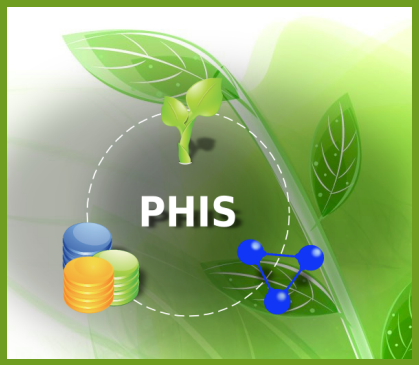


INRA
SCIENCE & IMPACT

Capitalisation et intégration sémantique de données de phénotypage

Contact: Pascal.Neveu@inra.fr

Data Challenges

More and more data!

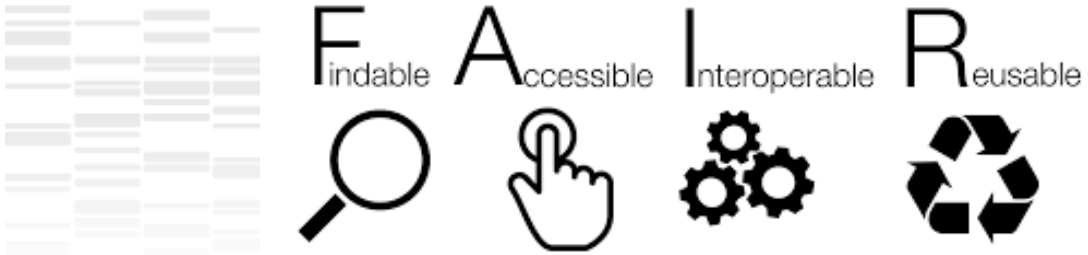
- Storage capacity, Network flow, etc.
  1 Gigabyte : $400K in 1980, $10K in 1990, $1K in 1995, $10 in 2000, $0,01 in 2017
- Various devices (on line or not), simulations, crowdsourcing, etc.
- Internet sources (Open, partners,)

Make data valuable!

- **Decision support**
- **Knowledge discovery**
- **New services**

- Population treatment → individualized treatment
- When data did not quite match what we expect!
- Which theories/models are consistent and which ones are not !
- ...

Need: A new generation of Information Systems



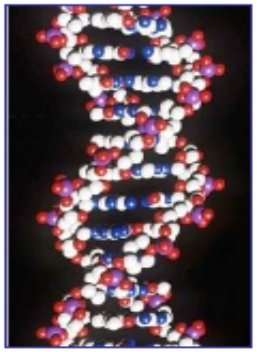
Findable: **PID**, standardized metadata and indexed in portals

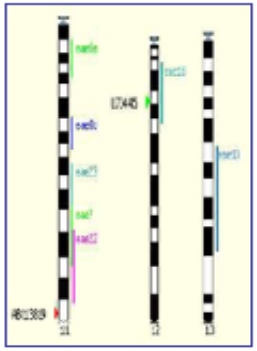
Accessible: open and standardized protocols (internet protocols), authentication* (if not open)

Interoperable: shared standardized formats and vocabularies (technology, syntax, **semantic**)

Reusable: provenance, domain relevant **metadata for understanding**

High Throughput Plant Phenotyping





Many Plant Genotypes

Interactions

Various Environments

High frequency observations of trait dynamics for big set of Phenotypes

High Throughput Plant Phenotyping: searching for the most adapted genotypes

Decision support

- **Links genomics with plant ecophysiology and agronomy**
- **Phenotype-driven gene function discovery**

Searching for the most adapted species/varieties for field challenges

- **Food security**
- **Climate Change adaptation**
- **AgroEcology**
- **Reduce inputs / natural resource preservation**
- **Safe and healthy food**

→ Take into account food transformation and consumer

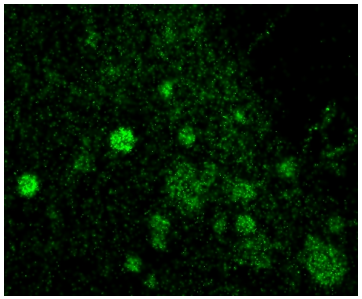
EMPHASIS

Emphasis European e-infrastructure

- Deals with several Petabytes of distributed data
- Makes FAIR data
- Based on Open technologies and standard (MIAPPE, BrAPI, etc)
- Standardized Identification
- Standardized Semantic
- Provenance and reproducibility data processing

Phenomics Data

Different scales

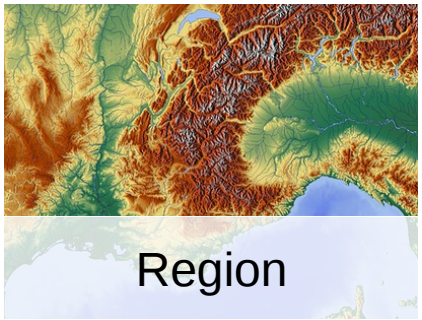


Intra-cellular

Organ

Plant

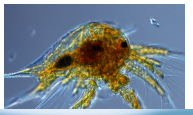
Field



Region

Phenomics Data

Different interactions



Phenomics Data

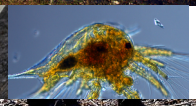
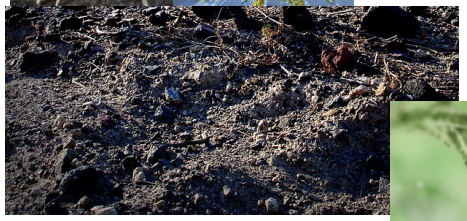
Different stages and transformations

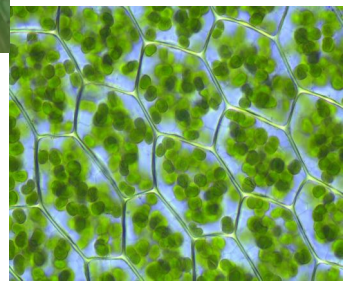











Phenomics Data

From various contexts

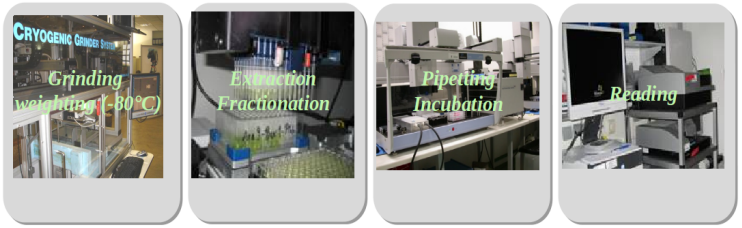
« omics » Platforms

Various data complex types

Genomics

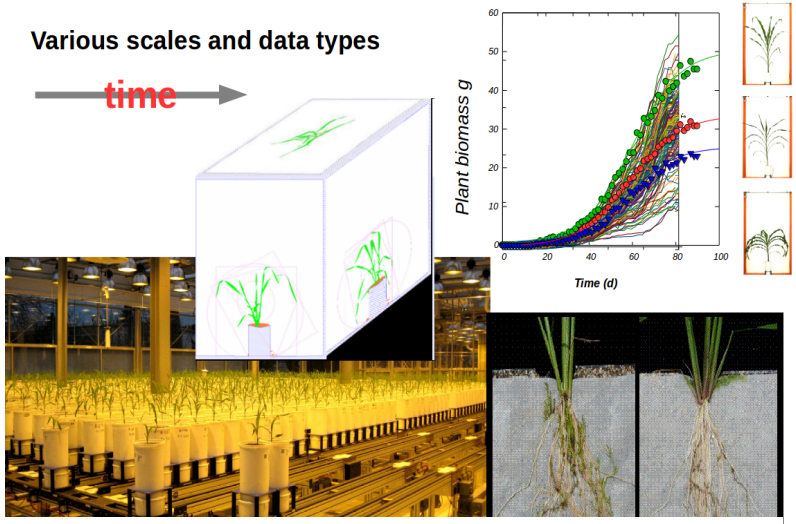
Composition and the structure of biopolymers

