# AgroPortal: a vocabulary and ontology repository for agronomy


Séminaire INRAE Semantic Linked Data

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Mistea
Mathématiques, Informatique et STatistique pour l'Environnement et l'Agronomie

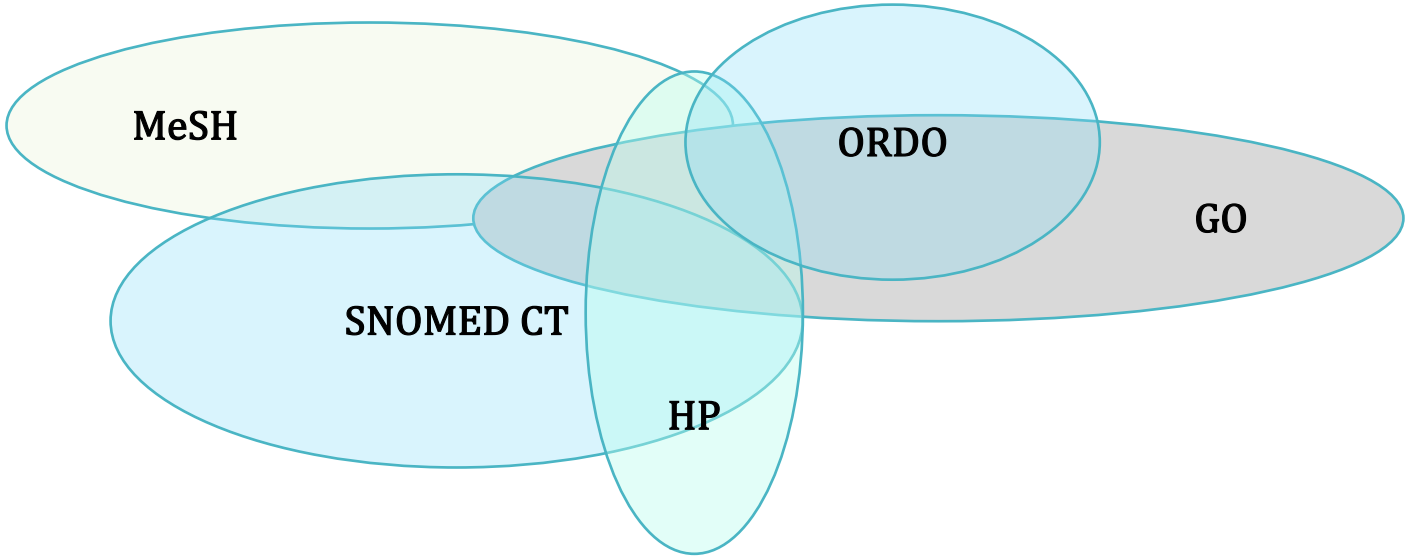
INRAE
la science pour la vie, l'humain, la terre

LIRMM
Laboratoire d'Informatique, de Robotique et de Microélectronique de Montpellier

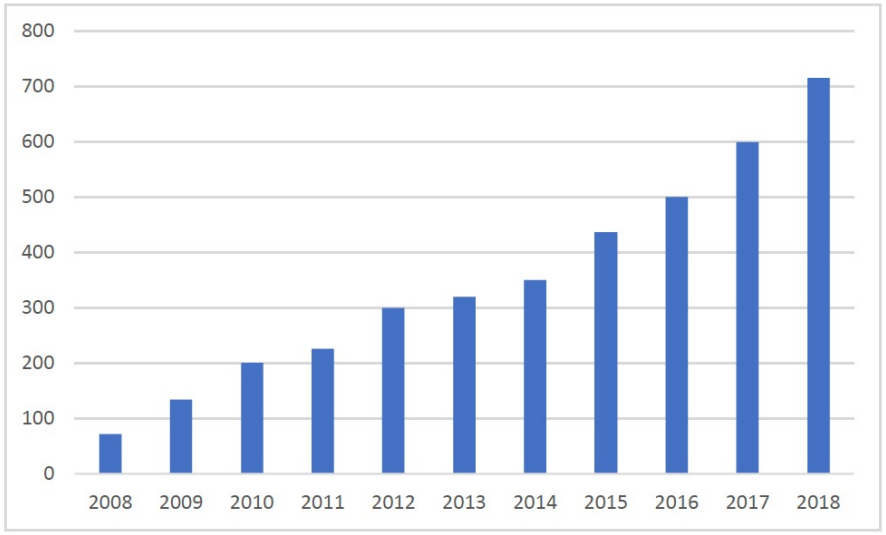
Université de Montpellier

# Issues with ontologies…

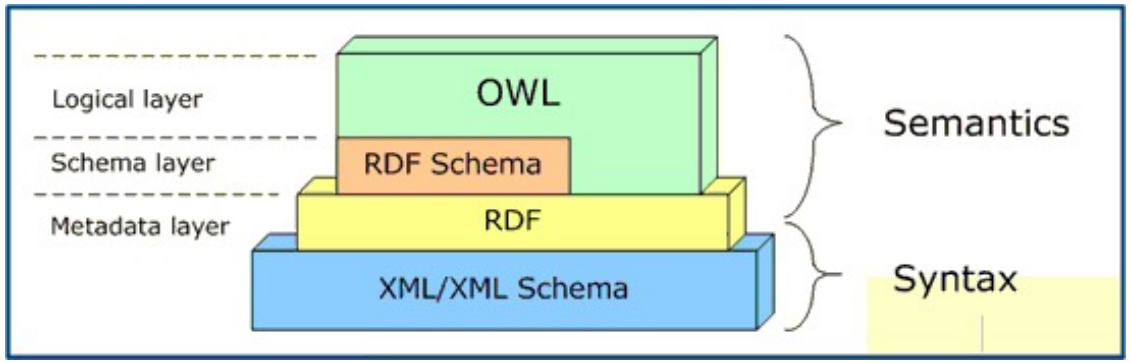
spread out, in different formats, of different size, with different structures




Overlapping ontologies




Number of ontologies in the NCBO BioPortal



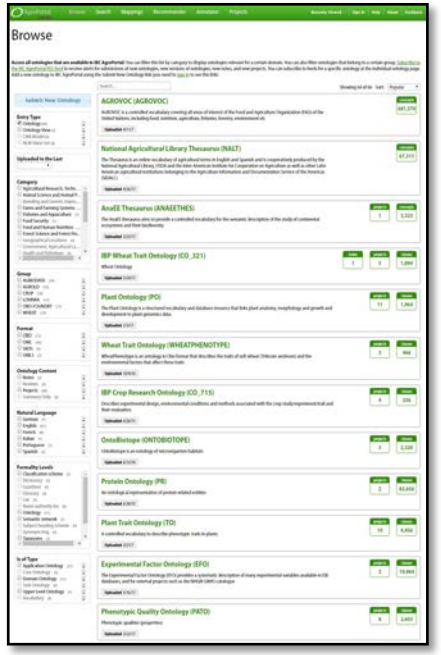

Variety of representation languages

# Why ontology repositories are important?

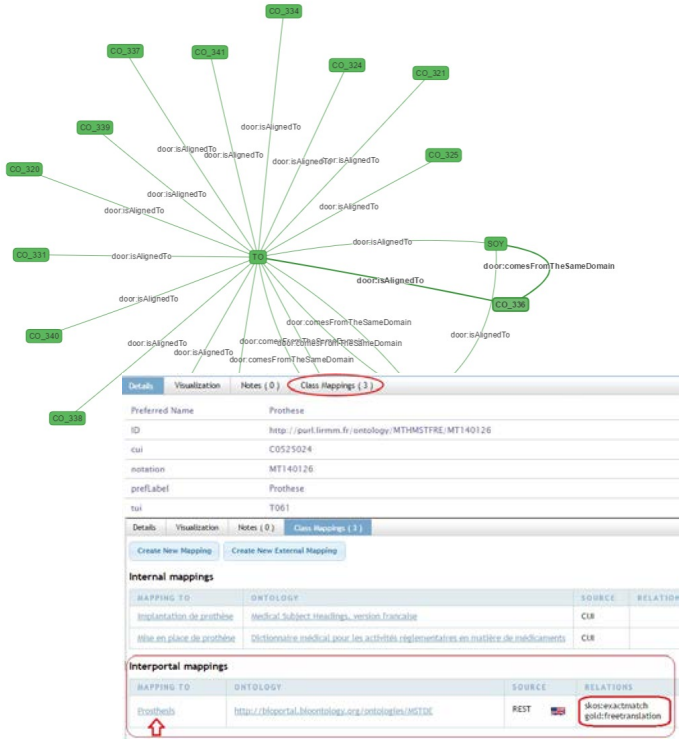
- You've built an ontology, how do you let the world know?
- You need an ontology, where do you go to get it?
- How do you know whether an ontology is any good?
- How do you find data resources that are relevant to the domain of the ontology (or to specific terms)?
- How could you leverage your ontology to enable new science?
- How could you use ontologies without managing them ?

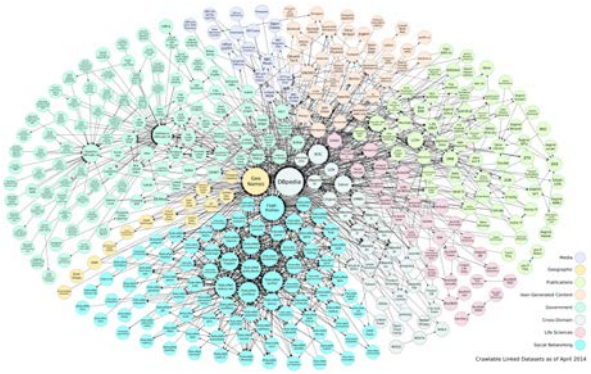
# Ontology repositories help to make ontologies FAIR

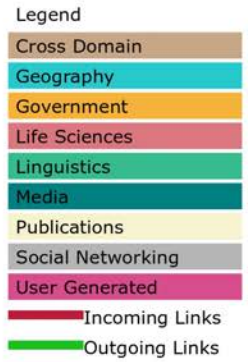
**F**indable **A**ccessible **I**nteroperable **R**e-usable







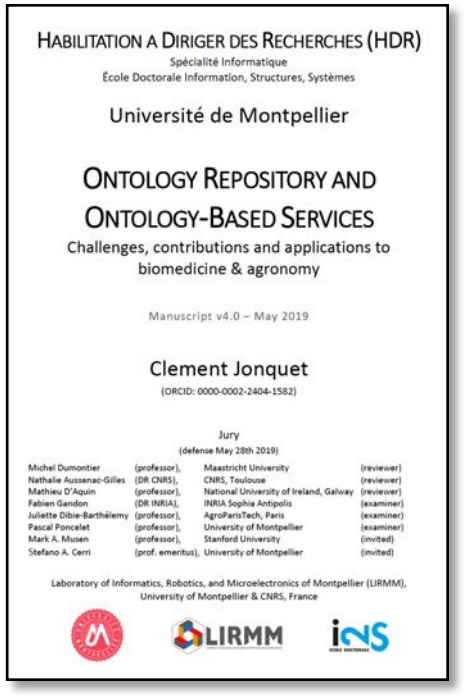






NCBO BioPortal data as of 2013

http://lod-cloud.net

# Challenges for ontology repositories



HABILITATION A DIRIGER DES RECHERCHES (HDR)
Spécialité Informatique
École Doctorale Information, Structures, Systèmes

Université de Montpellier

ONTOLOGY REPOSITORY AND ONTOLOGY-BASED SERVICES
Challenges, contributions and applications to biomedicine & agronomy

Manuscript v4.0 – May 2019

Clement Jonquet
(ORCID: 0000-0002-2404-1582)

Jury
(defense May 28th 2019)

| | | | |
|---|---|---|---|
| Michel Dumontier | (professor), | Maastricht University | (reviewer) |
| Nathalie Aussenac-Gilles | (DR CNRS), | CNRS, Toulouse | (reviewer) |
| Mathieu D'Aquin | (professor), | National University of Ireland, Galway | (reviewer) |
| Fabien Gandon | (DR INRIA), | INRIA Sophia Antipolis | (examiner) |
| Juliette Dibie-Barthélemy | (professor), | AgroParisTech, Paris | (examiner) |
| Pascal Poncelet | (professor), | University of Montpellier | (examiner) |
| Mark A. Musen | (professor), | Stanford University | (invited) |
| Stefano A. Cerri | (prof. emeritus), | University of Montpellier | (invited) |

Laboratory of Informatics, Robotics, and Microelectronics of Montpellier (LIRMM), University of Montpellier & CNRS, France

LIRMM

- Ontology metadata, evaluation and selection
- Multilingualism
- Ontology alignment
- Generic ontology-based services (especially for free text data)
- Annotations and linked data
- Scalability and interoperability

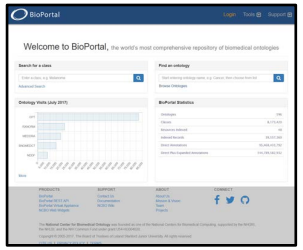
# AgroPortal: a vocabulary and ontology repository for agronomy

http://agroportal.lirmm.fr

- Develop and support a reference ontology repository
  - Primary focus on the agronomy & close related domains (plant sciences, food and biodiversity)

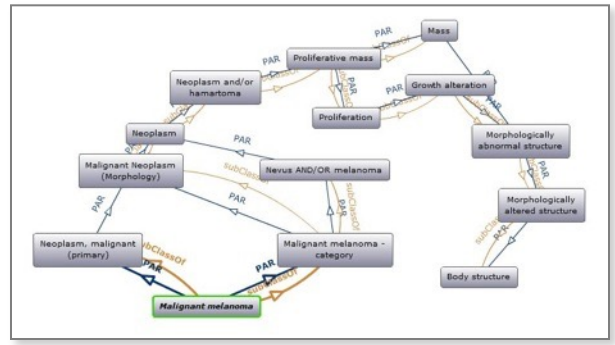
- Reusing the NCBO BioPortal technology
  - Avoid to re-implement what has been done, facilitate interoperability
  - Reusing the scientific outcomes, experience & methods of the biomedical domain

- Enable straightforward use of agronomic related ontologies
  - Respect the requirements & specificities of the agronomic community
  - Fully semantic web compliant infrastructure
  - Enable new science

