Ontoanimal Tools: Web-based Ontology Tools

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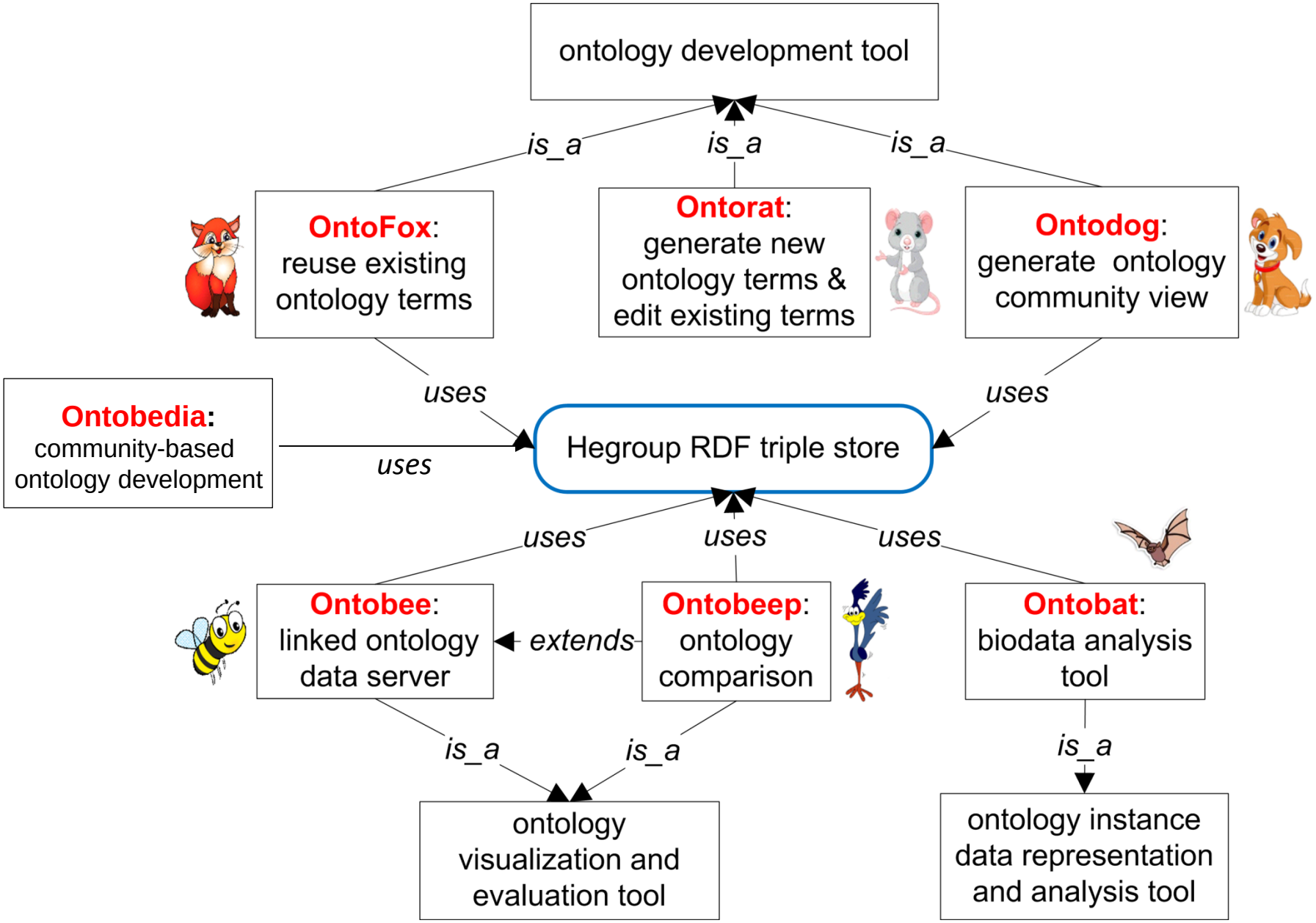
Ontoanimal Tools

- A suite of web-based ontology tools developed to support efficient and integrated ontology development and applications
- The Ontoanimal tools suite includes
  - OntoFox
  - Ontodog
  - Ontorat
  - Ontobee
  - Ontobeep
  - Ontobat
  - Ontobedia
- Each tool has specific functions
- Developed by Dr. Yongqun(Oliver) He group


ontology development tool
is_a
is_a
is_a
OntoFox: reuse existing ontology terms
Ontorat: generate new ontology terms & edit existing terms
Ontodog: generate ontology community view
Ontobedia: community-based ontology development
uses
uses
uses
Hegroup RDF triple store
uses
uses
uses
Ontobee: linked ontology data server
extends
Ontobeep: ontology comparison
Ontobat: biodata analysis tool
is_a
is_a
is_a
ontology visualization and evaluation tool
ontology instance data representation and analysis tool

ONTOBEE

LINKED ONTOLOGY DATA SERVER

Ontobee

- http://www.ontobee.org
- An ontology browser
- A linked ontology data server for dereferencing ontology terms
- Provide term statistics of an ontology

Ontology Summary Page

Ontology Statistics Page

Ontobee http://www.ontobee.org/ontostat/OBI

Home | Introduction | Statistics | SPARQL | Ontobeep | Tutorial | FAQs | References | Links | Contact | Acknowledge | News

Statistics of Ontology for Biomedical Investigations

Ontology: OBI

Index	Ontology Prefix	Class	ObjectProperty	DatatypeProperty	AnnotationProperty	Instance	Total
1	BFO	36	8	0	4	0	48
2	CARO	5	0	0	0	0	5
3	CHEBI	56	0	0	0	0	56
4	CL	23	0	0	0	0	23
5	CLO	6	0	0	0	0	6
6	ENVO	3	0	0	0	0	3
7	GAZ	1	0	0	0	1	2
8	GO	143	0	0	0	0	143
9	HP	1	0	0	0	0	1
10	IAO	125	16	4	29	19	193
11	IDO	2	0	0	0	0	2
12	NCBITaxon	32	0	0	0	0	32
13	OBI	2,376	40	2	4	84	2,506

Ontobee http://purl.obolibrary.org/obo/OBI_0000070

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Ontology for Biomedical Investigations

Keywords: Search terms

Class: assay

Term IRI: http://purl.obolibrary.org/obo/OBI_0000070

Definition: A planned process with the objective to produce information about the material entity that is the evaluant, by physically examining it or its proxies.

