

FAIR+E Knowledge Graphs

Semantic Units and Knowledge Graph Building Blocks

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Extended version from the talk given at the TIB Retreat, October 2021

FAIR Guiding Principles

Specification

[Wilkinson et al. \(2016\): The FAIR Guiding Principles for scientific data management and stewardship. *Scientific Data* 3\(1\): 160018.](#)

Findable

- F1. (meta)data are assigned a globally unique and persistent identifier
- F2. data are described with rich metadata (defined by R1 below)
- F3. metadata clearly and explicitly include the identifier of the data it describes
- F4. (meta)data are registered or indexed in a searchable resource

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

Accessible

- A1. (meta)data are retrievable by their identifier using a standardized communications protocol
 - A1.1 the protocol is open, free, and universally implementable
 - A1.2 the protocol allows for an authentication and authorization procedure, where necessary
- A2. metadata are accessible, even when the data are no longer available

Reusable

- R1. (meta)data are richly described with a plurality of accurate and relevant attributes
 - R1.1. (meta)data are released with a clear and accessible data usage license
 - R1.2. (meta)data are associated with detailed provenance
 - R1.3. (meta)data meet domain-relevant community standards

FAIR Guiding Principles

Cost of not having FAIR research data

European Commission. Directorate General for Research and Innovation (2018): Cost-Benefit Analysis for FAIR Research Data: Cost of Not Having FAIR Research Data.

Likely cost of not having FAIR research data

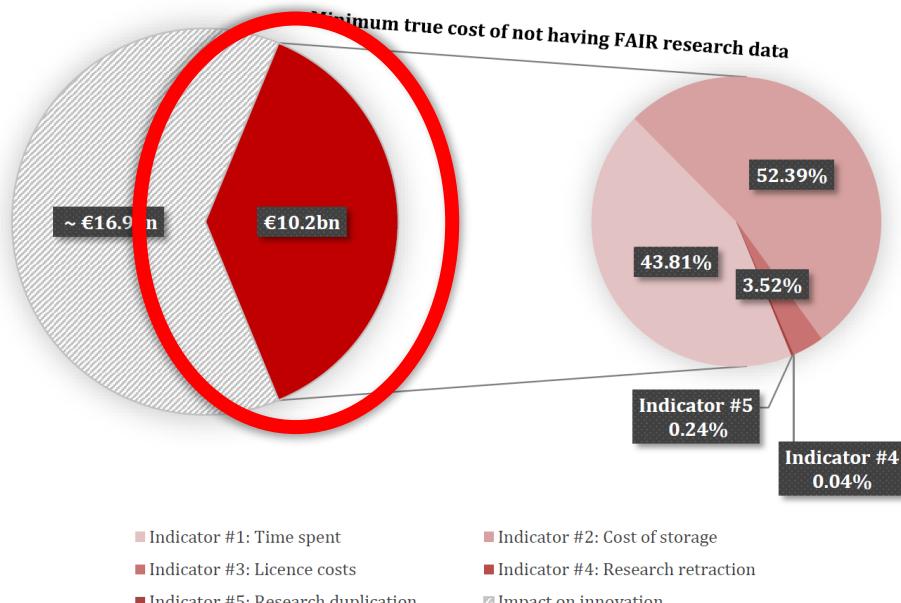
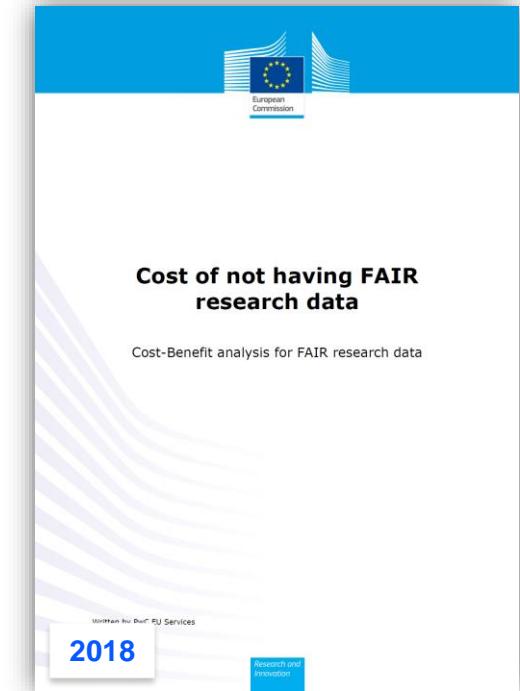


Figure 5: Cost breakdown

Plus 16 billion EURO
on top

*(estimated effects of
data-quality and
machine-actionability)*



FAIR Guiding Principles

FAIR Digital Objects



European Commission Expert Group on FAIR Data (2018): Turning FAIR into reality. <https://doi.org/10.2777/1524>.

central concept to the realization of FAIR:

FAIR Digital Objects

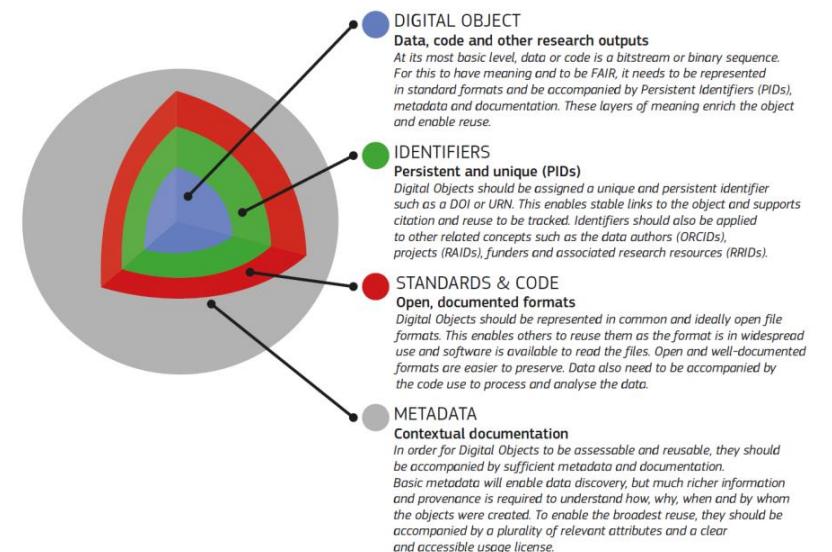


Figure 8. A model for FAIR Digital Objects

FAIR Guiding Principles

FAIR Digital Objects

European Commission. (2021): *EOSC Interoperability Framework: Report from the EOSC Executive Board Working Groups FAIR and Architecture*. <https://data.europa.eu/doi/10.2777/620649>.