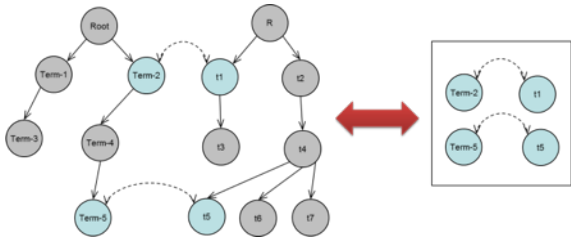



http://bioportal.bioontology.org

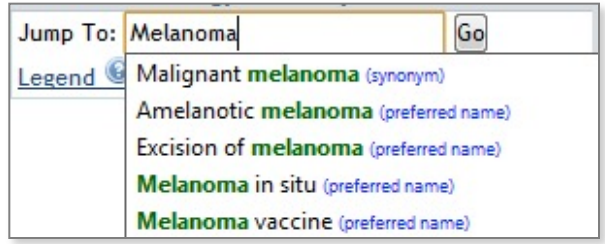
**Ontology Services** → 
- Search
- Traverse
- Comment
- Download




**Mapping Services** →
- Create
- Upload
- Download



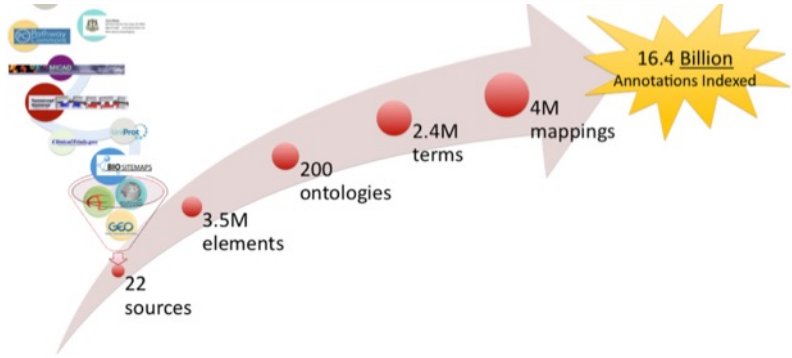

**Widgets** →
- Tree-view
- Auto-complete
- Graph-view




**Annotation** → Term recognition

Expression, Expression of bladder, bladder, smooth, bladder muscle, muscle, smooth muscle, cells, mechanical, mechanical stimulation, stimulation, Chronic, results, bladder overdistension, associated, associated with, with, loss, genes, altered

**Data Access** → Search "data" annotated with a given term



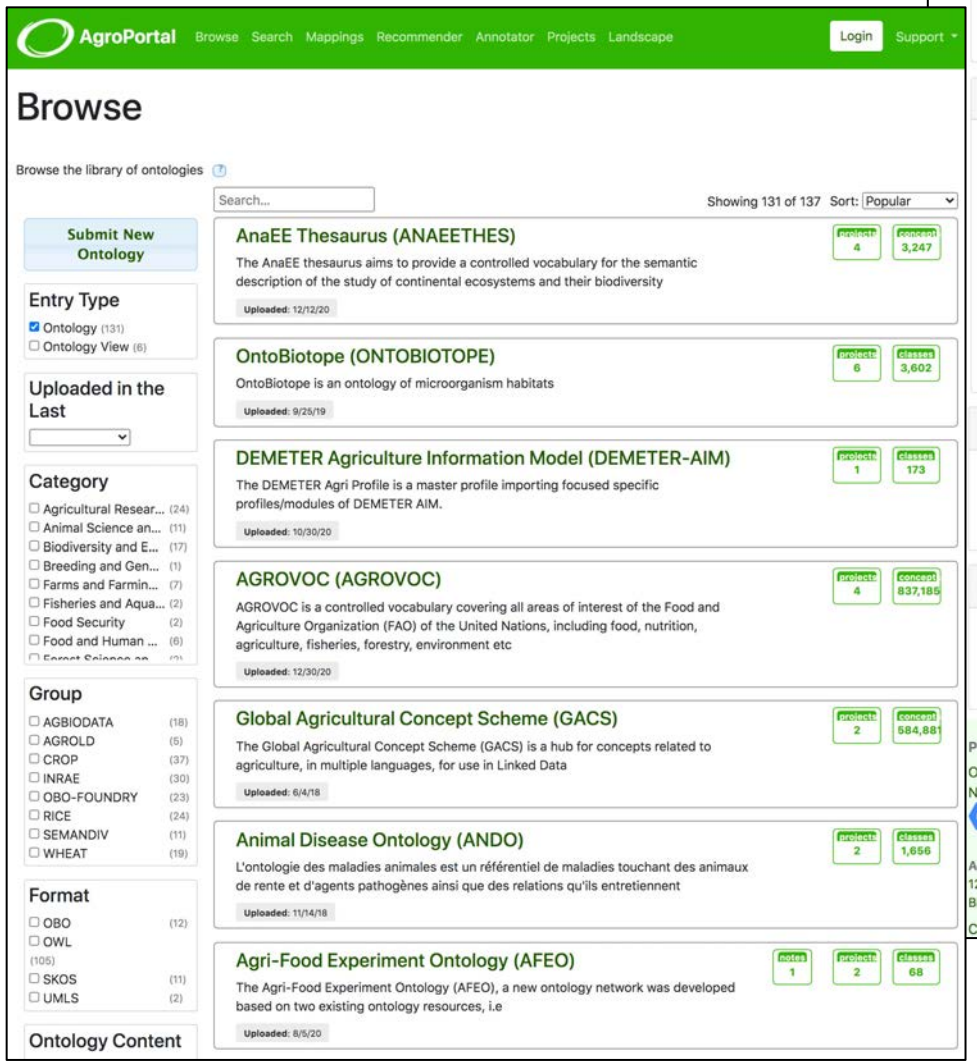

http://data.bioontology.org

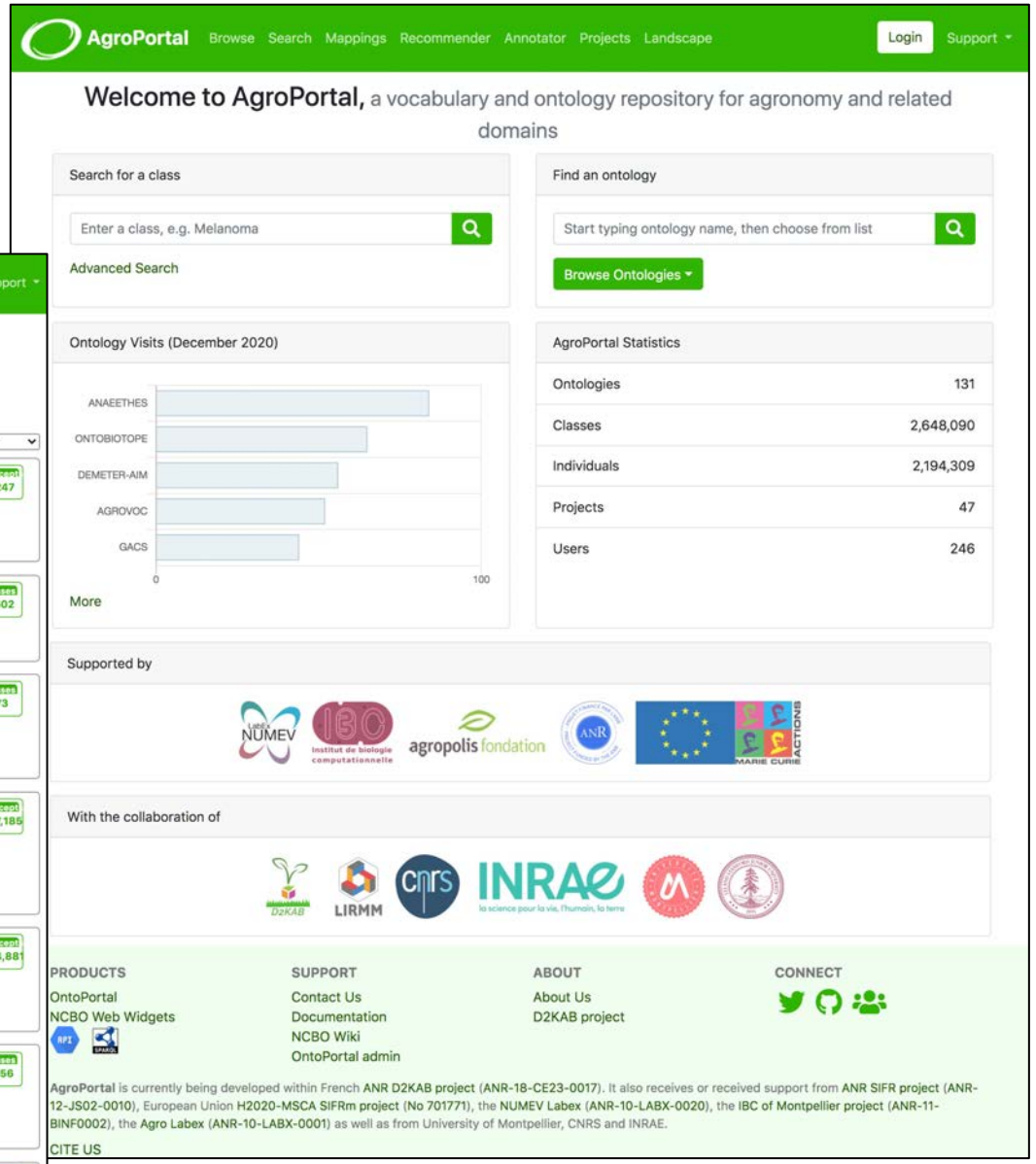
# AgroPortal an ontology repository

for agronomy, food, plant sciences & biodiversity

http://agroportal.lirmm.fr

- Publish, search, download
- Browse, visualize
- Peer review
- Versioning
- Annotation
- Recommendation
- Mapping
- Notes
- Projects



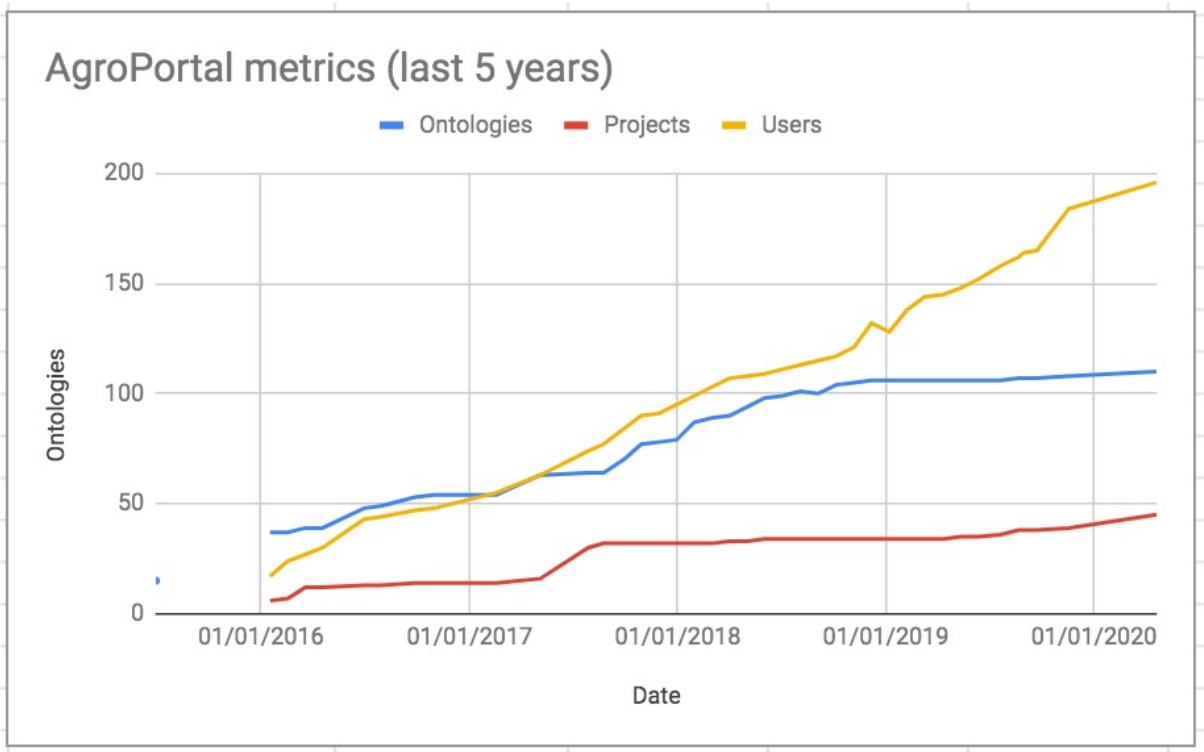

- 131 ontologies, 90 candidates
- 5 driving use cases
- ~240 registered users

C. Jonquet, A. Toulet, (…) P. Larmande. **AgroPortal: an ontology repository for agronomy**, *Computers and Electronics in Agriculture*. Jan 2018. 144, pp.126-143. Elsevier.

