EMPHASIS

PHENET

PHENET-EMPHASIS Data Management Training

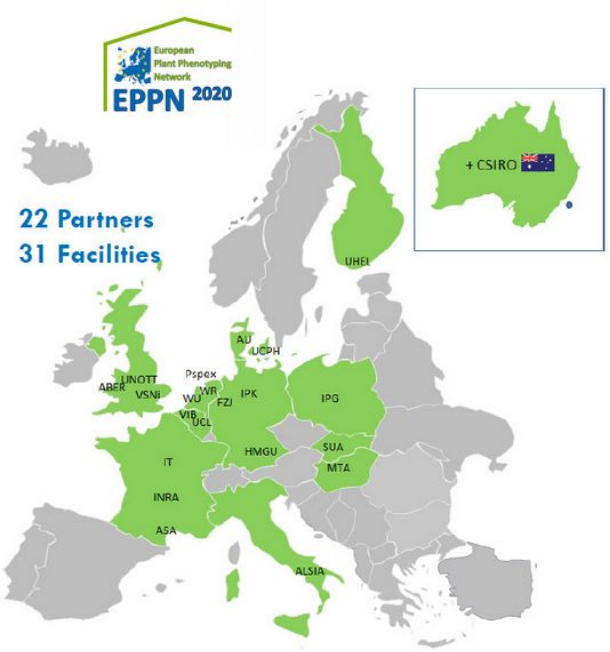
Introduction to PHIS

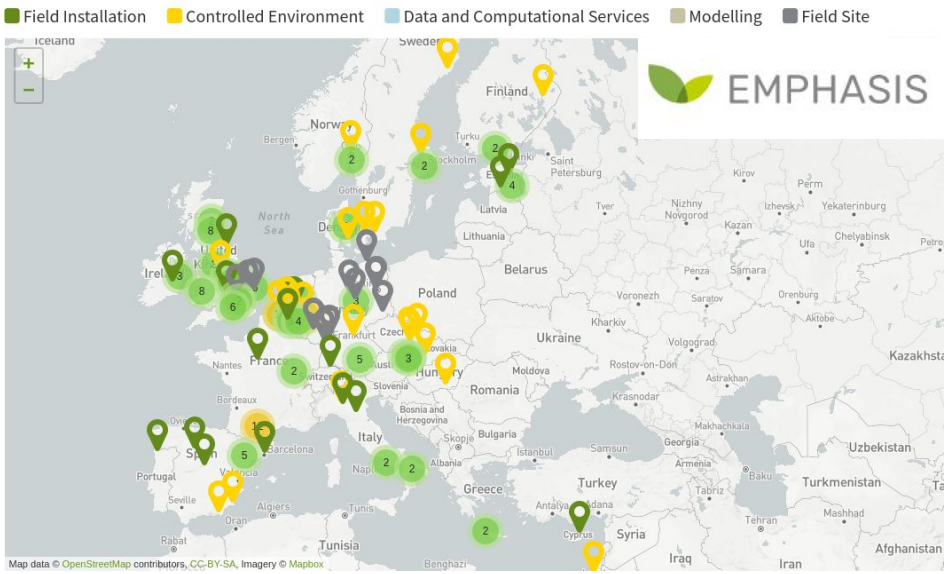
Phenotyping Hybrid Information System

Thursday 05/12/2024

Isabelle Alic (INRAE)

Phenotyping communities





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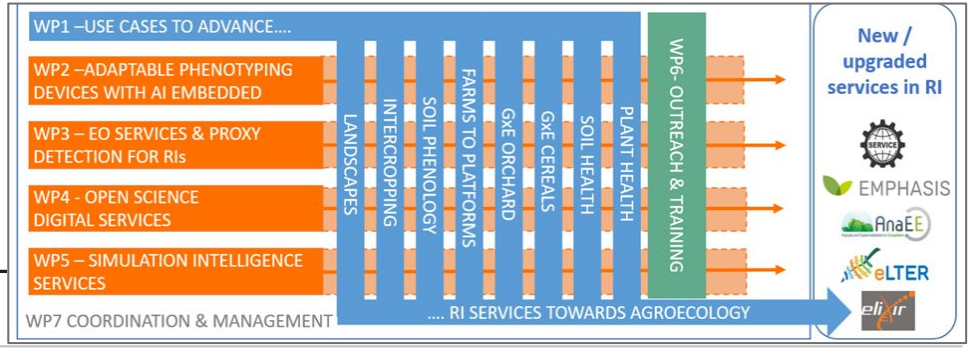


Phenomics Data Challenge

Plant Phenomics Experiments

- Expensive, require a lot of resources and often very hard
- Cannot be reproduced
- Huge and complex datasets
- Strong needs of transparence: reproducibility for data analytics

Save time, make data valuable!

But re-analyses, meta-analyses and new analyses

→ impossible without rich metadata

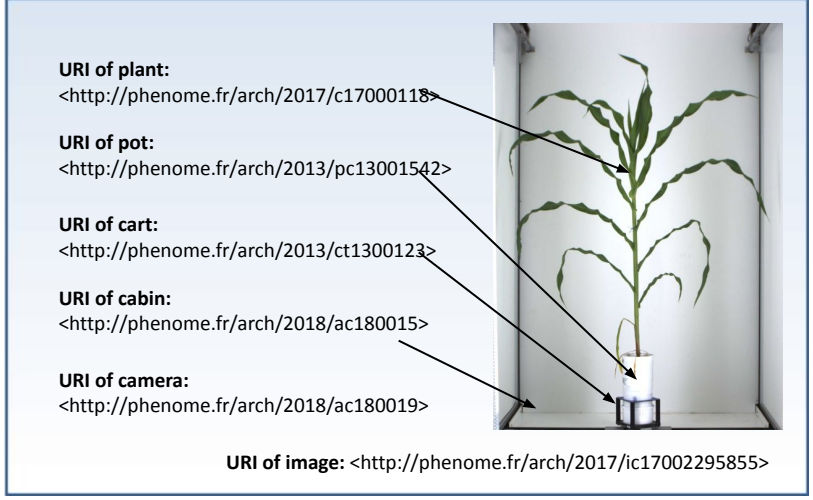
Make FAIR data, structure your data

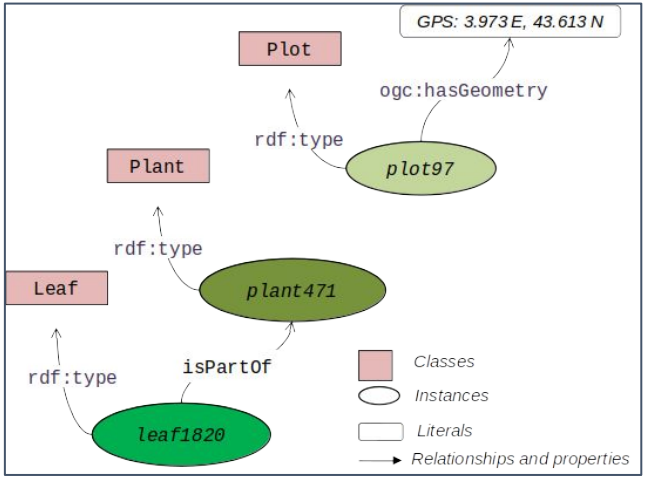
Identification

- Everything can be identified: plants, experiments, sensors, events, etc.
- Persistent, unambiguous, resolvable

Semantics

- Naming Conventions
- Controlled vocabulary
- Formalized relationships between entities
- Data annotation and enrichment





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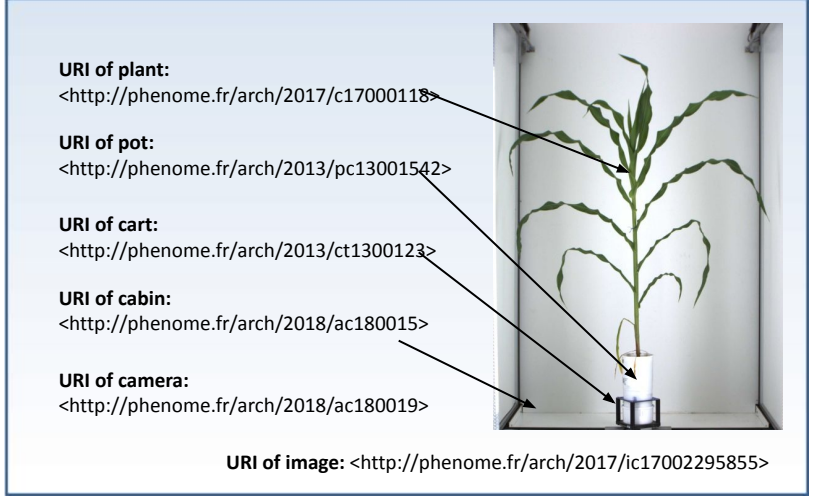
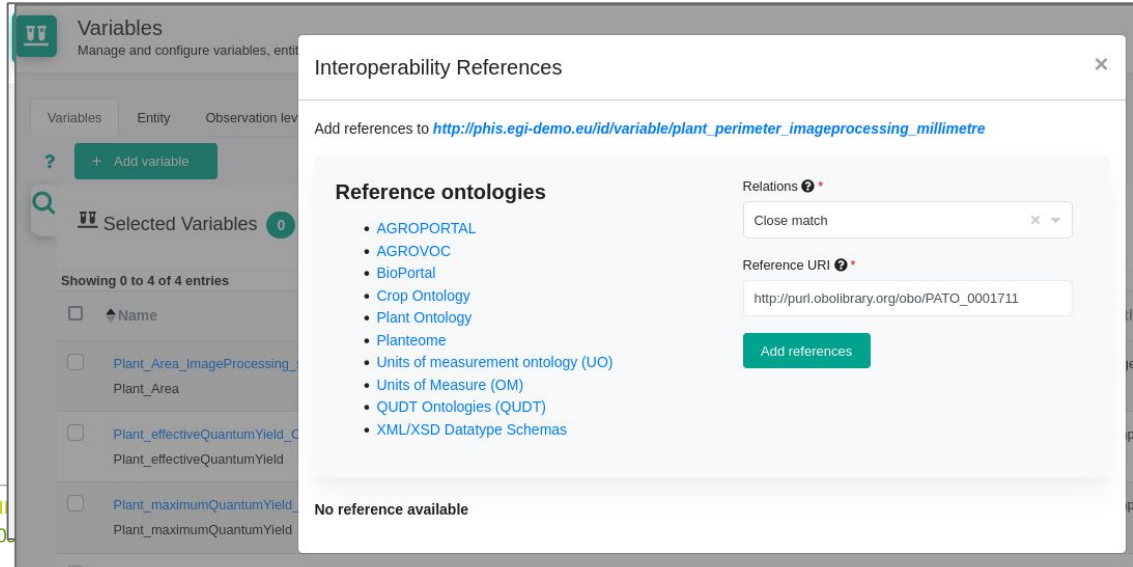
How?

