

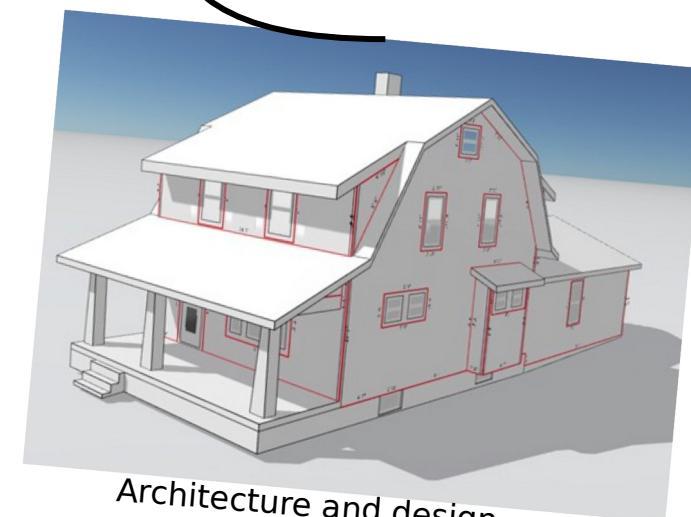
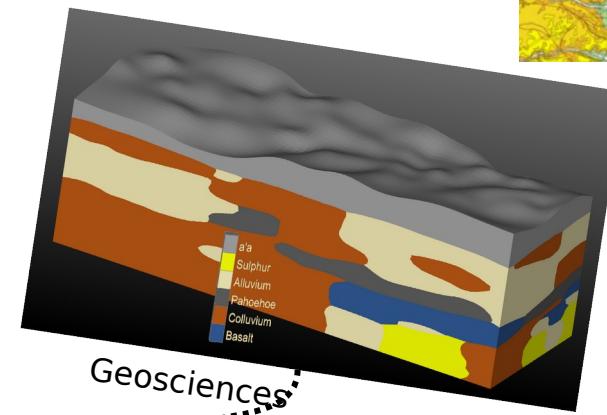
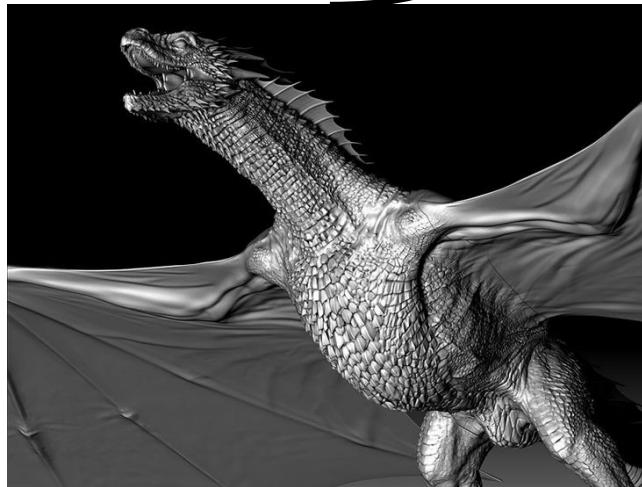
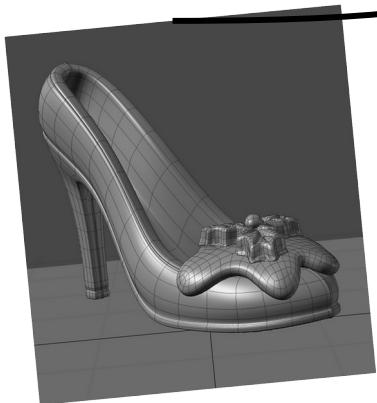
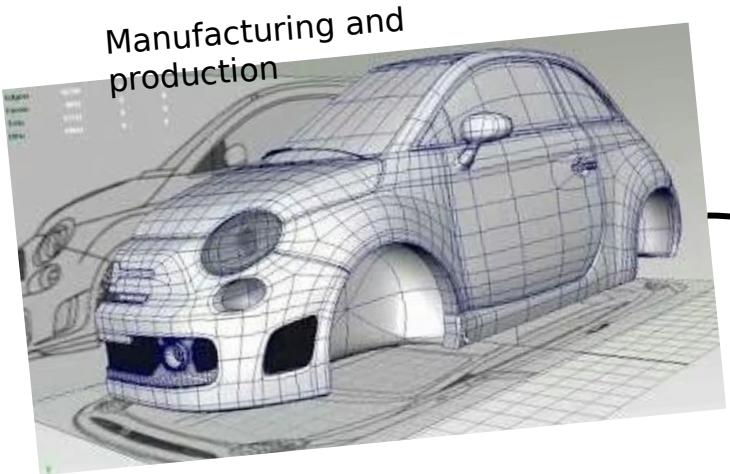
Geological Knowledge Formalization and processes Automation for 3D Reconstruction of Subsoil Architecture

Ontologie, Web Services, Interopérabilité
interdisciplinarité

28/29 November, Tours, France

Imadeddine Laouici

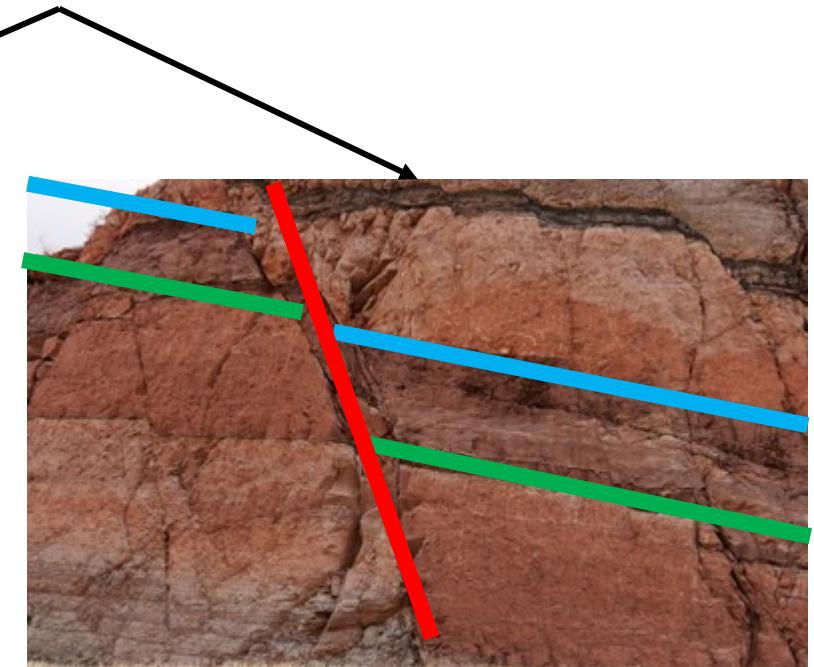
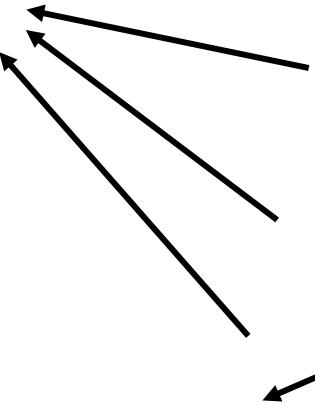
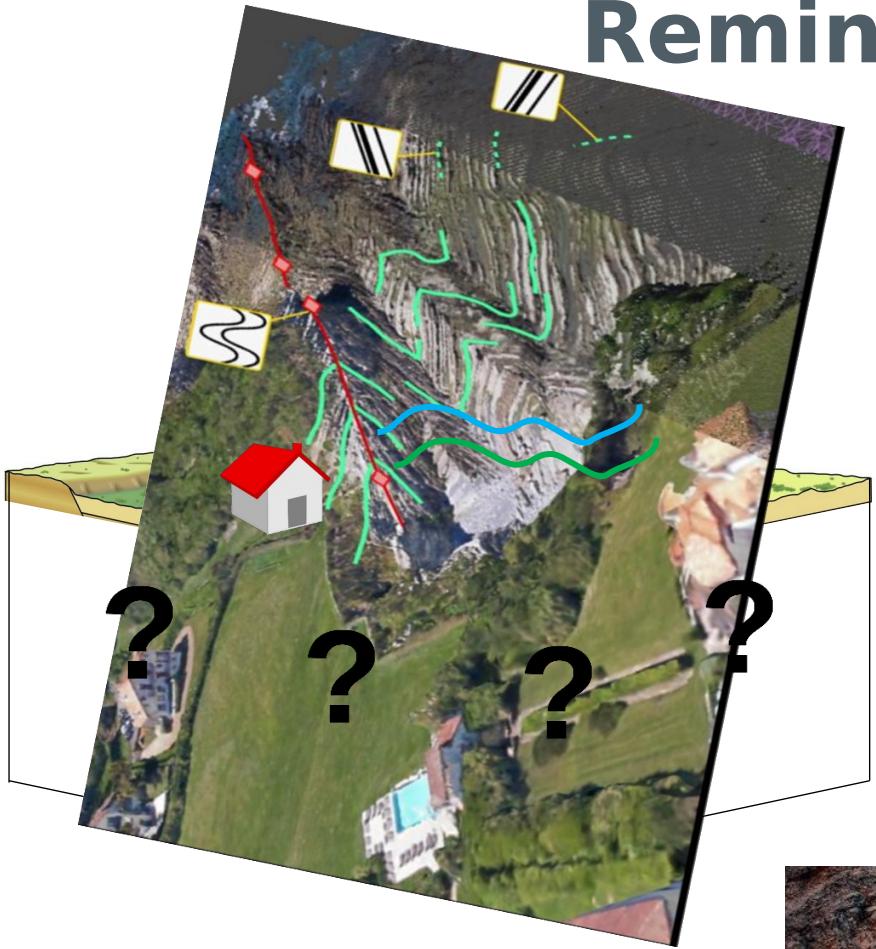
Reminder 3D models



