Alfred Wegener Institute
Helmholtz Centre for Polar and
Marine Research

Putting the “I” in FAIR through knowledge representation

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OBO Operations Committee

ESIP Semantic Tech Co-chair

Learning objectives

- **Introduction to the main concepts needed to approach interoperability, as defined in FAIR**
- **(Some) demystification of the issues and approaches**
- **Guidelines on how to use and shape community interoperability resources for your purposes**

FAIR

TO BE INTEROPERABLE:

I1. (meta)data use a **formal,** accessible, shared, and broadly applicable language for **knowledge representation**.

I2. (meta)data use vocabularies that **follow FAIR principles.**

I3. (meta)data include **qualified** references to other (meta)data.

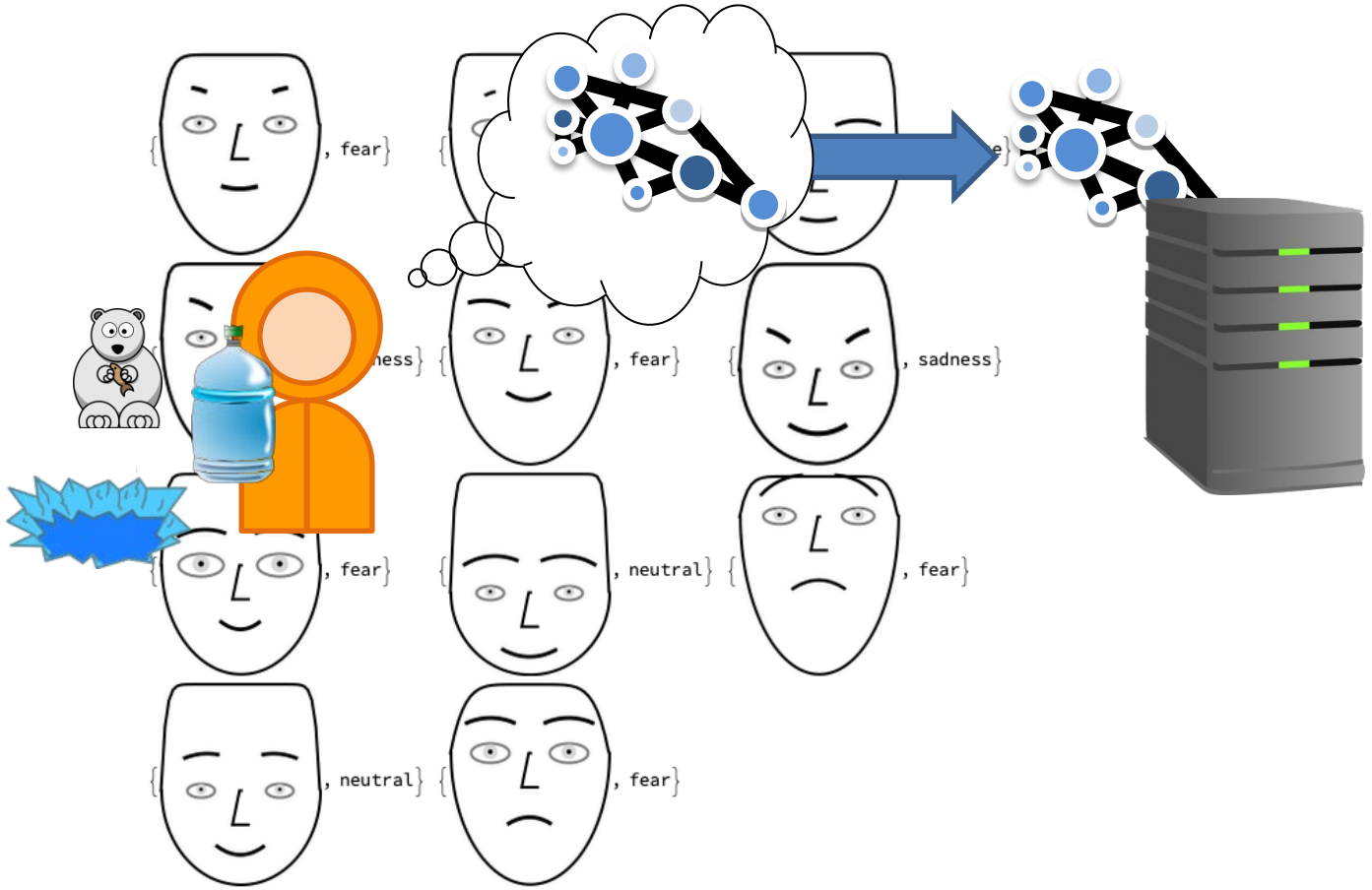
What does this mean to you?

Knowledge representation (KR)

AI

KR

ML



Direct transfer for human to machine knowledge / intelligence

Lots of consistent data signatures -> expectation

Why bother?

Semantic Understanding is Difficult!

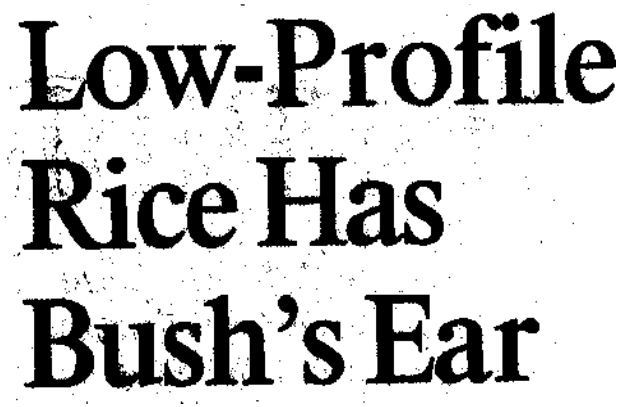
Sea surface temperature: measured 3 m above surface
Sea surface temperature: measured at surface

Variable t: temperature
Variable t: time

Data quality= 5

Let's eat, Grandma.
Let's eat Grandma.

Time flies like an arrow.
Fruit flies like a pie.



LA Times headline

Adapted from Raskin, 2006


CC Snežana Trifunović

FAO: FRA 2000 on definitions of forest and forest change

Includes: forest nurseries and seed orchards that constitute an integral part of the forest; **forest roads**, **cleared tracts**, firebreaks and other small open areas; […] **plantations primarily used for forestry purposes, including rubberwood plantations and cork oak stands.**

Excludes: Land predominantly used for agricultural practices

http://www.fao.org/docrep/006/ad665e/ad665e06.htm

https://www.cbd.int/forest/definitions.shtml

25 YEARS Convention on Biological Diversity
SAFEGUARDING LIFE ON EARTH

Definitions

Indicative definitions taken from the Report of the ad hoc technical expert group on forest biological diversity

The group considers the FAO definition of a forest as the basic one (FAO, 1998; FRA 2000), but acknowledge that many other useful definitions of "forest" exist in published form.

The fact that "forest" has been defined in many ways is a reflection of the diversity of forests and forest ecosystems in the world and of the diversity of human approaches to forests…

Rubber plantations classified as "forest"

… Once land is classed as "forest," developers can continue to convert more biodiverse natural forests to monocrop plantations without it ever showing up in any statistical sources…

WWF. Palm oil & forest conversion. Accessed 2015-09-02

http://wwf.panda.org/what_we_do/footprint/agriculture/palm_oil/environmental_impacts/forest_conversion/

POLICY PERSPECTIVE

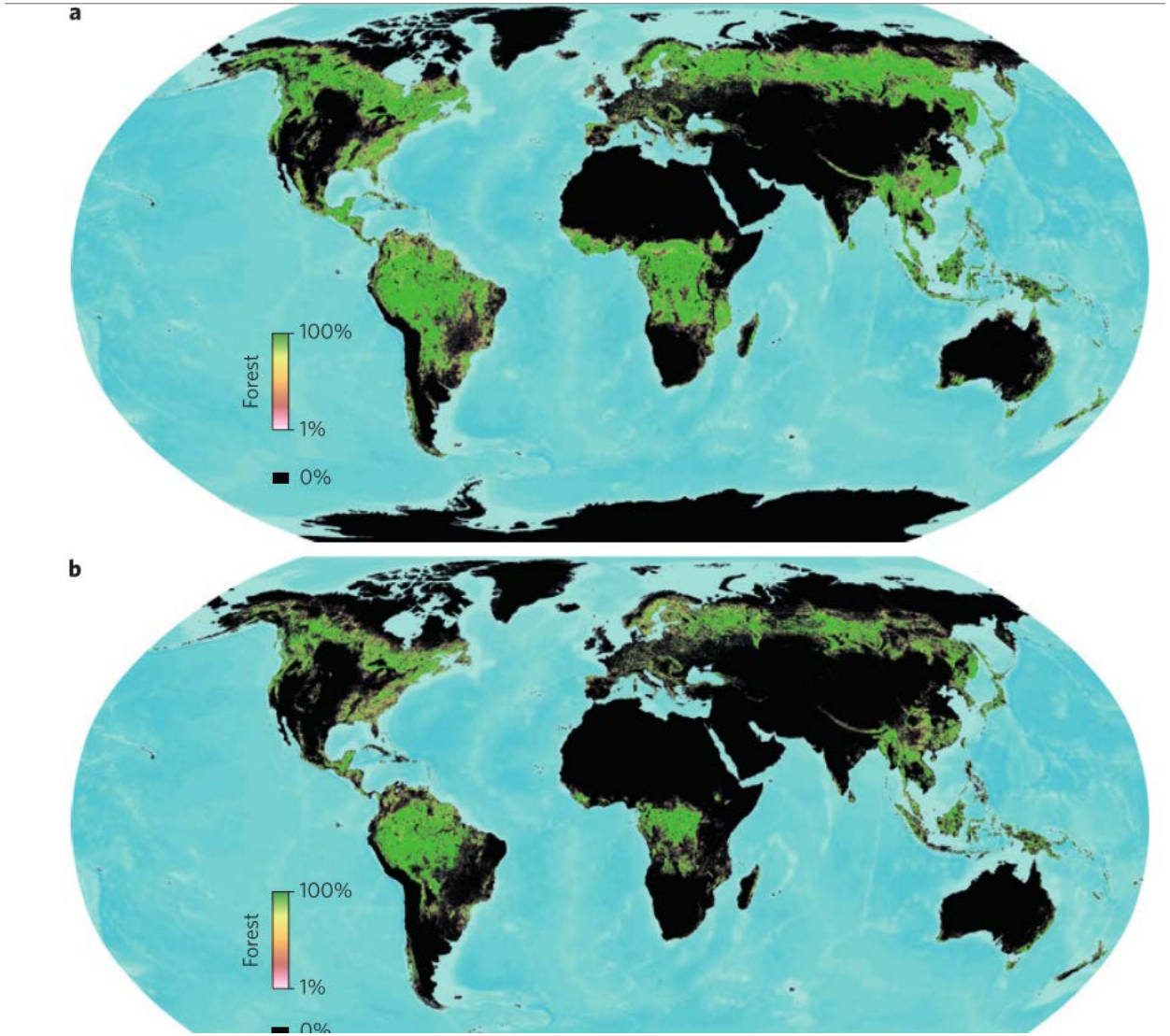
Critical need for new definitions of “forest” and “forest degradation” in global climate change agreements

Nophea Sasaki[1,2] & Francis E. Putz[3]

[1] Harvard Forest, Harvard University, Petersham, MA 01366, USA
[2] Graduate School of Applied Informatics, University of Hyogo, Kobe, Japan
[3] Department of Biology, University of Florida, Gainesville, FL 32611, USA

We also recommend that to avoid conflicts between conservation goals, global agreements that pertain to the fates of forests **include requirements for more detailed definitions of “forest” in national-level implementation guidelines**.

Potential variation under the United Nations Framework Convention on Climate Change



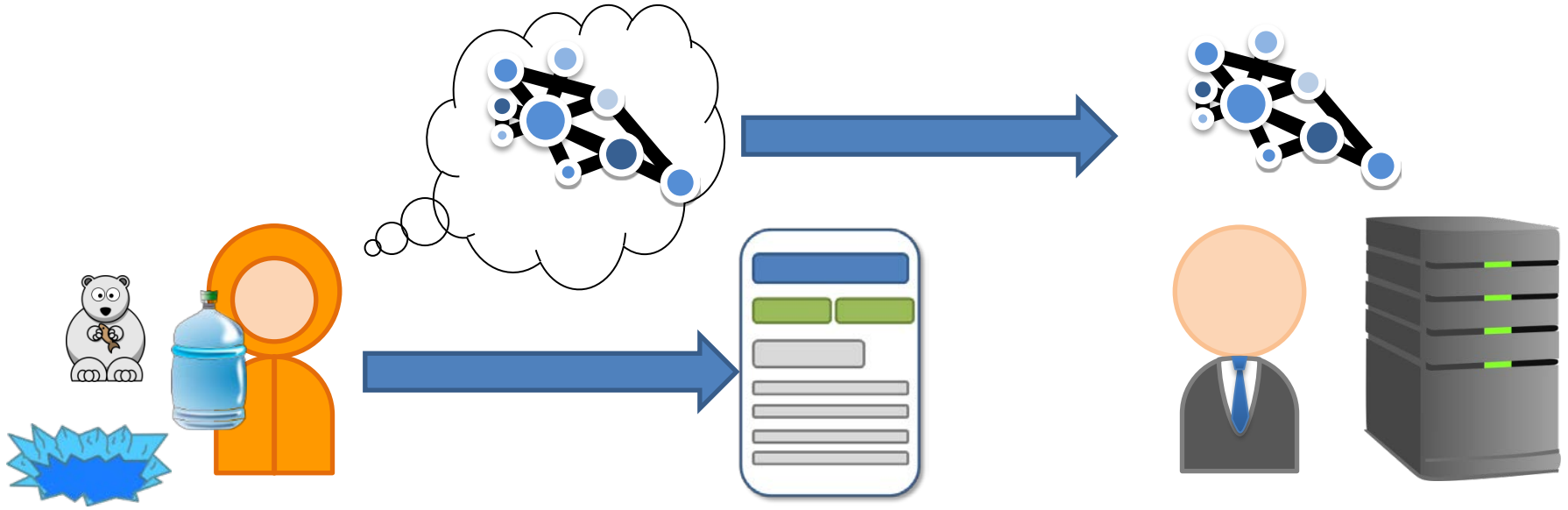
10 % canopy cover threshold

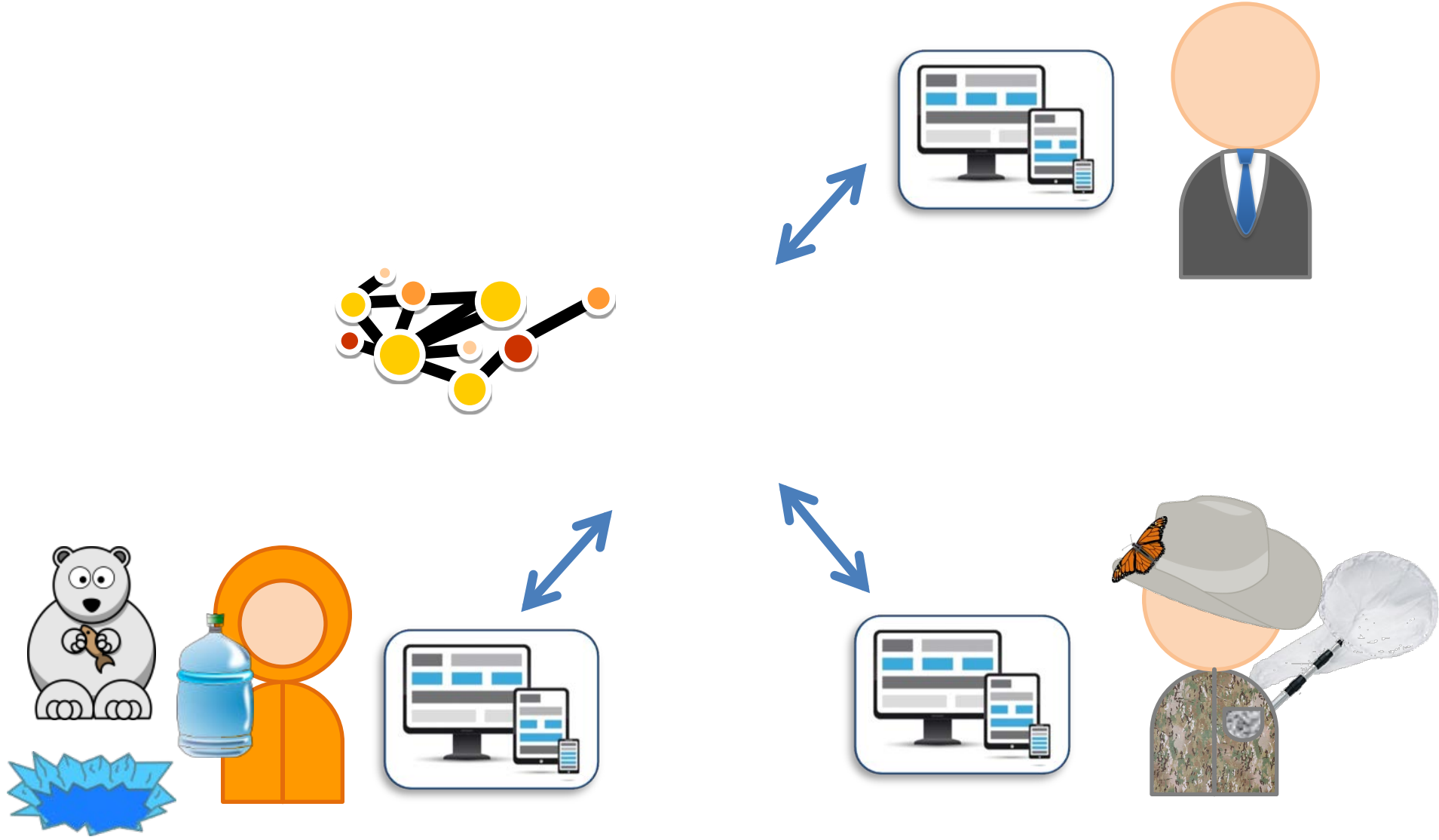
30 % canopy cover threshold

Sexton et al. (2015). Conservation policy and the measurement of forests. *Nature Climate Change*, *6*(October), 1–6.