PHIS, an **ontology driven** Information System





OpenSILEX Galaxy

PHENOME EMPHASIS FRANCE

PHIS

Plant Phenotyping

Sixtine

Annual crops
Systems trials
Arboriculture - vines

Agro-Ecology

Sun'Agri

OpenSILEX

Environment & Processes

LBE Laboratoire Biotechnologie de l'Environnement

Envibis

Viticulture Oenology

Vitis Explorer

Sinfonia

VitiOeno

Instance Ressources

OpenSILEX Galaxy

PHENOME EMPHASIS | FRANCE

PHIS

Plant Phenotyping

M3P
Diaphen
Pheno3c
Helsinki
Emphasis Ressources
Louvain
Phenotoul
...
Copenhague
Phenome Ressources

Agro-Ecology

Sun'Agri

OpenSILEX

Sixtine

Annual crops
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Vine
LaCage
GCIE
U2E
Orchard

Environment & Processes

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Envibis

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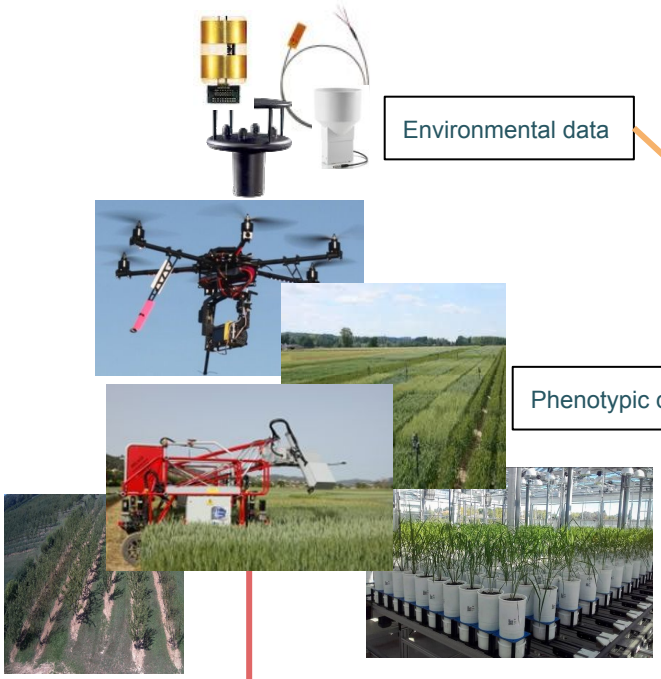
Instance Ressources

PHIS: an Ontology driven Information System for Plant Phenomics



Environmental data

Phenotypic data

Scripts

Analysis, sharing, etc.

Community - Interoperability

miappe

User interface

PHIS

Metadata semantic description

- Experiments
- Plots
- Factors
- Sensors
- Variables

Data

Findable Accessible Interoperable Reusable

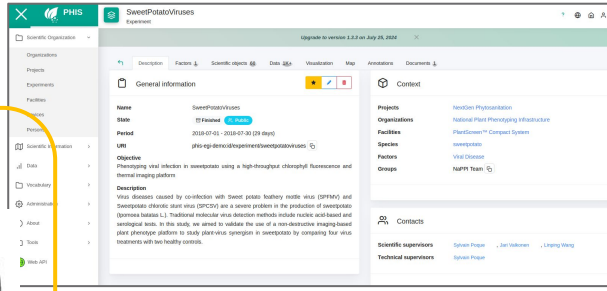
File storage system

iRODS

Image processing Advanced data extraction

Image processing Analysis pipeline

PHIS Architecture



Analyse

RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

recherche.data.gouv.fr

Scripts

Sensor

Web Interface

swagger

EGI Check-In

Java

API, Web Services
REST / JSON

NoSQL
(MongoDB)

Triplestore
(RDF4J, GraphDB)

Datafiles

Data

iRODS

aws

Amazon S3

EGI DataHub

egi

Infrastructure

An ontology driven approach

- **Scientific objects** (plants, plant organs, plots, etc.)
  Identified by URI
- **Events** (management, failures, weather, etc..)
  Identified by URI
- **Variables, Documents, Observations and Softwares** are associated with these Objects and Events. Identified by URI
- **The organisation and linking of Objects and Events** is done with controlled semantics (ontology references, vocabularies, thesauruses, taxonomies), application Ontologies and semantic web languages (RDF, OWL, SKOS)

Ontologies in OpenSILEX - PHIS

- Standard ontologies
  - **time Ontology**: formalizes concepts related to time
  - **SOSA**: formalizes concepts related to sensor
  - **annotation ontology (ao)**: formalizes concepts related to annotation
  - **dublin core (dc)**: formalizes concepts related to documents
  - **foaf**: formalizes concepts related to persons

Ontologies in OpenSILEX - PHIS

- Domain ontologies
  - Crop Ontology
  - Agro ontology, PPEO (MIAPPE)
  - PlantOntology + TO + PATO
  - Unit Ontology
  - Envo, etc.

Ontologies in OpenSILEX - PHIS

- Application ontologies
  - **oeso**: Ontology of Experimental Scientific Objects (entities)

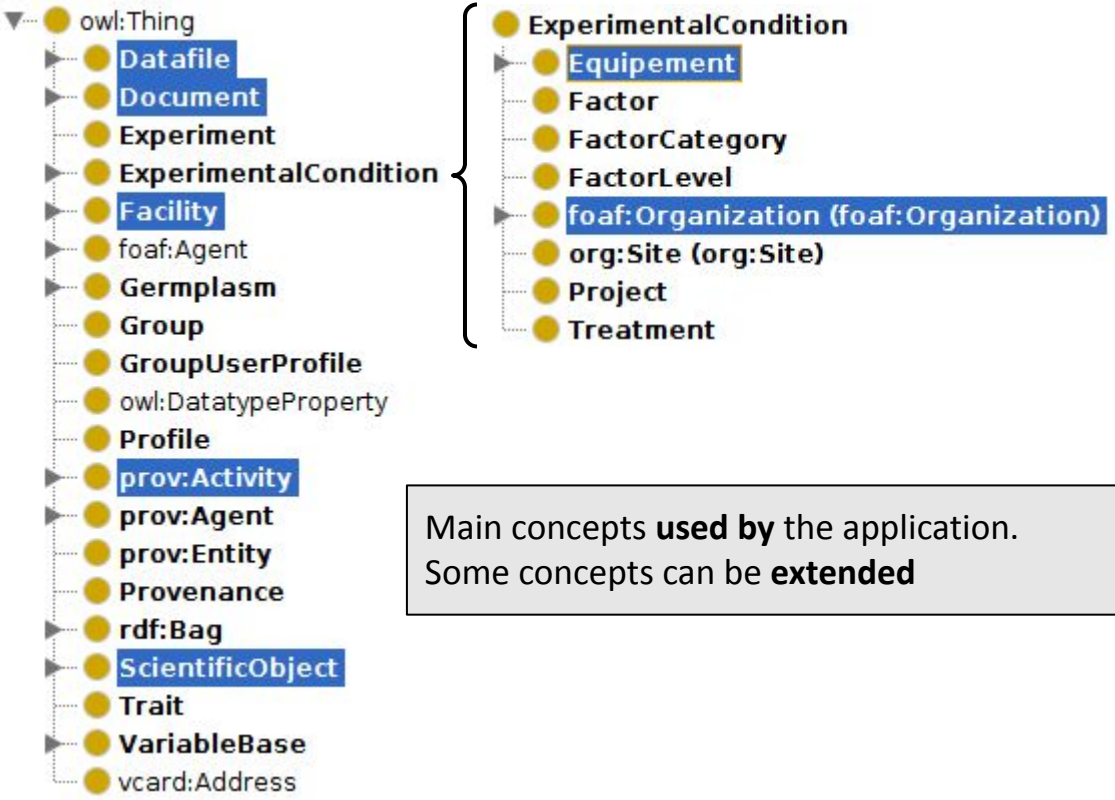
    oepo: Ontology of Experimental Phenotypic Objects

    main concepts: experiment objects, qualities, experimental information

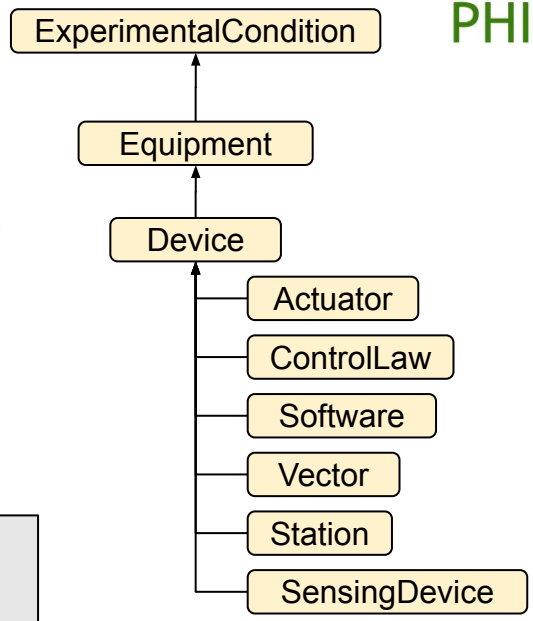
  - **oeev**: ontology of experimental events

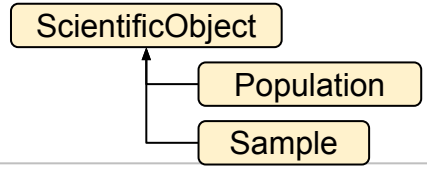
    main concepts: move, device management, object management, faults, etc.

