

Webinar – 15th- 16th December 2020

Using ontologies to improve animal science research

Organizing center: INRAE (France)

Target participants: Scientists, RI technicians, Bachelor, Master or PhD students

Objectives

- Understand the usefulness of the ontologies to annotate experimental dataset
- Use these ontologies and reference them in publications
- Use the ontologies adapted to SmartCow

Pre requisite skills: Basic knowledge in biology

Program

Tuesday 15 December 2020, 9:45 – 15:30

9:45-10:00 Introduction of the course by R. Baumont and C. Hurtaud, INRAE (France)

10:00 -12:00 What is an ontology? by Olivier Dameron, University of Rennes 1 (France)

1. Definition
2. History
3. Examples of use of ontologies (application of ontologies)
4. Exercises:
 - i. How to build a small ontology?
 - ii. How to use ontologies to annotate data with the open-source editor Protégé?
 - iii. How to use ontologies to retrieve data with the open-source editor Protégé?

12:00 – 13:30 lunchbreak

13:30-15:30 The ontology engineering lifecycle and its best practices by Monika Solanki, Agrimetrics (UK)

Wednesday 16 December, 10:00 -12:00

1. Presentation of French ontologies from INRAE
 - a. ATOL ontology by Catherine Hurtaud and Linh Chi Nguyen, INRAE (France) (25 min)
 - b. EOL ontology by Jérôme Bugeon, INRAE (France) (15 min)
 - c. AHOL ontology by Marie-Christine Meunier-Salaün, INRAE (France) (15 min)
2. Example of application/use of an ontology AHOL for professional use, by Marie-Christine Meunier-Salaün, INRAE (France) (20 min)
3. Text based annotation with ontologies, Claire Nédellec INRAE (France) (45 min)

SmartCow

*an integrated infrastructure for increased
research capability and innovation in the
European cattle sector*

Webinar

**Using ontologies to improve
animal science research**

Dr. René Baumont (INRAE, Project Coordinator)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement n°730924

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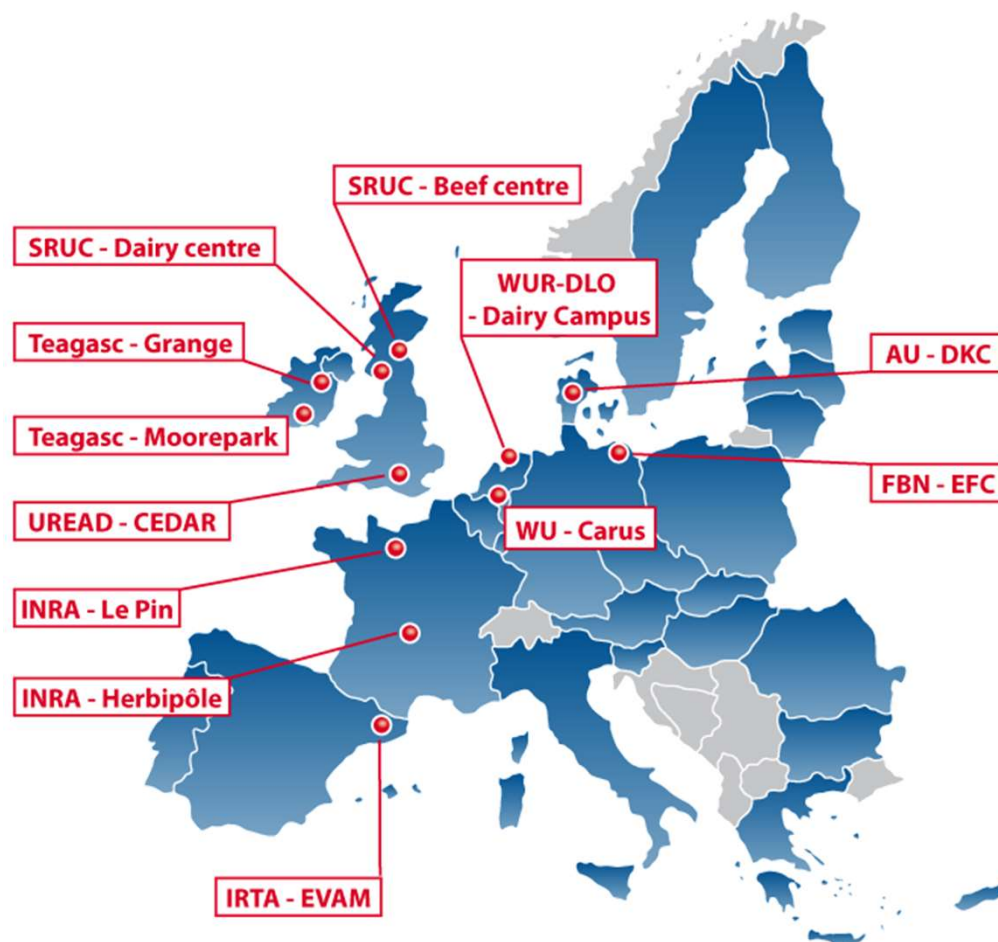
Concept and objective of SmartCow

- Better coordination of research infrastructures (RIs) in the cattle sector is necessary to develop more efficient approaches to address the various challenges in cattle breeding and research
- SmartCow is a first step towards the integration of RIs for the European cattle sector, developing:
 - **Networking activities:** mapping RIs, adopting common language, the best standardized techniques and data sharing
 - **Joint research activities:** improving GSM and 'proxies' to phenotype new and more complex animal traits
 - **Transnational access:** providing researchers an easy access to high quality services and resources



SmartCow at a glance

2018 - 2022



First-class Cattle Research Infrastructures (RIs) across Europe:

- 11 major RIs distributed in 7 EU countries
- 12 locations, which include 18 installations
- 2500 dairy and 1000 beef cows

- **Networking of RIs** to inventorize resources, harmonize procedures, and share data
 - **Joint research activities** to improve experimental methods and phenotyping capability
 - **Interaction with stakeholders** to stay in line with industry needs and improve dissemination
- <http://www.smartcow.eu/stakeholders/>

TRAINING PROGRAM

For Scientists, Technicians, Stakeholders, PhD students

- Face-to-face training courses
- Free web-conferences
- One-day study tours in 4 different countries

<http://www.smartcow.eu/resources/training/>

TRANSNATIONAL ACCESS CALLS

Offers external users (academic and industry) free access to SmartCow RIs

- 30 projects during the 4 years of SmartCow
- Access to around 10,000 cow-weeks

<http://www.smartcow.eu/calls/>



This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement n°730924.



A training and study tour program

It consists of:

- Face-to-face training courses (1-3 days)
- Web conference training courses, accessible with PC, Internet + phone (2 hours)
- One-day study tours

It aims to share the results of the project : methods, techniques, use of tools...

- *CH4 emissions, Feed efficiency, Ethics in animal experimentation, NIRS, Sensors, Ontologies...*

It includes lectures, exchanges with scientists, visit of RI facilities and farms...

...But Covid-19 crisis obliged turning into webinar all training activities since March 2020...



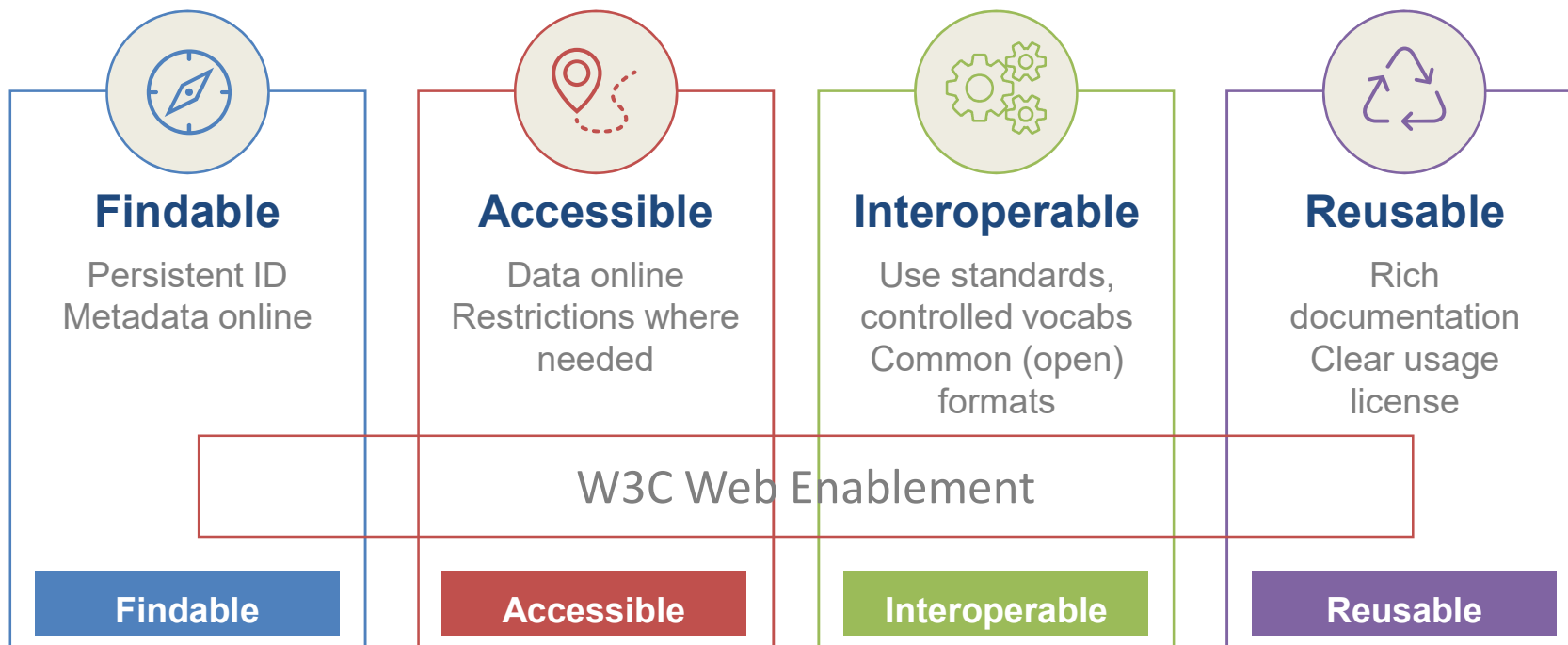
Research infrastructures in SmartCow

- Large range of data are obtained on animals, feeds and environment in various conditions



FAIR Principles in SmartCow

- Principles to ensure that data are shared in a way that enables & enhances reuse, by humans and machines



Source: <https://doi.org/10.5281/zenodo.1065991>

Ontologies in SmartCow

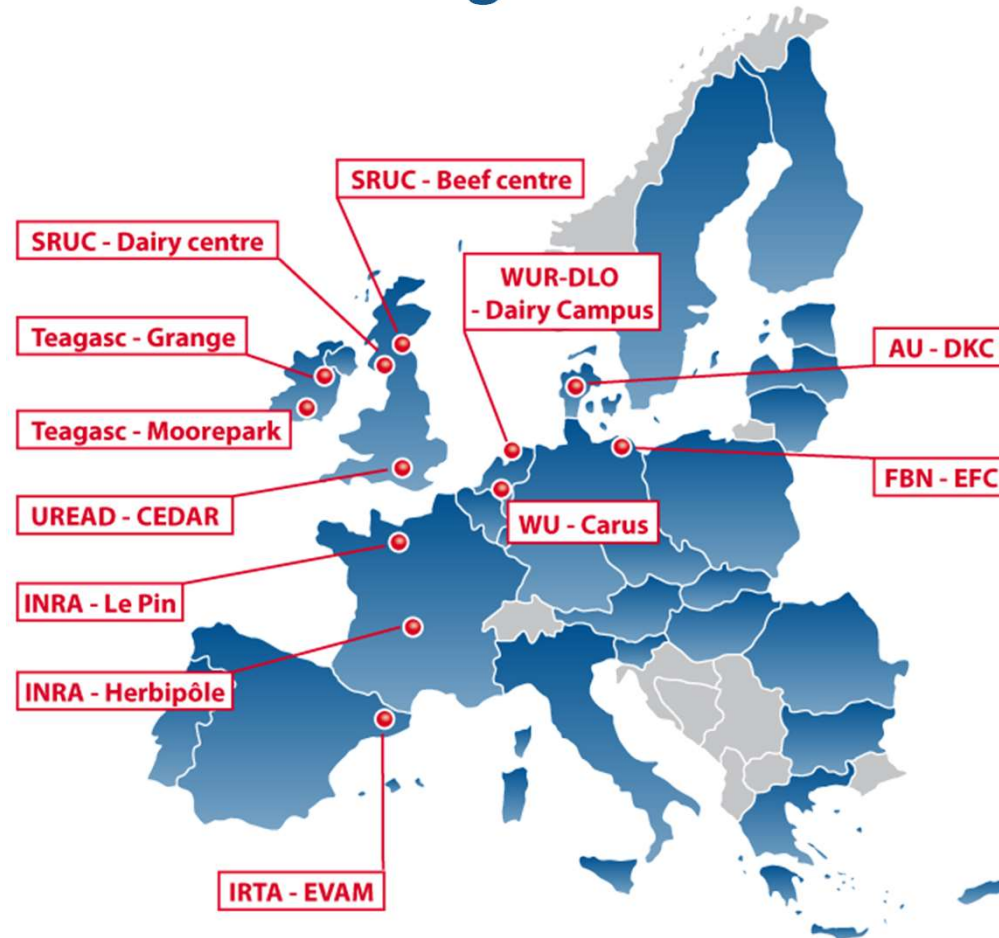
- The DMP outlines the use of a **common language to describe data** and the development of a tool that allow to exploit data in accordance with FAIR principles:
 - Use of open standards and open **data ontologies** to simplify access and inter-operability of data
 - ➔ *Improve and foster the use of ATOL, EOL and AHOL*
 - ➔ *92 new terms added since the beginning of SmartCow*
 - Development of a **cloud-based data platform** to upload, control sharing and link the data to get additional insights and store the data beyond the life of the project.
 - **Standardize the vocabulary** and make links between how observations are described and **livestock ontologies**



Thank you for your attention



SmartCow at a glance



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*an integrated infrastructure for increased
research capability and innovation in the
European cattle sector*

Webinar:

**Using ontologies to improve animal
science research**

15-16 December 2020

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Program of the webinar

Tuesday 15 December morning 9:45-12:00

- ❑ 9:45-10:00 Introduction of the course by R. Baumont and C. Hurtaud, INRAE (France)
- ❑ 10:00 -12:00 What is an ontology? by Olivier Dameron, University of Rennes 1 (France)
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- ❑ 12:00 – 13:30 Lunchbreak



Program of the webinar

Tuesday 15 December afternoon

- 13:30-15:30 The ontology engineering lifecycle and its best practices by Monika Solanki, Agrimetrics (UK)

Part 1 - 45 minutes presentation, Q&A and a 5 minutes break

Part 2- 45 minutes presentation, hands-on & Q&A



Program of the webinar

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 - c. AHOL ontology by Marie-Christine Meunier-Salaün, INRAE (France) (15 min)
- ❑ 10:55-11:15 Example of application/use of an ontology AHOL for professional use, by Marie-Christine Meunier-Salaün, INRAE (France) (20 min)
- ❑ 11:15-12:00 Text based annotation with ontologies, Claire Nédellec INRAE (France) (45 min)



During the webinar

- ☐ If you have a question, please use the chat.
- ☐ Linh Chi and I will be moderators for the questions. We will ask the questions for you during or after the presentations

Have a good webinar from :



Rennes, France



Paris, France



Reading, Great Britain



What is an ontology?

Olivier Dameron

Université de Rennes 1

15 December 2020



“Ontologies make people happier”
Ph. Rocca-Serra, 2011-10-18

Life science data

Big data and the deluge of life science data

Big data

Datasets so **large** or **complex** that traditional data processing is inadequate [Laney2001]

Life science: data deluge [Aldhous1993]

- computerized biomedical data
- genomics and bioinformatics

Science, 1993 Oct 22;262(5133):502-3.

Managing the genome data deluge.

Aldhous P.

PMID: 8211171 [PubMed - indexed for MEDLINE]

Science, 1995 Aug 4;269(5224):630.

Europe opens institute to deal with gene data deluge.

Williams N.

PMID: 7624788 [PubMed - indexed for MEDLINE]

Too much data for current processing capabilities

- data production rates outpace CPU improvements
- current analysis methods do not scale up

The Widening Gulf between Genomics Data Generation and Consumption: A Practical Guide to Big Data Transfer Technology



Frank A. Feltus¹, Joseph R. Breen III², Juan Deng³, Ryan S. Izard³, Christopher A. Konger⁴, Walter B. Ligon III³, Don Preuss⁵ and Kuang-Ching Wang³

BIOINFORMATICS AND BIOLOGY INSIGHTS 2015:9(S1)

What to expect for 2025?

Our estimation is that genomics is a “four-headed beast” – it is either **on par with or the most demanding domain** [...] in terms of

- data acquisition
- data storage
- data distribution
- **data analysis**

Big Data: Astronomical or Genomical?

Zachary D. Stephens¹, Skylar Y. Lee¹, Faraz Faghri², Roy H. Campbell², Chengxiang Zhai³, Miles J. Efron⁴, Ravishanker Iyer¹, Michael C. Schatz^{5*}, Saurabh Sinha^{3*}, Gene E. Robinson^{6*}

PLOS Biology | DOI:10.1371/journal.pbio.1002195 July 7, 2015

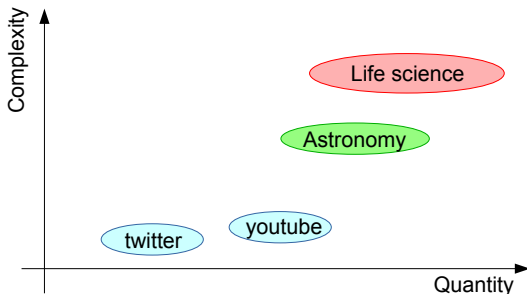
Table 1. Four domains of Big Data in 2025. In each of the four domains, the projected annual storage and computing needs are presented across the data lifecycle.

Data Phase	Astronomy	Twitter	YouTube	Genomics
Acquisition	25 zetta-bytes/year	0.5–15 billion tweets/year	500–900 million hours/year	1 zetta-bases/year
Storage	1 EB/year	1–17 PB/year	1–2 EB/year	2–40 EB/year
Analysis	In situ data reduction	Topic and sentiment mining	Limited requirements	Heterogeneous data and analysis
	Real-time processing	Metadata analysis		Variant calling, ~2 trillion central processing unit (CPU) hours
	Massive volumes			All-pairs genome alignments, ~10,000 trillion CPU hours
Distribution	Dedicated lines from antennae to server (600 TB/s)	Small units of distribution	Major component of modern user's bandwidth (10 MB/s)	Many small (10 MB/s) and fewer massive (10 TB/s) data movement

doi:10.1371/journal.pbio.1002195.t001

Degrees of data complexity

- multiple scales (heterogeneity)
- (highly) interdependent at each scale
- interdependent between scales
- variability
- incompleteness
- evolution
- distributed (and lack of interoperability)



Challenge (computational)

How to handle this complexity?

- Experts are very good at doing it on their domain (hint)
 - on their domain
 - on their data
- The difficulty is to do it **systematically**
- Expertise = ability to use knowledge for interpreting data
- We should use their expertise, not try to outperform them

Annotations for describing complex and massive data

Capturing expertise with annotations

Annotation

Annotation = result of some interpretation process

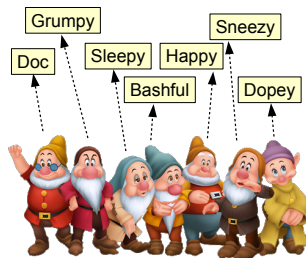


Capturing expertise with annotations

Annotation

Annotation = result of some interpretation process

- ideally by an expert (from big data to smart data)
- usually requires some background knowledge
- formalisation ranging from free text to controlled vocabularies to (shared) semantic framework [semantic spectrum]



The data annotation process

Annotate data =

- describe **explicitly** the relevant **elements** in your data and the **relations** between these elements
 - so that users (incl. you and the non-experts) or programs do not have to go once again through the tedious process of interpreting them
-
- is important!
 - seems easy...
 - **exercise 1: describe a set of images**
 - ... but turns out to be more difficult than expected
 - describing and interpreting the data is for domain experts
 - formalizing and representing the annotations and their dependencies is for data engineers

Using annotations for overcoming data complexity

Add annotations? But we have too much data already!

Benefits

- can be used as proxy to complex data
- simplifies by providing a compact abstraction
- overcomes variability
- enriches by making explicit the underlying meaning

Storing, sharing and reusing these annotations is the key to life science data systematic analysis

Ontologies for interpreting annotations

Knowledge underlying annotations remains to be represented

- “Much of biology works by applying prior knowledge [...] to an unknown entity” [Stevens2000]
- “The complex biological data stored in bioinformatics databases often require the addition of knowledge to specify and constrain the values held in that database” [Stevens2000]

Ontology

Formal representation of knowledge in which the essential terms are combined with structuring rules that describe the relationships between them [Bard2004]



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Journal of Biomedical Informatics 39 (2006) 314–320

Journal of
Biomedical
Informatics

www.elsevier.com/locate/jbi

Brief Bioinform. 2000 Nov;1(4): 398–414.

Ontology-based knowledge representation for bioinformatics.

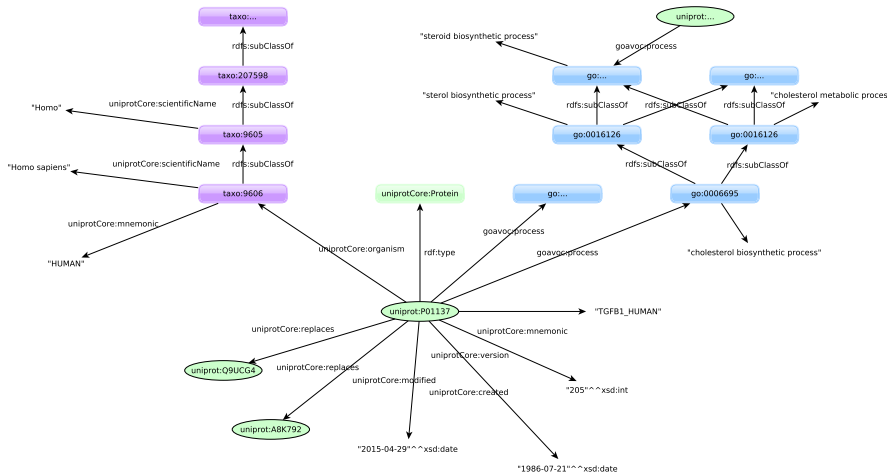
Stevens R¹, Goble CA, Bechhofer S.