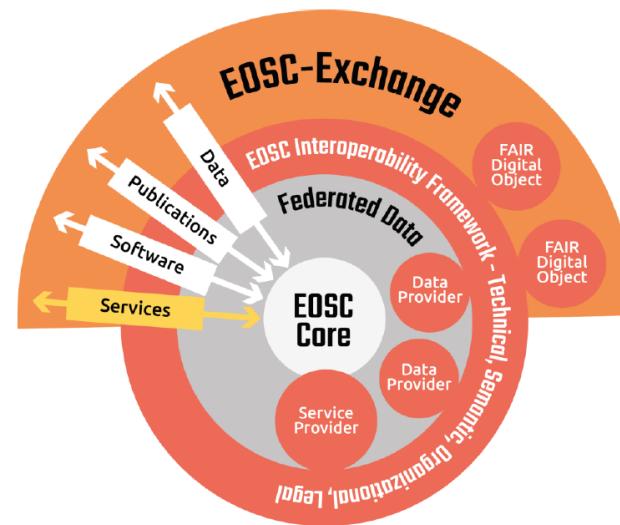
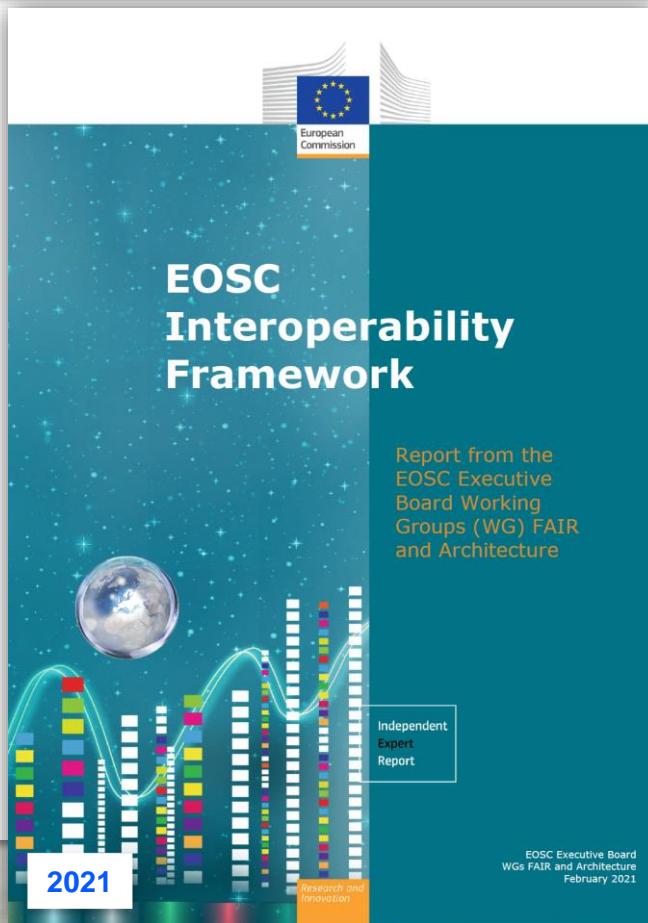


Figure 1. Schematic representation of key elements of EOSC Interoperability Framework.

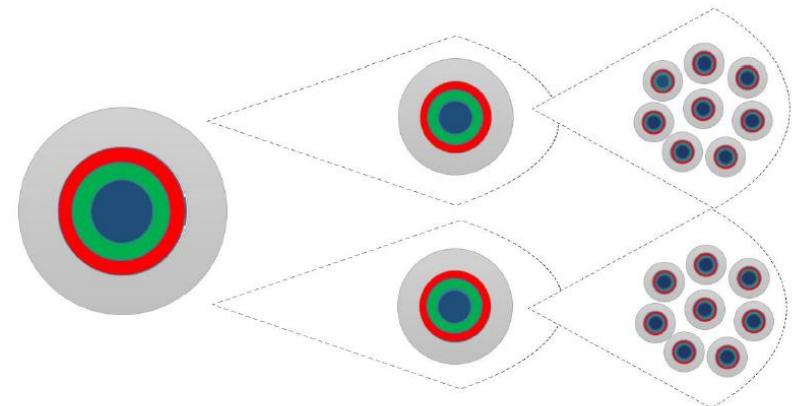


Figure 3. A FAIR Digital Object may be decomposed in other more fine-grained ones.



FAIR+E Knowledge Graphs

Outline

- What is a **Semantic Unit**?
- How could they improve the **explorability** of FAIR KGs (**FAIR+E**)?
- What is a **Knowledge Graph Building Block** (KGBB)?
- My journey into learning **Python** – a small prototype for KGBBs.
- Throughout, I will discuss, how this could improve the **ORKG**.

Semantic Units



Semantic Units

Characterization

Semantic units **partition** a knowledge graph into **identifiable** and **semantically meaningful** sets of triples, i.e., subgraphs that form **units of representation** (short: semantic units).



Semantic Units

Characterization

Each semantic unit is represented in the graph with its own resource (= node) and its own Unique Persistent and Resolvable Identifier (UPRI). You can, thus, refer to it when making statements about its contents. This allows you, in a very intuitive way, to make statements about statements.



Semantic Units

Classification of semantic units

Each semantic unit is an instance of at least one **semantic unit class**.

The **class's definition** specifies the **type of information** that its instances contain. The classes are organized hierarchically, resulting in an **ontology of semantic units**.



Semantic Units

Classification of semantic units

Each semantic

The **class's def**

contain. The cl

ontology of sem

semantic units summarize the contents of a knowledge graph and can be used for **profiling** it

tic unit class.
hat its instances
ng in an



Semantic Units

Classification of semantic units

Each semantic

The class's

contain. The

ontology of

semantic unit classes provide another

entry-point for querying and exploring

the graph, searching for a specific

type of information

tic unit class.

hat its instances

ng in an



Semantic Units

Characterization

Semantic units can **consist of other semantic units**. They therefore **organize** and **structure** the knowledge graph into partially **overlapping**, partially **enclosed subgraphs**.



Semantic Units

Characterization

Seven basic categories of semantic units can be distinguished.

Assertion Units



Semantic Units

Assertion Unit

An assertion is a proposition which is asserted or denied to be true. An assertion unit is the smallest independent and semantically meaningful unit of information for a human reader.



Semantic Units

Assertion Unit

Example for an assertion unit would be a **weight measurement**.



Semantic Units

Assertion Unit

Assertion units are the **most basic** category of semantic units. Every other category of semantic unit is directly or indirectly **based on** assertion units.



Semantic Units

Modularity of Semantic Units

Modularity:

When an assertion unit is **changed**, the change will be **visible** in all the semantic units that contain it, because the information is **stored at one location**. Because of that, you can also refer to semantic units **from other** knowledge graphs.

Topic Units



Semantic Units

Topic Unit

Topic units include all assertion units whose contents a human reader wants to access through the same user interface (UI) page.