Annotations

- **editor note:**12/3/12: BP: the reference to the 'physical examination' is included to point out that a prediction is not an assay, as that does not require physical examiniation.
- **definition editor:**PlanAndPlannedProcess Branch
- **IEDB alternative term:**any method
- **ISA alternative term:**study assay
- **alternative term:**measuring; scientific observation
- **definition source:**OBI branch derived
- **example of usage:**Assay the wavelength of light emitted by excited Neon atoms. Count of geese flying over a house.
- **has curation status:**ready for release

Equivalents

- achieves_planned_objective some assay objective

Class Hierarchy

Thing
+ entity
+ occurrent
+ process
+ planned process
- data item extraction from journal article
more...
- assay
- Bernoulli trial
+ imaging assay

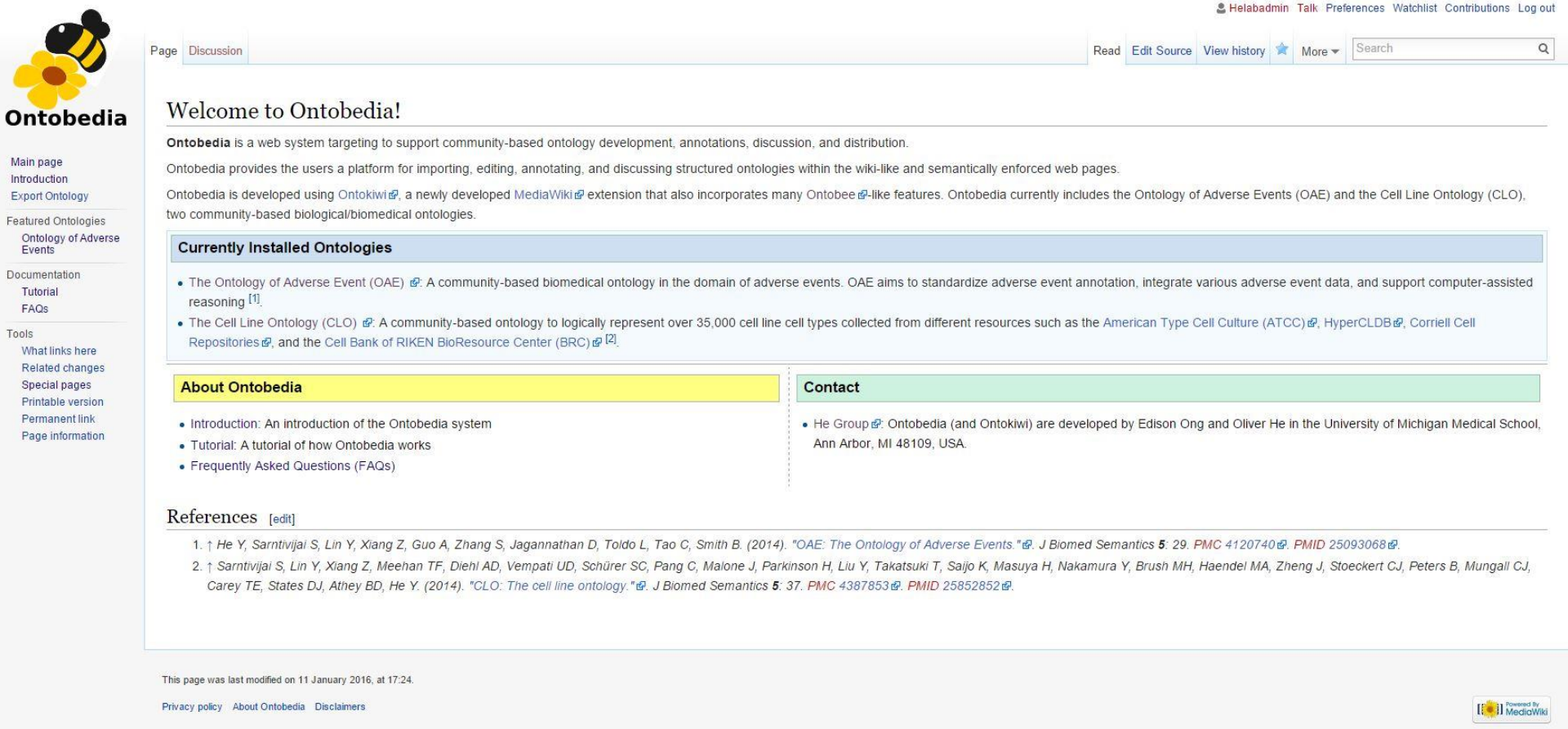
ONTOBEDIA

COMMUNITY-BASED ONTOLOGY DEVELOPMENT

Ontobedia

- http://ontobedia.hegroup.org
- Integrate two platforms, Wikipedia, and Ontobee
- Allow users edit/comment the ontology terms
- Reference:
  - https://jointsummits2016.zerista.com/event/member/234769