Beyond the data deluge: Data integration and bio-ontologies

Judith A. Blake *, Carol J. Bult

Ontologies specify the meaning of annotations

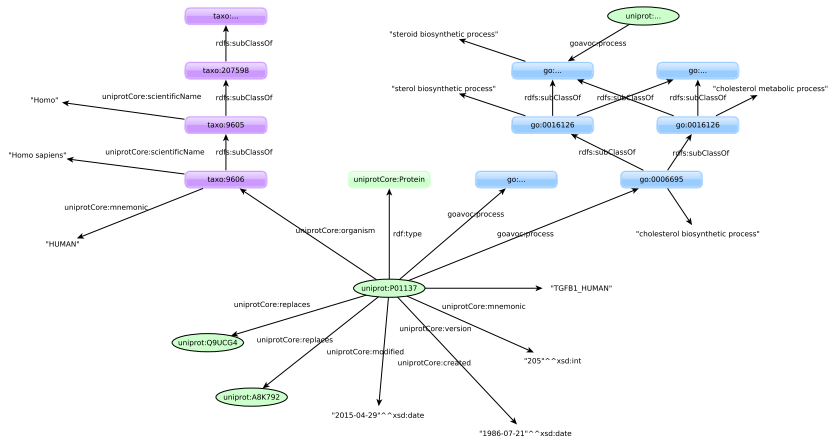
Knowledge is represented as relations between sets of entities



Ontologies support reasoning about annotations

Reasoning

Method for traversing or enriching the graph of data



Semantic Web offers a unified framework to Linked Data

- **RDF** for representing and aggregating entities descriptions
- **RDFS+OWL** for representing domain knowledge (and combine it with data descriptions)
- **SPARQL** for querying everything (possibly from multiple repositories)

SPARQL endpoints offer unified query access to RDF repositories
ex: Fuseki, Virtuoso,...

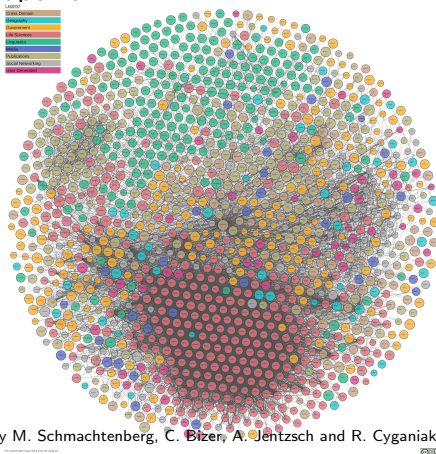
Linked Open Data: a federation of RDF repositories

LODStats (<http://lodstats.aksw.org/>) [Ermilov2016]

- 9960 datasets; 149.10^9 triples
- general scope; Life sciences = major field (size+density)

Linked open data (in 2019-03-29)

- RDF repositories can be queried in SPARQL via endpoints
- data from one endpoint can make references to data from another endpoint



Linked open data cloud, by M. Schmachtenberg, C. Bizer, A. Jentzsch and R. Cyganiak <http://lod-cloud.net/>

Ontologies: what they are

- Annotations' underlying structure
- (Formalized) representations of domain knowledge
- Relations that are **always** true, independently from anecdotic facts

Rule of thumb

what is implicit in a factual document is often background knowledge that belongs to an ontology

Ontologies: what they are not

- Ontology (the branch of philosophy)
- Controlled vocabularies, terminologies,... (although both are useful and often connected)
- Sets of annotated data (**genericity** is the key)

From controlled vocabularies to ontologies

- **Controlled vocabulary:** **set of words** used preferentially to ensure annotation uniformity
- **Terminology:** **vocabulary** with additional information (e.g. synonyms) and relations (e.g. antonyms, broader than, narrower than, related to,...). Ex: Wordnet
- **Taxonomy** (hopefully) **formal organisation of concepts** along the “is a” relation (subsumption). Ex: classification of species
 - language-independent
 - can be associated to controlled vocabularies and terminologies
- **Ontology:** **taxonomy with additional relations**, constraints, and (hopefully) formal definitions. Ex: Gene Ontology, ChEBI...

Ontologies mostly deal with **sets of entities** (classes)

- Which properties are shared by these entities (necessary)
 - How some of these properties define the set (necessary and sufficient)
 - What are the possible values for some of the properties (fractures are located on bones, no “fracture of the eyelid”)
 - What are the relations with other sets of entities
-
- Classes are organized from general to particular (taxonomy)
 - The subclass – superclass relation corresponds to set inclusion
 - A class can have several parents
 - The properties of the superclass also apply to all its descendents (inheritance)

Ontologies in use: use the MeSH to query pubmed

handle synonyms

In pubmed (<https://pubmed.ncbi.nlm.nih.gov/>)

- look for articles about vitamin c as a full text search
- examine one of the articles and look for the MeSH annotations
- look for the MeSH term vitamin c and the articles it annotates
- look for the MeSH term ascorbic acid and the articles it annotates

handle taxonomy

In MeSH (<https://www.ncbi.nlm.nih.gov/mesh/>)

- look for cardiovascular disease
- select the relevant MeSH term
(<https://www.ncbi.nlm.nih.gov/mesh/68002318>)
- look at its synonyms and its descendents
- add it to the search builder
- search on pubmed

Ontologies in use: Gene Ontology

In the GO website (<http://geneontology.org/>)

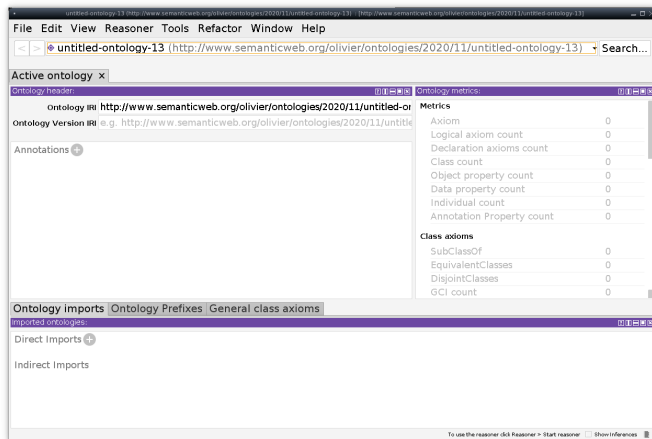
- look for “glucose metabolic process”
- select “ontology” in the radio box below the search field, and search
- select the GO term (<http://amigo.geneontology.org/amigo/term/GO:0006006>)
- select the “Graph view” or the “Inferred tree view” tab and visualize its ancestors and its descendants
- for Homo sapiens, how many proteins are annotated by this GO term? How many miRNA?

Synthesis

- Life science **data** are distributed and highly complex
- **Annotations** address complexity
- Ontologies formalize the **knowledge** underlying annotations
 - Reused across datasets
 - Shared for interoperability
 - Support reasoning
 - For programs more than humans
- the Semantic Web provides an infrastructure supporting integration and **reasoning**
- Life science annotations and ontologies have matured

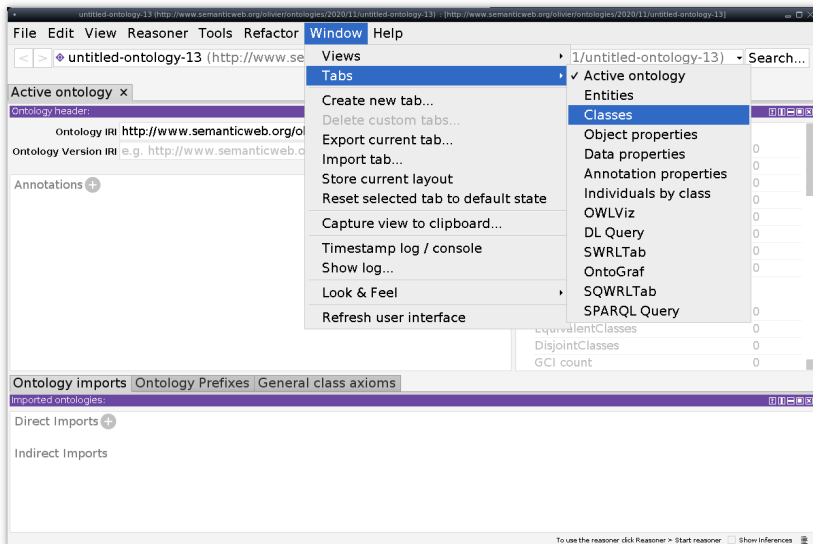
Hands-on session: build your own ontologies

Your first ontology with Protégé

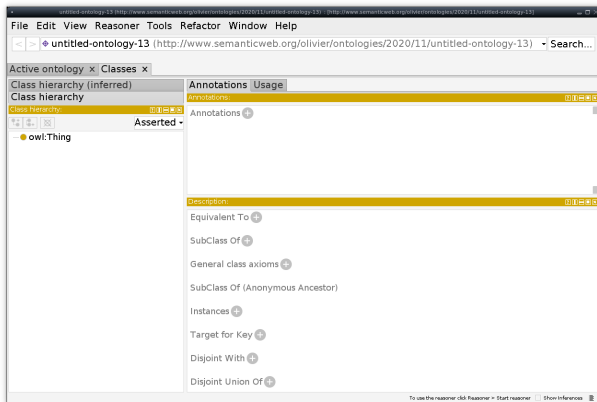


- 1 Retrieve Protégé from <https://protege.stanford.edu/>
- 2 select the “Active ontology” tab
- 3 adjust the ontology IRI (= template for the future identifiers)

Activate the “Classes” tab (if not already visible)

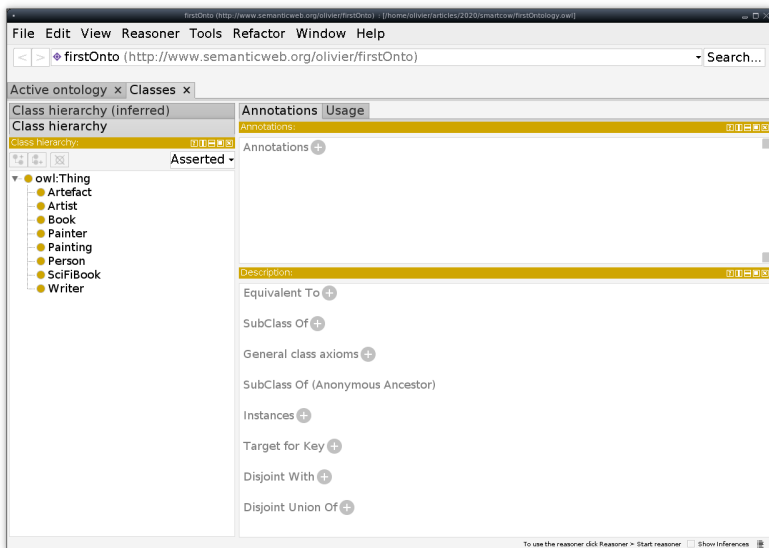


“Classes” tab organization



- left: hierarchy of classes (top = general; bottom = particular)
- top right: annotations for describing the hierarchy active class
- bottom right: properties formalizing the hierarchy active class

Create new classes



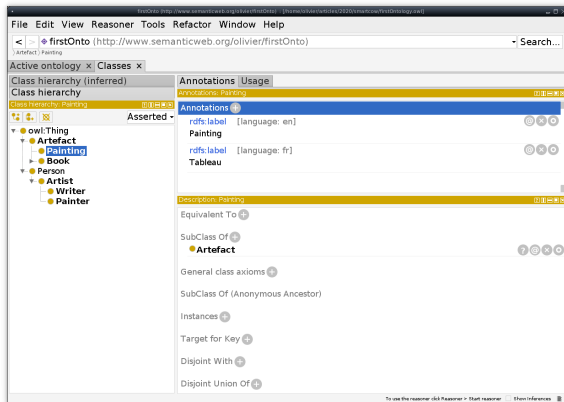
Organize classes into a hierarchy

The screenshot displays the firstOnto web application interface. The browser address bar shows the URL `http://www.semanticweb.org/olivier/firstOnto`. The application has a menu bar with **File**, **Edit**, **View**, **Reasoner**, **Tools**, **Refactor**, **Window**, and **Help**. Below the menu is a search bar containing the text `firstOnto (http://www.semanticweb.org/olivier/firstOnto)` and a **Search...** button.

The main interface is divided into two panes. The left pane, titled **Active ontology x Classes x**, contains a **Class hierarchy (inferred)** section. It shows a tree structure of classes: **owl:Thing** (expanded), **Artefact**, **Painting**, **Book**, **SciFiBook**, **Person**, **Artist**, **Writer**, and **Painter**. The right pane, titled **Annotations Usage**, shows the **Annotations: owl:Thing** section. It includes a **Annotations +** button and a **Description: owl:Thing** section. The description section lists several properties with expandable buttons: **Equivalent To +**, **SubClass Of +**, **General class axioms +**, **SubClass Of (Anonymous Ancestor)**, **Instances +**, **Target for Key +**, **Disjoint With +**, and **Disjoint Union Of +**.

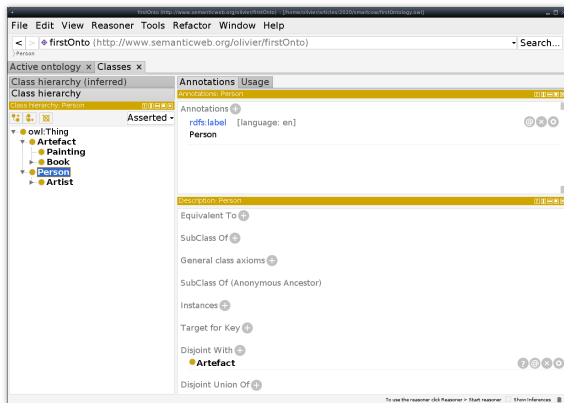
At the bottom of the application window, there is a status bar with the text: **To use the reasoner click Reasoner > Start reasoner** and a checkbox for **Show Inferences**.

Annotate the classes



- `rdfs:label` = name(s) of the class
- `rdfs:comment` = description of textual definition

Disjoint classes cannot have common instances



- Person and Artefact are disjoint
- Painter and Writer are not
- notice that by inheritance, Painter and Artefact are also disjoint

Classes can have multiple parents

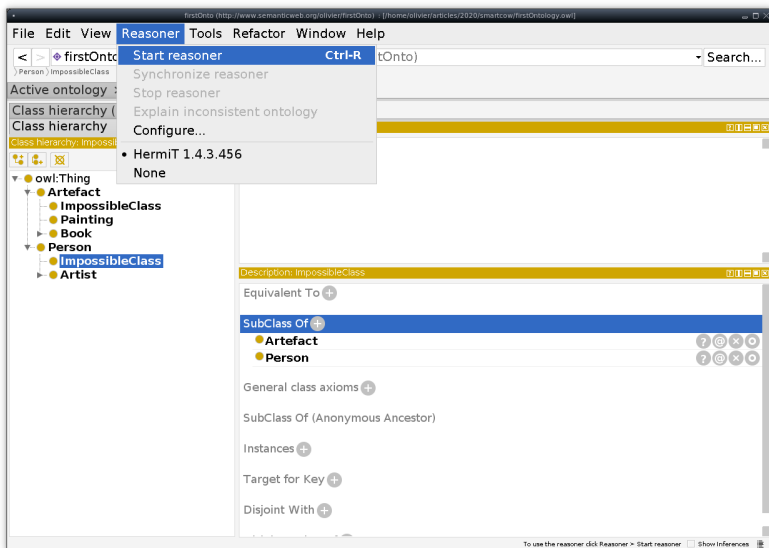
The screenshot shows the firstOnto web application interface. The top menu bar includes File, Edit, View, Reasoner, Tools, Refactor, Window, and Help. The address bar shows the URL <http://www.semanticweb.org/olivier/firstOnto>. The main content area is divided into several panels:

- Active ontology x Classes x**: A tabbed interface showing the current ontology and a list of classes.
- Class hierarchy (inferred)**: A tree view showing the hierarchy of classes. Under **owl:Thing**, there are **Artefact** and **Person**. **ImpossibleClass** is listed as a subclass of both **Artefact** and **Person**.
- Annotations: ImpossibleClass**: A panel showing annotations for the selected class.
- Description: ImpossibleClass**: A panel showing the description of the class.
- SubClass Of**: A panel showing the classes that **ImpossibleClass** is a subclass of, which are **Artefact** and **Person**.
- General class axioms**: A panel showing the general class axioms.
- SubClass Of (Anonymous Ancestor)**: A panel showing the anonymous ancestor of the class.
- Instances**: A panel showing the instances of the class.
- Target for Key**: A panel showing the target for the key.
- Disjoint With**: A panel showing the disjoint with classes.

The bottom status bar indicates: "To use the reasoner click Reasoner > Start reasoner" and "Show Inferences".

- notice that `ImpossibleClass` appears twice in the hierarchy

Start the reasoner

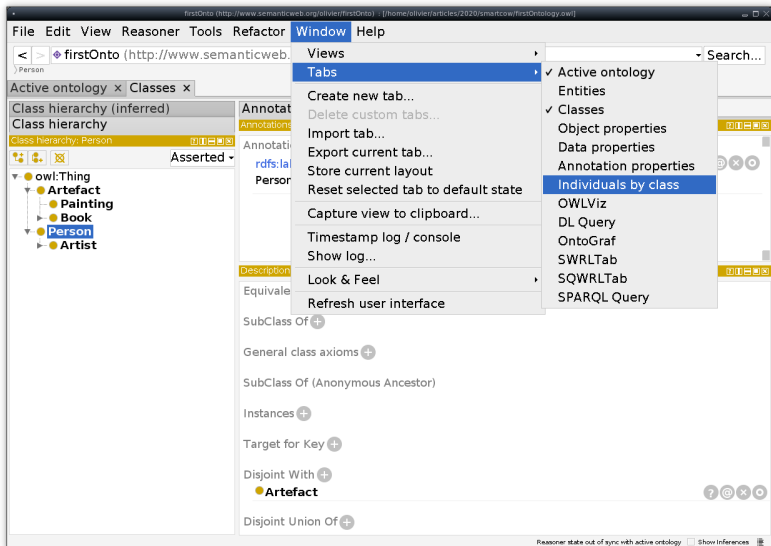


The reasoner detects inconsistent classes

The screenshot shows the firstOnto web application interface. The top menu bar includes File, Edit, View, Reasoner, Tools, Refactor, Window, and Help. The address bar shows the URL <http://www.semanticweb.org/olivier/firstOnto>. The main content area is divided into two panes. The left pane, titled 'Active ontology x Classes x', displays the 'Class hierarchy (inferred)' view. It shows a tree structure starting with 'owl:Thing', which has two children: 'owl:Nothing' (highlighted in red) and 'ImpossibleClass' (highlighted in blue). Below these are 'Artefact' and 'Person'. The right pane, titled 'Annotations Usage', shows the 'Annotations: ImpossibleClass' view. It includes a search bar, a description of 'ImpossibleClass', and several expandable sections: 'Equivalent To', 'SubClass Of' (showing 'Artefact' and 'Person'), 'General class axioms', 'SubClass Of (Anonymous Ancestor)', 'Instances', 'Target for Key', and 'Disjoint With'. The bottom status bar indicates 'Reasoner active' and 'Show Inferences'.

- notice that we switched to the inferred class hierarchy

Activate the “Individuals” tab



Create an instance of the Painter class

The screenshot displays the firstOnto web interface, which is used for managing ontologies. The browser address bar shows the URL <http://www.semanticweb.org/olivier/firstOnto>. The interface includes a menu bar (File, Edit, View, Reasoner, Tools, Refactor, Window, Help) and a search bar.

The main content area is divided into several panels:

- Class hierarchy:** A tree view showing the ontology structure. The hierarchy is: `owl:Thing` (parent) → `Artefact` (child) → `Person` (child) → `Artist` (child) → `Painter` (child) → `Writer` (child). The `Painter` class is highlighted.
- Active ontology:** A tab showing the active ontology, which is `firstOnto`.
- Annotations:** A panel showing annotations for the selected class (`Painter`). It includes a search bar and a list of annotations.
- Property assertions:** A panel showing property assertions for the selected class (`Painter`). It includes a search bar and a list of property assertions.
- Direct instances:** A panel showing direct instances of the selected class (`Painter`). It includes a search bar and a list of instances.

The `Painter` class is highlighted in the class hierarchy, and the `leonaldoDaVinci` instance is listed under the `Direct instances` panel. The URL <http://www.semanticweb.org/olivier/firstOnto#leonaldoDaVinci> is displayed at the bottom of the interface.

Create an instance of disjoint classes

The screenshot shows the firstOnto web interface. The top menu bar includes File, Edit, View, Reasoner, Tools, Refactor, Window, and Help. The address bar shows the URL <http://www.semanticweb.org/olivier/firstOnto>. The main interface is divided into several panes:

- Class hierarchy:** A tree view showing the hierarchy: owl:Thing > Artefact > Person > Artist > Painter > Writer. The 'Painter' class is highlighted.
- Annotations:** A pane showing annotations for the selected class, currently empty.
- Property assertions:** A pane showing property assertions for the selected class, currently empty.
- Direct instances:** A pane showing direct instances of the selected class. It lists 'impossiblePerson' and 'leonardoDaVinci'.
- Types:** A pane showing the types of the selected class, listing 'Artefact' and 'Painter'.

The 'impossiblePerson' instance is highlighted, and its description is shown as 'impossiblePerson'. The 'Types' pane shows that 'impossiblePerson' is of type 'Artefact' and 'Painter'. The 'Direct instances' pane shows that 'impossiblePerson' is a direct instance of 'Painter'.

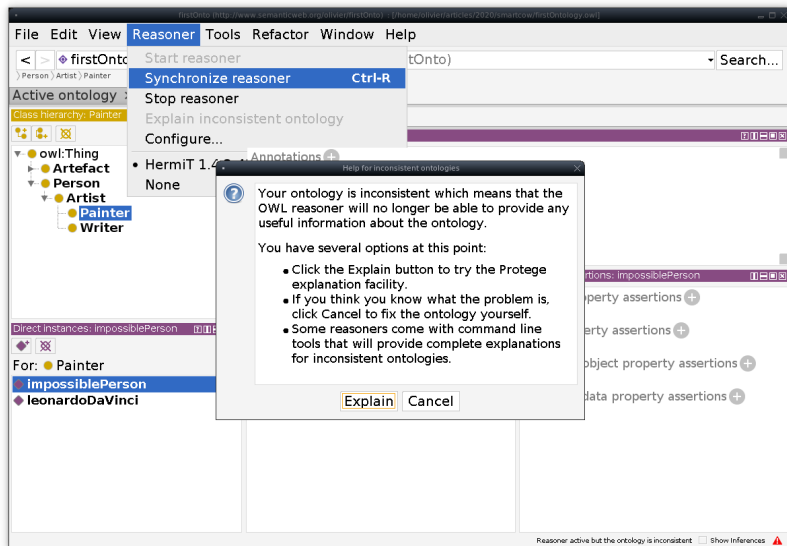
At the bottom, a status bar indicates 'Reasoner state out of sync with active ontology' and 'Show Inferences'.

