

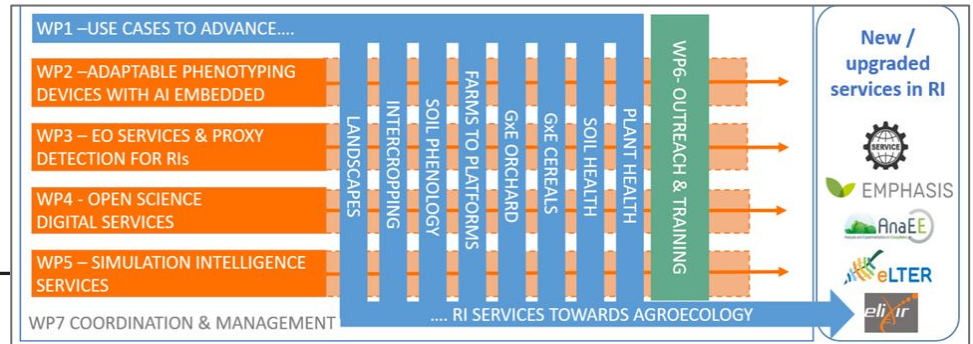
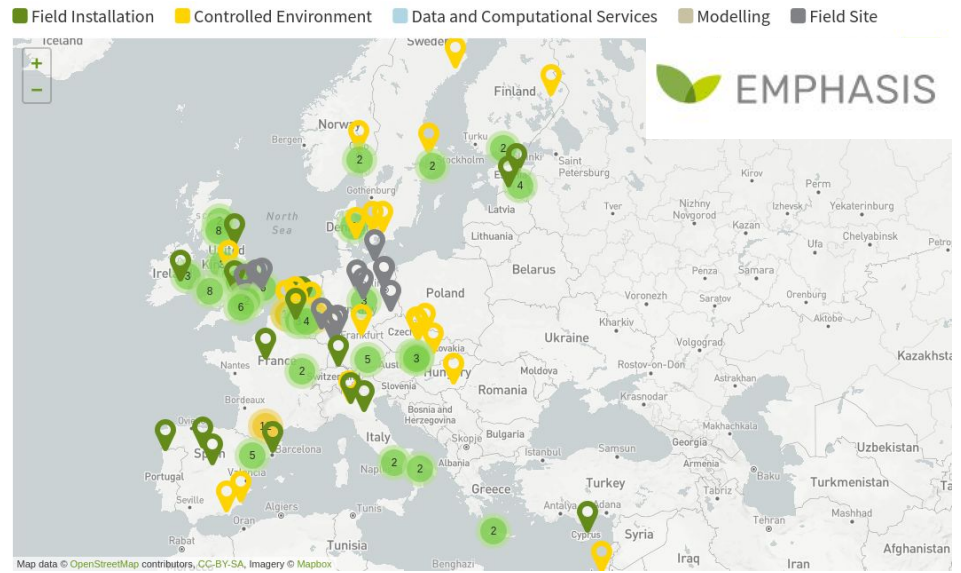
PHENET-EMPHASIS Data Management Training

Introduction to PHIS Phenotyping Hybrid Information System

Thursday 05/12/2024

Isabelle Alic (INRAE)

Phenotyping communities



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 transparency: 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

URI of plant:

<<http://phenome.fr/arch/2017/c17000118>>

URI of pot:

<<http://phenome.fr/arch/2013/pc13001542>>

URI of cart:

<<http://phenome.fr/arch/2013/ct1300123>>

URI of cabin:

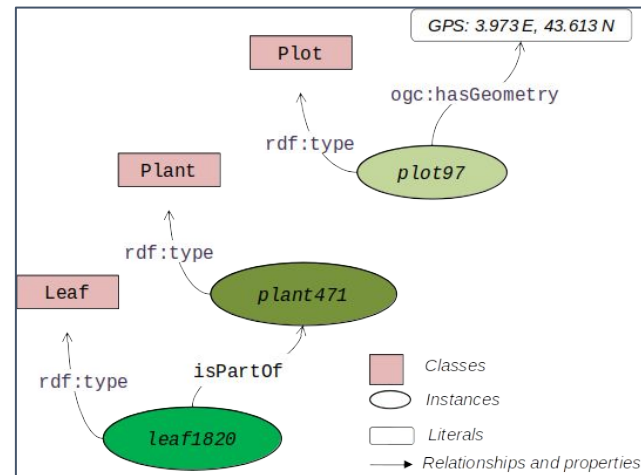
<<http://phenome.fr/arch/2018/ac180015>>

URI of camera:

<<http://phenome.fr/arch/2018/ac180019>>



URI of image: <<http://phenome.fr/arch/2017/ic17002295855>>



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

How?

PHIS, an ontology driven Information System



URI of plant:
<<http://phenome.fr/arch/2017/c17000118>>

URI of pot:
<<http://phenome.fr/arch/2013/pc13001542>>

URI of cart:
<<http://phenome.fr/arch/2013/ct1300123>>

URI of cabin:
<<http://phenome.fr/arch/2018/ac180015>>

URI of camera:
<<http://phenome.fr/arch/2018/ac180019>>

URI of image: <<http://phenome.fr/arch/2017/ic17002295855>>

Variables
Manage and configure variables, entities, and observations.

Variables Entity Observation level

+ Add variable

Selected Variables 0

Showing 0 to 4 of 4 entries

<input type="checkbox"/>	Name
<input type="checkbox"/>	Plant_Area_ImageProcessing_Plant_Area
<input type="checkbox"/>	Plant_effectiveQuantumYield_C
<input type="checkbox"/>	Plant_maximumQuantumYield

Interoperability References

Add references to http://phis.egi-demo.eu/id/variable/plant_perimeter_imageprocessing_millimetre

Reference ontologies

- AGROPORAL
- AGROVOC
- BioPortal
- Crop Ontology
- Plant Ontology
- Planteome
- Units of measurement ontology (UO)
- Units of Measure (OM)
- QUDT Ontologies (QUDT)
- XML/XSD Datatype Schemas

Relations ⓘ *

Close match

Reference URI ⓘ *

http://purl.obolibrary.org/obo/PATO_0001711

Add references

No reference available

OpenSILEX Galaxy

PHENOME
EMPHASIS | FRANCE

Plant Phenotyping



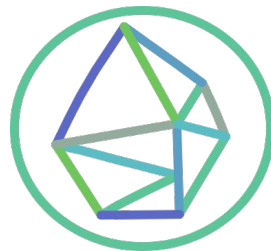
Sixtine

Annual crops
Systems trials
Arboriculture - vines

Agro-Ecology



Sun'Agri



OpenSILEX

Environment & Processes



Viticulture Oenology

Vitis Explorer



Sinfonia



VitiOeno

Instance Ressources



EMPHASIS

Introduction to Phenotyping Hybrid Information System (PHIS)