Knowledge & information

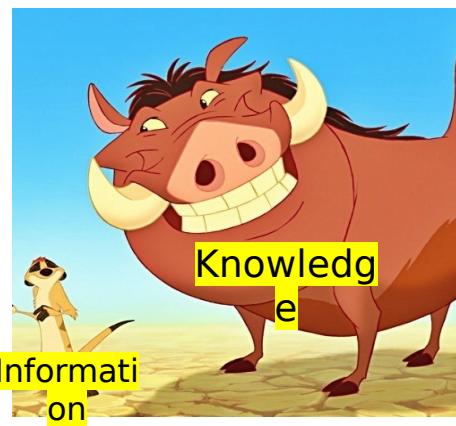
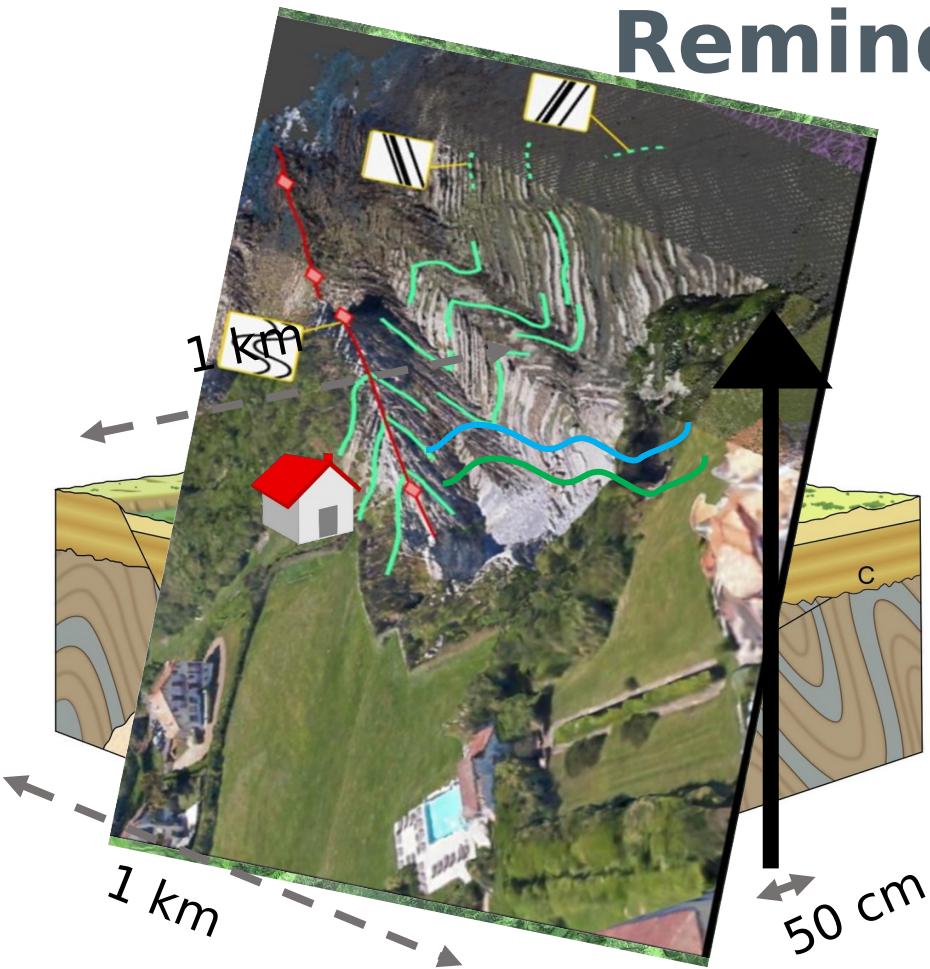