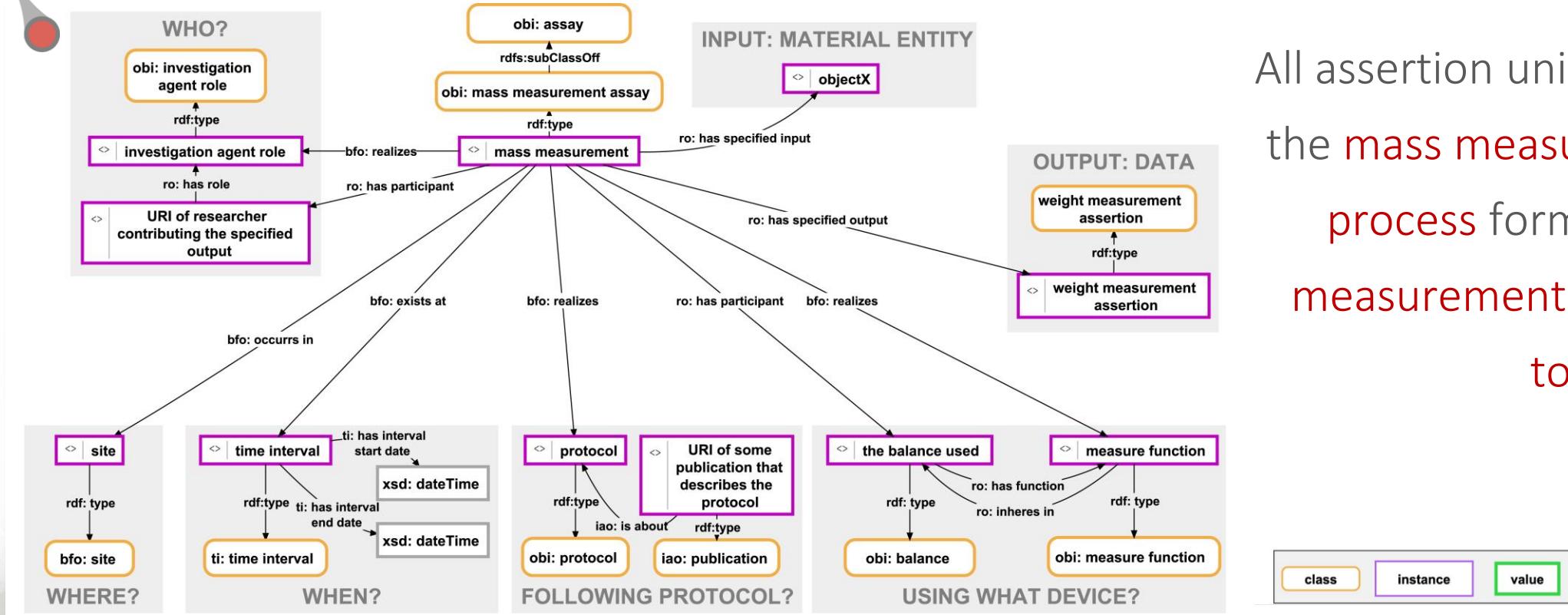
Semantic Units

Topic Unit

In most cases, a topic unit contains **all assertion units about the same object.**

Semantic Units

Topic Unit



All assertion units about the mass measurement process form a mass measurement process topic unit.

Semantic Units

Topic Unit

A given **assertion unit** can be contained in **more than one topic unit**.

Entry Units

Semantic Units

Entry Unit

Entry units include all assertion and topic units whose contents a human reader wants to access in a UI as a set of linked pages.



Semantic Units

Five levels of representational granularity

These three basic categories of semantic units organize the overall data graph into five distinct **levels of representational granularity**:

Triples > Assertion Units > Topic Units > Entry Units > Graph

Granularity Tree Units



Semantic Units

Granularity Tree Unit

A **granularity tree unit** comprises several assertion units that, together, represent a **granularity tree**.



Semantic Units

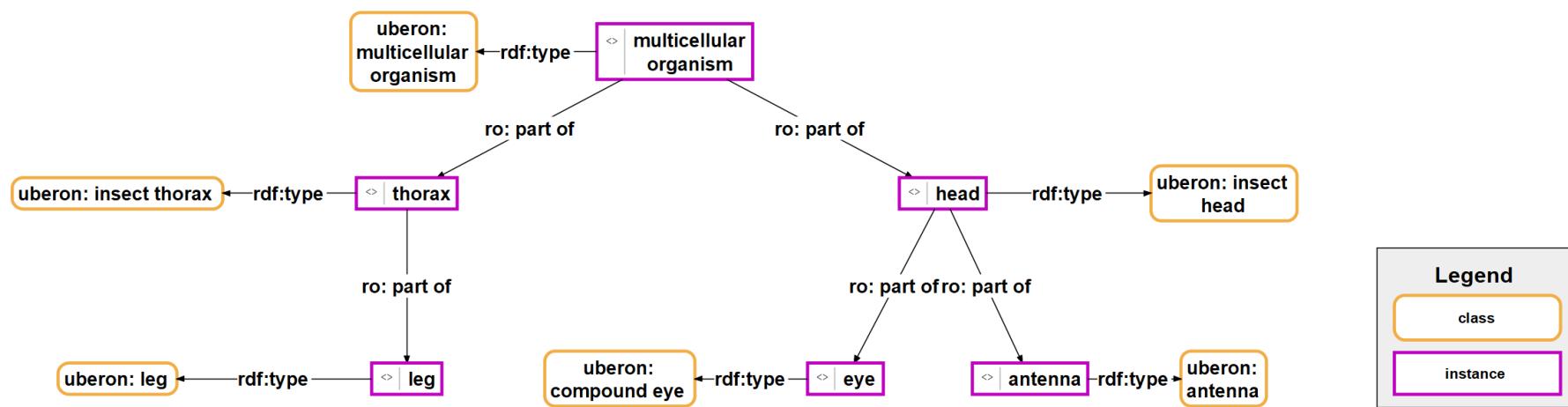
Granularity Tree Unit

Any type of assertion unit that is based on a **partial order relation** (transitive, reflexive, antisymmetric) can give rise to a corresponding **type of granularity tree** that can be managed, and its corresponding subgraph be identified, through a **granularity tree unit**.

Semantic Units

Granularity Tree Unit

E.g., the partonomy of anatomical parts of an organism and thus a **parthood-based granularity tree**:



List Units



Semantic Units

List Unit

A **list unit** consists of an **ordered list of resources** such as an ordered list of authors of a scholarly publication.

Dataset Units

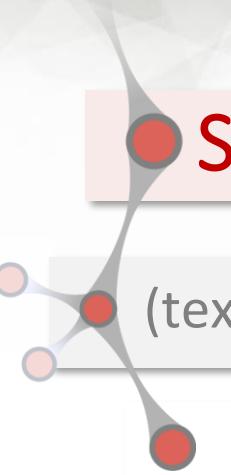


Semantic Units

List Unit -> Dataset Unit

Because each semantic unit is represented in the graph with its own resource, a list can also **exclusively consist of semantic units**, in which case we refer to them as **dataset units**.

(Text-Resource) Hybrid Units



Semantic Units

(text-resource) Hybrid Unit

Sometimes, users want to define a new resource or describe information but **cannot** provide it in a **machine-actionable way**. Instead, they provide a **human-readable textual definition/description**.

Semantic Units

(text-resource) Hybrid Unit

These texts can be annotated by recognizing entities that are known to the knowledge graph. By connecting identified entities with the hybrid unit resource via **isAbout relations**, the information from the texts is made somewhat machine-accessible.

Semantic Units

(text-resource) Hybrid Unit

The screenshot shows the ORKG platform interface. At the top, there is a navigation bar with 'ORKG' logo, 'View', 'Tools', and 'About' options. Below the navigation is a search bar with a magnifying glass icon and a red 'Add new' button. On the left, there's a sidebar with 'Properties' and 'Highlights' sections. The main area displays a list of research contributions. The first contribution is titled 'Biodistribution and biomaging studies of hybrid paclitaxel nanocrystals: Lessons learned of the EPR effect and image-guided drug delivery' from 2013. The second contribution is 'In Vivo Investigation of Hybrid Paclitaxel Nanocrystals with Dual Fluorescent Probes for Cancer Theranostics' from 2013. The third contribution is 'Paclitaxel nanosuspensions coated with P-gp inhibitory surfactants: I. Acute toxicity and pharmacokinetics studies' from 2013. Each contribution has a detailed description and some text highlighted in blue.