Ontologies in OpenSILEX - PHIS

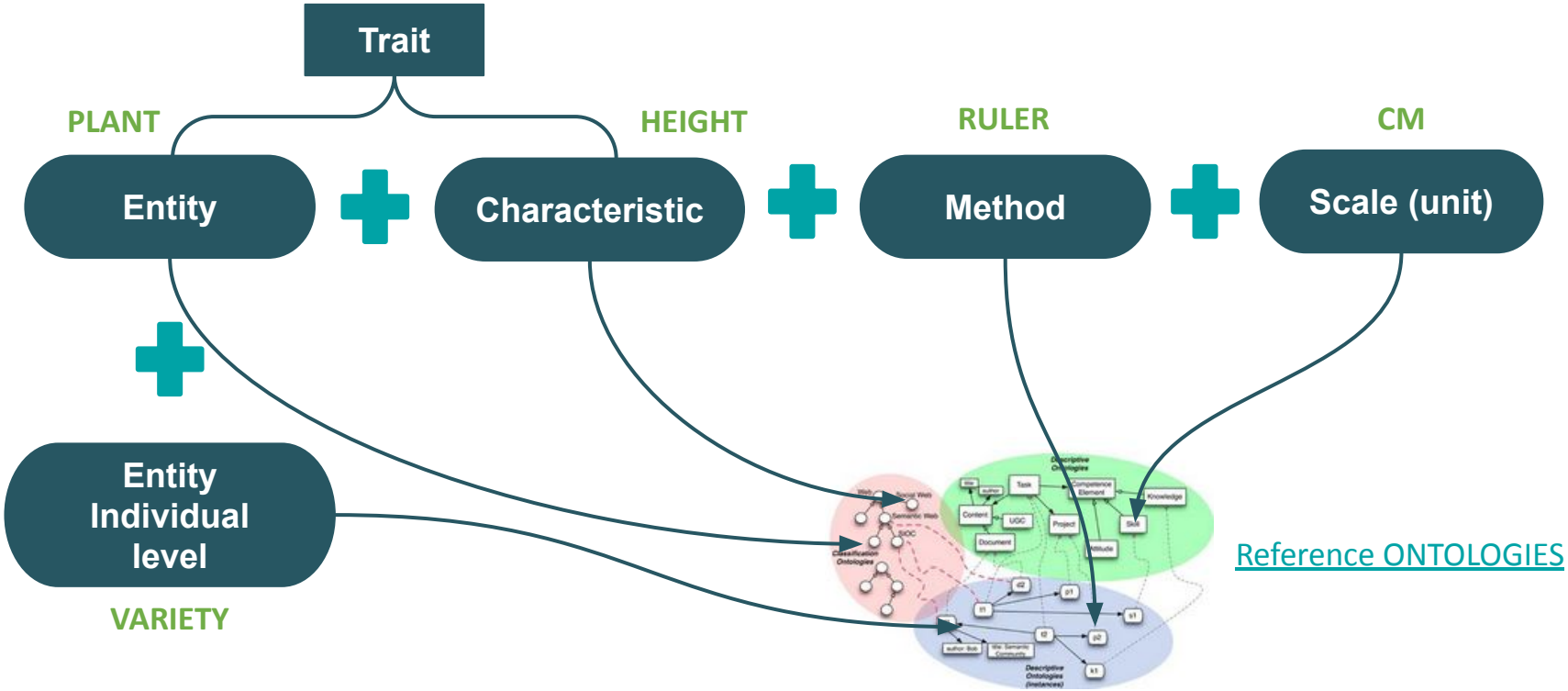


Main concepts **used by** the application.
Some concepts can be **extended**

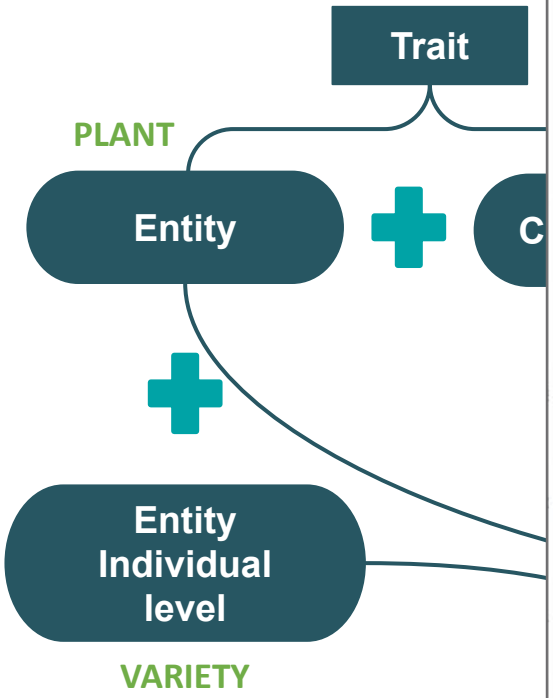




Variables model



Variables mo



Add variable

URI

autogenerated URI

Entity *
Plant

Observation level
Search and select an observation level

Characteristic *
Height

Species
Select species

Method *
Ruler

Trait already existing in an ontology

Unit/Scale *
Centimeter

Name *
Plant_Height_Ruler_centimeter

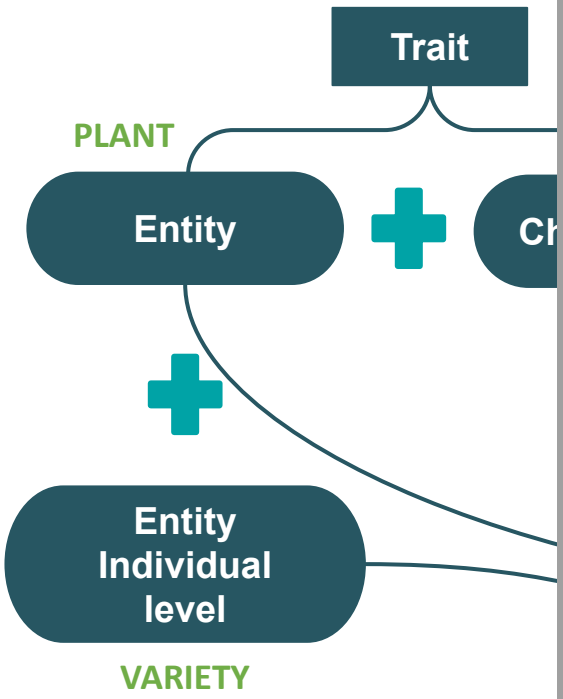
Alternative name
Plant_Height

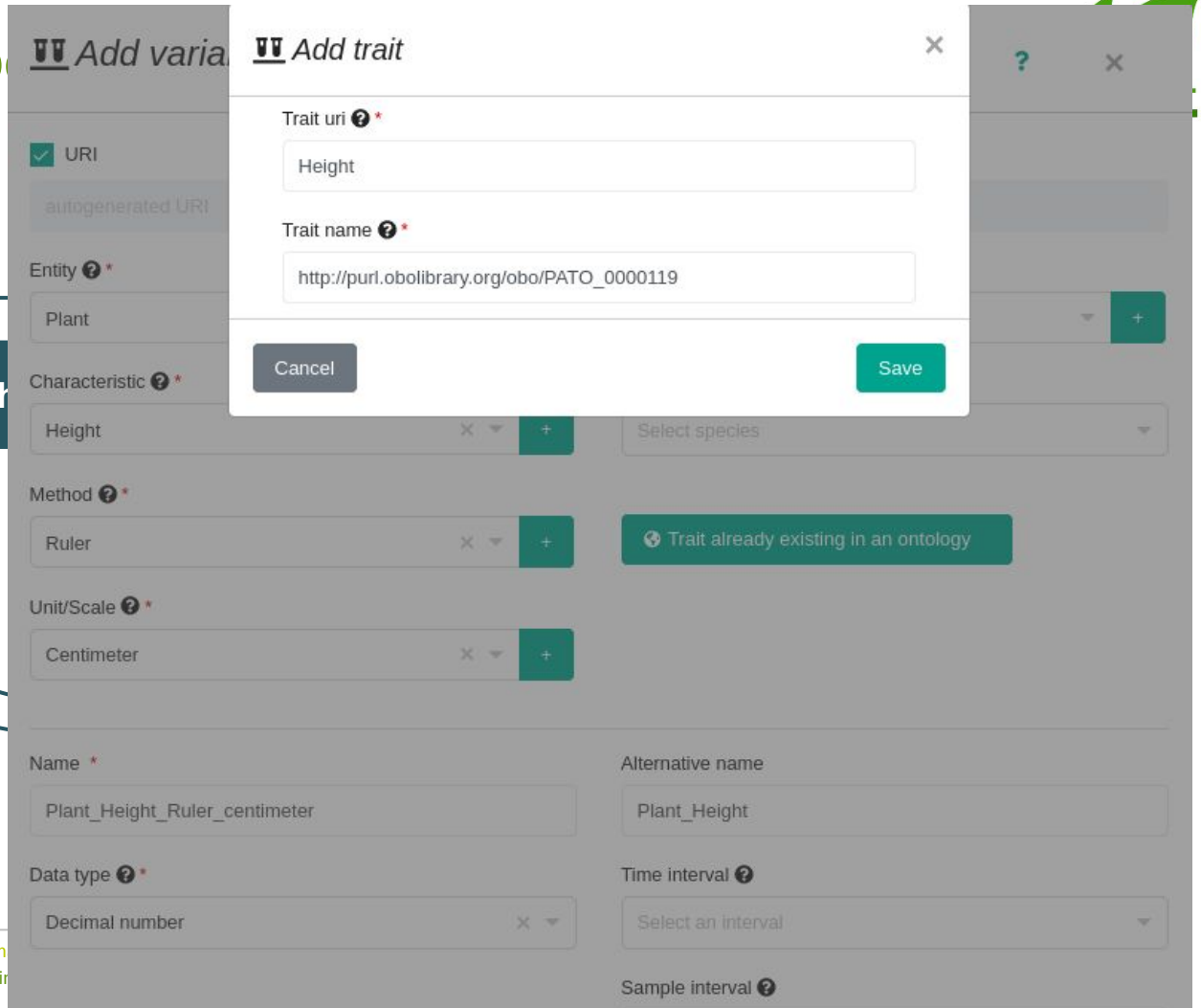
Data type *
Decimal number

Time interval
Select an interval

Sample interval

Variables mo

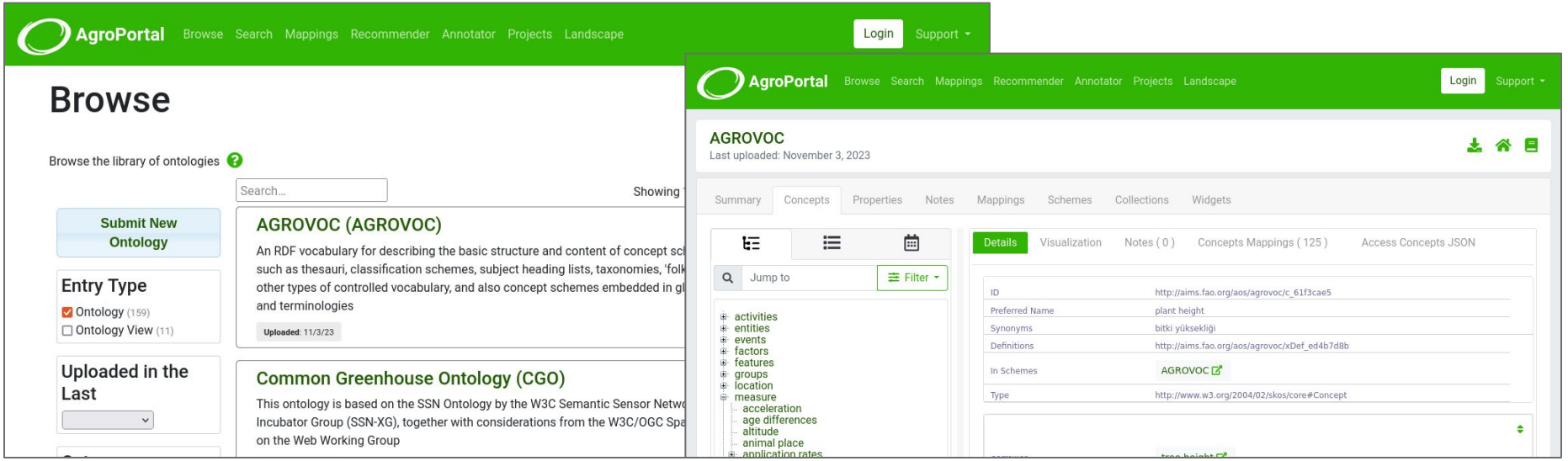




Variables Sharing

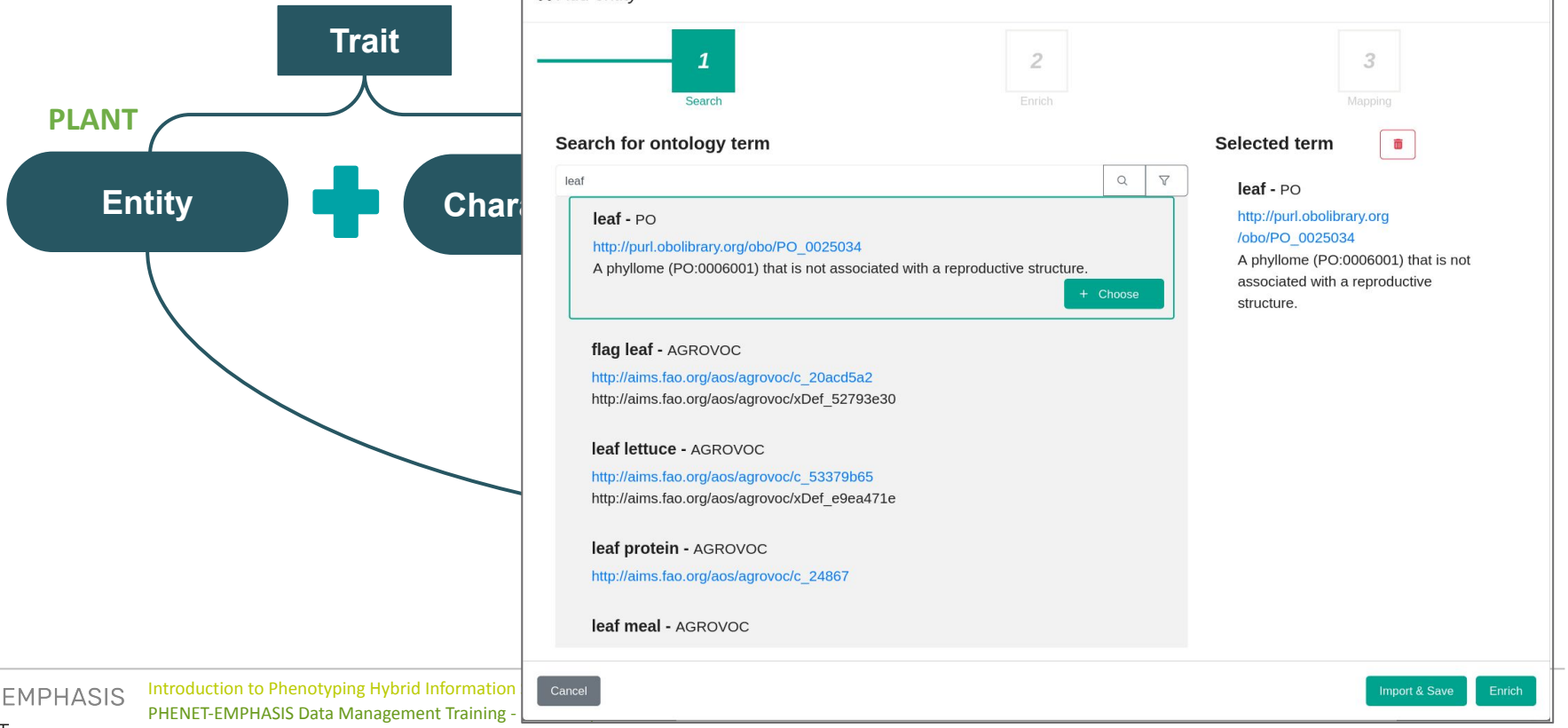
Link these elements to existing ontologies

Agroportal, The home of ontologies and semantic artefacts in agri-food and related domains.- http://agroportal.lirmm.fr/