We need to make sure that we're talking about the same thing

Accurate knowledge transfer and machine representation is key





The Terminology Zoo

Controlled vocabulary

- A list of terms controlled by some authority - e.g. a dropdown list.

Glossary

- A collection of terms and their definitions, possibly with synonyms - e.g. NSIDC's Cryosphere Glossary: https://nsidc.org/cryosphere/glossary

Thesaurus

- A structured controlled vocabulary where each term is annotated with information and/or metadata (e.g. definition, source) and its hierarchical, associative, or equivalence relationships to other terms in the thesaurus.

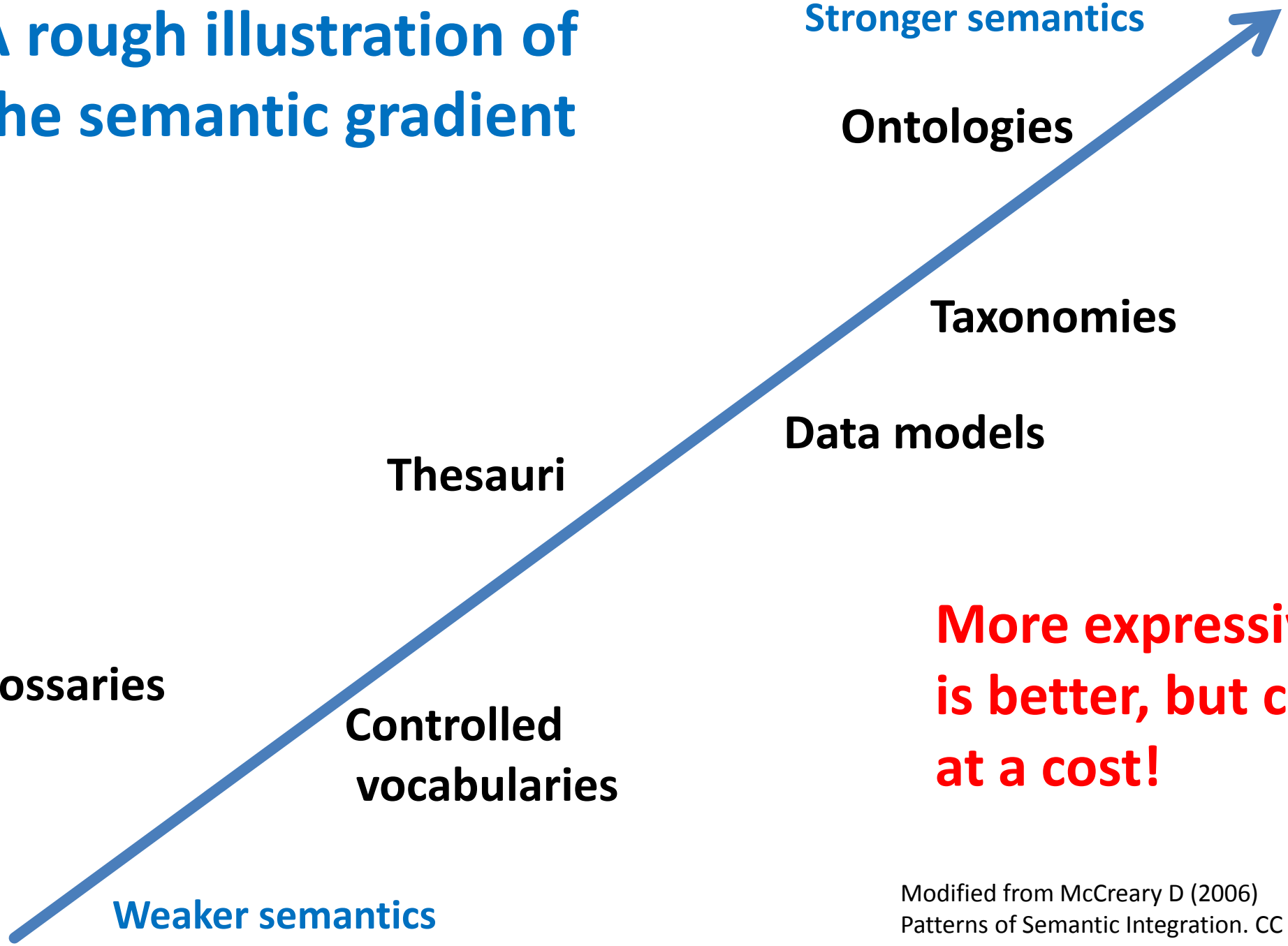
Taxonomy

- A hierarchy of terms organized as a tree structure without formal relationships to terms in other trees. Terms that are deeper in the tree (i.e. towards the leaves) may gain and lose properties relative to their ancestors.

Ontology

- A formal representation of knowledge, typically in a graph or network structure, with both human and machine-readable definitions, with logical relationships (axioms) between the terms, which together define a domain of knowledge.

A rough illustration of the semantic gradient



More expressiveness is better, but comes at a cost!

Modified from McCreary D (2006) Patterns of Semantic Integration. CC 2.5

Encoding (more) expressive terminologies

Warning!!!

Adopting a format is not enough to make a terminology interoperable or sufficiently formal to be useful in FAIR solutions!

We never say “My code is in R, so it must be statistically great”

FAIR

How does each encoding (if used well) address I1-I3?

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RDF

Resource Description Framework

RDF

Resource Description Framework

A family W3C specifications originally designed as a metadata data model.

It has come to be used as a general method for conceptual description or modeling of information that is implemented in web resources, using a variety of syntax notations and data serialization formats. It is also used in knowledge management applications.

RDF was adopted as a W3C recommendation in 1999. The RDF 1.0 specification was published in 2004, the RDF 1.1 specification in 2014.

https://en.wikipedia.org/wiki/Resource_Description_Framework

RDF

Resource Description Framework

Based on the idea of making statements about resources (in particular web resources) in expressions of the form subject–predicate–object, known as **triples.**

The subject denotes the resource, and the predicate denotes traits or aspects of the resource, and expresses a relationship between the subject and the object.

‘the sky’ ‘has the colour’ blue

https://en.wikipedia.org/wiki/Resource_Description_Framework

RDF

Resource Description Framework

Let's see if we can find this online…

RDF can be expressed in different "serialisations" such as N-Triples, **Turtle**, RDF/XML

All components have some control

```
@prefix eric:    <http://www.w3.org/People/EM/contact#> .
@prefix contact: <http://www.w3.org/2000/10/swap/pim/contact#> .
@prefix rdf:     <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .

eric:me contact:fullName "Eric Miller" .
eric:me contact:mailbox <mailto:e.miller123(at)example> .
eric:me contact:personalTitle "Dr." .
eric:me rdf:type contact:Person .
```

https://en.wikipedia.org/wiki/Resource_Description_Framework

RDF/XML

```
<?xml version="1.0" encoding="utf-8"?>
<rdf:RDF xmlns:contact="http://www.w3.org/2000/10/swap/pim/contact#" xmlns:eric="http:/
xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#">
  <rdf:Description rdf:about="http://www.w3.org/People/EM/contact#me">
    <contact:fullName>Eric Miller</contact:fullName>
  </rdf:Description>
  <rdf:Description rdf:about="http://www.w3.org/People/EM/contact#me">
    <contact:mailbox rdf:resource="mailto:e.miller123(at)example"/>
  </rdf:Description>
  <rdf:Description rdf:about="http://www.w3.org/People/EM/contact#me">
    <contact:personalTitle>Dr.</contact:personalTitle>
  </rdf:Description>
  <rdf:Description rdf:about="http://www.w3.org/People/EM/contact#me">
    <rdf:type rdf:resource="http://www.w3.org/2000/10/swap/pim/contact#Person"/>
  </rdf:Description>
</rdf:RDF>
```

https://en.wikipedia.org/wiki/Resource_Description_Framework

SKOS

Simple Knowledge Organization System

SKOS

Simple Knowledge Organization System

SKOS Vocabulary Organized by Theme

Concepts	Labels & Notation	Documentation	Semantic Relations	Mapping Properties	Collections
Concept	prefLabel	note	broader	broadMatch	Collection
ConceptScheme	altLabel	changeNote	narrower	narrowMatch	orderedCollection
inScheme	hiddenLabel	definition	related	relatedMatch	member
hasTopConcept	notation	editorialNote	broaderTransitive	closeMatch	memberList
topConceptOf		example	narrowerTransitive	exactMatch	
		historyNote	semanticRelation	mappingRelation	
		scopeNote			

https://en.wikipedia.org/wiki/SKOS

BODC parameter semantic model chemical substances

⇑ -- (1-methylethyl)benzene --

Allowing label variation

URI	http://vocab.nerc.ac.uk/collection/S27/current/CS003258/
Identifier ()	SDN:S27::CS003258
Preferred label (en)	**(1-methylethyl)benzene**
Alternative label ()	isopropylbenzene cumene
Version Info ()	2
Has Current Version	http://vocab.nerc.ac.uk/collection/S27/current/CS003258/2/
PAV Version ()	2
PAV Authored On ()	2017-06-30 09:13:37.0
Definition (en)	Unavailable
Deprecated ()	false
Same as ()	http://chem.sis.nlm.nih.gov/chemidplus/rn/98-82-8
Same as ()	http://purl.obolibrary.org/obo/CHEBI_34656
Same as ()	http://environment.data.gov.au/def/object/isopropylbenzene
Broader	http://vocab.nerc.ac.uk/collection/S01/current/S016/
Narrower	http://vocab.nerc.ac.uk/collection/P01/current/RWS00119/
Date ()	2017-06-30 09:13:37.0

Qualified references to other metadata

http://vocab.nerc.ac.uk/collection/S27/current/

<skos:member>
<skos:Concept rdf:about="http://vocab.nerc.ac.uk/collection/S27/current/CS003258/">
<dc:identifier>SDN:S27::CS003258</dc:identifier>
<dce:identifier>SDN:S27::CS003258</dce:identifier>
<dc:date>2017-06-30 09:13:37.0</dc:date>
<skos:notation>SDN:S27::CS003258</skos:notation>
<skos:prefLabel xml:lang="en">(1-methylethyl)benzene</skos:prefLabel>
<skos:altLabel>isopropylbenzene cumene</skos:altLabel>
<skos:definition xml:lang="en">Unavailable</skos:definition>
<owl:versionInfo>2</owl:versionInfo>
<pav:hasCurrentVersion rdf:resource="http://vocab.nerc.ac.uk/collection/S27/current/CS003258/2/"/>
<pav:version>2</pav:version>
<pav:authoredOn>2017-06-30 09:13:37.0</pav:authoredOn>
<skos:note xml:lang="en">accepted</skos:note>
<owl:deprecated>false</owl:deprecated>
<skos:narrower rdf:resource="http://vocab.nerc.ac.uk/collection/P01/current/RWS00119/"/>
<skos:broader rdf:resource="http://vocab.nerc.ac.uk/collection/S01/current/S016/"/>
<owl:sameAs rdf:resource="http://chem.sis.nlm.nih.gov/chemidplus/rn/98-82-8"/>
<owl:sameAs rdf:resource="http://purl.obolibrary.org/obo/CHEBI_34656"/>
<owl:sameAs rdf:resource="http://environment.data.gov.au/def/object/isopropylbenzene"/>
<void:inDataset rdf:resource="http://vocab.nerc.ac.uk/.well-known/void"/>
</skos:Concept>
</skos:member>

<skos:member>
<skos:Concept rdf:about="http://vocab.nerc.ac.uk/collection/S27/current/CS003258/">
<dc:identifier>SDN:S27::CS003258</dc:identifier>
<dce:identifier>SDN:S27::CS003258</dce:identifier>
<dc:date>2017-06-30 09:13:37.0</dc:date>
<skos:notation>SDN:S27::CS003258</skos:notation>
<skos:prefLabel xml:lang="en">(1-methylethyl)benzene</skos:prefLabel>
<skos:altLabel>isopropylbenzene cumene</skos:altLabel>
<skos:definition xml:lang="en">Unavailable</skos:definition>
<owl:versionInfo>2</owl:versionInfo>
<pav:hasCurrentVersion rdf:resource="http://vocab.nerc.ac.uk/collection/S27/current/CS003258/2/"/>
<pav:version>2</pav:version>
<pav:authoredOn>2017-06-30 09:13:37.0</pav:authoredOn>
<skos:note xml:lang="en">accepted</skos:note>
<owl:deprecated>false</owl:deprecated>
<skos:narrower rdf:resource="http://vocab.nerc.ac.uk/collection/P01/current/RWS00119/"/>
<skos:broader rdf:resource="http://vocab.nerc.ac.uk/collection/S01/current/S016/"/>
<owl:sameAs rdf:resource="http://chem.sis.nlm.nih.gov/chemidplus/rn/98-82-8"/>
<owl:sameAs rdf:resource="http://purl.obolibrary.org/obo/CHEBI_34656"/>
<owl:sameAs rdf:resource="http://environment.data.gov.au/def/object/isopropylbenzene"/>
<void:inDataset rdf:resource="http://vocab.nerc.ac.uk/.well-known/void"/>
</skos:Concept>
</skos:member>

Reuse of F,A
“annotation properties”

OWL

Web Ontology Language

OWL

Web Ontology Language

The Web Ontology Language (OWL) is a **family** of knowledge representation languages for authoring ontologies.

Ontologies are a **formal** way to describe taxonomies and classification networks, essentially defining the structure of knowledge for various domains: the nouns representing classes of objects and the verbs representing relations between the objects

https://en.wikipedia.org/wiki/Web_Ontology_Language

OWL

Web Ontology Language

The OWL languages are characterized by formal semantics. They are built upon W3C RDF

OWL classes correspond to description logic (DL) concepts, OWL properties (relations) to DL roles, while individuals are called the same way in both the OWL and the DL terminology.

If the logic used in an OWL resource is well controlled, it can be used for **reasoning and inference**

https://en.wikipedia.org/wiki/Web_Ontology_Language

Class: transpiration
Term
IRI: http://purl.obolibrary.org/obo/ENVO_02500035
Definition: Transpiration is the process of water movement through a plant and its evaporation from aerial parts of that plant, such as from leaves but also from stems and flowers.