Synchronize the reasoner

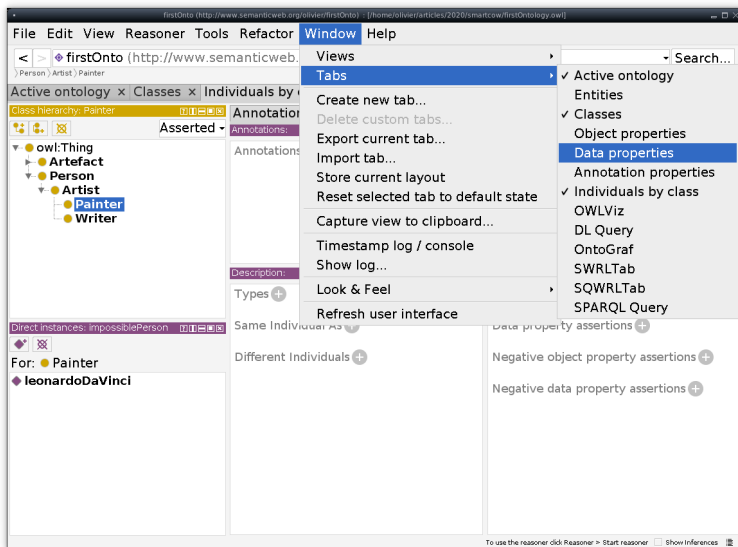
The screenshot displays the firstOnto application window. The 'Reasoner' menu is open, showing options: 'Start reasoner', 'Synchronize reasoner' (highlighted with a blue bar and 'Ctrl-R'), 'Stop reasoner', 'Explain inconsistent ontology', and 'Configure...'. Below these options, the reasoner version 'HermiT 1.4.3.456' and the status 'None' are listed.

The main interface shows a class hierarchy on the left with 'Painter' selected. The central pane displays the 'Description: impossiblePerson' with a 'Types' section listing 'Artefact' and 'Painter'. The right pane shows 'Property assertions: impossiblePerson' with expandable sections for 'Object property assertions', 'Data property assertions', 'Negative object property assertions', and 'Negative data property assertions'. The bottom status bar indicates 'Reasoner state out of sync with active ontology' and includes a 'Show Inferences' checkbox.

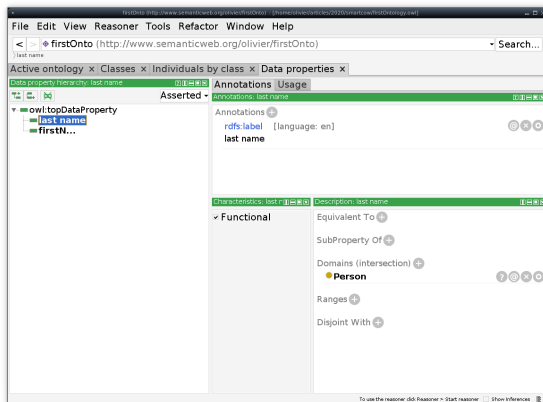
The reasoner detects inconsistent individuals



Activate the “Datatype properties” tab



Create datatype properties



- create relations which values are strings, numbers, dates...
- the domain is the set of individuals for which this relation makes sense
- functional property (checkbox) can have at most one value

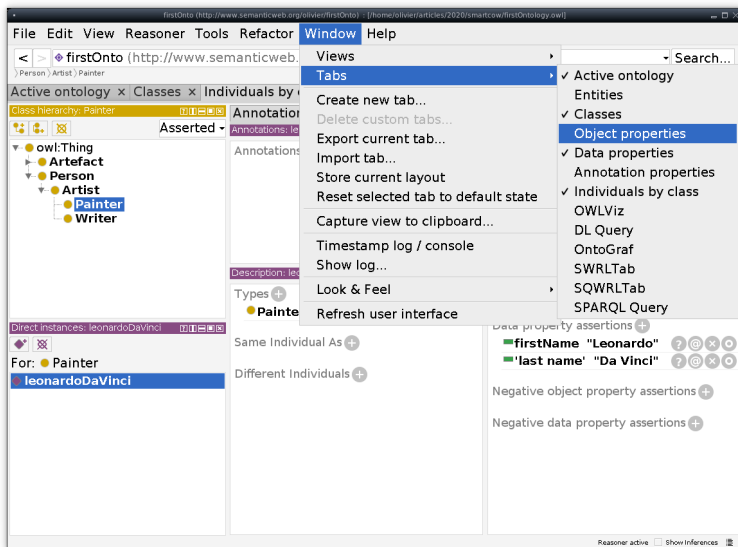
Use datatype properties to describe individuals

The screenshot displays the firstOnto web application interface. The top navigation bar includes menus for File, Edit, View, Reasoner, Tools, Refactor, Window, and Help. The address bar shows the URL `http://www.semanticweb.org/olivier/firstOnto`. The main interface is divided into several panels:

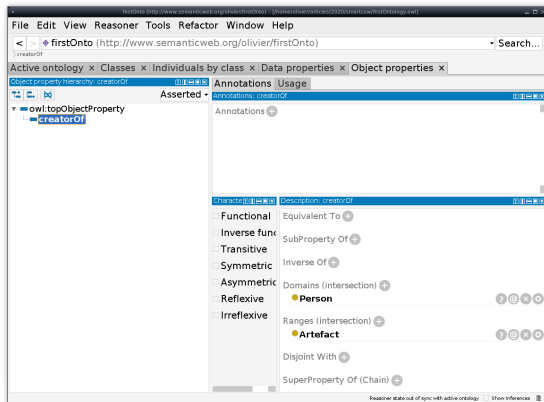
- Class hierarchy:** A tree view on the left showing the ontology structure: `owl:Thing` (parent) contains `Artefact` and `Person`. `Person` contains `Artist`, which in turn contains `Painter` and `Writer`. The `Painter` class is currently selected.
- Annotations:** A panel titled "Annotations: leonardoDaVinci" with a sub-tab "Asserted". It currently shows no annotations.
- Description:** A panel titled "Description: leonardoDaVinci" showing the type `Painter`.
- Property assertions:** A panel titled "Property assertions: leonardoDaVinci" containing:
 - Data property assertions:** A list of assertions for the individual `leonardoDaVinci`:
 - `firstName "Leonardo"`
 - `'last name' "Da Vinci"`
 - Negative object property assertions:** A section with a plus icon to add assertions.
 - Negative data property assertions:** A section with a plus icon to add assertions.

At the bottom of the interface, there is a status bar with the text: "To use the reasoner click Reasoner > Start reasoner" and a checkbox for "Show inferences".

Activate the “Object properties” tab



Create an object property



- create relations between individuals
- domain = set of individuals for which this relation makes sense
- range = set of possible values for the relation

Create an instance of Painting

The screenshot shows the firstOnto web interface. The browser address bar displays `firstOnto (http://www.semanticweb.org/olivier/firstOnto)`. The interface includes a menu bar (File, Edit, View, Reasoner, Tools, Refactor, Window, Help) and a tab bar with the following tabs: `Active ontology`, `Classes`, `Individuals by class`, `Data properties`, and `Object properties`. The `Classes` tab is active, showing a class hierarchy on the left. The hierarchy is as follows:

- owl:Thing
 - Artefact
 - Book
 - Painting
 - Person
 - Artist
 - Painter
 - Writer

The `Painting` class is highlighted. Below the hierarchy, the `Direct instances: monaLisaPainting` section shows a list of instances with `monaLisaPainting` selected. The `Annotations` tab is also visible, showing a list of annotations for `monaLisaPainting`. The `Property assertions: monaLisaPainting` section shows various assertion types, including `Object property assertions`, `Data property assertions`, `Negative object property assertions`, and `Negative data property assertions`. The `Reasoner state out of sync with active ontology` message is displayed at the bottom.

<http://www.semanticweb.org/olivier/firstOnto#monaLisaPainting>

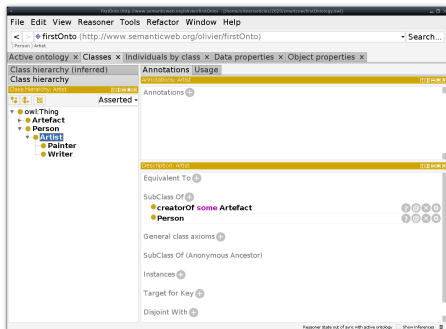
Use an object property to connect Da Vinci and Mona Lisa

The screenshot displays the firstOnto web application interface. The top navigation bar includes 'File', 'Edit', 'View', 'Reasoner', 'Tools', 'Refactor', 'Window', and 'Help'. The address bar shows the URL 'firstOnto (http://www.semanticweb.org/olivier/firstOnto)'. The main interface is divided into several panels:

- Class hierarchy:** A tree view on the left showing the hierarchy: owl:Thing > Artefact > Book > Painting > Person > Artist > Painter. The 'Painter' class is selected and highlighted in blue.
- Annotations:** A panel titled 'Annotations: leonardoDaVinci' with a search bar and a list of annotations.
- Property assertions:** A panel titled 'Property assertions: leonardoDaVinci' showing object property assertions. It includes a section for 'Object property assertions' with a list of assertions: 'creatorOf monaLisaPainting'. Below this, there are sections for 'Data property assertions' (showing 'firstName "Leonardo"' and 'last name "Da Vinci"') and 'Negative object property assertions' and 'Negative data property assertions'.
- Direct instances:** A panel titled 'Direct instances: leonardoDaVinci' showing a list of instances. The instance 'leonardoDaVinci' is selected and highlighted in blue.

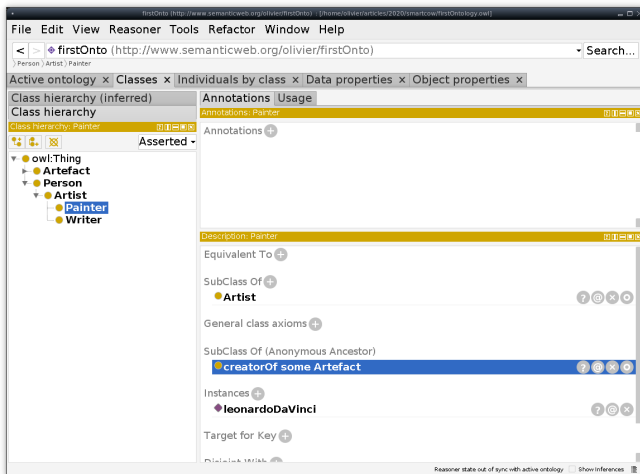
The bottom status bar indicates 'Reasoner state out of sync with active ontology' and provides a 'Show Inferences' button.

Use properties to add constraints to classes



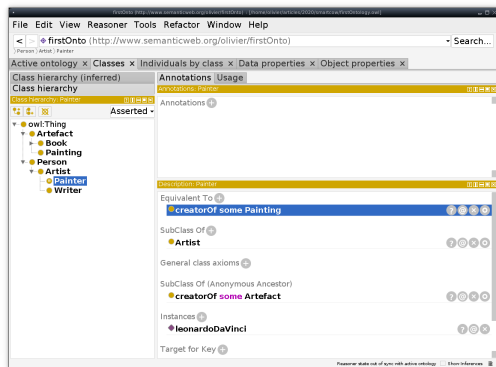
- if x is an instance of Artist, then
 - x is the creatorOf at least one y (notice the “some” keyword)
 - this y is an instance of Artefact
- NB1: y can be unspecified; the reasoner knows there is one
- NB2: being an artist \Rightarrow having created an artefact
but having created an artefact does not make you an artist

A class' constraints are inherited by its subclasses



- because all Painters are Artists, they must have created at least one Artefact

Defined classes



- we refine the (inherited) constraint for Painter so that the must have created at least one Painting (which is a subclass of Artefact)
- defined instead of subclass:
having created a painting \Leftrightarrow being a painter

Defined classes

The screenshot shows the firstOnto web application interface. The top navigation bar includes 'File', 'Edit', 'View', 'Reasoner', 'Tools', 'Refactor', 'Window', and 'Help'. The address bar displays 'firstOnto (http://www.semanticweb.org/olivier/firstOnto)' with a search field. Below the navigation bar, tabs for 'Active ontology', 'Classes', 'Individuals by class', 'Data properties', and 'Object properties' are visible. The 'Classes' tab is active, showing a 'Class hierarchy (inferred)' on the left and a detailed view of the 'Writer' class on the right.

Class hierarchy (inferred):

- owl:Thing
 - Artefact
 - Book
 - Painting
 - Person
 - Artist
 - Painter
 - Writer**

Annotations: Writer

Annotations +

Description: Writer

Equivalent To +

- creatorOf some Book

SubClass Of +

- Artist

General class axioms +

SubClass Of (Anonymous Ancestor)

- creatorOf some Artefact

Instances +

Target for Key +

Reasoner state out of sync with active ontology ☐ Show Inferences

Dune is a book

The screenshot shows the firstOnto web application interface. The browser address bar displays the URL `http://www.semanticweb.org/olivier/firstOnto`. The application has a menu bar with options: File, Edit, View, Reasoner, Tools, Refactor, Window, and Help. Below the menu is a search bar and a tab for 'firstOnto'. The main interface is divided into several panels:

- Class hierarchy:** A tree view showing the ontology structure. The hierarchy is: `owl:Thing` (parent) contains `Artefact` (child), `Person` (child), and `Artist` (child). `Artefact` contains `Book` (child) and `Painting` (child). `Person` contains `Painter` (child) and `Writer` (child). The `Book` class is highlighted.
- Annotations:** A panel showing annotations for the selected class. It includes a search bar and a list of annotations.
- Property assertions:** A panel showing property assertions for the selected class. It includes a search bar and a list of assertions.
- Direct instances:** A panel showing direct instances of the selected class. It includes a search bar and a list of instances. The instance `Dune` is highlighted.

The URL `http://www.semanticweb.org/olivier/firstOnto#Dune` is displayed at the bottom of the interface.

Frank Herbert is a Person and created Dune

The screenshot displays the firstOnto web application interface. The top navigation bar includes menus for File, Edit, View, Reasoner, Tools, Refactor, Window, and Help. The address bar shows the URL `http://www.semanticweb.org/olivier/firstOnto`. The main interface is divided into several panels:

- Class hierarchy:** A tree view showing the ontology structure. The hierarchy is: `owl:Thing` (parent) → `Artefact` (child) → `Book`, `Painting`, `Person` (children of `Artefact`). `Person` has children `Artist`, `Painter`, and `Writer`. The `Person` class is currently selected.
- Annotations:** A panel for viewing annotations for the selected class.
- Description:** A panel showing the description of the selected class, which is `Person`.
- Property assertions:** A panel showing assertions for the selected class. It includes:
 - Object property assertions:** `creatorOf Dune`
 - Data property assertions:** `'last name' "Herbert"` and `'firstName' "Frank"`
 - Negative object property assertions:** (empty)
 - Negative data property assertions:** (empty)

The bottom status bar indicates "Reasoner state out of sync with active ontology" and provides a "Show Inferences" button.

Synchronize the reasoner

The screenshot shows the firstOnto application window. The 'Reasoner' menu is open, highlighting the 'Synchronize reasoner' option (Ctrl-R). A tooltip explains that the current reasoner is active but out of sync with the ontology, and that clicking this button will resynchronize it. The interface includes a class hierarchy on the left, a description pane for 'FrankHerbert' (a Person), and a property assertions pane showing object and data properties.

firstOnto (http://www.semanticweb.org/olivier/firstOnto) [home/olivier/articles/2020/smartcow/firstOntology.owl]

File Edit View **Reasoner** Tools Refactor Window Help

< > firstOnto Start reasoner tOnto) Search...

Person

Active ontology :
Class hierarchy: Person
owl:Thing
Artefact
Book
SciFiBook
Painting
Person
Artist
Painter
Writer

Direct instances: FrankHerbert
For: Person
FrankHerbert

Reasoner state: out of sync with active ontology

Reasoner menu options:
Start reasoner
Synchronize reasoner (Ctrl-R)
Stop reasoner
Explain
HermiT 1.4.3.456
None

Tooltip text:
The current reasoner is active but has not taken into account the recent changes to the ontology. In this mode, reasoning results may be inaccurate. Pushing this button will resynchronize the reasoner with the ontology leading to inferences that are once again accurate.

Description: FrankHerbert
Types: Person
Same Individual As
Different Individuals

Property assertions: FrankHerbert
Object property assertions: creatorOf Dune
Data property assertions: 'last name' "Herbert", 'first name' "Frank"
Negative object property assertions
Negative data property assertions

Reasoner state out of sync with active ontology ☐ Show Inferences

Class definition: Frank Herbert is recognized as a Writer

The screenshot displays the firstOnto web application interface. The top navigation bar includes menus for File, Edit, View, Reasoner, Tools, Refactor, Window, and Help. The address bar shows the URL `http://www.semanticweb.org/olivier/firstOnto`. Below the navigation bar, there are tabs for "Active ontology", "Classes", "Individuals by class", "Data properties", and "Object properties". The "Classes" tab is active, showing a class hierarchy for "Writer". The hierarchy is as follows: owl:Thing -> Artefact -> Person -> Artist -> Painter -> Writer. The "Writer" class is highlighted. Below the hierarchy, there is a section for "Individuals by type (Inferred): FrankHerb". This section lists several classes with their counts: Book (1), Painter (1), Painting (1), and Writer (1). The "Writer" class is highlighted, and the instance "FrankHerbert" is listed below it. To the right of the class hierarchy, there are tabs for "Annotations" and "Usage". The "Annotations" tab is active, showing a list of annotations for "FrankHerbert". Below the annotations, there is a section for "Description: FrankHerbert". This section includes a "Types" list with "Person" highlighted, and a "Property assertions" section. The "Property assertions" section lists "Object property assertions" (creatorOf Dune), "Data property assertions" (last name "Herbert", firstName "Frank"), "Negative object property assertions", and "Negative data property assertions". At the bottom of the interface, there is a status bar with the text "Reasoner active" and "Show Inferences".

Create and define SciFiWriter as a subclass of Person

The screenshot shows the firstOnto web interface. The top navigation bar includes 'File', 'Edit', 'View', 'Reasoner', 'Tools', 'Refactor', 'Window', and 'Help'. The address bar shows 'firstOnto (http://www.semanticweb.org/olivier/firstOnto)'. The main interface is divided into several panes:

- Class hierarchy (inferred):** Shows a tree structure of classes. Under 'Person', 'SciFiWriter' is highlighted as a subclass of 'Artist'.
- Annotations:** Shows 'Annotations: SciFiWriter'.
- Description: SciFiWriter:** Shows the following details:
 - Equivalent To:** `creatorOf some SciFiBook`
 - SubClass Of:** `Artist`
 - General class axioms:**
 - SubClass Of (Anonymous Ancestor):** `creatorOf some Artefact`
 - Instances:**
 - Target for Key:**

The bottom status bar indicates 'Reasoner state out of sync with active ontology' and 'Show Inferences'.

Synchronize the reasoner

The screenshot shows the firstOnto application window. The menu bar includes File, Edit, View, Reasoner, Tools, Refactor, Window, and Help. The Reasoner menu is open, displaying options: Start reasoner, Synchronize reasoner (highlighted with a tooltip), Stop reasoner, Explain inferences, and Configure... The tooltip for 'Synchronize reasoner' contains the text: 'The current reasoner is active but has not taken into account the recent changes to the ontology. In this mode, reasoning results may be inaccurate. Pushing this button will resynchronize the reasoner with the ontology leading to inferences that are once again accurate.' Below the menu, the left sidebar shows the 'Active ontology' section with a class hierarchy tree. The tree structure is: owl:Thing -> Artefact -> Book -> SciFiBook -> Painting -> Person -> Artist -> SciFiWriter -> Painter -> Writer. The 'SciFiWriter' class is selected. The main panel displays the 'Description: SciFiWriter' section, which includes: 'Equivalent To' with the axiom 'creatorOf some SciFiBook', 'SubClass Of' with the axiom 'Artist', 'General class axioms', 'SubClass Of (Anonymous Ancestor)' with the axiom 'creatorOf some Artefact', 'Instances', and 'Target for Key'. At the bottom of the window, a status bar indicates 'Reasoner state out of sync with active ontology' and a checkbox for 'Show Inferences'.

firstOnto (http://www.semanticweb.org/olivier/firstOnto) [home/olivier/articles/2020/smartcow/firstOntology.owl]

File Edit View Reasoner Tools Refactor Window Help

< > firstOnto Start reasoner tOnto) Search...

Person Artist SciFiWriter

Active ontology:

Class hierarchy (

Class hierarchy: SciFiWriter

owl:Thing

Artefact

Book

SciFiBook

Painting

Person

Artist

SciFiWriter

Painter

Writer

Stop reasoner The current reasoner is active but has not taken into account the recent changes to the ontology. In this mode, reasoning results may be inaccurate. Pushing this button will resynchronize the reasoner with the ontology leading to inferences that are once again accurate.

Explain inferences

Configure...

• Hermit 1.4.3.456

None

Description: SciFiWriter

Equivalent To +

• creatorOf some SciFiBook

SubClass Of +

• Artist

General class axioms +

SubClass Of (Anonymous Ancestor)

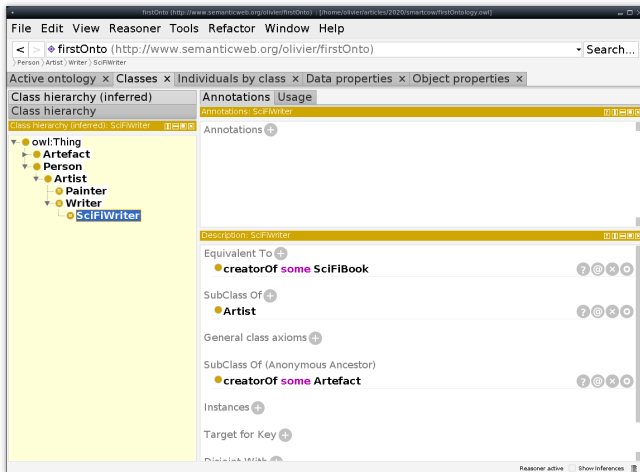
• creatorOf some Artefact

Instances +

Target for Key +

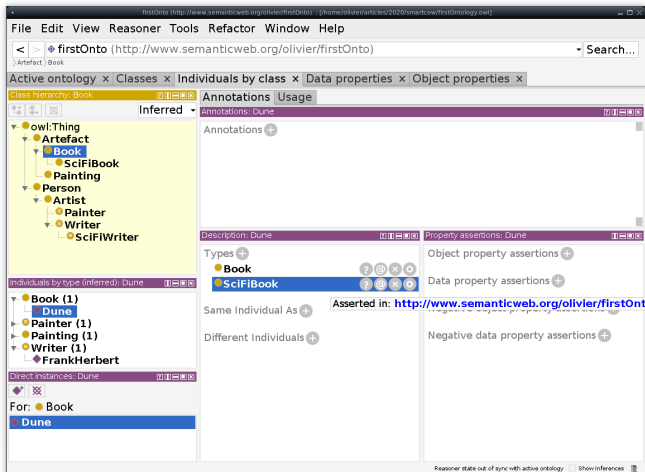
Reasoner state out of sync with active ontology ☐ Show Inferences

SciFiWriter is inferred to a subclass of Writer



- let the reasoner organize the classes for you!