# 2016: Five original driving agronomic use cases

- IBC Rice Genomics & AgroLD project
  - Data integration and knowledge management related to rice (P. Larmande)
- RDA Wheat Data Interoperability working group
  - Common framework for publishing wheat data (E. Dzalé-Yeumo)
- LovInra : INRA Linked Open Vocabularies
  - Vocabularies produced by INRA scientists (S. Aubin)
- Crop Ontology project
  - Ontologies for describing crop germplasm & traits (E. Arnaud)
- GODAN global map of agri-food data standards
  - VEST/AgroPortal MAP of standards (V. Pesce)

# A growing interest in the community



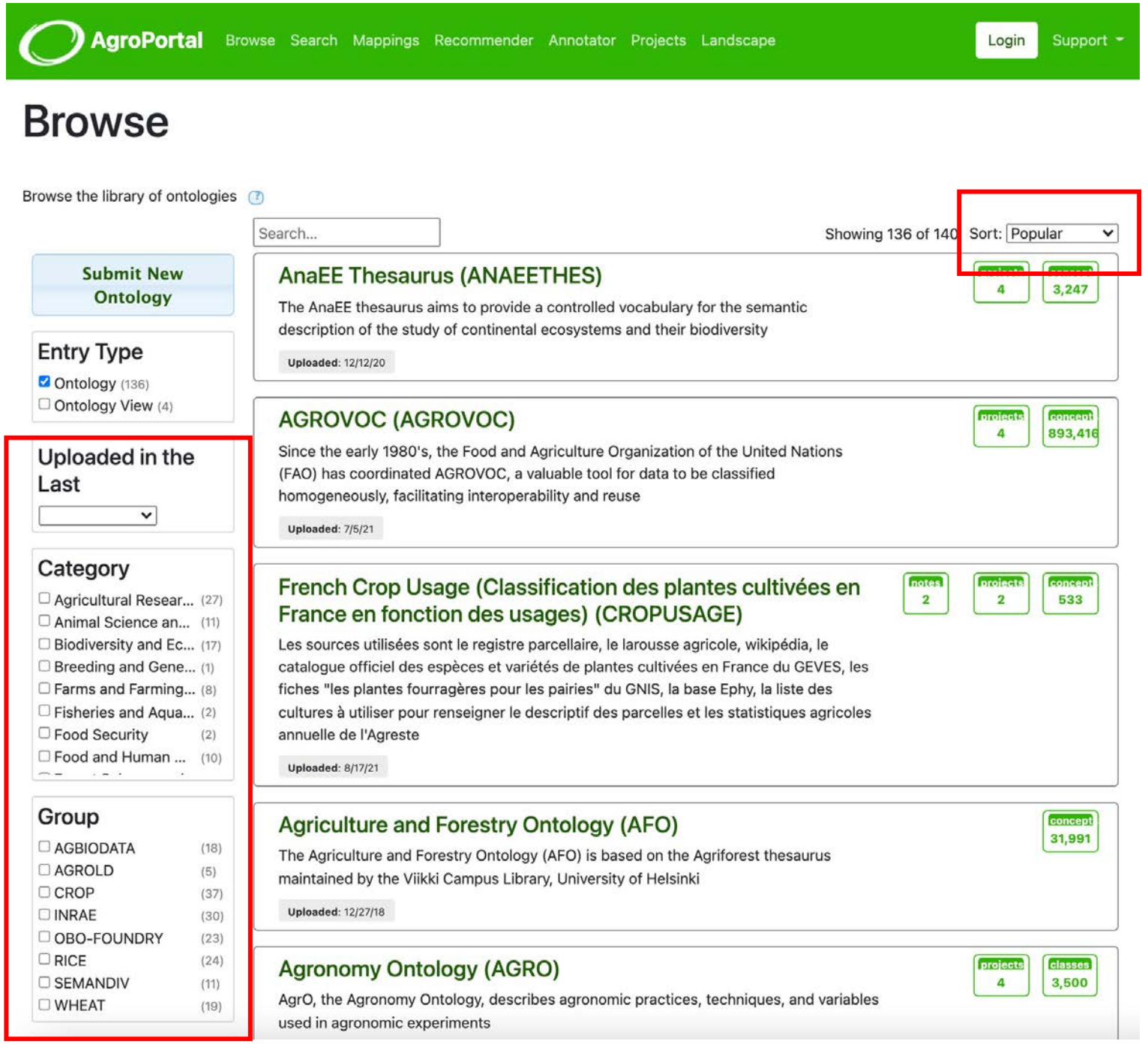

- RDA Agrismeantics WG
- GO-FAIR Food System Implementation Network
- D2KAB ANR project
- Adoptions by projects e.g. PHIS, AgroLD
- SemanDiv CNRS WG
- AgroHackathons
- Maybe:
  - IC-FOODS initiative
  - ELIXIR F&N community

# Examples of ontologies uploaded in AgroPortal

| Title | Format | Groups | Size |
|---|---|---|---|
| **IBP Rice Trait Ontology (CO_320)** | OWL | CROP, RICE | ~2K |
| **IBP Wheat Trait Ontology (CO_321)** | OWL | CROP, WHEAT | ~1K |
| **IBP Wheat Anatomy Ontology (CO_121)** | OBO | CROP, WHEAT | ~80 |
| **IBP Crop Research (CO_715)** | OBO | CROP | ~250 |
| **Multi-Crop Passport Ontology (CO_020)** | OBO | CROP | ~90 |
| **Biorefinery (BIOREFINERY)** | OWL | LOVINRA | ~300 |
| **Matter Transfer (TRANSMAT)** | OWL | LOVINRA | ~1.1K |
| **Plant Ontology (PO)** | OWL | WHEAT, RICE, OBOF | ~2K |
| **Plant Trait Ontology (TO)** | OWL | WHEAT, RICE, OBOF | ~4.4K |
| **Durum Wheat (DURUM_WHEAT)** | OWL | LOVINRA | ~130 |
| **Agricultural Experiments (AEO)** | OWL | LOVINRA | ~60 |
| **Environment Ontology (ENVO)** | OWL | WHEAT, OBOF | ~6.3K |
| **NCBI Organismal Classification (NCBITAXON)** | RRF | WHEAT | ~900K |
| **AnaEE Thesaurus (ANAEE)** | SKOS | LOVINRA | ~3.3K |
| **French Crop Usage (CROPUSAGE)** | SKOS | none | ~300 |
| **Agrovoc (AGROVOC)** | SKOS | none | ~32K |
| **Food Ontology (FOODON)** | OWL | OBOF | ~10K |
| **National Agriculture Library Thesaurus (NALT)** | SKOS | none | ~67K |
| **Global Agricultural Concept Scheme (GACS)** | SKOS | none | ~585K |

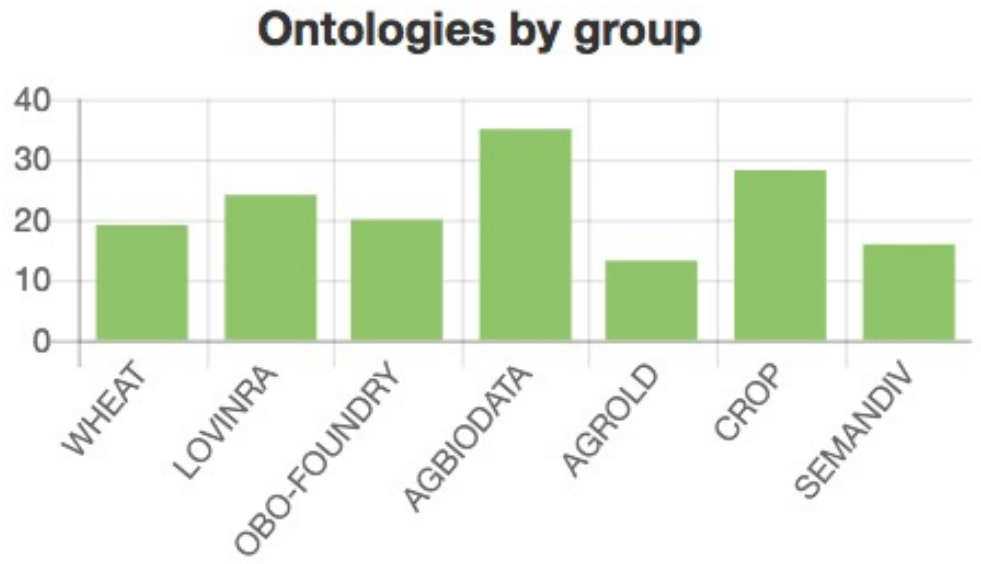
# Browse and select ontologies

- Allows to search, order and select ontologies using a facetted search approach, based on the metadata



# Ontology groups and categories

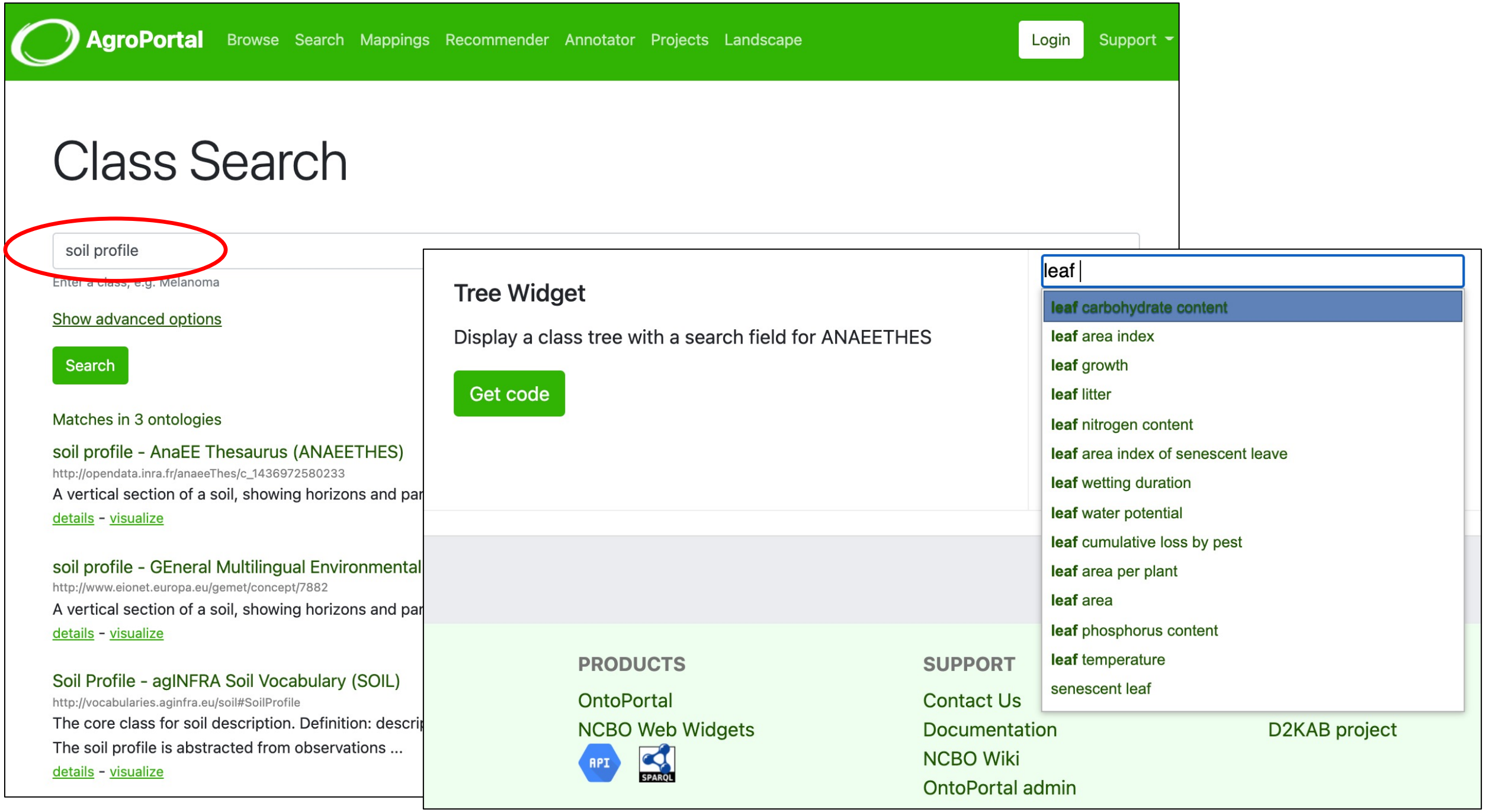
| Category | Number |
|---|---|
| Plant Phenotypes and Traits | 31 |
| Plant Anatomy and Development | 4 |
| Natural Resources, Earth and Environment | 12 |
| Animal Science and Animal Products | 6 |
| Agricultural Research, Technology and Engineering | 15 |
| Breeding and Genetic Improvement | 1 |
| Plant Science and Plant Products | 7 |
| Plant Genetic Resources | 2 |
| Food and Human Nutrition | 7 |
| Food Security | 2 |
| Taxonomic Classifications of Organisms | 6 |
| Farms and Farming Systems | 5 |
| Fisheries and Aquaculture | 2 |
| Forest Science and Forest Products | 2 |
| Biodiversity and Ecology | 14 |




Specific slices display to use only the ontologies of a group

http://crop.agroportal.lirmm.fr

http://inrae.agroportal.lirmm.fr/


AgroPortal
Browse
Search
Mappings
Recommender
Annotator
Projects
Landscape
Login
Support
Class Search
soil profile
Enter a class, e.g. Melanoma
Show advanced options
Search
Matches in 3 ontologies
soil profile - AnaEE Thesaurus (ANAEETHES)
http://opendata.inra.fr/anaeeThes/c_1436972580233
A vertical section of a soil, showing horizons and par
details - visualize
soil profile - GEneral Multilingual Environmental
http://www.eionet.europa.eu/gemet/concept/7882
A vertical section of a soil, showing horizons and par
details - visualize
Soil Profile - agINFRA Soil Vocabulary (SOIL)
http://vocabularies.aginfra.eu/soil#SoilProfile
The core class for soil description. Definition: descri
The soil profile is abstracted from observations ...
details - visualize
Tree Widget
Display a class tree with a search field for ANAEETHES
Get code
leaf
leaf carbohydrate content
leaf area index
leaf growth
leaf litter
leaf nitrogen content
leaf area index of senescent leave
leaf wetting duration
leaf water potential
leaf cumulative loss by pest
leaf area per plant
leaf area
leaf phosphorus content
leaf temperature
senescent leaf
PRODUCTS
OntoPortal
NCBO Web Widgets
API
SPARQL
SUPPORT
Contact Us
Documentation
NCBO Wiki
OntoPortal admin
D2KAB project