Superclasses & Asserted Axioms

- material transport process
- has part some evaporation

Uses in this ontology
evapotranspiration subClassOf : has part some (hydrological evaporation and transpiration)

Thing
+ entity
+ occurrent
+ process
+ environmental system process
+ material transport process
+ volcanic eruption
+ mass wasting
- geological subsidence
- atmospheric subsidence
+ rock-precursor intrusion process
+ precipitation process
+ tectonic movement
- photoevaporation
+ atmospheric escape
+ advective transport process
+ erosion
+ primary aerosol formation process
- transportation
+ flooding
- evapotranspiration
+ aeolian transport process
- frost heaving process
- exudation of carbohydrates
more...
- transpiration

Just one of several common OWL serialisations Q: which one is it?

```
<!-- http://purl.obolibrary.org/obo/ENVO_02500035 -->

  <owl:Class rdf:about="http://purl.obolibrary.org/obo/ENVO_02500035">
    <rdfs:subClassOf rdf:resource="http://purl.obolibrary.org/obo/ENVO_03000010"/>
    <rdfs:subClassOf>
      <owl:Restriction>
        <owl:onProperty rdf:resource="http://purl.obolibrary.org/obo/BFO_0000051"/>
        <owl:someValuesFrom rdf:resource="http://purl.obolibrary.org/obo/ENVO_02500034"/>
      </owl:Restriction>
    </rdfs:subClassOf>
    <obo:IAO_0000115>Transpiration is the process of water movement through a plant and its evaporation from aerial parts of that plant, such as from leaves but also from stems and flowers.</obo:IAO_0000115>
    <rdfs:comment>Needs a process part &amp;quot;water transport&amp;quot; or similar and some link to plants to be complete.</rdfs:comment>
    <rdfs:label>transpiration</rdfs:label>
  </owl:Class>
```

Notice the reuse of existing annotation properties…

```
<!-- http://purl.obolibrary.org/obo/ENVO_02500035 -->

  <owl:Class rdf:about="http://purl.obolibrary.org/obo/ENVO_02500035">
    <rdfs:subClassOf rdf:resource="http://purl.obolibrary.org/obo/ENVO_03000010"/>
    <rdfs:subClassOf>
      <owl:Restriction>
        <owl:onProperty rdf:resource="http://purl.obolibrary.org/obo/BFO_0000051"/>
        <owl:someValuesFrom rdf:resource="http://purl.obolibrary.org/obo/ENVO_02500034"/>
      </owl:Restriction>
    </rdfs:subClassOf>
    <obo:IAO_0000115>Transpiration is the process of water movement through a plant and its evaporation from aerial parts of that plant, such as from leaves but also from stems and flowers.</obo:IAO_0000115>
    <rdfs:comment>Needs a process part &amp;quot;water transport&amp;quot; or similar and some link to plants to be complete.</rdfs:comment>
    <rdfs:label>transpiration</rdfs:label>
  </owl:Class>
```

Notice also that OWL allows more expressivity formalism (if it's used correctly)

```
<!-- http://purl.obolibrary.org/obo/ENVO_02500035 -->

  <owl:Class rdf:about="http://purl.obolibrary.org/obo/ENVO_02500035">
    <rdfs:subClassOf rdf:resource="http://purl.obolibrary.org/obo/ENVO_03000010"/>
    <rdfs:subClassOf>
      <owl:Restriction>
        <owl:onProperty rdf:resource="http://purl.obolibrary.org/obo/BFO_0000051"/>
        <owl:someValuesFrom rdf:resource="http://purl.obolibrary.org/obo/ENVO_02500034"/>
      </owl:Restriction>
    </rdfs:subClassOf>
    <obo:IAO_0000115>Transpiration is the process of water movement through a plant and its evaporation from aerial parts of that plant, such as from leaves but also from stems and flowers.</obo:IAO_0000115>
    <rdfs:comment>Needs a process part &amp;quot;water transport&amp;quot; or similar and some link to plants to be complete.</rdfs:comment>
    <rdfs:label>transpiration</rdfs:label>
  </owl:Class>
```

We rarely write this out manually, tools like Protégé and TopBraid autogenerate this code while you edit the ontology in a GUI

```
<!-- http://purl.obolibrary.org/obo/ENVO_02500035 -->

  <owl:Class rdf:about="http://purl.obolibrary.org/obo/ENVO_02500035">
    <rdfs:subClassOf rdf:resource="http://purl.obolibrary.org/obo/ENVO_03000010"/>
    <rdfs:subClassOf>
      <owl:Restriction>
        <owl:onProperty rdf:resource="http://purl.obolibrary.org/obo/BFO_0000051"/>
        <owl:someValuesFrom rdf:resource="http://purl.obolibrary.org/obo/ENVO_02500034"/>
      </owl:Restriction>
    </rdfs:subClassOf>
    <obo:IAO_0000115>Transpiration is the process of water movement through a plant and its evaporation from aerial parts of that plant, such as from leaves but also from stems and flowers.</obo:IAO_0000115>
    <rdfs:comment>Needs a process part &amp;quot;water transport&amp;quot; or similar and some link to plants to be complete.</rdfs:comment>
    <rdfs:label>transpiration</rdfs:label>
  </owl:Class>
```

This is a reference to OBO's Information Artifact Ontology and expands to http://purl.obolibrary.org/obo/IAO_0000115 "textual definition"

This bit identifies the superclass of “transpiration”, which is ‘material transport process’ [ENVO_03000010]

```
<!-- http://purl.obolibrary.org/obo/ENVO_02500035 -->

  <owl:Class rdf:about="http://purl.obolibrary.org/obo/ENVO_02500035">
    <rdfs:subClassOf rdf:resource="http://purl.obolibrary.org/obo/ENVO_03000010"/>
    <rdfs:subClassOf>
      <owl:Restriction>
        <owl:onProperty rdf:resource="http://purl.obolibrary.org/obo/BFO_0000051"/>
        <owl:someValuesFrom rdf:resource="http://purl.obolibrary.org/obo/ENVO_02500034"/>
      </owl:Restriction>
    </rdfs:subClassOf>
    <obo:IAO_0000115>Transpiration is the process of water movement through a plant and its evaporation from aerial parts of that plant, such as from leaves but also from stems and flowers.</obo:IAO_0000115>
    <rdfs:comment>Needs a process part &amp;quot;water transport&amp;quot; or similar and some link to plants to be complete.</rdfs:comment>
    <rdfs:label>transpiration</rdfs:label>
  </owl:Class>
```

That is, transpiration is a subClassOf ‘material transport process’, inherting all of its properties and the proteries of its superclasses

```
<!-- http://purl.obolibrary.org/obo/ENVO_02500035 -->

  <owl:Class rdf:about="http://purl.obolibrary.org/obo/ENVO_02500035">
    <rdfs:subClassOf rdf:resource="http://purl.obolibrary.org/obo/ENVO_03000010"/>
    <rdfs:subClassOf>
      <owl:Restriction>
        <owl:onProperty rdf:resource="http://purl.obolibrary.org/obo/BFO_0000051"/>
        <owl:someValuesFrom rdf:resource="http://purl.obolibrary.org/obo/ENVO_02500034"/>
      </owl:Restriction>
    </rdfs:subClassOf>
    <obo:IAO_0000115>Transpiration is the process of water movement through a plant and its evaporation from aerial parts of that plant, such as from leaves but also from stems and flowers.</obo:IAO_0000115>
    <rdfs:comment>Needs a process part &amp;quot;water transport&amp;quot; or similar and some link to plants to be complete.</rdfs:comment>
    <rdfs:label>transpiration</rdfs:label>
  </owl:Class>
```

This bit creates a logical statement that says that "transpiration"…

'has part' [BFO_0000051] some evaporation [ENVO_02500034]

OWL

Web Ontology Language

OWL is intended to express complex conceptual structures, which can be used to generate **rich metadata** and support inference tools.

Constructing useful web ontologies is demanding in terms of expertise, effort, and cost. In many cases, this type of effort might be superfluous or unsuited to requirements, and SKOS might be a better choice.

https://en.wikipedia.org/wiki/Web_Ontology_Language

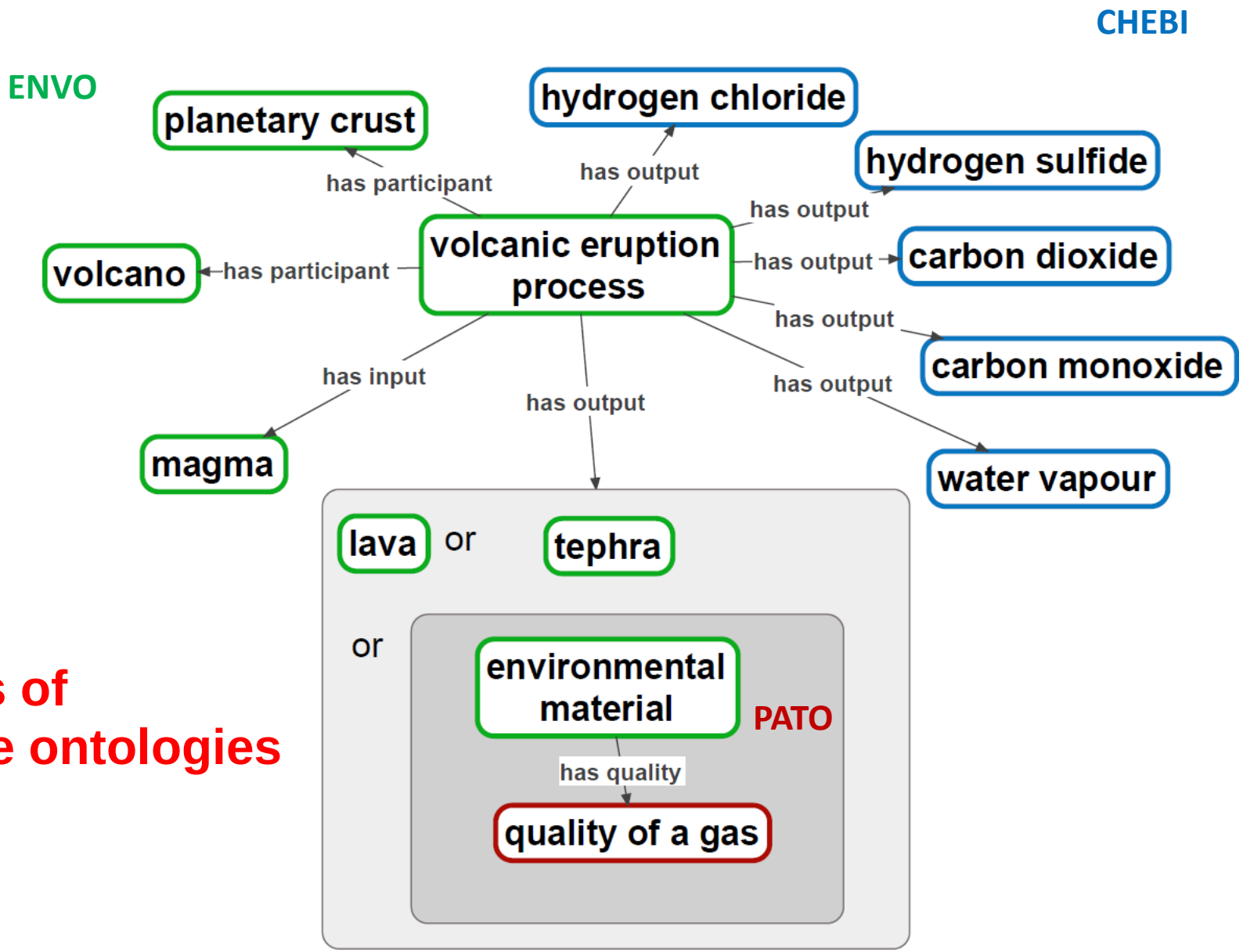
data_about: volcanic eruption

Not so rich

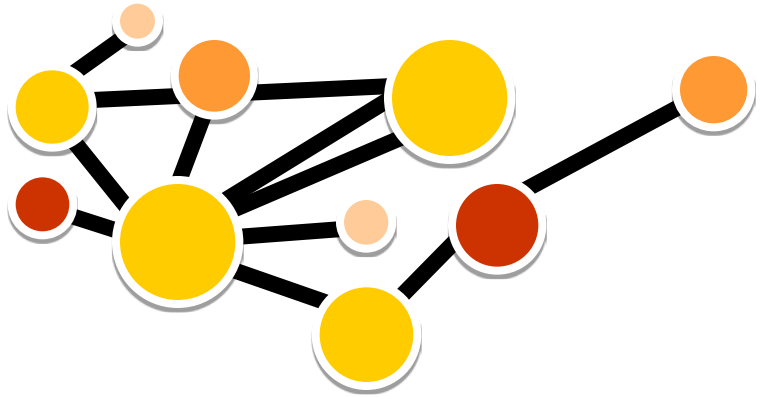
data_about: http://purl.obolibrary.org/obo/ENVO_01000634

Any richer?

:: http://purl.obolibrary.org/obo/ENVO_01000634

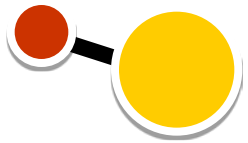


Note imports of interoperable ontologies

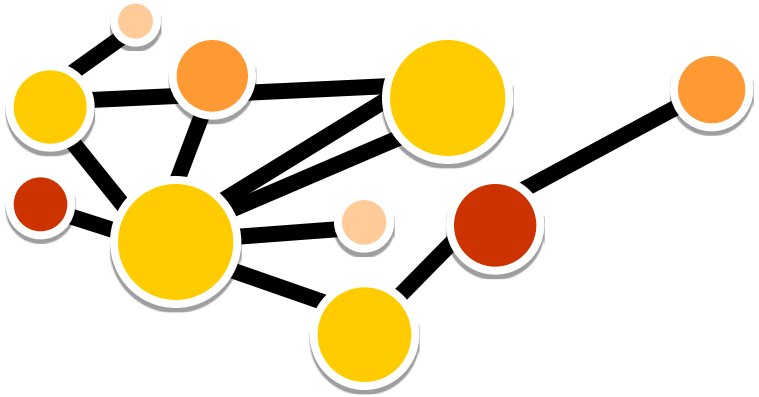


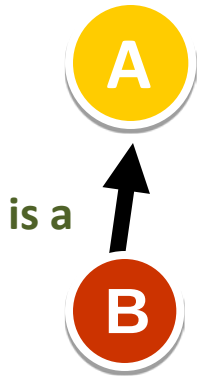
An ontology is a controlled, logically structured representation of reality that is renders *knowledge* human and machine readable

clearly-defined ‘classes’ for each entity
(may have one or more labels)



defined relationships between classes



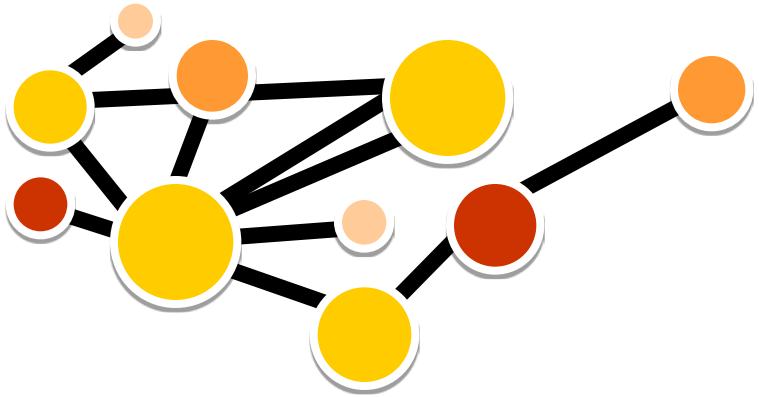


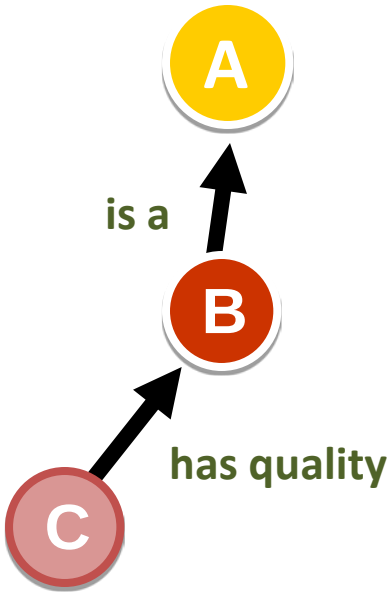
Main hierarchies are formed by subclass relations:

A B is an A which Cs

genus differentia

A red chair is a chair which has a red quality



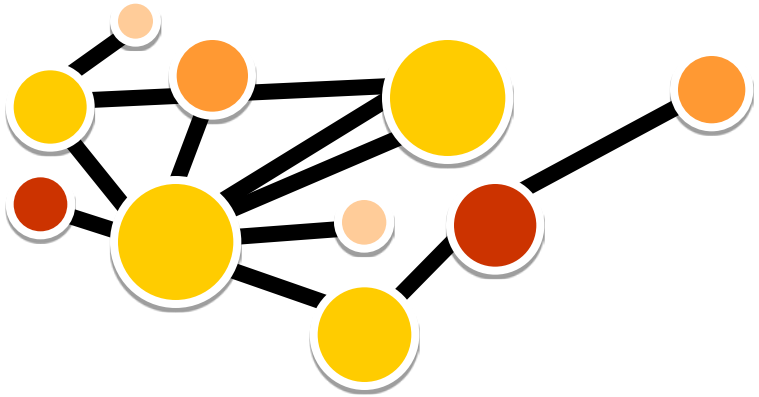


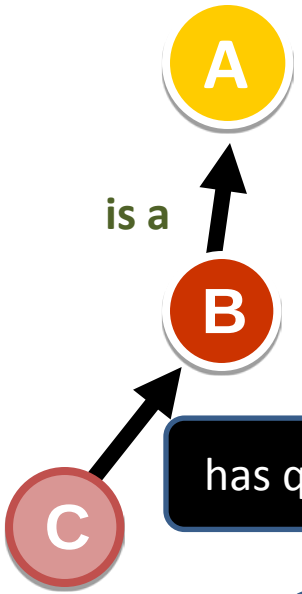
But more logical constraints can be added to increase expressivity

A B is an A which Cs

genus differentia

A red chair is a chair which has a red quality





Each node and its logical relations should be web-accessible with stable URIs for generalised access

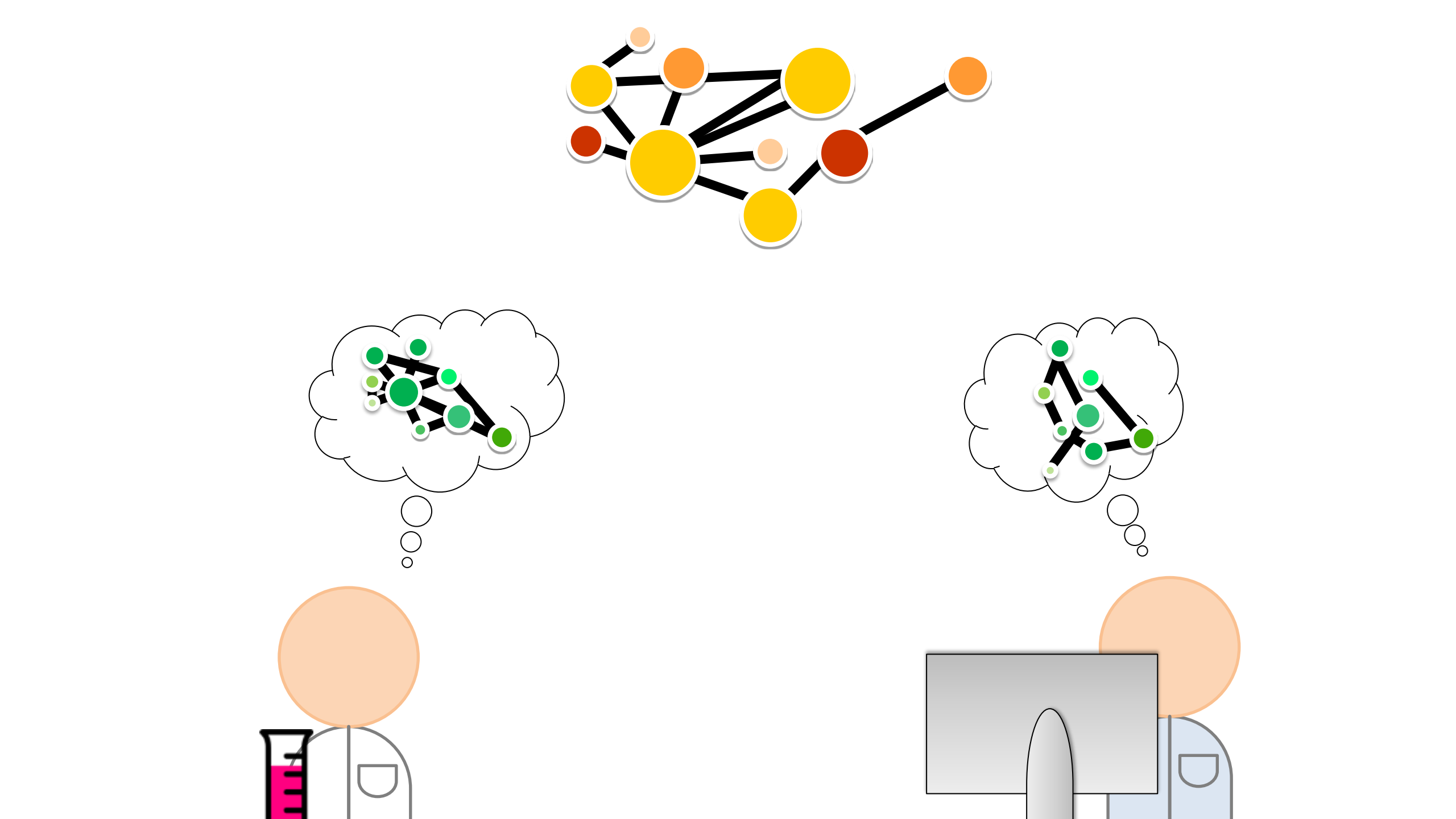
http://purl.obolibrary.org/obo/RO_0000053

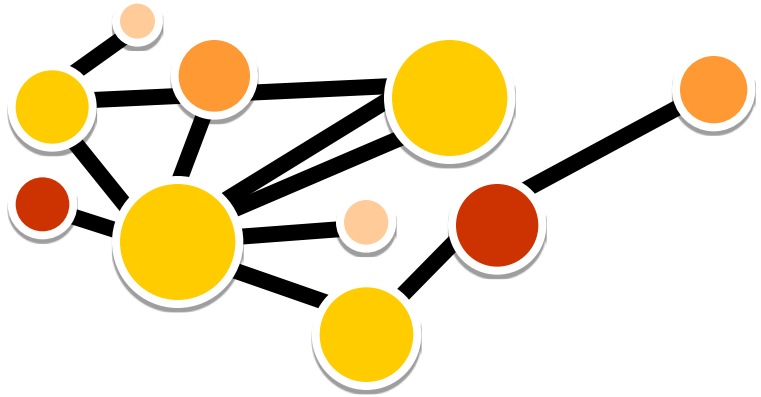
http://purl.obolibrary.org/obo/ENVO_01000586

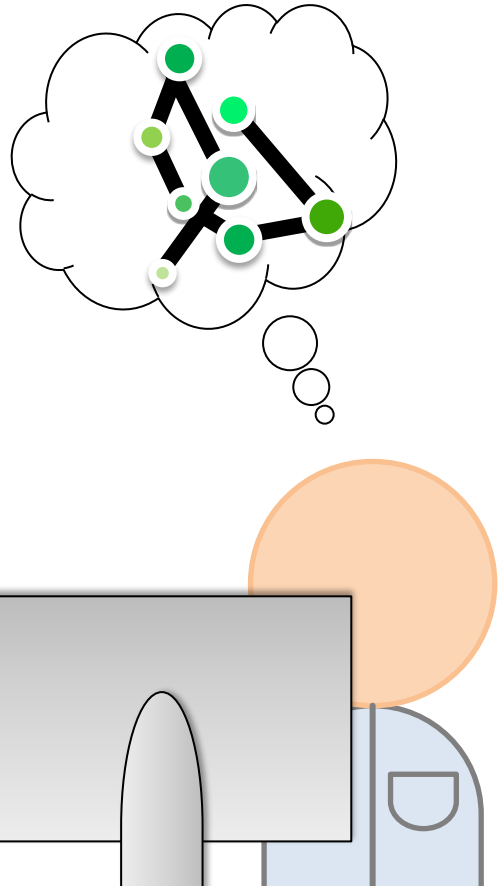
A red chair is a chair which has a red quality

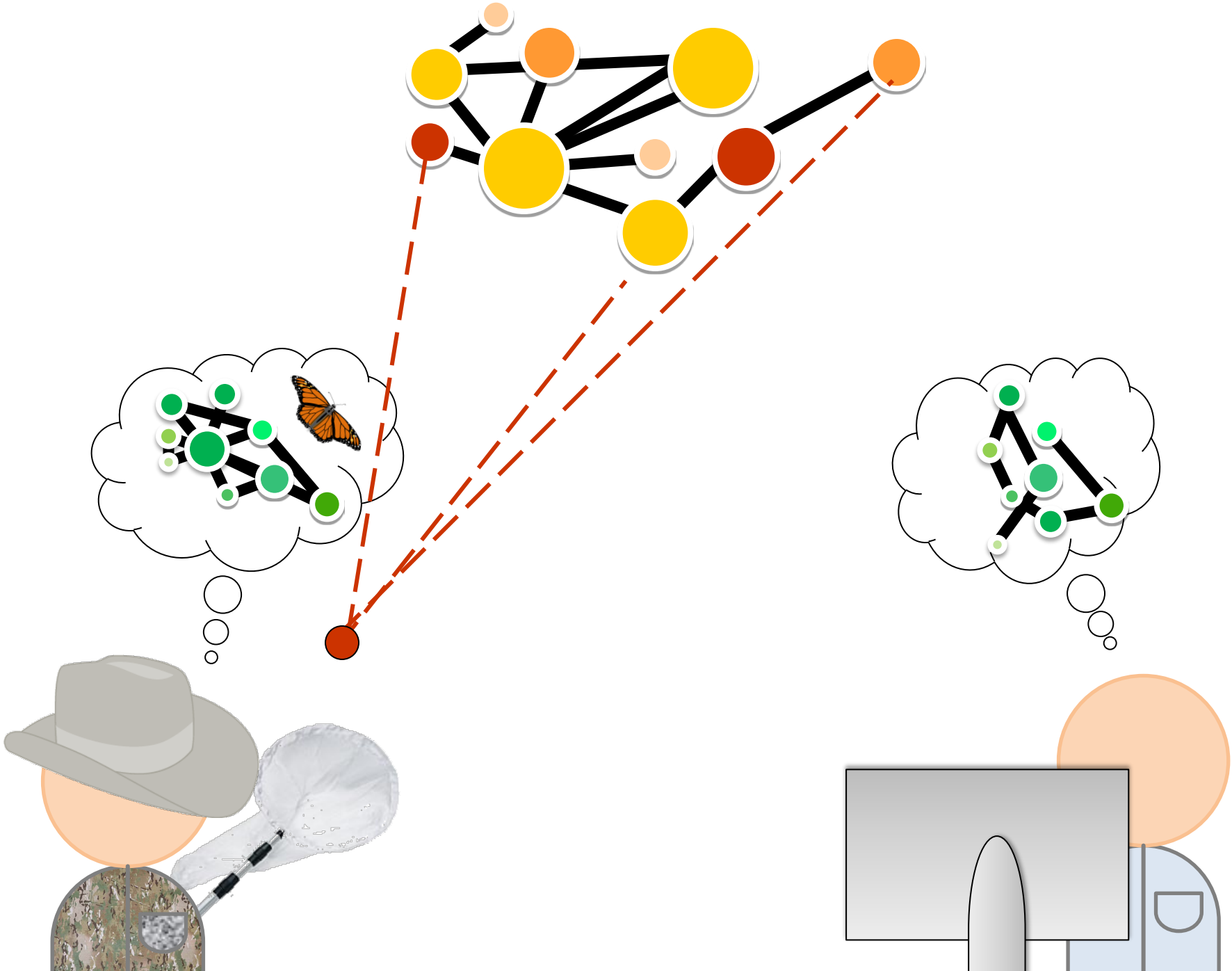
http://purl.obolibrary.org/obo/PATO_0000322

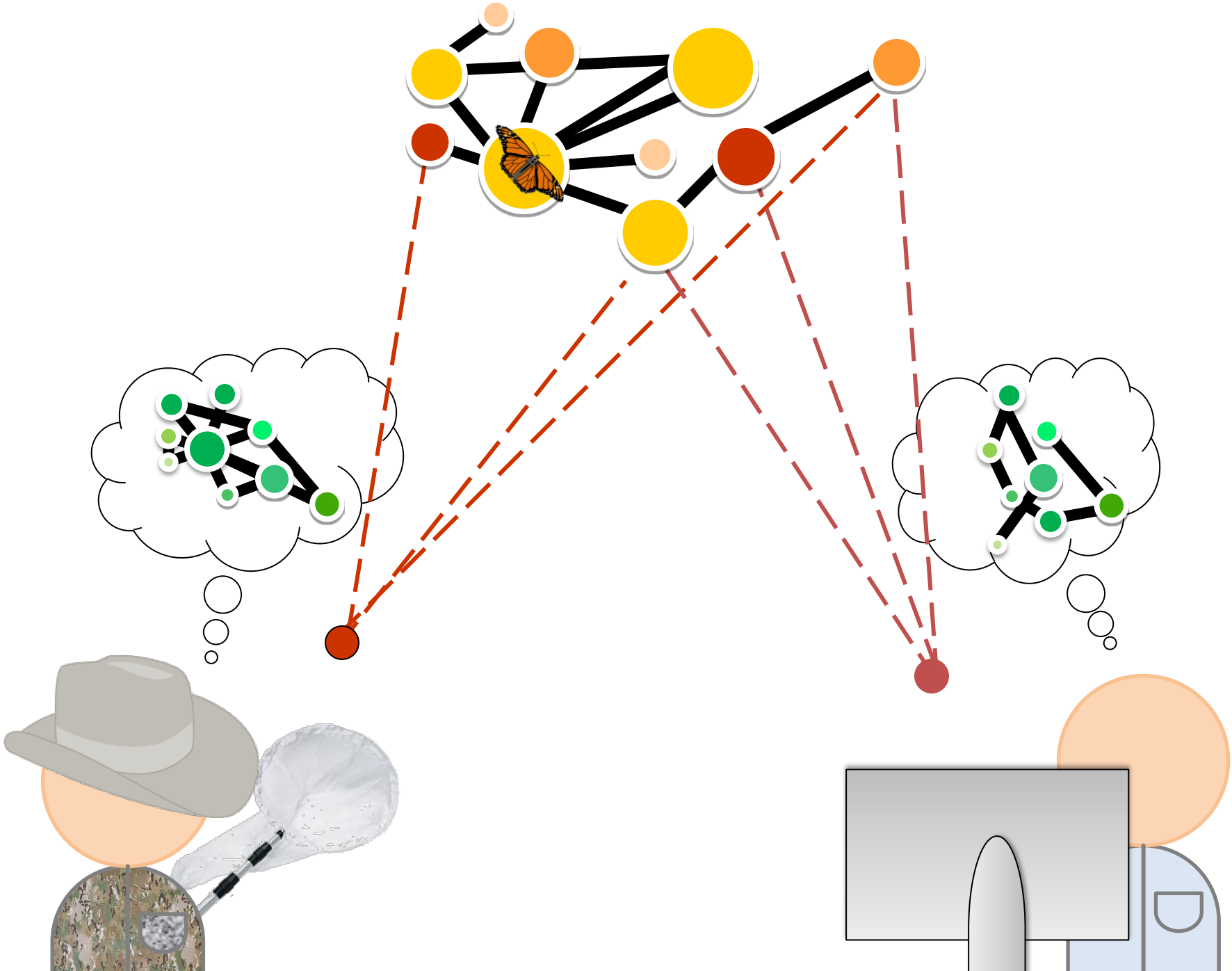
Relations (Object properties) can have domain and range constraints