Make Dune an instance of SciFiBook...



- an individual can be an instance of multiple classes

... automatically makes Frank Herbert a SciFiWriter

The screenshot displays the firstOnto web interface, which is a Semantic Web browser. The browser's address bar shows the URL `http://www.semanticweb.org/olivier/firstOnto/`. The interface includes a menu bar with options: File, Edit, View, Reasoner, Tools, Refactor, Window, and Help. Below the menu is a search bar with the text "firstOnto (http://www.semanticweb.org/olivier/firstOnto)" and a "Search..." button. The main content area is divided into several panes. On the left, the "Class Hierarchy: SciFiWriter" pane shows a tree structure of classes: owl:Thing, Artefact, Book, Painting, Person, Artist, Painter, Writer, and SciFiWriter. The "Inferred" pane shows the same hierarchy. The "Individuals by type (inferred): FrankHerb" pane lists instances: Painter (1), Painting (1), SciFiBook (1), and SciFiWriter (1), with FrankHerb highlighted. The "Direct instances:" pane shows "For: SciFiWriter". The "Annotations: FrankHerb" pane shows a list of annotations. The "Description: FrankHerb" pane shows the types of FrankHerb: Person. The "Property assertions: FrankHerb" pane shows object property assertions: creatorOf Dune, and data property assertions: last name "Herbert" and firstName "Frank". The "Reasoner active" checkbox is checked at the bottom right.

Synthesis

- describe your data as precisely as possible
- formalize your ontology as finely as possible
 - disjoint classes help detect inconsistencies
 - in your ontology (cf. `ImpossibleClass`)
 - in your data (cf. `impossiblePerson`)
 - necessary constraints (cf. `Artist`)
 - definitions (cf. `Painter` and `Writer`)
- let the reasoner do the tedious part of ontology maintenance
- enjoin the new capability to query your data

SmartCow

*an integrated infrastructure for increased
research capability and innovation in the
European cattle sector*

Webinar:

**Using ontologies to improve animal
science research**

15-16 December 2020

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement n°730924

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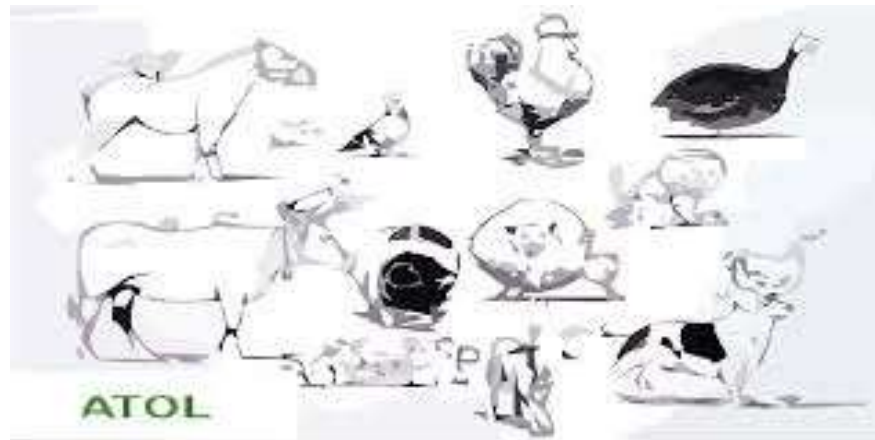
Program of the webinar

Wednesday 16 December morning 10:00-12:00

- ❑ 10:00-10:55 Presentation of French ontologies from INRAE
 - a. ATOL ontology by Catherine Hurtaud, INRAE (France) (25 min)
 - b. EOL ontology by Jérôme Bugeon, INRAE (France) (15 min)
 - c. AHOL ontology by Marie-Christine Meunier-Salaün, INRAE (France) (15 min)
- ❑ 10:55-11:15 Example of application/use of an ontology AHOL for professional use, by Marie-Christine Meunier-Salaün, INRAE (France) (20 min)
- ❑ 5 min break
- ❑ 11:20-12:00 Text based annotation with ontologies, Claire Nédellec INRAE (France) (40 min)



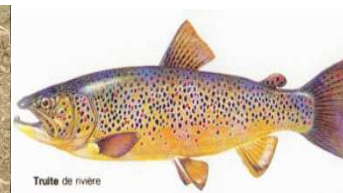
Animal Trait Ontology for Livestock: ATOL





INRAE motivations

- ❑ Promote a common culture for INRAE scientists using animal models and different approaches
- ❑ Develop a common language with geneticists
- ❑ Have an ontological base of the traits of interest for production animals and associated measurement techniques, in order to promote collaborative projects, referenced publications, data management and help teaching
- ❑ Actively participate in the implementation of the VT-USA database by introducing generic animal traits used in Europe



Motivations

J Anim Sci. 2008 June ; 86(6): 1485–1491. doi:10.2527/jas.2008-0930.

Animal trait ontology: The importance and usefulness of a unified trait vocabulary for animal species

L. M. Hughes^{*}, J. Bao[†], Z.-L. Hu^{*}, V. Honavar[†], and J. M. Reecy^{*}

^{*} *Department of Animal Science, Center for Integrated Animal Genomics, Iowa State University, 2255 Kildee Hall, Ames 50011*

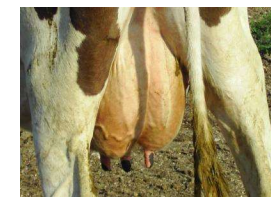
[†] *Department of Computer Science, Artificial Intelligence Research Laboratory, Iowa State University, 211 Atanasoff Hall, Ames 50011*

- ❑ Meeting with James Reecy (december 2008): presentation of his project VT sustained by **USDA-National Animal Genome Research = objective of Production**
- ❑ Program is aimed at the development of a **standardized trait ontology for farm animals and software tools** to assist the research community in collaborative creation, editing, maintenance, and use of such an ontology

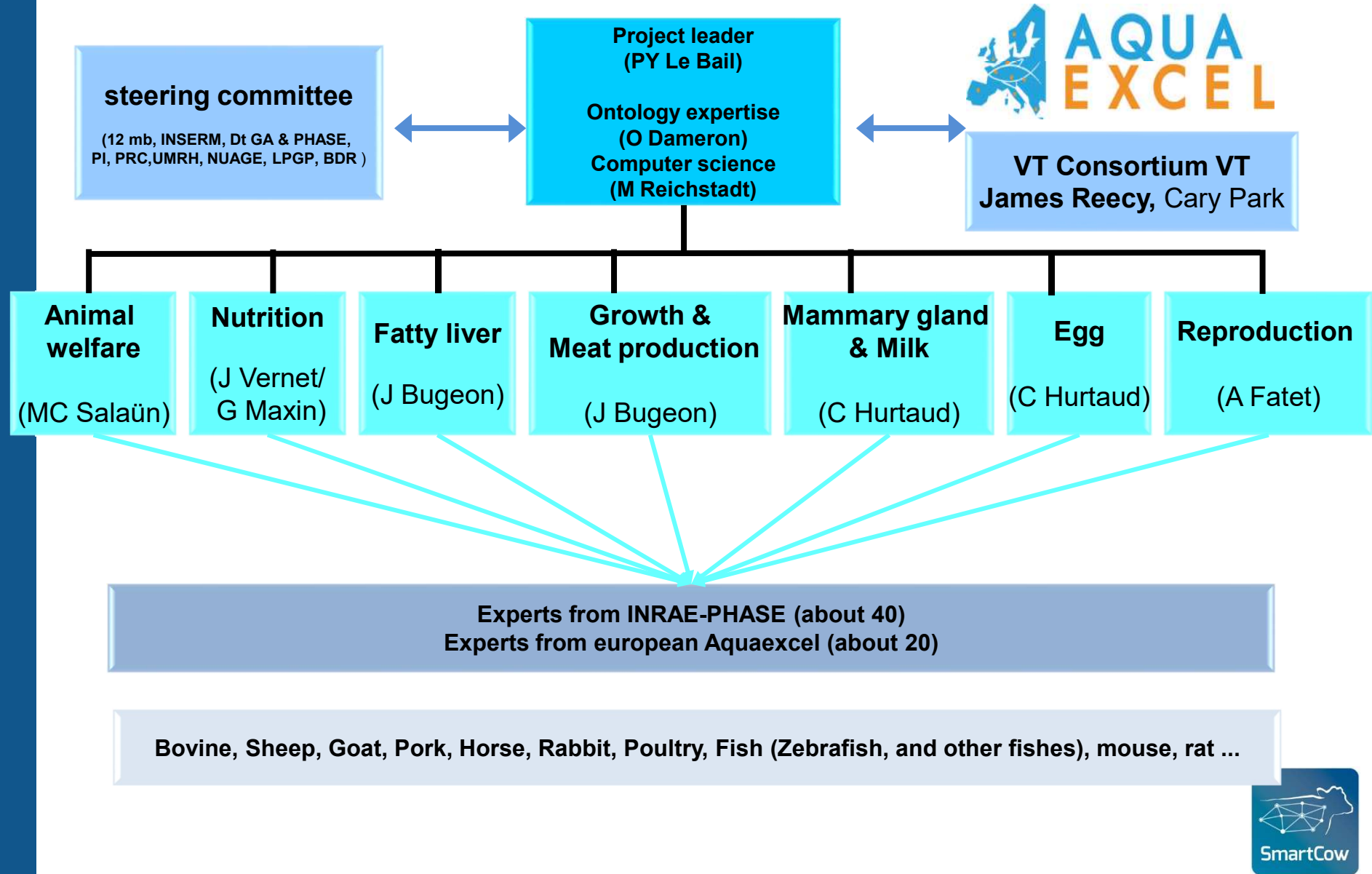


The ATOL project at the origin: the objectives


- ❑ Have a **reference ontology** for the phenotyping of farm animals and shared by the international scientific and teaching community
- ❑ Have a **language** usable by **computer programs** (database management, semantic analysis, modeling, etc.)
- ❑ Have the most **generic** traits possible for vertebrates
- ❑ Make the ontology as **operational** as possible and close to measurement techniques (collectors, users)
- ❑ Structure the base for **production** purposes



ATOL: Structure and network



ATOL: the complete hierarchy

- ▶  animal trait of livestock
 - ▶  animal welfare trait
 - ▶  egg trait
 - ▶  fatty liver trait
 - ▶  growth and meat production trait
 - ▶  mammary gland and milk production trait
 - ▶  nutrition trait
 - ▶  reproduction trait

ATOL: the complete hierarchy

animal trait of livestock

- ▶ animal welfare trait
- ▶ egg trait
- ▶ fatty liver trait
- ▶ growth and meat production trait
- ▶ mammary gland and milk production trait
- ▶ nutrition trait
- ▶ reproduction trait



animal welfare trait

- ▶ animal performance trait
 - ▶ animal production trait
 - ▶ body conformation trait
 - ▶ growth trait
- ▶ health trait
 - ▶ disease susceptibility trait
 - ▶ health body trait
 - ▶ immunity system trait
- ▶ psychoneurophysiological state trait
 - ▶ behaviour trait
 - ▶ biological rhythm trait
 - ▶ cognitive function trait
 - ▶ emotional and stress function tra
 - ▶ pain response trait
 - ▶ reflex response trait
 - ▶ sensory capacities trait

ATOL: the complete hierarchy

animal trait of livestock

- ▶ animal welfare trait
- ▶ egg trait
- ▶ fatty liver trait
- ▶ growth and meat production trait
- ▶ mammary gland and milk production
- ▶ nutrition trait
- ▶ reproduction trait



egg trait

- ▶ egg formation trait
 - ▶ hormonal mechanisms^{ooo}
 - ▶ organ^{ooo}
- ▶ egg production trait
 - ▶ egg morphological production trait
 - ▶ egg quantitative production trait °
- ▶ egg quality trait
 - ▶ egg biological activity trait
 - ▶ egg composition trait
 - ▶ egg mechanical properties trait
 - ▶ egg organoleptic trait
 - ▶ egg technological trait

ATOL: the complete hierarchy

animal trait of livestock

- ▶ animal welfare trait
- ▶ egg trait
- ▶ fatty liver trait
- ▶ growth and meat production trait
- ▶ mammary gland and milk production trait
- ▶ nutrition trait
- ▶ reproduction trait



fatty liver trait

- ▶ fatty liver physiology
 - ▶ fatty liver enzyme activity
- ▶ fatty liver quality
 - ▶ fatty liver nutritional quality
 - ▶ technological and organoleptic quality



ATOL: the complete hierarchy

animal trait of livestock

▷ animal welfare trait

▷ egg trait

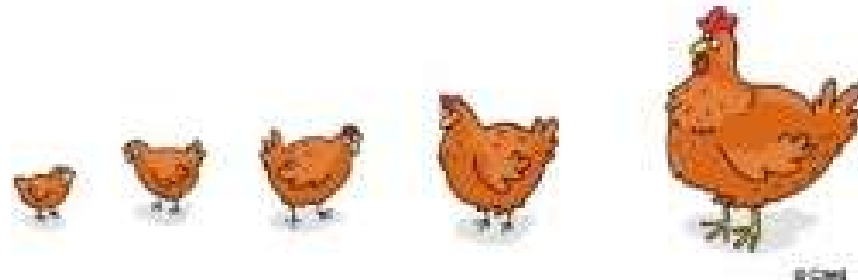
▷ fatty liver trait

▷ growth and meat production trait

▷ mammary gland and milk production trait

▷ nutrition trait

▷ reproduction trait



growth and meat production trait

▷ adipose tissue trait

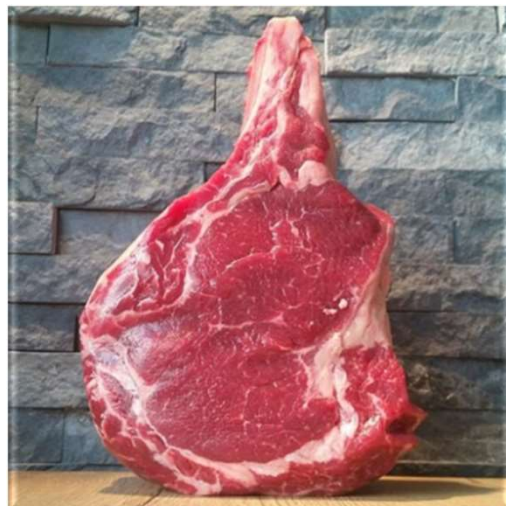
▷ body slaughter trait

▷ carcass quality trait

▷ growth trait

▷ meat quality trait

▷ muscular system trait



ATOL: the complete hierarchy

animal trait of livestock

- ▶ animal welfare trait
- ▶ egg trait
- ▶ fatty liver trait
- ▶ growth and meat production trait
- ▶ mammary gland and milk production trait
- ▶ nutrition trait
- ▶ reproduction trait



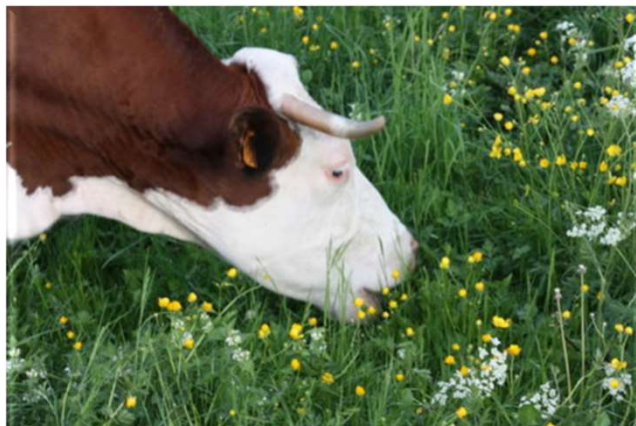
mammary gland and milk production trait

- ▶ mammary gland production trait
 - ▶ colostrum trait
 - ▶ milk ejection trait
 - ▶ milk trait
- ▶ mammary gland trait
 - ▶ mammary gland microbiology trait
 - ▶ mammary gland morphology trait
 - ▶ mammary gland physiology trait

ATOL: the complete hierarchy

📁 animal trait of livestock

- ▷ 📁 animal welfare trait
- ▷ 📁 egg trait
- ▷ 📁 fatty liver trait
- ▷ 📁 growth and meat production trait
- ▷ 📁 mammary gland and milk production trait
- ▷ 📁 **nutrition trait**
- ▷ 📁 reproduction trait



📁 nutrition trait

- ▷ 📁 animal feed efficiency
- ▷ 📁 animal requirement
- ▷ 📁 digestive system morphology
- ▷ 📁 digestive system physiology
- ▷ 📁 ingestion
- ▷ 📁 nutrient balance
- ▷ 📁 supplementation

ATOL: the complete hierarchy

animal trait of livestock

- ▶ animal welfare trait
- ▶ egg trait
- ▶ fatty liver trait
- ▶ growth and meat production trait
- ▶ mammary gland and milk production trait
- ▶ nutrition trait
- ▶ reproduction trait



reproduction trait

- ▶ conception physiology
- ▶ endocrine reproductive system
- ▶ female reproductive feature
- ▶ male reproductive feature
- ▶ sex determination

ATOL: number of traits



More than 3000 traits in September 2020



ATOL: structure of a trait « water intake »



Animal trait of livestock

Is a

Nutrition trait

Is a

Ingestion

Is a

Water intake



ATOL: structure of a trait « water intake »

The screenshot displays the INRAE ATOL ontology interface. On the left, a tree view shows the hierarchy of traits, with 'water intake' selected under 'ingestion'. The main panel shows the details for the trait 'ATOL_0001529', which is circled in blue. A blue arrow points from this ID to its Uniform Resource Identifier (URI): http://opendata.inra.fr/ATOL/ATOL_0001529.

Informations

Name	water intake
Nom	ingestion d'eau
Definition (en)	any measurable characteristic related to the amount of water (CHEBI:15377) intake
Definition (fr)	toute caractéristique mesurable associée à la quantité d'eau (CHEBI:15377) ingérée
Source	INRAE
Link	No results
Comments	No results

Synonyms

Exact synonyms

- intake of water
- uptake of water
- water consumption
- water ingestion

Related synonyms

No results

Species

- Birds
- Fish
- Mammals

Measurement methods

ATOL: structure of a trait « water intake »

INRAE

Ontologies - ATOL - EOL - AHOL

atol

Show in tree

- animal trait of livestock
 - animal welfare trait
 - egg trait
 - fatty liver trait
 - growth and meat production trait
 - mammary gland and milk production trait
 - nutrition trait
 - animal feed efficiency
 - animal requirement
 - digestive system morphology
 - digestive system physiology
 - ingestion
 - energy intake
 - feed intake
 - feeding duration
 - intake capacity
 - mineral intake
 - nitrogen intake
 - water intake
 - nutrient balance
 - supplementation
 - reproduction trait

Ontologies

ATOL_0001529

Informations

Name	water intake
Nom	ingestion d'eau
Definition (en)	any measurable characteristic related to the amount of water (CHEBI:15377) intake
Definition (fr)	toute caractéristique mesurable associée à la quantité d'eau (CHEBI:15377) ingérée
Source	INRAE
Link	No results
Comments	No results

Synonyms

Exact synonyms

- intake of water
- uptake of water
- water consumption
- water ingestion

Related synonyms

No results

Species

- Birds
- Fish
- Mammals

Measurement methods

ATOL: structure of a trait « water intake »

The screenshot displays the ATOL web interface. On the left is a navigation tree under the 'animal trait of livestock' category, with 'water intake' selected. The main content area is titled 'ATOL_0001529' and contains several sections:

- Informations:** A table with the following data:

Field	Value
Name	water intake
Nom	ingestion d'eau
Definition (en)	any measurable characteristic related to the amount of water (CHEBI:15377) intake
Definition (fr)	toute caractéristique mesurable associée à la quantité d'eau (CHEBI:15377) ingérée
Source	INRAE
Link	No results
Comments	No results
- Synonyms:** A table with two sections:

Exact synonyms
intake of water
uptake of water
water consumption
water ingestion
Related synonyms
No results
- Measurement methods:** (Section header visible, content not fully shown)
- Species:** A list of species categories: Birds, Fish, and Mammals.

A blue arrow points from the 'INRAE' source entry in the 'Informations' table to the 'Species' section, with the text 'Ontology, book of ref, adapted from X,...' written next to it.

ATOL: structure of a trait « water intake »

The screenshot displays the ATOL ontology interface. On the left, a tree view shows the hierarchy of traits, with 'water intake' selected under 'ingestion'. The main panel shows the details for 'ATOL_0001529'. The 'Informations' section includes fields for Name, Nom, Definition (en), Definition (fr), Source, Link, and Comments. The 'Synonyms' section lists exact synonyms: 'intake of water', 'uptake of water', 'water consumption', and 'water ingestion'. The 'Species' section lists 'Birds', 'Fish', and 'Mammals'. The 'Measurement methods' section is also visible.