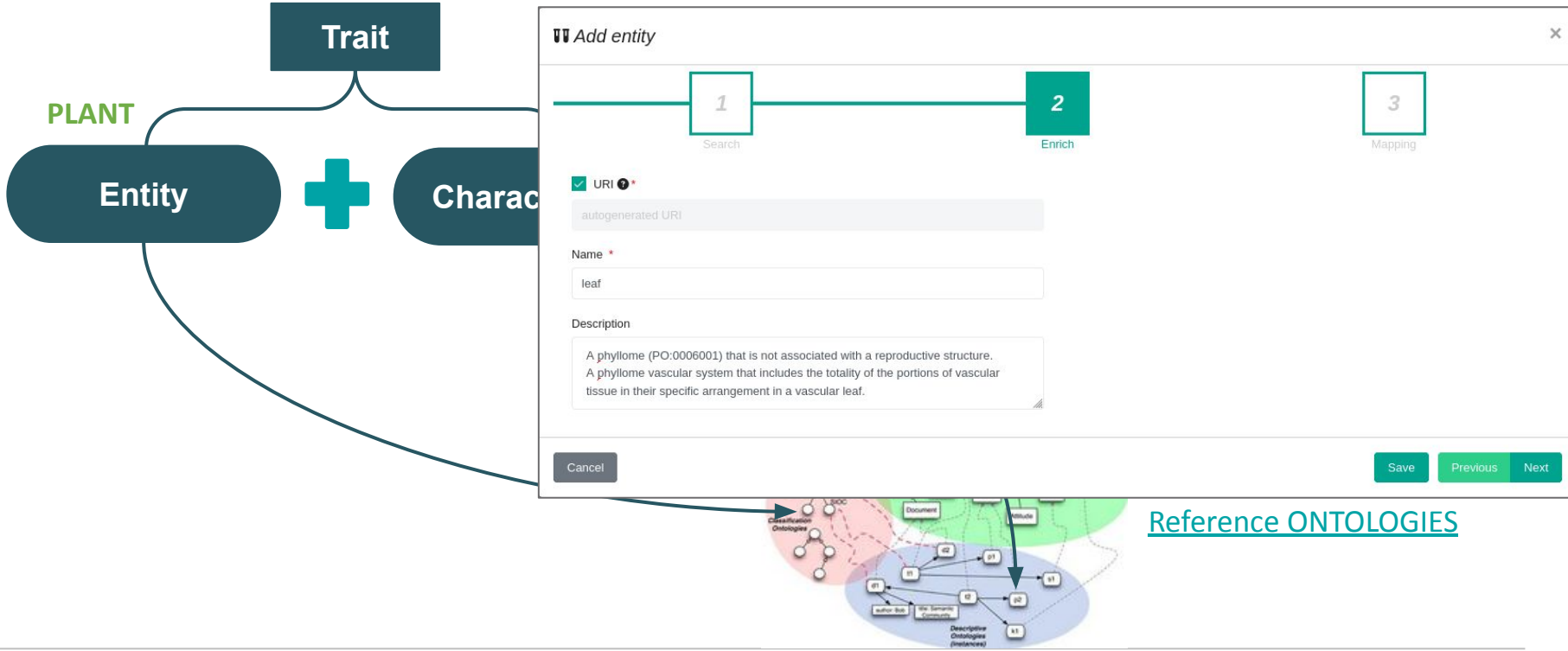
Describing a variable

Searching for an ontological concept



Describing a variable

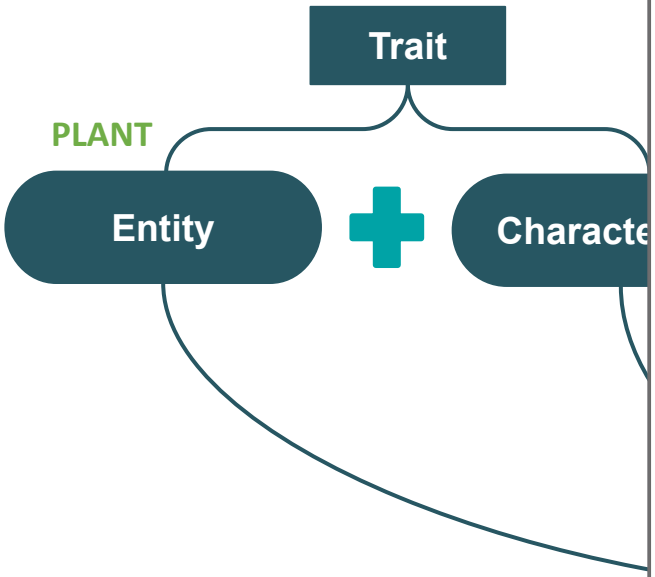
Enriching the concept

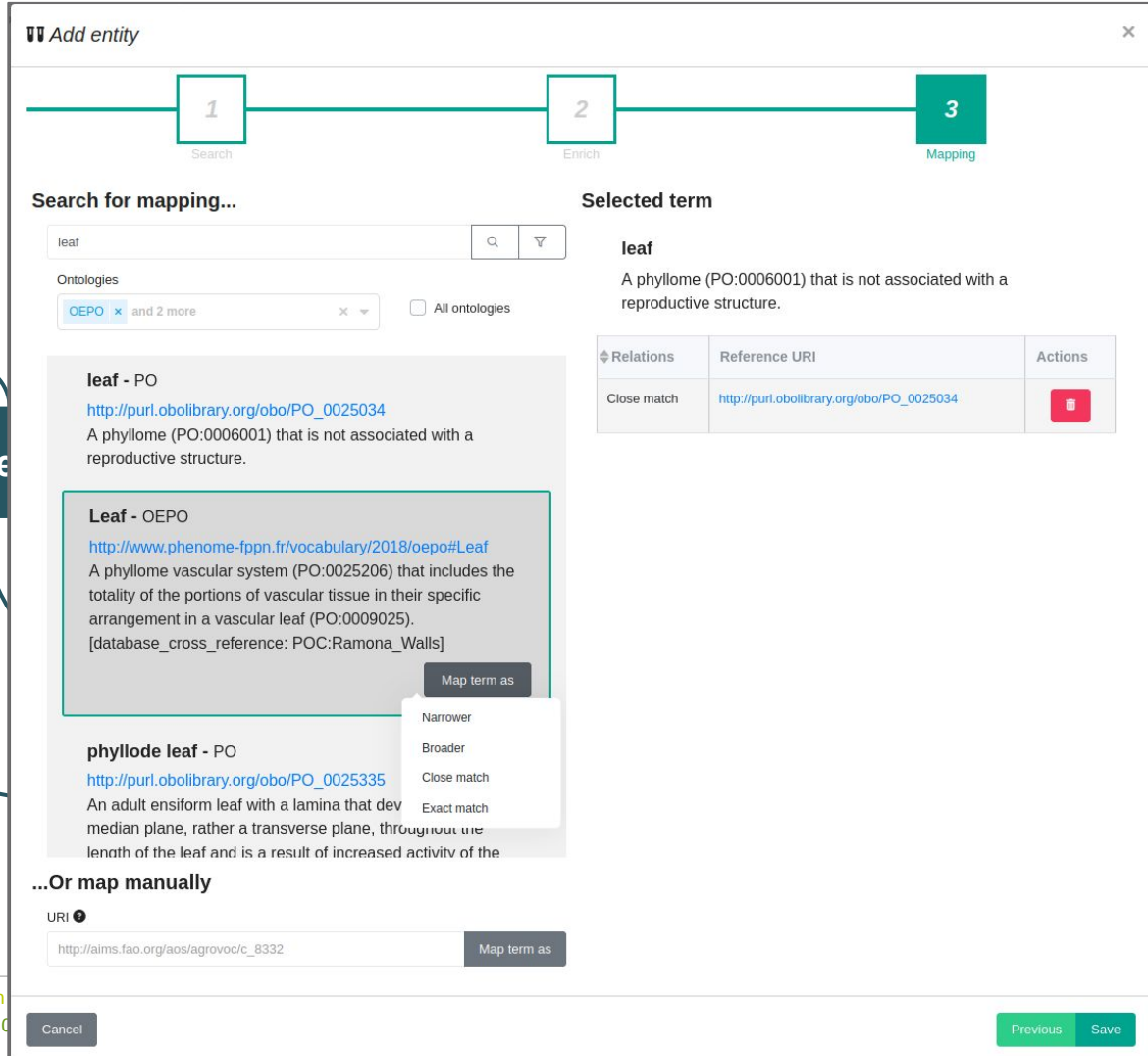


Reference ONTOLOGIES

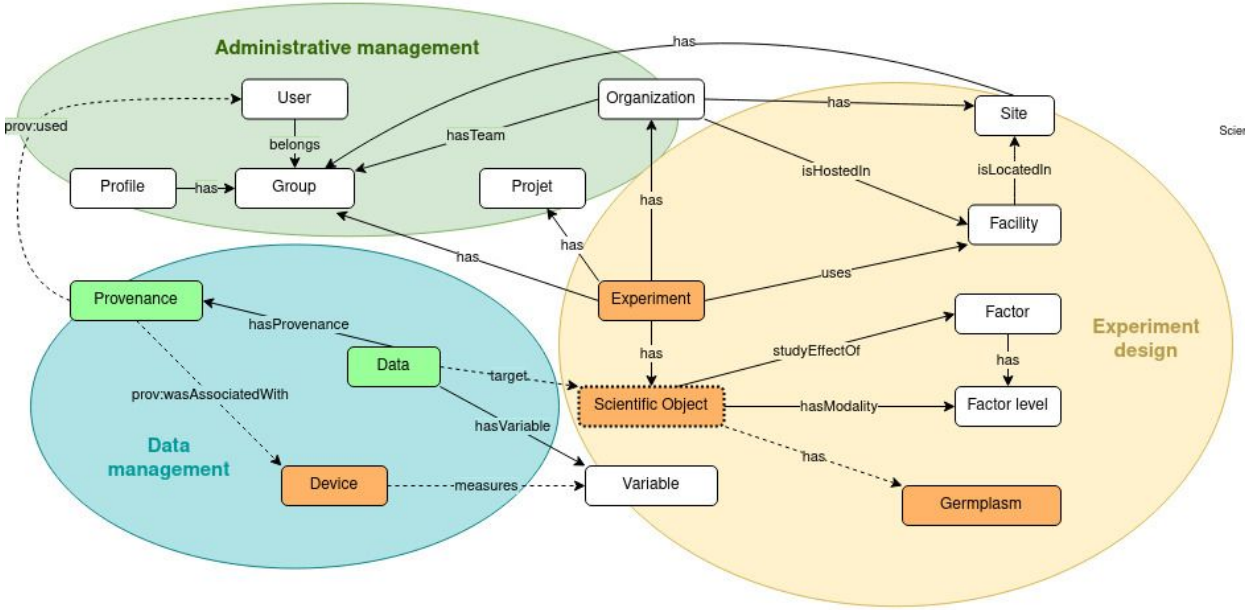
Describing a variable

Concept alignment





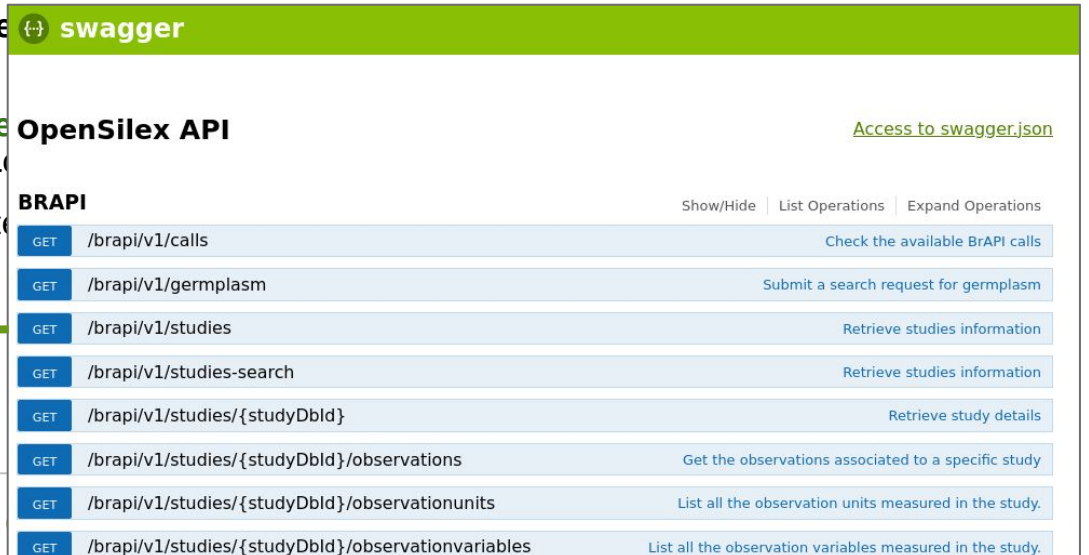
The different concepts of PHIS and their relationships



PHIS and standards - BrAPI

BrAPI - https://brapi.org/

- Standardized RESTful web service API specification for communicating plant breeding data
  - **BrAPI-Core - Organization and management:** Programs, Trials, Studies, Locations, People, and Lists