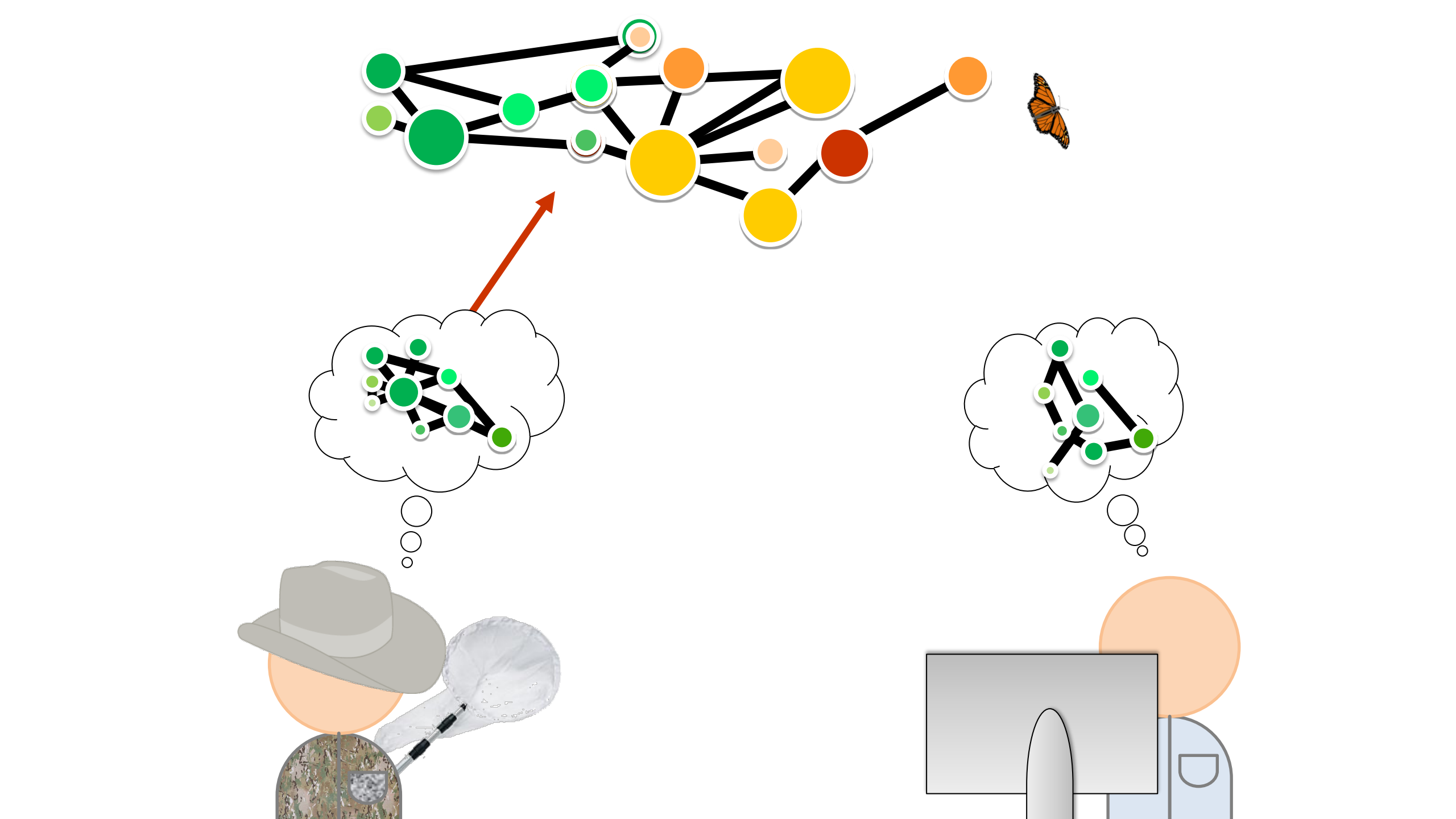


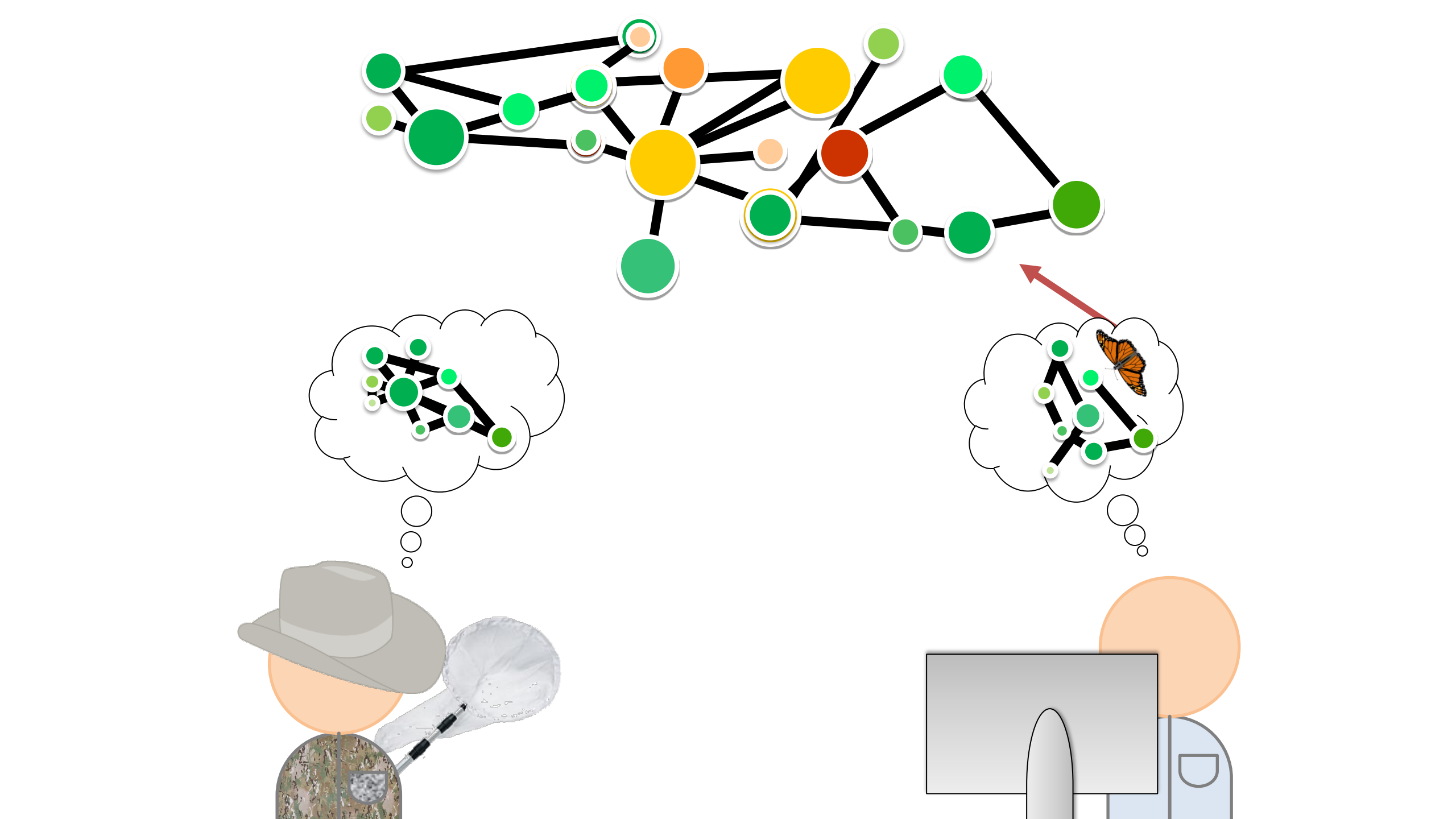


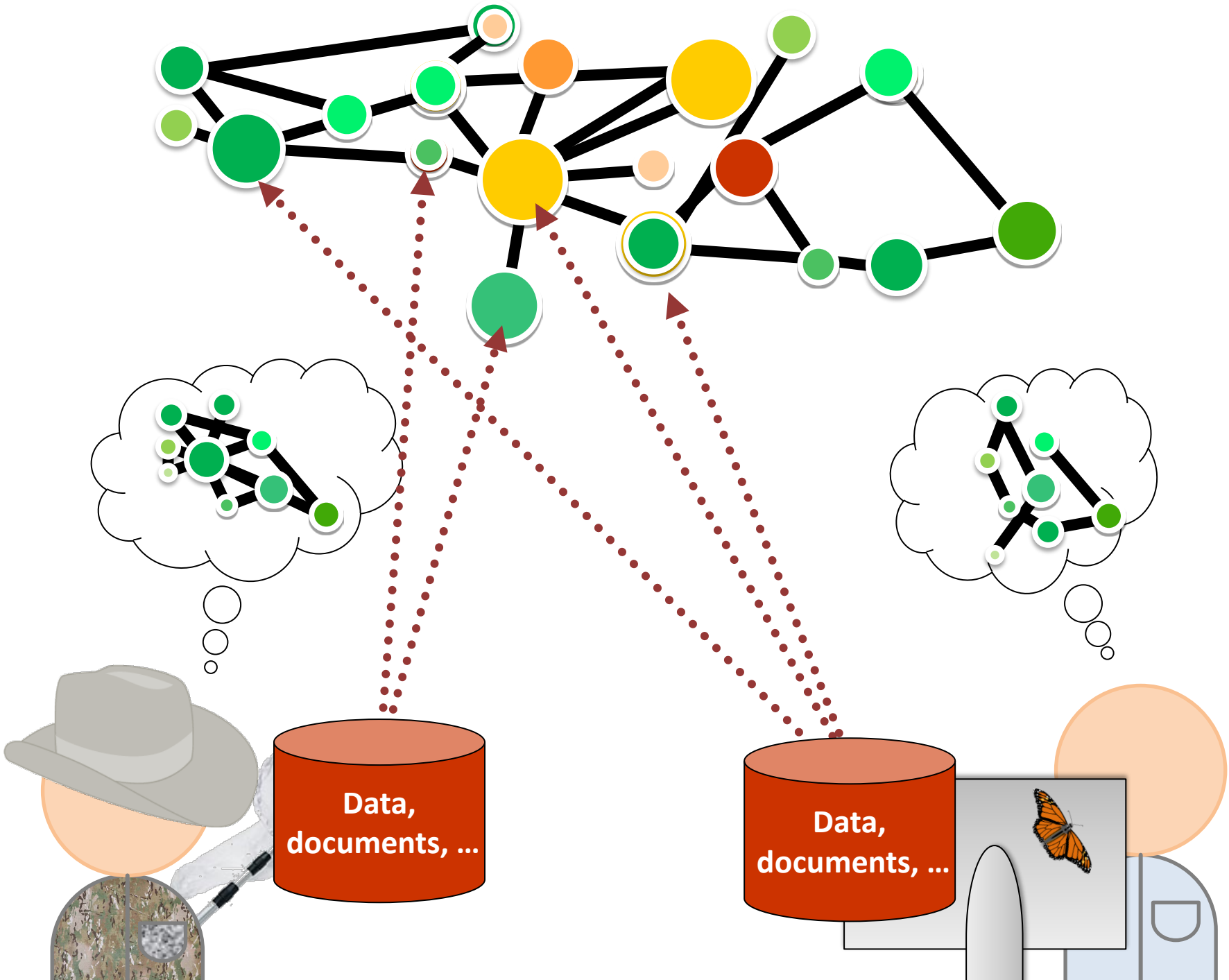






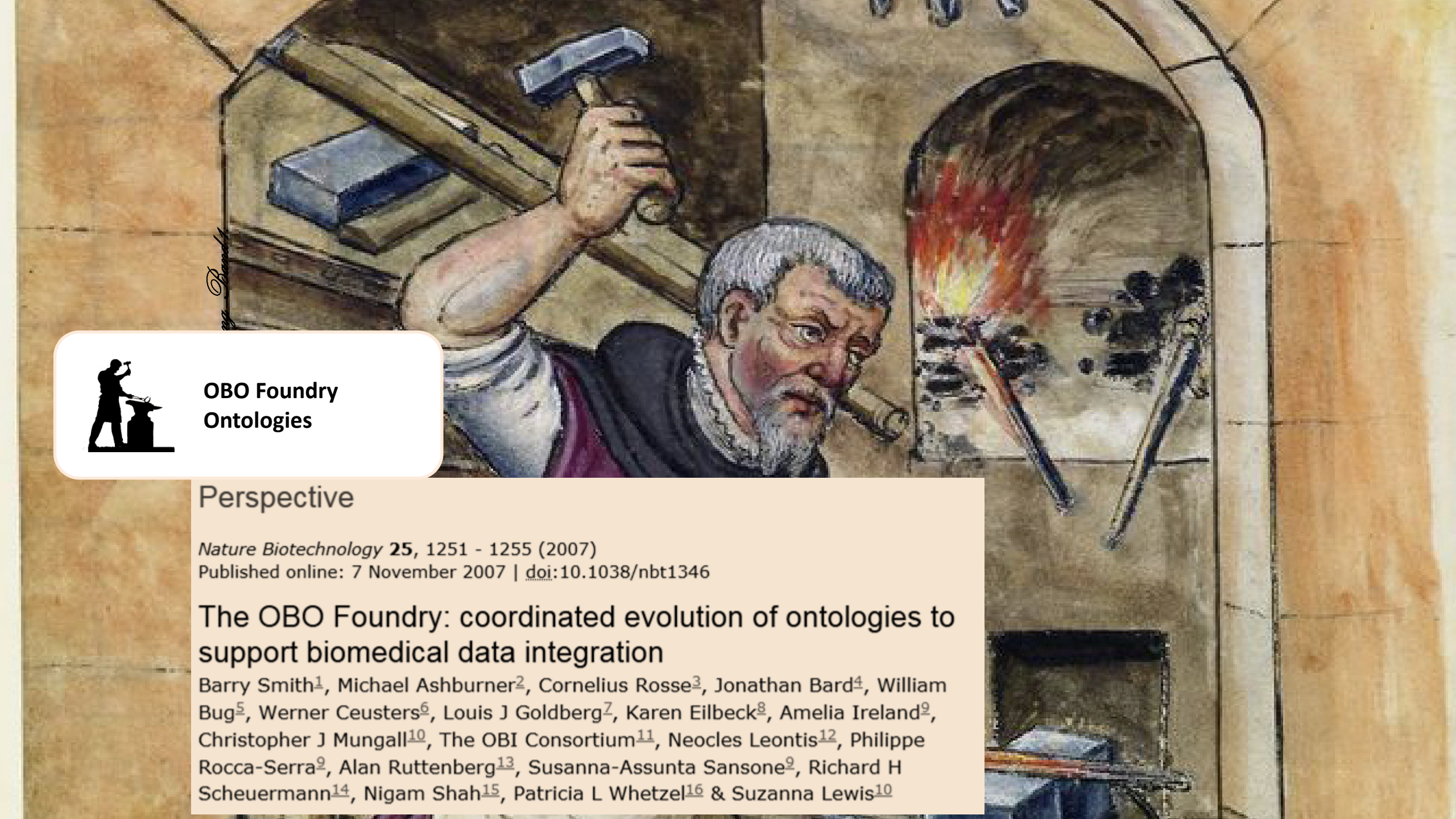





Data, documents, …
Data, documents, …

In the beginning, IS-A was quite simple. Today, however, there are almost as many meanings for this inheritance link as there are knowledge-representation systems.