INRAE

Ontologies - ATOL - EOL - AHOL

atol

Show in tree

- animal trait of livestock
 - animal welfare trait
 - egg trait
 - fatty liver trait
 - growth and meat production trait
 - mammary gland and milk production trait
 - nutrition trait
 - animal feed efficiency
 - animal requirement
 - digestive system morphology
 - digestive system physiology
 - ingestion
 - energy intake
 - feed intake
 - feeding duration
 - intake capacity
 - mineral intake
 - nitrogen intake
 - water intake
 - nutrient balance
 - supplementation
 - reproduction trait

ATOL_0001529

Informations

Name	water intake
Nom	ingestion d'eau
Definition (en)	any measurable characteristic related to the amount of water (CHEBI:15377) intake
Definition (fr)	toute caractéristique mesurable associée à la quantité d'eau (CHEBI:15377) ingérée
Source	INRAE
Link	No results
Comments	No results

Synonyms

Exact synonyms

- intake of water
- uptake of water
- water consumption
- water ingestion

Related synonyms

No results


Species

- Birds
- Fish
- Mammals

Measurement methods

Exact or approximate synonym

ATOL: structure of a trait « water intake »



Species (absent/present)
Ontologies - ATOL - EOL - AHOL

atol

Show in tree

- animal trait of livestock
 - animal welfare trait
 - egg trait
 - fatty liver trait
 - growth and meat production trait
 - mammary gland and milk production trait
 - nutrition trait
 - animal feed efficiency
 - animal requirement
 - digestive system morphology
 - digestive system physiology
 - ingestion
 - energy intake
 - feed intake
 - feeding duration
 - intake capacity
 - mineral intake
 - nitrogen intake
 - water intake**
 - nutrient balance
 - supplementation
 - reproduction trait

Ontologies

ATOL_0001529

Informations

Name	
Nom	
Definition (en)	any measurable chara
Definition (fr)	toute caractéristique m
Source	
Link	
Comments	

Synonyms

Exact synonyms

- intake of water
- uptake of water
- water consumption
- water ingestion

Related synonyms

No results

Measurement methods

Species

Birds


- Chicken present
- Duck present
- Goose present
- Quail present
- Turkey present

Fish

- Carp present
- Cod present
- Salmon present
- SeaBass present
- SeaBream present
- Tilapia present
- Trout present
- ZebraFish present

Mammals

- Cattle present
- Goat present
- Horse present
- Mouse present
- Pig present
- Rabbit present
- Sheep present



ATOL: structure of a trait « water intake »

The screenshot displays the ATOL ontology interface. On the left, a tree view shows the hierarchy of traits, with 'water intake' selected under 'ingestion'. The main panel shows the details for ATOL_0001529. The 'Informations' section includes fields for Name, Nom, Definition (en), Definition (fr), Source, Link, and Comments. The 'Synonyms' section lists exact and related synonyms. The 'Measurement methods' section is highlighted with a blue circle and an arrow pointing to it from the text 'video, article of reference, methods'. The 'Species' section lists Birds, Fish, and Mammals.

Informations	
Name	water intake
Nom	ingestion d'eau
Definition (en)	any measurable characteristic related to the amount of water (CHEBI:15377) intake
Definition (fr)	toute caractéristique mesurable associée à la quantité d'eau (CHEBI:15377) ingérée
Source	INRAE
Link	No results
Comments	No results

Synonyms	
Exact synonyms	intake of water uptake of water water consumption water ingestion
Related synonyms	No results

Species	
Birds	
Fish	
Mammals	

Measurement methods

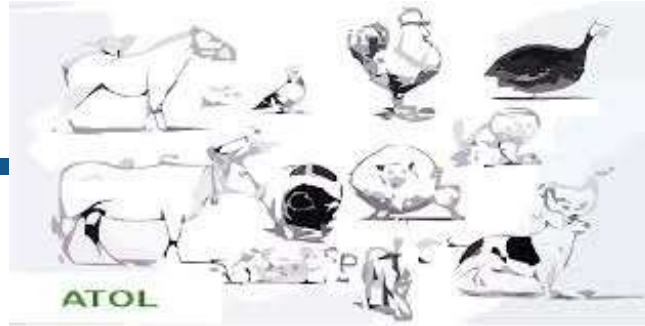
video, article of reference, methods

Sadjad Danesh Mesgaran, Björn Kuhla

Institute of Nutritional Physiology "Oskar Kellner," Leibniz Institute for Farm Animal Biology (FBN), Wilhelm-Stahl-Allee 2, 18196 Dummerstorf, Germany

Guideline on measuring individual water intake in dairy cow (ATOL_0001529)





<https://www.atol-ontology.com/en/erter-2/>



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European cattle sector*

Webinar:

**Using ontologies to improve animal
science research**

8-9 October 2020

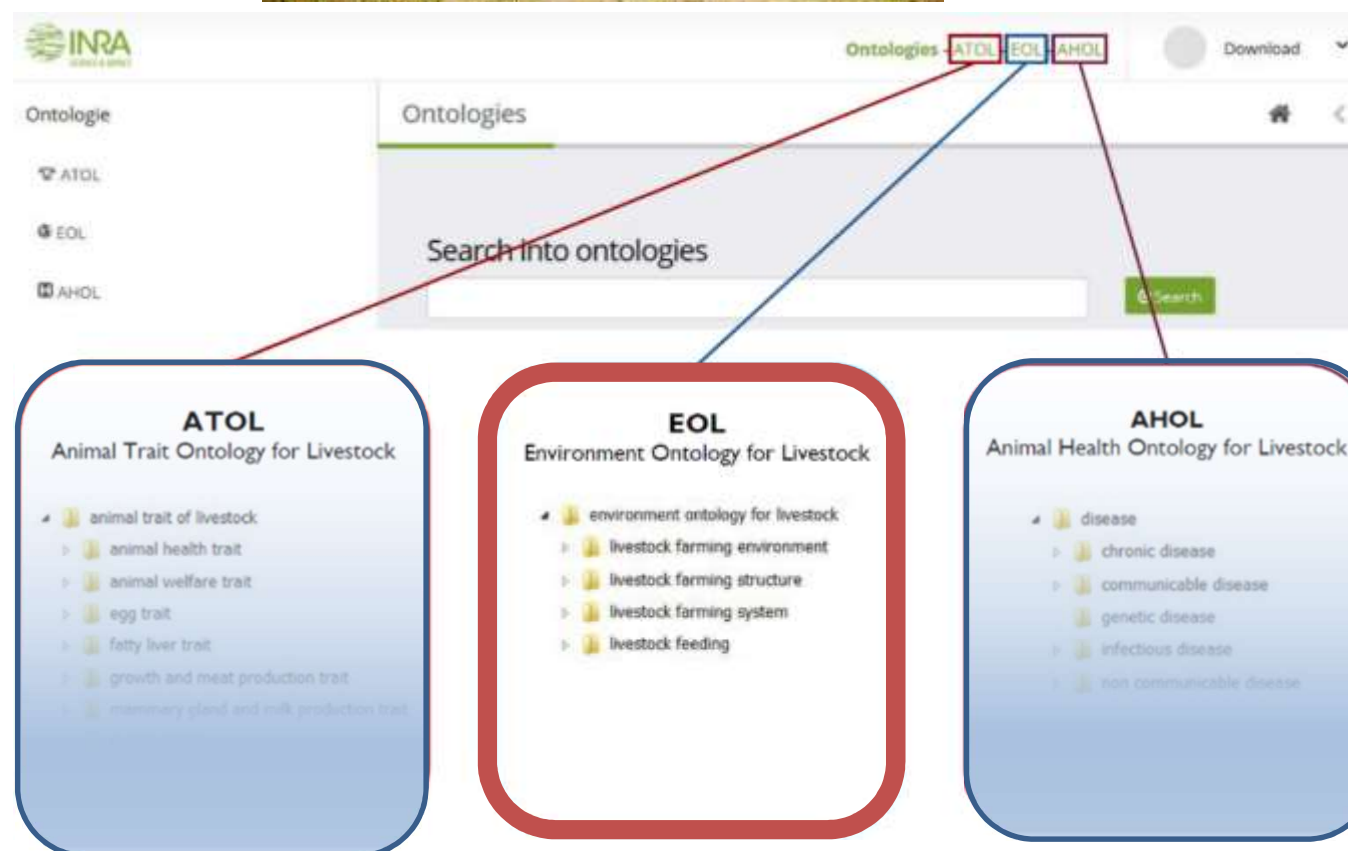
Jerôme BUGEON
INRAE LPGP Rennes

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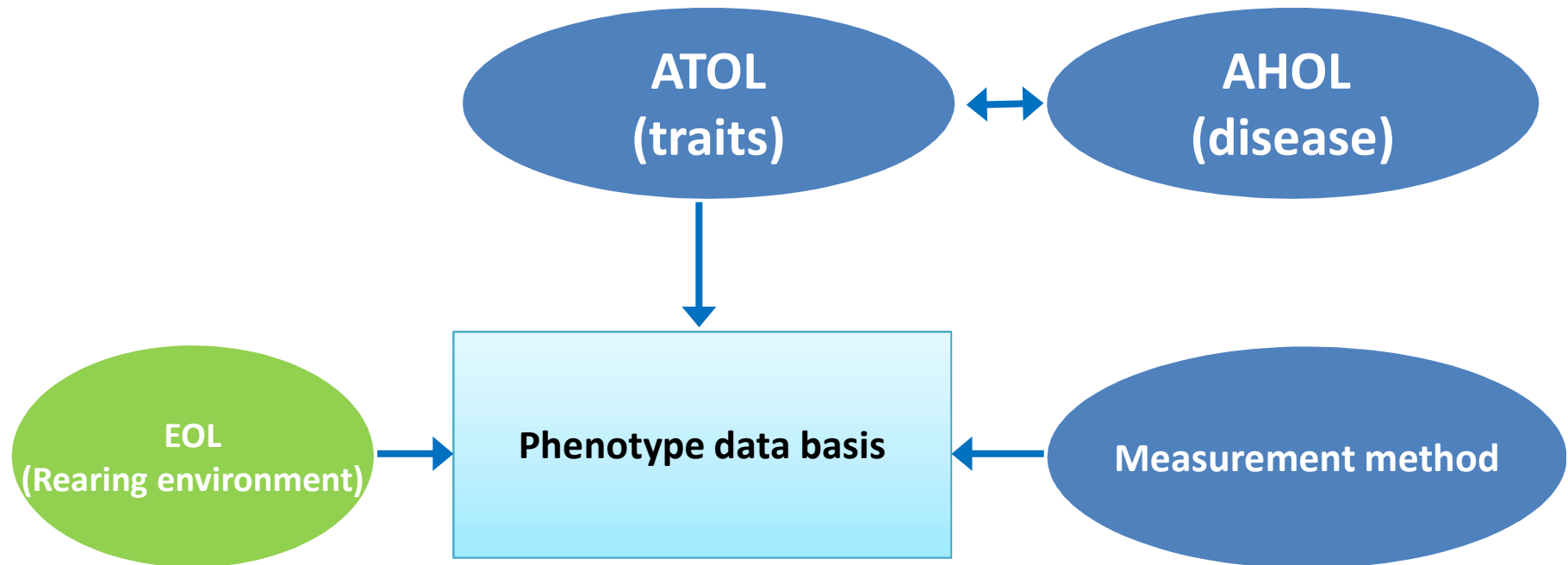


Environment Ontology for Livestock: EOL



Why EOL ?

A phenotype depends on the genotype and the environment
($P = G + E + Epi$).



EOL: the hierarchy






Impact of the living/rearing environment on the phenotypic traits

INRAE

eol

Filter:

☐ Show in tree

- ▲  environment ontology for livestock
 - ▶  livestock farming environment
 - ▶  livestock farming structure
 - ▶  livestock farming system
 - ▶  livestock feeding

The proximal environnement

Rearing structure

Choice made by the farmer

Feeding (quantity, quality)



What's around me ?



How I conceived and managed my farm ?



EOL: the hierarchy

The proximal environnement

- environment ontology for livestock
 - livestock farming environment
 - livestock farming structure
 - livestock farming system
 - livestock feeding
- environment ontology for livestock
 - livestock farming environment
 - rearing living environment
 - livestock abundance
 - animal biomass
 - animal density
 - livestock group characteristic
 - livestock group size
 - livestock group structure
 - rearing biocoenosis context
 - rearing physicochemical environment
 - air rearing environment
 - light rearing environment
 - soil environment
 - water rearing environment



What's around me ?



EOL: the hierarchy

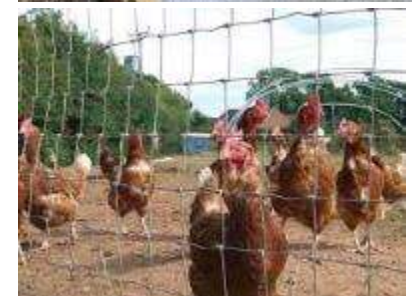
Rearing structure

- environment ontology for livestock
 - livestock farming environment
 - livestock farming structure
 - livestock farming system
 - livestock feeding



- environment ontology for livestock
 - livestock farming environment
 - livestock farming structure
 - experimental structure equipment
 - respiration chamber
 - rearing structure equipment
 - animal handling facility
 - enrichment rearing equipment
 - rearing structure material
 - environmental material
 - rearing structure physical dimension
 - aquaculture rearing structure ph
 - terrestrial rearing structure physi
 - rearing structure type
 - aquatic rearing structure
 - terrestrial rearing structure

What's around me ?



EOL: the hierarchy

- environment ontology for livestock

- ▶ livestock farming environment
- ▶ livestock farming structure
- ▶ livestock farming system
- ▶ livestock feeding



Choice made by the farmer

- livestock farming system

- ▶ aquatic farming system
 - ▶ aquatic management system
 - ▶ aquatic rearing stage unit
 - ▶ biome support
 - ▶ product oriented aquatic rearing
 - ▶ species association system
- ▶ precision livestock farming system
 - ▶ animal material
 - ▶ body evaluation material
- ▶ terrestrial farming system
 - ▶ biome support
 - ▶ product oriented terrestrial rearing
 - ▶ species association system
 - ▶ terrestrial management housing
 - ▶ terrestrial rearing stage unit

How I conceived and managed my farm ?



EOL: the hierarchy

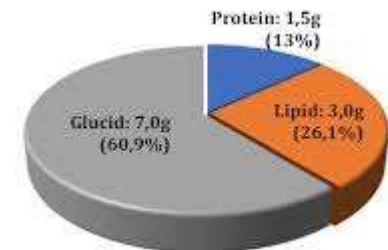
Feeding (quantity, quality)

- environment ontology for livestock
 - livestock farming environment
 - livestock farming structure
 - livestock farming system
 - livestock feeding



- livestock feeding
 - diet change
 - diet characteristic
 - dietary relative composition
 - diet delivery
 - feed delivery
 - milk delivery
 - water delivery
 - feed characteristic
 - feed buffer ability
 - feed chemical composition
 - feed energy content
 - feed nature
 - feed pH
 - feed physical characteristic
 - feed preservative content

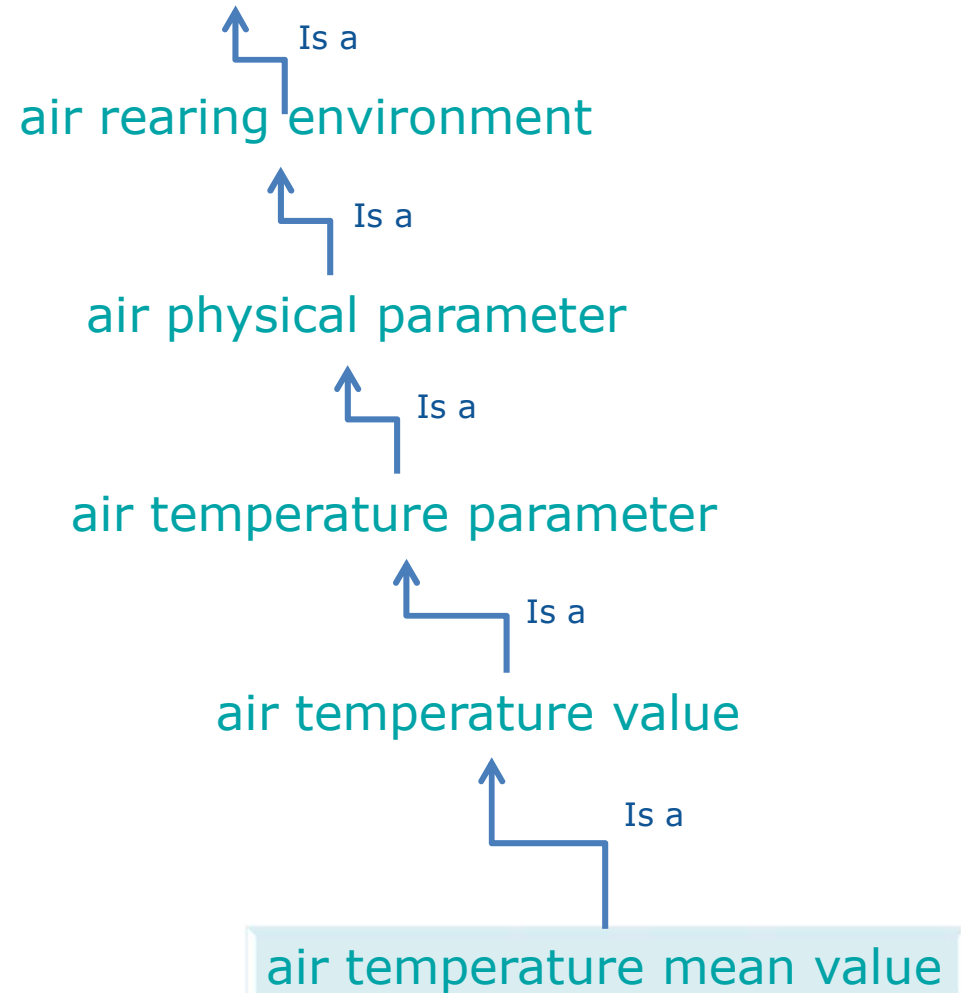
How I conceived and managed my farm ?



EOL: structure of a trait « air temperature mean value »

- rearing physicochemical environment
 - air rearing environment
 - air chemical parameter
 - air physical parameter
 - air density
 - air enthalpy
 - air movement
 - air particle content
 - air pressure
 - air temperature parameter
 - air dew temperature
 - air fluctuation temperature
 - air temperature value
 - air temperature maximum value
 - air temperature mean value
 - air temperature minimum value
 - instantaneous air temperature

Rearing physical environment



EOL: structure of a trait « soil copper content»

eol

- air rearing environment
 - air chemical parameter
 - air physical parameter
- light rearing environment
 - light intensity
 - light spectrum
 - photoperiod
 - type of light
 - artificial light
 - daylight
- soil environment
 - soil chemical parameter
 - carbon to nitrogen ratio
 - soil cation exchange capacity
 - soil mineral matter compound
 - soil element trace metallic
 - soil chromium content
 - soil copper content
 - soil magnesium content
 - soil mercury content
 - soil zinc content
 - soil nitrogen compound
 - soil phosphorus compound
 - soil organic matter compound
 - soil pH
 - soil salinity

Ontologies

environment ontology for livestock / livestock farming environment / rearing physicochemical environment / soil environment / soil chemical parameter / soil mineral matter compound / soil element trace metallic compound

EOL_0001840

Uniform Resource Identifier (URI)
http://opendata.inra.fr/EOL/EOL_0001840

Informations

Name	soil copper content
Definition (en)	content of copper (CHEBI:28694) in soil
Source	INRAE
Link	https://www.ebi.ac.uk/chebi/searchId.do?chebiId=CHEBI:28694
Comments	No results

Synonyms

Exact synonyms
No results

Related synonyms
No results

Measurement methods

No results

EOL: structure of a trait «soil copper content»

eol

- air rearing environment
 - air chemical parameter
 - air physical parameter
- light rearing environment
 - light intensity
 - light spectrum
 - photoperiod
- type of light
 - artificial light
 - daylight
- soil environment
 - soil chemical parameter
 - carbon to nitrogen ratio
 - soil cation exchange capacity
 - soil mineral matter compound
 - soil element trace metallic compound
 - soil chromium content
 - soil copper content
 - soil magnesium content
 - soil mercury content
 - soil zinc content
 - soil nitrogen compound
 - soil phosphorus compound
 - soil organic matter compound
 - soil pH
 - soil salinity

Ontologies

environment ontology for livestock / livestock farming environment / rearing physicochemical environment / soil environment / soil chemical parameter / soil mineral matter compound / soil element trace metallic compound / soil copper content

EOL_0001840

Informations

Name	soil copper content
Definition (en)	content of copper (CHEBI:28694) in soil
Source	INRAE
Link	https://www.ebi.ac.uk/chebi/searchId.do?chebiId=CHEBI:28694
Comments	No results

Synonyms

Exact synonyms
No results

Related synonyms
No results

Measurement methods

No results

A definition (english only)

Link to another ontology

EOL: structure of a trait «soil copper content»

eol

- air rearing environment
 - air chemical parameter
 - air physical parameter
- light rearing environment
 - light intensity
 - light spectrum
 - photoperiod
- type of light
 - artificial light
 - daylight
- soil environment
 - soil chemical parameter
 - carbon to nitrogen ratio
 - soil cation exchange capacity
 - soil mineral matter compound
 - soil element trace metallic compound
 - soil chromium content
 - soil copper content
 - soil magnesium content
 - soil mercury content
 - soil zinc content
 - soil nitrogen compound
 - soil phosphorus compound
 - soil organic matter compound
 - soil pH
 - soil salinity

Ontologies

environment ontology for livestock / livestock farming environment / rearing physicochemical environment / soil environment / soil chemical parameter / soil mineral matter compound / soil element trace metallic compound / soil copper content

EOL_0001840

Informations

Name	soil copper content
Definition (en)	content of copper (CHEBI:28694) in soil
Source	INRAE
Link	https://www.ebi.ac.uk/chebi/searchId.do?chebiId=CHEBI:28694
Comments	No results

Synonyms

Exact synonyms

No results

Related synonyms

No results

Some synonyms

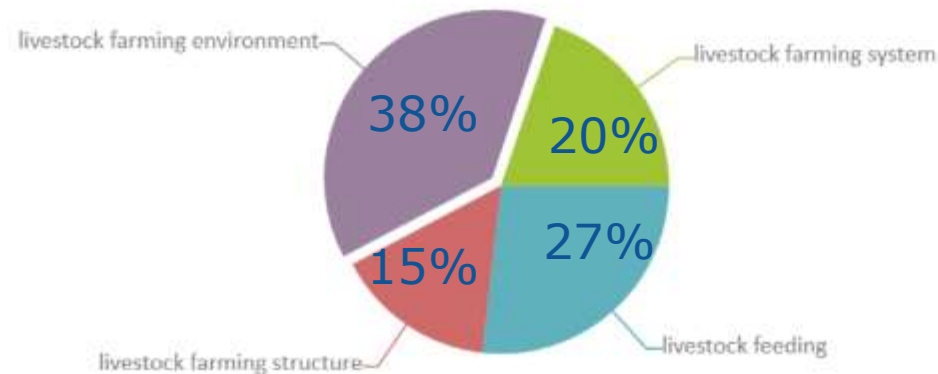
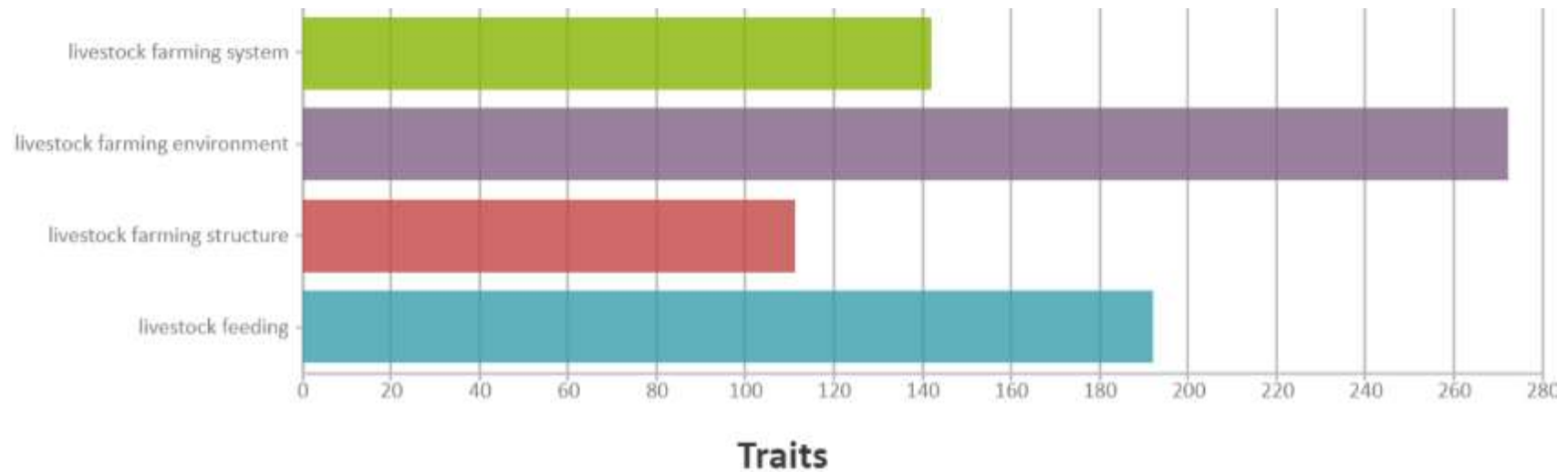
Measurement methods

No results

How this parameter is measured



EOL: number of parameters



More than 700 parameters in December 2020



THANK YOU
FOR YOUR
ATTENTION



INRAE

Livestock Ontologies

ATOL – EOL – AHOL

ONTOLOGIES

ATOL STRUCTURE

ACTORS

BIBLIOGRAPHY



Eol



The EOL ontology describes environmental conditions of livestock farms. More specifically, it describes the feeding modalities, the environment, the structure of livestock farms and rearing systems.