Reminder surface vs sous-sol

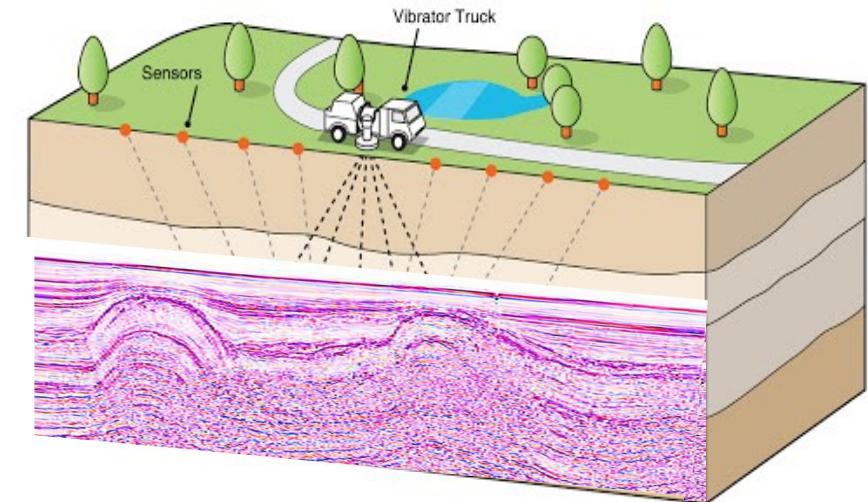




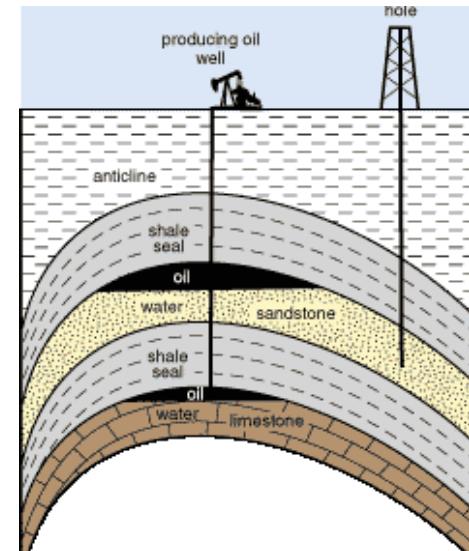
Reminder Subsurface data & information



**Geophysical
exploration**



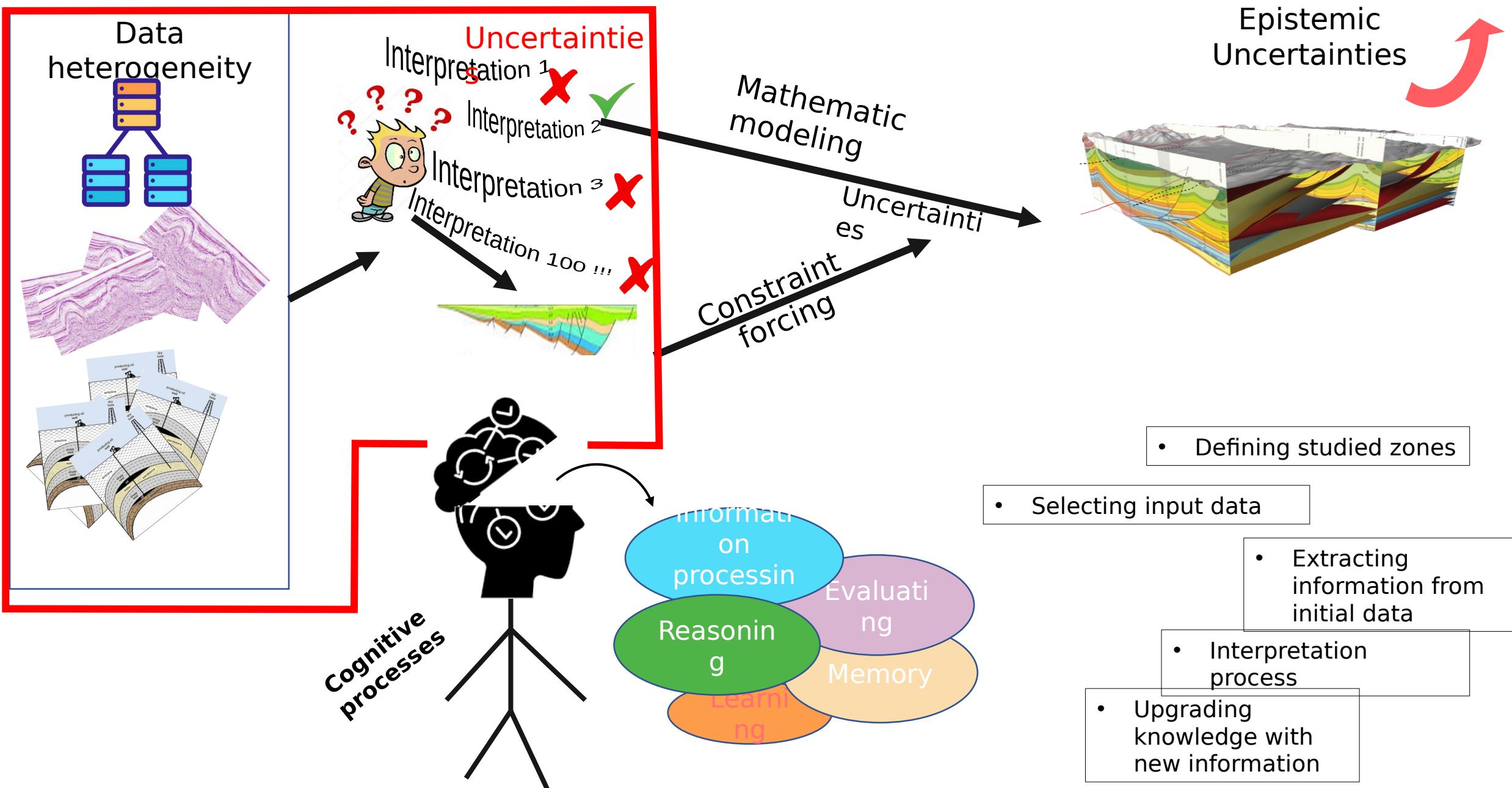
**Drilling
exploration**



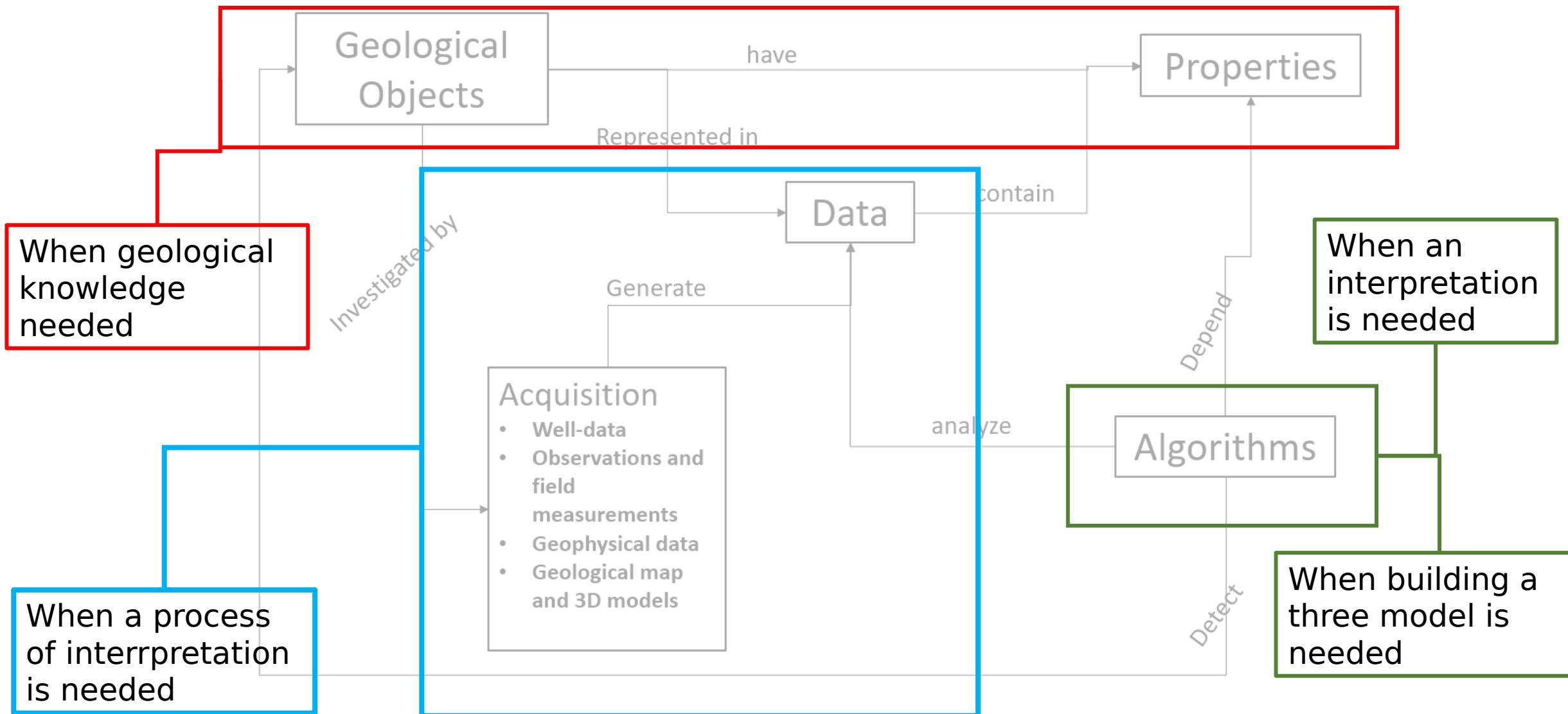
interpretation

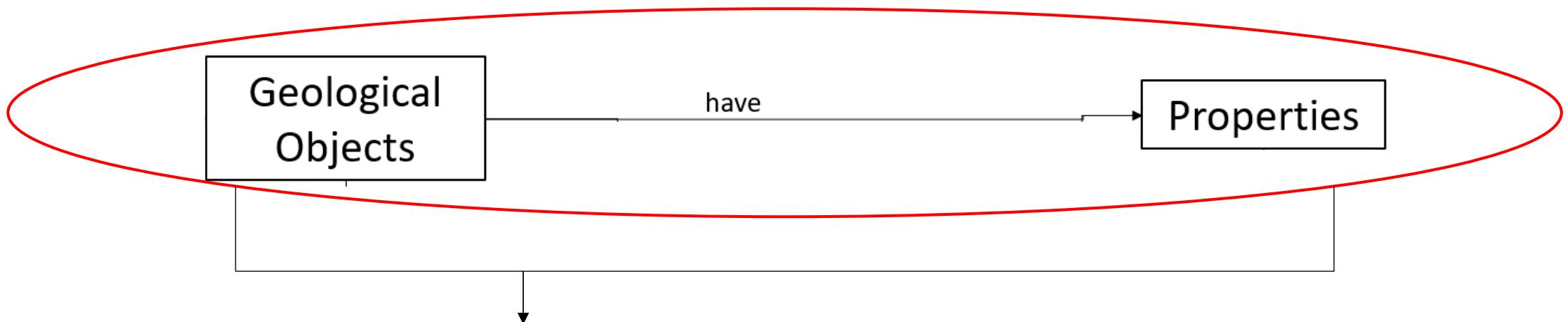


PhD project



Proposed ontological model





GSO Modular Organization LAYERCAKE ONTOLOGY

COMMON (static) after BFO, DOLCE, UFO, other + GSO