Ontobedia Main Page



OAE:OAE_0000003

Label: causal adverse event

IRI: http://purl.obolibrary.org/obo/OAE_0000003

Type: Class

Annotation:

- definition:
  - an adverse event which is a causal adverse event, a pathological bodily process that is induced by a medical intervention.
- editor_note:
  - YH: The term 'causal adverse event' has the same meaning as we previously defined as 'adverse event'. Reference: He Y, Xiang Z, Sarntivijai S, Toldo L, Ceusters W. OAE: a realism-based biomedical ontology for the representation of adverse events. Adverse Event Representation Workshop, International Conference on Biomedical Ontologies (ICBO), University at Buffalo, NY, July 26-30, 2011. Full lenghth conference proceeding paper. We made the name changing as a way to make OAE cover the broader sense of the 'adverse event' which does not assume definite causal effect between an adverse event and a medical intervention.
- term_editor:
  - YH
- alternative_term:
  - adverse effect
- definition_source:
  - Committee to Review Adverse Effects of Vaccines; Institute of Medicine; Stratton K, Ford A, Rusch E, Clayton EW, editors. Adverse Effects of Vaccines: Evidence and Causality. Washington (DC): National Academies Press (US); 2011 Aug. http://www.ncbi.nlm.nih.gov/pubmed/24624471.
  - He Y, Xiang Z, Sarntivijai S, Toldo L, Ceusters W. OAE: a realism-based biomedical ontology for the representation of adverse events. Adverse Event Representation Workshop, International Conference on Biomedical Ontologies (ICBO), University at Buffalo, NY, July 26-30, 2011. Full lenghth conference proceeding paper.

Class Hierarchy

Thing
+ entity
+ occurrent
+ process
+ bodily process
+ pathological bodily process
+ adverse event
+ vaccine adverse event
+ adverse drug event
+ medical device adverse event
+ nutritional product adverse event
+ musculoskeletal or connective tissue AE
+ tumor AE
+ systematic AE
+ metabolism, endocrine or exocrine system AE
- clinical trial adverse event
- influenza like illness AE
+ hair, skin or nail AE
+ congenital AE
+ abdominal AE
- sclerosis AE
- non-serious adverse event
- purulent discharge AE
- suspiciousness AE
- therapy adverse event
- injury or procedural complication AE
more...
- causal adverse event

Contents [hide]

1 Information Not In OAE
1.1 Causal adverse event pattern
1.2 Causal adverse event assessment
2 References

Ontology Content

Equivalent Axiom

- (adverse event and (**induced_by** some medical intervention))

As clearly stated in the VAERS vaccine adverse event reporting system and the FAERS drug adverse event reporting system, clinically reported vaccine or drug adverse events do not imply causality.

Causal adverse event pattern [edit]

A basic design pattern for 'adverse event' and 'causal adverse event' is laid out in the OAE paper [1]. A 'causal adverse event' is fully defined with an equivalence class axiom as: *'adverse event' and ('induced_by' some 'medical intervention')*. According to the OAE model, the causal chain of an adverse event (AE) process includes three subtypes of processes:

1. *Initial stage causal AE sub-process*: occurs immediately after a medical intervention, and ends when the single chain process begins to be forked into sub-processes leading to different fates including positive preventative or therapeutic effect, noises, and adverse events.
2. *Intermediate stage causal AE sub-process*: includes a series of intermediate smaller sub-processes.
3. *Late stage AE formation sub-process*: the execution stage leading to a pathological clinical outcome(s), similar to the caspase cascade execution stage of apoptotic cell death.

Causal adverse event assessment [edit]

It is unlikely to assert an AE causality as a definite "yes" or "no". The AE causality is typically defined as a probability or hypothesis. OAE includes terms representing different methods for AE causality analysis. For example, OAE includes 'Naranjo ADR Probability score' that can be used to annotate data relating the likelihood of a causal drug AE based on patient's answers to pre-designed questions [2].

The CDISC system classifies five causality levels:

1. *not related*,
2. *unlikely related*,
3. *possibly related*,
4. *probably related*,
5. *definitely related*.

These causality types are also represented in OAE.

In addition, AE case reports in a case reporting system (e.g., VAERS) can be analysed using statistical methods such as filtering based on a case number cutoff, proportional reporting ratio (PRR), and Chi-square test.

Furthermore, randomized controlled trials can be implemented to evaluate a causality hypothesis.

As reported in a 2012 study, using VAERS case report data and related documentation, expert reviews could assess the likelihood of adverse event causality into different categories such as definite, probable, possible, unlikely or unrelated [3]. Less than one quarter of VAERS reports were assessed as probable or definite causality, which were dominated by local reactions, allergic reactions, or symptoms known to be linked to the administered vaccine.

References [edit]

1. ↑ *He Y, Sarntivijai S, Lin Y, Xiang Z, Guo A, Zhang S, Jagannathan D, Toldo L, Tao C, Smith B. (2014). "OAE: The Ontology of Adverse Events.". J Biomed Semantics* ***5****: 29. PMC 4120740. PMID 25093068.*
2. ↑ *Naranjo CA, Busto U, Sellers EM, Sandor P, Ruiz I, Roberts EA, Janecek E, Domecq C, Greenblatt DJ. (1981). "A method for estimating the probability of adverse drug reactions.". Clin Pharmacol Ther. 30(2): 239–245. PMID 7249508.*
3. ↑ *Williams SE1, Pahud BA, Vellozzi C, Donofrio PD, Dekker CL, Halsey N, Klein NP, Baxter RP, Marchant CD, Larussa PS, Barnett ED, Tokars JI, McGeeney BE, Sparks RC, Aukes LL, Jakob K, Coronel S, Sejvar JJ, Slade BA, Edwards KM. (2012). "Causality assessment of adverse events reported to the Vaccine Adverse Event Reporting System (VAERS).". Vaccine. 30(50): 7253–9. PMID 23063829.*