AgroPortal Browse Search Mappings Recommender Annotator Projects Landscape

# AnaEE Thesaurus

Last uploaded: December 12, 2020

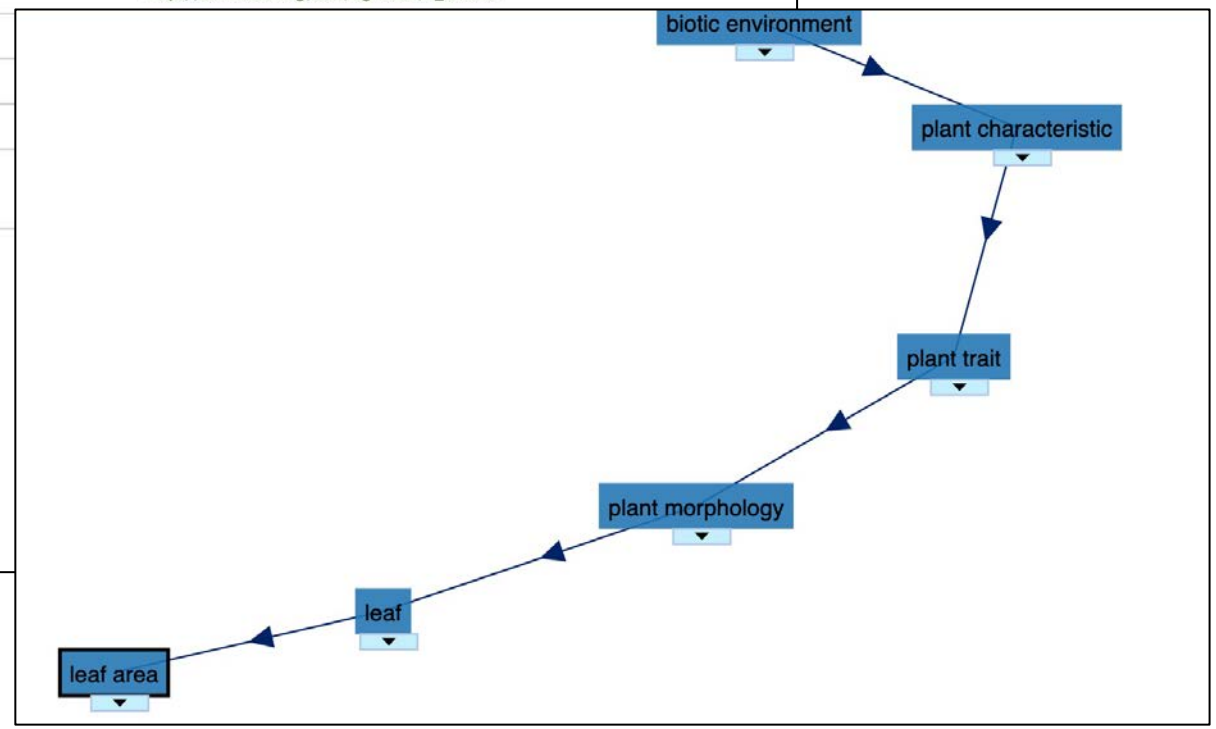
Summary | Classes | Properties | Notes | Mappings | Widgets

Jump to:

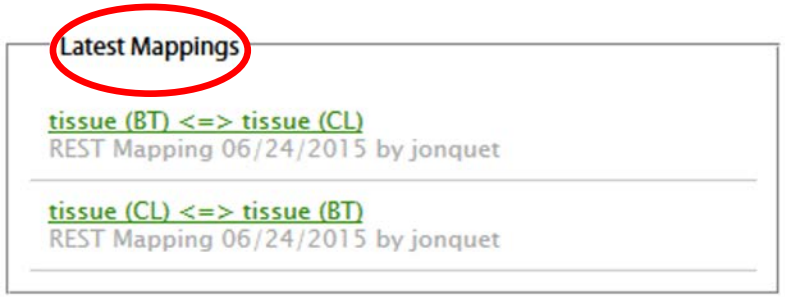
- abiotic environment
- biotic environment
  - anatomy
  - animal characteristic
  - biodiversity
  - biomass
  - living organism (classification)
  - microorganism characteristic
  - phenology
  - plant characteristic
    - plant community
    - plant population
    - plant trait
      - crop age
      - ecophysiological trait
      - plant age
      - plant biomass
      - plant carbon content
      - plant development stage
      - plant dispersal
      - plant growth
      - plant morphology
        - bark
        - dendrometry
        - leaf
          - fallen leaf
          - foliar index
          - green leaf
          - **leaf area**
          - leaf area index
          - leaf area per plant
          - leaf carbohydrate content

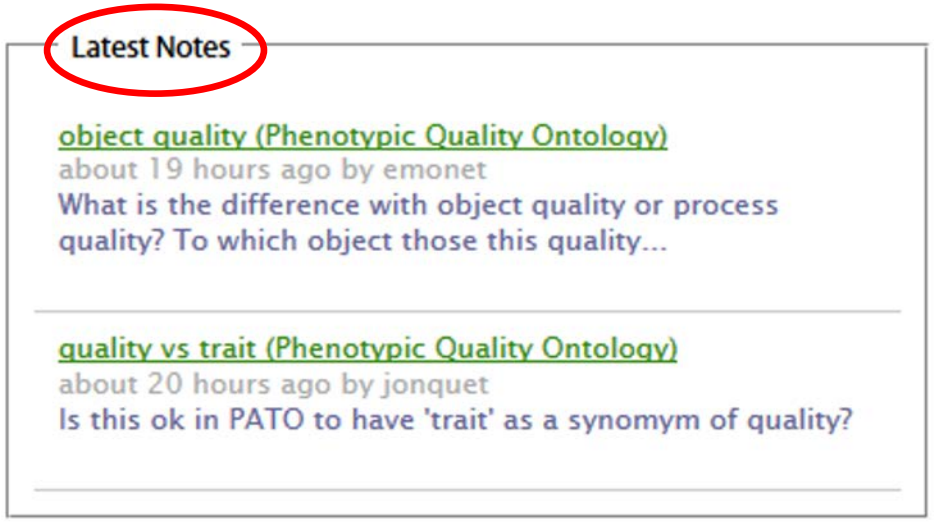
Details | Visualization | Notes ( 0 ) | Class Mappings ( 15 ) | Access Class JSON

| | |
|---|---|
| Preferred Name | leaf area |
| ID | http://opendata.inra.fr/anaeeThes/c4_2876 |
| broader | leaf |
| created | 2016-12-09T11:50:00Z |
| exactMatch | http://aims.fao.org/aos/agrovoc/c_16110 |
| hasStatus | |
| inScheme | |
| modified | |
| prefLabel | |



# Community based functionalities




# Building a list of properties to describe ontologies

- Pickup properties and relations from 23 existing vocabularies
- Existing properties in ontology repositories (especially BioPortal)
  - Non specific properties that may "return to the ontology"
- Map them all together
  - Strong overlap e.g., 25 properties to describe dates


346 relevant properties that could be used to described ontologies

127 used to build a new metadata model

# MOD 1.4 (August, 2018)

(https://www.isibang.ac.in/ns/mod/index.html)

Stable

## MOD: Metadata for Ontology Description and publication

### Release August 2, 2018

**This version:**
http://www.isibang.ac.in/ns/mod/1.4

**Latest version:**
http://www.isibang.ac.in/ns/mod/1.4

**Previous version:**
http://www.isibang.ac.in/ns/mod/1.2
https://www.isibang.ac.in/ns/mod/1.1
https://www.isibang.ac.in/ns/mod/1.0

**Revision:**
1.4

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**Publisher:**
http://www.isibang.ac.in/

**Download serialization:**
Format JSON LD | Format RDF/XML | Format N Triples | Format TTL

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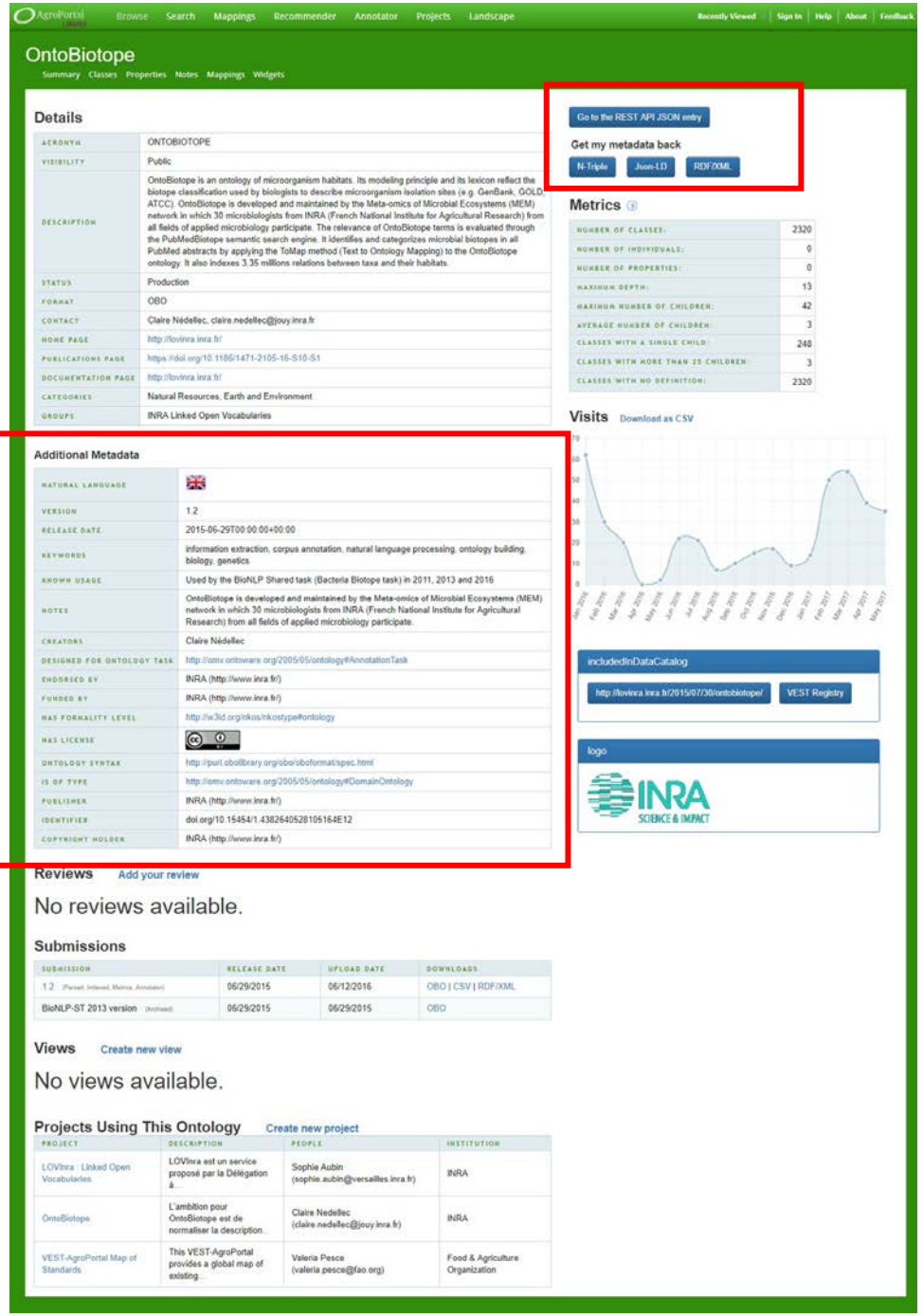
**Cite as:**
Dutta, B., Toulet, A., Emonet, V. and Jonquet, C. (2017). New Generation Metadata vocabulary Description and Publication. In E. Garoufallou, S. Virkus, R. Siatri and D. Koutso Communications in Computer and Information Science (CCIS) 755, proceedings of 11th M Semantics Research Conference (MTSR 2017), November 28 - December 1, 2017, Talli Springer Nature, pp. 173-185.


**Classes**: 24
**Object property**: 44
**Data property**: 96

# Describe ontologies with semantic metadata

- Display “per ontology”
  - Ontology specific properties => viewable and editable within the ontology specific page
- Everything you need to know about an ontology
- URIs used in the backend to store the information
  - e.g., CC-BY => https://creativecommons.org/licenses/by-nd/4.0/
- “Get my metadata back” buttons



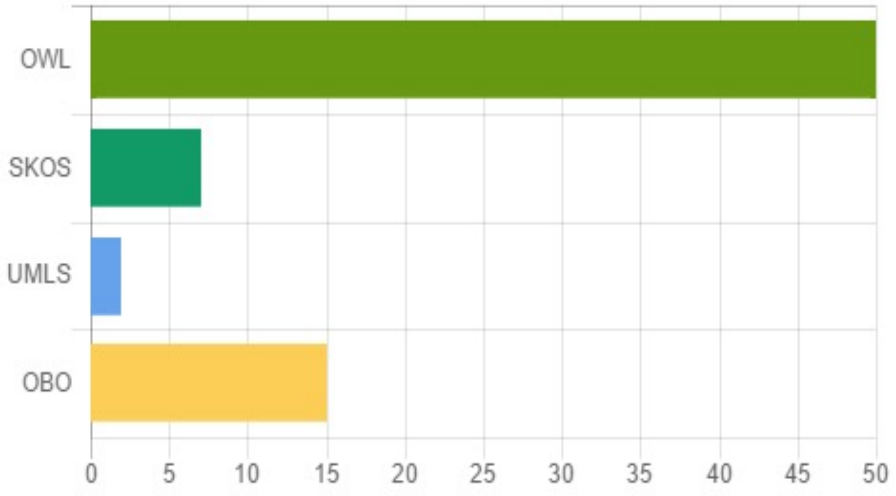

# AgroPortal landscape page

- Display “per property”
  - Global presentation of the properties
  - Synthesis diagrams & listing

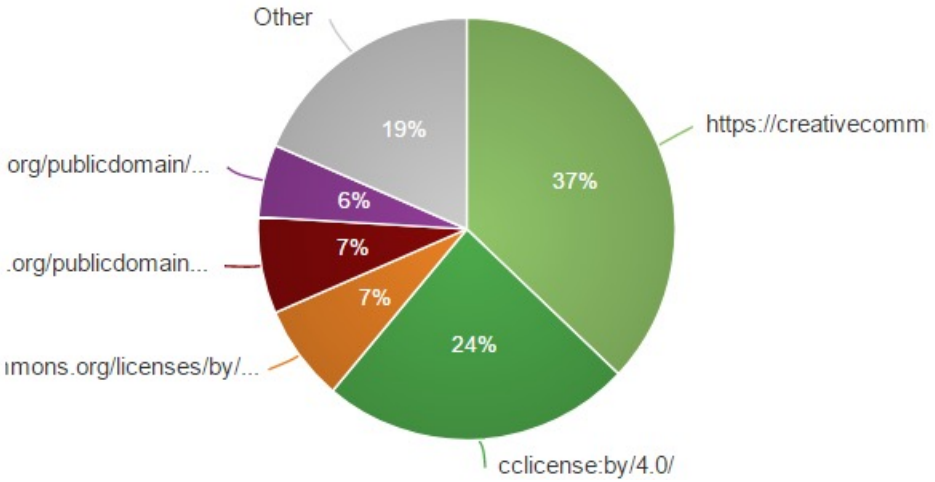
- Allows to explore the agronomical ontology landscape by automatically aggregating the metadata fields of each ontologies in explicit visualizations (charts, term cloud and graphs).