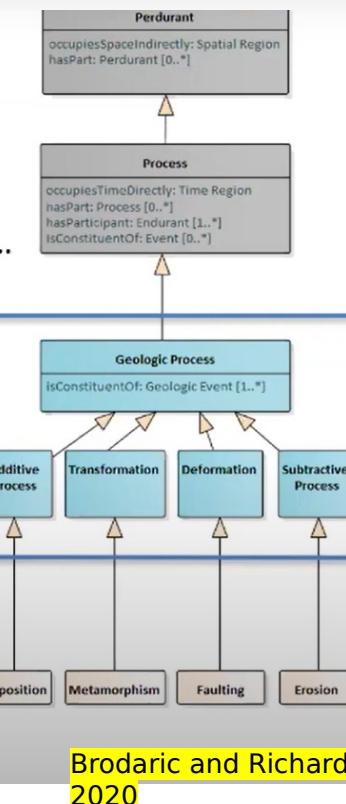
general framework: e.g. object, matter, process, event, quality, space, time,...

GEOLOGY (static) after NADM, GeoSciML, DOLCE Rocks

geology framework: e.g. geologic: unit, structure, event, material,...

MODULES (extensible, exchangeable) after GeoSciML,...

geology modules: e.g. qualities, settings, structures, rock types, minerals, elements, time scales,...

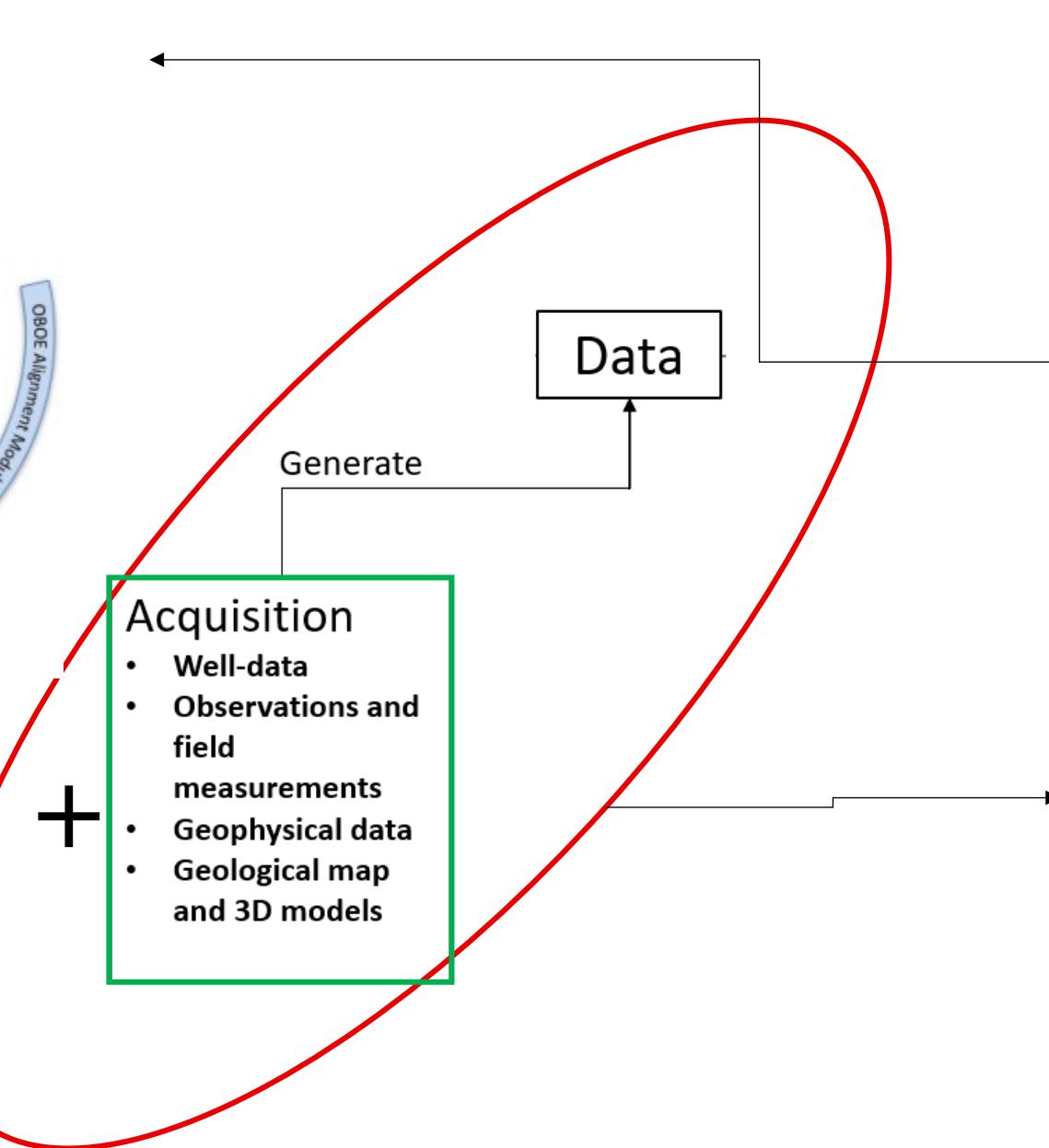
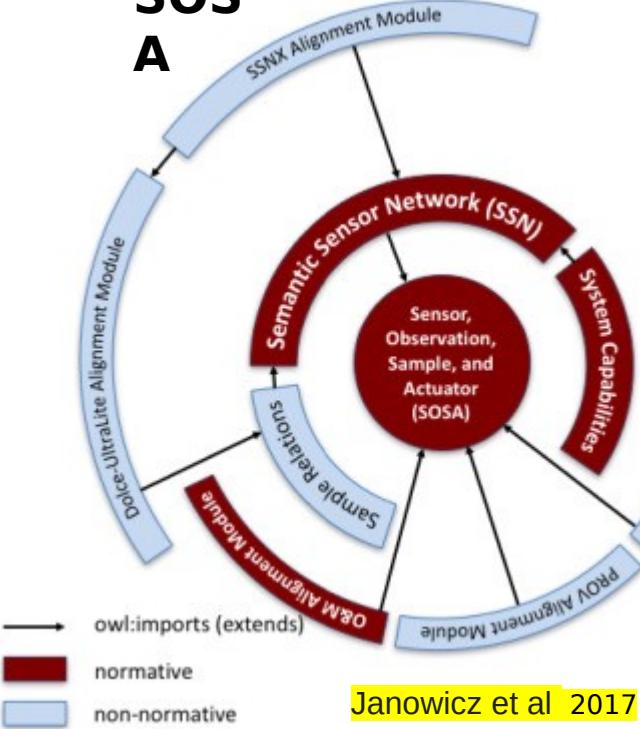