Category: OAE

Wiki-page content

ONTOFOX

REUSE EXISTING ONTOLOGY TERMS

Reuse Existing Ontology Resources

- OntoFox
  - A web application for ontology term extraction
  - Require ontologies triple store
- Protégé plugin
- OWLAPI
  - Ontology module extraction
  - Require programming skills

OntoFox

- http://ontofox.hegroup.org/
- A web-based tool that allows users easily reuse the terms defined in external ontologies
  - Support MIREOT (Minimum Information to Reference External Ontology Terms)
  - Support import modules
  - And more …
    - Include all children of a given term
    - Include No/Computed/All Intermediates: no/computed/all intermediate of source terms are retrieved
- Can extract both classes and object properties
- Tutorials available on: http://ontofox.hegroup.org/tutorial/index.php
- **Reference:** Xiang Z, Courtot M, Brinkman RR, Ruttenberg A, He Y. OntoFox: web-based support for ontology reuse. *BMC Research Notes*. 2010, 3:175. PMID: 20569493

What is MIREOT?

- MIREOT stands for **M**inimum **I**nformation to **R**eference **E**xternal **O**ntology **T**erms
- A mechanism to specify, in your ontology, individual terms you want to use from another ontology
- Developed by OBI developers
  - Courtot, M, *et al* (2011). MIREOT: the Minimum Information to Reference an External Ontology Term. Applied Ontology 6, 23-33

Why MIREOT?

- Import of a whole ontology may have too much overhead or may cause inconsistencies and unexpected inferences.
- Creating new terms that replicate those in other ontologies is redundant and makes data integration harder, even if you cross-reference back to the original resource.
- Import modules

What is the minimal information required to refer to another ontology's term?

- IRI of the class
- IRI of the source ontology
- Superclass of the class in your ontology

$\Rightarrow$ this ***minimal set*** allows unambiguous identification of a term. Based on this, when we specify the terms of interest, tools can use that information to manage importing additional information related to the terms to our ontology

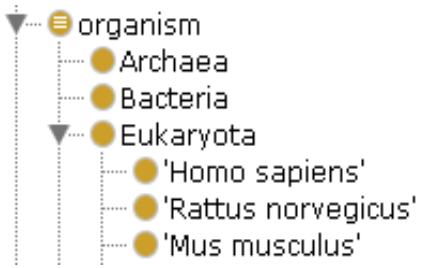
Demo

- Import following NCBITaxon terms:
  - Homo sapiens (NCBITaxon_9606)
  - Mus musculus (NCBITaxon_10090)
  - Rattus norvegicus (NCBITaxon_10116)

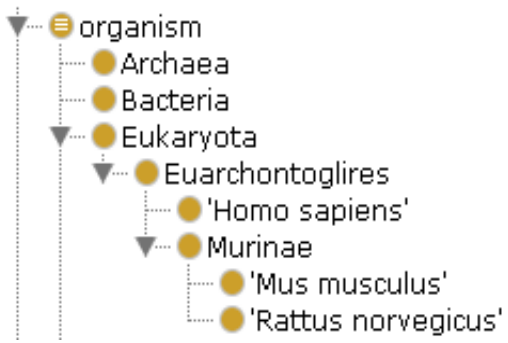
  To Ontology of Biomedical Investigations (OBI)
  - As subclasses of organism (OBI_0100026)
- Using
  - MIREOT strategy
  - Include all Intermediates
  - Include computed Intermediates
- Import some cell type terms including all axioms to OBI

Results of Extraction Using Different Options

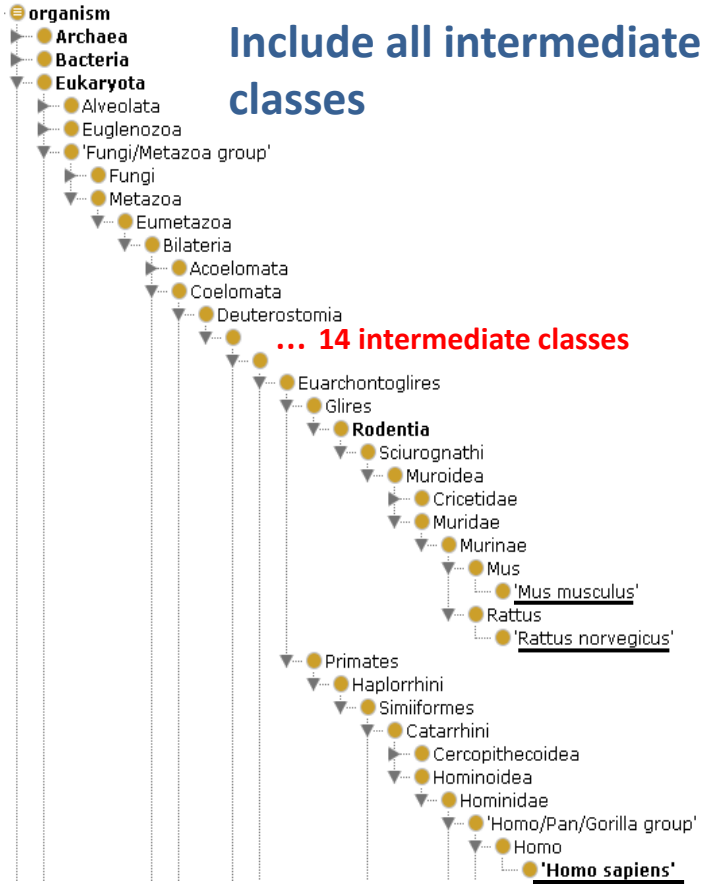
MIREOT



Include computed intermediate classes



Include all intermediate classes



ONTODOG

GENERATE ONTOLOGY COMMUNITY VIEW

Why Need To Generate Ontology View?