Clement Jonquet, Anne Toulet, Biswanath Dutta, Vincent Emonet. Harnessing the power of unified metadata in an ontology repository: the case of AgroPortal. *Journal on Data Semantics*, Springer, 2018, pp.1-31.

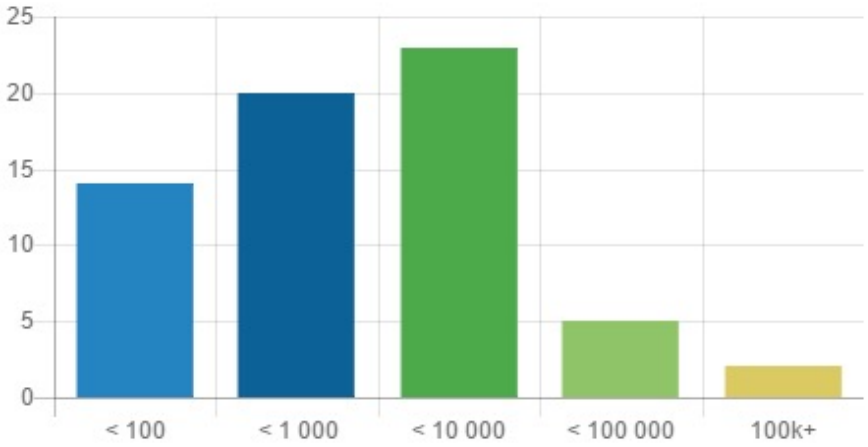
# Format



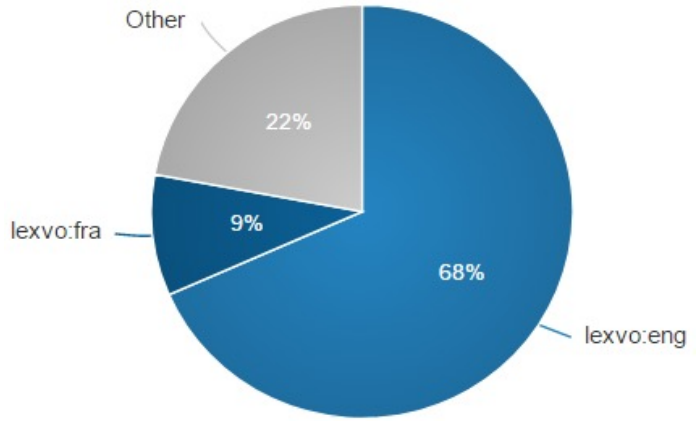

# License



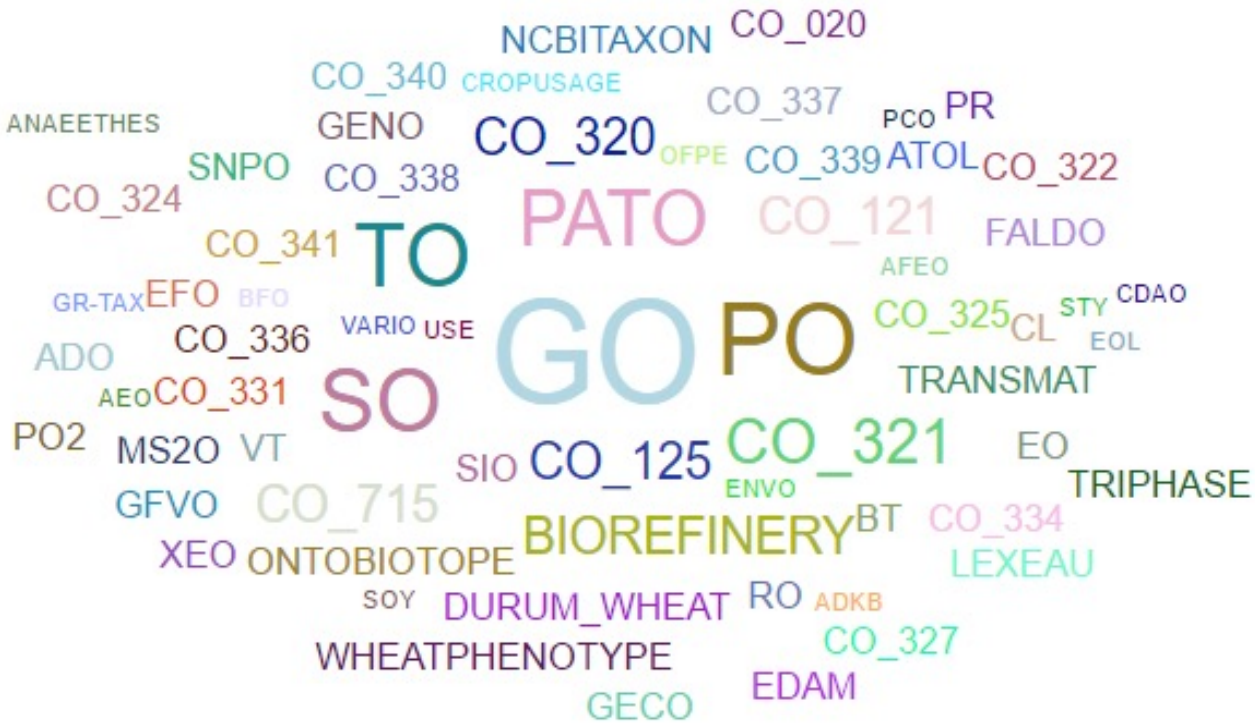

# Size



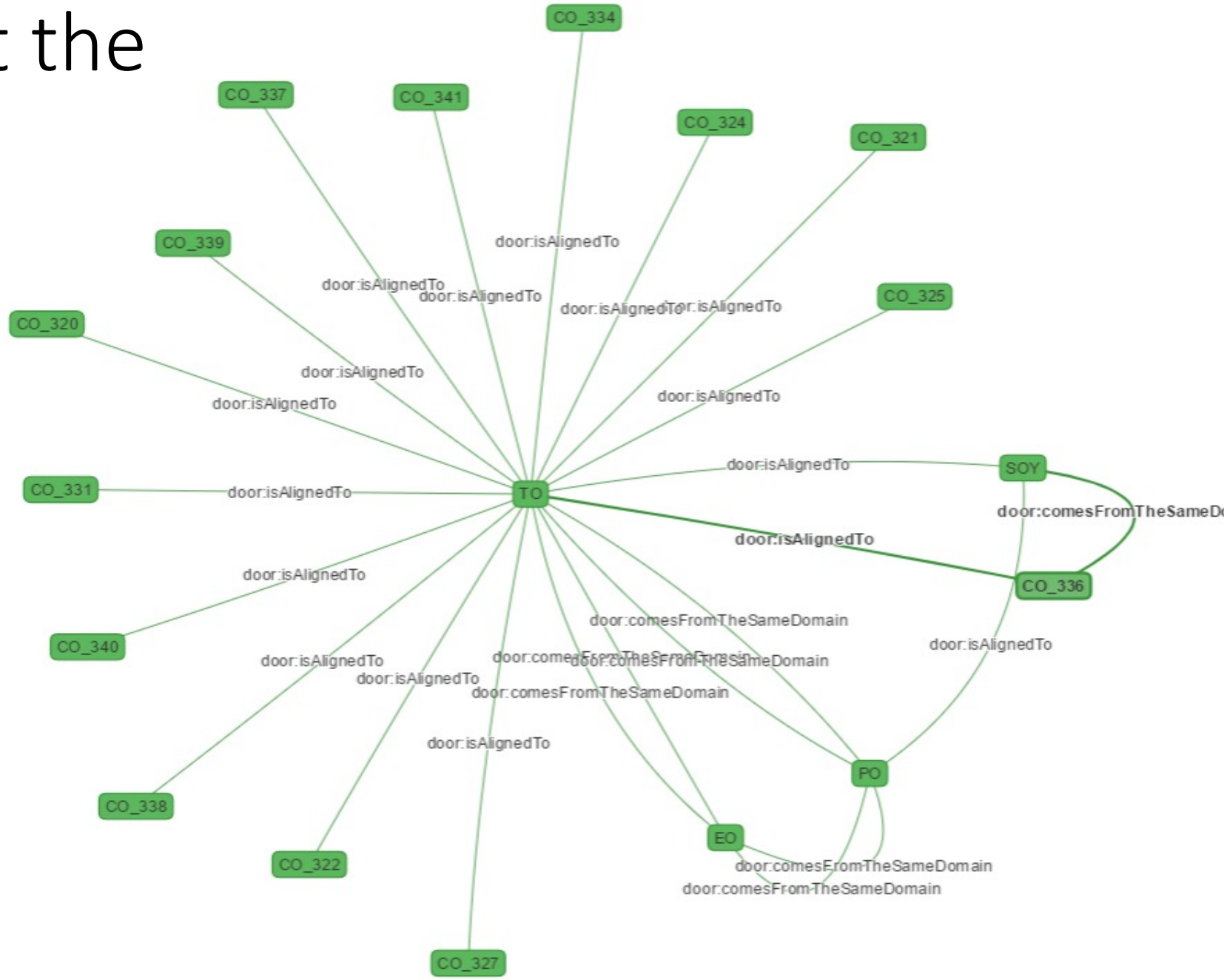

# Language



# Information about the community

# Information about the ontology network



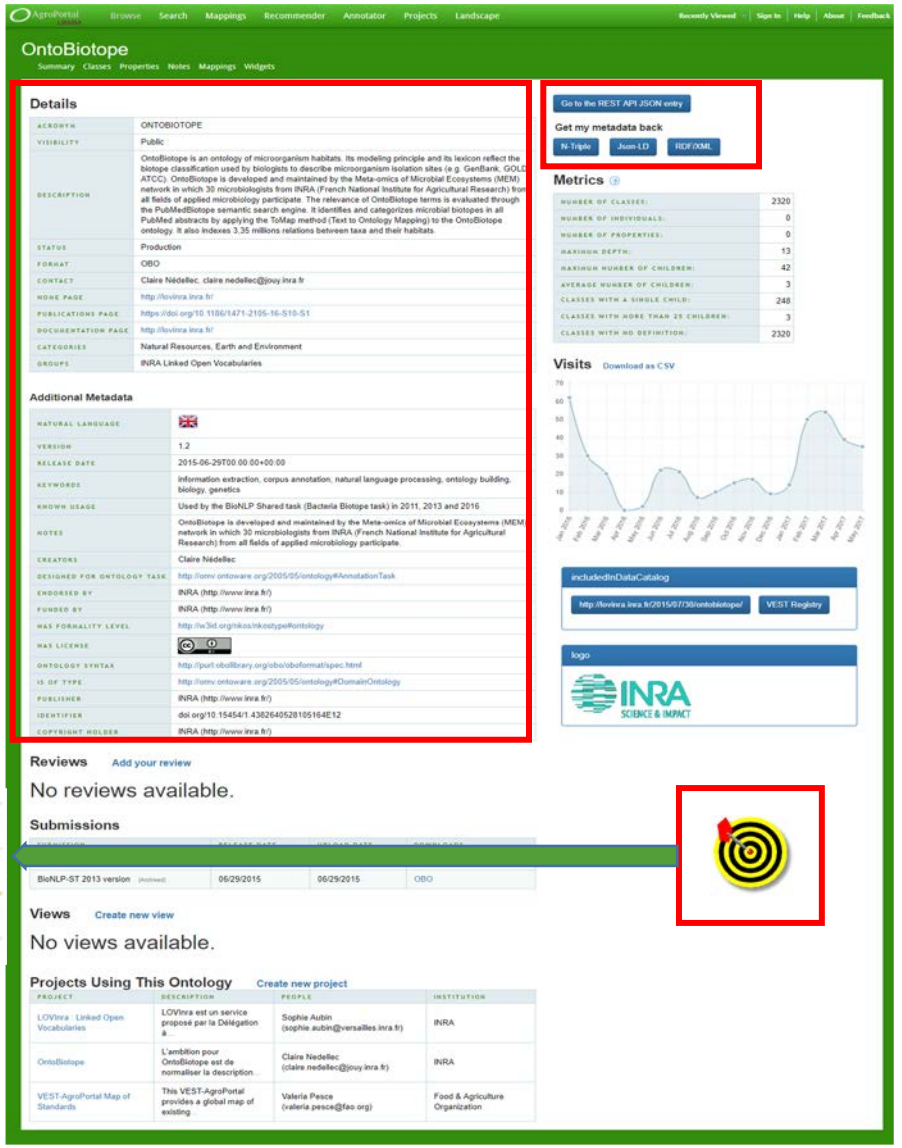
- [ ] omv:useImports
- [ ] door:isAlignedTo
- [x] door:ontologyRelatedTo
- [ ] omv:isBackwardCompatibleWith
- [ ] omv:isIncompatibleWith
- [x] door:comesFromTheSameDomain
- [x] door:similarTo
- [ ] door:explanationEvolution
- [ ] voaf:generalizes
- [ ] door:hasDisparateModelling
- [ ] dct:hasPart
- [ ] voaf:usedBy
- [ ] schema:workTranslation
- [ ] schema:translationOfWork