PHENET-EMPHASIS Data Management Training - Paris - 04, 05 & 06 December 2024

OpenSILEX Galaxy



Plant Phenotyping

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

Agro-Ecology



OpenSILEX



Sixtine

Annual crops
Systems trials
Arboriculture - vines

Vine
LaCage GCIE
U2E
Orchard

Environment & Processes



Viticulture Oenology

Vitis Explorer



Sinfonia



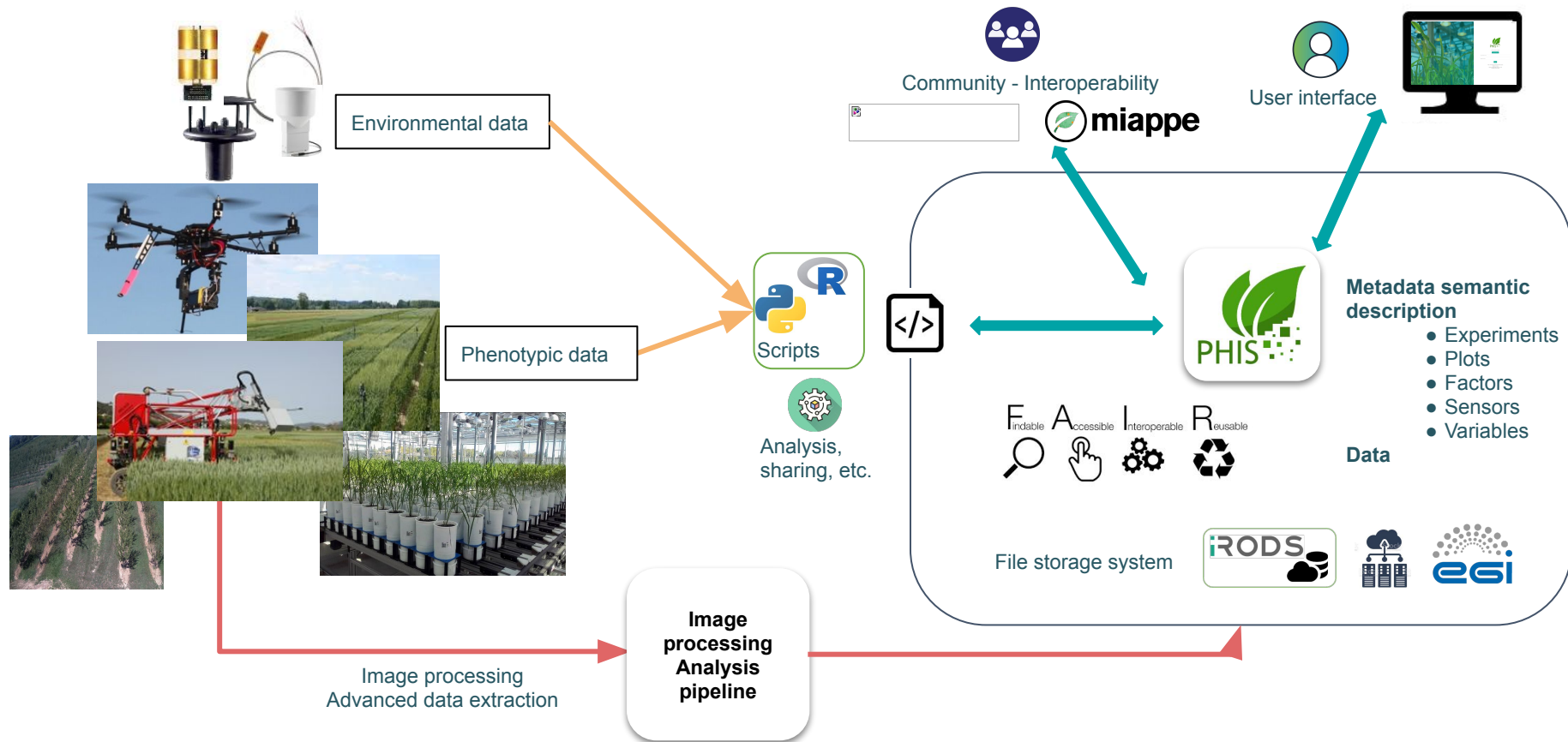
VitiOeno

Instance Ressources

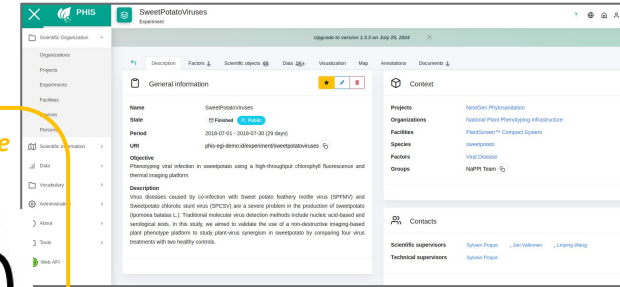
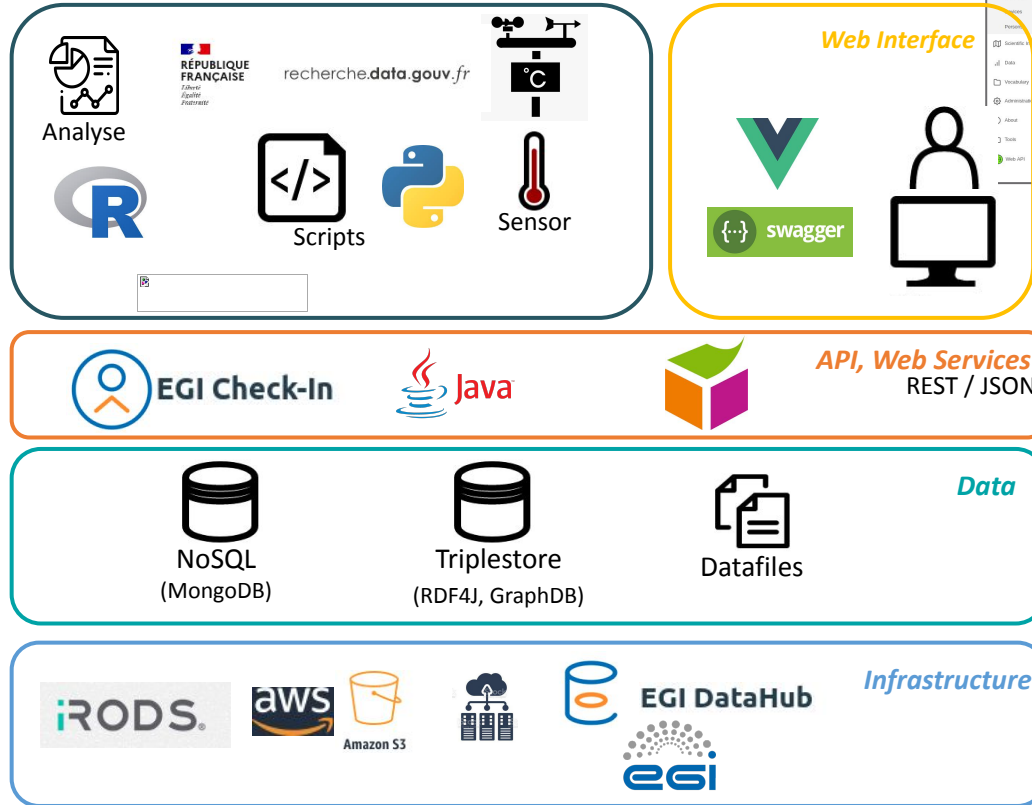


EMPHASIS

PHIS: an Ontology driven Information System for Plant Phenomics



PHIS Architecture





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)