  - **BrAPI-Phenotyping - Entities related to phenotypic observations:** Observation Units, Observations, Observation Variables, Traits, Scales, Methods, and Images
  - **BrAPI-Genotyping - Entities re**
    Sets, Variants, etc.
  - **BrAPI-Germplasm - Entities re**
    Germplasm Attributes, Seed L
- PHIS: BrAPI WebServices implemente

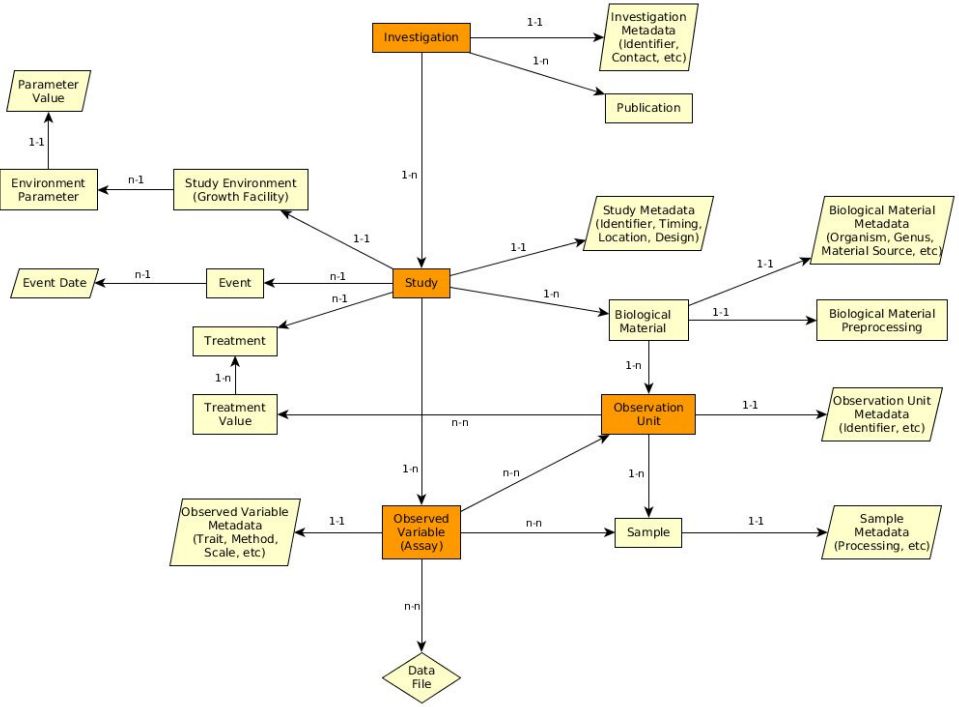


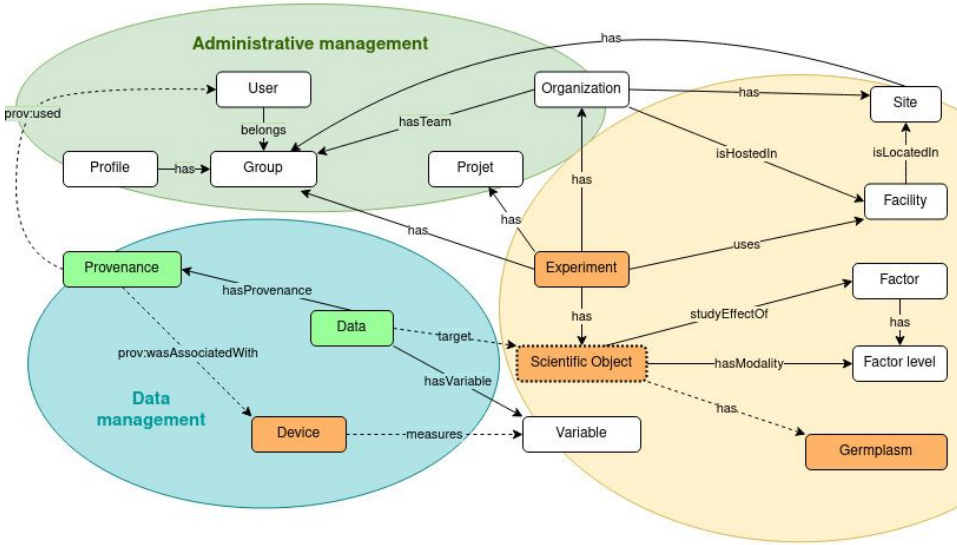
PHIS and standards - MIAPPE

MIAPPE - https://www.miappe.org/

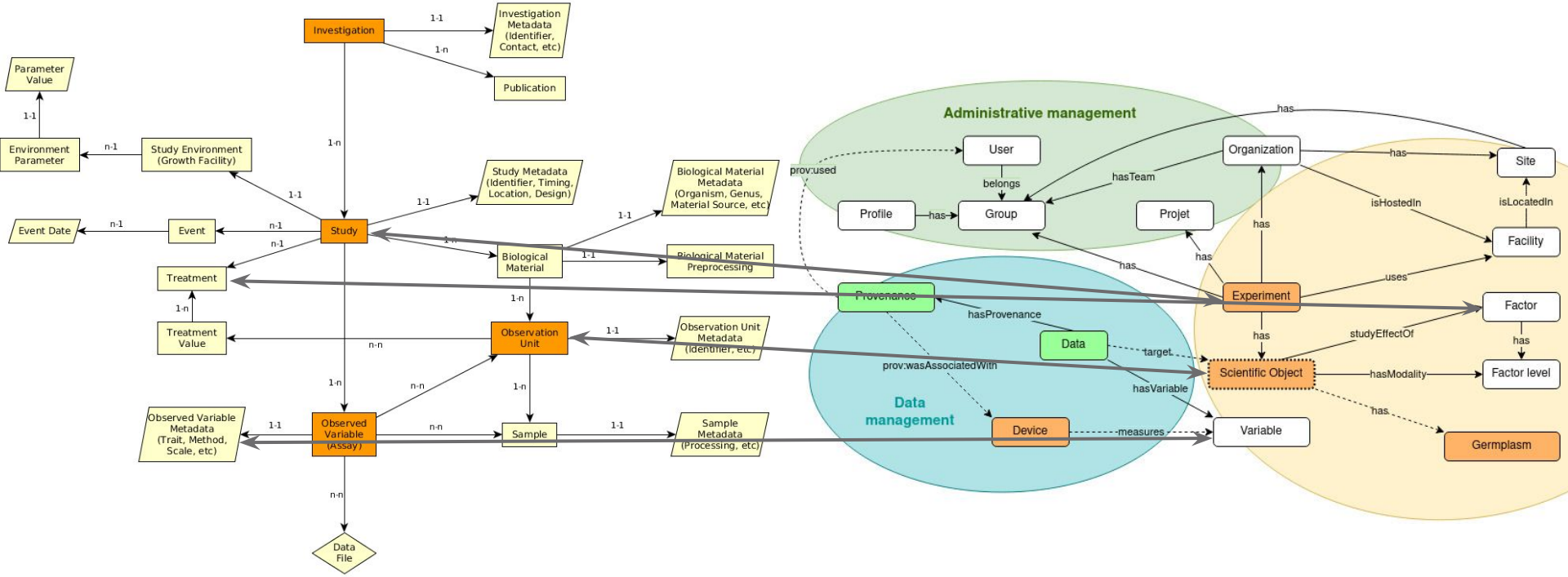
- Minimum Information About Plant Phenotyping Experiments
- Open, community driven, data standard designed to harmonize data from plant phenotyping experiments
- Mapping with other standards (ISA-Tools , BrAPI)
- PHIS is MIAPPE-compliant