Filter Network

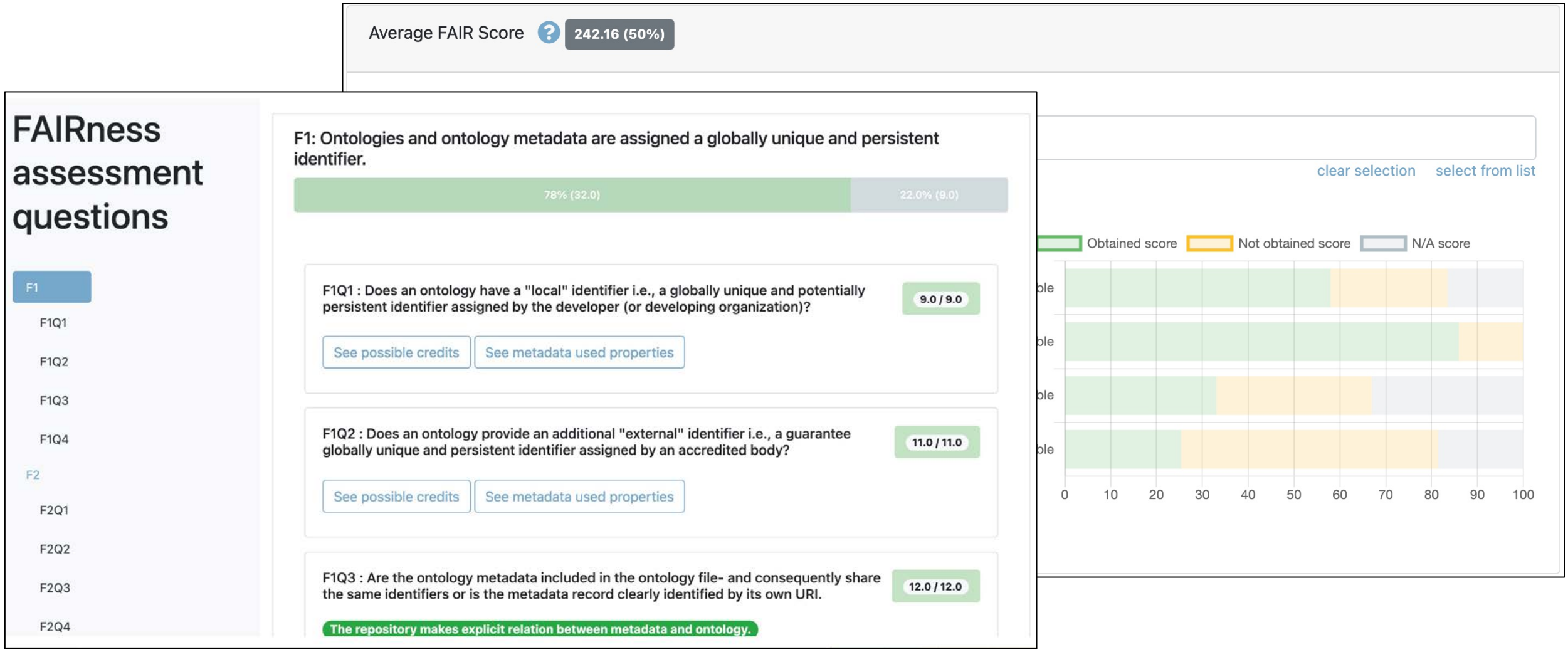
# Our objective now: automatic FAIRness assessment of an ontology

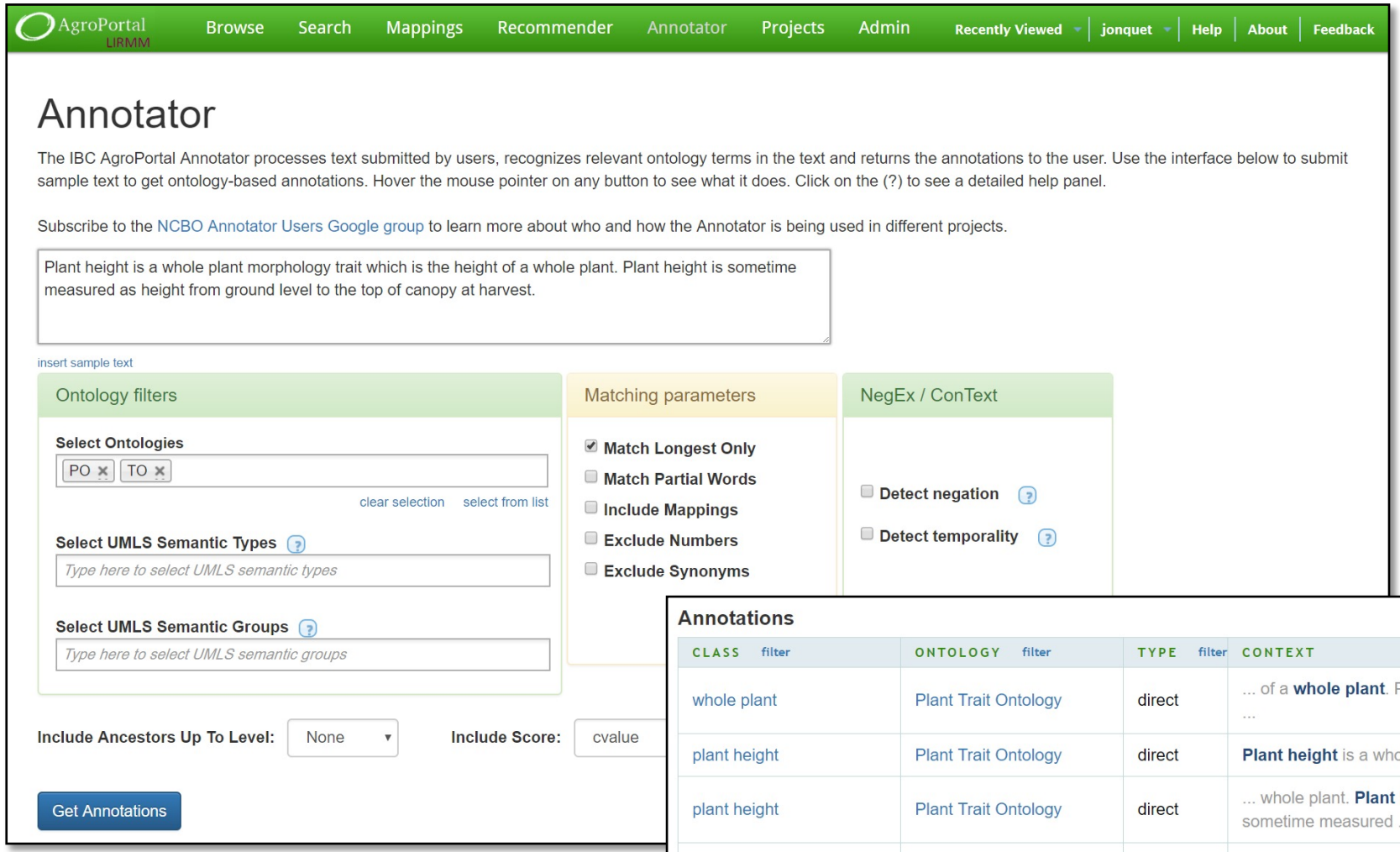
1. within AgroPortal
2. outside of AgroPortal

- Enhance the level FAIRness of ontologies.
- Help users respect the I2 FAIR principle.
- Help users in identifying FAIR ontologies.
- Provide useful analysis of the semantic agronomic landscape.

# Ontology FAIRness assessment
(to be released end 2021!!)






# AgroPortal Annotator

## identifies ontology concepts within plain text for semantic indexing

**Annotations**

*total results 7 (direct 7 / ancestor 0 / mapping 0)*

| CLASS filter | ONTOLOGY filter | TYPE filter | CONTEXT | MATCHED CLASS filter | MATCHED ONTOLOGY filter | SCORE |
|---|---|---|---|---|---|---|
| whole plant | Plant Trait Ontology | direct | ... of a **whole plant**. Plant height is ... | whole plant | Plant Trait Ontology | 10.000 |
| plant height | Plant Trait Ontology | direct | **Plant height** is a whole ... | plant height | Plant Trait Ontology | 8.644 |
| plant height | Plant Trait Ontology | direct | ... whole plant. **Plant height** is sometime measured ... | plant height | Plant Trait Ontology | 8.644 |
| whole plant morphology trait | Plant Trait Ontology | direct | ... is a **whole plant morphology trait** which is the ... | whole plant morphology trait | Plant Trait Ontology | 6.644 |
| whole plant | Plant Ontology | direct | ... of a **whole plant**. Plant height is ... | whole plant | Plant Ontology | 6.644 |
| height | Plant Trait Ontology | direct | ... is the **height** of a whole ... | height | Plant Trait Ontology | 4.322 |
| height | Plant Trait Ontology | direct | ... measured as **height** from ground level ... | height | Plant Trait Ontology | 4.322 |

**Format Results As:** JSON

Sprouting
Initial Vigor
Color of unexpanded apical leaves
Color of first fully expanded leaf
Leaf vein color
Apical Pubescence
Length of stipules
Number of leaf lobes
Leaf lobe position
Angle of petiole insertion
Petiole length
Petiole color
Anthocyanin pigmentation
Growth habit of young stem
Pubescence of young stem
Stem color
Leaf scar prominence
Apical branching
Branching levels
Branching Angle
Height of first apical branch
Height of plant
Total fresh weight foliage and stems
Total fresh weight foliage and stems
Number harvested

Root number
Fresh weight of storage root
Fresh root yield
Dry yield
Harvest index
Proportion of lodged plants
Leaf retention
Plant architecture
Flowers (50%)
Sepal Color
Disc Color
Sigma color
Ovary color
Anther color
Female stamenoids
Male Sterile
Days to Flower
Fruit set
Fruit Exocarp
Ploidy
Seed oclor

AgroPortal LIRMM Browse Search Mappings

## Annotator

The IBC AgroPortal Annotator processes text submitted by user
on any button to see what it does. Click on the (?) to see a detai

Subscribe to the NCBO Annotator Users Google group to learn

Plant architecture
Flowers (50%)
Sepal Color
Disc Color

Cassava Trait Ontology

Ontology filters

Select Ontologies

CO_334 ×

clear selection select from list


```
- {
  - annotatedClass: {
      @id: "http://www.cropontology.org/rdf/CO_334:0000386",
      @type: "http://www.w3.org/2002/07/owl#Class"
    },
    hierarchy: [ ],
  - annotations: [
    - {
        from: 11,
        to: 23,
        matchType: "PREF",
        text: "INITIAL VIGOR"
      }
    ],
```

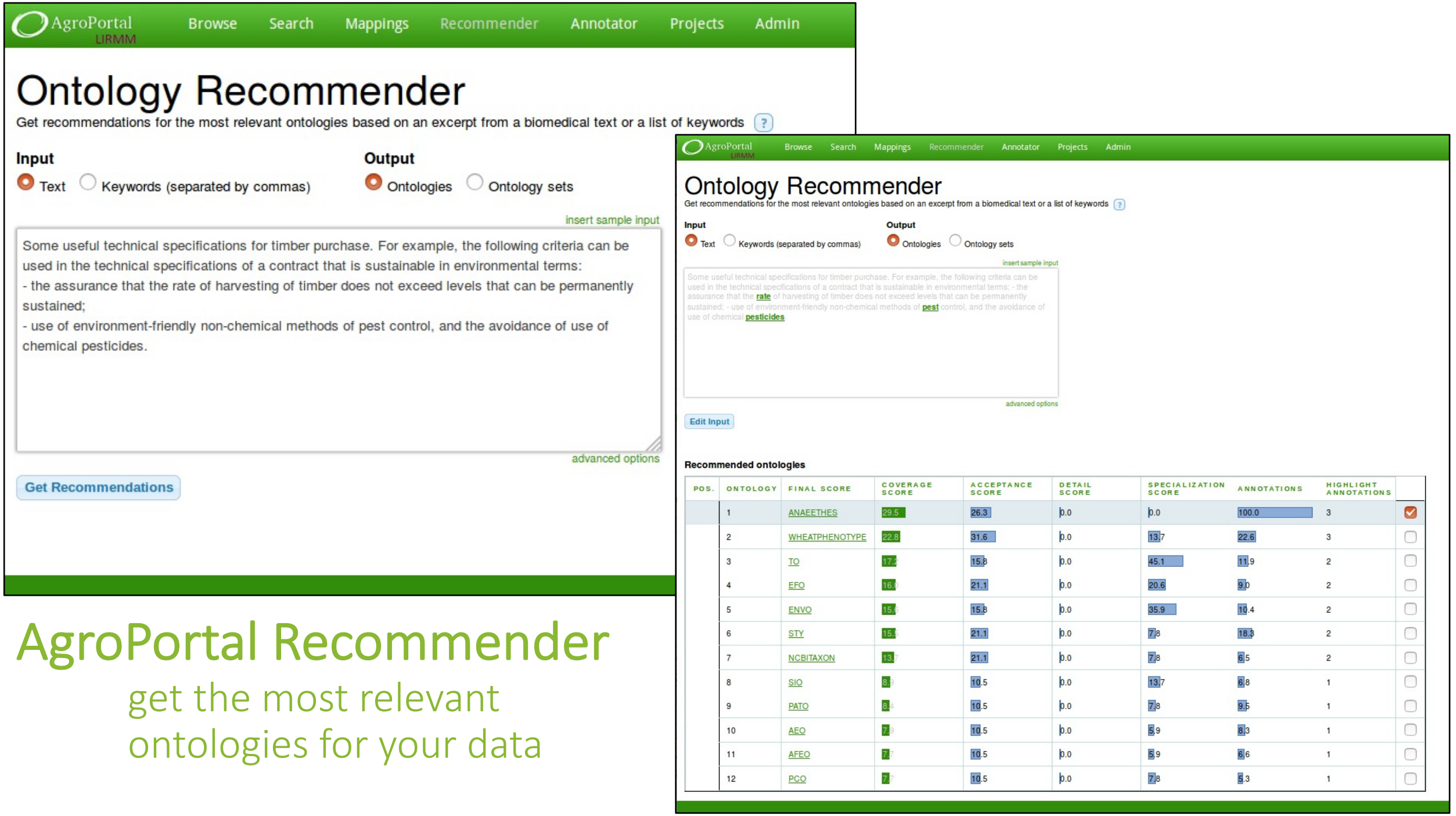

## Cassava Trait Ontology

Summary Classes Properties Notes Mappings Widgets

Jump To:

- Cassava trait
  - Agronomical trait
    - Anthocyanin Pigmentation
    - Ease of Harvest
    - Female Stamenoids
    - Fresh Shoot Weight
    - Fruit Exocarp Texture
    - Fruit set presence
    - **Initial Vigor**
    - Leaf weight
    - Male Sterile
    - Marketable root number

| | |
|---|---|
| Preferred Name | Initial Vigor |
| Synonyms | Initial plant vigor |
| Definitions | Initial plant vigor at one month after planting |