Quantification of metabolites and enzyme activities



Green house Platforms

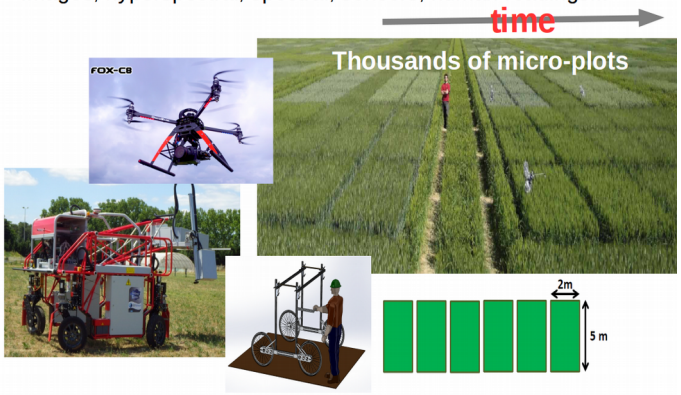
Various scales and data types



Field Platforms

Various scales and data types

- Cell, organ, plant, population
- Images, hyperspectral, spectral, sensors, human readings...

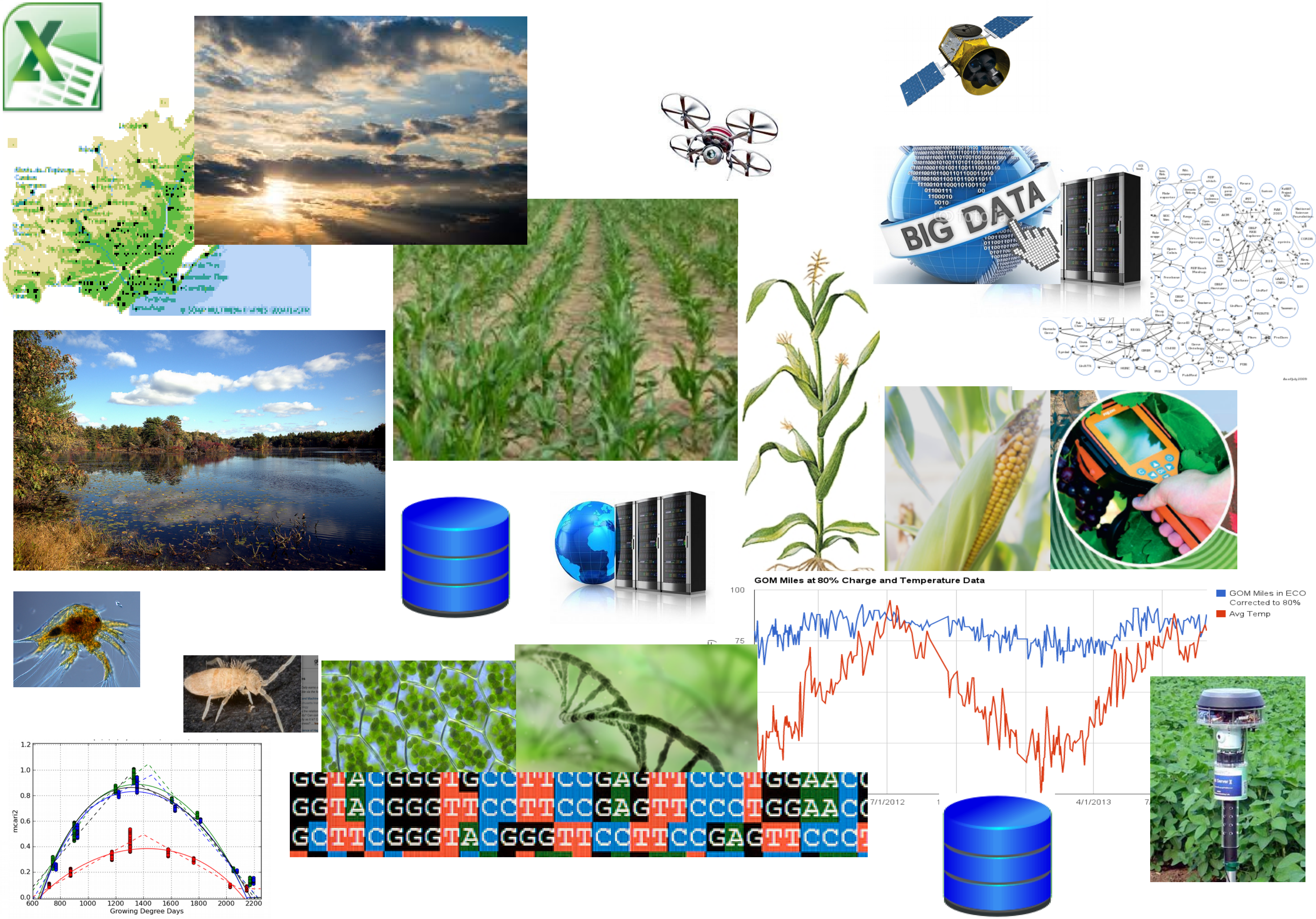


Farm Platforms

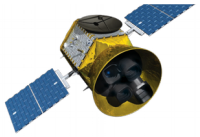
Various scales and data types from thousands of farms

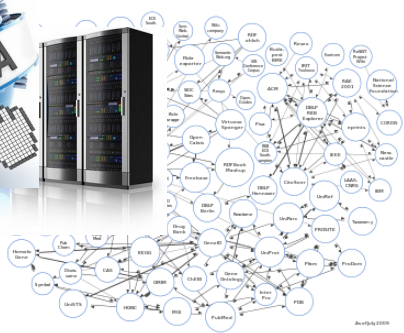
- organ, plant, population, site
- Images, sensors, human readings...