— Ronald J. Brachman, What IS-A is and isn't



OBO Foundry Ontologies

Perspective

Nature Biotechnology **25**, 1251 - 1255 (2007)
Published online: 7 November 2007 | doi:10.1038/nbt1346

The OBO Foundry: coordinated evolution of ontologies to support biomedical data integration

Barry Smith[1], Michael Ashburner[2], Cornelius Rosse[3], Jonathan Bard[4], William Bug[5], Werner Ceusters[6], Louis J Goldberg[7], Karen Eilbeck[8], Amelia Ireland[9], Christopher J Mungall[10], The OBI Consortium[11], Neocles Leontis[12], Philippe Rocca-Serra[9], Alan Ruttenberg[13], Susanna-Assunta Sansone[9], Richard H Scheuermann[14], Nigam Shah[15], Patricia L Whetzel[16] & Suzanna Lewis[10]

Defined in the Basic Formal Ontology

RELATION TO TIME / GRAIN	CONTINUANT					OCCURRENT	
	INDEPENDENT			DEPENDENT			
ORGAN AND ORGANISM	Organism (NCBI Taxonomy)	Anatomical Entity (FMA, CARO)	Environments (ENVO)	Organ Function (FMP, CPRO)	Phenotypic Quality (PATO)	Biological Process (GO)	Environmental processes (ENVO)
CELL AND CELLULAR COMPONENT	Cell (CL)	Cellular Component (FMA, GO)		Cellular Function (GO)			
MOLECULE	Molecule (ChEBI, SO, RnaO, PrO)			Molecular Function (GO)		Molecular Process (GO)	

Adapted from the Open Biomedical Ontology (OBO) Foundry proposal http://obofoundry.org/

OBO Foundry Principles

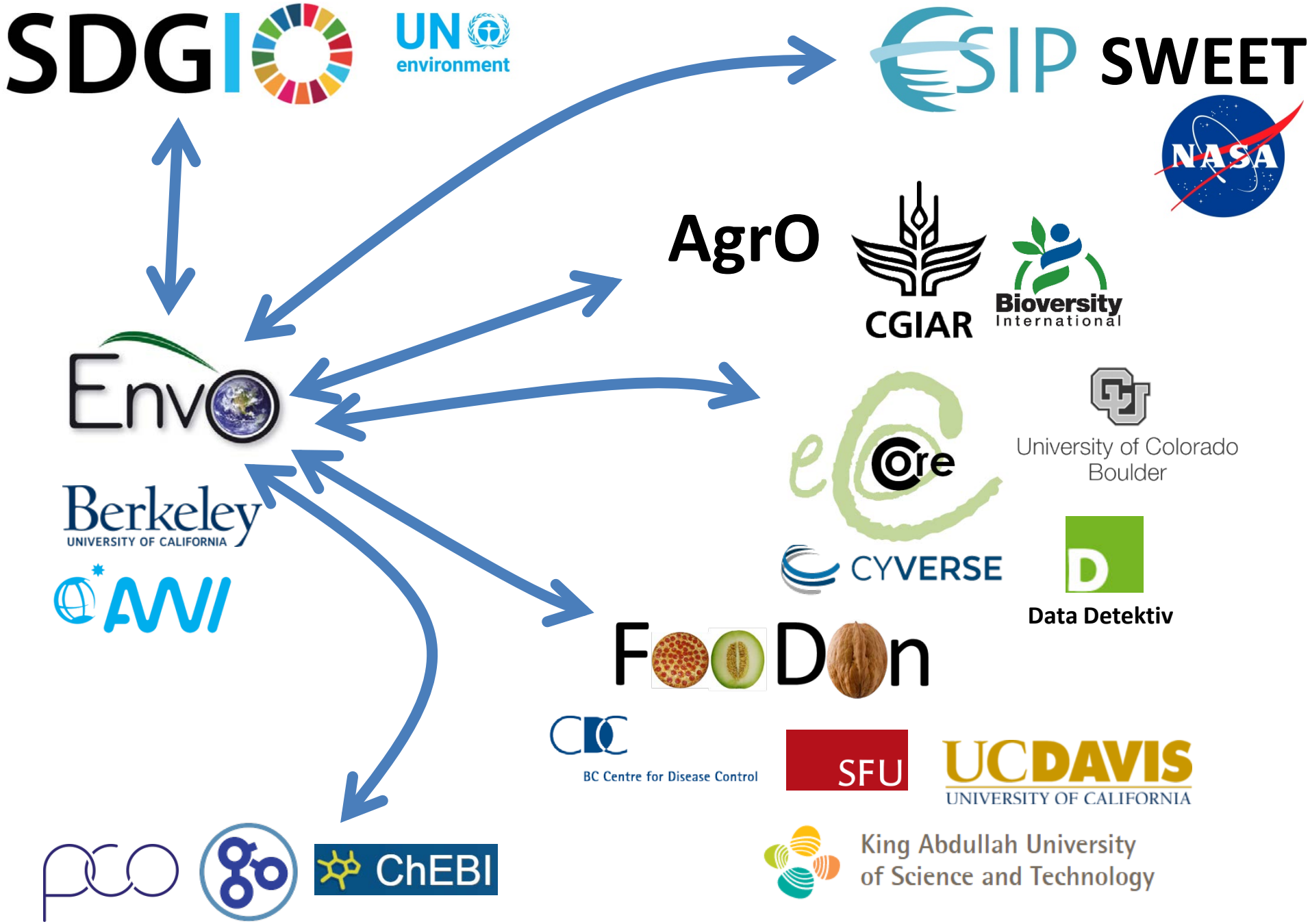
1. Versioning
2. Common Format
3. URI/Identifier Space
4. Naming Conventions
5. Textual Definitions
6. Documented Plurality of Users
7. Open
8. Commitment To Collaboration
9. Maintenance
10. Scope
11. Relations
12. Locus of Authority
13. Documentation

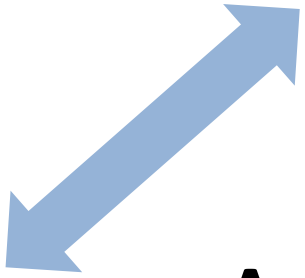
These principles are intended as normative for OBO Foundry ontologies, and ontologies submitted for review will be evaluated according to them.

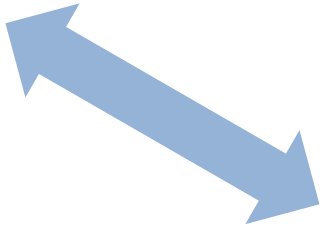
We consider these to be generally good practice, and recommend they be considered even if there are no plans to submit an ontology for review by the Foundry.

Where we use capitalized words such as "MUST", and "SHOULD", they will be interpreted according to RFC 2119: Key words for use in RFCs to Indicate Requirement Levels when the principles are applied during reviews of ontologies for inclusion in the Foundry.

http://obofoundry.org/principles/fp-000-summary.html


SDGIO
UN environment
SIP SWEET
NASA
AgrO
CGIAR
Bioversity International
Envo
Berkeley UNIVERSITY OF CALIFORNIA
AWI
eCore
CYVERSE
University of Colorado Boulder
Data Detektiv
FoodOn
BC Centre for Disease Control
SFU
UCDAVIS UNIVERSITY OF CALIFORNIA
King Abdullah University of Science and Technology
ChEBI





Active and sustained alignment efforts ongoing

SWEET

Polar Semantics WG

Map to NERC VS #731

Open **pbuttigieg** opened this issue on Mar 20 · 12 comments

pbuttigieg commented on Mar 20 Member

In #728, created during a BODC / NERC-VS, BCO-DMO, and ENVO meeting at the Marine Institute in Dublin, we demonstrated how we would map ontology terms to the SKOS resources in the NERC VS.

We'd like to do this *en masse* as has been done for the SWEET-ENVO mapping by **@cmungall**:
https://github.com/cmungall/sweet-obo-alignment

Indeed, the NERC Vocabs can be mapped to UBERON and several other OBO resources too.

@gwemon could you suggest which vocabs we should target first? Things that deal with environmental entities (geographic features, materials, etc) and anatomy would be a good place to start.

Ping:
@gwemon
@ashepherd
@adamml

gwemon commented on Mar 21

@pbuttigieg @cmungall
You could start with the following:
Matrix domain entities: http://vocab.nerc.ac.uk/collection/S21/current/
Matrix phase entities: http://vocab.nerc.ac.uk/collection/S23/current/
The one mentioned by Alex above is our chemical substance vocab:
http://vocab.nerc.ac.uk/collection/S27/current/
The physical entity name and its subgroups: http://vocab.nerc.ac.uk/collection/S18/current/ and
http://vocab.nerc.ac.uk/collection/S19/current/
The datum vocab: http://vocab.nerc.ac.uk/collection/S20/current/
The one for organs and various body parts is: http://vocab.nerc.ac.uk/collection/S12/current/
Any questions pls let us know.

Mapping to S23

Notes

The notes below clarify why S23 terms may be aligned to ENVO terms with somewhat different labels. In all cases, the semantics reflect the S23 definitions, rather than their label.

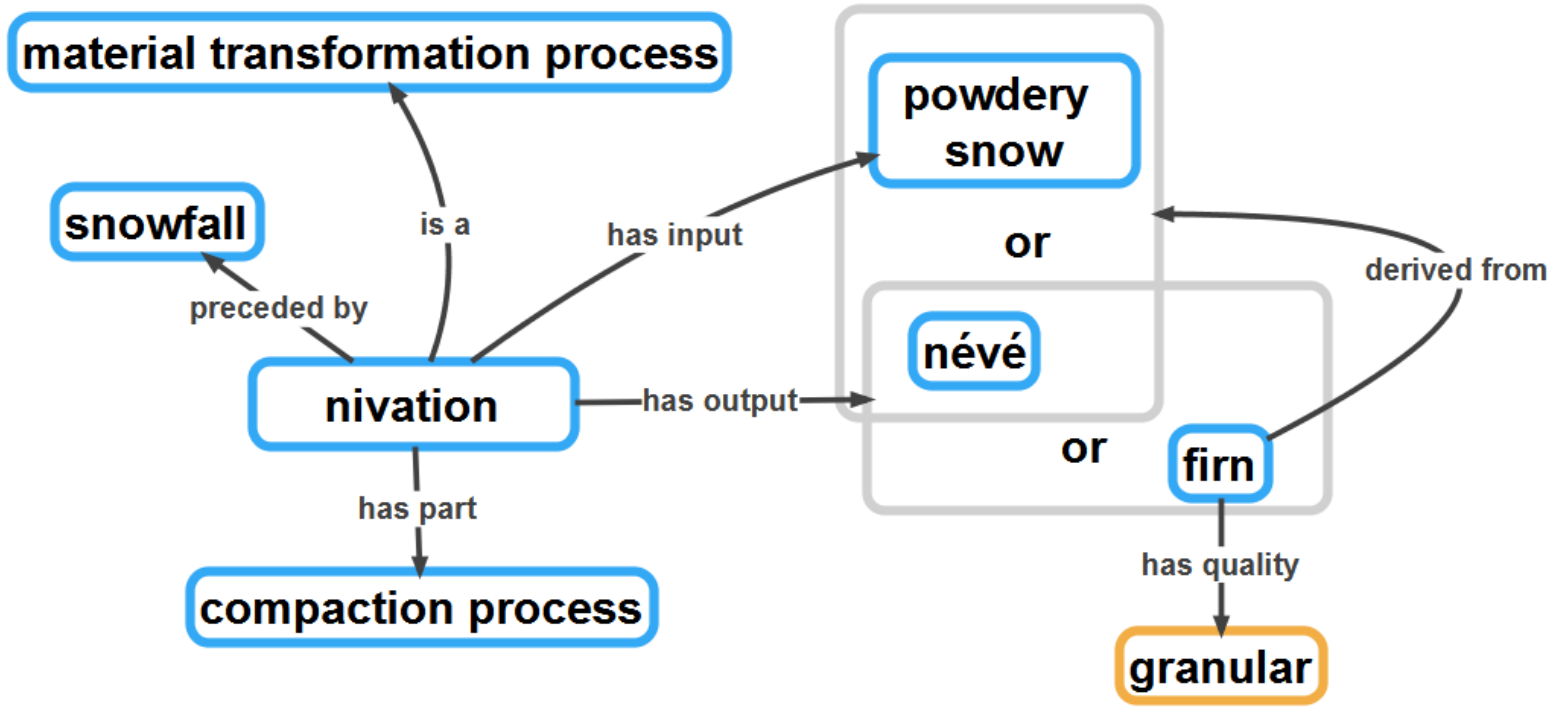
0. These are values of a categorical variable rather than references to bona fide entities. We wouldn't create classes in ENVO for these.
1. The definition in S23 specifies that this is part of an atmosphere, rather than any aerosol.
2. The definition in S23 doesn't sound like a quality/property, but references the actual solids which are amorphous.
3. This has been axiomatised with GO:biological_process and CHEBI carbonates.
4. This class has been linked to the hydrosphere via parthood
5. As mentioned above, this term's definition does not describe the phase, but the gaseous portions of the atmosphere .

Some cool examples…

Developing cryosemantics

- Development work including ontologists, subject experts, and logicians organised around cryohackathons
- Currently led by Ruth Duerr and PL Buttigieg – working through an immense WMO-commissioned definition synthesis (GCW, NSIDC, …) by R Duerr
- Cryohackathons and open to all and deal with a cluster of terms each month
- Expert knowledge is added to the ontologies in real-time
- All contributors are nano-credited in the ontology terms they co-develop
- OBO's ENVO and ESIP's SWEET being aligned and made interoperable in the process

A fragment of envoPolar's nivation semantics



envoPolar

PATO

Each node links to many others in ENVO and other interoperating ontologies

EnvironmentOntology / **envo**

Unwatch 19 | Unstar 33 | Fork 20

Code | Issues 326 | Pull requests 5 | Projects 12 | Wiki | Insights | Settings

Revise thermokarst semantics #746

Edit | New issue

Open **pbuttigieg** opened this issue an hour ago · 0 comments

pbuttigieg commented an hour ago — Member

For example, ENVO_01001498 could be a permafrost thawing process *or* a massive ground ice melting process.

