



A Knowledge Graph for Data Management in Farming, Agriculture, and Climate

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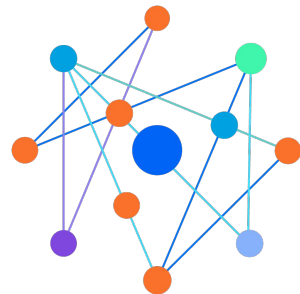


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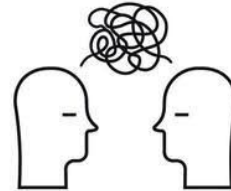
Introduction



Farmers' challenges



Difficulty to plan irrigation due to unpredictable climate change



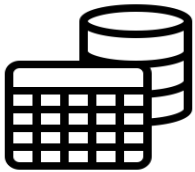
Miscommunication with stakeholders who have limiting agricultural knowledge

Introduction

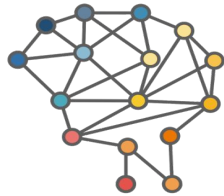
Objective: develop a systematic approach to represent relationship between farm, agriculture and climate and store these data

Solution:

Knowledge Graph



Data



Ontology

“ **'Ontology'** is the term used to refer to the shared understanding of some domain of interest. ”

- *Ontologies: Principles, methods and applications, 1996, Prof. Michael Gruninger*

Introduction

Dataset:

- Canadian Government Climate data: https://climate.weather.gc.ca/index_e.html
- Farm data: geographical coordinates of farm and field polygons

Competency questions to define ontology scope:

- When will the next rainfall first become available to my farm?
- What is the precipitation amount that may impact my field?
- What is the optimal irrigation schedule for my crops?



State-of-the-art Ontologies

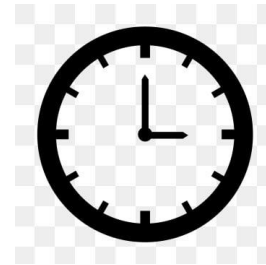
SWEET
(Semantic Web for Earth and
Environmental Terminology)



OSP
(Soil Properties and Processes)