# AgroPortal Recommender

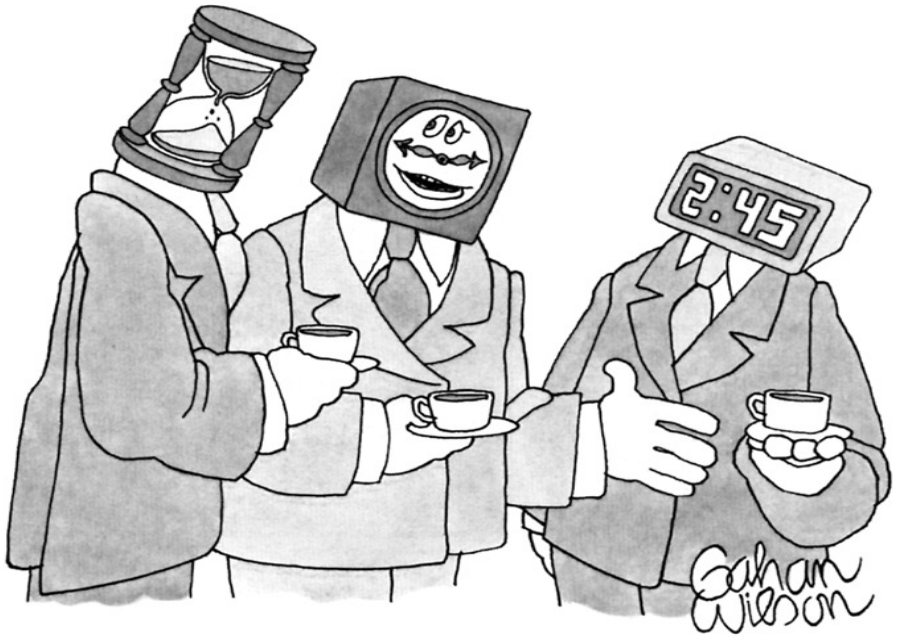
## get the most relevant ontologies for your data

# Ontology alignment

- Ontologies, vocabularies, and terminologies inevitably overlap in coverage

- Mappings do not always belong to an ontology
  - The community needs a place to store and retrieve them
  - That's the role of the ontology repository

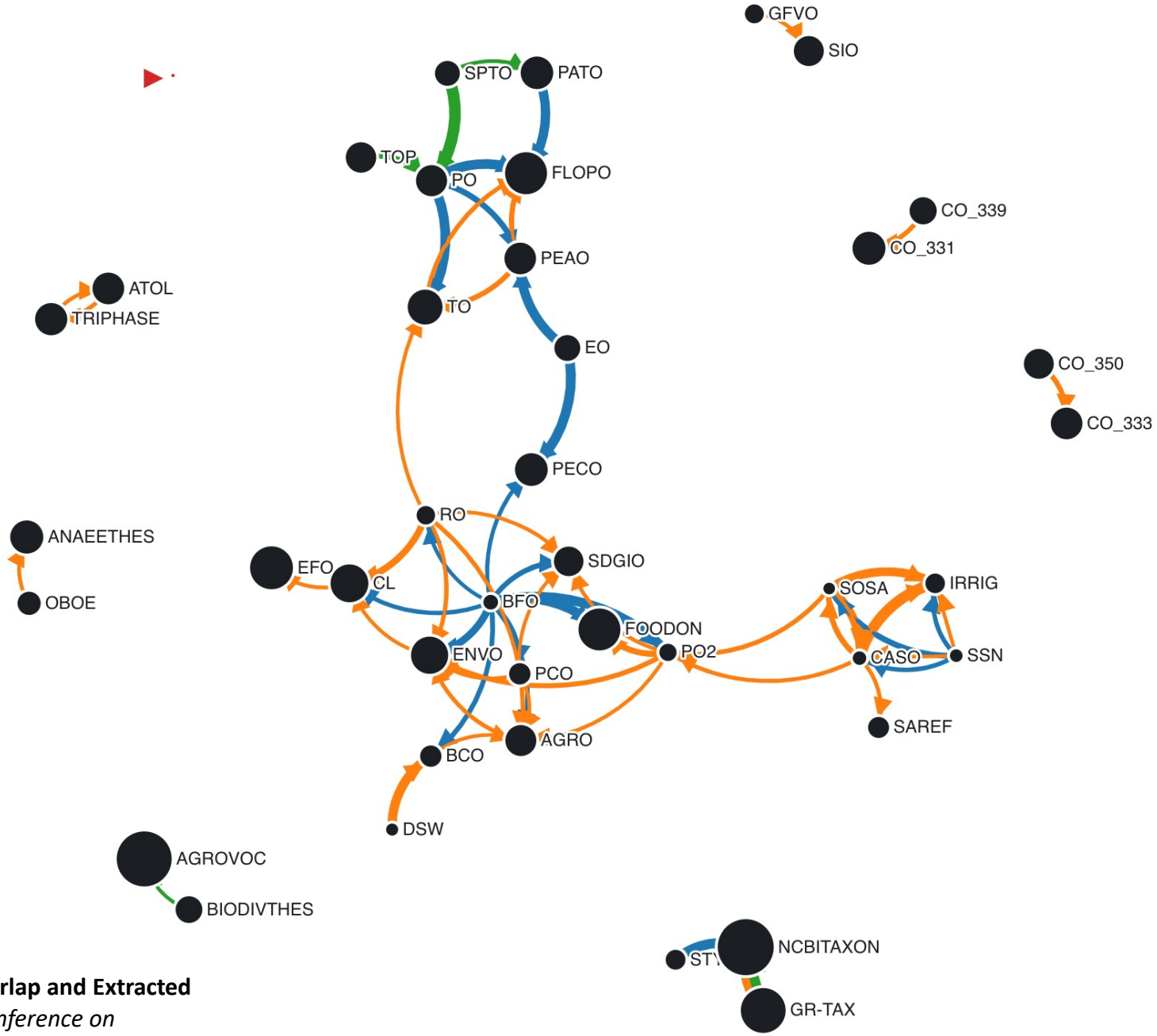
- Dealing with mappings is a technical, data and scientific challenge
  - Capture the whole mapping lifecycle
  - Semantically described with plenty of provenance information




*"Basically, we're all trying to say the same thing."*

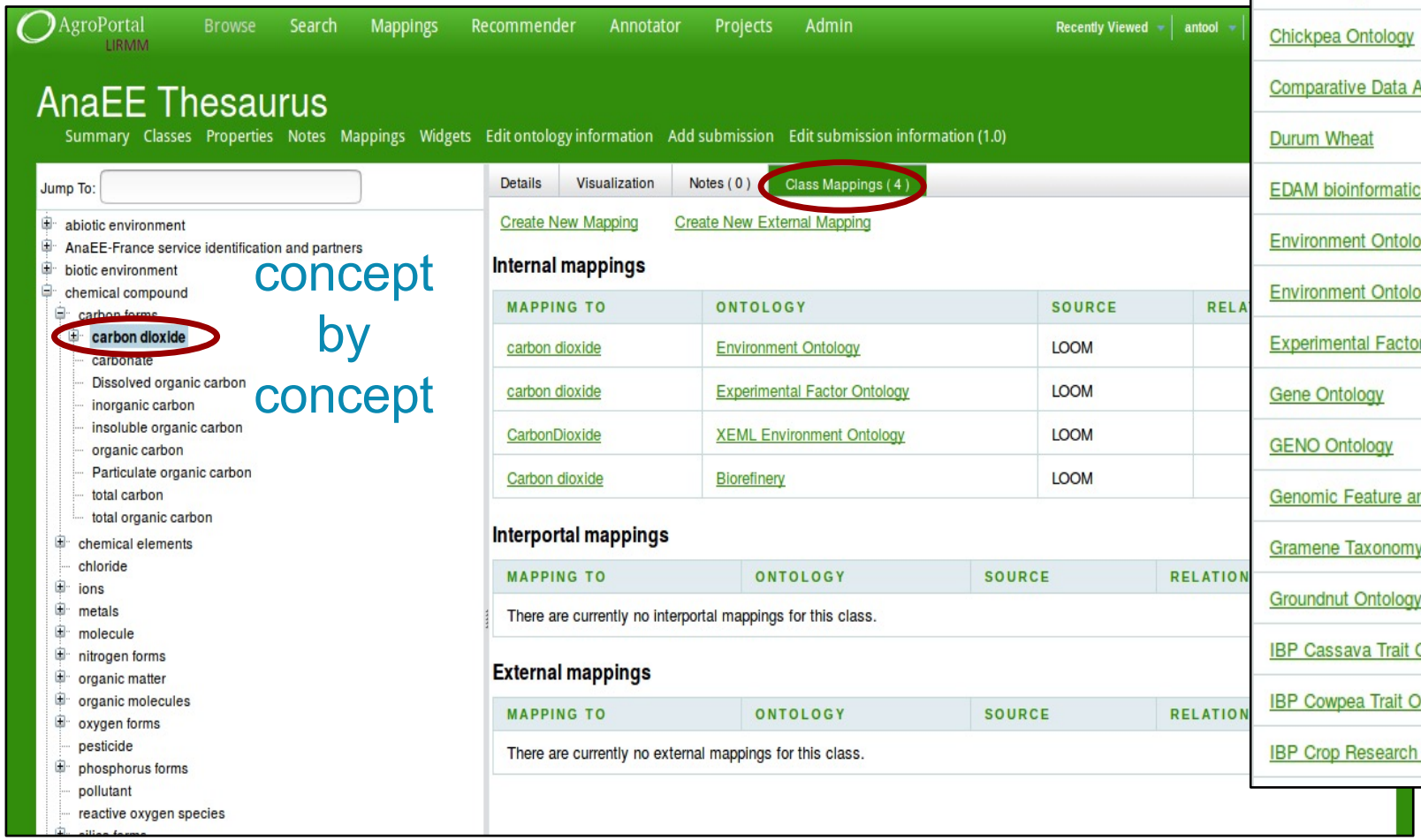
# All aspects of ontology alignments

# Term reuse, term overlap and extracted mappings




A. Laadhar, E. Abrahão, C. Jonquet. **Analysis of Term Reuse, Term Overlap and Extracted Mappings across AgroPortal Semantic Resources**. In *International Conference on Knowledge Engineering and Knowledge Management*, pp. 71-87, 2020.