Hybrid units can be used in the ORKG whenever users struggle with semantically modelling information.

Semantic Units provide a new framework for ...

... aligning graphs



Semantic Units as a framework for...

... aligning graphs

Two graphs can be aligned in a **step-by-step procedure**, starting with **entry units** belonging to the same entry unit **class**, and continuing with **topic units**, then with **assertion units**, and finally the **individual triples**.



Semantic Units as a framework for...

... aligning graphs

Two graphs can be aligned if their
entry units belong to the same
topic units, then we can

use semantic units, thus, support
subgraph-matching

ture, starting with
and continuing with
individual triples.

Semantic Units as a framework for...

... aligning graphs

The screenshot shows the ORKG interface with the following details:

- Header:** ORKG, View, Tools, About, Search bar, Add new button, Profile icon.
- Breadcrumbs:** Home > Life Sciences > Nursing Pharmacology, Toxicology and Environmental Health > Medicinal Chemistry and Pharmaceutics.
- Section:** Comparison (11)
- Text:** A comparison between studies have prepared Drug nanocrystals to enhance the delivery of anticancer drugs into cancer cells.
- Table:** A table showing the main aspects of the comparison between different studies that have used Drug nanocrystals to enhance the delivery of anticancer drugs into cancer cells, including the properties of the nanoparticles and their effects in vitro and in vivo.
- Metadata:** September 2021, Karim Shalaby, DOI: 10.48366/r142850.
- Table Content:** The table displays five rows of data, each representing a study or contribution. The columns include:
 - Properties:** Formulation and antitumor activity evaluation of nanocrystalline suspensions of poorly soluble anticancer drugs (1996 - Contribution 1), Cellular Uptake Mechanism of Paclitaxel Nanocrystals Determined by Confocal Imaging and Kinetic Measurement (2015 - Contribution 1), Hybrid Nanocrystals: Achieving Concurrent Therapeutic and Bioimaging Functionalities toward Solid Tumors (2011 - Contribution 1), Biodistribution of paclitaxel nanocrystals: Lessons learned from effect and drug delivery (2013 - Contribution 1).
 - Has research problem:** Nanocrystals for cancer treatment.
 - Uses drug:** Paclitaxel, Camptothecin, Etoposide.

Search results can be aligned and, in case entry units employ the same types of topic units, displayed in a table, like comparisons in ORKG.

**... modelling negations and
cardinality restrictions**



Semantic Units as a framework for...

... modelling Negations and Cardinality Restrictions

The ORKG follows the **Open World Assumption**, which assumes incomplete information by default. Therefore, absence of information about an entity or a fact does not necessarily imply information about the absence of that entity or the negation of that fact.

lack of evidence is not evidence of lack



Semantic Units as a framework for...

... modelling Negations and Cardinality Restrictions

Negation:

*"This multicellular organism has a head that has **no** antenna."*

Cardinality restriction:

*"This head possesses **exactly three** eyes."*



Semantic Units as a framework for...

... modelling Negations and Cardinality Restrictions

Negation:

*"This multicellular organism has a head that
has no antenna."*

negated parthood
assertion

Cardinality restriction:

"This head possesses exactly three eyes."

Semantic Units as a framework for...

... modelling Negations and Cardinality Restrictions

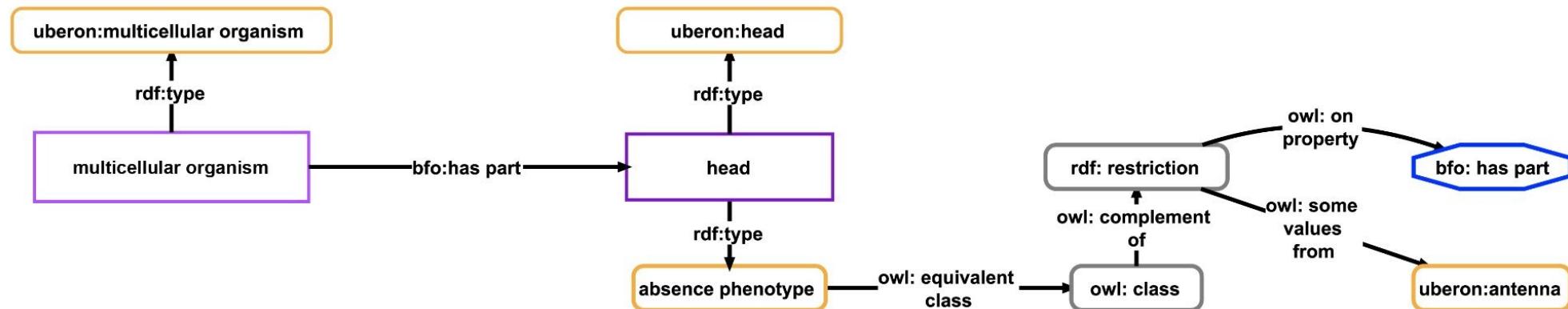
C)

OWL Manchester Syntax expression

absence phenotype class axiom: not (has part some antenna)

D)

Conventional OWL model

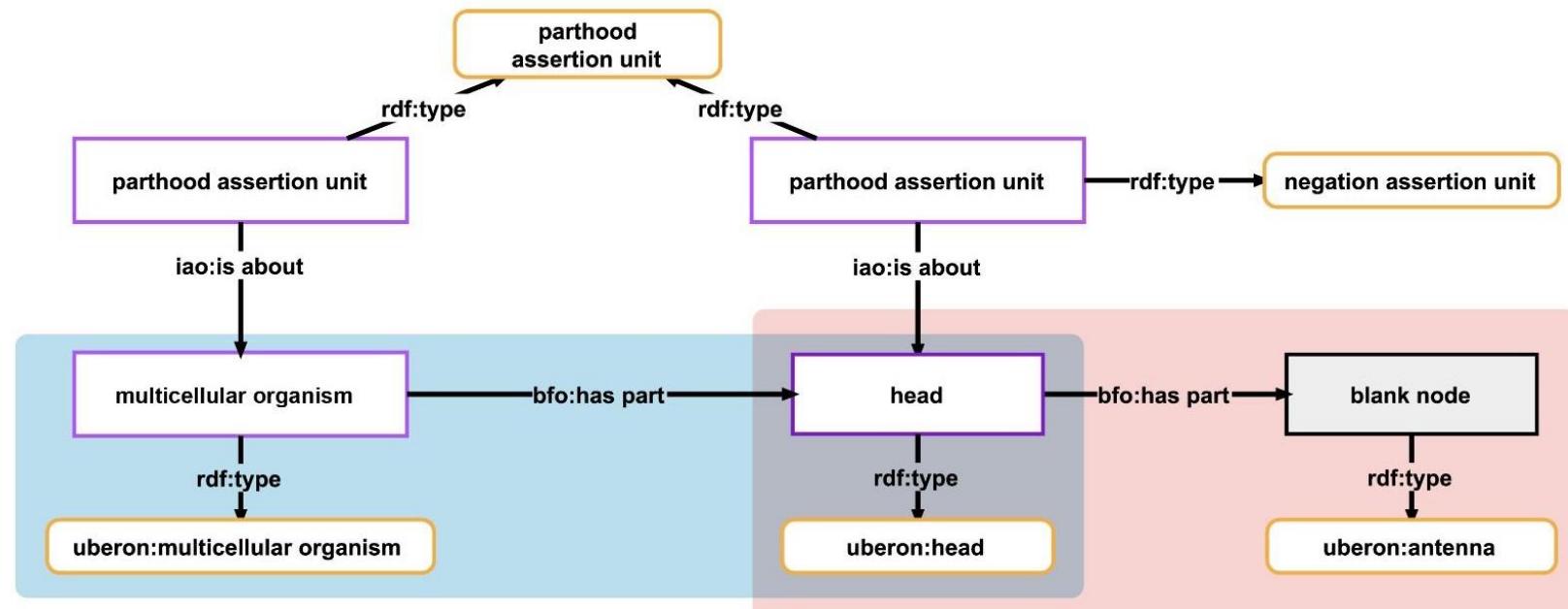


Semantic Units as a framework for...