Phenomics Data

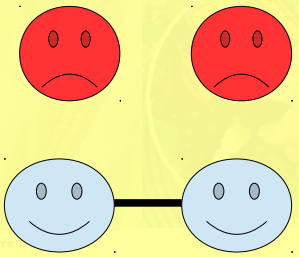


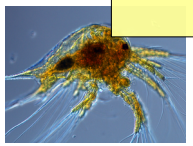
Phenomics Data

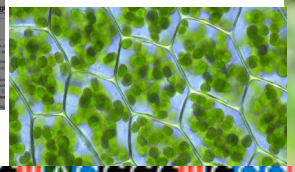


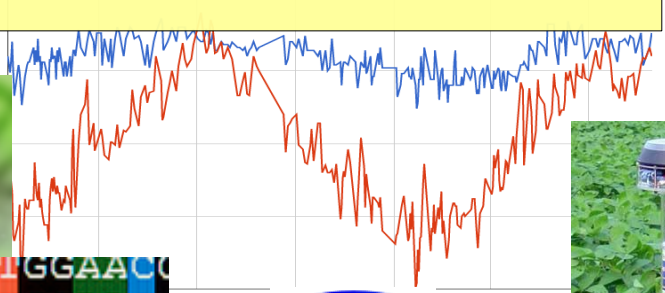


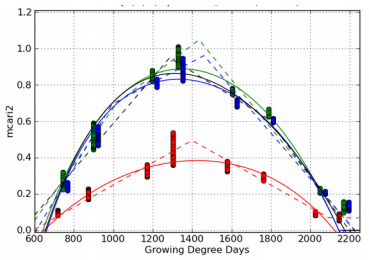
- **Orphan data → Worthless!**
- **Data have value if they are grouped**











Phenomics Data

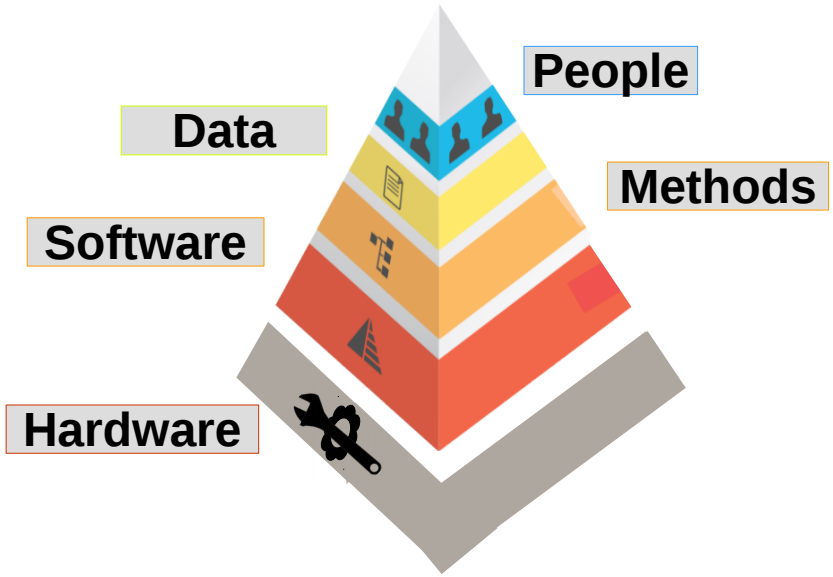
How to structure data ?

OpenSILEX

OpenSILEX is an Open source software set

- Methods, tools, components to implement information systems for experimental data in agriculture and environment

→ for organisation, collection, structuration, storage, exchange and treatment of information



OpenSILEX - PHIS

- **PHIS is an instance of OpenSILEX**

- **Designed for data management in phenotyping platforms**
  - Management of huge, complex and heterogeneous data (millions of images, sensor data, from different sites, etc)

- **Implement good practices of data management**
  - Make FAIR data
  - Flexible
  - Ability to understand and reproduce data processing
  - Ability to enforce DMP and Open Science

OpenSilex approach

Scientific objects (plant, plant organ, plot, etc.) are:

- Identified by **URI** standardized, unambiguous, shared, etc

Events (management, faults, meteo, etc)

- Identified by **URI**

- **Organisation and linking → objects and events with a controlled s**emantic (Ontology) such as a context specific **application Ontologies (RDF*, OWL*)** and allows to link **reference ontologies (SKOS*)**

Measurements, Documents, Observations, Metadata are associated with these Objects and Events

* Semantic Web languages

OpenSILEX–PHIS Identification

URI: string used to identify a resource (Web standardized syntax)

→ **Standardized, unambiguous**

`http://www.phis.inra.fr/path/identifier`

`Persitence and dereferencing (ePIC B2HANDLE)`

Possible use of prefix

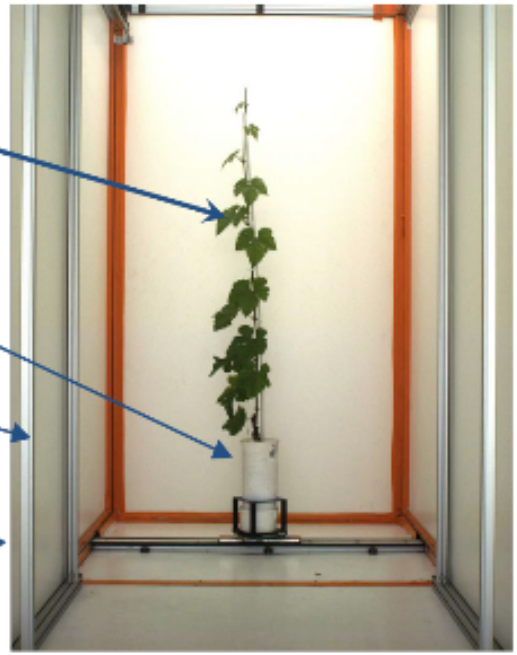
URI of plant :
mp3:arch/2014/pl/000000012