Geometric and topological properties

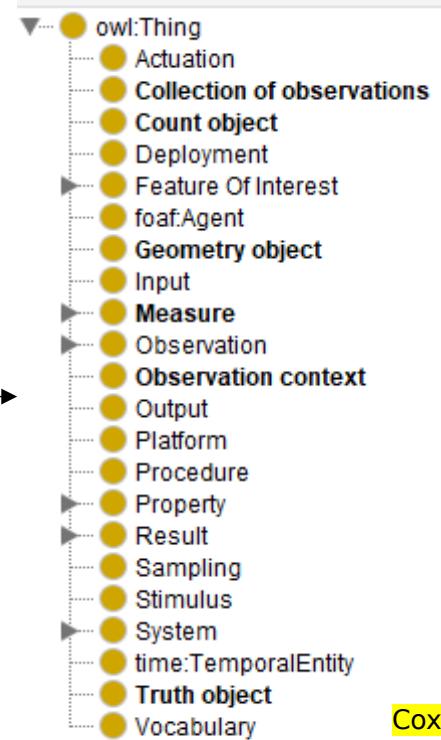
Geologic expression of objects

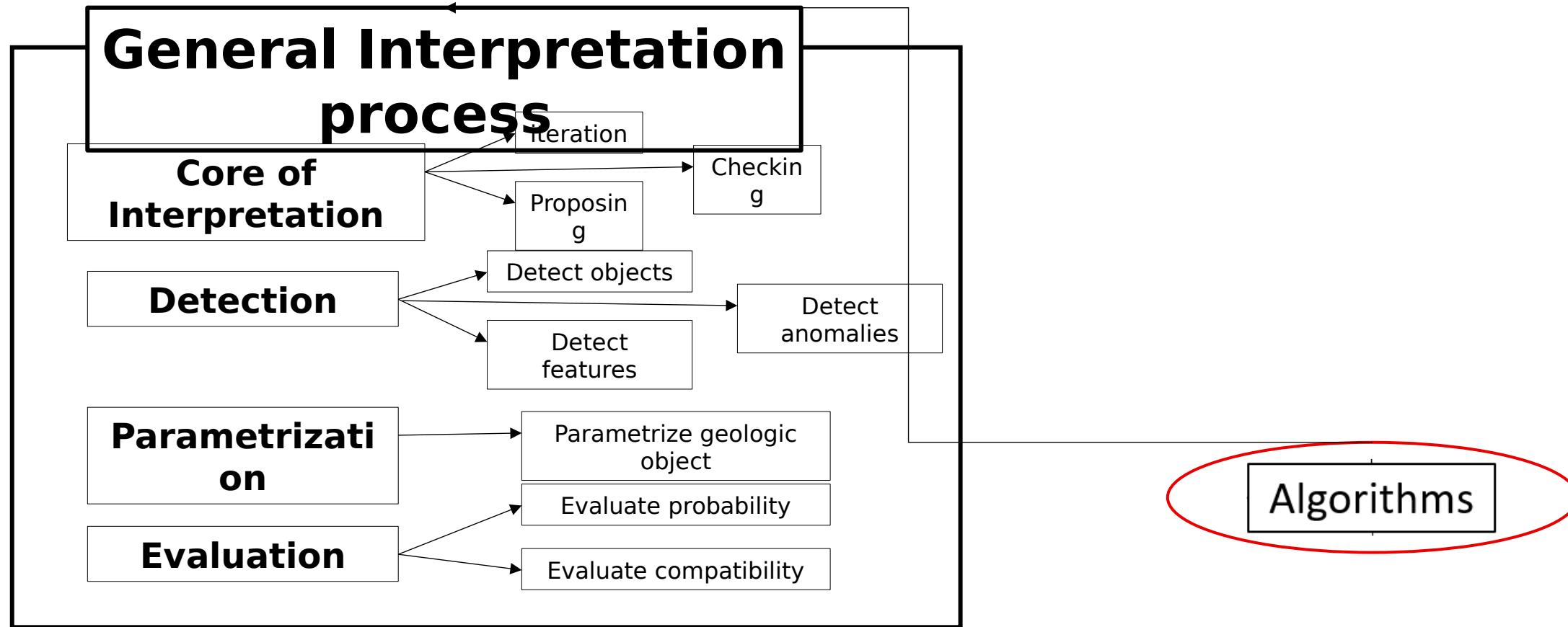
Recognition features of geological objects

SOS

A

OM_lite





VOCABS

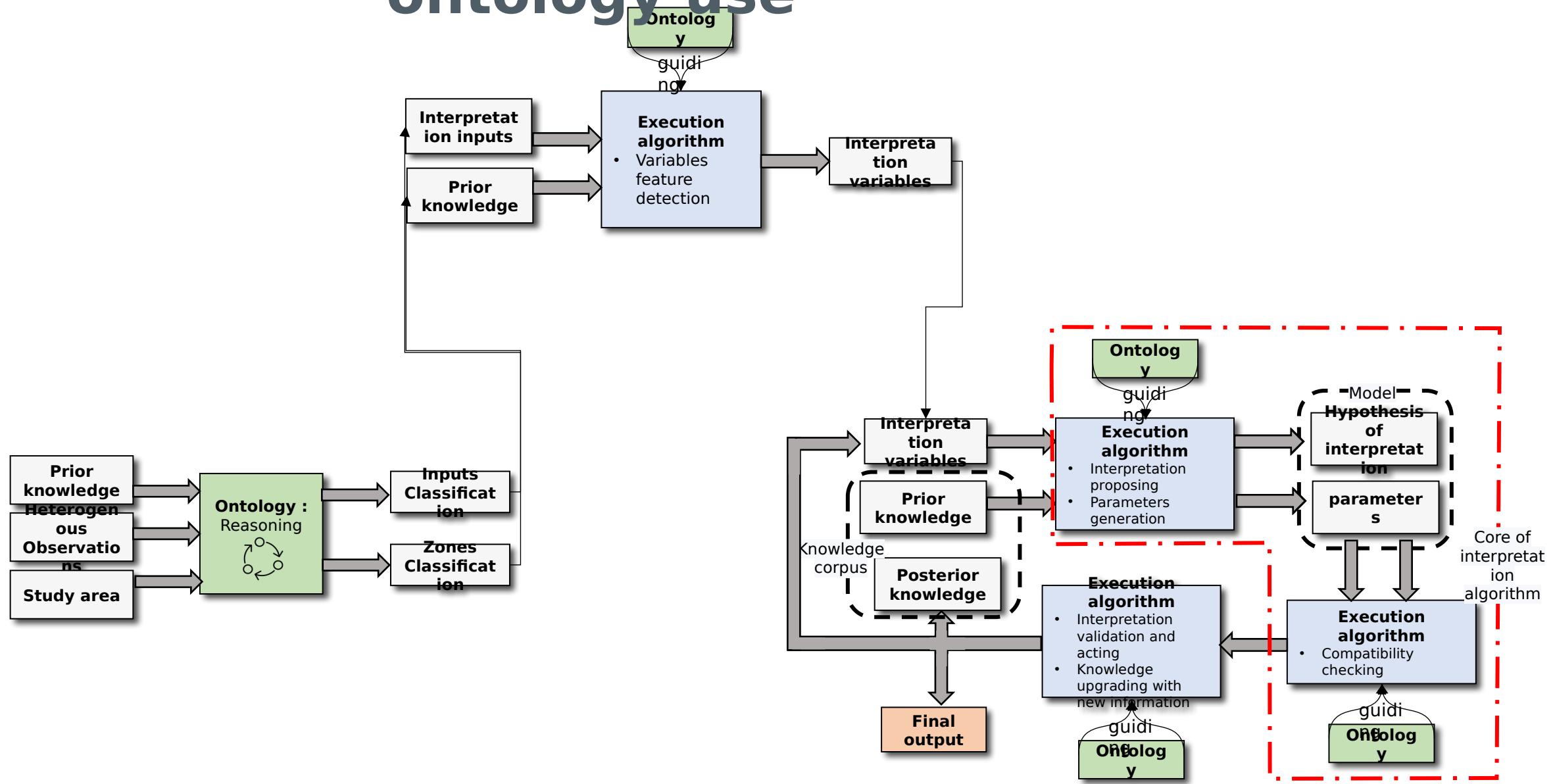
TERMS

AGENTS

SPARQL/DUMP

MEX Algorithm Ontology ([mexalgo](#))