Time



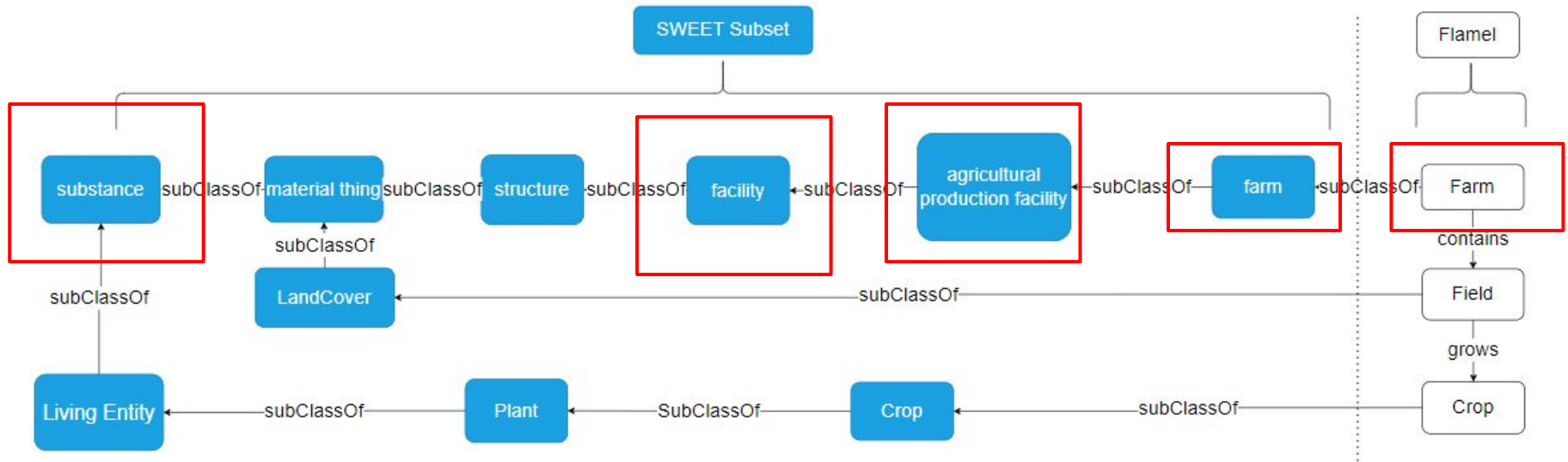
GeoSparql



FLAMEL Ontology

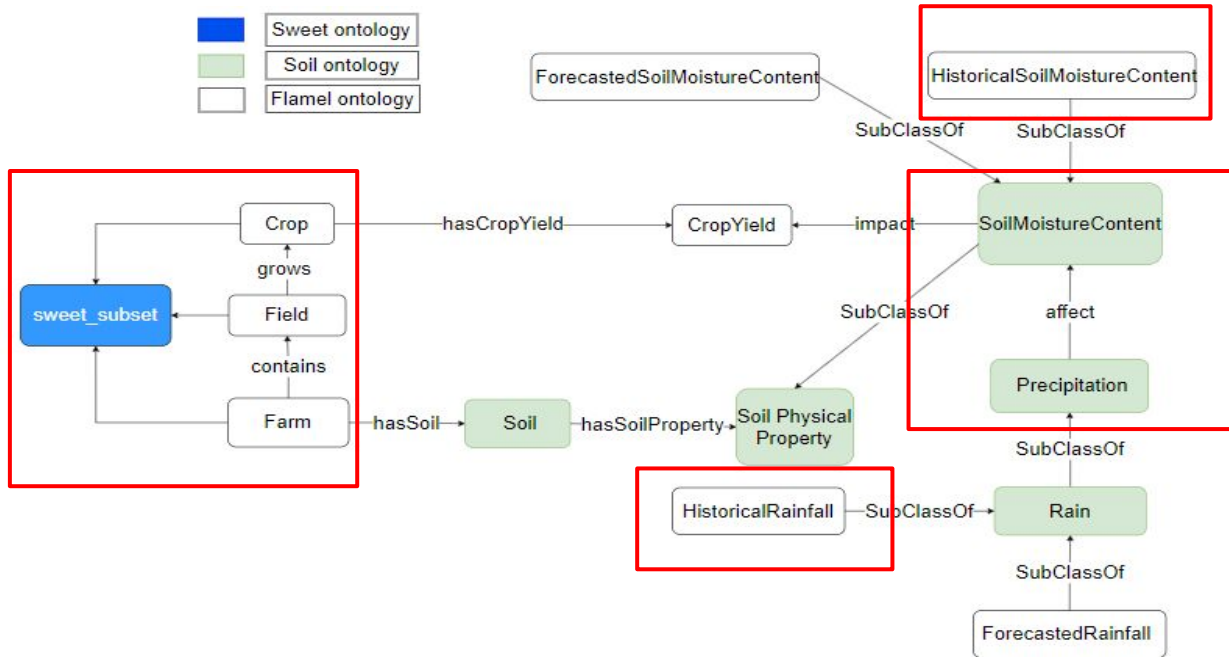
Knowledge Graph Integration

- Step 1: Modularization of the SWEET ontology (10,239 concepts and 359 properties)