- Generally very large and highly detailed
  - GO contains over 30,000 terms, many details in annotation of gene and gene products
- Different applications may use only portions of the reference ontology, based on needs

Generate Ontology View/SLIM Tools

- OntoDog (Web Tool, OWL Format)
  - http://ontodog.hegroup.org/
  - Subset of an ontology including all logical axioms
  - Able to add extra labels
  - Bioinformatics. 2014; doi: 10.1093/bioinformatics/btu008.
- SLIM (desktop/web application, OBO/OWL Format)
  - Subset of an ontology
  - Using GO as an example:
    http://geneontology.org/page/go-slim-and-subset-guide
- OWL API (OWL module)
  - Subset of an ontology including all logical axioms

Ontodog

- http://ontodog.hegroup.org/
- One implementation of generation of ontology custom view automatically
- Web application tool, no installation and minimal ontology knowledge required
  - Provide templates to tag the ontology view terms in a tab delimited file
  - Extract any subset of a source ontology
  - Generate view annotation owl file
- Tutotial: http://ontodog.hegroup.org/tutorial/index.php
- Reference: Zheng, J., Xiang, Z., Stoeckert, C.J., Jr., and He, Y. (2014). Ontodog: a web-based ontology community view generation tool. *Bioinformatics* 30, 1340-1342

Ontology Community View

- a subset of the whole ontology or tagged subset of terms in the whole ontology to meet users' specific need
- contains user preferred labels where needed

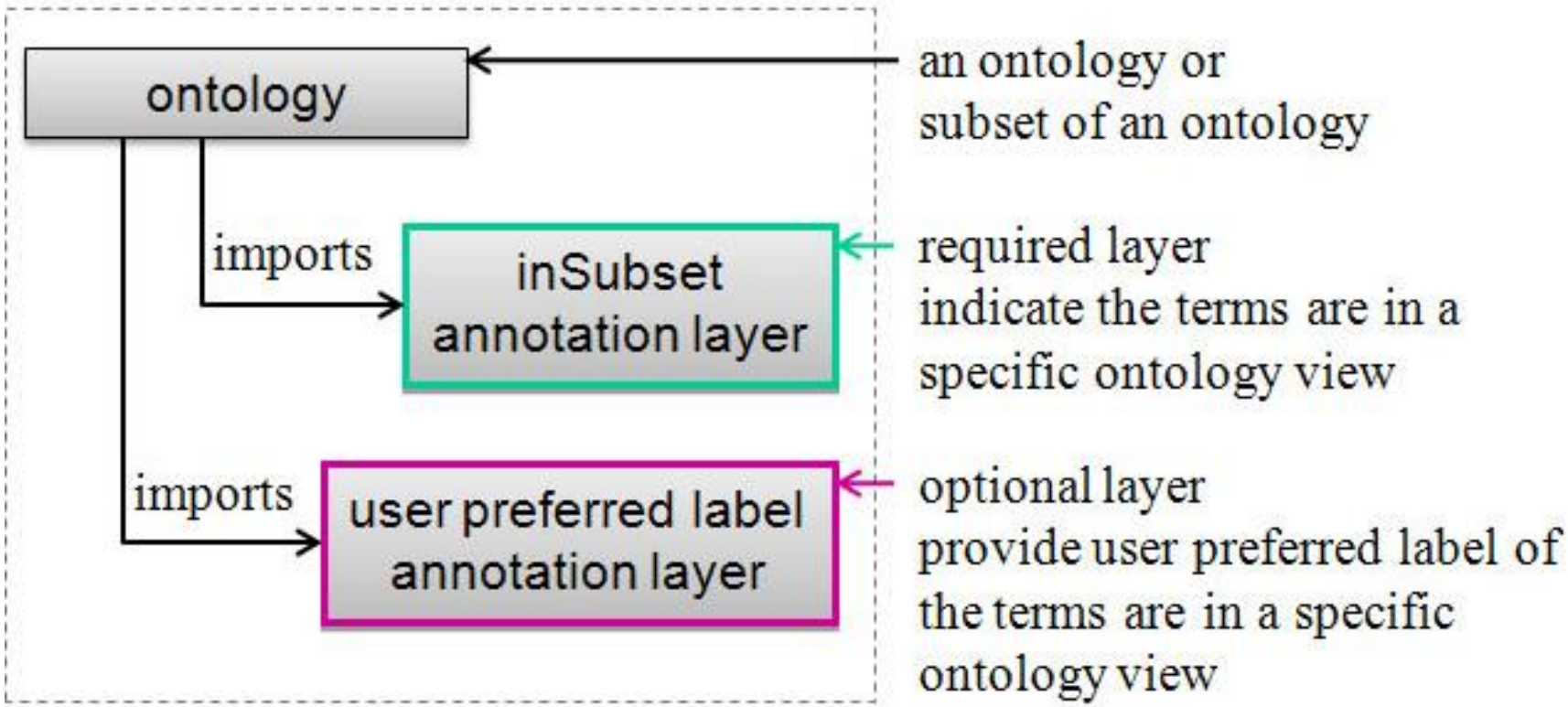
Annotation Properties

- Annotation property
  - Tag the terms interesting to a specific community and/or application
  - Provide user preferred labels
- Examples
  - inSubset annotation property

  Indicate the terms in which custom views
  - FGED alternative term

  User preferred label, as subclass of ‘alternative term’