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Webinar:

Animal Health Ontology for livestock AHOL

MC Meunier-Salaün

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AHOL Ontology

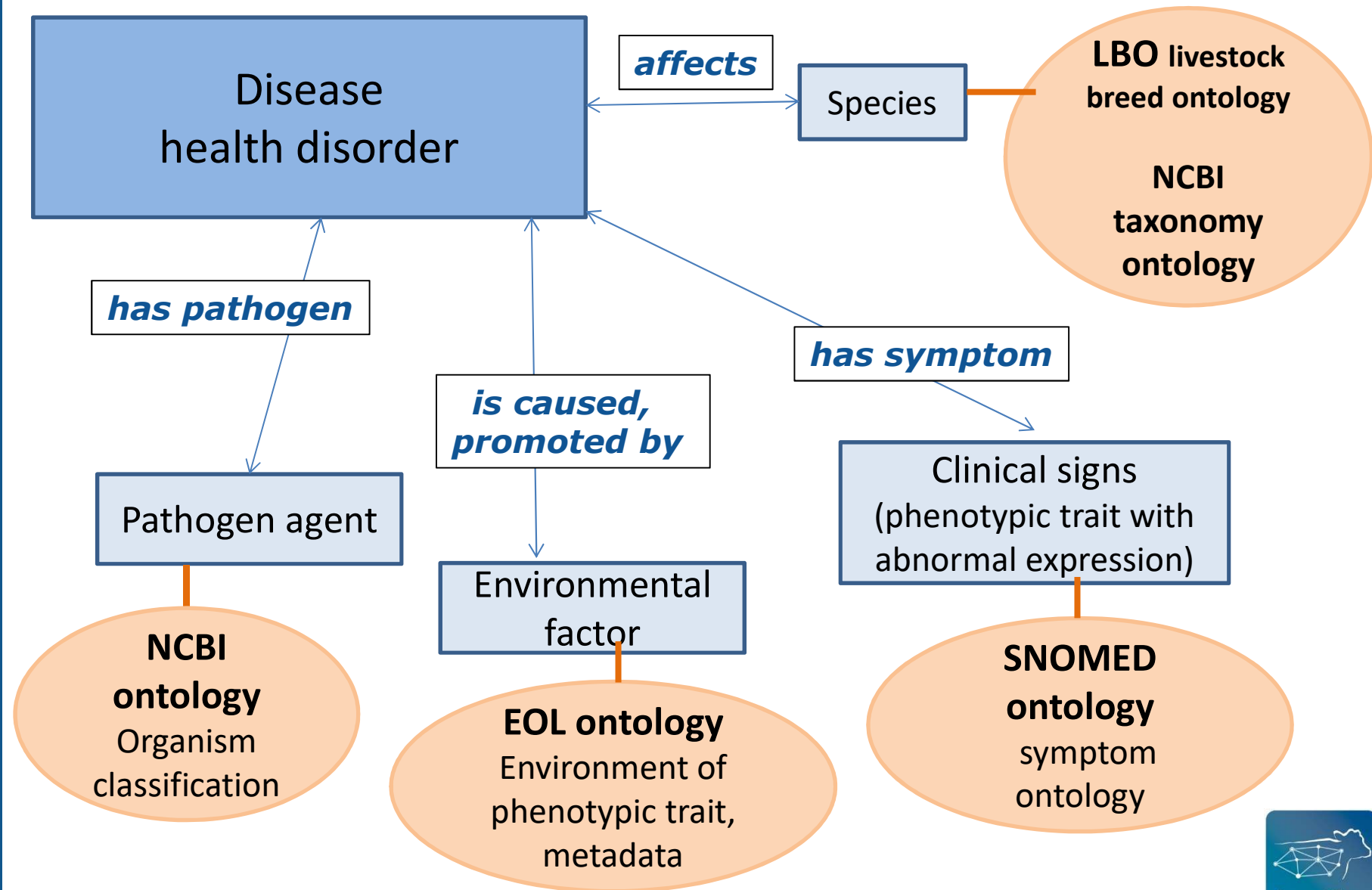
Objectives

- fine description of the health status of individuals and flocks in different species of animal production
 - multispecies focus
 - production disease : agent or factor involved
 - * pathogen agent (infectious diseases)
 - * environmental factors
 - clinical signs related to disease or health disorder
- Further : applications using ontologies dedicated to the animal production sector : health management of herd, diagnosis tool

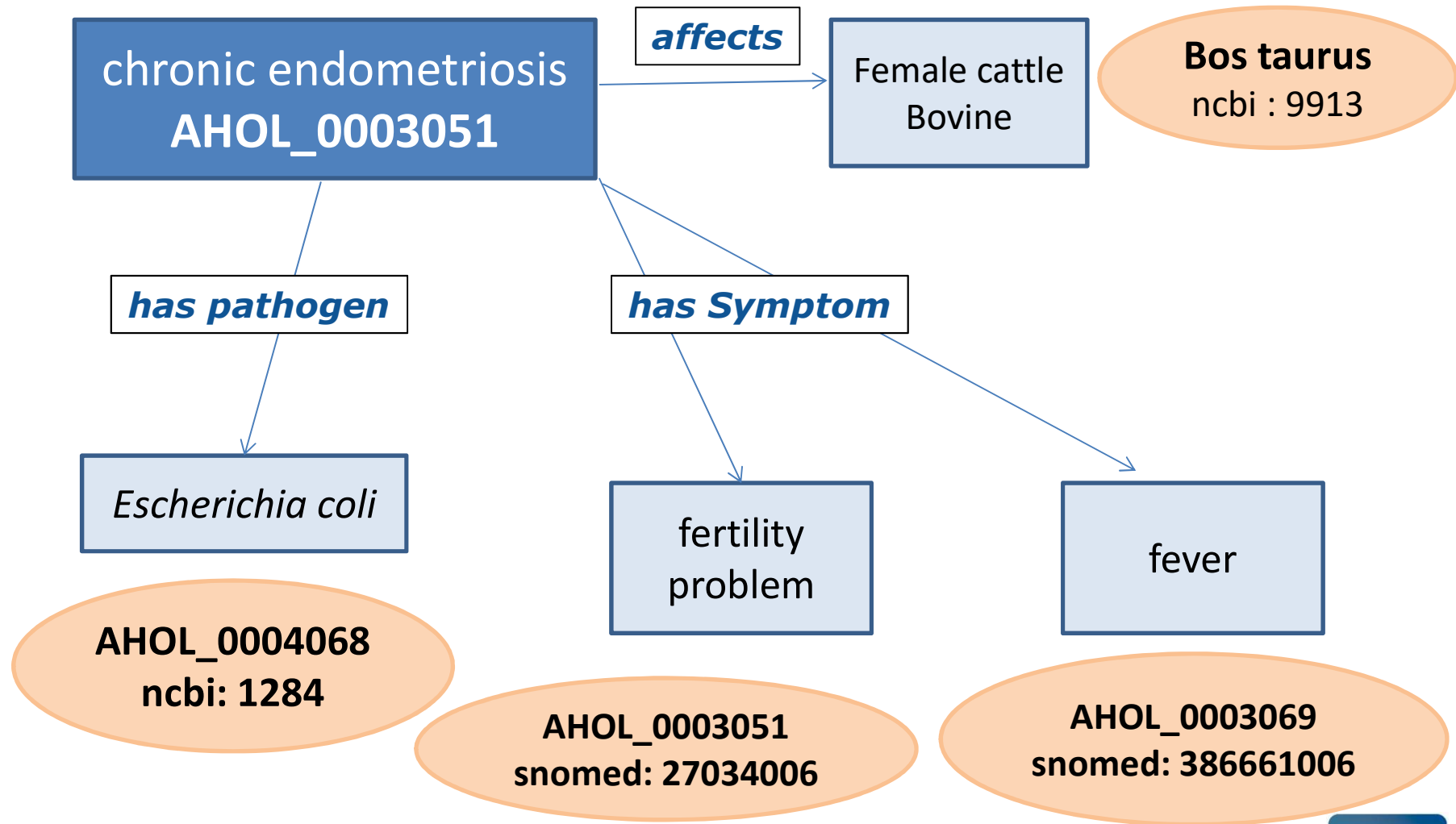


AHOL – perimeter focus on the disease/health disorder

properties : specie affected, causes, consequences



AHOL – Example



AHOL – hierarchy

main branches 177 maladies

The screenshot shows the AHOL web interface. On the left, there's a search bar and a filter dropdown set to 'disease'. Below it, a list of main branches is shown: chronic disease, communicable disease, genetic disease, infectious disease, and non communicable disease. On the right, a 'Traits' horizontal bar chart displays the count of diseases for each category.

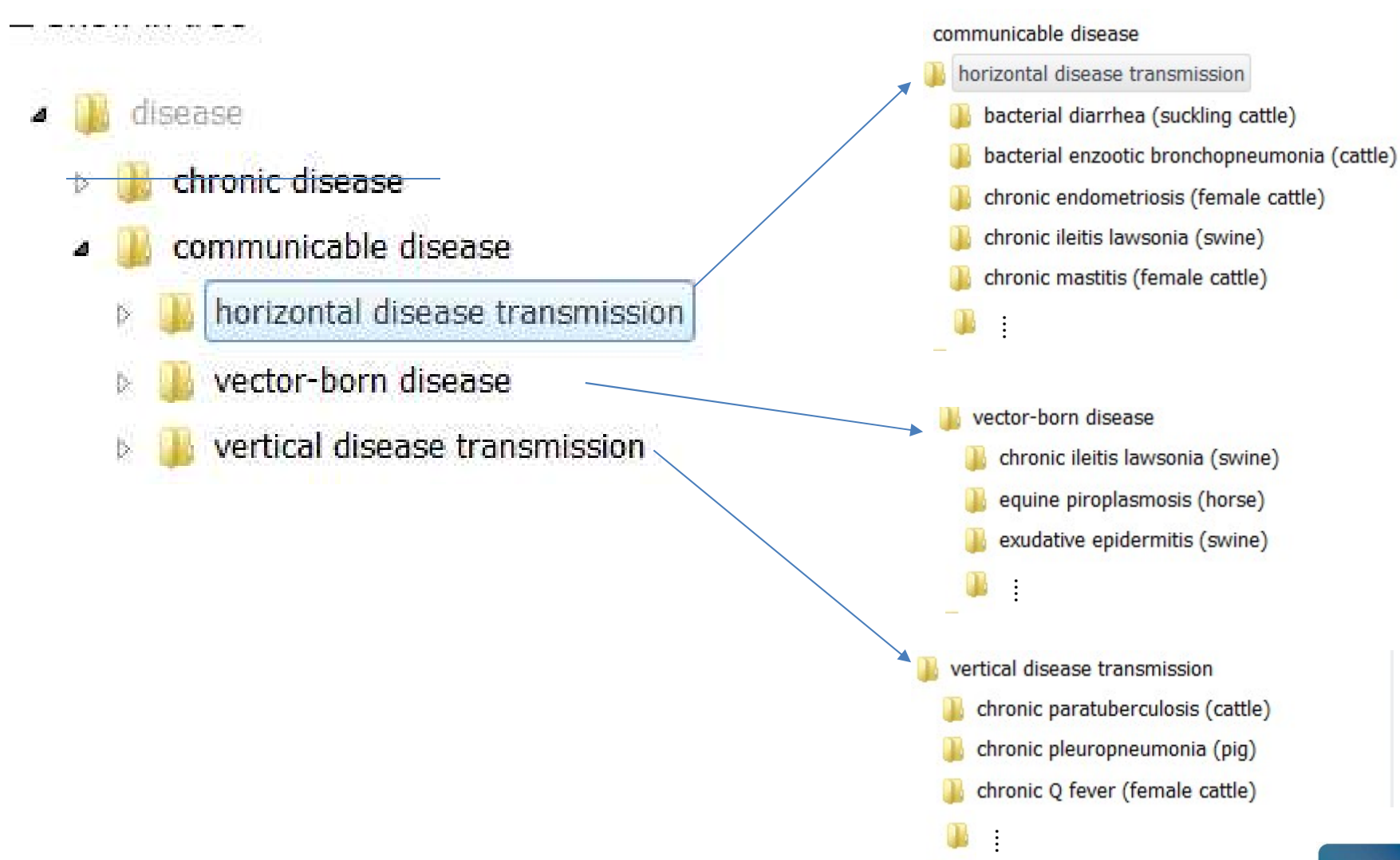
Trait	Count
genetic disease	0
infectious disease	64
non communicable disease	18
communicable disease	76
chronic disease	18

On going work to
*** enrich the hierarchy with new branches**
*** add new diseases**

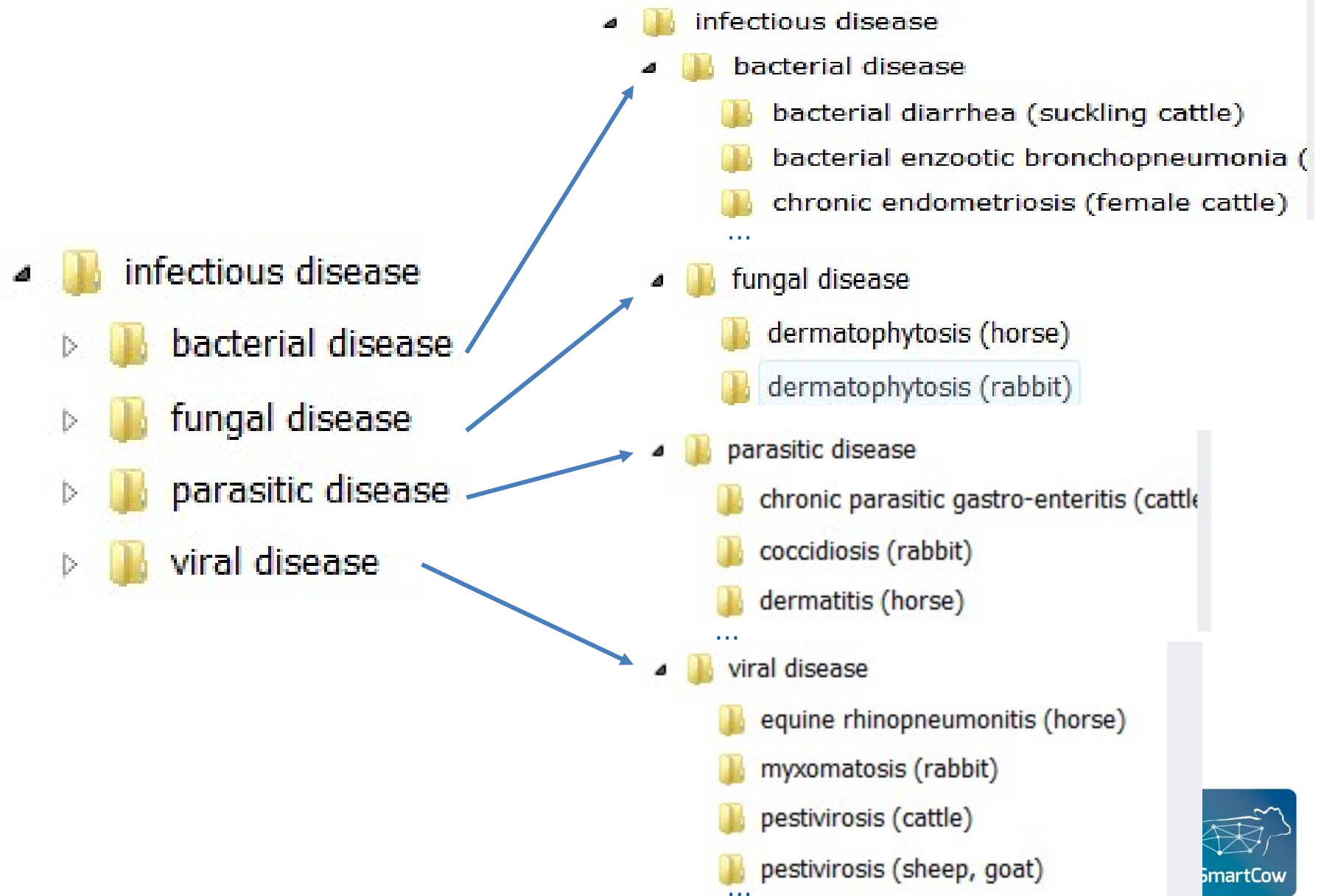
especially genetic disease – non communicable disease



AHOL – communicable disease branch



AHOL – infectious disease branch




AHOL – non communicable disease branch

-  non communicable disease
 -  allergic disorder
 -  metabolic disorder
 -  mycotoxin-related disorder
 -  nutritionnal disorder
 -  nutriment-related disorder
 -  micronutrient-related disorder
 -  physical disorders
 -  skin disorder
 -  muscelsqueletal disorder
 -  neurological disorder
 -  psychological disease
 -  cognitive disorder
 -  developmental disorder
 -  toxic-related disorder
 -  tumor cancer disease

AHOL – properties of disease

Example bacterial diarrhea



Ontologies - ATOL - EOL - AHOL

Download

ahol_diseases

disease

chronic disease

communicable disease

horizontal disease transmission

bacterial diarrhea (suckling ca

bacterial enzootic bronchopneumon

chronic endometritis (female cattl

chronic ileitis lawsonia (swine)

chronic mastitis (female cattle)

chronic parasitic gastro-enteritis (c

chronic paratuberculosis (cattle)

chronic pleuropneumonia (pig)

chronic Q fever (female cattle)

chronic swine erysipelas (pig)

clostridiosis (suckling pig)

clostridium spiroforme enterotoxen

coccidiosis (rabbit)

colibacillosis (post weaning rabbit)

colibacillosis (suckling rabbit)

colibacillosis (swine)

dermatophytosis (rabbit)

enzootic bronchopneumonia (swine)

epizootic rabbit enteropathy (rabbit)

exudative epidermitis (swine)

ileite lawsonia (growing swine)

leptospirosis (gestating pig)

leptospirosis (pig)

mastitis (female cattle)

myxomatosis (rabbit)

parasitic gastro-enteritis (cattle)

pasteurellosis (gestating rabbit)

Ontologies

animal health trait / disease / communicable disease / horizontal disease transmission / bacterial diarrhea (suckling cattle)

AHOL_0005060

Unique Identifier (ID), Uniform Ressource Identifier (URI) http://opendata.inra.fr/AHOL/AHOL_0005060

Informations

Name	bacterial diarrhea (suckling cattle)
Nom	diarrhée bactérienne (bovin allaité)
Definition (en)	Frequent elimination of loose stools. It has toxic, nutritional, parasitic or most often infectious origins.
Definition (fr)	Elimination fréquente de selles liquides. Elle est d'origine toxique, nutritionnelle, parasitaire ou le plus souvent infectieuse.
Source	INRAE/ONIRIS/ENV
Comments	<i>pictures, reference publication, methods</i>