oepe: Ontology of Experimental Phenotypic Objects

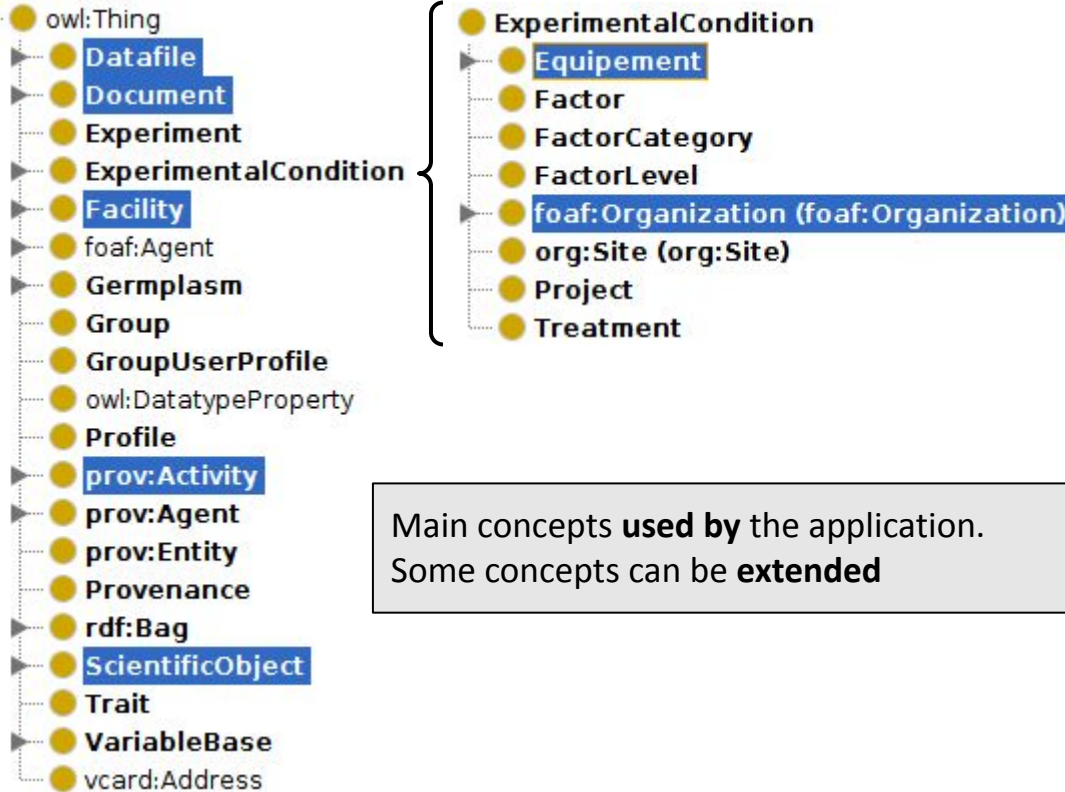
main concepts: experiment objects, qualities, experimental information

- **oeev**: ontology of experimental events

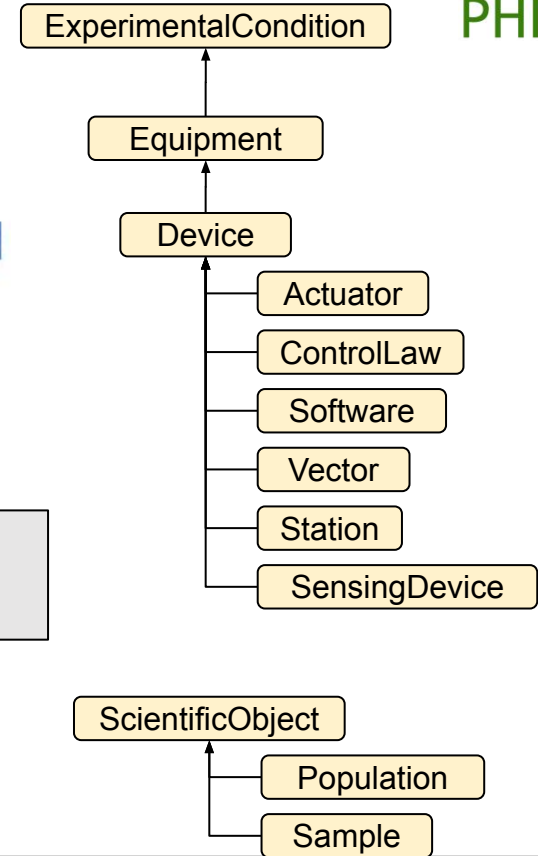
main concepts: move, device management, object management, faults, etc.