... modelling Negations and Cardinality Restrictions

E)

Assertion units model



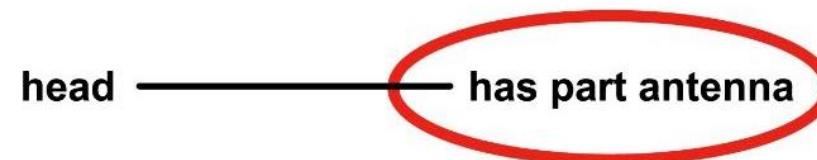
negated
parthood
assertion unit

Semantic Units as a framework for...

... modelling Negations and Cardinality Restrictions

F)

Peirce's predicate logic system of existential graphs



similar approach

Sowa, JF (2011): Peirce's tutorial on existential graphs. *Semiotica*, 2011(186), 347–394. <https://doi.org/10.1515/semi.2011.060>



Semantic Units as a framework for...

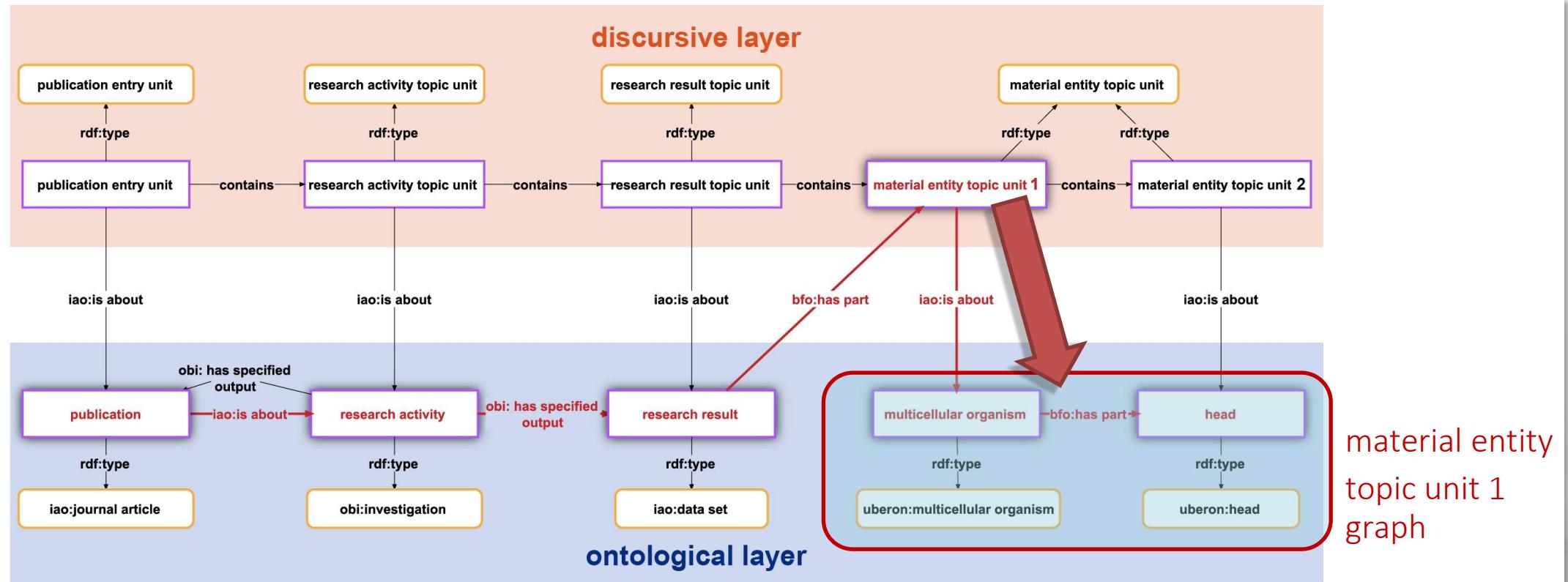
... modelling Negations and Cardinality Restrictions

Currently, in the ORKG we have no schema for modelling negations or cardinality restrictions in a machine-actionable way.

**... documenting and relating
ontological and discursive
information**

Semantic Units as a framework for...

... documenting and relating ontological and discursive information



How to implement Semantic Units?



Implementing Semantic Units

Neo4j

In Neo4j, all nodes and relations belonging to a particular semantic unit can be identified by a corresponding key-value pair.

E.g., assertion_URI:[UPRI,...] ; with the UPRI of the particular assertion unit

Implementing Semantic Units

RDF/OWL

```
@prefix this: <http://purl.org/np/RAahmqVhN4_-p09GANFc_CWXiofqIAwqcqWEMR1VhHq_w> .  
@prefix sub: <http://purl.org/np/RAahmqVhN4_-p09GANFc_CWXiofqIAwqcqWEMR1VhHq_w#> .  
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .  
@prefix dct: <http://purl.org/dc/terms/> .  
@prefix prov: <http://www.w3.org/ns/prov#> .  
@prefix np: <http://www.nanopub.org/nschema#> .  
@prefix orcid: <https://orcid.org/> .  
@prefix nt: <https://w3id.org/np/o/ntemplate/> .  
@prefix foaf: <http://xmlns.com/foaf/0.1/> .  
@prefix npx: <http://purl.org/nanopub/x/> .  
  
sub:Head {  
    this: np:hasAssertion sub:assertion ;  
    np:hasProvenance sub:provenance ;  
    np:hasPublicationInfo sub:pubinfo ;  
    a np:Nanopublication .  
}  
  
sub:assertion {  
    orcid:0000-0002-1267-0234 foaf:knows orcid:0000-0001-5118-256X .  
}  
  
sub:provenance {  
    sub:assertion prov:wasAttributedTo orcid:0000-0002-1267-0234 .  
}  
  
sub:pubinfo {  
    sub:sig:npx:hasAlgorithm "RSA" ;  
    npx:hasPublicKey "MIGfMA0GCSqGSIb3DQEBAQUAA4GNADCBiQKBgQCwUtewGCpT5vIfXYE1bf/Uqu1ojqnWdYxv+yS080u18Gu7m8KoyPAwvvaPj01vPtHrg000gMmkxzKhYknEja8qV7erxZNYpSB3/3+S2puW0Yas78UnQvjBhSmDdmry4D4VvvNIiUmdu0xcia47dTfu4j4DvfHnGd6hVe5+goqdewIDAQAB" ;  
    npx:hasSignature "NTtRuw9QUNHmekbmfdk6gUg/ONRNEIsrvhS0c0Sby3A1vPLkbfbwIv1j6U28EaTpp4YVOZJg8j41xxDUNMA7CjsGU6RxmcPgziYqLNH0/5o05WJLHcEfoB1X62p2TIWntQm3r8lu/Rhenvk/I2TYssvlAFJjQxuhCGp7mQ=" ;  
    npx:hasSignatureTarget this: .  
    this: dct:created "2020-05-07T08:14:30.231+02:00"^^xsd:dateTime ;  
    dct:creator orcid:0000-0002-1267-0234 ;  
    nt:wasCreatedFromTemplate <http://purl.org/np/RA3abHjDRJb6g1o50JNxhUg94rJ3DhRCE1ZPsT7cr-L8> .  
}
```

Figure 2 Example nanopublication in TriG notation that was published with Nanobench.