Annotation Layers



Ontology Community View

obi.owl

```
<?xml version="1.0"?>
<rdf:RDF xmlns="http://purl.obolibrary.org/obo/obi.owl#"
    xml:base="http://purl.obolibrary.org/obo/obi.owl"
    xmlns:ro="http://www.obofoundry.org/ro/ro.owl#"
    xmlns:p3=http://purl.obolibrary.org/obo/iao/dev/iao-main.owl#
    xmlns:snap=http://www.ifomis.org/bfo/1.1/snap#
    xmlns:bfo=http://www.ifomis.org/bfo/1.1#
    xmlns:rdf=http://www.w3.org/1999/02/22-rdf-syntax-ns#
    xmlns:owl=http://www.w3.org/2002/07/owl#
    ……
    xmlns:span="http://www.ifomis.org/bfo/1.1/span#">
   <owl:Ontology rdf:about=http://purl.obolibrary.org/obo/obi.owl>
   …….
```

source ontology

1

subset of source ontology

obi_FGED.owl

```
<?xml version="1.0"?>
<rdf:RDF xmlns="http://purl.obolibrary.org/obo/obi.owl#"
    xml:base="http://purl.obolibrary.org/obo/obi.owl"
    xmlns:ro="http://www.obofoundry.org/ro/ro.owl#"
    xmlns:p3=http://purl.obolibrary.org/obo/iao/dev/iao-main.owl#
    xmlns:snap=http://www.ifomis.org/bfo/1.1/snap#
    xmlns:bfo=http://www.ifomis.org/bfo/1.1#
    xmlns:rdf=http://www.w3.org/1999/02/22-rdf-syntax-ns#
    xmlns:owl=http://www.w3.org/2002/07/owl#
    ……
    xmlns:span="http://www.ifomis.org/bfo/1.1/span#">
   <owl:Ontology rdf:about=http://purl.obolibrary.org/obo/obi_FGED.owl>
   …….
```

2 view annotation layer

view_annot.owl

```
<rdf:Description rdf:about="http://purl.org/obo/owl/NCBITaxon#NCBITaxon_8360">
  <obo:OBI_9991119 xml:lang="en">Xenopodinae</obo:OBI_9991119>
</rdf:Description>
<rdf:Description rdf:about="http://purl.obolibrary.org/obo/OBI_0000879">
  <obo:OBI_9991119 xml:lang="en">random primed DNA labeling</obo:OBI_9991119>
</rdf:Description>
……
```

1 imports 2 = 4 ontology view

```
<?xml version="1.0"?>
<rdf:RDF xmlns="http://purl.obolibrary.org/obo/obi.owl#"
    xml:base="http://purl.obolibrary.org/obo/obi.owl"
    xmlns:ro="http://www.obofoundry.org/ro/ro.owl#"
    xmlns:p3=http://purl.obolibrary.org/obo/iao/dev/iao-main.owl#
    xmlns:snap=http://www.ifomis.org/bfo/1.1/snap#
    xmlns:bfo=http://www.ifomis.org/bfo/1.1#
    xmlns:rdf=http://www.w3.org/1999/02/22-rdf-syntax-ns#
    xmlns:owl=http://www.w3.org/2002/07/owl#
    ……
    xmlns:span="http://www.ifomis.org/bfo/1.1/span#">
   <owl:Ontology rdf:about=http://purl.obolibrary.org/obo/obi_FGED.owl>
   <owl:imports rdf:resource="http://purl.obolibrary.org/obo/obi/view_annot.owl"/>
   ……
```

3 view annotation property defined in 1 or 2

```
<owl:AnnotationProperty rdf:about="http://purl.obolibrary.org/obo/OBI_9991119">
   <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string">FGED alternative
term</rdfs:label>
   <obo:IAO_0000115 rdf:datatype="http://www.w3.org/2001/XMLSchema#string">An alternative
term used by the Functional Genomics Data (FGED) Society.</obo:IAO_0000115>
   <rdfs:subPropertyOf rdf:resource="http://purl.obolibrary.org/obo/IAO_0000118"/>
</owl:AnnotationProperty>
```

Advantage: add separate view annotation layer to source or subset of source ontology
- provide flexibility

Demo

- Add Chinese Labels To Ontology (OBI core)
  - Input term file: OBI_core_input_ch.xls
  - Source ontology: OBI
  - Output setting: user preferred annotation
    - URI of owl file: http://purl.obolibrary.org/obo/chinese_label.owl
    - Annotation property URI: Chinese label
    - Language of annotation values used: English
  - Output file: chinese_label.owl

  View: import chinese_label.owl to obi_core.owl

ONTOBEEP

ONTOLOGY COMPARISON

Compare Ontologies (OWL format)

- Bubastis (web and stand alone)

  http://www.ebi.ac.uk/efo/bubastis/

  (compare different versions of same ontology)
- OntoBeep (web tool)

  http://www.ontobee.org/ontobeep/index.php

  (compare up to three different ontologies)
- Protégé (stand alone)

  (compare ontology between different versions, or different ontologies)

Ontobeep

- http://ori.ontobee.hegroup.org/ontobeep/
- Compare different ontologies by aligning them from the roots of these ontologies
- Identifies common terms existing in two or three ontologies

Ontobeep

Ontobeep is an ontology alignment and comparison program that aligns, compares, and displays the similarities and differences among selected ontologies available in Ontobee. Ontobeep also provides a Statistics page to summarize the findings out of the ontology alignment and comparison. See more information in Ontobeep Tutorial.