Ontologies in OpenSILEX - PHIS

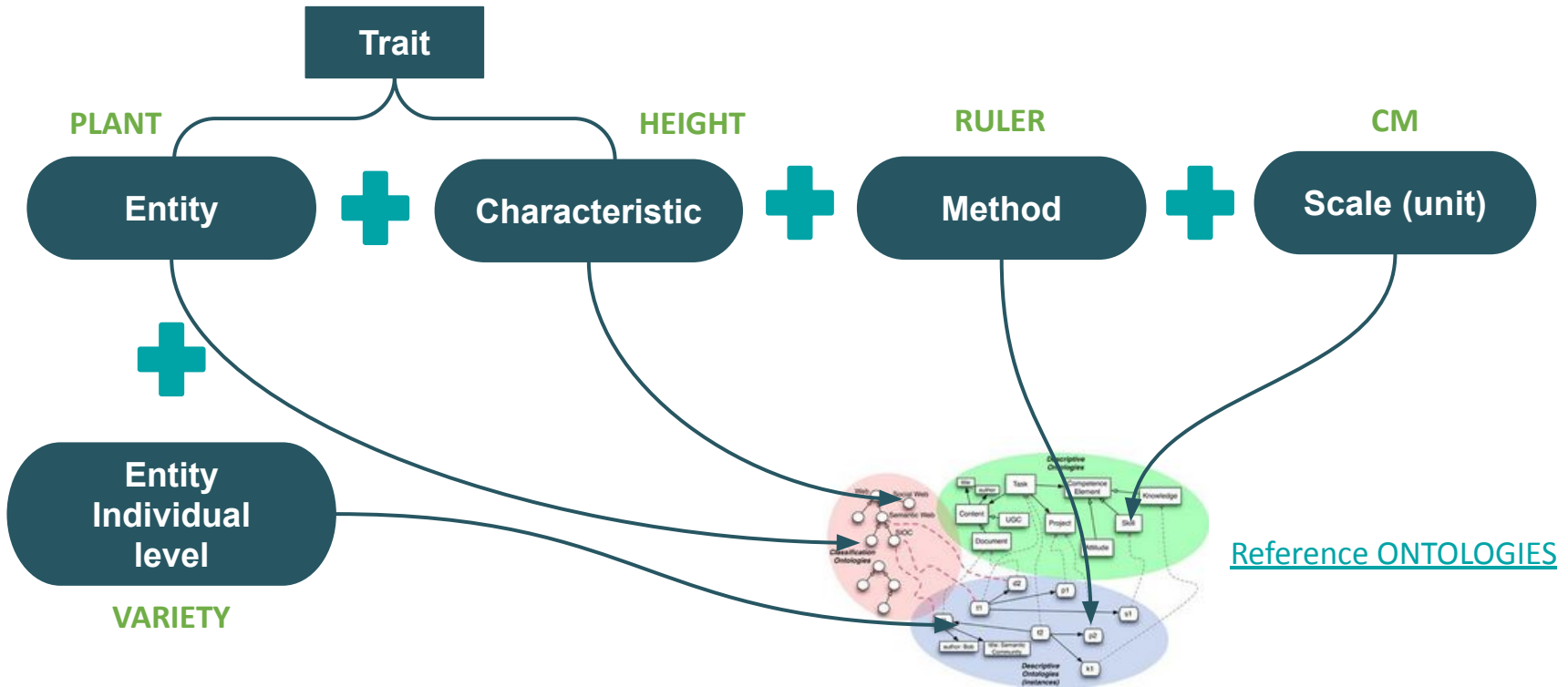


Main concepts **used by** the application.
Some concepts can be **extended**



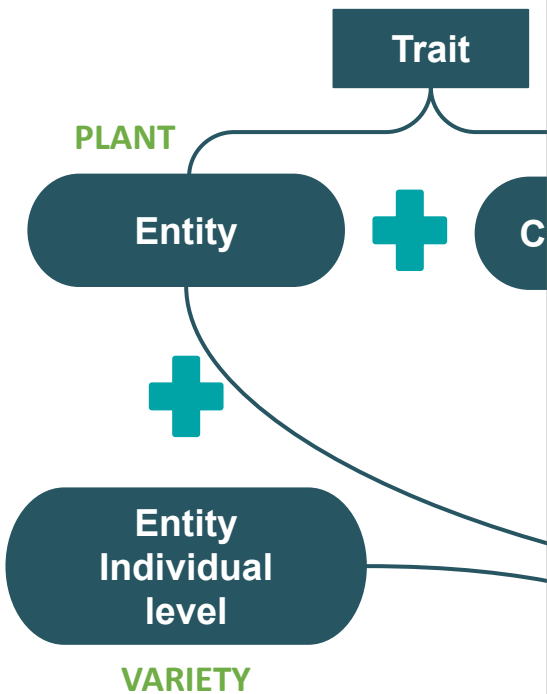


Variables model





Variables mo



Add variable

URI
autogenerated URI

Entity *
Plant x +

Characteristic *
Height x +

Method *
Ruler x +

Unit/Scale *
Centimeter x +

Observation level ?
Search and select an observation level x +

Species
Select species x

Trait already existing in an ontology

Name *
Plant_Height_Ruler_centimeter

Alternative name
Plant_Height

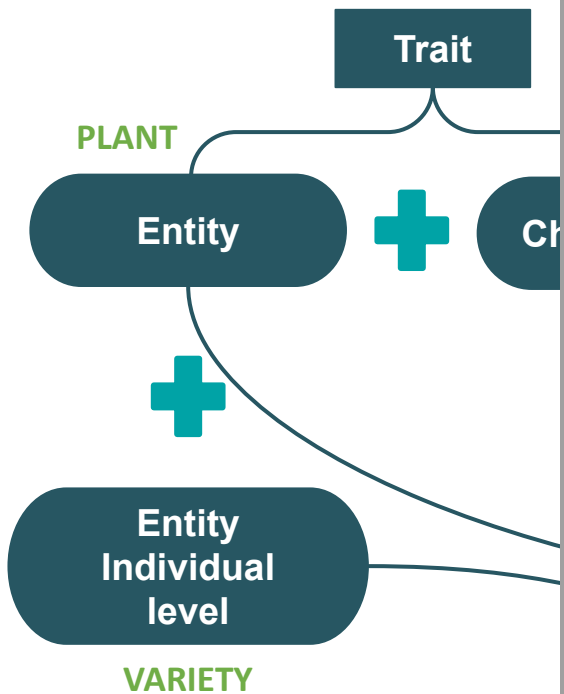
Data type *
Decimal number x

Time interval ?
Select an interval x

Sample interval ?



Variables model



The screenshot shows a web interface for adding a trait. A dialog box titled "Add trait" is open, with the following fields and values:

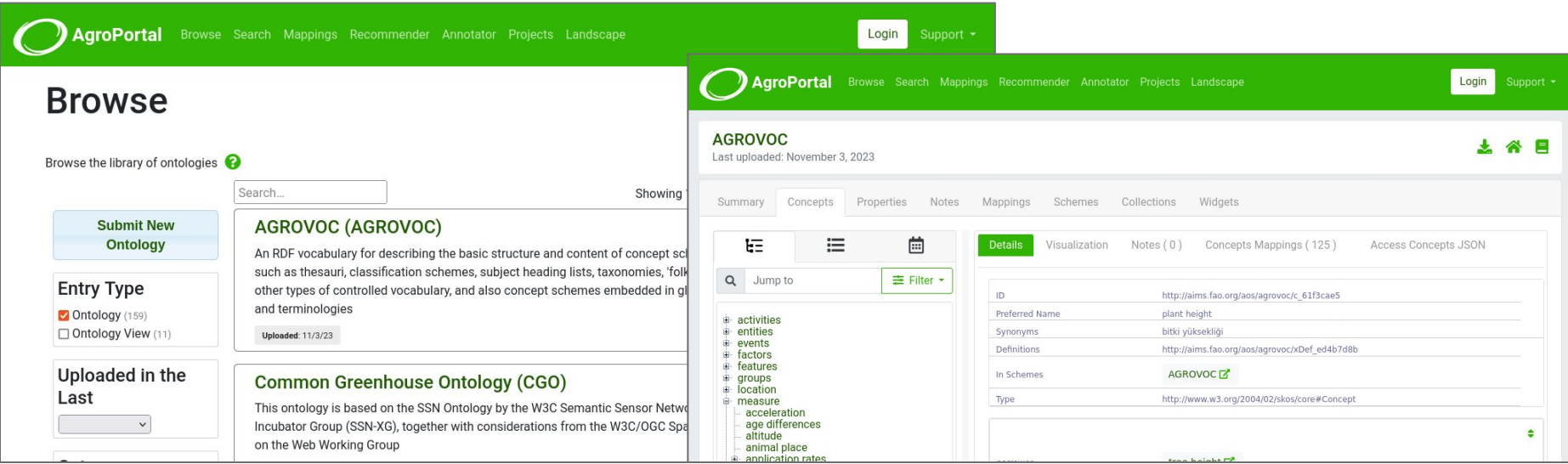
- URI:** URI, autogenerated URI
- Trait uri:**
- Trait name:**
- Entity:**
- Characteristic:**
- Method:**
- Unit/Scale:**
- Name:**
- Alternative name:**
- Data type:**
- Time interval:**
- Sample interval:**

The background interface shows a list of traits with a "Trait already existing in an ontology" error message.

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/>



The screenshot displays the AgroPortal interface. The top navigation bar includes 'AgroPortal', 'Browse', 'Search', 'Mappings', 'Recommender', 'Annotator', 'Projects', 'Landscape', 'Login', and 'Support'. The main content area is divided into two sections. The left section, titled 'Browse', shows a search bar and a list of ontologies. The right section, titled 'AGROVOC', shows the details of the AGROVOC ontology, including a list of concepts and a table of properties.

Browse

Browse the library of ontologies ?

Search...

Showing

Submit New Ontology

Entry Type

- Ontology** (159)
- Ontology View** (11)

Uploaded in the Last

AGROVOC (AGROVOC)

An RDF vocabulary for describing the basic structure and content of concept schemes, such as thesauri, classification schemes, subject heading lists, taxonomies, folksonomies, and other types of controlled vocabulary, and also concept schemes embedded in glossaries and terminologies

Uploaded: 11/3/23

Common Greenhouse Ontology (CGO)

This ontology is based on the SSN Ontology by the W3C Semantic Sensor Network Incubator Group (SSN-XG), together with considerations from the W3C/OGC Spatial Ontology on the Web Working Group

AGROVOC

Last updated: November 3, 2023

Summary Concepts Properties Notes Mappings Schemes Collections Widgets

Jump to Filter

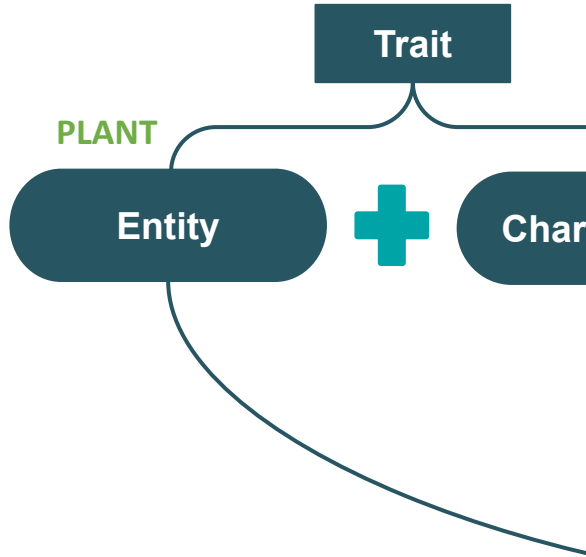
Details Visualization Notes (0) Concepts Mappings (125) Access Concepts JSON

ID	http://aims.fao.org/aos/agrovoc/c_61f3cae5
Preferred Name	plant height
Synonyms	bitki yüksekligi
Definitions	http://aims.fao.org/aos/agrovoc/xDef_ed4b7d8b
In Schemes	AGROVOC
Type	http://www.w3.org/2004/02/skos/core#Concept