URI of pot :
mp3:arch/2001/pt/000001542

URI of cabin :
mp3:arch/2010/ca/cabine2

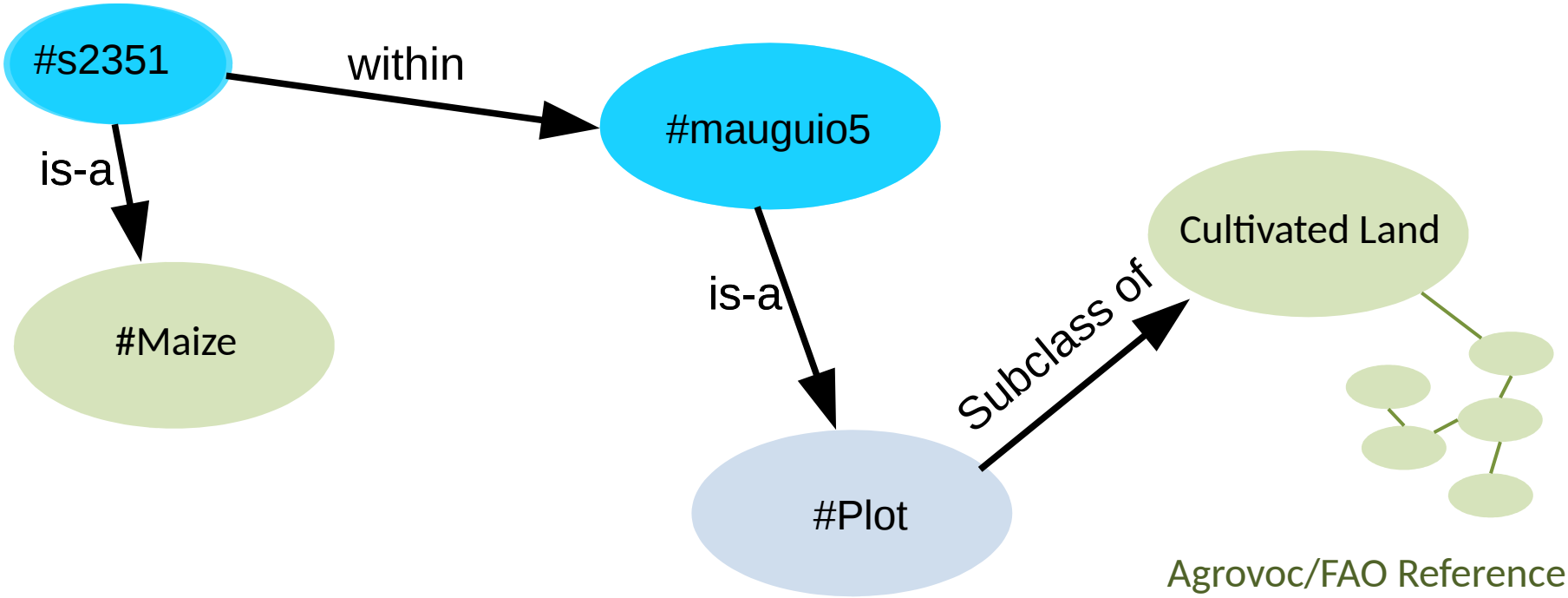
URI of camera :
mp3:arch/2011/ss/00003312

URI of image :
mp3:arch/2015/im/000000564



OpenSILEX - PHIS

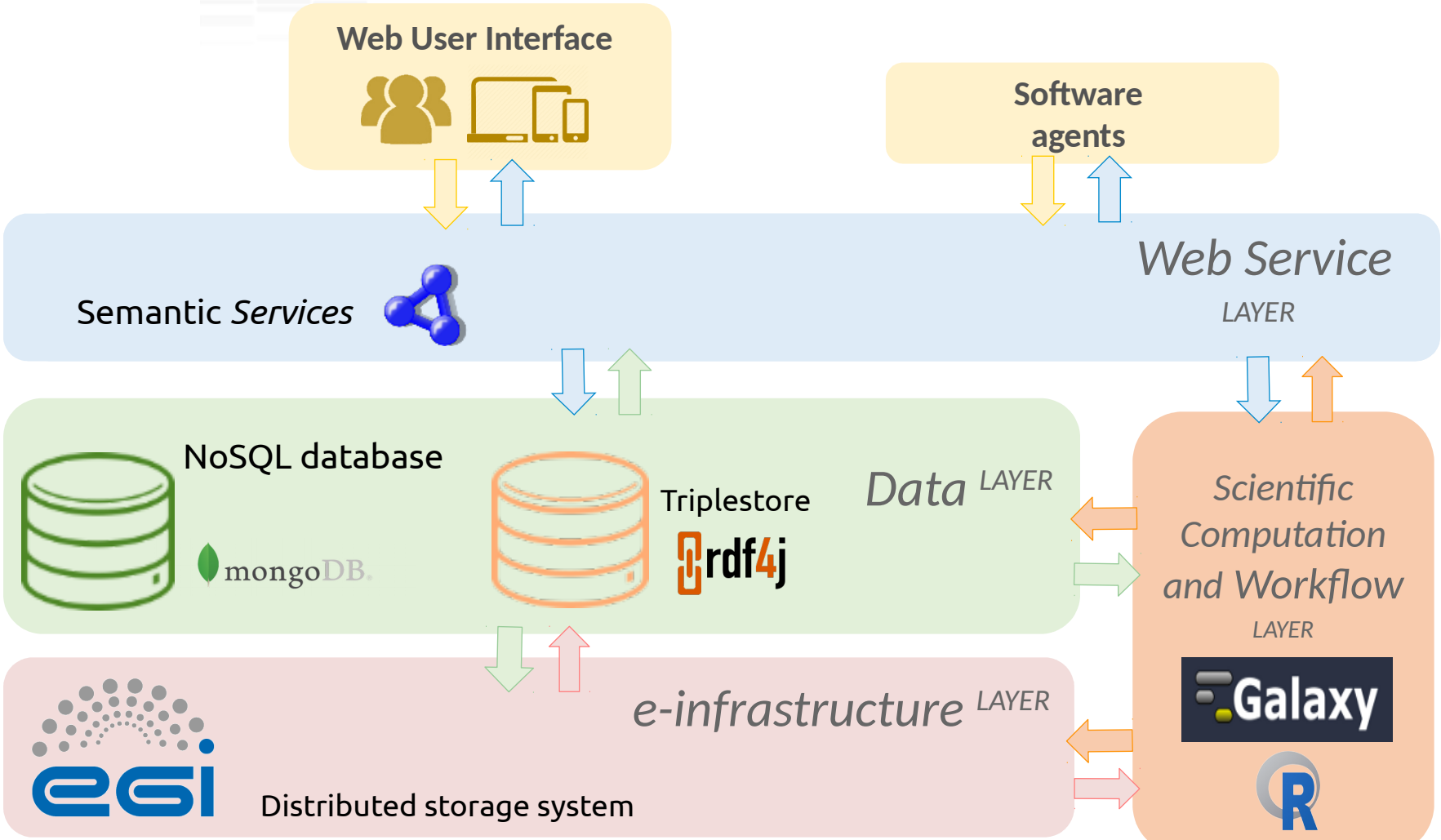
- Metadata / ontologies provide the meaning of data
  → Link each data element to a controlled, shared, vocabulary and **machine readable** vocabulary