PHIS and standards - MIAPPE





PHIS and standards - MIAPPE

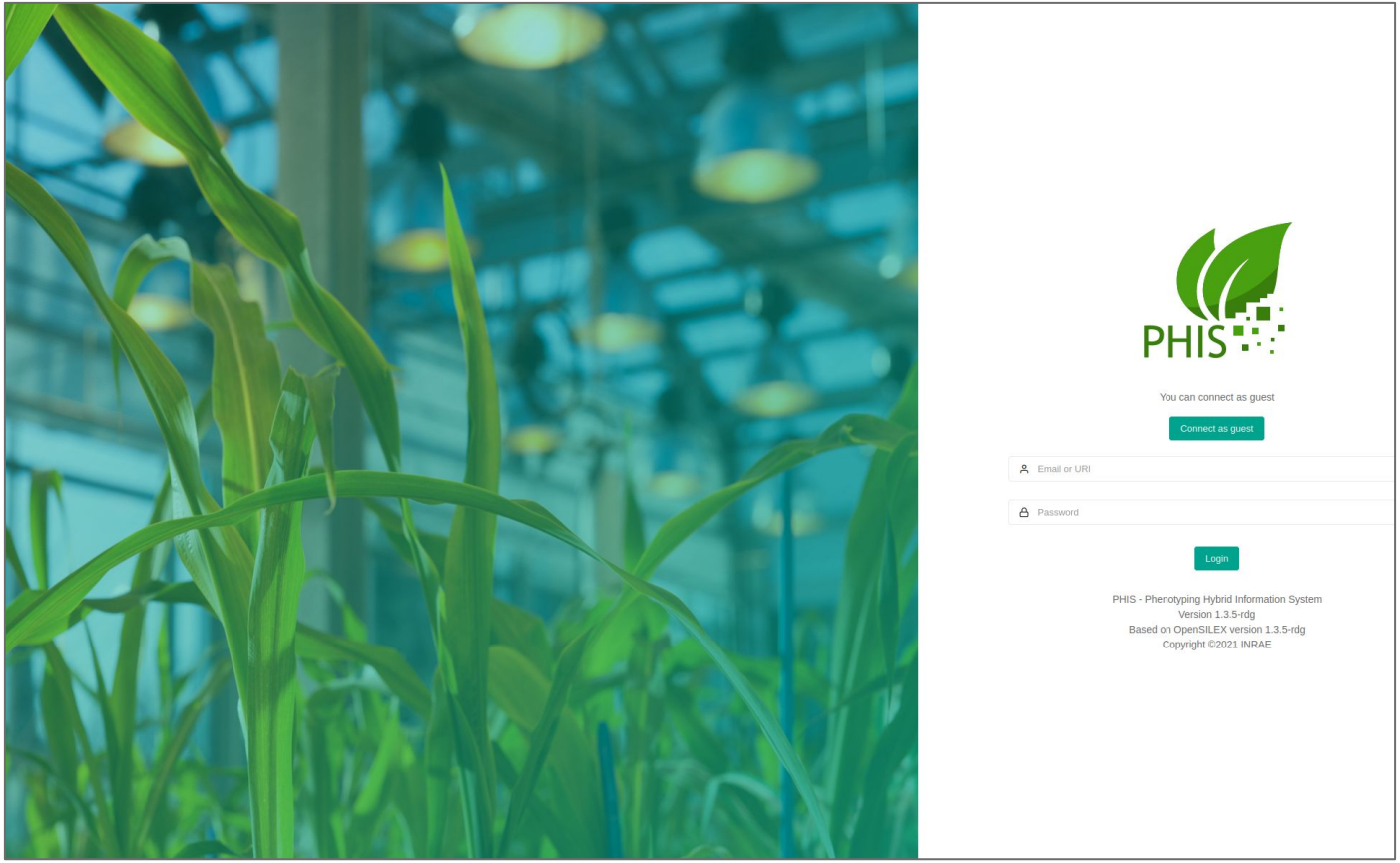


PHIS and standards - AgMIP / ICASA

AgMIP - https://agmip.org/

- Agricultural Model Intercomparison and Improvement Project
- ICASA - https://agmip.github.io/ICASA.html
  - International Consortium for Agricultural Systems Applications
  - **ICASA Data Dictionary** for use in AgMIP data interoperability protocols
- Work in Progress: link PHIS-AgMIP/ICASA
  - Development of standardised, high-level data web services

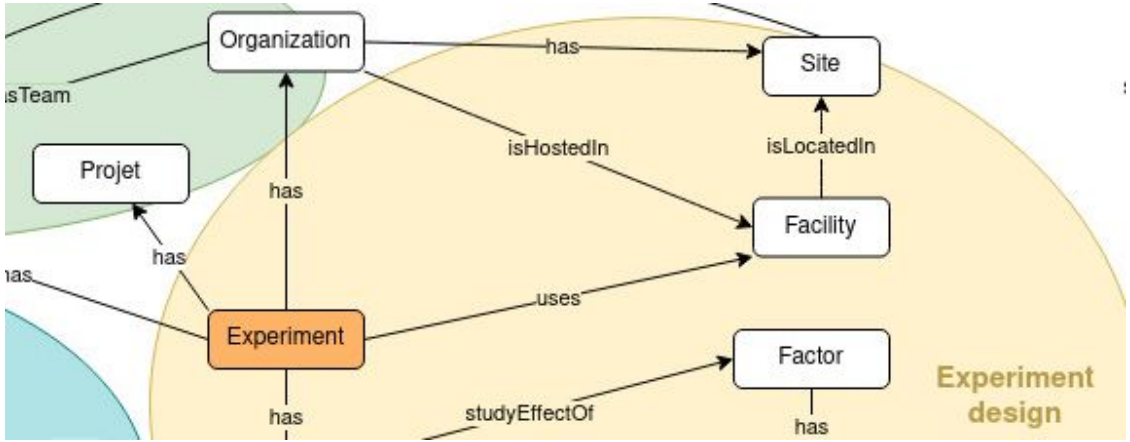
PHIS Demonstration



Friendly User Interfaces

PHIS Interfaces allow management of

- **Scientific Organization**
  - Project information
  - Experimental context
  - Facilities
  - Sensors



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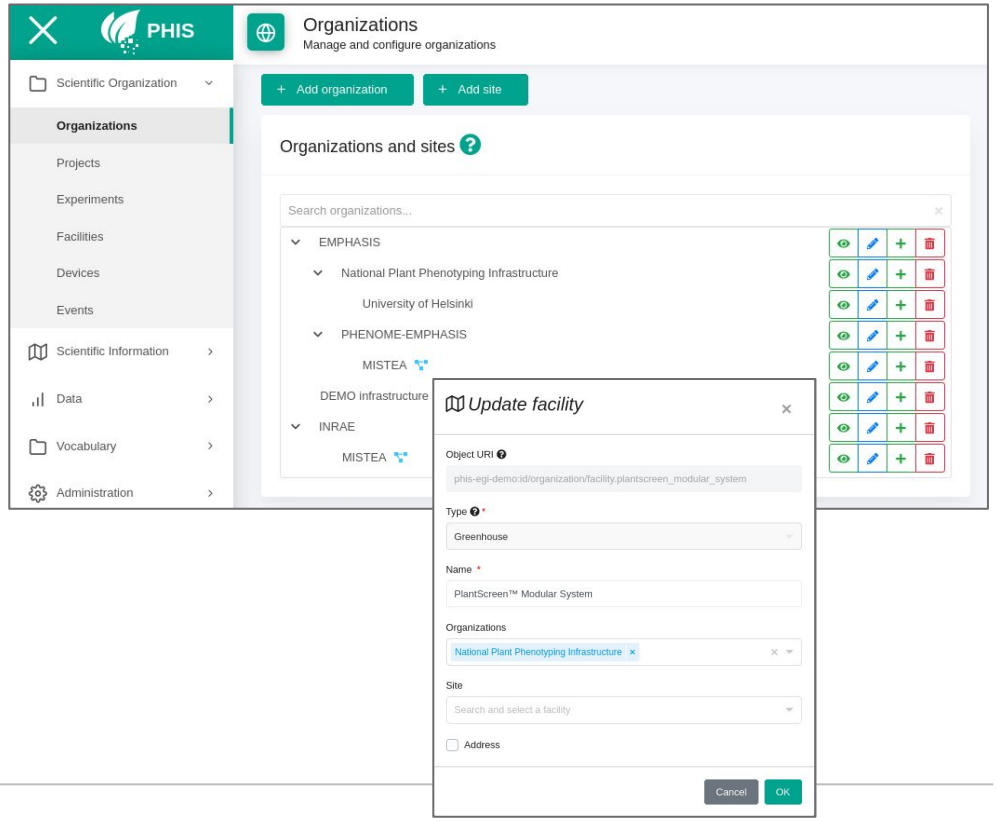

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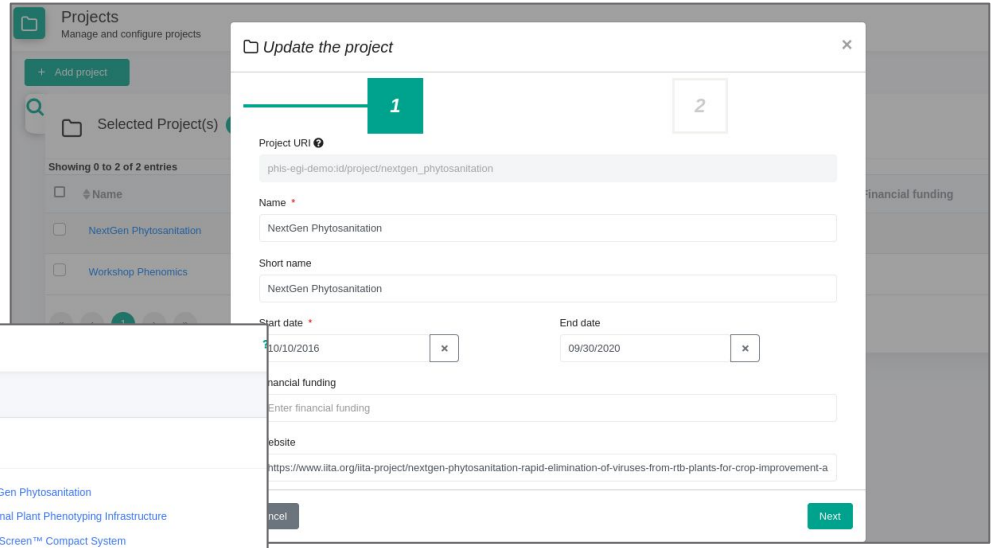