Full-size DOI: 10.7717/peerj-cs.387/fig-2

In **RDF/OWL**, a semantic unit can be organized like a nanopublication, using **Named Graphs**.

Kuhn, T et al. (2021): Semantic micro-contributions with decentralized nanopublication services. *PeerJ Computer Science*, 7, e387. <https://doi.org/10.7717/peerj-cs.387>

Implementing Semantic Units

FAIR Digital Objects

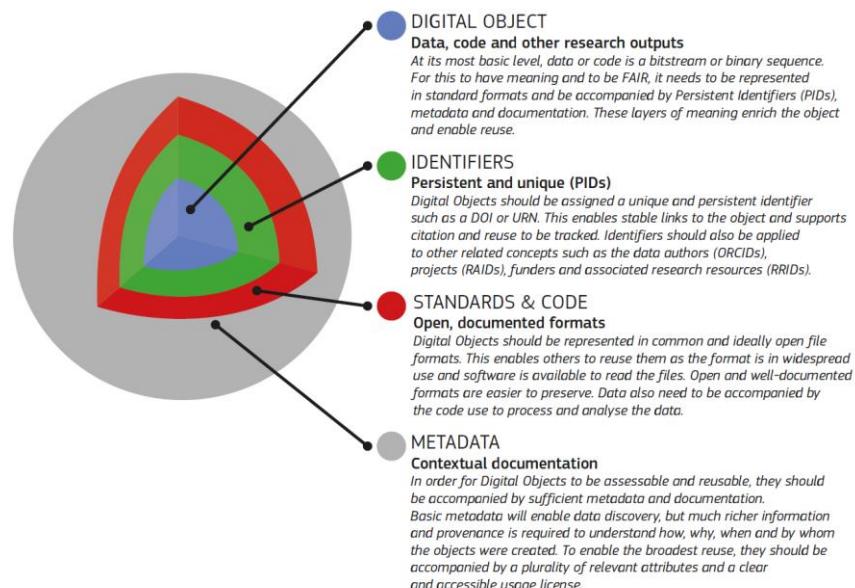


Figure 8. A model for FAIR Digital Objects

European Commission Expert Group on FAIR Data (2018): Turning FAIR into reality. <https://doi.org/10.2777/1524>.

Semantic units can be implemented to form FAIR Digital Objects.



Implementing Semantic Units

FAIR Digital Objects

European Commission. (2021): *EOSC Interoperability Framework: Report from the EOSC Executive Board Working Groups FAIR and Architecture*. <https://data.europa.eu/doi/10.2777/620649>.

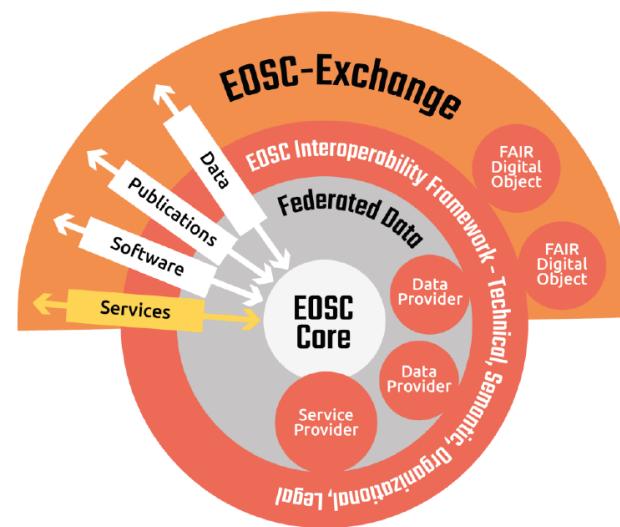
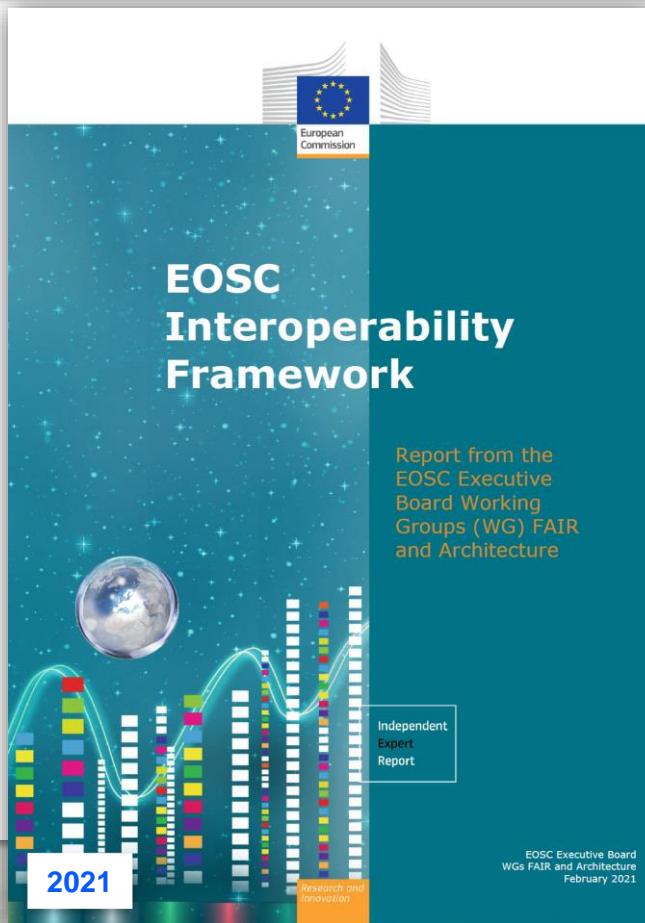


Figure 1. Schematic representation of key elements of EOSC Interoperability Framework.

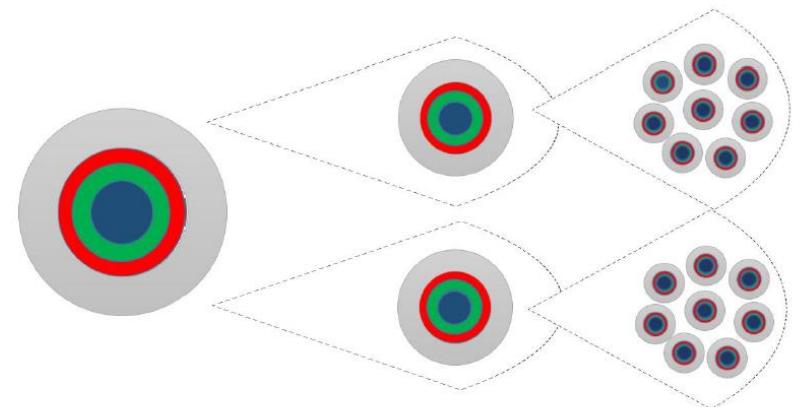


Figure 3. A FAIR Digital Object may be decomposed in other more fine-grained ones.