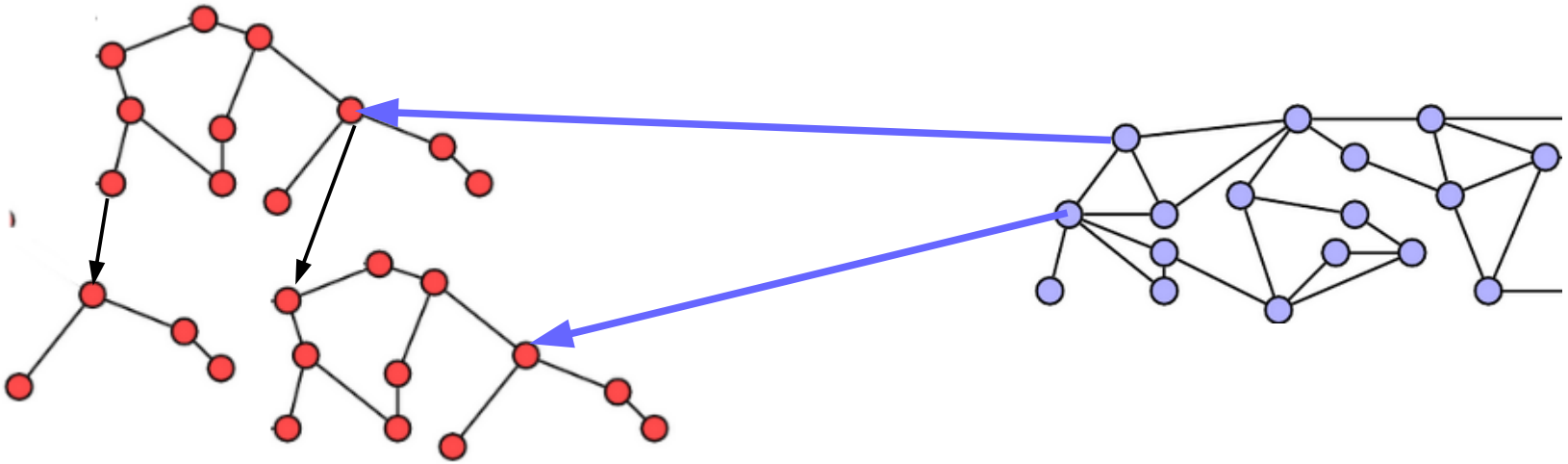
OpenSILEX - PHIS

- Main technologies
  - Semantic Web → semantic interoperability, complexity and metadata
  - NOSQL for storage large data (spatial features)
  - Web Services for data access and data publication
  - R interfaces for data visualisation and data analytics

