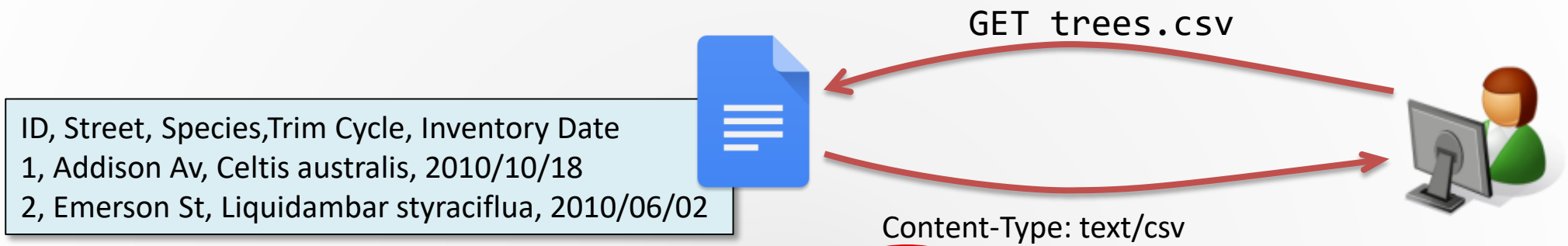
CSVW: CSV on the Web

https://www.w3.org/2013/csvw/




```
{ "@context":["http://www.w3.org/ns/csvw", {"@language": "en"}],
  "url": "trees.csv",  "dc:title": "Trees",
  "dc:license": { "@id": "http://.../../cc-by/"},
  "dc:modified": {"@value": "2010-12-31",  "@type": "xsd:date"},
  "tableSchema": {
    "columns": [
      { "name": "ID",  "titles": ["ID", "Identifier"],  "datatype":"string",  "required": true },
      { "name": "Street",  "titles": "On Street",  "dc:description": "…", "datatype": "string" }, ...
    ],
    "primaryKey": "ID",    "aboutUrl": "#id-{ID}" }}
```

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Direct Mapping of a RDB to RDF

https://www.w3.org/TR/2012/REC-rdb-direct-mapping-20120927/

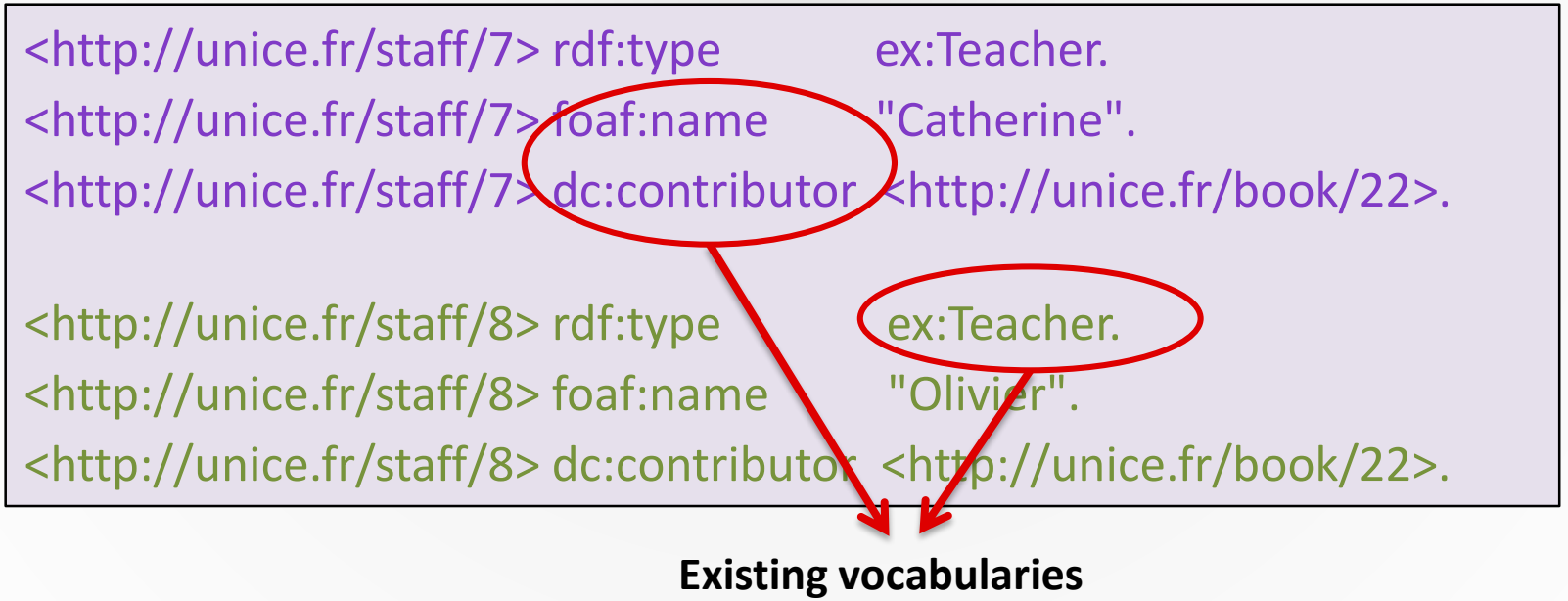
Table: PEOPLE		
ID	FNAME	WROTE *(FK BOOK/ID)*
7	**Catherine**	**22**
8	**Olivier**	**22**
…	…	…

```
<PEOPLE/ID=7> rdf:type              <PEOPLE> .
<PEOPLE/ID=7> <PEOPLE#FNAME>  "Catherine" .
<PEOPLE/ID=7> <PEOPLE#WROTE>  <BOOK/ID=22> .

<PEOPLE/ID=8> rdf:type              <People> .
<PEOPLE/ID=8> <PEOPLE#FNAME>  "Olivier" .
<PEOPLE/ID=8> <PEOPLE#WROTE>  <BOOK/ID=22> .
```