Symptoms

dehydration
fever *AHOL_0003000*
growth retardation

Pathogens

escherichia coli

Species

mammals

Suckling cattle present

Environmental factor
ex : instantaneous air temperature *EOL_0000253*

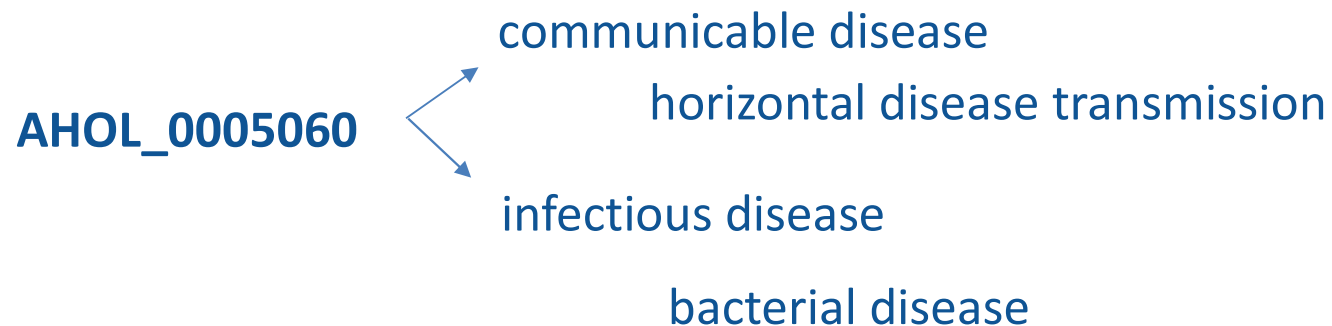
SmartCow – AHOL

Exercise

<https://www.atol-ontology.com/ahol/>

Request on disease / pathogen / symptom

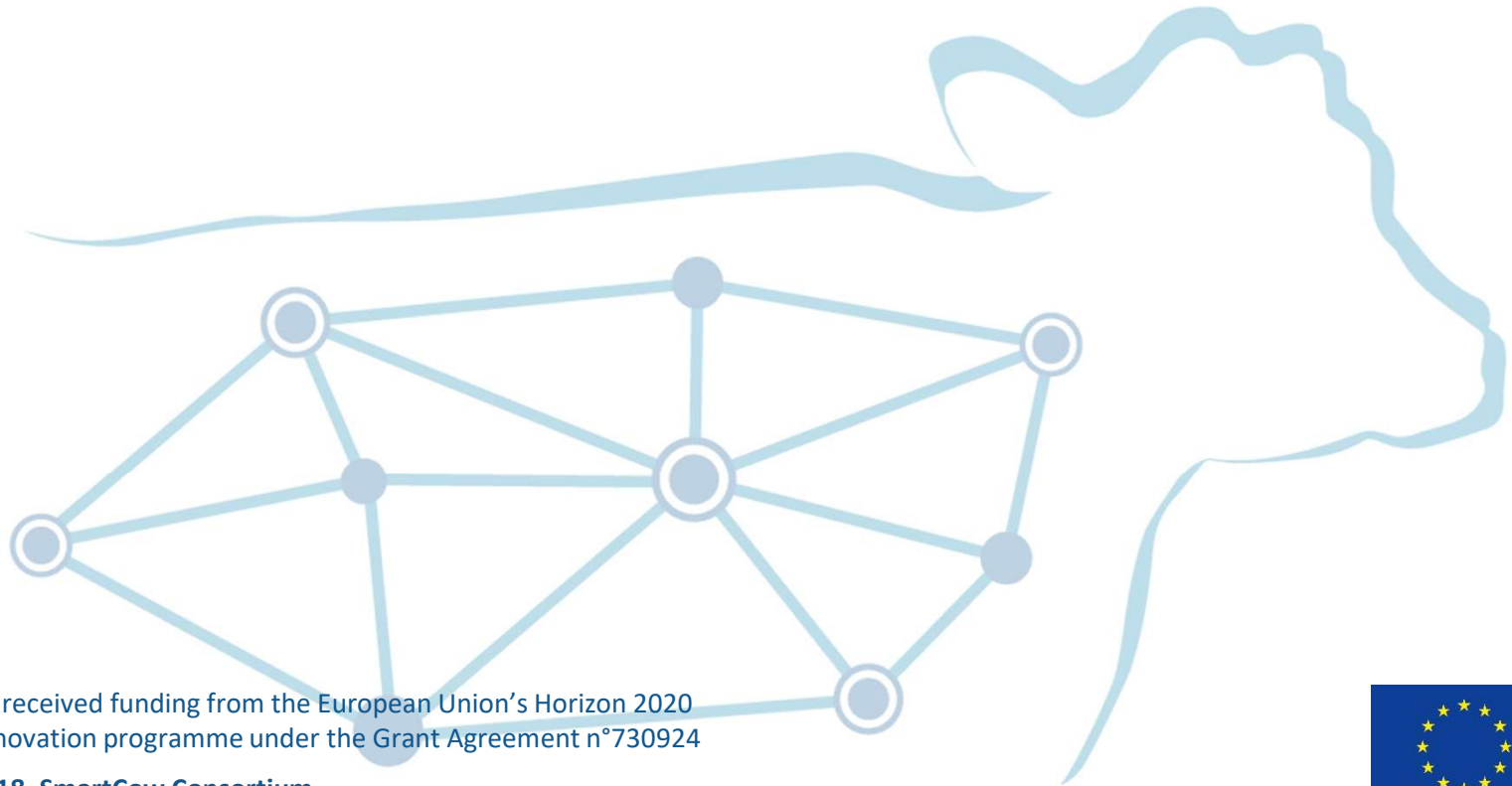
bacterial diarrhea (suckling cattle) 2 matches



.....

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Thanks for your attention



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Webinar:

Applications of the ontology AHOL

MC Meunier-Salaün

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Applications of AHOL Ontology

Objectives

- Creation of centralized databases with computer interface with ontologies => annotated databases on health events
- Diagnosis tool using knowledge of the ontology

Applications of AHOL Ontology

annotated on farm databases

- annotated databases on health events
- query and exploit data on health events in correspondence with ontologies identifiers via a formal language (*ex SPARQL query*)
- assess the health status of animal or herd from queries on the frequency of diseases, the presence of pathogens, the expression of clinical signs
- allow interoperable datasets using the same reference identifier



Applications of AHOL Ontology

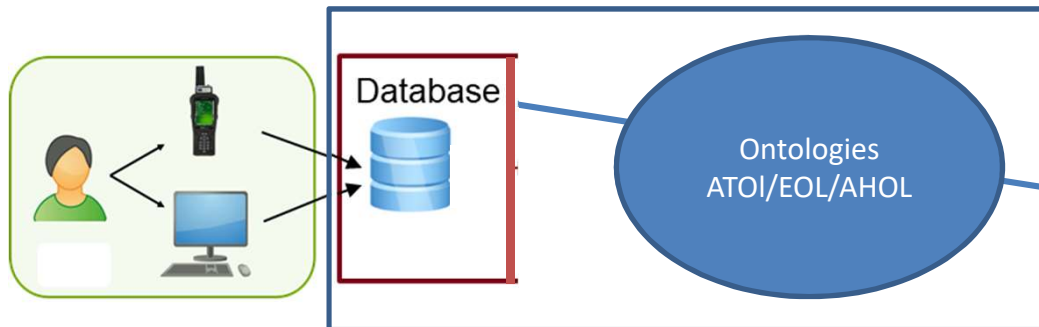
principle of the interface with ontology

Experimental/farm Unit

Data collectors at the animal level



On farm database



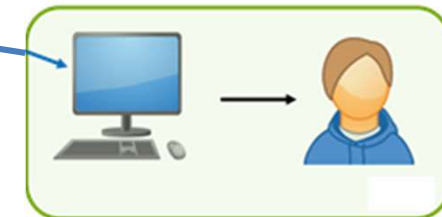
Computer app

Users (scientist/ manager)

Data extraction
from queries of the farm database



User database



Web app

Applications of AHOL Ontology

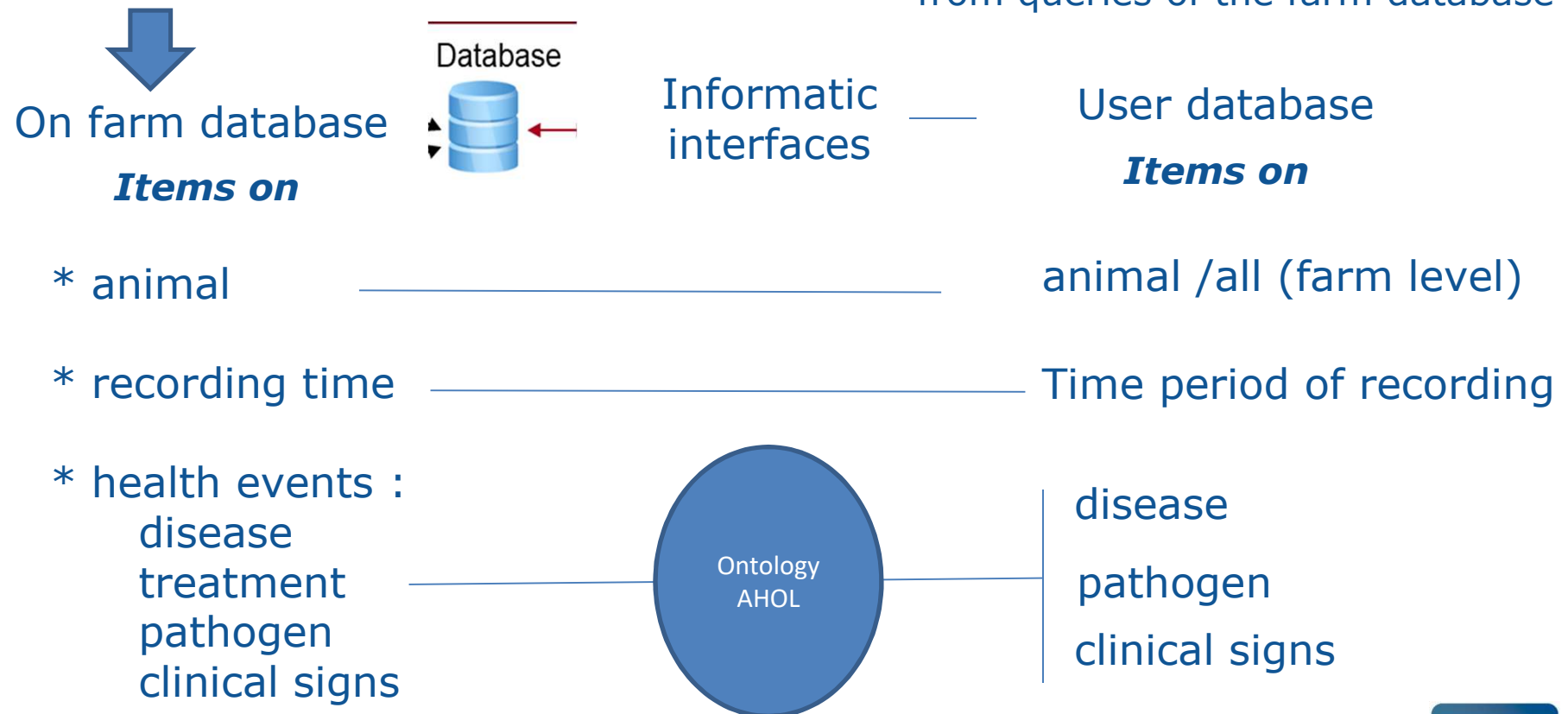
principle of the interface with ontology

Experimental/farm Unit

Users (scientist/ manager)

Data collectors at the animal level

Data extraction
from queries of the farm database



Annotated files from data extraction of the user database

Data extraction



- Query items
- animals from the experiment
 - recording period : 01/01/2020 to 01/10/2020
 - on event clinical signs : lameness

data file with various format

[Copy](#)[Excel](#)[CSV](#)[PDF](#)[Print](#)

Animal	Start	End	Treatment	Event family	Event	Id AHOL
805471	01/01/2020	01/10/2020	MELOVEM	members	lameness	AHOL_0003029
060032	01/01/2020	01/10/2020	-	members	lameness	AHOL_0003029
....						

- shared datasets for health status of several farms
- meta analysis on experimental health dataset

a significant added value for standardized registration, optimal operation, and sharing of health data, and broader phenotypic data (ATOL) and their context (EOL) collected on animals



Applications of AHOL Ontology : diagnostic tool

- Query the ontology via an app (web, smartphone) to confirm health diagnosis
 - disease suspected : check the pathogen or clinical symptom related to
 - pathogen found : check potential diseases related to
 - clinical signs recorded : check potential disease related to
- ➔ Potential tool to check, to improve knowledge on health



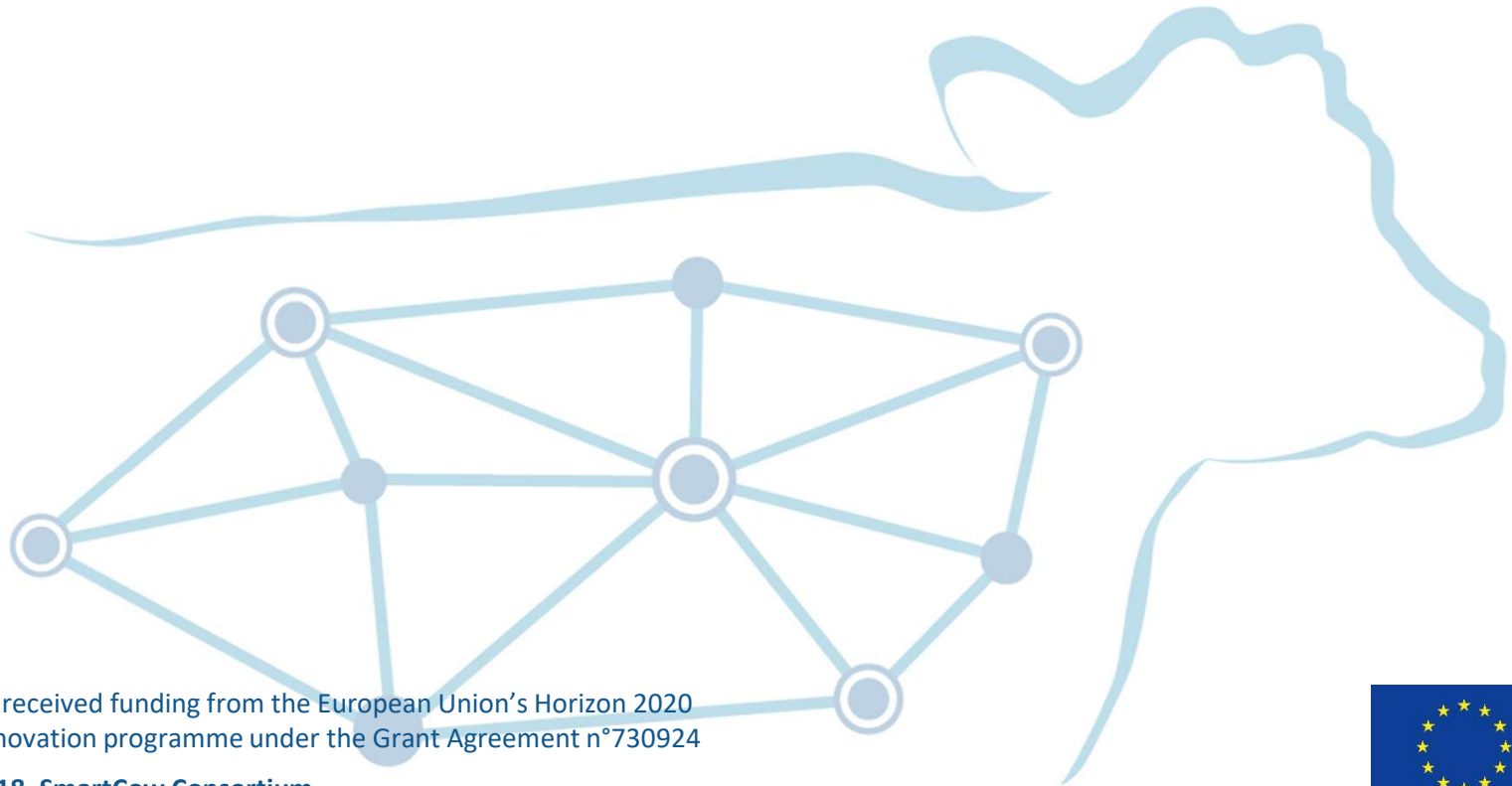
Applications of AHOL Ontology : diagnostic tool

- Assess the health status of animal or herd from queries on the frequency of diseases, the presence of pathogens, the expression of clinical signs
- Allow interoperable datasets using the same reference identifier



SmartCow

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Webinar

**Using ontologies to improve animal
science research**

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Text-based annotation with ontologies

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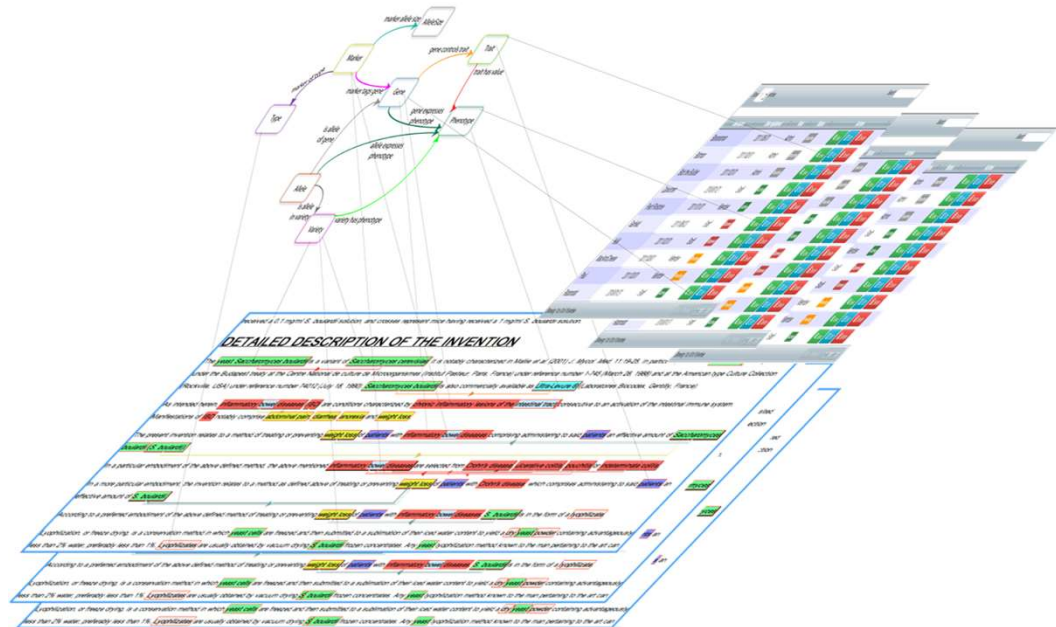
Using ontologies to combine data from multiple sources

Objective

Centralize, structure and standardize information
For better access and reuse

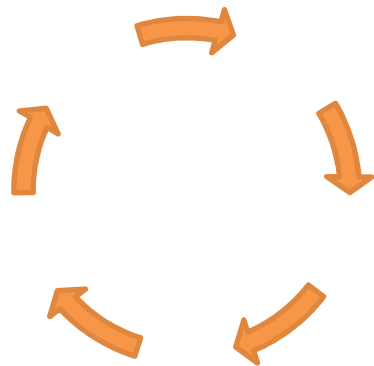
Free text data are many

Text mining
transforms
unstructured data
into structured data



Combining data from multiple sources

Information from bibliography



- Supports research hypotheses
- Supports experimental condition settings
- Confirms experiments results by previous published work
- Meta-analysis



Ontology for data annotation



mapping

ATOL

Experimental data

- ☐ animal trait of livestock
 - ☐ mammary gland and milk production trait
 - ☐ mammary gland production trait
 - ☐ milk trait
 - ☐ milk composition trait
 - ☐ milk organic acid trait
 - ☐ milk citric acid concentration

Parameter	Group 1 [‡]	Group 2	Group 3
Number of cows	49	23	18
Milk yield/milking (kg)	11.16 ^a ± 0.37	10.92 ^{ab} ± 0.59	9.37 ^b ± 0.37
Fat (%)	4.77 ^a ± 0.13	4.79 ^a ± 0.21	5.08 ^a ± 0.13
Total protein (%)	3.55 ^a ± 0.04	3.51 ^a ± 0.07	3.55 ^a ± 0.04
Casein (%)	2.61 ^a ± 0.03	2.57 ^a ± 0.05	2.56 ^a ± 0.03
Whey protein (%)	0.94 ^a ± 0.02	0.94 ^a ± 0.03	0.98 ^a ± 0.02
Casein number	0.74 ^a ± 0.00	0.73 ^{ab} ± 0.01	0.72 ^b ± 0.01
Lactose (%)	4.55 ^A ± 0.03	4.51 ^{ab} ± 0.04	4.39 ^c ± 0.03
Citric acid (%)	0.16 ^a ± 0.00	0.16 ^a ± 0.01	0.16 ^a ± 0.01
Log SCC (cells/ml)	4.50(32 [†]) ^A ± 0.05	5.20(160 [†]) ^B ± 0.07	5.89(784 [†]) ^C ± 0.08

milk organic acid trait

milk citric acid concentration



Ontology for annotation of textual data



The **citric acid in whole milk** was measured at different intervals

Different parameters of **milk samples** (fat, total protein, casein, lactose, total solids, solids non-fat, **citric acid**, [..])

The effect of subclinical mastitis on the **citric acid concentration of cow's milk** was studied

Milk citrate concentration of affected animals was significantly lower

Factors influencing **milk citric acid concentrations in dairy cows**

Choline, carnitine, **citric acid** and lactose **in milk** were correlated with

Ontology for annotation of textual data



milk organic acid trait

milk citric acid concentration

measure
of

citric
acid

milk

cattle

Factors influencing **milk citric acid concentrations in dairy cows**

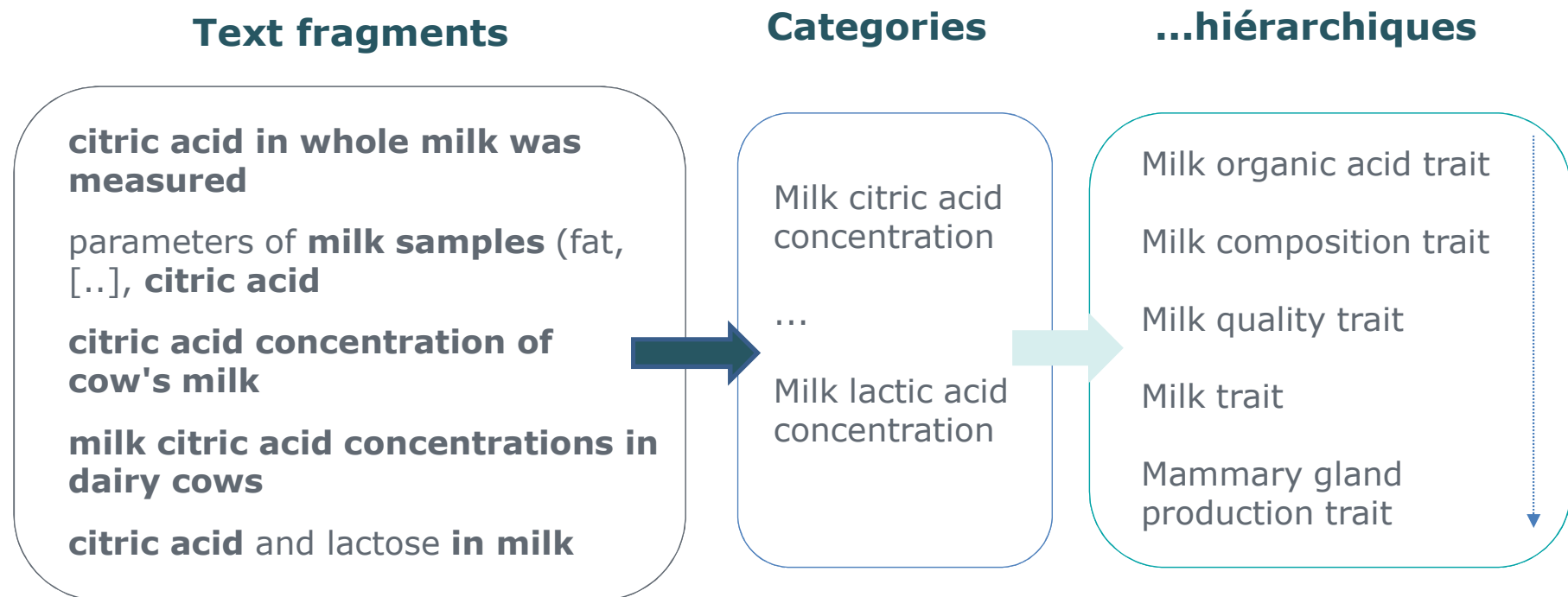
From
concept

Lexicon,
syntax

To text

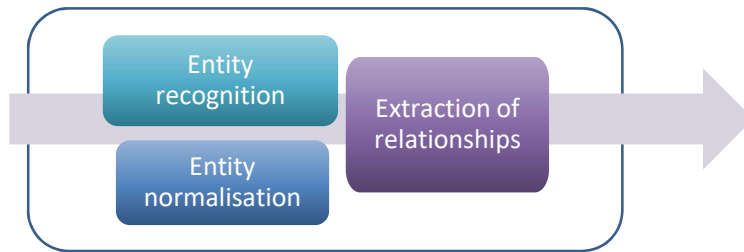
The **citric acid in whole milk was measured** at different intervals

How to find information on milk composition, citric acid and other components



Enable conceptual abstraction = By climbing the hierarchy

Automatic extraction of information



Effect of Pathogen-Specific Clinical Mastitis on Milk Yield in Dairy Cows

Our objective was to estimate the effects of the first occurrence of pathogen-specific clinical mastitis (CM) on milk yield in 3071 dairy cows in 2 New York State farms. The pathogens studied were *Streptococcus* spp., *Staphylococcus aureus*, *Staphylococcus* spp., *Escherichia coli*, *Klebsiella* spp., *Arcanobacterium pyogenes*, other pathogens grouped together, and "no pathogen isolated."