OpenSILEX - PHIS



OpenSILEX - PHIS



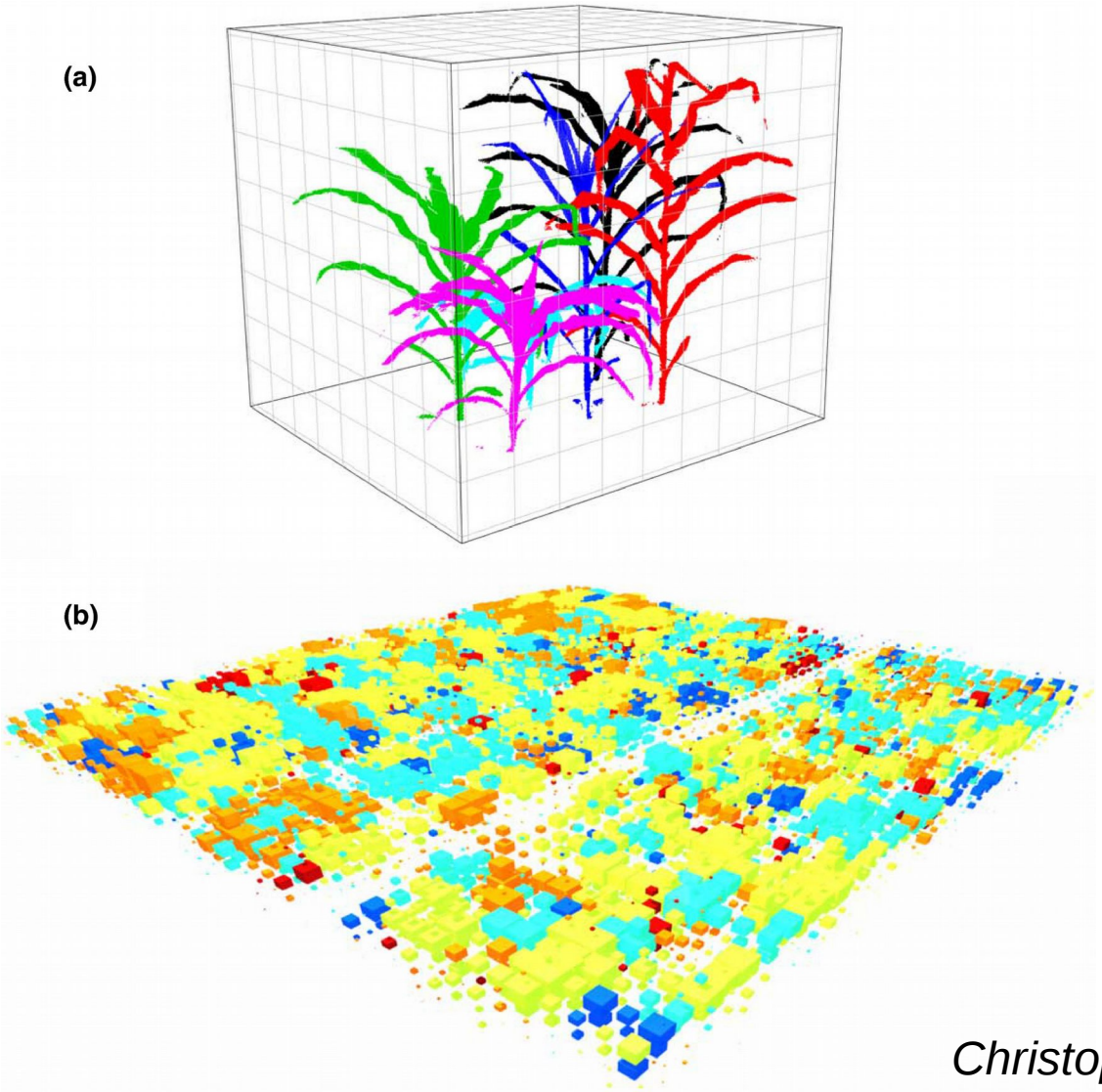
Reference ontologies

Application ontologies

Published in AgroPortal

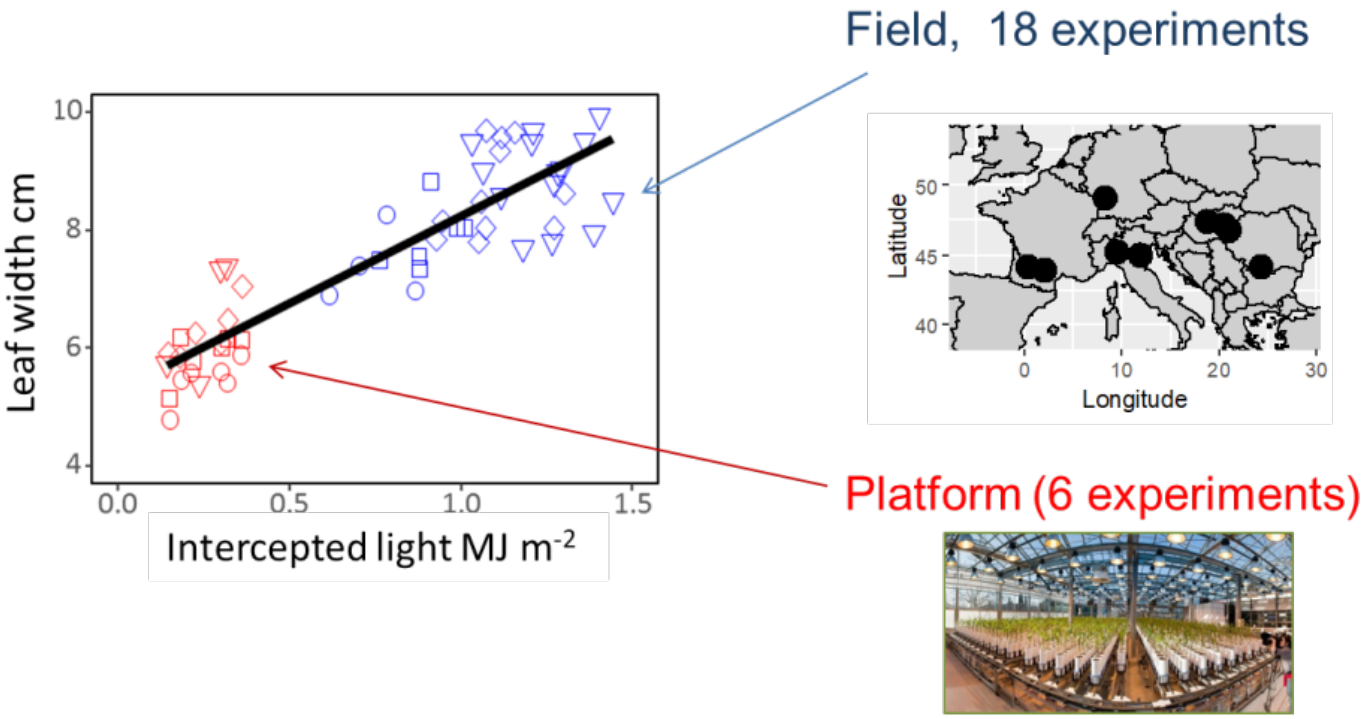
Knowledge Discovery Illustration

PHIS provides contextualisation: intercepted light value



Christophe Pradal

Knowledge Discovery Illustration

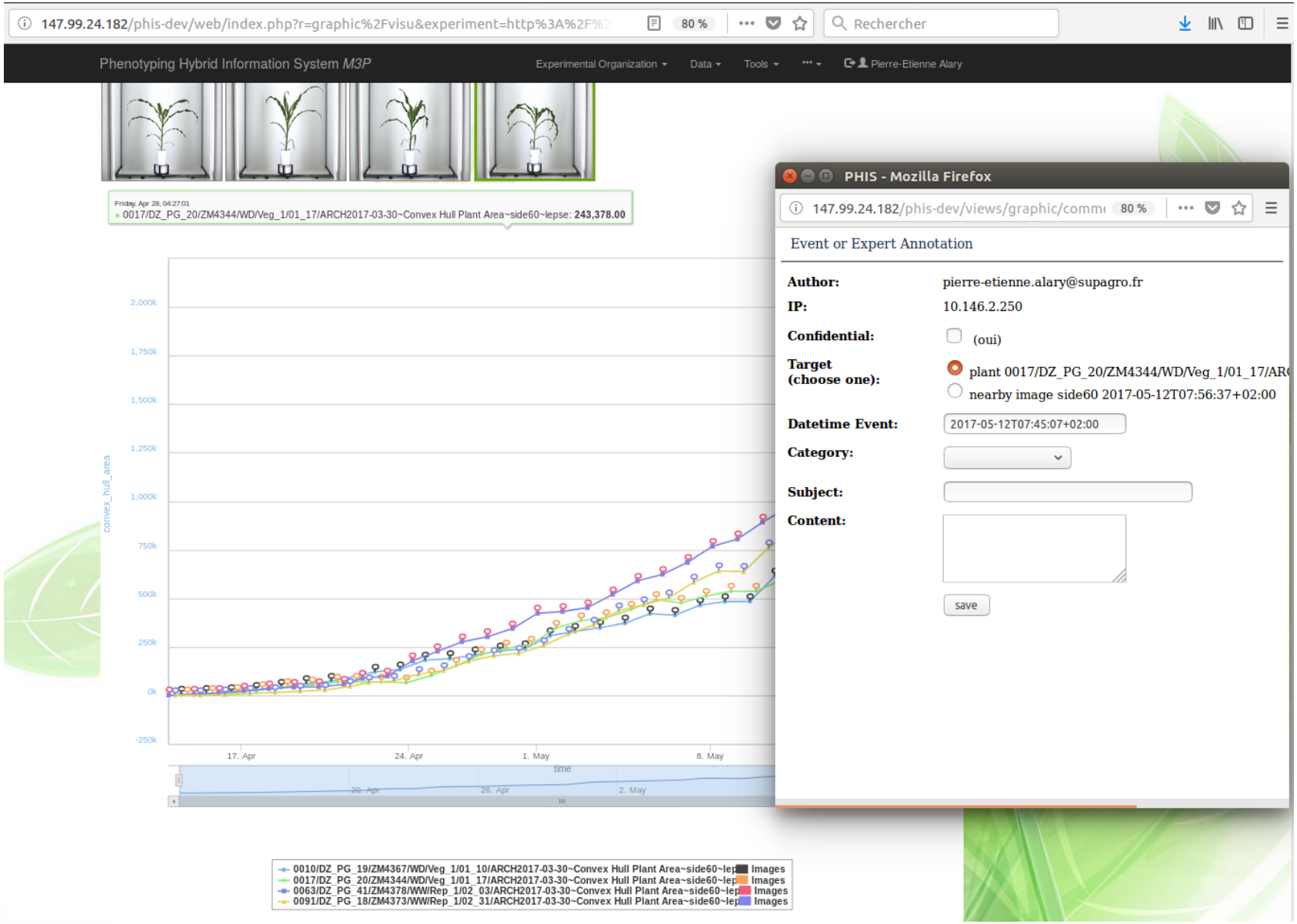


A common relationship between leaf width and intercepted light per plant accounted for variations in width between fields, and for the difference between field and greenhouse