Custom Mapping of a RDB to RDF

Table: PEOPLE		
ID	FNAME	WROTE *(FK BOOK/ID)*
7	**Catherine**	**22**
8	**Olivier**	**22**
…	…	…



Custom Mapping of a RDB to RDF with R2RML

http://www.w3.org/TR/r2rml/

```
<#MapPeople>
  rr:logicalTable [ rr:tableName "PEOPLE" ];
  rr:subjectMap [
    rr:template "http://unice.fr/staff/{ID}";
    rr:class ex:Teacher;
  ];
  rr:predicateObjectMap [
    rr:predicate foaf:name;
    rr:objectMap [ rr:column "FNAME" ];
  ].
```

```
<http://unice.fr/staff/7> rdf:type  ex:Teacher.
<http://unice.fr/staff/7> foaf:name "Catherine".
<http://unice.fr/staff/8> rdf:type  ex:Teacher.
<http://unice.fr/staff/8> foaf:name "Olivier".
```

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Mapping of a NoSQL DBs to RDF with xR2RML

```
{ "id": 106,
  "firstname": "John",
  "emails": [ "john@foo.com", "john@example.org" ]
}
```

mongoDB

xR2RML

```
<#MapMbox>
  xrr:logicalSource [ xrr:query "db.people.find({'emails':{$ne: null}})" ];
  rr:subjectMap [ rr:template "http://example.org/member/{$.id}" ];
  rr:predicateObjectMap [
     rr:predicate foaf:mbox;
     rr:objectMap [ xrr:reference "$.emails.*"; rr:termType rr:Literal ]
  ].
```

```
<http://example.org/member/106> foaf:mbox "john@foo.com".
<http://example.org/member/106> foaf:mbox "john@example.org".
```

Many methods for many types of data sources

HTML

RDFa, Microformats

XML

AstroGrid-D, SPARQL2XQuery, XSPARQL

CSV/TSV/Spreadsheets

XLWrap, Linked CSV, CSVW, RML

JSON

TARQL, JSON-LD, RML

Relational Databases

D2RQ, R_2O, Ultrawrap, Triplify, SM
R2RML: Morph-RDB, ontop, Virtuoso

NoSQL

xR2RML (MongoDB), ontop (MongoDB), [Mugnier et al, 2016]

Multiple formats

RML, TARQL, Apache Any23, DataLift, SPARQL-Generate

M.L. Mugnier, M.C. Rousset, and F. Ulliana. “Ontology-Mediated Queries for NOSQL Databases.” In *Proc. AAAI*. 2016.