Queue for discussion with Cryohackathon crew
@rduerr

pbuttigieg self-assigned this an hour ago

pbuttigieg added **bug** **enhancement** labels an hour ago

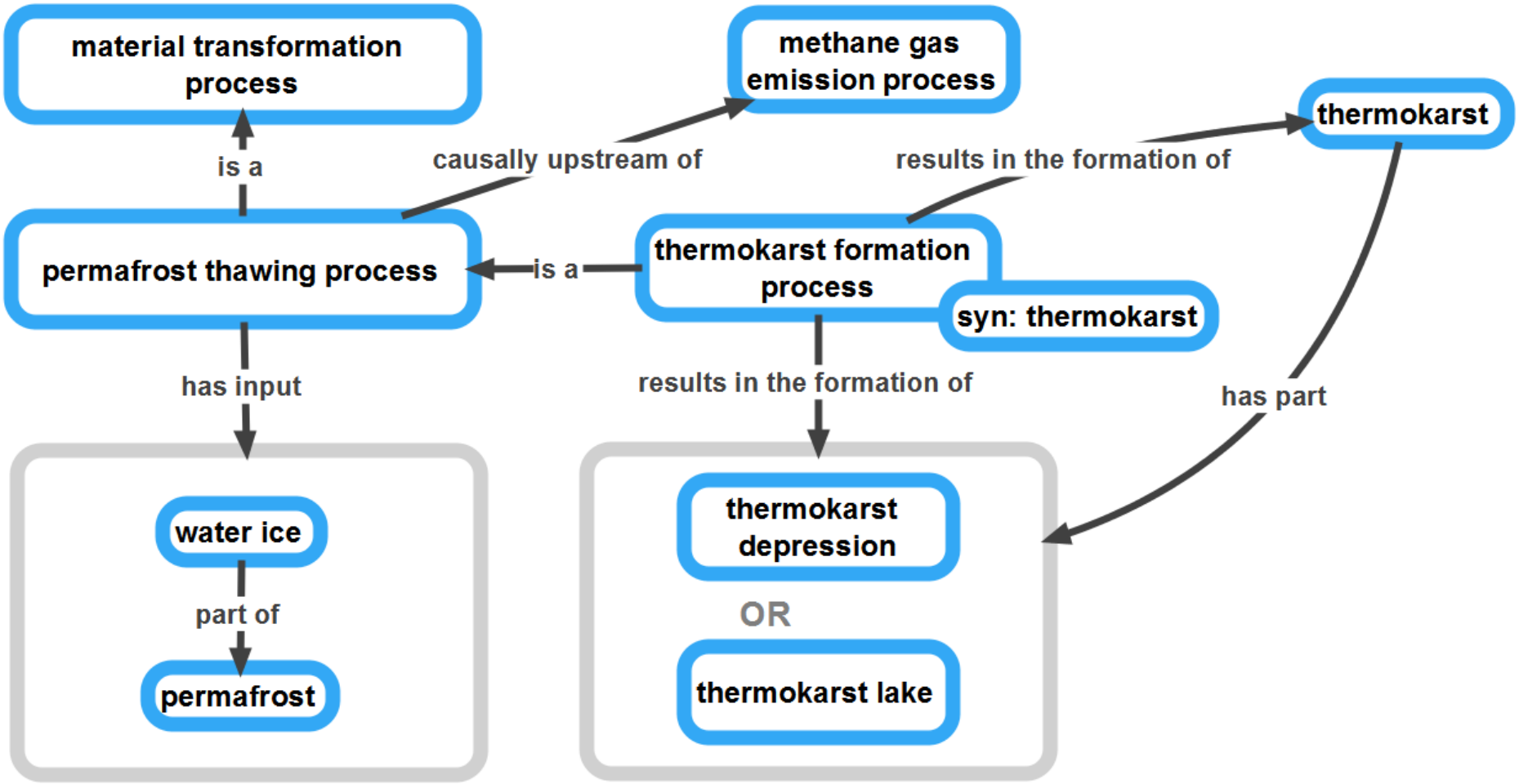
Assignees
pbuttigieg

Labels
bug
enhancement

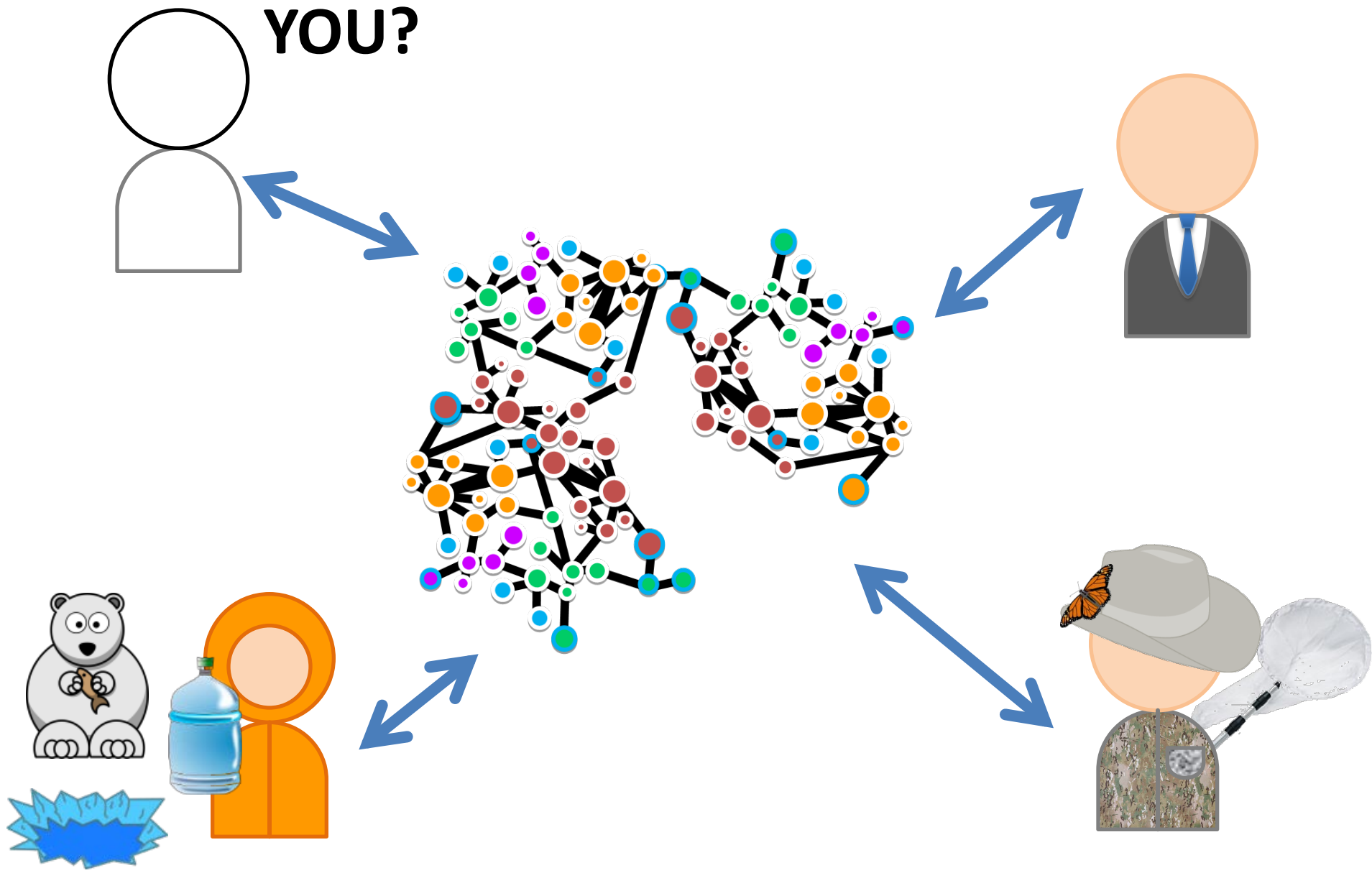
Projects
cryophile (awaiting triage)

Milestone

(part of) the current state of thermokarst semantics



Queued for upcoming cryohackathon


YOU?

Sounds scarier than it is …

Key dimensions of a reference ontology for annotation

Survives funding cycles and has (or can easily add) maintainers, editors, and developers as time goes by

→ follows some global rubric of development

Alfred Wegener Institute
Helmholtz Centre for Polar and
Marine Research

Semantic search

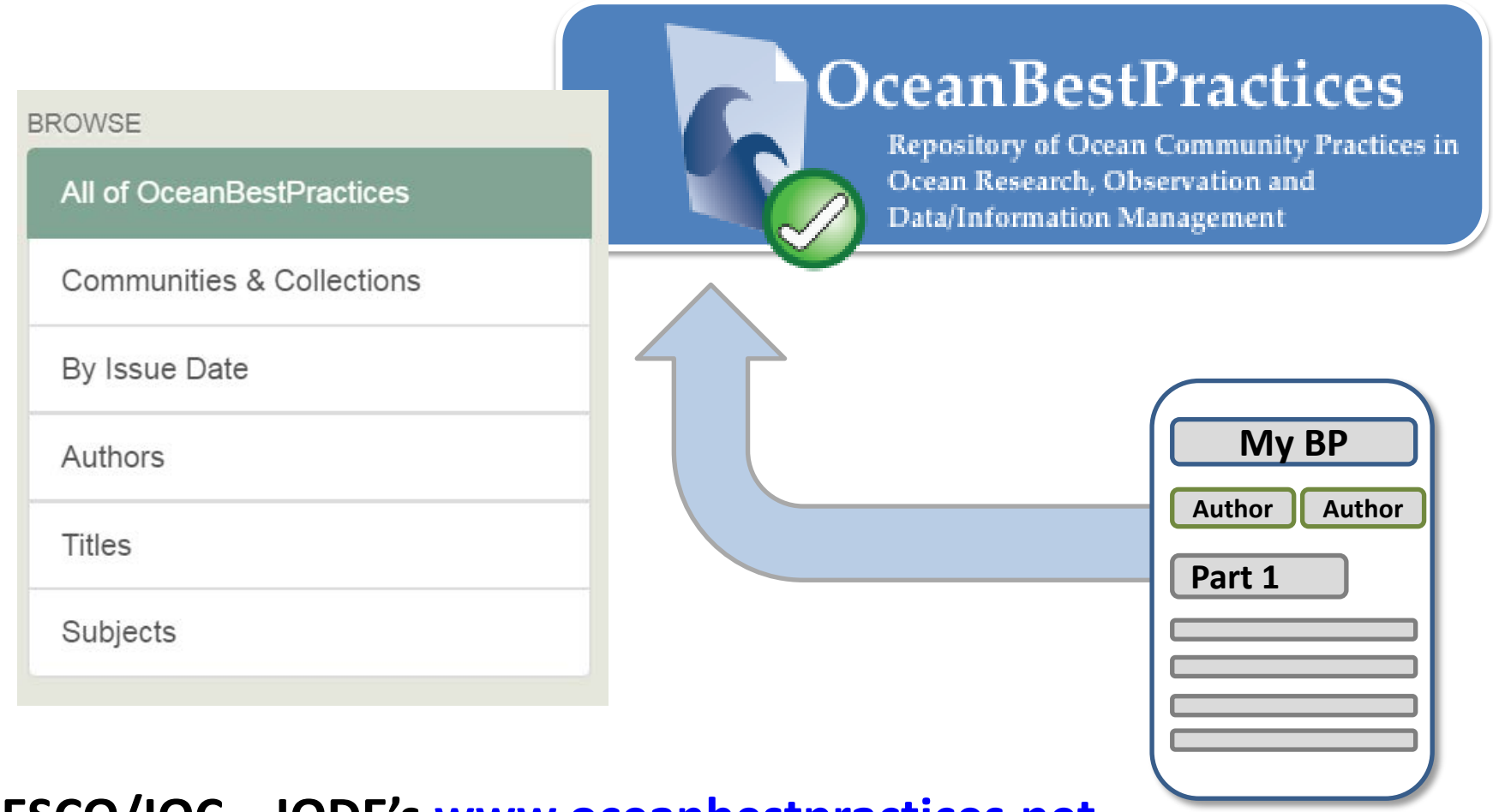
Pier Luigi Buttigieg
OBO Operations Committee
ESIP Semantic Tech Co-chair

Live demo

See slide notes for some examples

Example of semantically boosted search

Easing users in to a full semantic solutions



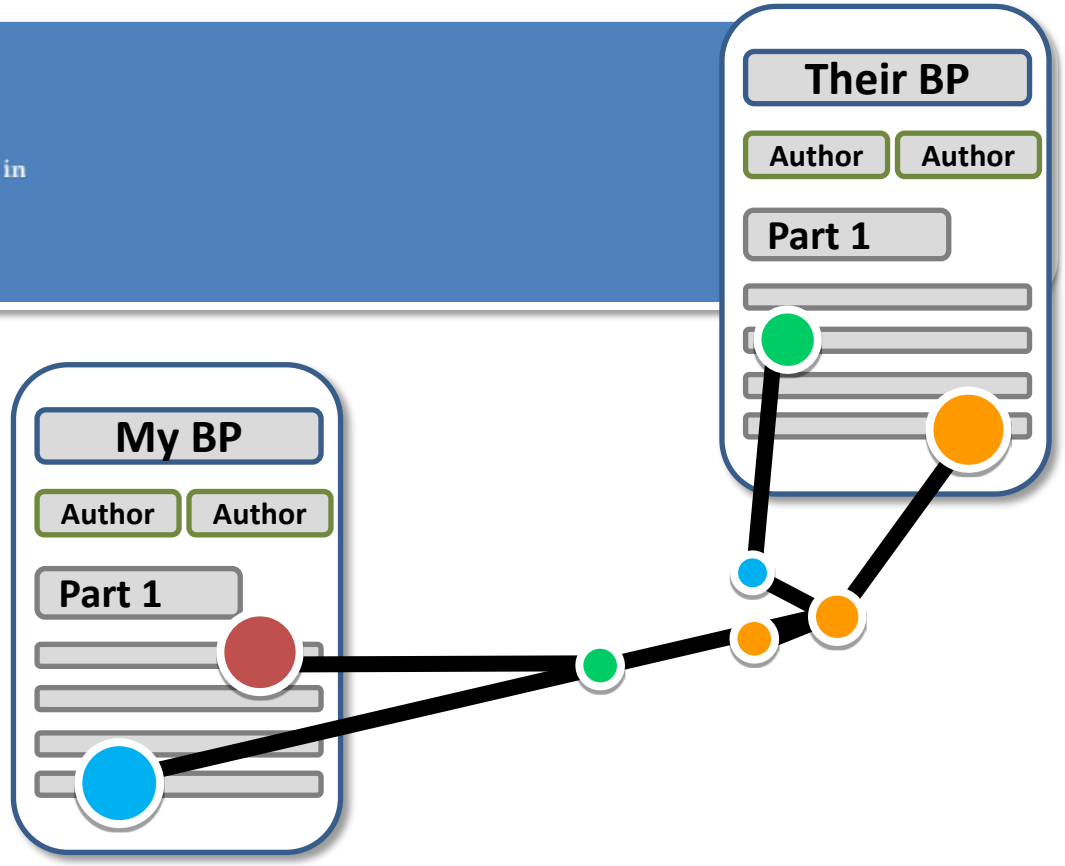
UNESCO/IOC – IODE's www.oceanbestpractices.net

OceanBestPractices

Repository of Ocean Community Practices in Ocean Research, Observation and Data/Information Management

BROWSE

- All of OceanBestPractices
- Communities & Collections
- By Issue Date
- Authors
- Titles
- Subjects