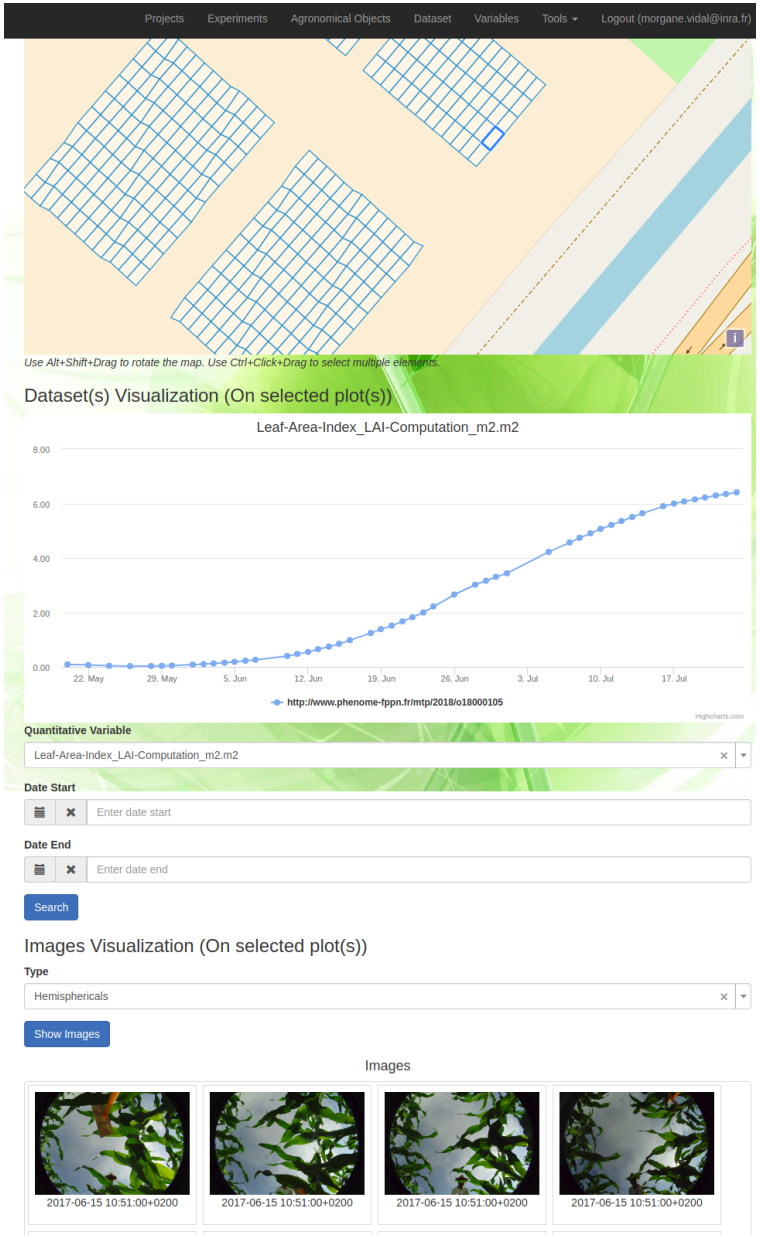
OpenSILEX

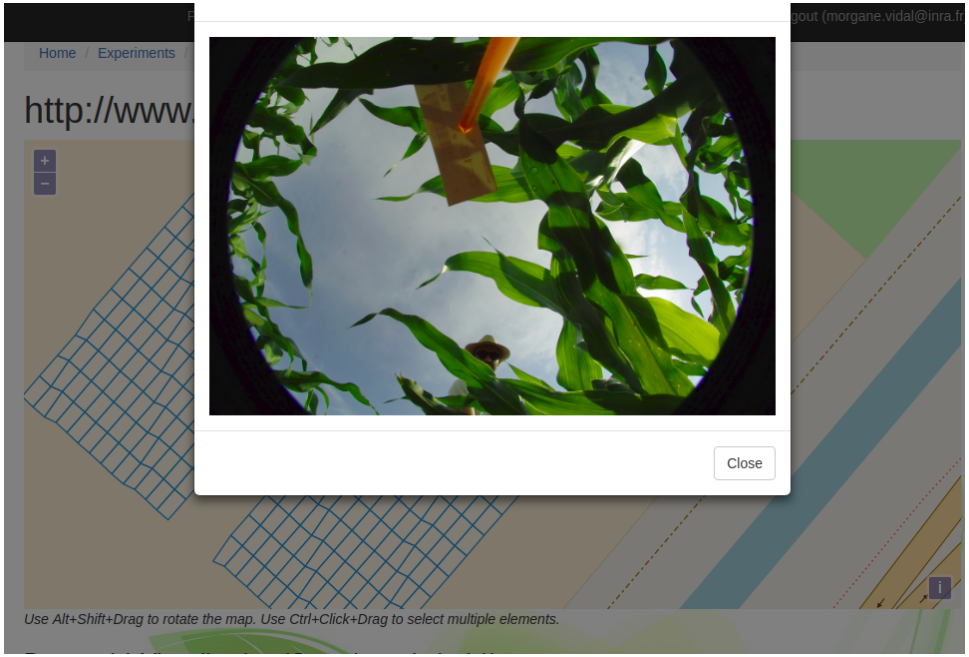
- ✔ **Allows management of huge and complex data**
- ✔ **Enables and facilitates cloud computing (data center, EGI)**
  - → **distributed computing, distributed storage, backup**
- ✔ **Free software and Open technologies**
- ✔ **International identification (URI and DOI)**
- ✔ **Semantic management (ontologies, standardized vocabularies)**
- ✔ **Provenance and reproducibility for data processing**
- ✔ **Flexible design**
- ✔ **5 instances of PHIS for various installations (field and greenhouse)**
- ✔ **Phenoarch instance → Over 300 Tb of data +10 plant species**
- ✔ **+ 2 instances (WEIS, SunAGRI) + WUR, CIRAD, Univ of Tokyo**
- ✔ MISTEA team: support and development, startup ?