Please select two to three ontologies:

- Adverse Event Reporting Ontology (AERO)
- Amphibian gross anatomy (AAO)
- Amphibian taxonomy (ATO)
- Anatomical Entity Ontology (AEO)
- Ascomycete phenotype ontology (APO)
- Basic Formal Ontology (BFO)
- Basic Formal Ontology (BFO) 1.1 (BFO11)
- Beta Cell Genomics Ontology (BCGO)
- Bilateria anatomy (BILA)
- Biological Collections Ontology (BCO)
- Biological imaging methods (FBbi)
- Biological Spatial Ontology (BSPO)
- BRENDA tissue / enzyme source (BTO)
- Brucellosis Ontology (IDOBRU)
- C. elegans development (WBls)
- C. elegans gross anatomy (WBbt)
- C. elegans phenotype (WBPhenotype)
- Cardiovascular Disease Ontology (CVDO)
- Cell Line Ontology (CLO)
- Cell type (CL)

Compare Selected

Compare Beta Cell Genomics Ontology (BCGO) with Ontology for Biomedical Investigation (OBI)

He Group
University of Michigan Medical School
Ann Arbor, MI 48109

Ontobeep

Expand One Level Down Statistics

- Root
  - BFO_0000001 | entity (BCGO) (OBI)
    - BFO_0000002 | continuant (BCGO) (OBI)
      - BFO_0000020 | specifically dependent continuant (BCGO) (OBI)
      - BFO_0000031 | generically dependent continuant (BCGO) (OBI)
        - IAO_0000030 | information content entity (BCGO) (OBI)
          - OBI_0000852 | record of missing knowledge (BCGO) (OBI)
          - IAO_0000033 | directive information entity (BCGO) (OBI)
          - IAO_0000009 | datum label (BCGO) (OBI)
          - IAO_0000308 | figure (BCGO) (OBI)
          - IAO_0000578 | centrally registered identifier (BCGO) (OBI)
          - IAO_0000310 | document (BCGO) (OBI)
          - IAO_0000300 | textual entity (BCGO) (OBI)
          - IAO_0000028 | symbol (BCGO) (OBI)
          - IAO_0000027 | data item (BCGO) (OBI)
          - OGMS_0000015 | clinical history (BCGO) (OBI)
          - IAO_0000429 | email address (BCGO) (OBI)
          - OBI_0000905 | sequence feature annotation (BCGO) (OBI)
          - ERO_0001716 | database (BCGO)
          - OBI_0001909 | conclusion based on data (BCGO) (OBI)
          - OBI_0001933 | value specification (BCGO) (OBI)
          - OBI_0000078 | eMedical record (OBI)
          - OBI_0000158 | eSource document (OBI)
          - OBI_0000210 | analytical cytology data file (OBI)
          - OBI_0302840 | curated information (OBI)
          - IAO_0000006 | narrative object (OBI)
          - IAO_0000314 | document part (OBI)
          - OBI_0000213 | fluorescence compensation matrix (OBI)
          - OBI_0302838 | validated information (OBI)

Ontobeep: Term statistics

Ontology	Number of terms (including imported)	Number of terms (excluding imported)
BCGO	2375	2376
OBI	3038	3039

Terms shared by all selected ontologies: 805

- Terms shared by BCGO & OBI: 805

Terms have two or more IDs:

1. **quality:**
   - http://purl.obolibrary.org/obo/PATO_0000001(BCGO)
   - http://purl.obolibrary.org/obo/BFO_0000019(BCGO) (OBI)
2. **multi-tissue structure:**
   - http://purl.obolibrary.org/obo/UBERON_0000481(BCGO)
   - http://purl.obolibrary.org/obo/CARO_0000055(OBI)
3. **epithelium:**
   - http://purl.obolibrary.org/obo/UBERON_0000483(BCGO)
   - http://purl.obolibrary.org/obo/CARO_0000066(OBI)
4. **circular:**
   - http://purl.obolibrary.org/obo/SO_0000988(BCGO) (OBI)
   - http://purl.obolibrary.org/obo/PATO_0000411(BCGO)
5. **infection:**
   - http://purl.obolibrary.org/obo/OBI_1110021(BCGO)
   - http://purl.obolibrary.org/obo/IDO_0000586(OBI)
6. **cancer:**
   - http://www.ebi.ac.uk/efo/EFO_0000311(BCGO)
   - http://purl.obolibrary.org/obo/OBI_1110053(OBI)
7. **Polyclonal rat PDX1 raised in rabbit:**
   - http://purl.obolibrary.org/obo/BCGO_9000272(BCGO)
   - http://purl.obolibrary.org/obo/BCGO_9000271(BCGO)
8. **Polyclonal mouse PDX1 raised in chicken:**

ONTOBAT

BIODATA ANALYSIS

Ontobat

- http://ontobat.hegroup.org
- Instance level ontology data generation and analysis
- Aims to support Linked Open Data (LOD) generation, following query, browsing, and statistical analysis
- Many features are under development
- Reference:

  http://ceur-ws.org/Vol-1327/icbo2014_paper_1358.pdf

ONTORAT

GENERATE/EDIT ONTOLOGY TERMS BASED ON DESIGN PATTERN

Generation Of A Large Number Of Ontology Terms With Common Design Pattern

- Manual implementation is time consuming, boring, and easy to make mistakes.
- Say, we needed to add >800 licensed animal vaccines to VO, all having the same pattern
  - Is licensed
  - Is used for one animal species
  - Protects against one or more infectious pathogens
  - Manufactured by a company
- QQT - Quick Term Templates

Quick Term Templates

Ontology Development Using Design Patterns

- Developed by OBI developers
- http://obi-ontology.org/page/Quick_Term_Templates
- When creating many terms that follow a shared pattern, use a spreadsheet instead of Protégé
- Reference: Phillippe RS, *et al*. Applied Ontology, vol. 6, no. 1, pp. 13-22, 2011