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Direct mapping: create my own vocabulary

Can be derived from an existing schema

May seem easier: *"I do whatever I want"*

But no added semantics, need to link my vocabulary with other ones

Custom Mapping: reuse existing vocabularies

Large variety of existing vocabularies

But may be difficult to find the appropriate one

- Partial coverage of the domain
- Granularity: too high (cumbersome), too low (useless)
- Different points of view

Frequently, a mixed approach is used

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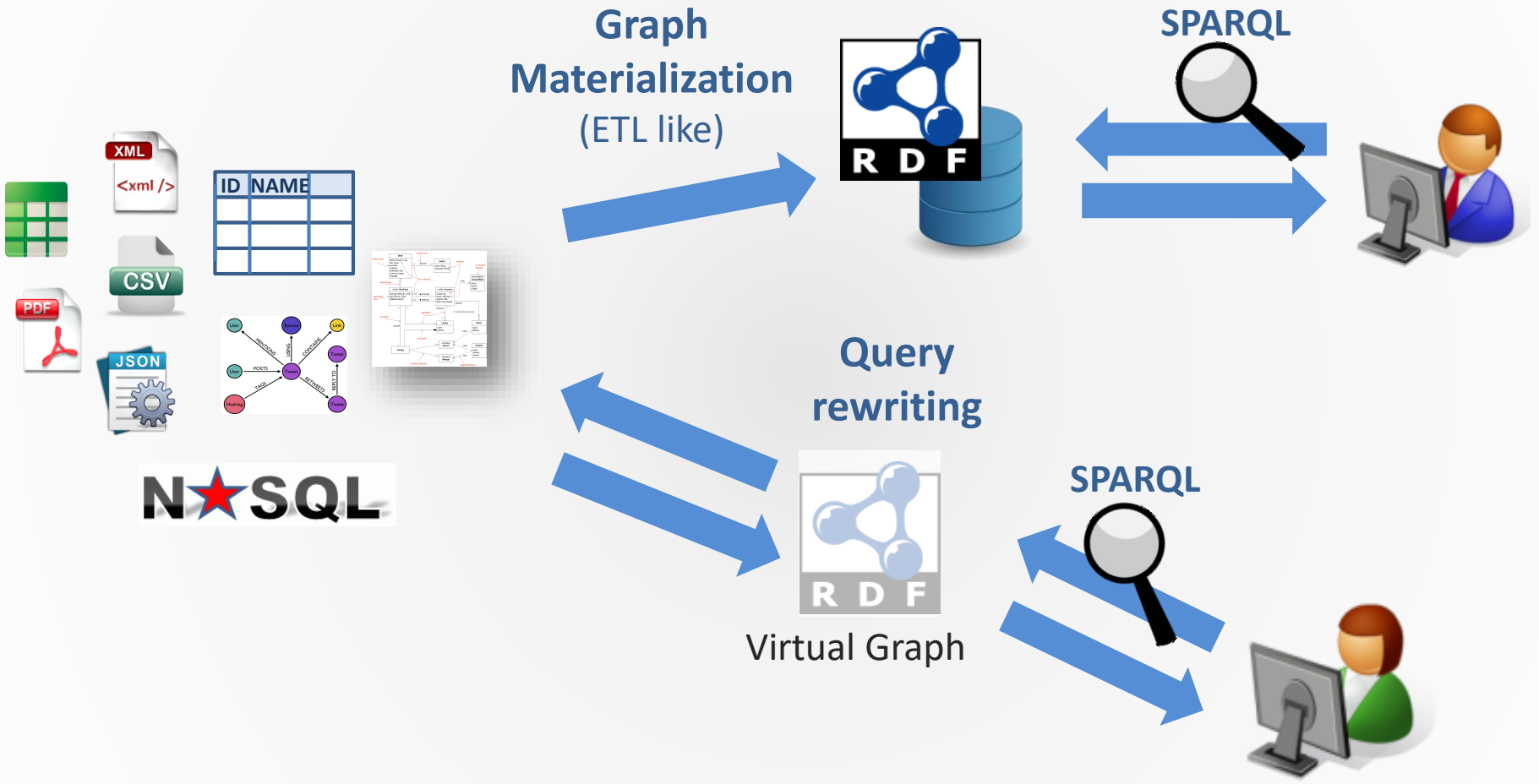
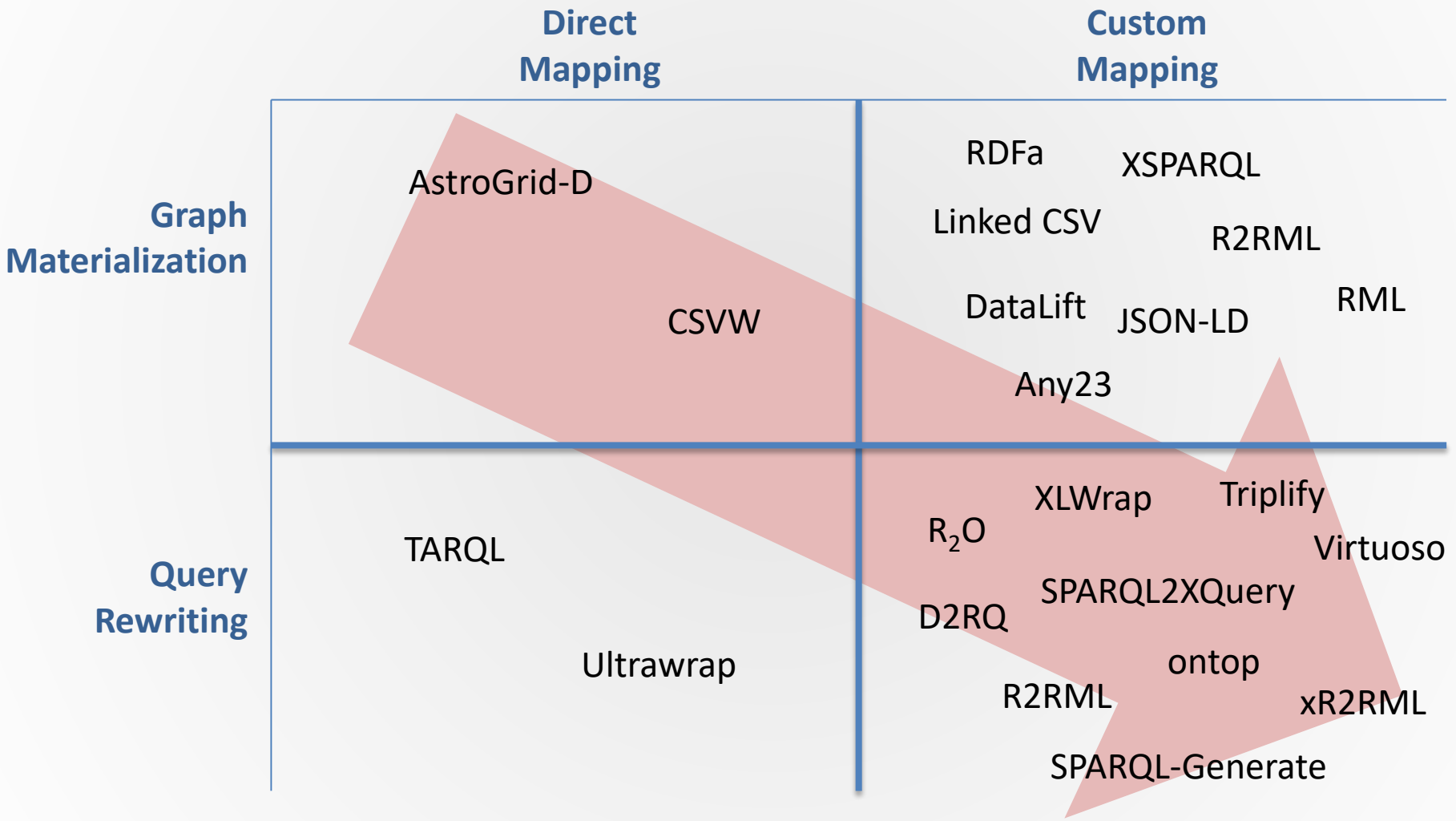
Two approaches to translate existing data sources in RDF