PHIS
Event annotation



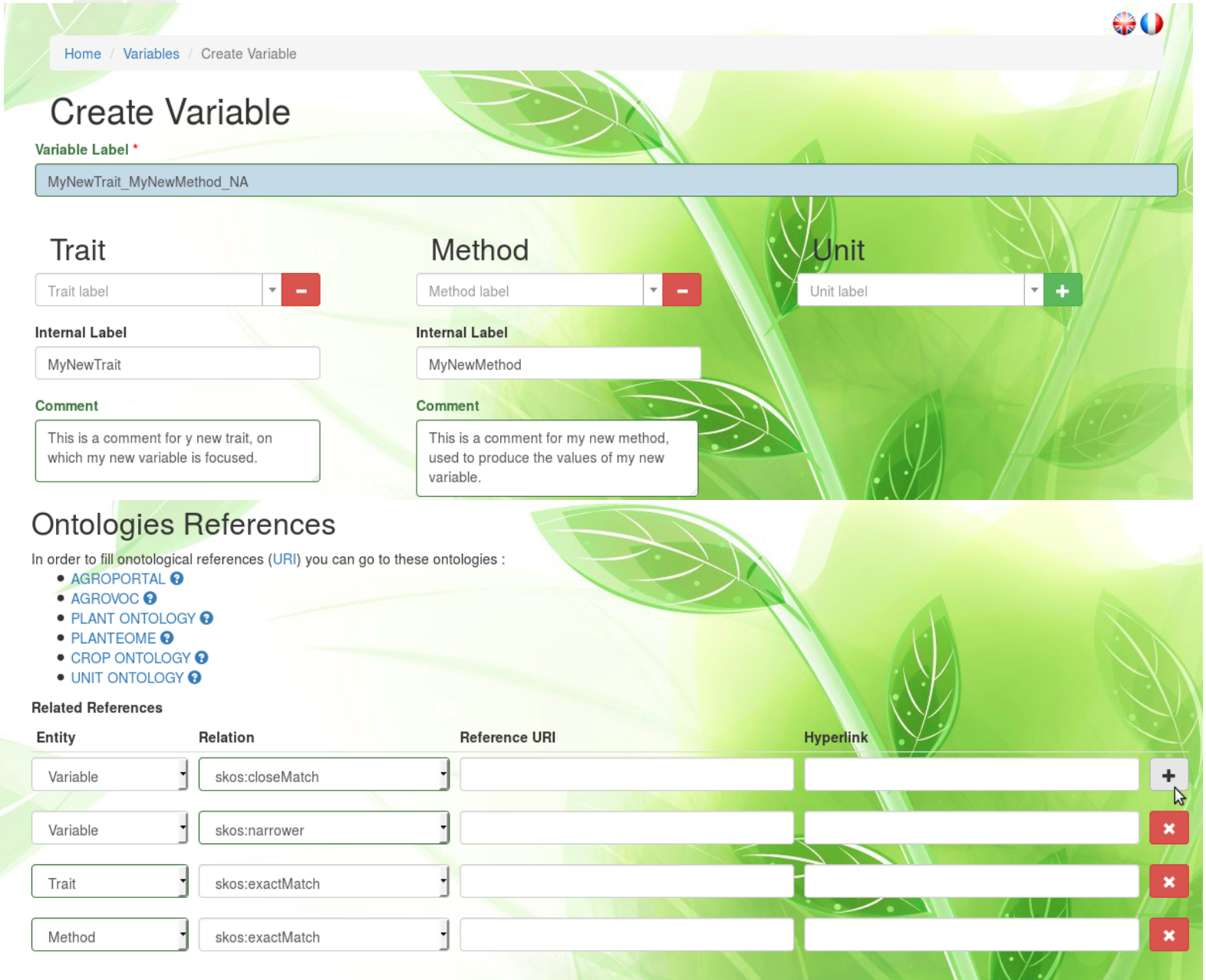
Trait – Images links





PHIS

Variable management and interoperability



PHIS
Workflow management

Home / Currents Tasks / Clean plant height using default

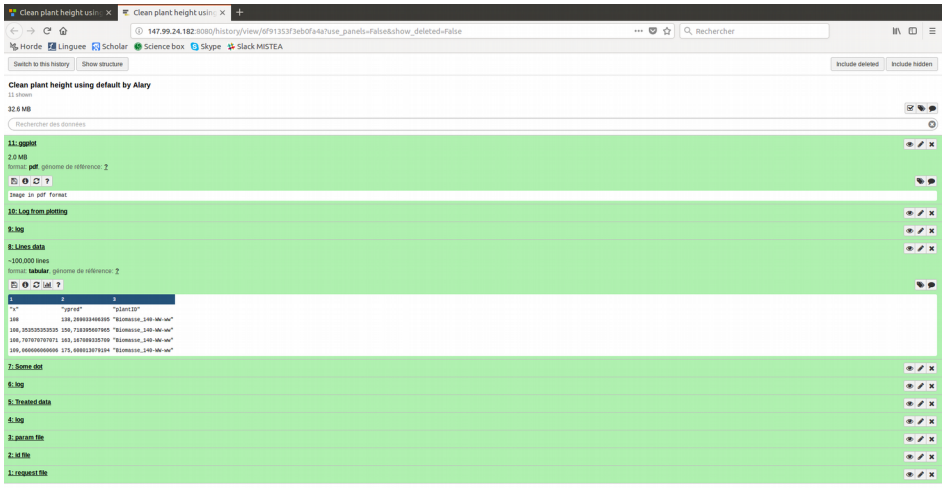
Clean plant height using default

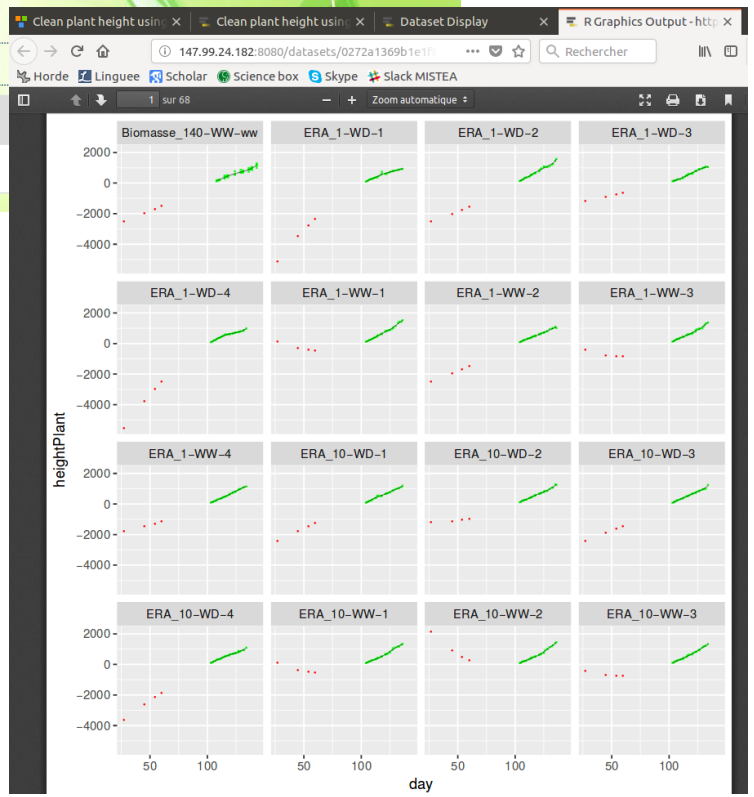
Workflow name	Clean plant height using default
Start	09-01-2018 13:53
End	09-01-2018 14:29

Open in Galaxy

Technical details

Invocation ID	40876639881ca029
History Id	6f91353f3eb0fa4a





OpenSILEX

- **PHIS** demonstration
  - http://phis.inra.fr/ Or http://www.opensilex.org/opensilex/web/
    Research paper:
    https://nph.onlinelibrary.wiley.com/doi/full/10.1111/nph.15385

- How to contribute to OpenSILEX?
  - Github repository: https://github.com/OpenSILEX/
  - Developer documentation: https://opensilex.github.io/docs-community-dev/

- User documentation of the version in development:
  - https://opensilex.github.io/phis-docs-community/

OpenSILEX

- ✔ **Allows management of huge and complex data**
- ✔ **Enables and facilitates cloud computing (data center, EGI)**
  - → **distributed computing, distributed storage, backup**
- ✔ **Open technologies**
- ✔ **International identification (URI and DOI)**
- ✔ **Semantic management (ontologies, standardized vocabularies)**
- ✔ **Portal interoperability and Open technologies**
- ✔ **Provenance and reproducibility for data processing**
- ✔ **Flexible design**
- ✔ **5 instances of PHIS for various installations (field and greenhouse)**
- ✔ **Phenoarch instance → Over 300 Tb of data over 10 plant species**
- ✔ **+ 2 instances (WEIS, SunAGRI)**
- ✔ MISTEA team: support and development, startup ?

Conclusion

OpenSILEX

- **Ensures and makes easy data findability and data access**
- **Provides description frame and an organisation**
- **Recommends and implements standards,**
- **makes easier data interoperability**
- **Provides data publication frame**