Enabling data exchange between SiriusQuality2 and PHIS information system through ICASA and AgMIP data standards and Tools

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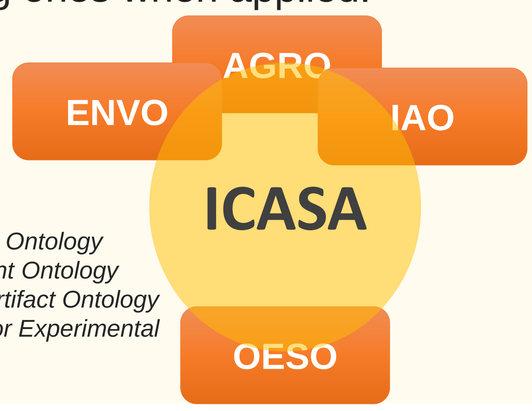
Context

In recent years, plant phenomics has generated unprecedented datasets including hundreds of genotypes tested in a number of environmental scenarios and crop management practices, which can be used to test novel mechanisms and models. However, integration of these datasets into crop models is challenging, since every model use different data formats and granularities. Therefore, adopting open standards becomes necessary. The ontology-driven information system for plant phenomics PHIS (Neveu *et al*. 2019) offers a suitable framework for organizing multi-source and multi-scale datasets whilst keeping flexibility and data interoperability following the FAIR principles (Wilkinson *et al*. 2016). Here we propose a two-way data exchange framework enabling data interoperability between crop growth models and PHIS using the ICASA Master Variables List (ICASA-MVL; White *et al*. 2013) and the AgMIP data standards and data translator tools (Porter *et al*. 2014).

Methods

Step 1

- An ICASA ontology was defined for incorporating terms and concepts listed in the ICASA-MVL V2 (White *et al.* 2013).
- The new ontology was inserted into PHIS and terms were matched with existing ones when applied.



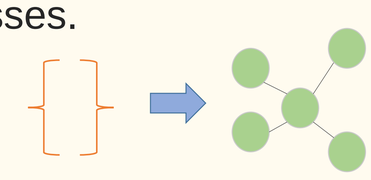
***AGRO**: Agronomy Ontology*
***ENVO**: Environment Ontology*
***IAO**: Information Artifact Ontology*
***OESO**: Ontology for Experimental Scientific Objects*

Step 2

- A simplified and flexible version of the AgMIP translator Excel spreadsheet was used to transform experimental data into a JSON AgMIP file.

Step 3

- JSON files were then scanned based on a **data mapping model** to extract specific subsets (e.g. experiments, management) and implicit relationships and classes.



DATA MAPPING MODEL

Classes:

experiment = (‘oeso:Experiment’, ‘$experiments[*]’)

Data Properties:

label = (experiment, ‘rdfs:label’, ‘$experiments[*].exname’)

Implicit Classes:

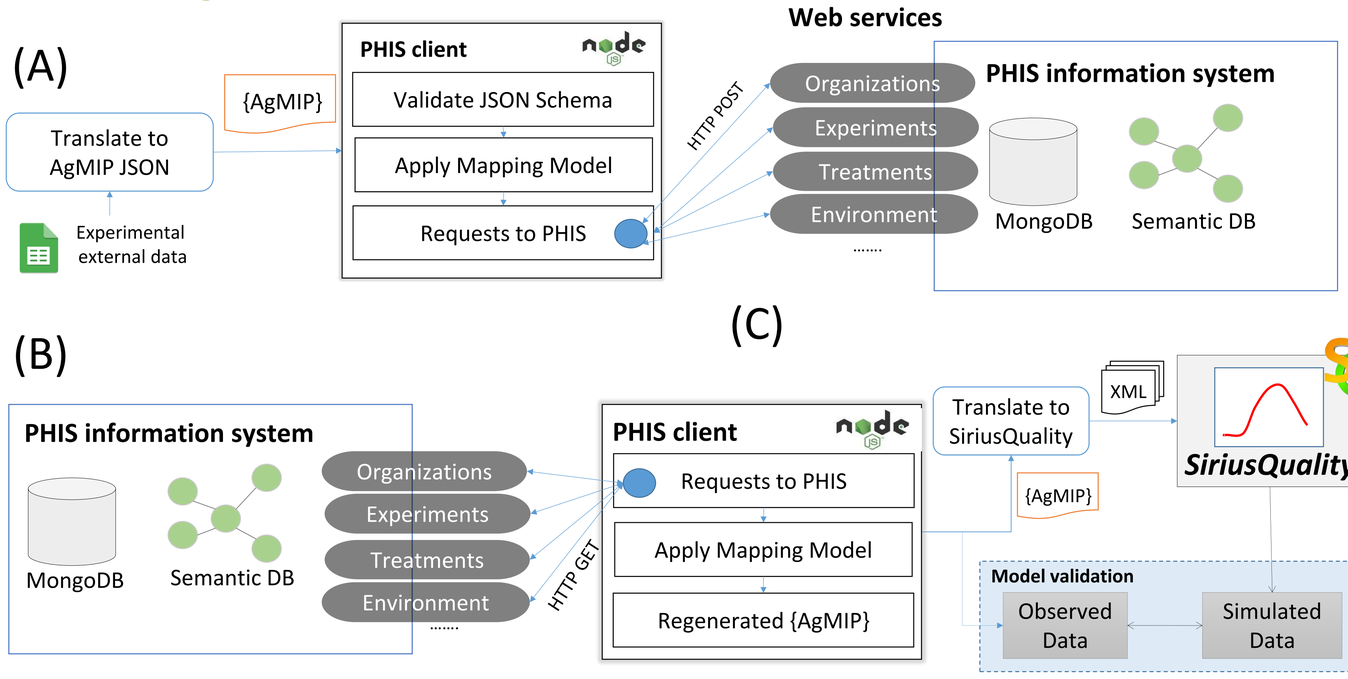
organization=(‘oeso:Organization’, ‘$experiment[*]’, ‘$experiment[*].institution’)

Object Properties:

participatesIn= (‘ro:participatesIn’, organization, experiment)

Results & Discussion

System Architecture:



Following the previous schema, formatted experimental data was unified and harmonized in PHIS using the available web services (Fig. 1A). Insertion process required several requests to keep PHIS data dependencies.

Inversely, following the same mapping model, experimental data was retrieved from PHIS and re-formatted into the JSON AgMIP format (Fig. 1B).

Specific and observed data was then used in the crop model SiriusQuality (Martre *et al*. 2006) to run simulations and assessing the performance of model simulations (Fig. 1C) using the appropriate Translator.

Conclusions

The methods presented here based on the ICASA-AgMIP data standards and the open source PHIS information system provide a framework for storing and organizing experimental following FAIR principles. This was exemplified by facilitating data exchange between PHIS and *SiriusQuality* crop model. The flexible schema proposed here can easily be extended to any crop model for which an AgMIP-JSON translator exist.

Martre *et al*. 2006. *European Journal of Agronomy*, 25:138-154.
Neveu *et al*. 2019. *New Phytologist*, 221:588-601.
Porter *et al*. 2014. *Environmental Modelling & Software*, 62:495-508
White et al. 2013. *Computers and Electronics in Agriculture*, 96:1-12.
Wilkinson *et al*. 2016. Scientific Data 3:160018.

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