System overview and ontology use





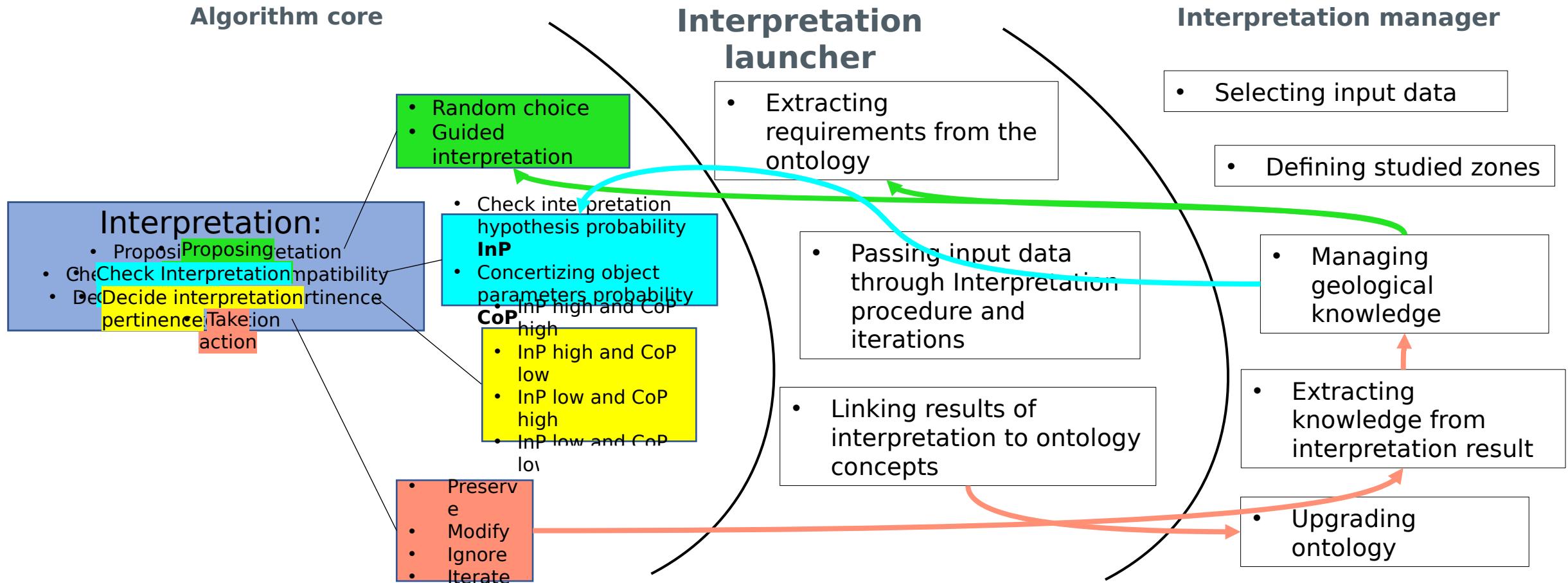
References

- Brodaric, B., & Richard, S. M. (2020, December). The GeoScience Ontology. In *AGU Fall Meeting Abstracts* (Vol. 2020, pp. IN030-07).
 - Janowicz, K., Haller, A., Cox, S. J., Le Phuoc, D., & Lefrançois, M. (2019). SOSA: A lightweight ontology for sensors, observations, samples, and actuators. *Journal of Web Semantics*, 56, 1-10.
 - Cox, S. J. (2017). Ontology for observations and sampling features, with alignments to existing models. *Semantic Web*, 8(3), 453-470.
-

Thank you for attention

- i.laouici@brgm.fr
- Imadeddine.laouici@univ-orleans.fr

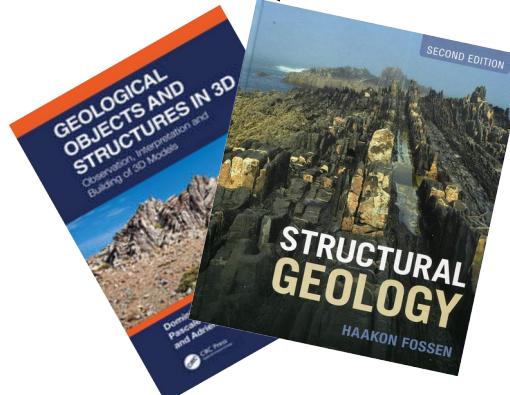
Algorithm architecture



General Overview



Geologica
Knowledge

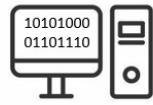


Verbal Communications:

- Courses
- Seminars
- Field work
- Documentary channels ...etc

Written Communication:

- Books
- Scientific papers and journals
- Map legends
- Rapport fin sondage



Geological Model



End-user

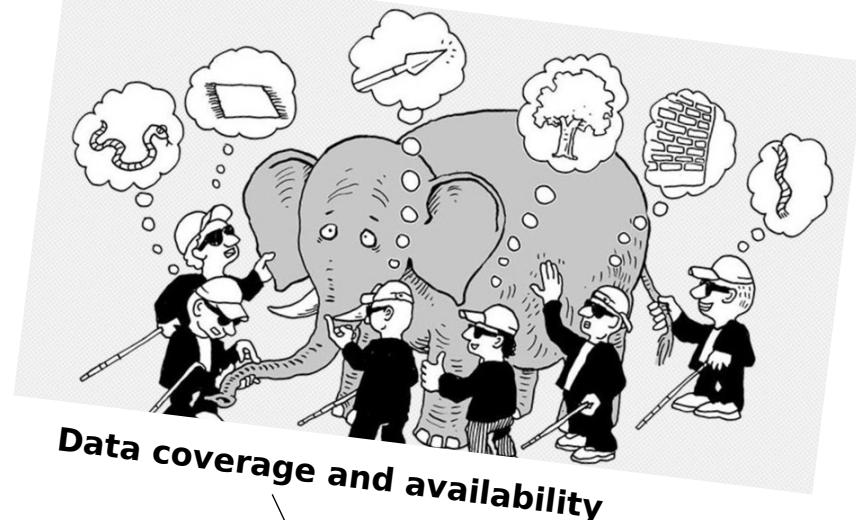
Numeric applications:

- Geomodelling
- Mapping
- Simulations
- NLP

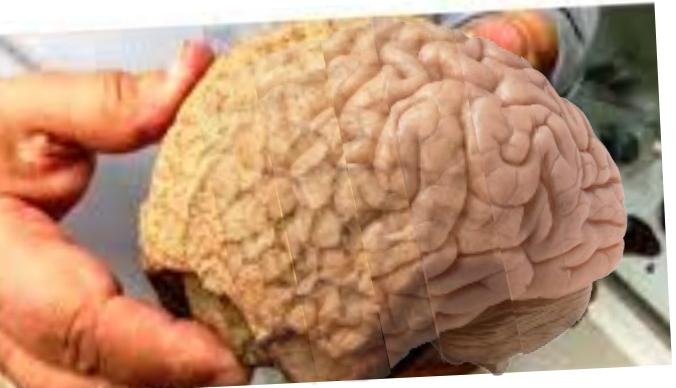
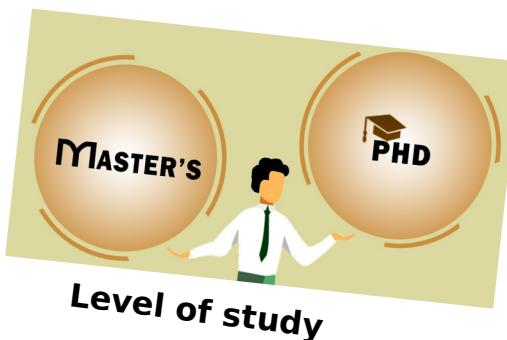
Backup