- activities
- entities
- events
- factors
- features
- groups
- location
- measure
 - acceleration
 - age differences
 - altitude
 - animal place
 - application rates

Describing a variable

Searching for an ontological concept



Add entity ✕

1
Search

2
Enrich

3
Mapping

Search for ontology term

🔍 ⌵

leaf - PO
http://purl.obolibrary.org/obo/PO_0025034
 A phyllome (PO:0006001) that is not associated with a reproductive structure.
+ Choose

flag leaf - AGROVOC
http://aims.fao.org/aos/agrovoc/c_20acd5a2
http://aims.fao.org/aos/agrovoc/xDef_52793e30

leaf lettuce - AGROVOC
http://aims.fao.org/aos/agrovoc/c_53379b65
http://aims.fao.org/aos/agrovoc/xDef_e9ea471e

leaf protein - AGROVOC
http://aims.fao.org/aos/agrovoc/c_24867

leaf meal - AGROVOC

Cancel

Import & Save

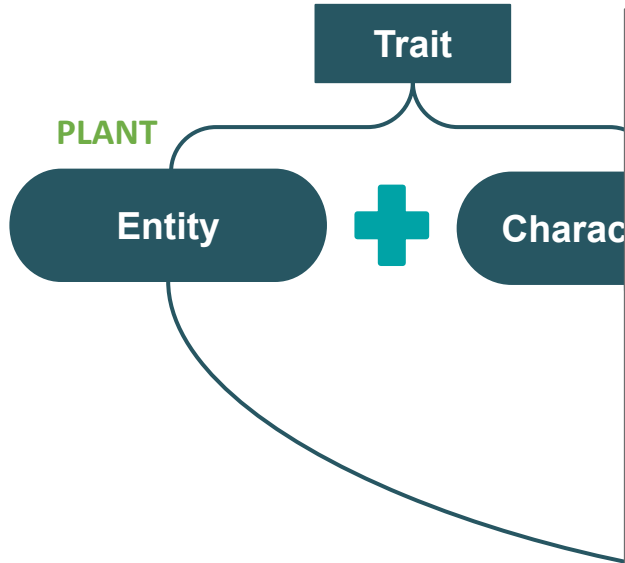
Enrich

Selected term ✖

leaf - PO
http://purl.obolibrary.org/obo/PO_0025034
 A phyllome (PO:0006001) that is not associated with a reproductive structure.

Describing a variable

Enriching the concept



Add entity ✕

1

2

3

Search
Enrich
Mapping

URI ⓘ •

autogenerated URI

Name *

leaf

Description

A phyllome (PO:0006001) that is not associated with a reproductive structure.

A phyllome vascular system that includes the totality of the portions of vascular tissue in their specific arrangement in a vascular leaf.

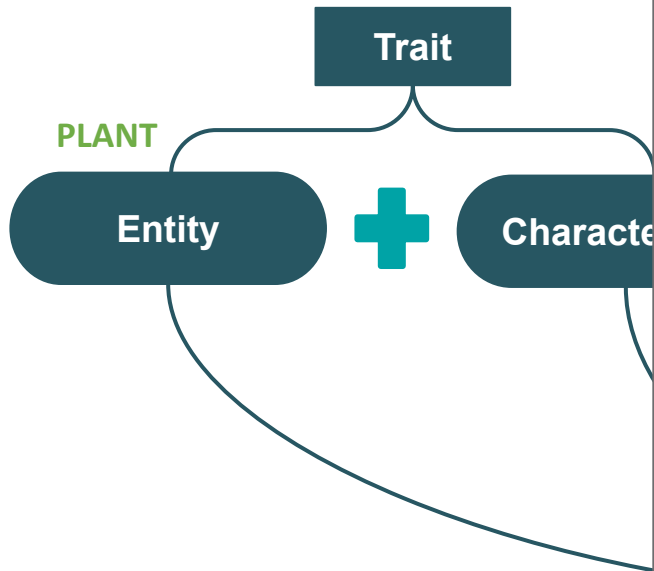
Cancel
Save
Previous
Next



[Reference ONTOLOGIES](#)

Describing a variable

Concept alignment



Add entity

1 Search 2 Enrich 3 Mapping

Search for mapping...

leaf

Ontologies
OEPO x and 2 more All ontologies

Selected term

leaf
A phyllome (PO:0006001) that is not associated with a reproductive structure.

Relations	Reference URI	Actions
Close match	http://purl.obolibrary.org/obo/PO_0025034	<input type="button" value="x"/>

leaf - PO
http://purl.obolibrary.org/obo/PO_0025034
A phyllome (PO:0006001) that is not associated with a reproductive structure.

Leaf - OEPO
<http://www.phenome-fppn.fr/vocabulary/2018/oeppo#Leaf>
A phyllome vascular system (PO:0025206) that includes the totality of the portions of vascular tissue in their specific arrangement in a vascular leaf (PO:0009025).
[database_cross_reference: POC:Ramona_Walls]

phyllode leaf - PO
http://purl.obolibrary.org/obo/PO_0025335
An adult ensiform leaf with a lamina that dev median plane, rather a transverse plane, throughout the length of the leaf and is a result of increased activity of the

Map term as

- Narrower
- Broader
- Close match
- Exact match

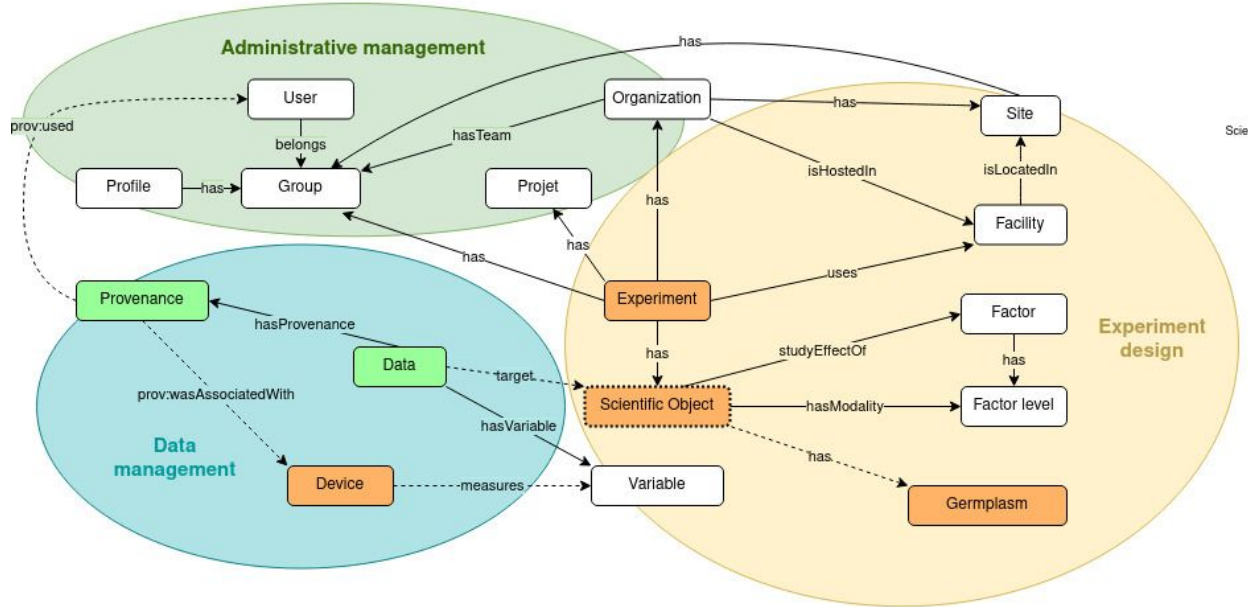
...Or map manually

URI





The different concepts of PHIS and their relationships



Scier



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 related to genotyping:** Sets, Variants, etc.
 - **BrAPI-Germplasm - Entities related to germplasm:** Germplasm Attributes, Seed Lots

➤ PHIS: BrAPI WebServices implementation

Method	Endpoint	Description
GET	/brapi/v1/calls	Check the available BrAPI calls
GET	/brapi/v1/germplasm	Submit a search request for germplasm
GET	/brapi/v1/studies	Retrieve studies information
GET	/brapi/v1/studies-search	Retrieve studies information
GET	/brapi/v1/studies/{studyDbId}	Retrieve study details
GET	/brapi/v1/studies/{studyDbId}/observations	Get the observations associated to a specific study
GET	/brapi/v1/studies/{studyDbId}/observationunits	List all the observation units measured in the study.
GET	/brapi/v1/studies/{studyDbId}/observationvariables	List all the observation variables measured in the study.