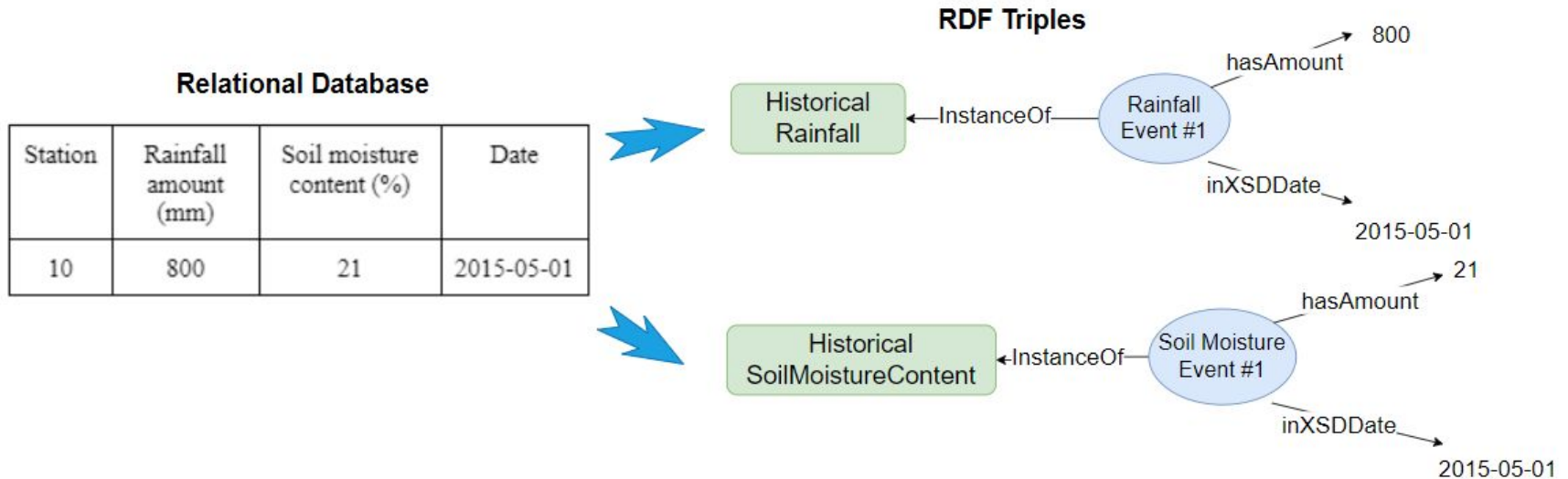
Knowledge Graph Integration

- Step 2: Merge with Other Concepts



Knowledge Graph Integration

- Step 3: Data Integration

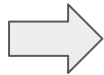


Querying the Knowledge Graph

- SPARQL: standard query language and protocol for Linked Open Data on the web or for RDF triplestores

Example 1: When will the next rainfall first become available to my farm?

```
SELECT ?date ?amount where {
?precipitation flm:affect ?SoilMoistureContent.
?precipitation flm:saturate ?field.
?precipitation flm:hasAmount ?amount.
?precipitation time:inXSDDate ?date
FILTER (?amount > 0.0 && ?date > "2015-05-10"^^xsd:date).}
```



Date
2015-05-15
2015-05-20



Example 2: What is the precipitation amount that will impact my field

```
SELECT * where {
?precipitation flm:saturate flm:field2.
flm:field2 flm:isSpatiallyDefinedBy ?FieldBoundary
?FieldBoundary flm:hasSpatialGeometry ?FieldGeometry
?precipitation flm:isSpatiallyDefinedBy ?PrecipitationBoundary
?PrecipitationBoundary flm:hasSpatialGeometry ?PrecipitationGeometry
?precipitation time:inXSDDate "2015-05-10"^^xsd:date.
filter(geo:ehOverlap(?FieldGeometry, ?PrecipitationGeometry))
}
```



Amount (inches)
30
40

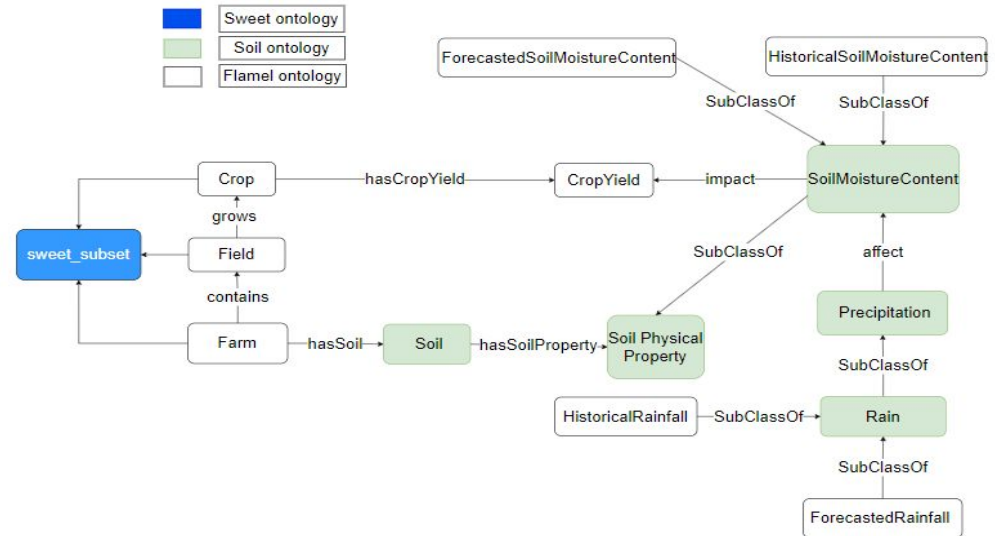
Discussion

- Knowledge graph vs. Relational Database

✔ Semantic Explainability

✔ Flexibility

✘ Data partitioning



Discussion

- Future application:



Financial Industry Business Ontology



Digital Twin



Large Language Model

Conclusion

- The **ontology design** aimed to help farmers and other stakeholders understand Farm, Agriculture and Weather.
- **Modularization of the SWEET ontology** led to a more manageable and efficient structure.
- Competency questions could be queried from knowledge graph by **SPARQL**, demonstrating strengths in semantic explainability and flexibility.
- The methodology presented in this research will continue to apply to different industries and generate great impact to the society.