Available Tools

- OntoRat (web tool, OWL format)
  - http://ontorat.hegroup.org/
  - *Journal of Biomedical Semantics*. 2015, 6:4 doi:10.1186/2041-1480-6-4. PMID: 25785185.
- TermGenie (web tool, OBO format)
  - TermGenie for GO
    http://go.termgenie.org/
  - *Journal of Biomedical Semantics. 2015, 5(1): 48.*
- Populous (OWL format)
  - *BMC bioinformatics. 2012, 13 Suppl 1:S5*.
- MappingMaster plug-in for Protégé 3.x

OntoRat

- http://ontorat.hegroup.org
- Generation of new classes following same pattern
  - Logical axioms
  - Annotation axioms
- Edition of existing ontology terms
  - Add new axioms
- Templates and examples: http://ontorat.hegroup.org/designtemplates

Ontorat Design and Implementation

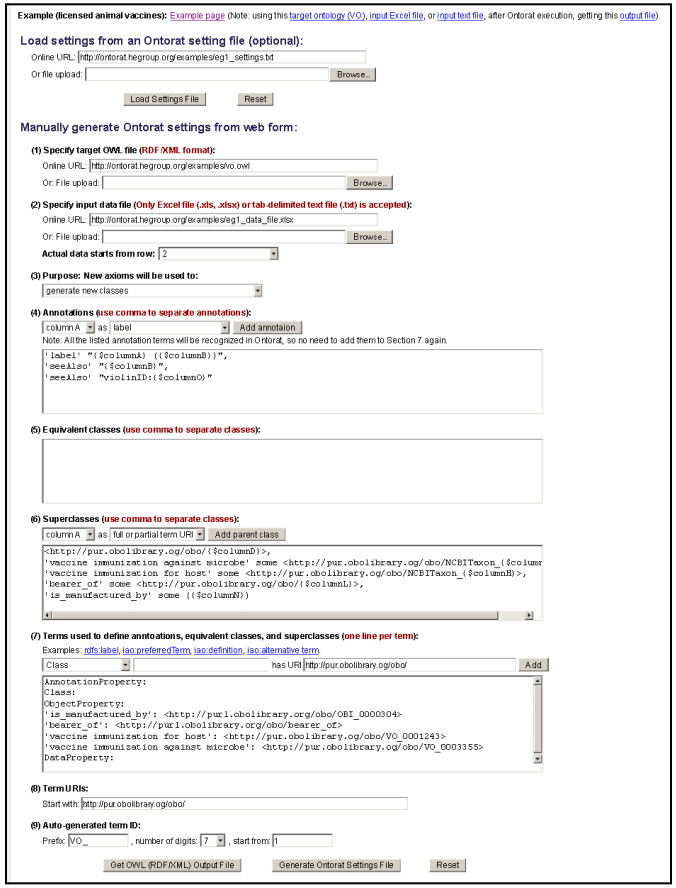
Input: needs Three Parts for Execution:

1)Target ontology → to avoid ID duplication
2)Input data file: Excel or tab-delimited text form
3)Setting scripts → use Manchester OWL Syntax
(note: settings can be stored and reused)

Output Results:

- OWL or Manchester syntax output file
- Can be imported/merged to target ontology using Protege-OWL editor

Ontorat Web Interface:

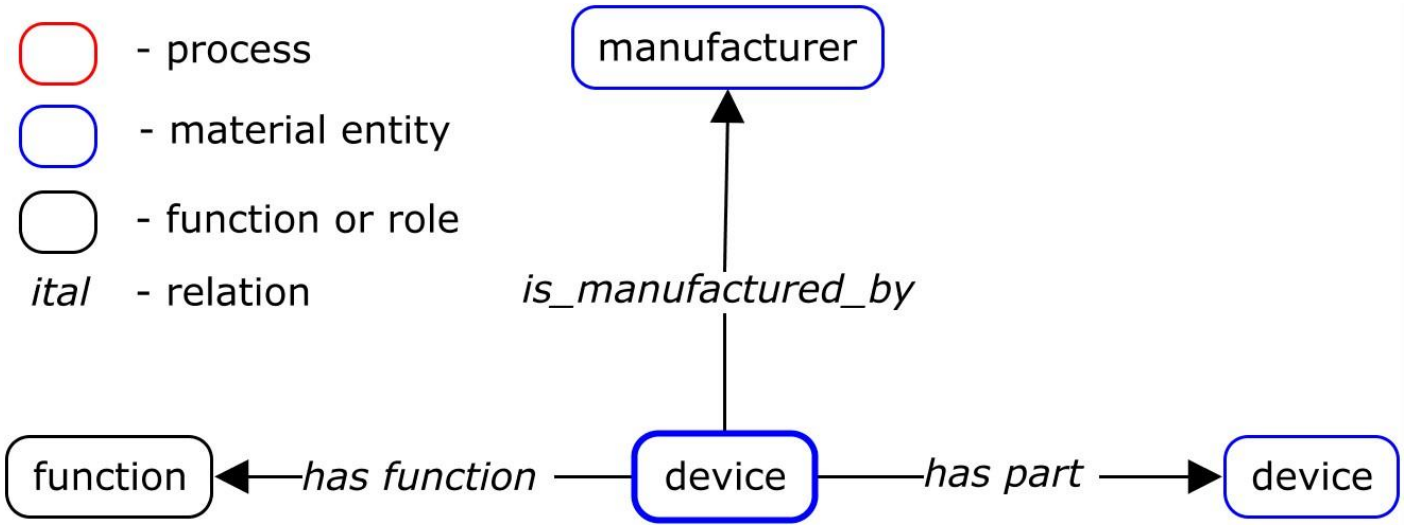


http://ontorat.hegroup.org

Demo: Device

- http://ontorat.hegroup.org/designtemplates/device/obi-device.php

Design pattern



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