Bond et al 2012
Wellmann & Caumon 2018

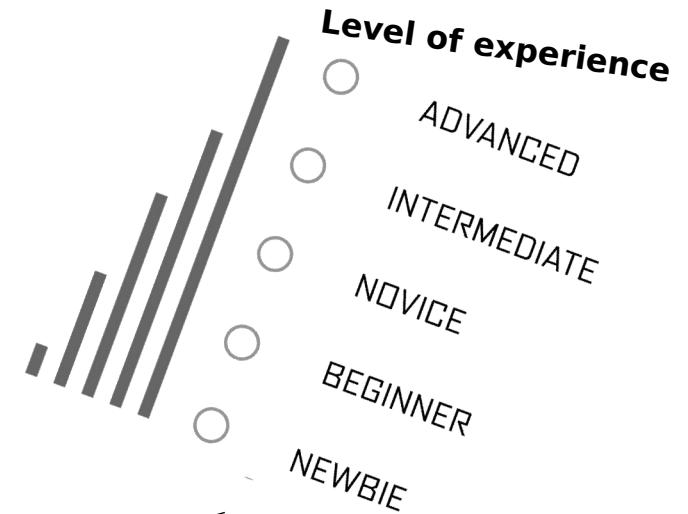
Epistemic uncertainties and interpretations biases



Geological
Knowledge



Mental processes

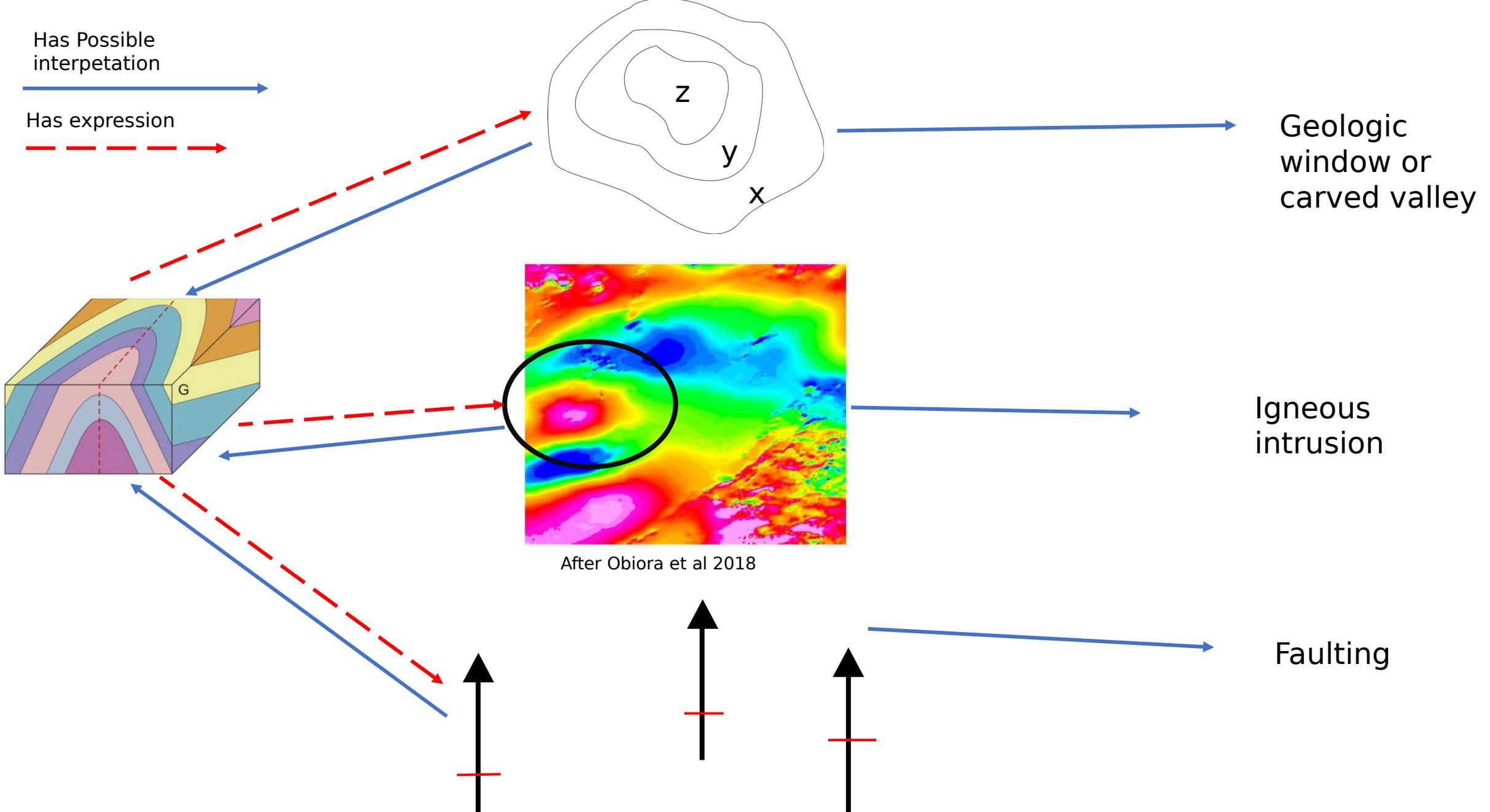


Backup

Object expressions

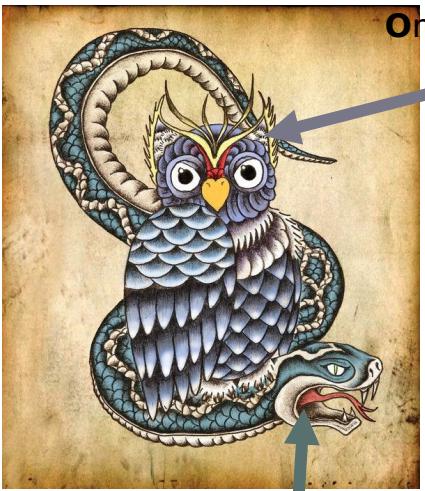
Has Possible interpretation

Has expression



Backup

Ontology implementation and serialization



Python

OWL Ontology Web Language

```
@prefix : <http://www.semanticweb.org/ilaouici/ontologies/2022/6/untilted-ontology-268#> .  
@prefix owl: <http://www.w3.org/2002/07/owl#> .  
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .  
@prefix xml: <http://www.w3.org/XML/1998/namespace> .  
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .  
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .  
@prefix rdf:type <http://www.semanticweb.org/ilaouici/ontologies/2022/6/untilted-ontology-268#> .  
  
##### Data properties #####  
# Data properties  
#####  
## http://www.semanticweb.org/ilaouici/ontologies/2022/6/untilted-ontology-268#date_end  
:date_end rdf:type owl:DatatypeProperty .  
  
## http://www.semanticweb.org/ilaouici/ontologies/2022/6/untilted-ontology-268#date_start  
:date_start rdf:type owl:DatatypeProperty .  
  
##### Classes #####  
# Classes  
#####  
## http://www.semanticweb.org/ilaouici/ontologies/2022/6/untilted-ontology-268#Aeronautics  
:Aeronautics rdf:type owl:Class ;  
    rdfs:subClassOf :Specialty .  
  
## http://www.semanticweb.org/ilaouici/ontologies/2022/6/untilted-ontology-268#City  
:City rdf:type owl:Class ;  
    rdfs:subClassOf :Country .  
  
## http://www.semanticweb.org/ilaouici/ontologies/2022/6/untilted-ontology-268#Conference  
:Conference rdf:type owl:Class ;  
    rdfs:subClassOf :Meeting .  
  
## http://www.semanticweb.org/ilaouici/ontologies/2022/6/untilted-ontology-268#Country  
:Country rdf:type owl:Class ;  
    rdfs:subClassOf :Place .
```