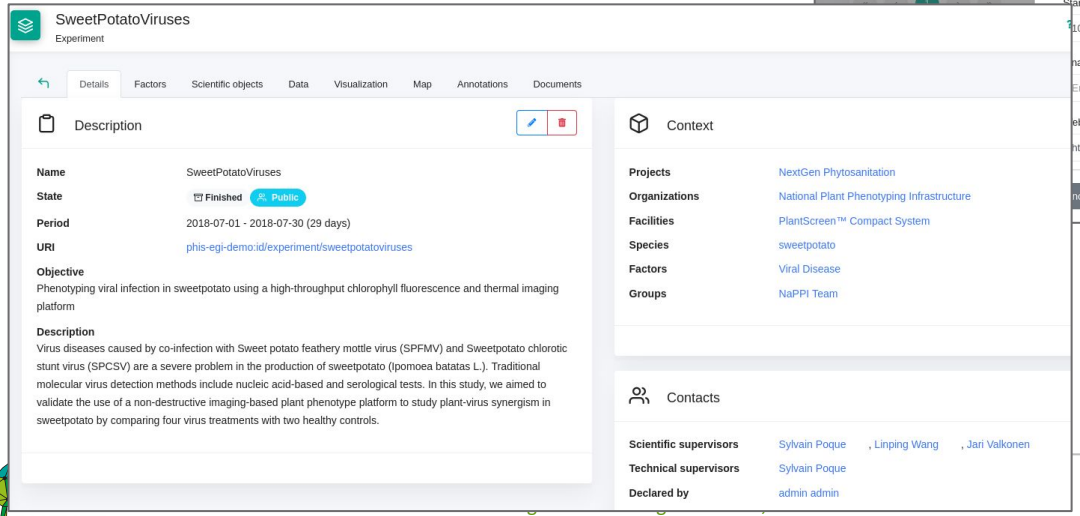

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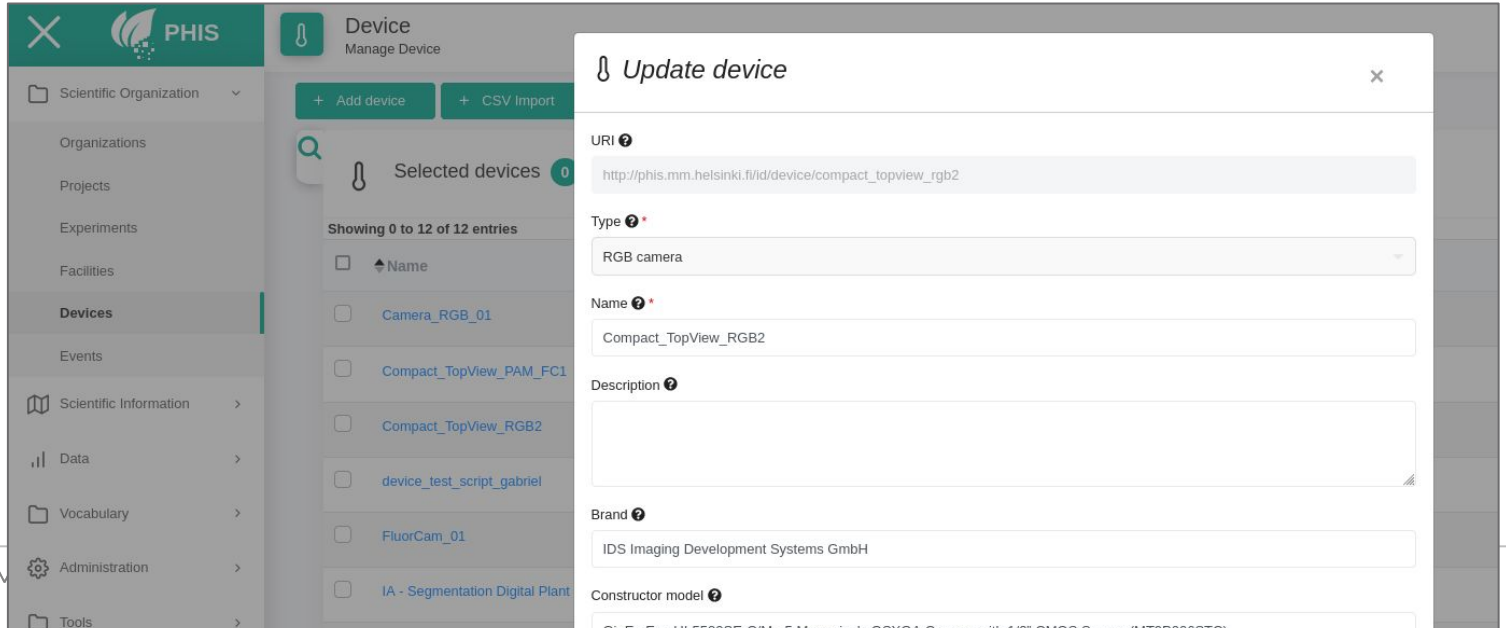
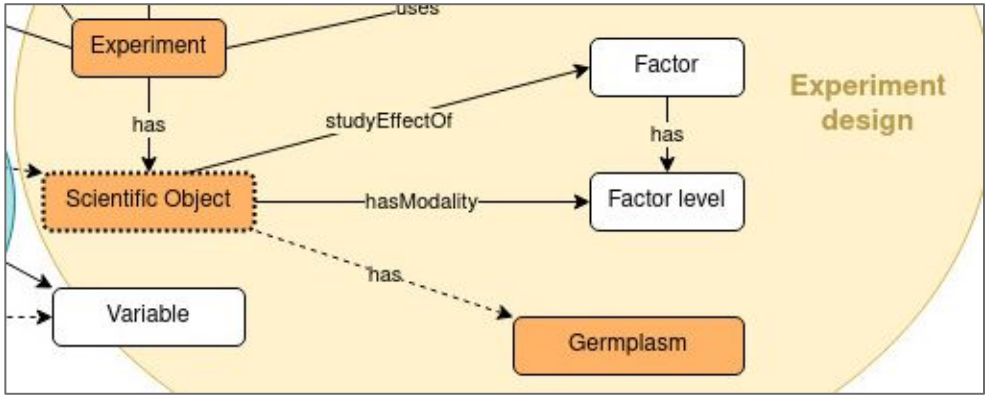


Friendly User Interfaces

PHIS Interfaces allow management of

- **Scientific Information**
  - Variables
  - Scientific objects
  - Germplasm
  - Documents



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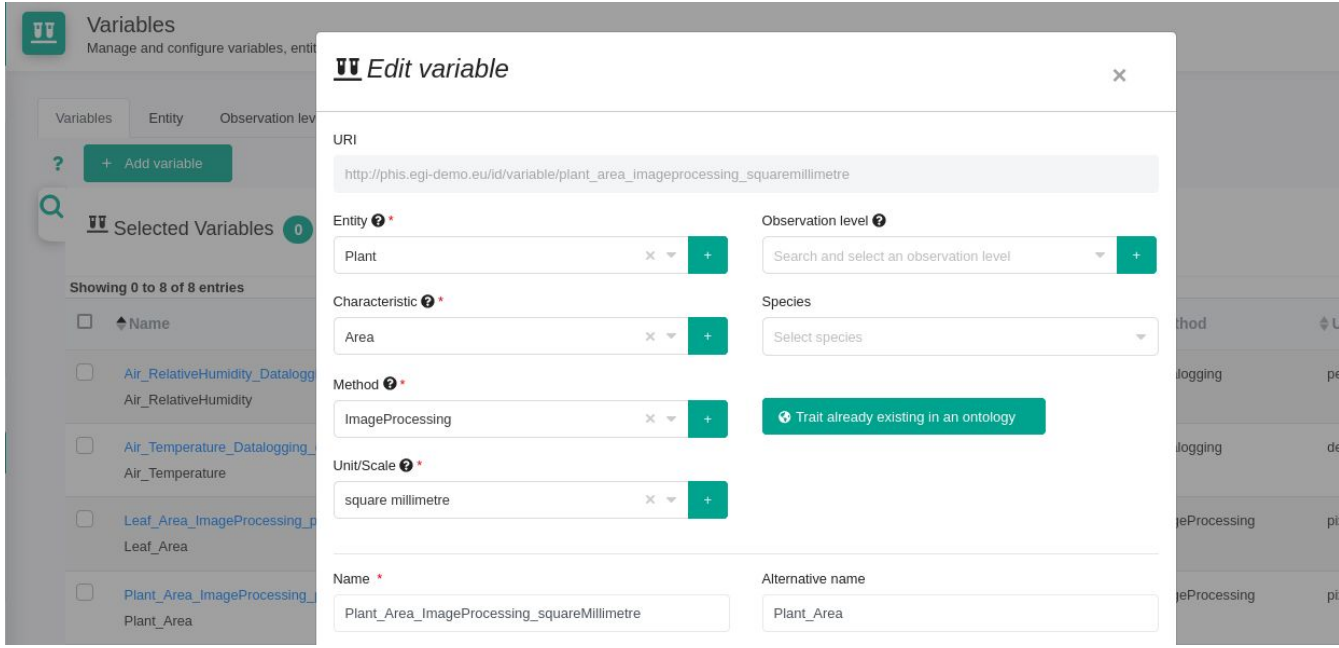

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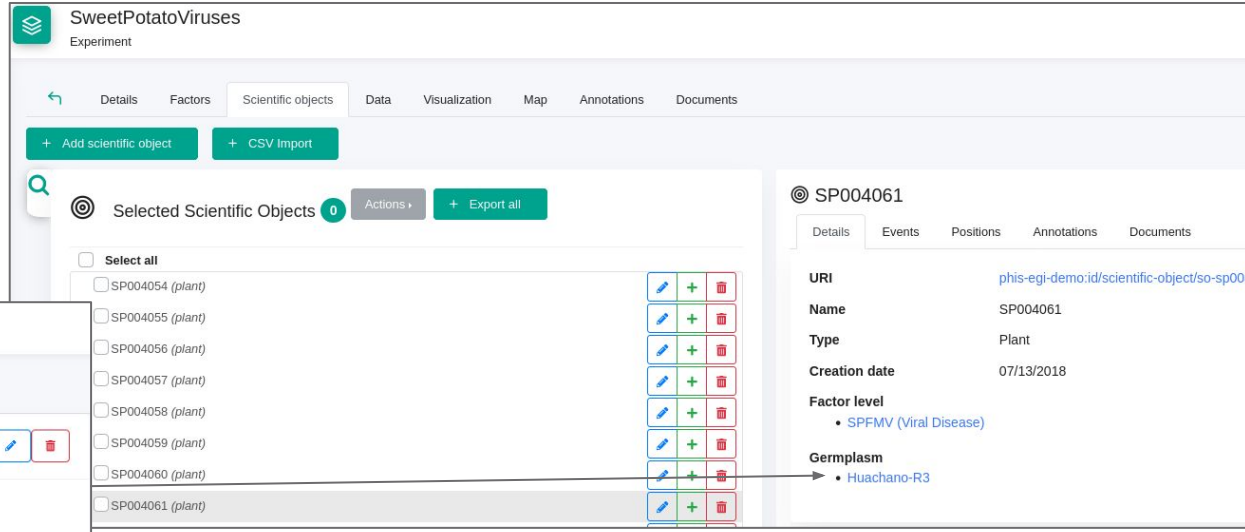
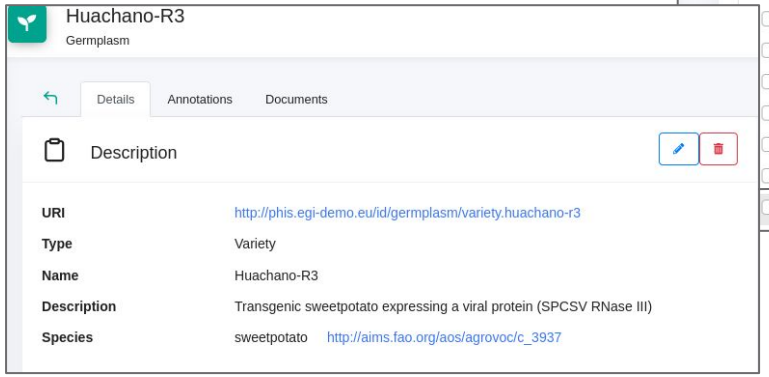
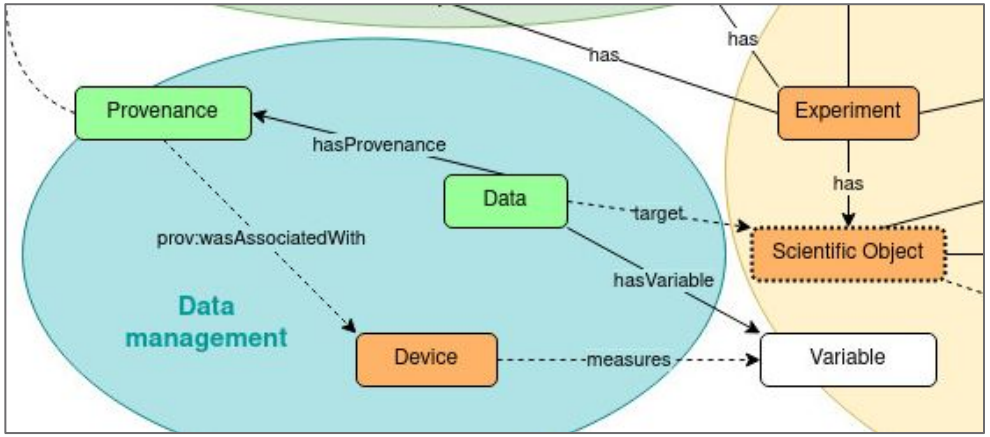