FAIR+E Knowledge Graphs



FAIR+E Knowledge Graphs

Explorability

By structuring and organizing FAIR knowledge graphs into semantically meaningful subgraphs and classifying the subgraphs into ontology classes, semantic units provide a framework for significantly improving the explorability and user-friendliness of knowledge graphs.



FAIR+E Knowledge Graphs

Explorability

Exploring by:

- ontology class
- semantic unit class

across representational granularity

(triple > assertion > topic > entry > graph)

FAIR+E Knowledge Graphs

Explorability

Jump to:

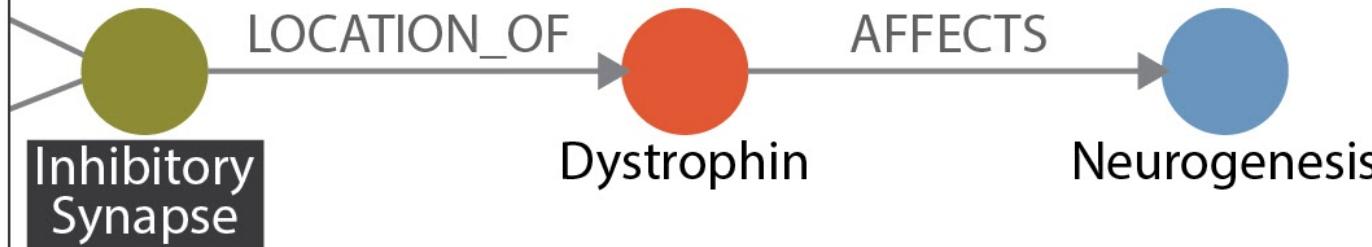
- · Publication title
- + · Page label
- + · Infected Hannover population
- · **Infected Berlin population**
 - · located in
 - · time period
 - · basic reproduction measurement
 - · basic reproduction measurement
 - · case fatality rate measurement
- + · Covid-19 disease process
- + · Page label

display selected
content here

FAIR+E Knowledge Graphs

Explorability

shows triple level graph



form-based display

forms

Inhibitory Synapse

location of:

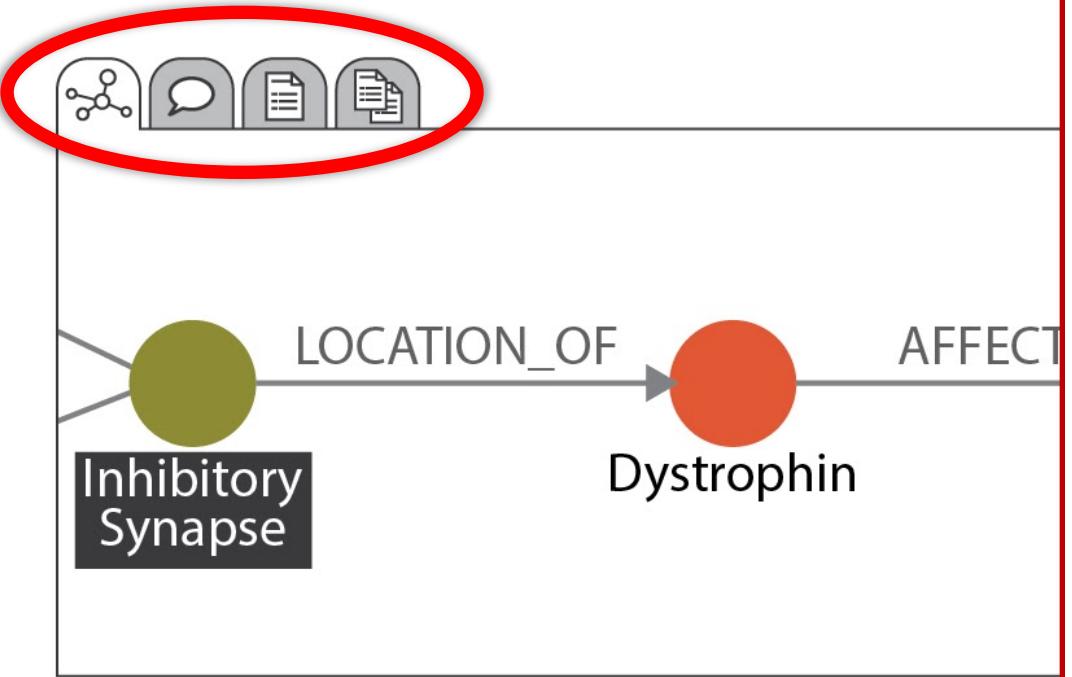
Dystrophin [ncit]

part of:

brain [fma]

FAIR+E Knowledge Graphs

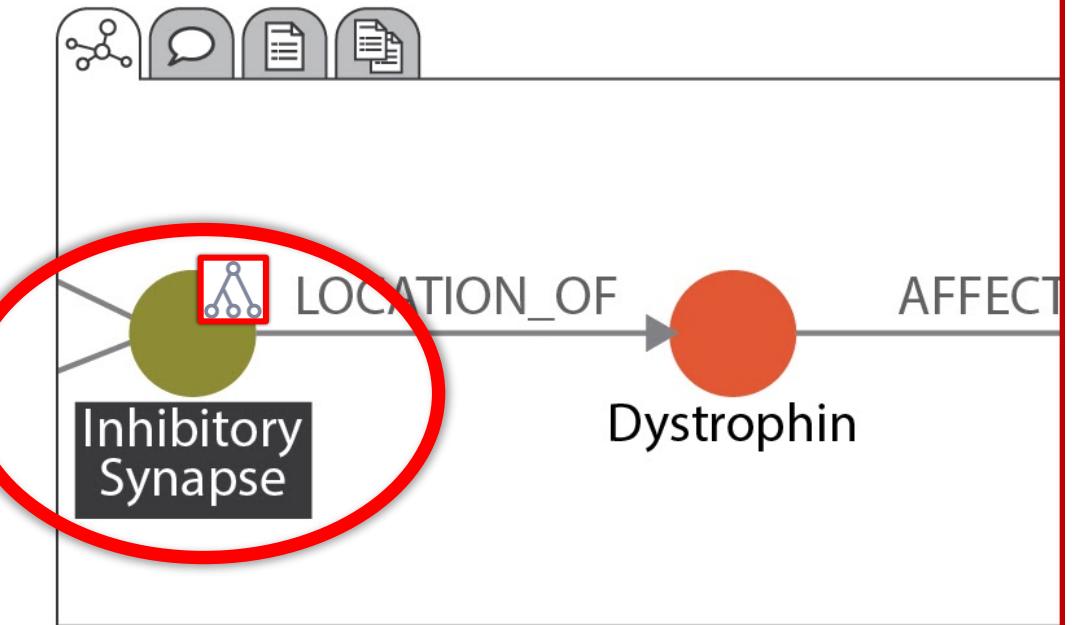
Explorability



users could **zoom in** and out across the different levels of **representational granularity**, filtering the graph to only those relations belonging to the respective level, from triples to entry units