.Turtle

```
<?xml version="1.0"?>  
<rdf:RDF xmlns="http://www.semanticweb.org/ilaouici/ontologies/2022/6/untilted-ontology-268#"  
    xmlns:owl="http://www.semanticweb.org/ilaouici/ontologies/2022/6/untilted-ontology-268"  
    xmlns:rdf="http://www.w3.org/2002/07/owl#"  
    xmlns:xml="http://www.w3.org/1999/02/22-rdf-syntax-ns#"  
    xmlns:xsd="http://www.w3.org/1998/namespace"  
    xmlns:rdfs="http://www.w3.org/2001/XMLSchema#"  
    xmlns:owl:Ontology rdf:about="http://www.semanticweb.org/ilaouici/ontologies/2022/6/untilted-ontology-268"/>  
  
  
// Data properties  
  
owl:DatatypeProperty rdf:about="http://www.semanticweb.org/ilaouici/ontologies/2022/6/untilted-ontology-268#date_end" />  
owl:DatatypeProperty rdf:about="http://www.semanticweb.org/ilaouici/ontologies/2022/6/untilted-ontology-268#date_start" />  
  
  
// Classes  
  
owl:Class rdf:about="http://www.semanticweb.org/ilaouici/ontologies/2022/6/untilted-ontology-268#Aeronautics">  
    <rdfs:subClassOf rdf:resource="http://www.semanticweb.org/ilaouici/ontologies/2022/6/untilted-ontology-268#Specialty"/>  
</owl:Class>
```

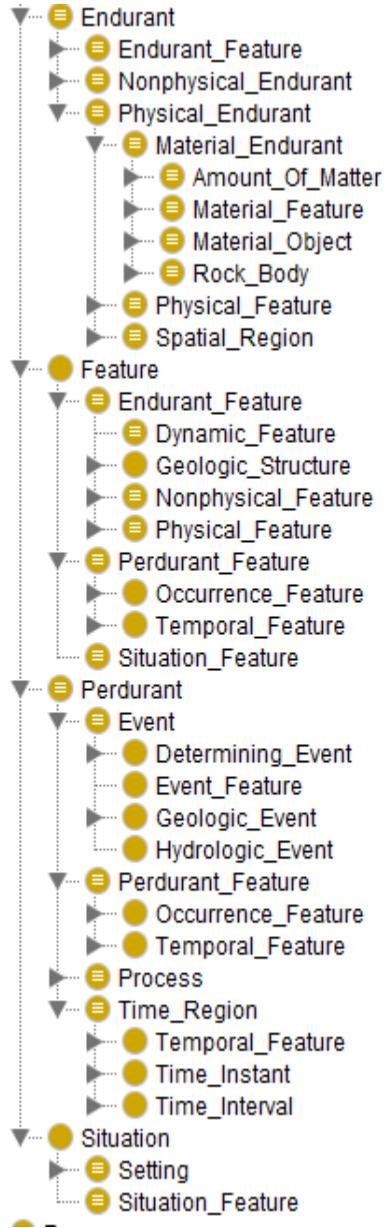
.RDF/XML

Backup

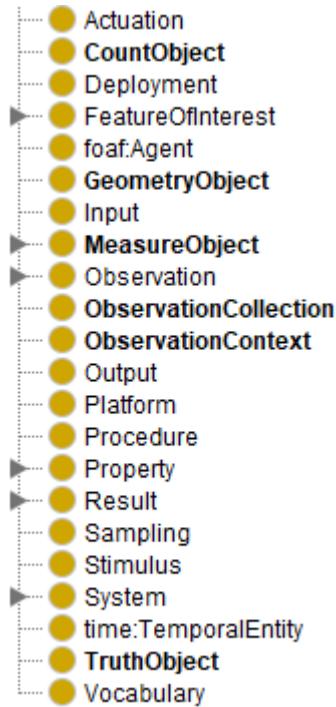


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Logical axiom count	16490
Declaration axioms count	6893
Class count	6700
Object property count	178

GeoScience Ontology
Brodaric & Richard
2019

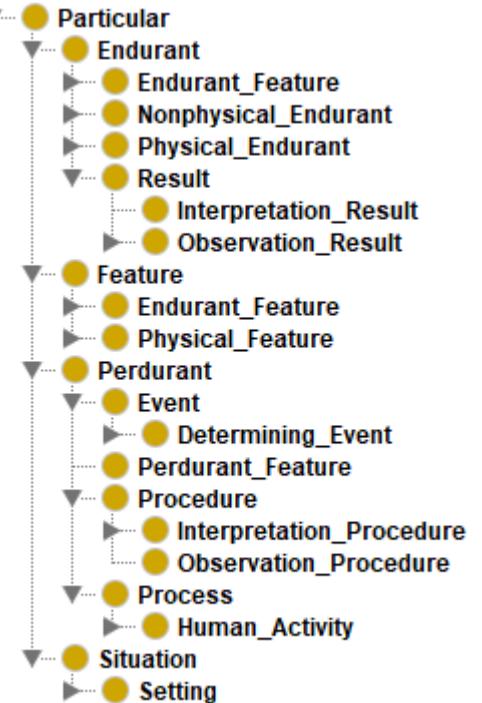


Ontologies hierarchy



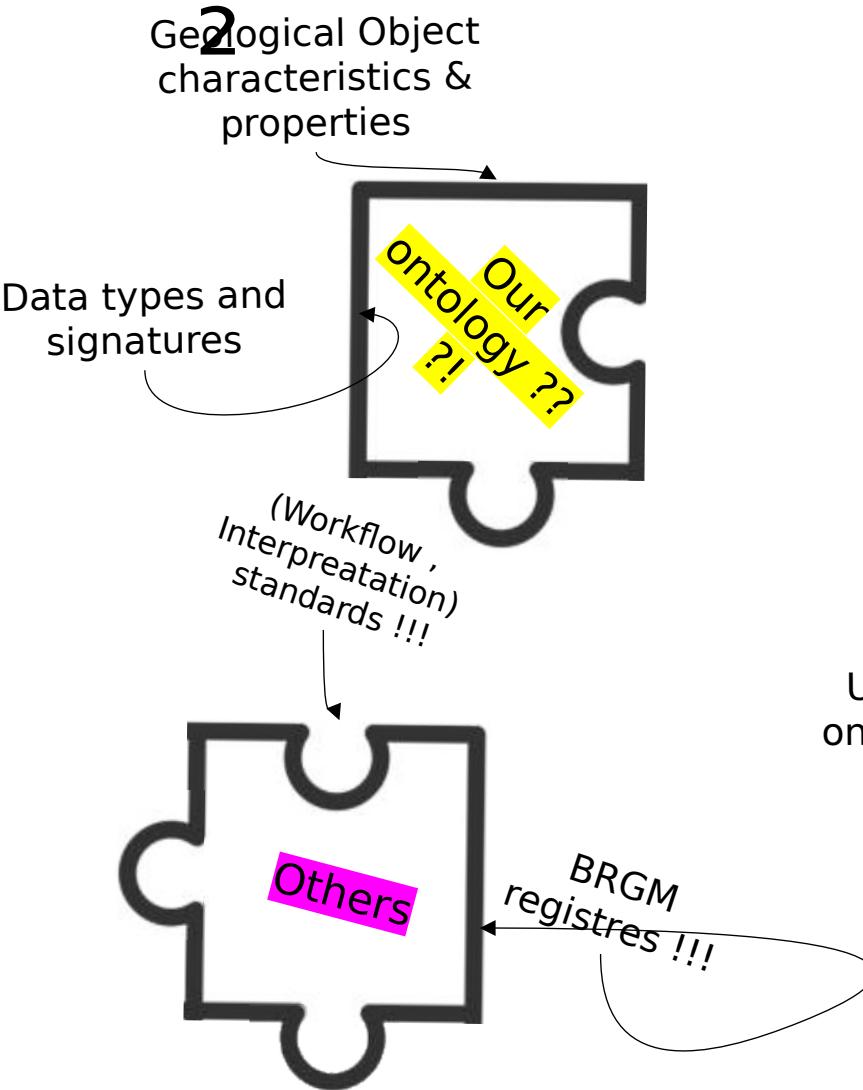
Axiom	720
Logical axiom count	147
Declaration axioms cou	99
Class count	35
Object property count	44

Observation and
Measurements lite ontology
Cox 2016



Geologic Interpretation and
modeling Ontology Laouici
et al 202x

Backup



System interoperability