Gröhn et al., 2004. [doi.org/10.3168/jds.S0022-0302\(04\)73472-4](https://doi.org/10.3168/jds.S0022-0302(04)73472-4)

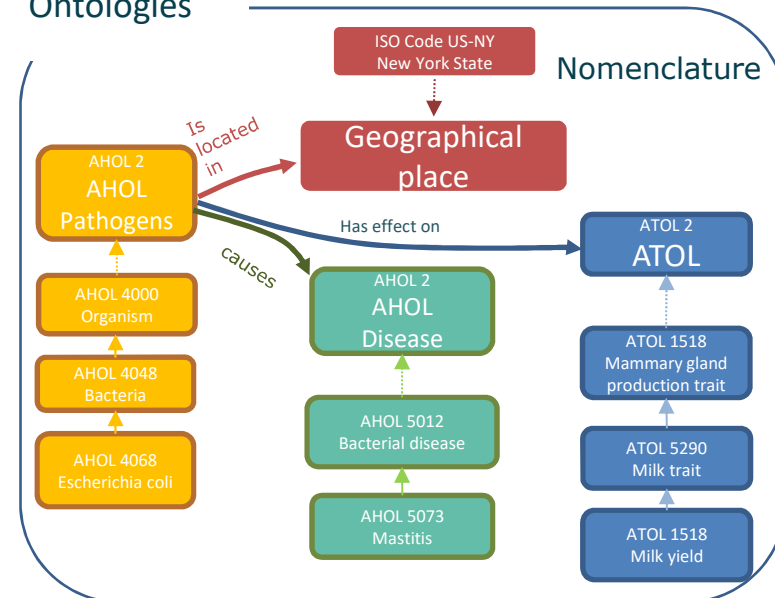
Gröhn et al., 2004. [doi.org/10.3168/jds.S0022-0302\(04\)73472-4](https://doi.org/10.3168/jds.S0022-0302(04)73472-4)

Gröhn et al., 2004. [doi.org/10.3168/jds.S0022-0302\(04\)73472-4](https://doi.org/10.3168/jds.S0022-0302(04)73472-4)

Text mining



Ontologies



Entity recognition

Entities types and boundaries

Effect of Pathogen-Specific Clinical Mastitis on Milk Yield in Dairy Cows

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EOL:Pathogen



EOL:Disease



ATOL:Trait



GeoNames



Mapping of Ontology concepts to text

Dealing with variation

Typographic variation

meat colour / meat color
crude fiber / crude fibre

Abbreviation

Lactobacillus spp. / Lactobacillus subspecies

Acronym

Colostrum somatic cell count / Colostrum SCC

Morphological variation

testicular size / testis size / testes size

Morpho-syntactic variation

weight seen at birth / weight at birth
activity for LDH / LDH activity
citric acid and lactose in milk / milk citric acid

Semantic variation

adipose tissue / fat tissue

Entity recognition

methods

Dictionary mapping

For strict nomenclature

Suffers from homonymy and ambiguity

Rules with criteria on context and entity composition

Good precision, poor recall

Supervised machine Learning from training examples

Probability of a word to belong to an entity of a given type

Required manual annotation

To be combined with word embeddings

Term extraction and entity type prediction by machine learning

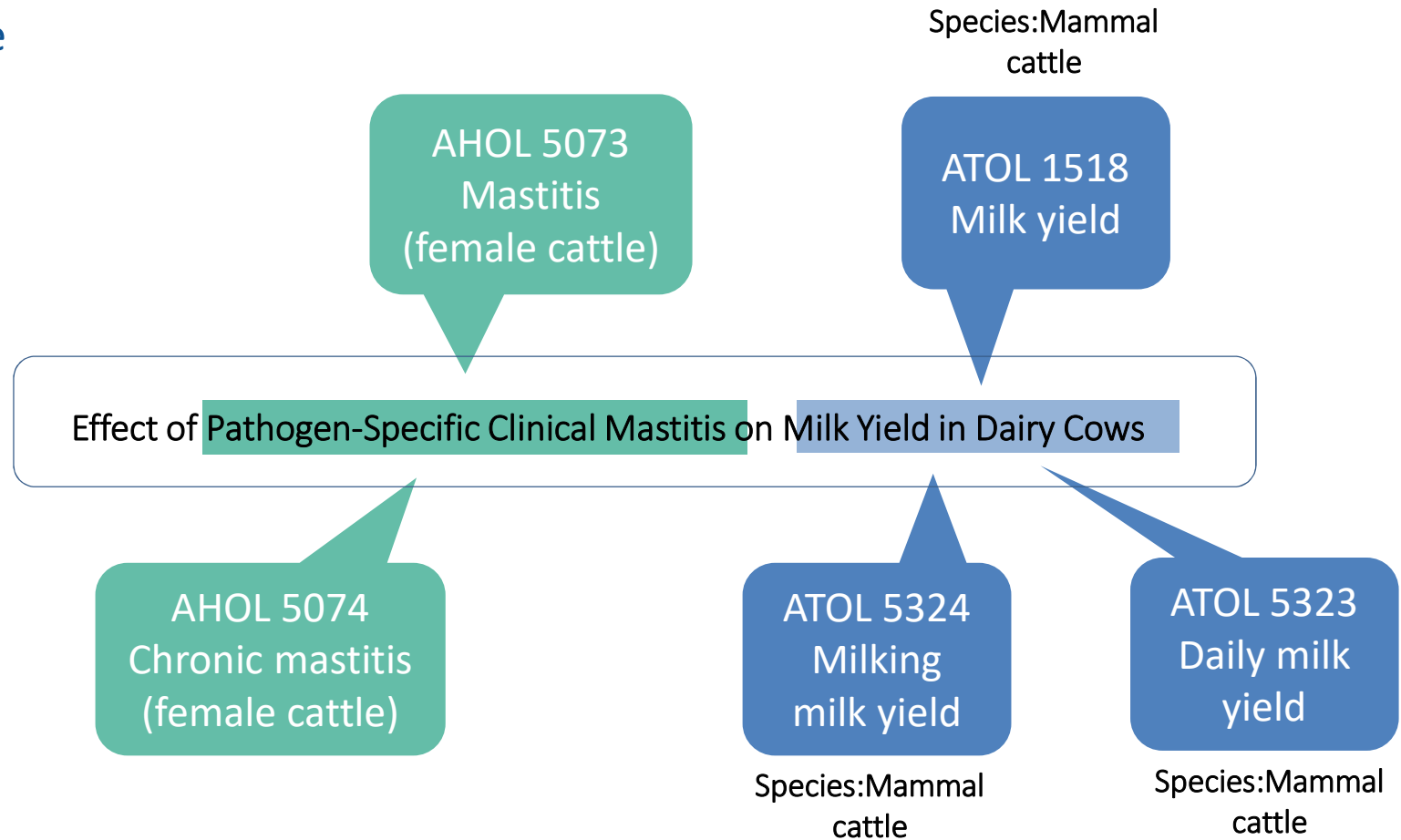
Good precision of the boundaries

To be combined with distant supervision



Entity normalization

Example



Entity normalization

methods



Similarity criteria between the entity and the class

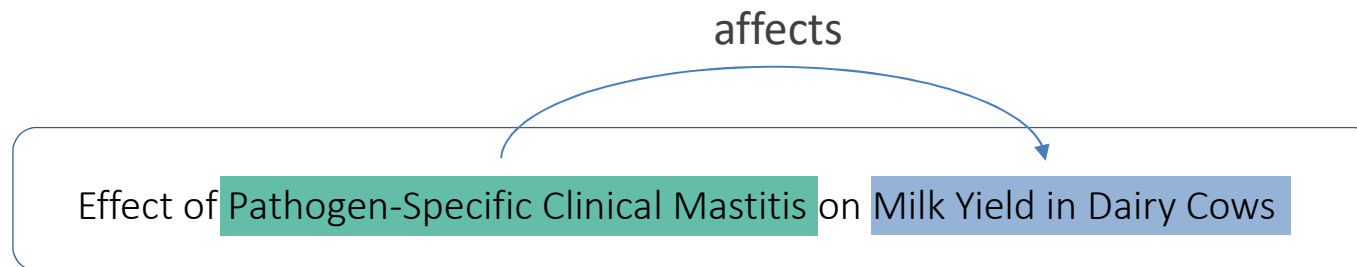
- Common words
- Same « head »
- Vector (word embedding) distance

Supervised machine Learning from examples

- Required manual annotation
- Zero-shot learning problem
- To be combined with word embeddings
- Using the structure of the ontology

Relationships

Examples and methods



Given the entities of the right type, predicts the relation ships

- Rules
- Supervised Machine Learning from positive and negative training examples of the relation

Applications

- **For animal research**

Semantic search of papers.

Combining data, experimental data and bibliographical results

Meta-analysis based on semantic annotation of experimental data tables

- **For decision support**

Cartography of main and secondary topics.

Who is working on what? Expert profiling

- **For Ontology extension**

Add or revise classes through bibliography analysis

Semantic search engine

Classical bibliography search

- Researchers face an overwhelming amount of publications.
- Technical terms are not known by researchers conducting interdisciplinary studies.
- Word-based search misses relevant papers.
- Terminology variation hinders efficient searching.

Semantic search principle. Search the full-text of documents for the *ontology concepts of the user query*. Not only user query words.

Benefits.

- Efficient search without the knowledge of the relevant keywords,
- Large collections can be automatically indexed and kept up to date.
- An alternative to time-consuming manual indexing of the papers

Semantic search engine - AlvisIR

ATOL 5
Mammary gland and
milk production trait

The screenshot displays the AlvisIR search engine interface. At the top, the search bar contains the query "milk production traits and Bos Taurus". Below the search bar, the results are organized into two main sections: "Taxa" and "ATOL Concepts".

Taxa

	10	20	All
Bos taurus	2122	179	
Data	332	179	
Metazoa	1338	156	
Bos taurus	3866	145	
test for taxonomy	331	94	
Ovis aries	747	65	
Homo sapiens	168	50	
Zea mays	340	48	
Hordeum vulgare	105	41	
Homo sapiens	99	30	

ATOL Concepts

	10	20	All
milk yield	1912	169	
lactation	2182	125	
feed intake	292	80	
age	626	77	
metabolism	275	66	
milk fat	405	56	
meal	187	54	
fertility	377	52	
milk composition	143	52	

The main search results pane displays a list of documents. The first result is titled "Genetic evaluation of Ethiopian Boran cattle and their crosses with Holstein Friesian in central Ethiopia: milk production traits". The abstract of this document is visible, discussing the genetic parameters of lactation (milk yield, LYD, 305-day milk yield, lactation length (LL), milk yield per day of lactation (DM) and lifetime milk yield (LTYD) were estimated in Ethiopian Boran cattle and their crosses with Holstein in central Ethiopia. The data analyzed included 2360 lactation records spread over 15 years. Ethiopian Boran cattle were consistently inferior ($P < 0.01$) to the Ethiopian Boran-Holstein crosses for the dairy traits studied. When the crosses were compared, LYD, 305YD and DM were higher ($P < 0.01$) for 75% and 87.5% crosses compared to 50% and 62.5% ones. However, the 50% crosses had higher ($P < 0.01$) LTYD than the other genetic groups. The individual additive genetic breed differences for milk production traits were all significant ($P < 0.01$). The estimates, in favor of Holstein, were 2055 ± 192 kg for LYD, 1776 ± 142 kg for 305YD, 108 ± 24 days for LL, 5.9 ± 0.5 kg for DM and 3353 ± 1294 kg for LTYD. Crossbreeding of the Holstein with the Ethiopian Boran resulted in desirable and significant ($P < 0.01$) individual heterosis for all milk production traits. The heterosis estimates were, 529 ± 98 , 427 ± 72 kg, 44 ± 12 days 1.47 ± 0.23 kg and 3337 ± 681 kg, for LYD, 305YD, LL, DM and LTYD, respectively. The maternal heterotic effects were non-significant ($P > 0.05$) for all traits. Heritabilities of LYD, 305YD, LL, DM and LTYD for Ethiopian Boran were 0.20 ± 0.03 , 0.18 ± 0.03 , 0.26 ± 0.03 , 0.13 ± 0.03 and 0.02 ± 0.04 , respectively. The corresponding estimates for crosses were 0.10 ± 0.002 , 0.11 ± 0.003 , 0.63 ± 0.02 , 0.45 ± 1.05 and 0.24 ± 0.11 , respectively. Selection within each of the genetic groups and crossbreeding should substantially improve the milk production potential of the Ethiopian Boran breed under such production system.

Combining experimental information and bibliography



Florilege, a database gathering microbial habitats, phenotypes and uses

Search relations by taxon

Streptococcus

TSV Download

Filter Selection

85 relations for the taxon Streptococcus

Source

PubMed
GenBank
CIRM-BIA
CIRM-Levures

Habitat

milk

☐ QPS only

Apply

SOURCE TEXT	TAXON	RELATION TYPE	HABITAT	QPS	SOURCE
24827399	Streptococcus thermophilus ASCC 1275	Lives in	milk		PubMed
31704010	Streptococcus thermophilus	Lives in	yak milk	✓	PubMed
	Streptococcus thermophilus	Lives in	milk	✓	CIRM-BIA
16754859, 24053819, 10932746	Streptococcus thermophilus	Lives in	milk	✓	PubMed
	Streptococcus thermophilus	Lives in	ewe milk	✓	CIRM-BIA
FJ915687, FJ915686, FJ915685	Streptococcus thermophilus	Lives in	goat milk	✓	GenBank
	Streptococcus thermophilus	Lives in	yak milk	✓	CIRM-BIA
19878555	Streptococcus thermophilus	Lives in	bovine milk	✓	PubMed
16297479	Streptococcus thermophilus	Lives in	cow milk	✓	PubMed
21995282	Streptococcus thermophilus LMD-9	Lives in	milk		PubMed
21131489	Streptococcus thermophilus ND03	Lives in	yak milk		PubMed
AB370974	Streptococcus uberis	Lives in	cow milk		GenBank

Databases
and
papers

Combining experimental information and bibliography

Genbank database

Streptococcus uberis gene for 16S ribosomal RNA, partial sequence, strain 362B-1

GenBank: AB370974.1

Go to: 

LOCUS AB370974 1481 bp DNA
DEFINITION Streptococcus uberis gene for 16S ribosomal RNA, partial sequence, strain: 1-362B-1.
ACCESSION AB370974
VERSION AB370974.1
FEATURES
source Location/Qualifiers
1..1481
/organism="Streptococcus uberis"
/mol_type="genomic DNA"
/strain="1-362B-1"
/isolation_source="mastitis milk of cow"
/db_xref="taxon:1349"
/country="Japan: Hokkaido, Ebetsu"
/collection_date="2006"
<1..>1481
/product="16S ribosomal RNA"
rRNA

AHOL 4036
Streptococcus
uberis

AHOL 5073
Mastitis
(female cattle)

Pubmed bibliography

Alvis Search Engine

Search: "Streptococcus uberis" lives in {habitat}/OBT:0000

10 Page 1 of 1

1 Ribotyping of **Streptococcus uberis** from a dairy's environment
Authors: Ruth N Zadoks Linda L Tikofsky Kathryn J Boor
2005 *Veterinary microbiology*

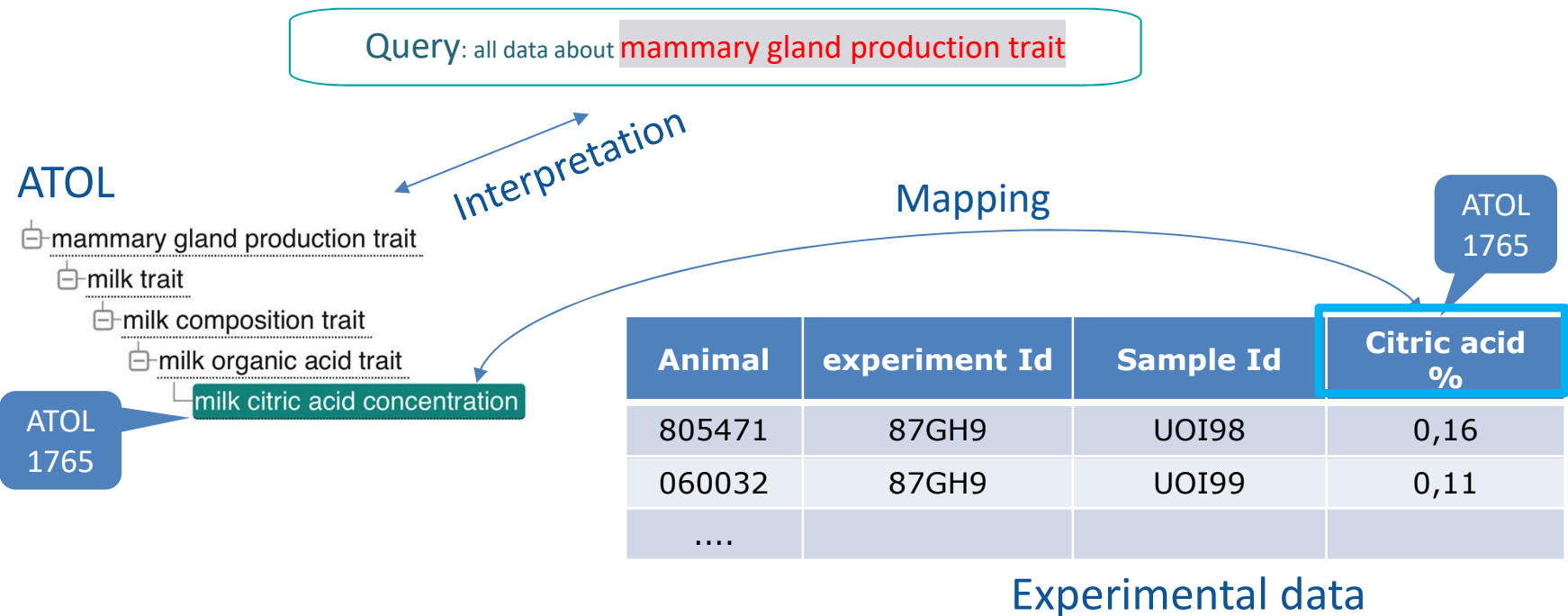
Abstract **Streptococcus uberis** is a major cause of bovine mastitis and exposure to the pathogen. To identify specific sources of mastitis-causing bacteria from the environment and feces of dry cows in a grazing herd. Environmental samples were collected from those found in milk. **S. uberis** was detected in 63% of 94 environmental samples, flies, in 23% of 107 fecal samples, and in 4% of 787 ruminant samples. Among 266 isolates. Per sample, up to five ribotypes were detected. Significant differences among environmental, fecal and milk samples. Specific environmental **S. uberis** were not identified. Fecal shedding was not persistent and did not occur in all samples. Fecal shedding of **S. uberis** was highest during the summer grazing season (13 of 35 samples) but not in non-farm soil (0 of 11 samples). We hypothesize that the maintenance of **S. uberis** populations in the dairy ecosystem.

Combining experimental information and bibliography

Extend the Information System to deal with semantic queries

Query interpretation

Result display



Combining experimental information and bibliography

Requirements

Extend the Information System to deal with semantic queries

- Query interpretation

- Result display

Alignment of the attributes of the database schema with the ontology classes

- Select the relevant attributes of the database (e.g. trait, disease)

- Manually align the attributes with the ontology classes

- Re index the data

Combining experimental information and bibliography

Requirements

Extend the Information System to deal with semantic queries

- Query interpretation

- Result display

Alignment of the attributes of the database schema with the ontology classes

- Select the relevant attributes of the database (e.g. trait, disease)

- Manually align the attributes with the ontology classes

- Re index the data

Semantic analysis of the text

- Identify relevant nomenclatures and ontologies

- Train the methods to recognize entites of the relevant class types

- Index the textual data with the trained methods

Combining experimental information and bibliography

Query: all data about **mammary gland production trait**

Interpretation

⊖ mammary gland production trait
⊖ milk trait
⊖ milk composition trait
⊖ milk organic acid trait
milk citric acid concentration

ATOL
1765

ATOL
1765

Factors influencing **milk citric acid concentrations in dairy cows**

Texte

ATOL
1765

Animal	experiment Id	Sample Id	Citric acid %
805471	87GH9	UOI98	0,16
060032	87GH9	UOI99	0,11
....			

Experimental data

Conclusion



Text mining transforms unstructured text into structured data

- Extracts information

- Relates it to domain knowledge by normalisation and extraction of relationships

Integration into a unified information system

- Mapping of the data schemata based on ontology

- May require more complex alignment rules (e.g. different measure units)

Next: align data, not only concepts

- Extraction of numbers from the text (e.g. tables)

- Transform numerical values into qualitative values (e.g. 0,15 = low)