EMPHASIS

Introduction to Phenotyping Hybrid Information System (PHIS)
PHENET-EMPHASIS Data Management Training - Paris - 04, 05 &



PHIS and standards - MIAPPE

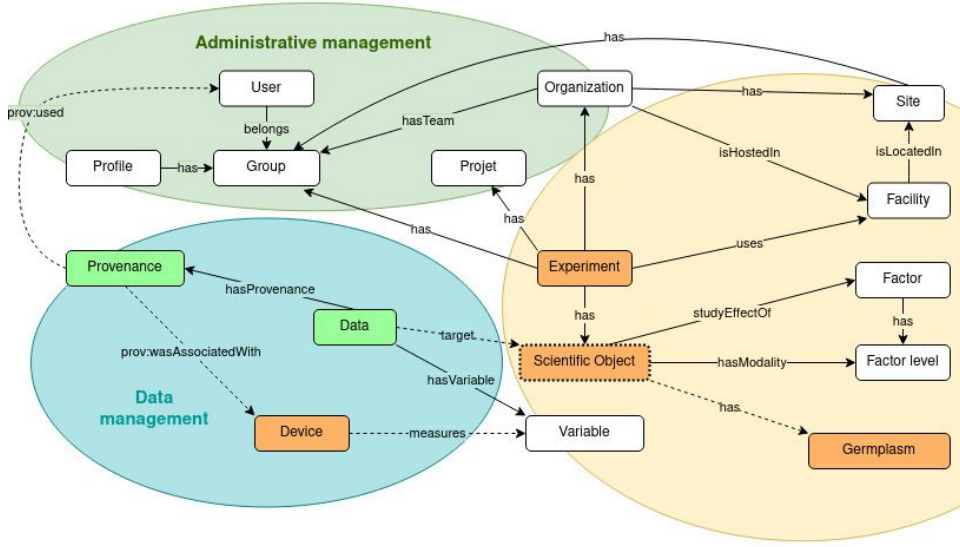
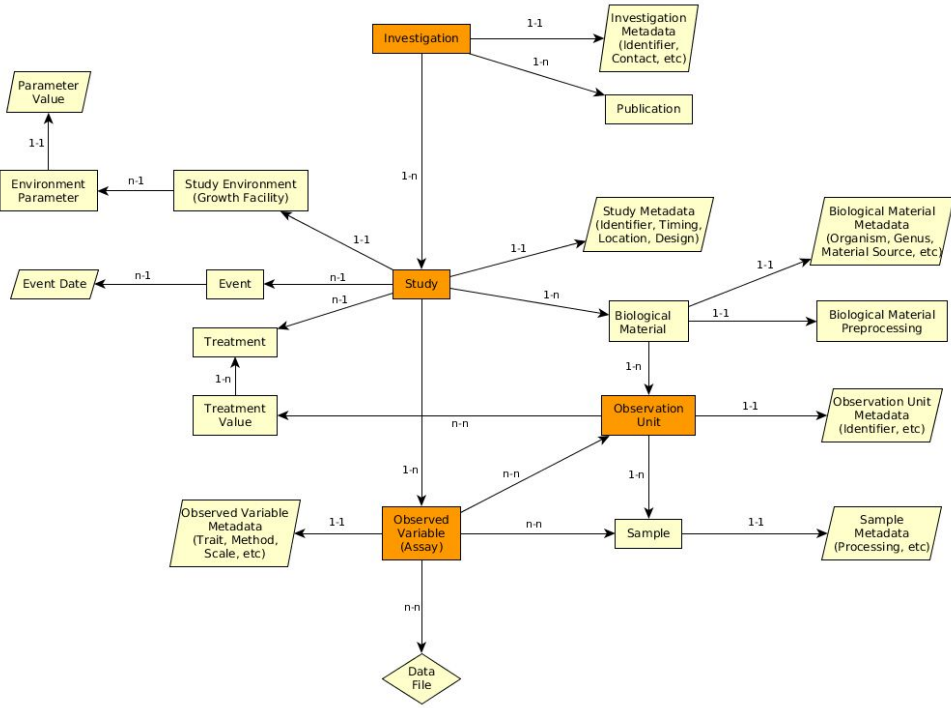


MIAPPE - <https://www.miappe.org/>

- 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

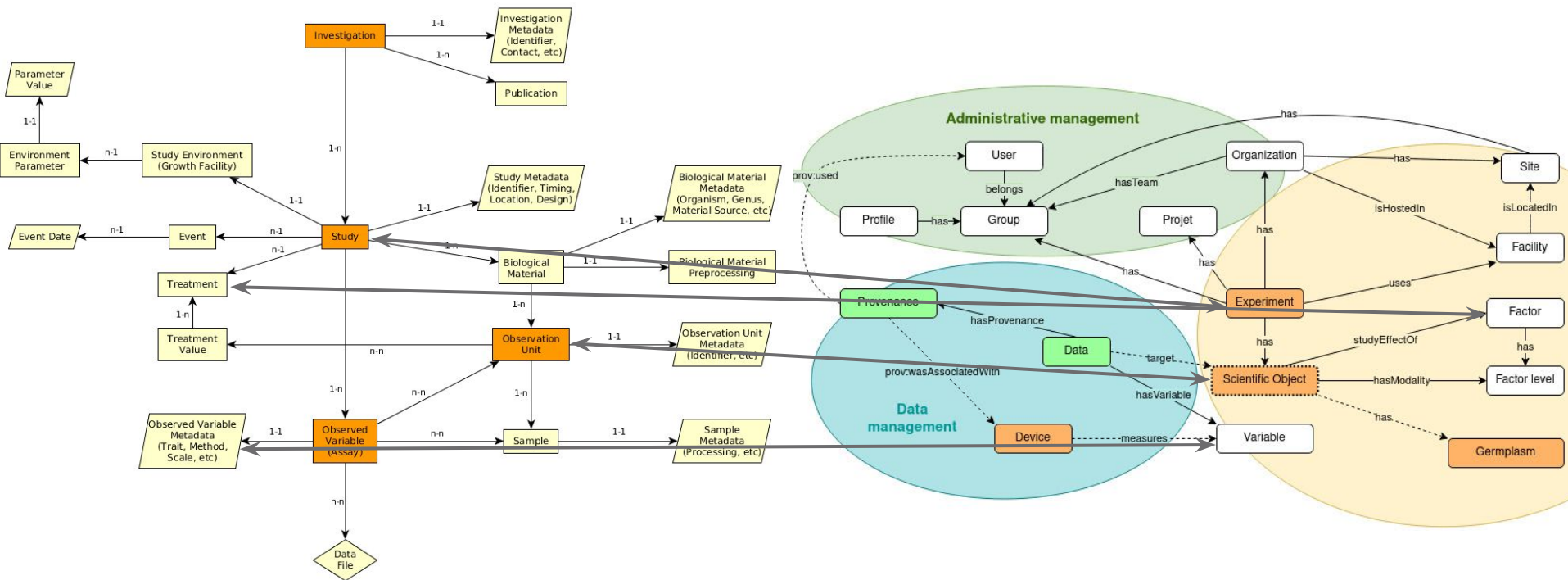


PHIS and standards - MIAPPE





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



You can connect as guest

[Connect as guest](#)