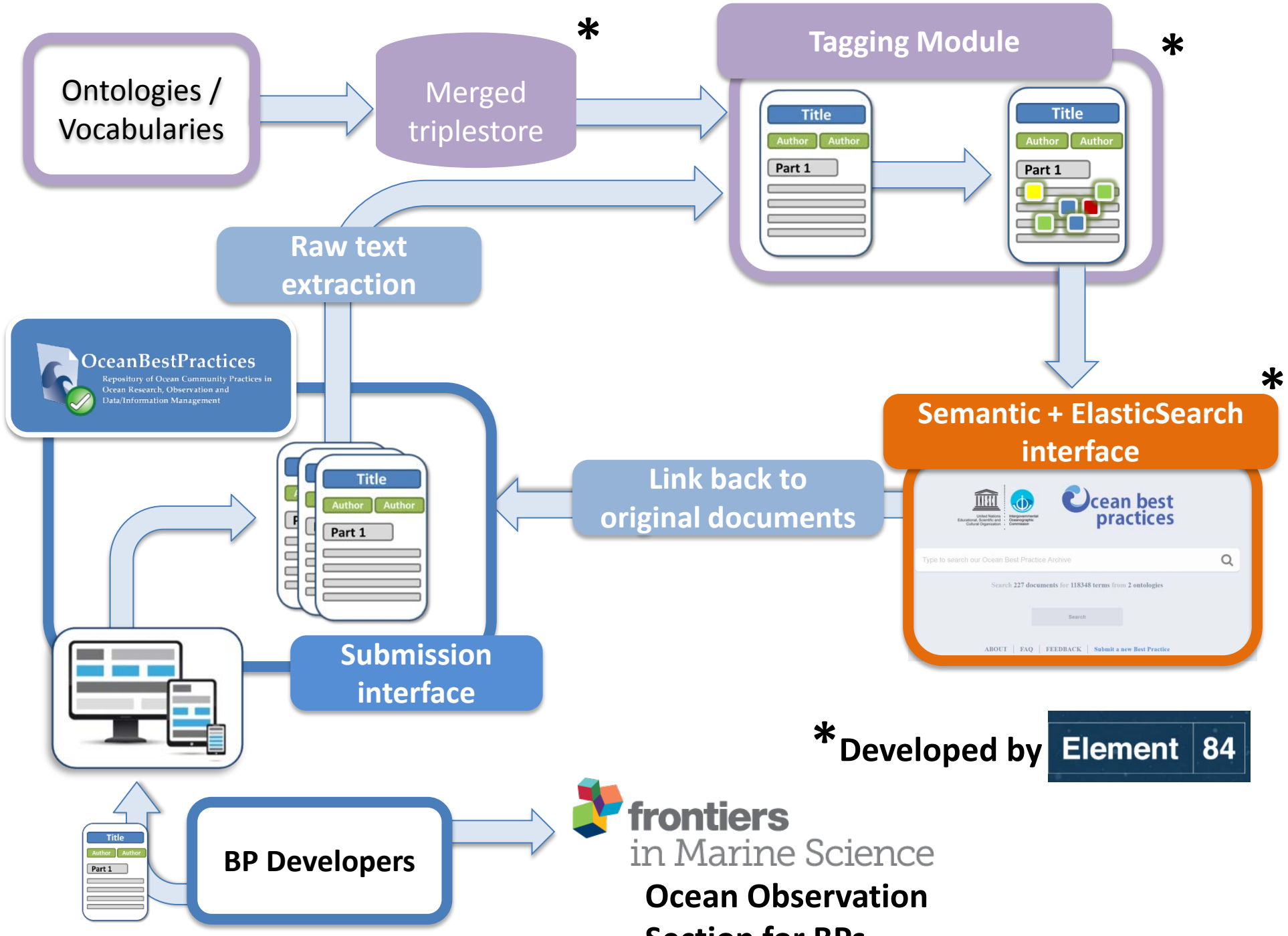


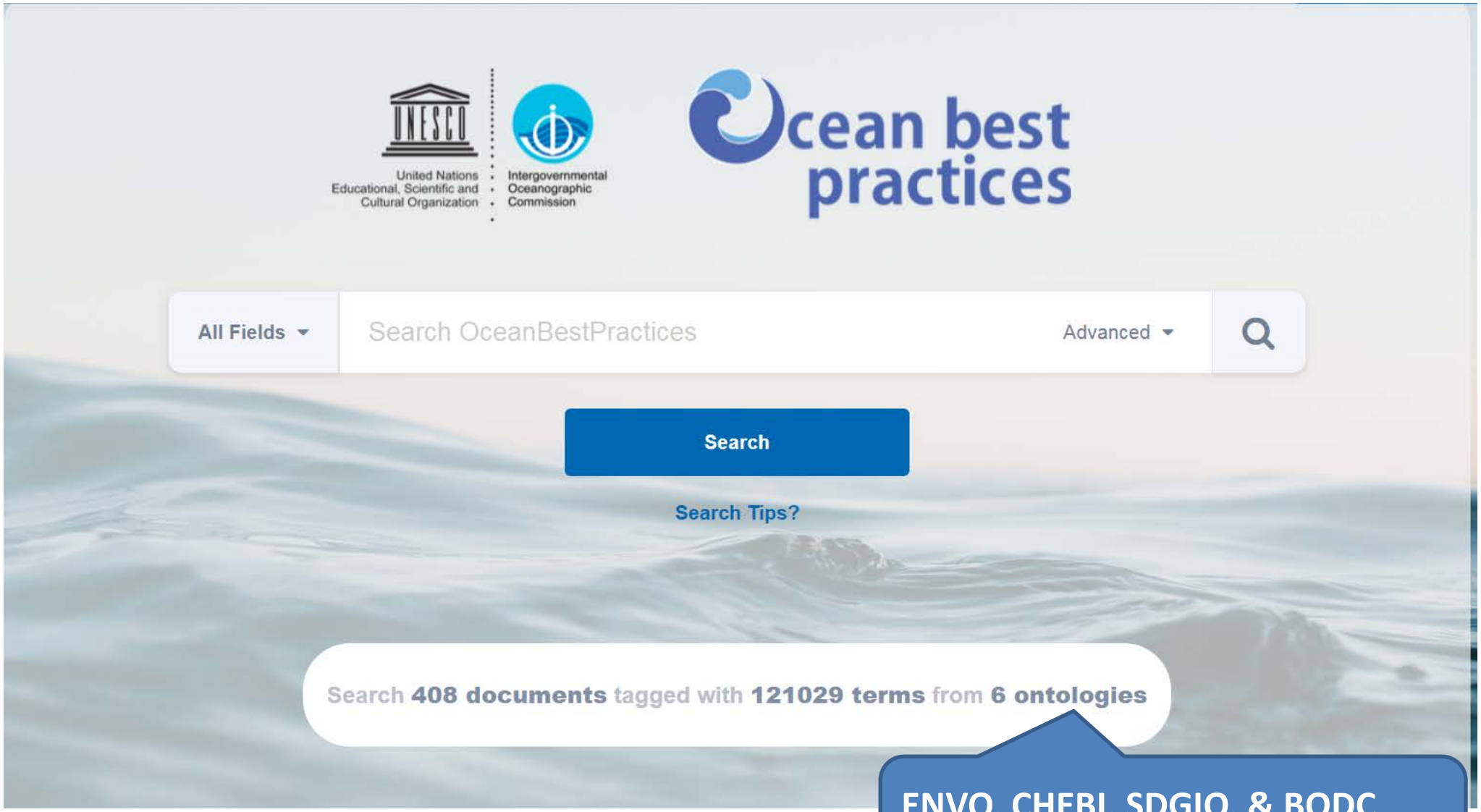
Sensors and platforms, Environments, Chemicals, SDGs…

BODC **NERC Vocab Server**

OBO Foundry Ontologies

ENVO, CHEBI, SDGIO


Ontologies / Vocabularies
Merged triplestore
*
Tagging Module
*
Title
Author
Author
Part 1
Raw text extraction
OceanBestPractices
Repository of Ocean Community Practices in Ocean Research, Observation and Data/Information Management
Semantic + ElasticSearch interface
*
Link back to original documents
Submission interface
BP Developers
*Developed by Element 84
frontiers in Marine Science
Ocean Observation Section for BPs


United Nations
Educational, Scientific and
Cultural Organization
Intergovernmental
Oceanographic
Commission
Ocean best
practices
All Fields
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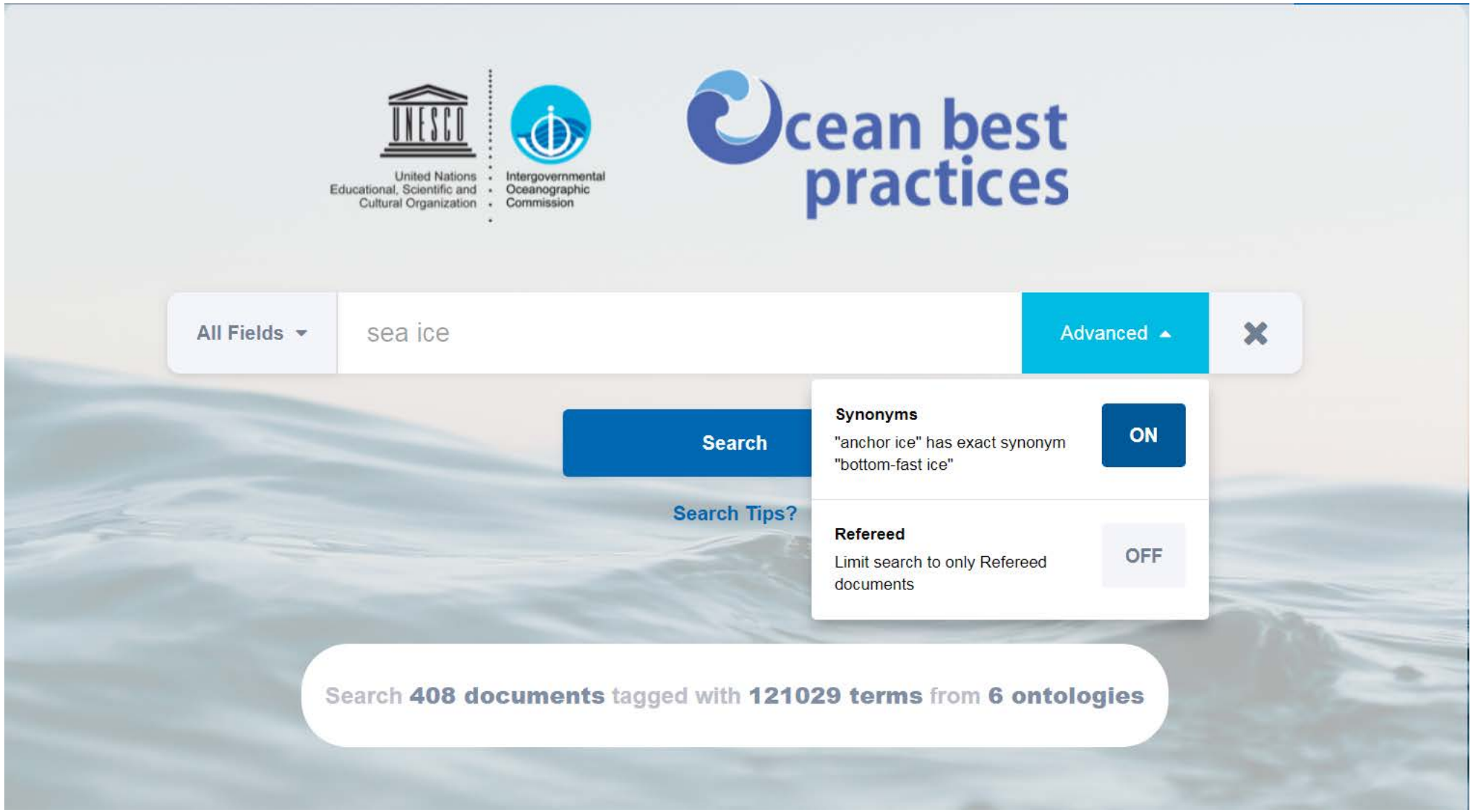
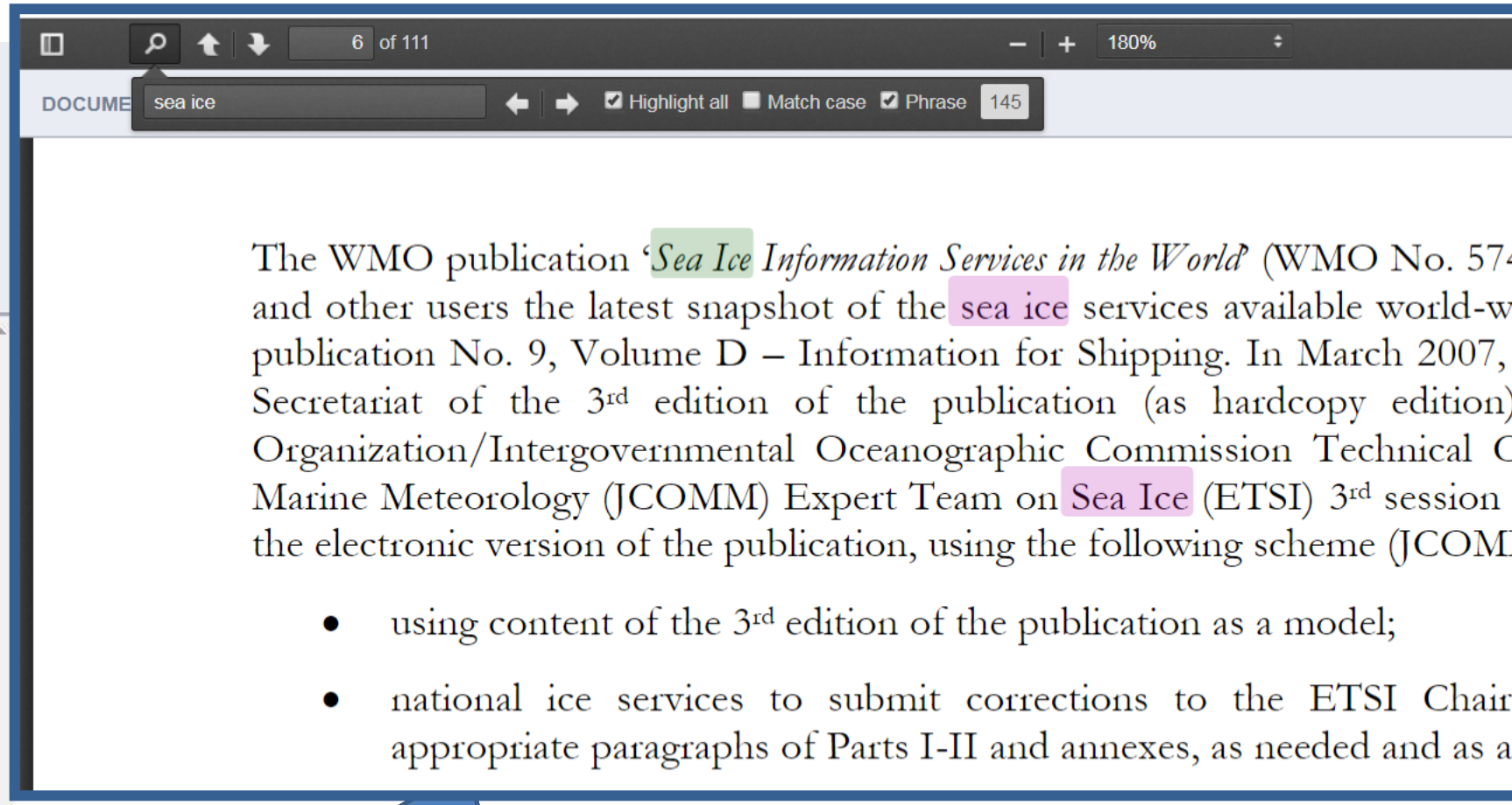
Advanced
Search
Search Tips?
Search 408 documents tagged with 121029 terms from 6 ontologies
ENVO, CHEBI, SDGIO, & BODC
sensor and platform vocabs


United Nations
Educational, Scientific and
Cultural Organization
Intergovernmental
Oceanographic
Commission
Ocean best
practices
All Fields
sea ice
Advanced
Search
Search Tips?
Synonyms
"anchor ice" has exact synonym
"bottom-fast ice"
ON
Refereed
Limit search to only Refereed
documents
OFF
Search 408 documents tagged with 121029 terms from 6 ontologies

Ocean best practices

Select View Tags on a search result to view keywords associated with that document and their relationships.

More about tags

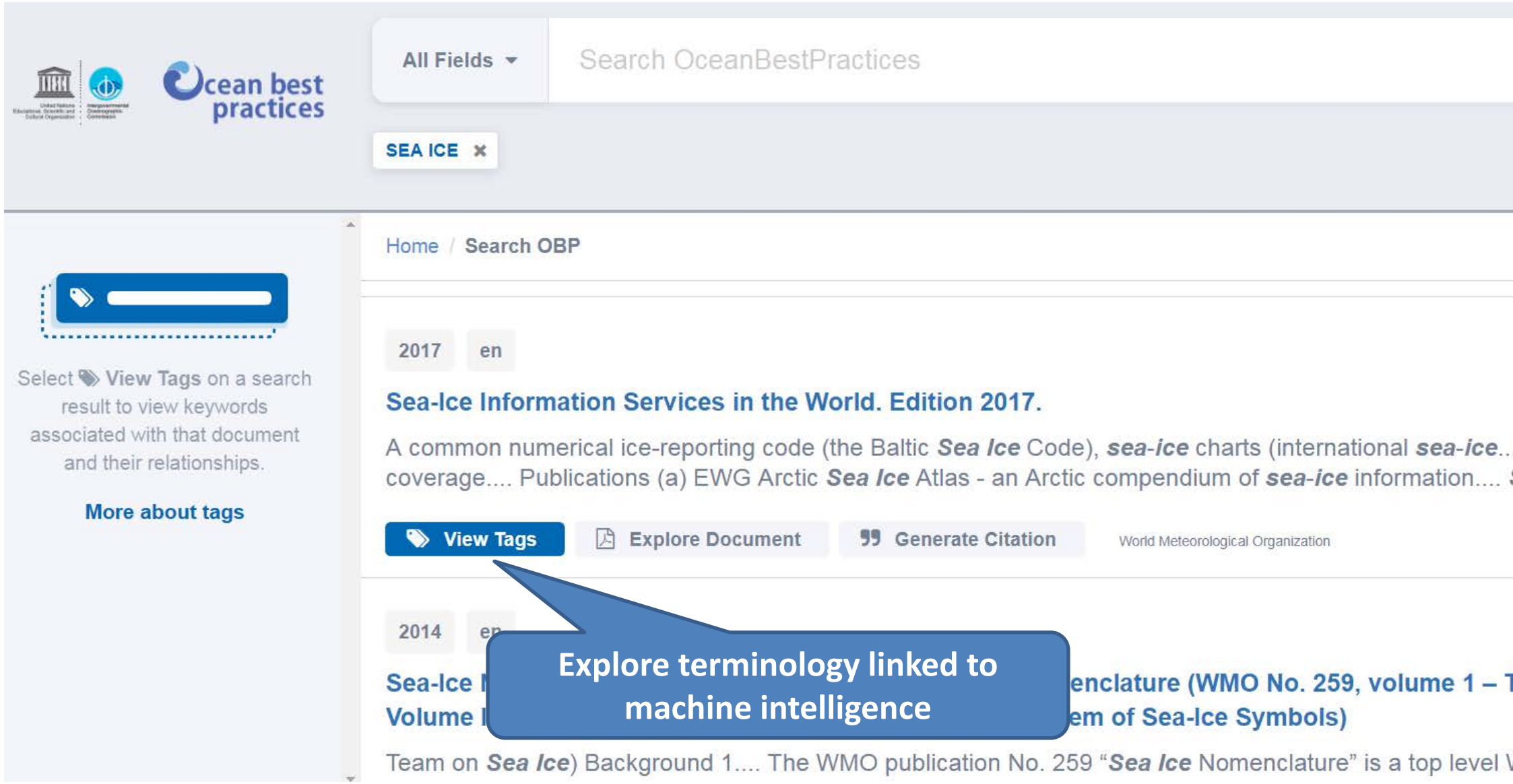


2014 en

Sea-Ice N enclature (WMO No. 259, volume 1 – T
Volume I em of Sea-Ice Symbols)

Team on ***Sea Ice***) Background 1.... The WMO publication No. 259 "***Sea Ice*** Nomenclature" is a top level V

Rapidly access document parts linked to terms of interest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Team on Sea Ice) Background 1.... The WMO publication No. 259 "Sea Ice Nomenclature" is a top level


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SEA ICE
Constrain / Expand searches assisted by knowledge models
ICE SHELF
is a ...
ice mass
... part of
ice rise
sea ice
(ENVO)
Special Sensor Microwave Imager
(SEAVOX DEVICE CATALOGUE)
marine environment
(ENVO)
drift ice
(SEAVOX PLATFORM CATEGORIES)
ice shelf
(ENVO)
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(SEAVOX PLATFORM
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(international sea-ice...
sea-ice information.... S
Viewing Tags
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cal Organization
The semantic context of each term is sourced from ontologies and vocabularies…
the WMO Sea Ice Nomenclature (WMO No. 259, volume 1 – Te
III – International System of Sea-Ice Symbols)
Team on Sea Ice) Background 1.... The WMO publication No. 259 "Sea Ice Nomenclature" is a top level W