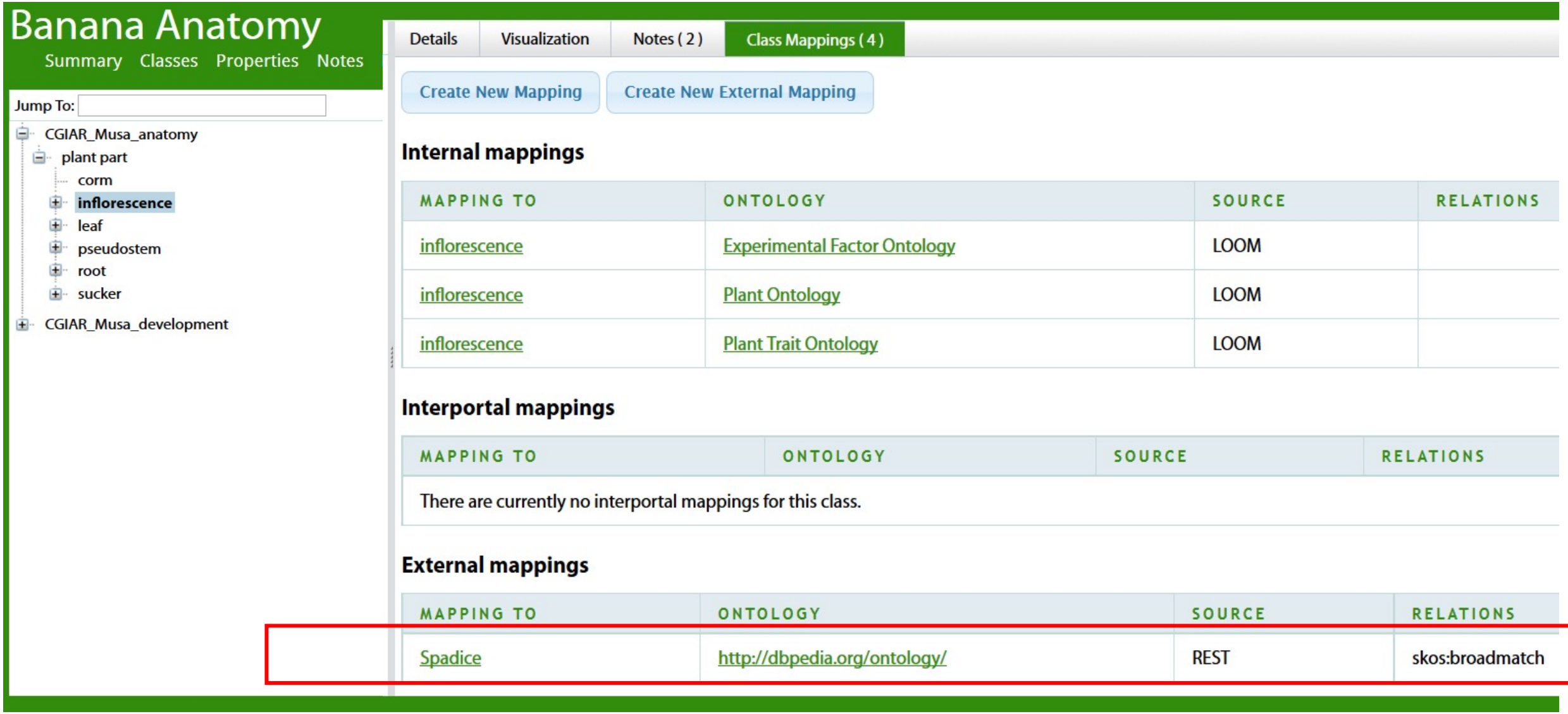
# Align ontologies one another




## Mappings

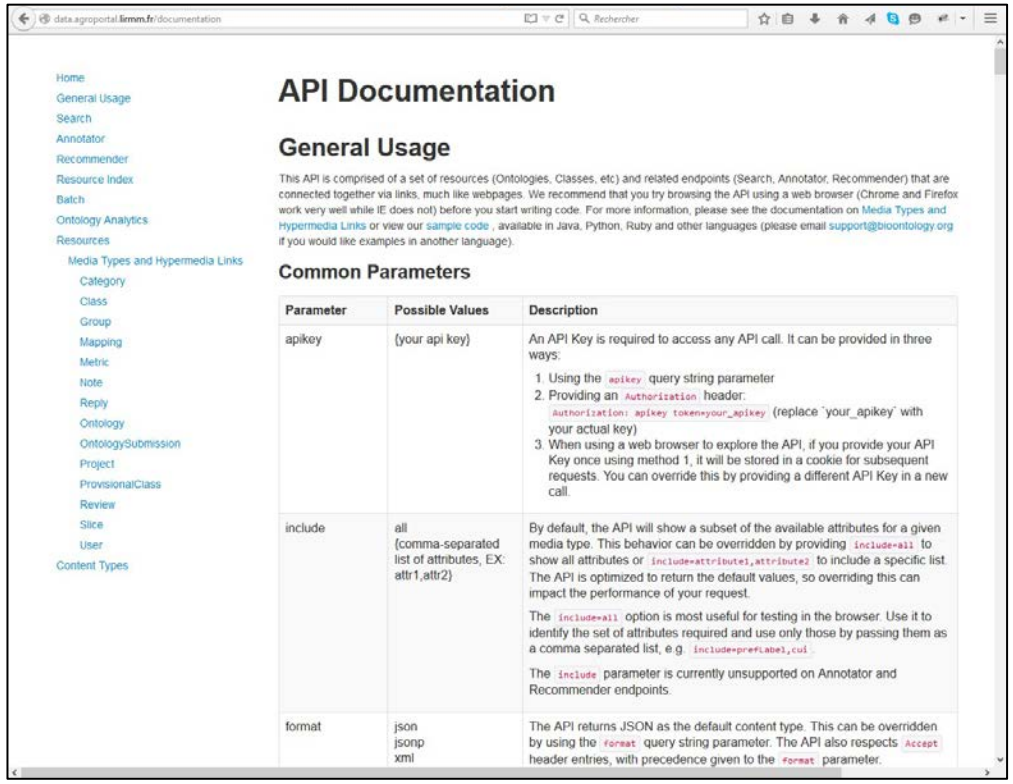
| ONTOLOGY | MAPPINGS |
|---|---|
| Agri-Food Experiment Ontology | 1 |
| Agricultural Experiments Ontology | 5 |
| Banana Anatomy | 2 |
| Basic Formal Ontology | 1 |
| Biorefinery | 13 |
| Cell Ontology | 4 |
| Chickpea Ontology | 14 |
| Comparative Data Analysis Ontology | 3 |
| Durum Wheat | 2 |
| EDAM bioinformatics operations, data types, formats, identifiers and topics | 25 |
| Environment Ontology | 72 |
| Environment Ontology for Livestock | 10 |
| Experimental Factor Ontology | 93 |
| Gene Ontology | 5 |
| GENO Ontology | 5 |
| Genomic Feature and Variation Ontology | 5 |
| Gramene Taxonomy Ontology | 3 |
| Groundnut Ontology | 16 |
| IBP Cassava Trait Ontology | 23 |
| IBP Cowpea Trait Ontology | 25 |
| IBP Crop Research Ontology | 22 |

# Enable to store external mappings
# i.e., mappings that only one part is in BioPortal



# REST Service API:

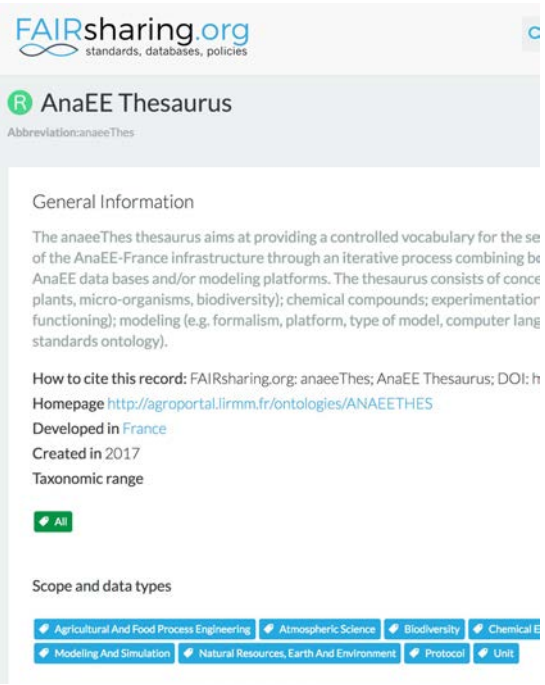
http://data.agroportal.lirmm.fr/documentation




# SPARQL endpoint:

http://sparql.agroportal.lirmm.fr

# Harvesting AgroPortal ontologies and vocabularies into FAIRsharing


Both manually curate the metadata … better synchronization of the fields to come….

AgroPortal has a new metadata model of 127 properties to describe ontologies & vocabularies

# Conclusions

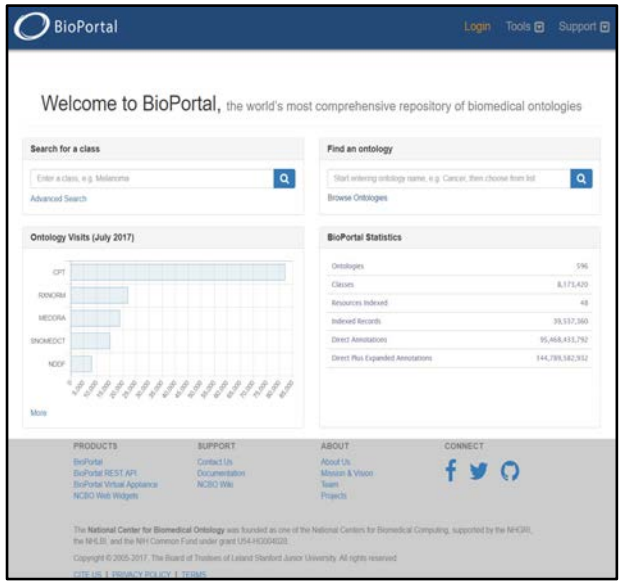
# ANR Project D2KAB: Data to Knowledge in Agronomy and Biodiversity (2019-2023)

*Create a framework to **turn agronomy and biodiversity data into knowledge –semantically described, interoperable, actionable, open–** and investigate scientific methods and tools to exploit this knowledge for applications in science & agriculture*

- How: Ontologies & Linked Open Data
  - 1 work-package on building and harnessing knowledge graphs
  - 2 work-packages of driving ag & biodiv projects (food packaging, agro-agri linked data, wheat phenotype, ecosystems & plant biogeography)

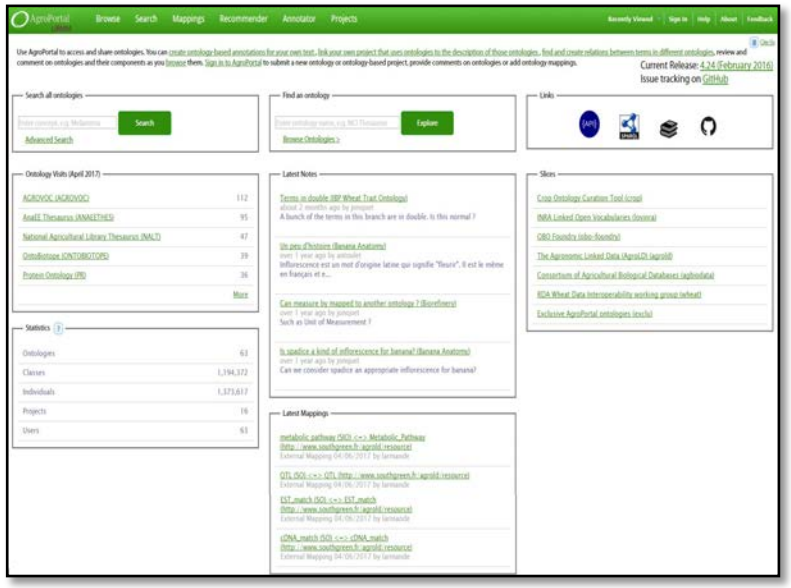
# We develop and maintain ontology repositories in the OntoPortal Alliance (1/2)

## BioPortal



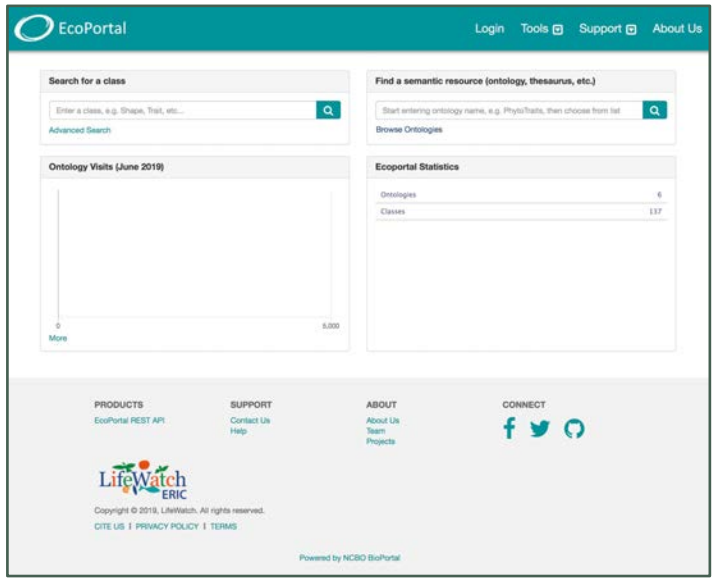

http://bioportal.bioontology.org

## AgroPortal




http://agroportal.lirmm.fr

## EcoPortal

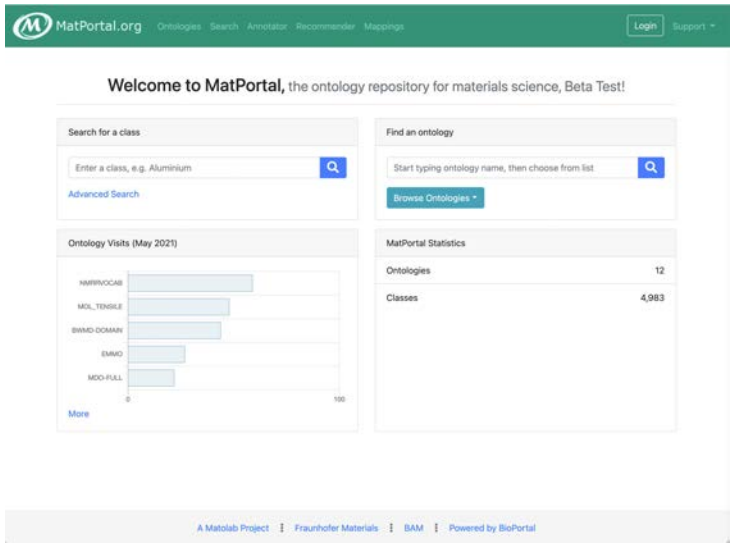



http://ecoportal.lifewatchitaly.eu

# We develop and maintain ontology repositories in the OntoPortal Alliance (2/2)

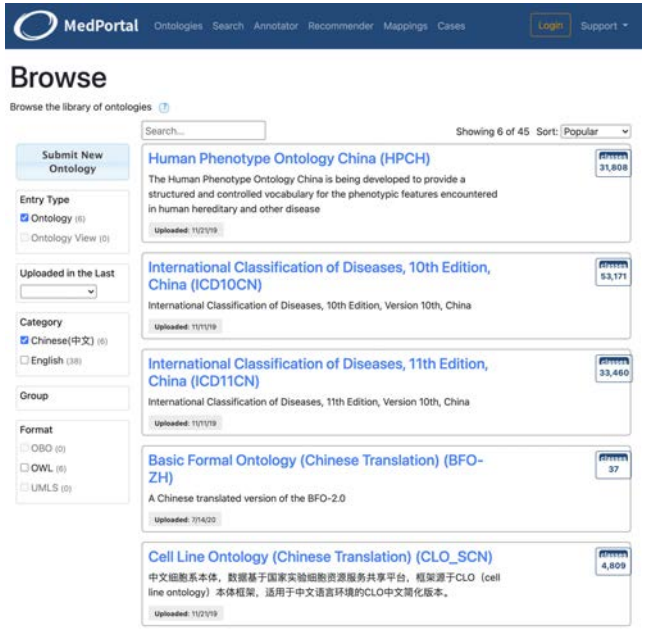
BAM Fraunhofer MATERIALS

MatPortal




https://matportal.org/

MedPortal




http://medportal.bmicc.cn/

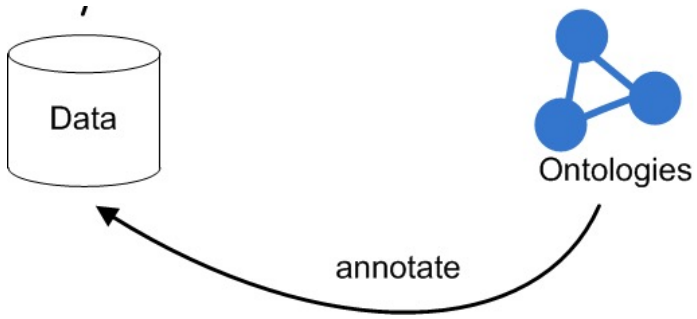
And other installations with

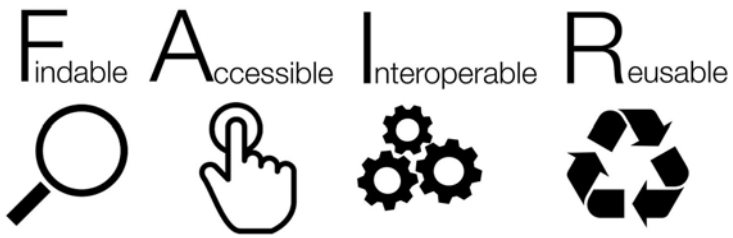
Cogni.zone



# Take home message

- Join us with your ontology project




# Credits (people & support)

OntoPortal team (from 2015 to 2021)

- Vincent Emonet
- Anne Toulet
- Andon Tchechmedjiev
- Amine Abdaoui
- Elcio Abrahao
- Amir Laadhar
- Jerome Lamarque
- Emna Amdouni
- Syphax Bouazzouni


# Questions ?

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