A large variety of approaches



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Making datasets **discoverable** and **reusable**

requires

high-quality, **comprehensive** metadata

Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE

data.gouv.fr

Plateforme ouverte des données publiques françaises

Découvrez l'OpenData **Données** **Tableau de bord** **Connexion / Inscription**

Recherche | Thématiques | + CONTRIBUEZ !

/ Jeux de données 1 à 20 sur 27346

Trier par ---

Population

Ce jeu de données permet d'accéder aux résultats des recensements de la population, à des séries chronologiques de la Banque de Données Macro-économiques de l'Insee sur le thème de la population et à d'autres données...

01/1901 à 07/2015 **Mensuelle** **France** **Commune française** **23** **32**

Indicateur Avancé Sanitaire IAS® - SYNDROME GRIPPAL

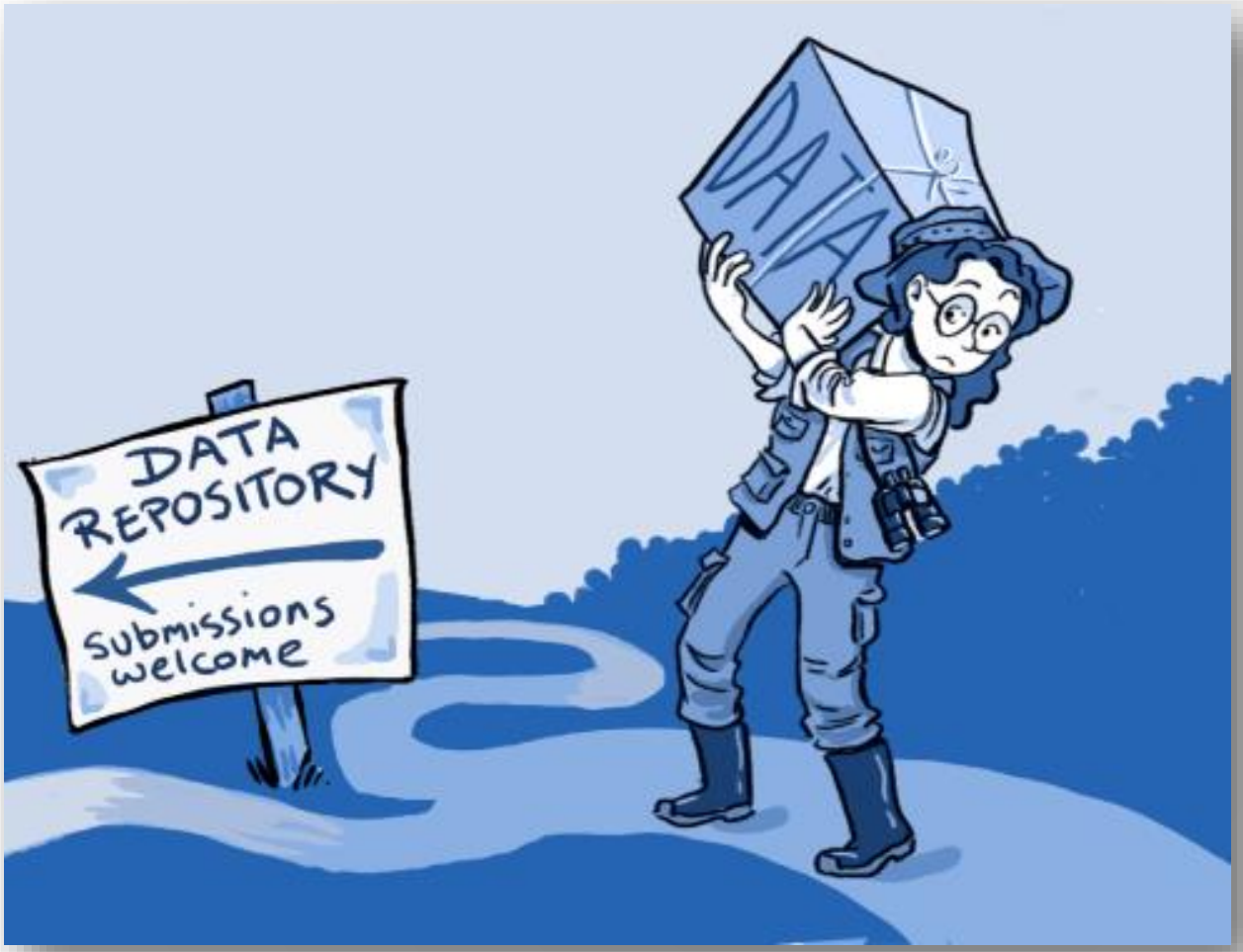
L'objectif de l'Indicateur Avancé Sanitaire (IAS®) "Syndrome Grippal" est de contribuer à la surveillance des syndromes grippaux en France en apportant des informations complémentaires à celles du réseau Sentinelles

Metadata are the key to enable dataset reuse

Context	Identification, authors, dates, license, version, reference articles
Access	Format, structure, location (dwld), query method
Meaning	What do the data represent? What concepts, entities, semantics?
Interpretation	Units (cm or inches, left/right)…
Provenance	Acquired with which equipment, parameters, protocols? Derived from which dataset? With which processing? Dataset-level or entity-level provenance
Statistics	Number of triples per property of class, links to other datasets…
…	

Several works normalize metadata descritpions

- CSVW: CSV on the Web
- DCAT: Data Catalog Vocabulary
  DCAT extensions, application profiles
  W3C Dataset Exchange Working Group
- VoID: Vocabulary of Interlinked Datasets
- HCLS: Health Care & Life Sciences Dataset Profile
- …



Thank you!