Friendly User Interfaces

PHIS Interfaces allow management of

- **Data**
  - Data visualization
  - Data provenance
  - Datafiles management



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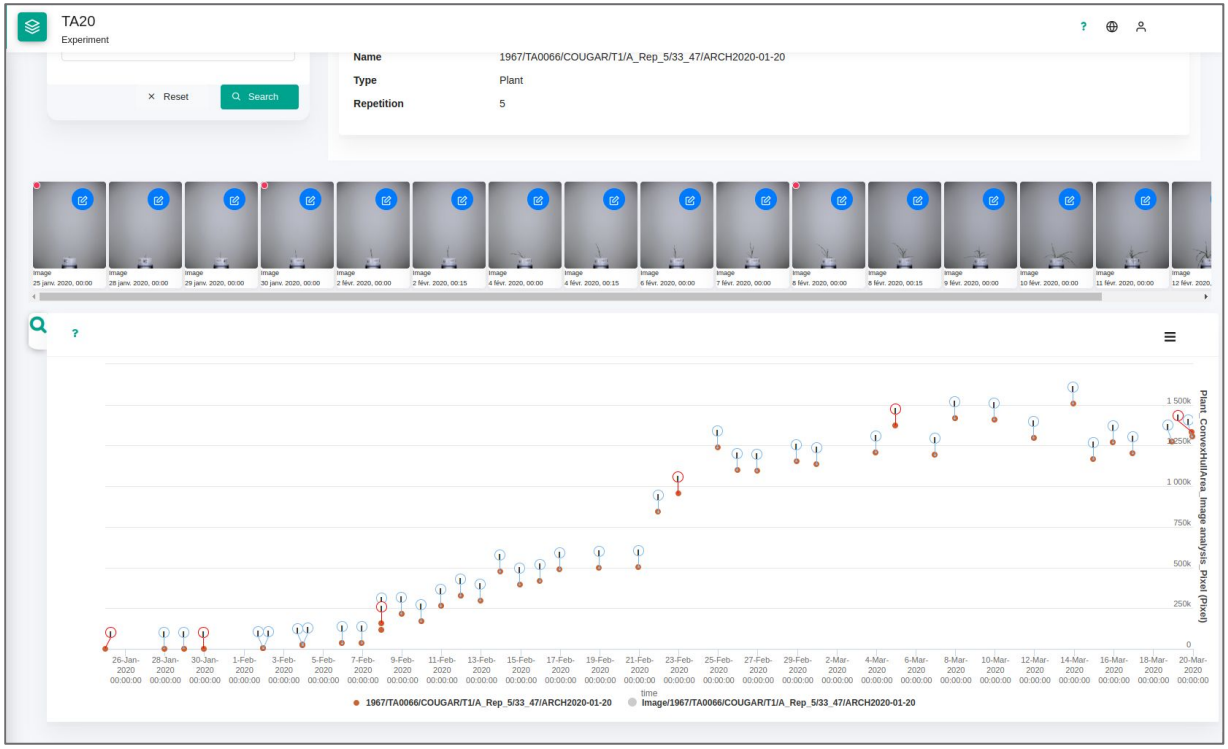


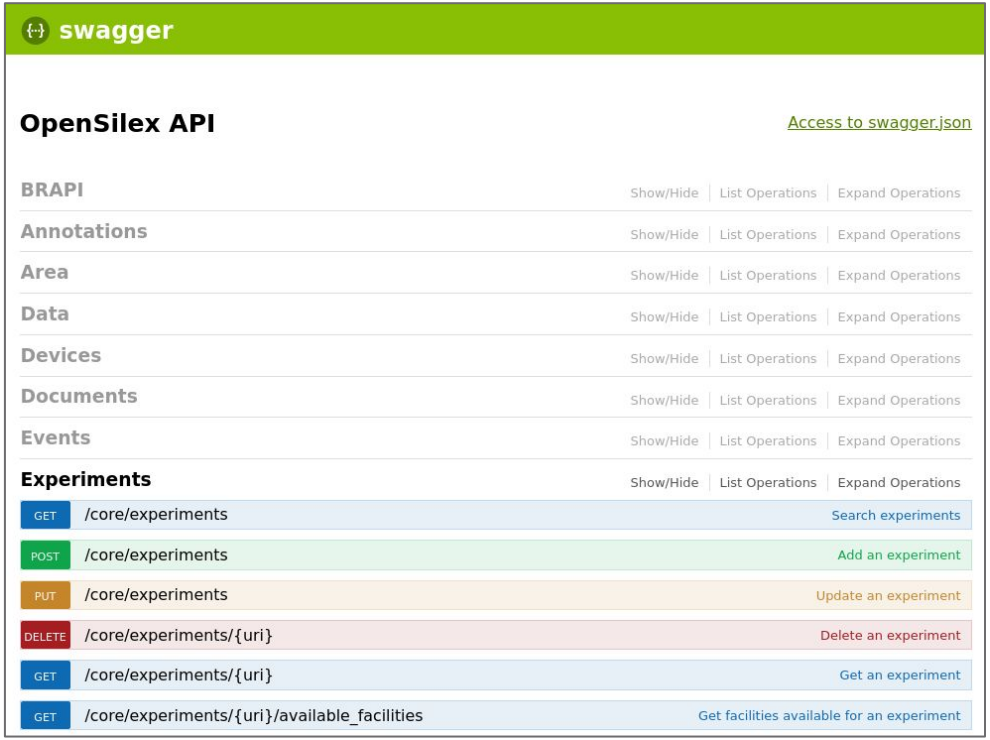
PHIS Swagger - Connection to clients

Another interface with the data

- Swagger

https://phis.emphasis.fedcloud.eu/egi-demo/api-docs/

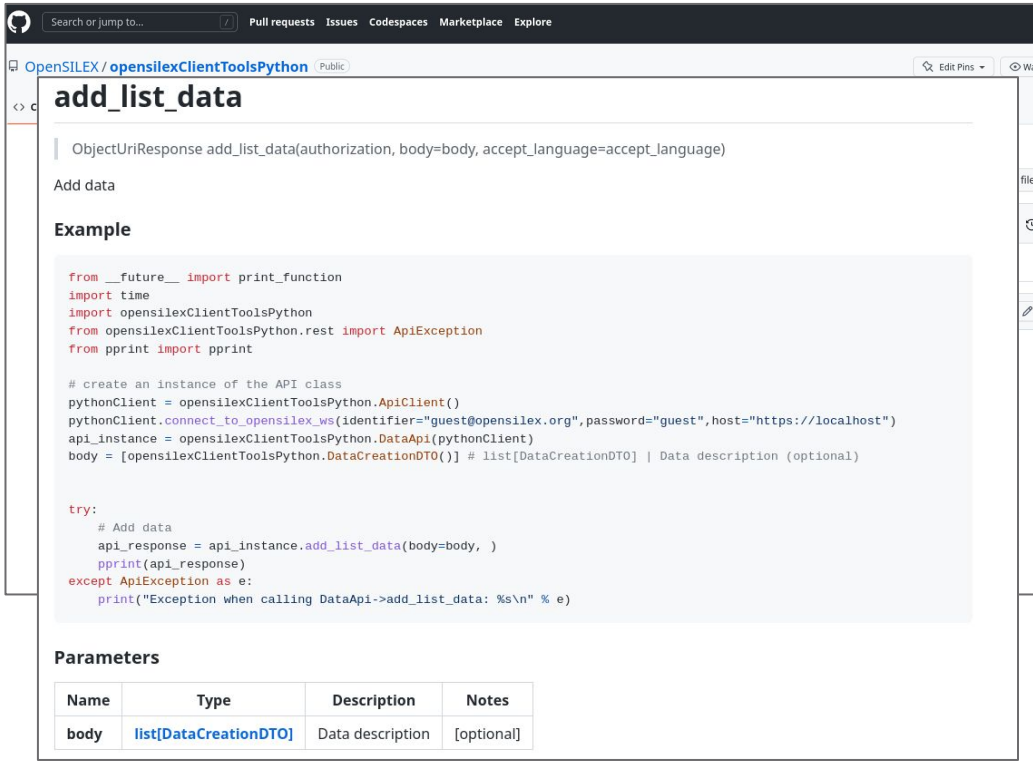
  - Based on OpenAPI https://www.openapis.org
  - Open description format for API services
  - Explore the different web services, and there return
  - Describe arguments and gives examples
  - Performs requests



PHIS Swagger - Connection to clients

Another interface with the data

- Python Client (Scripts)
  - Repository Github : https://github.com/OpenSILEX/opensilexClientPython
  - Based on autogenerated client : https://github.com/OpenSILEX/opensilexClientToolsPython
- R Client (Package)
  - Repository Github : https://github.com/OpenSILEX/opensilexClientR
  - Based on autogenerated client : https://github.com/OpenSILEX/opensilexClientToolsR



Conclusion

- PHIS: used in several phenotyping platforms
- Work in conjunction with standards (BrAPI - MIAPPE)
- Ongoing developments
  - New functionalities
  - Adaptation to the needs / evolution of research
  - Support
  - Link with research teams
- OpenSILEX: opening to other communities

PHIS-OpenSILEX useful links

OpenSILEX

- OpenSILEX website: http://opensilex.org/
- **OpenSILEX demo: http://opensilex.org/sandbox/app/ *(guest@opensilex.org / guest)***
- How to contribute to OpenSILEX?
  - Github repository: https://github.com/OpenSILEX/
  - Developer documentation: https://opensilex.github.io/docs-community-dev/
  - OpenSILEX Docker: https://github.com/OpenSILEX/opensilex-docker-compose
- User documentation: https://opensilex.github.io/phis-docs-community/

PHIS

- PHIS website: http://phis.inrae.fr/
- Research paper: https://nph.onlinelibrary.wiley.com/doi/full/10.1111/nph.15385
- Variables declaration tutorial: https://www.youtube.com/watch?v=Pvz9o-b_Mok