[Login](#)

PHIS - Phenotyping Hybrid Information System
Version 1.3.5-rdg
Based on OpenSILEX version 1.3.5-rdg
Copyright ©2021 INRAE



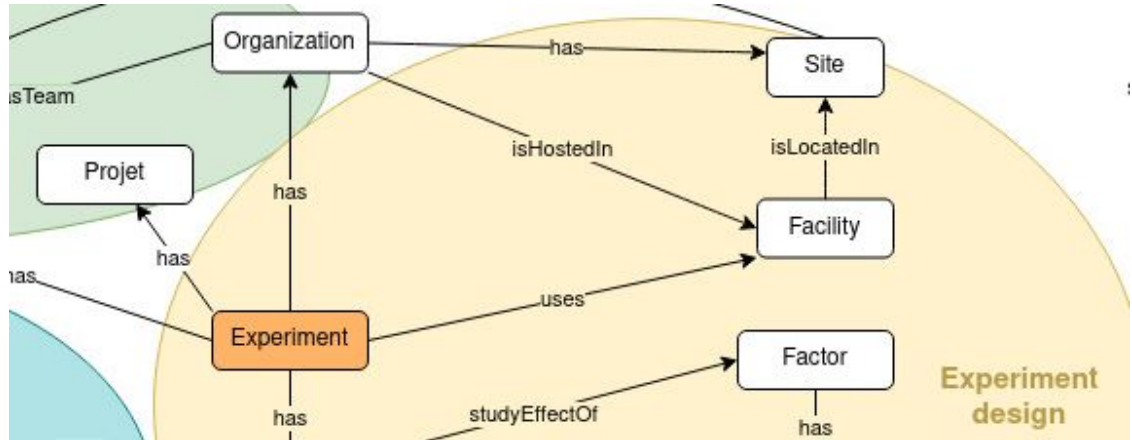
Friendly User Interfaces

PHIS Interfaces allow management of



- **Scientific Organization**

- Project information
- Experimental context
- Facilities
- Sensors





Friendly User Interfaces

PHIS Interfaces allow management of



- **Scientific Organization**

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

The screenshot displays the PHIS 'Organizations' management interface. The main view shows a tree structure of organizations and sites. An 'Update facility' modal is open, showing fields for Object URI, Type (Greenhouse), Name (PlantScreen™ Modular System), Organizations (National Plant Phenotyping Infrastructure), Site, and Address.



Friendly User Interfaces

PHIS Interfaces allow management of



- **Scientific Organization**

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

Projects
Manage and configure projects

+ Add project

Selected Project(s)

Showing 0 to 2 of 2 entries

Name

NextGen Phytosanitation

Workshop Phenomics

Update the project

Project URI

phis-egi-demo.id/project/nextgen_phytosanitation

Name *

NextGen Phytosanitation

Short name

NextGen Phytosanitation

Start date *

10/10/2016

End date

09/30/2020

financial funding

Enter financial funding

website

https://www.ilita.org/ilita-project/nextgen-phytosanitation-rapid-elimination-of-viruses-from-rtb-plants-for-crop-improvement-a

cancel

Next

SweetPotatoViruses
Experiment

Details Factors Scientific objects Data Visualization Map Annotations Documents

Description

Name SweetPotatoViruses

State Finished Public

Period 2018-07-01 - 2018-07-30 (29 days)

URI phis-egi-demo.id/experiment/sweetpotatoviruses

Objective
Phenotyping viral infection in sweetpotato using a high-throughput chlorophyll fluorescence and thermal imaging platform

Description
Virus diseases caused by co-infection with Sweet potato feathery mottle virus (SPFMV) and Sweetpotato chlorotic stunt virus (SPCSV) are a severe problem in the production of sweetpotato (*Ipomoea batatas* L.). Traditional molecular virus detection methods include nucleic acid-based and serological tests. In this study, we aimed to validate the use of a non-destructive imaging-based plant phenotype platform to study plant-virus synergism in sweetpotato by comparing four virus treatments with two healthy controls.

Context

Projects [NextGen Phytosanitation](#)

Organizations [National Plant Phenotyping Infrastructure](#)

Facilities [PlantScreen™ Compact System](#)

Species [sweetpotato](#)

Factors [Viral Disease](#)

Groups [NaPPI Team](#)

Contacts

Scientific supervisors [Sylvain Poque](#), [Linping Wang](#), [Jari Valkonen](#)

Technical supervisors [Sylvain Poque](#)

Declared by [admin admin](#)



Friendly User Interfaces

PHIS Interfaces allow management of



- **Scientific Organization**

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

The screenshot displays the PHIS web interface. On the left is a navigation sidebar with categories like 'Scientific Organization', 'Scientific Information', 'Data', 'Vocabulary', 'Administration', and 'Tools'. The main content area shows the 'Device' management page with a search bar and a list of devices. A modal window titled 'Update device' is open, containing the following fields:

- URI**: `http://phis.mm.helsinki.fi/id/device/compact_topview_rgb2`
- Type**: RGB camera
- Name**: Compact_TopView_RGB2
- Description**: (empty text area)
- Brand**: IDS Imaging Development Systems GmbH
- Constructor model**: (partially visible)





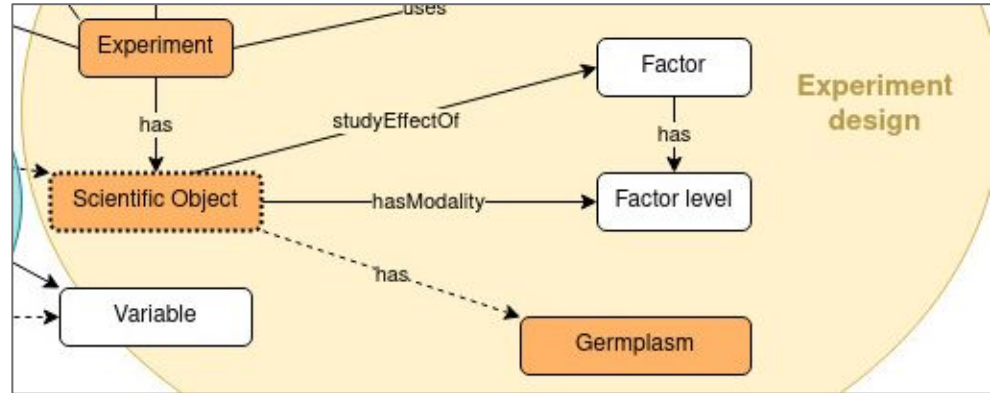
Friendly User Interfaces

PHIS Interfaces allow management of



- **Scientific Information**

- Variables
- Scientific objects
- Germplasm
- Documents





Friendly User Interfaces

PHIS Interfaces allow management of



- **Scientific Information**

- Variables
- Scientific objects
- Germplasm
- Documents

The screenshot displays the PHIS 'Variables' management interface. The main panel shows a list of variables with columns for Name, Entity, and Observation level. A modal window titled 'Edit variable' is open, showing fields for URI, Entity (Plant), Characteristic (Area), Method (ImageProcessing), Unit/Scale (square millimetre), Observation level, Species, Name (Plant_Area_ImageProcessing_squareMillimetre), and Alternative name (Plant_Area). A green button indicates 'Trait already existing in an ontology'.



Friendly User Interfaces

PHIS Interfaces allow management of



- **Scientific Information**

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

SweetPotatoViruses
Experiment

Details Factors Scientific objects Data Visualization Map Annotations Documents

+ Add scientific object + CSV Import

Selected Scientific Objects 0 Actions + + Export all

Select all

- SP004054 (plant)
- SP004055 (plant)
- SP004056 (plant)
- SP004057 (plant)
- SP004058 (plant)
- SP004059 (plant)
- SP004060 (plant)
- SP004061 (plant)

Details Events Positions Annotations Documents

URI phis.egi-demo.eu/id/scientific-object/so-sp004061

Name SP004061

Type Plant

Creation date 07/13/2018

Factor level

- SPFMV (Viral Disease)

Germplasm

- [Huachano-R3](#)

Huachano-R3
Germplasm

Details Annotations Documents

Description

URI <http://phis.egi-demo.eu/id/germplasm/variety.huachano-r3>

Type Variety

Name Huachano-R3

Description Transgenic sweetpotato expressing a viral protein (SPCSV RNase III)

Species sweetpotato http://aims.fao.org/aos/agrovoc/c_3937

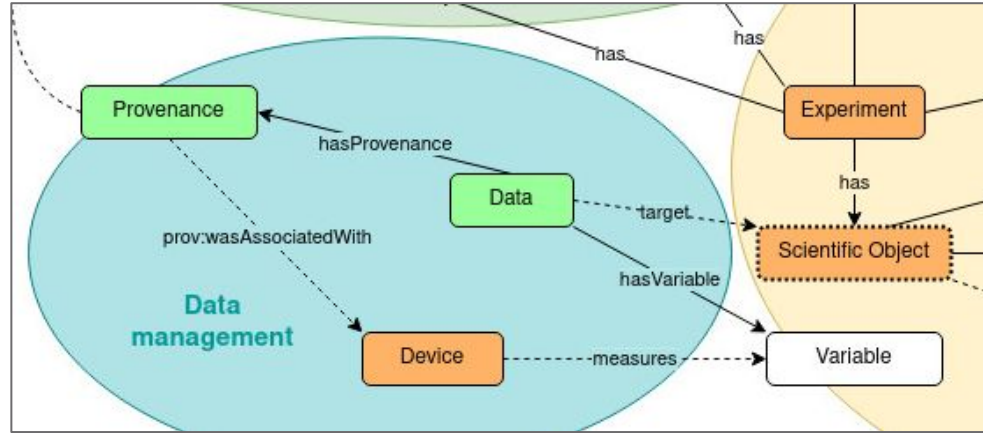


Friendly User Interfaces

PHIS Interfaces allow management of



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



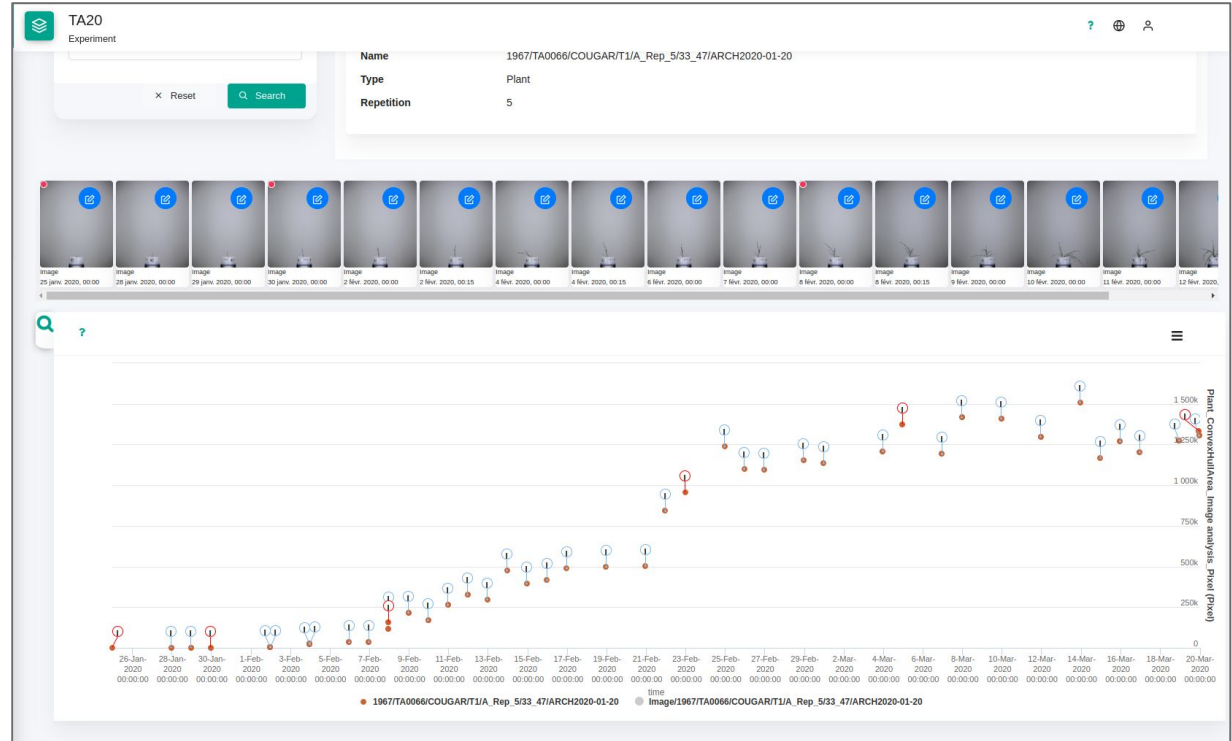


Friendly User Interfaces

PHIS Interfaces allow management of



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





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

The screenshot shows the Swagger UI for the OpenSilex API. The interface has a green header with the 'swagger' logo. Below the header, the title 'OpenSilex API' is displayed with a link to 'Access to swagger.json'. The main content area lists various API endpoints with their methods and descriptions. Each endpoint row includes a 'Show/Hide' button, a 'List Operations' button, and an 'Expand Operations' button. The endpoints listed are:

Method	Endpoint	Description
GET	/core/experiments	Search experiments
POST	/core/experiments	Add an experiment
PUT	/core/experiments	Update an experiment
DELETE	/core/experiments/{uri}	Delete an experiment
GET	/core/experiments/{uri}	Get an experiment
GET	/core/experiments/{uri}/available_facilities	Get facilities available for an experiment





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>

The screenshot shows a Swagger API interface for the endpoint `add_list_data`. The interface includes a search bar at the top, navigation links for Pull requests, Issues, Codespaces, Marketplace, and Explore. The endpoint is identified as `OpenSILEX / opensilexClientToolsPython` and is public. The response type is `ObjectUriResponse add_list_data(authorization, body=body, accept_language=accept_language)`. Below this, there is a section for "Add data" and an "Example" section containing a Python code snippet. The code snippet demonstrates how to create an instance of the API class, connect to the OpenSILEX web service, and call the `add_list_data` method. The code includes comments and error handling for `ApiException`. At the bottom of the interface, there is a "Parameters" section with a table listing the parameters for the endpoint.

```
from __future__ import print_function
import time
import opensilexClientToolsPython
from opensilexClientToolsPython.rest import ApiException
from pprint import pprint

# create an instance of the API class
pythonClient = opensilexClientToolsPython.ApiClient()
pythonClient.connect_to_opensilex_ws(identifier="guest@opensilex.org", password="guest", host="https://localhost")
api_instance = opensilexClientToolsPython.DataApi(pythonClient)
body = [opensilexClientToolsPython.DataCreationDTO()] # list[DataCreationDTO] | Data description (optional)

try:
    # Add data
    api_response = api_instance.add_list_data(body=body, )
    pprint(api_response)
except ApiException as e:
    print("Exception when calling DataApi->add_list_data: %s\n" % e)
```

Name	Type	Description	Notes
body	list[DataCreationDTO]	Data description	[optional]



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