FAIR+E Knowledge Graphs

Explorability



Icons on nodes in the graph could indicate that a node belongs to a granularity tree unit, and by clicking on the icon, the graph would be filtered to show only the subgraph of the granularity tree unit

Knowledge Graph Building Block (KGBB)

My small side project:

Python-Neo4j-based
proof-of-concept
for KGBBs

GitHub <https://github.com/LarsVogt/Knowledge-Graph-Building-Blocks>

Python-Neo4j-based KGBB Prototype Application

Me learning Python

- I had **no** programming experience at all
- I **learned** the basics of Python in two weeks **Easter vacation**
- I developed my **Python-Neo4j KGBB Prototype** within **three months** in my **spare time**

Select an action

[delete graph](#)[search page](#)[view entry list](#)

Add new publication

DOI: add publication

uses CrossRef API for fetching
metadata by DOI



A Descriptive Morphology of the Ant {GenusProcryptocerus}(Hymenoptera: Formicidae)

Entry Metadata: URI: 7f36cef5-48ca-49de-90a8-d76c12e25f0a; creator: ORKGuserORCID; created on: 2021-09-29T15:01:01.761000000; last updated on: 2021-09-29T15:01:01.761000000

- Research overview
 - Research result
 - Research objective
 - Research method

entry versions: no version saved yet

[Save snapshot of live version](#)

Title:

A Descriptive Morphology of the Ant {GenusProcryptocerus}(Hymenoptera: Formicidae)

doi 10.1673/031.010.11101

Year: 2010

Authors: F. Serna, W. Mackay

Journal: Journal of Insect Science

Publisher: Oxford University Press (OUP)

has research topic: [add](#)



[Return to Entry List](#)

[Return to Lobby](#)

Scholar Publishing ORCID Data Publishing Module of the AntsDB Project

156 <div class="data_row" style="font-size: 20px; margin: 20px 0px 20px 30px;">Title:
157 <div class="datum" style="font-size: 19px;">{{ entry_dict[0].get('text') }}</div>
158 </div>
159
160 <div class="data_row">doi
161 <div class="datum">{{ entry_dict[0].get('object').get('publication_doi') }}</div>
162 </div>
163
164 <div class="data_row">Year:
165 <div class="datum">{{ entry_dict[0].get('object').get('publication_year') }}</div>
166 </div>
167
168 <div class="data_row">Authors:
169 <div class="datum">{{ entry_dict[0].get('object').get('publication_authors') }}</div>
170 </div>
171
172 <div class="data_row">Journal:
173 <div class="datum">{{ entry_dict[0].get('object').get('publication_journal') }}</div>
174 </div>
175
176 <div class="data_row">Publisher:
177 <div class="datum">{{ entry_dict[0].get('object').get('publication_publisher') }}</div>
178 </div>
179
180
181
182
183 { set topic_uri = entry_dict[0].get('id') }
184
185
186 { for child in entry_dict }
187

101 morphology of the Ant {GenusProcyptocerus}(Hymenoptera: Formicidae)

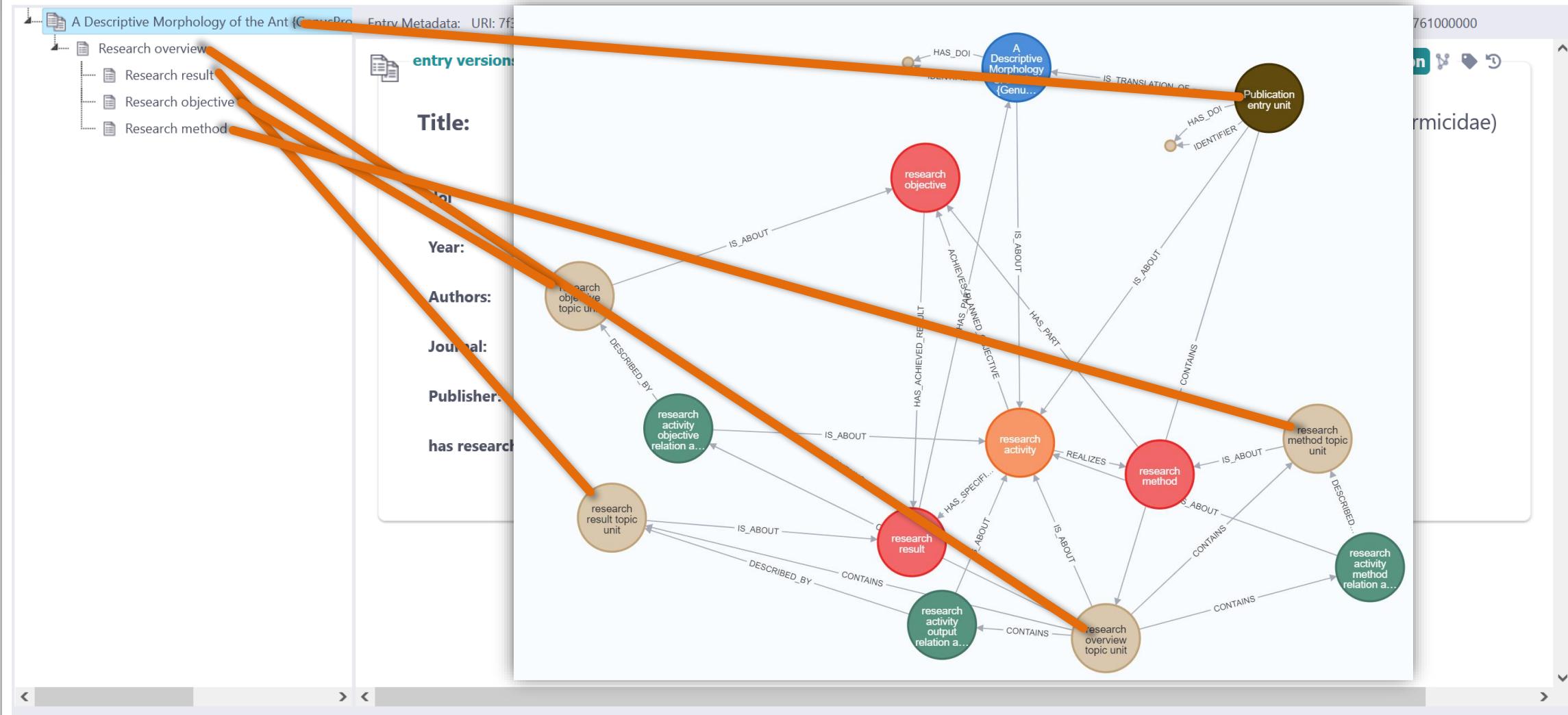
Save snapshot of live version

orphology of the Ant {GenusProcyptocerus}(Hymenoptera: Formicidae)

101 human-readable data representation is decoupled from machine-actionable data graph by using a complex data structure with FLASK Jinja2 templates

Return to Entry List

Return to Lobby



[Return to Entry List](#)

[Return to Lobby](#)



A Descriptive Morphology of the Ant {Genus Procryptocerus} (Hymenoptera: Formicidae)

Entry Metadata: URI: 7f36cef5-48ca-49de-90a8-d76c12e25f0

Version: 2021-09-29T15:01:01.761000000

Snapshot of live version

entry versions: no version saved yet

Title: A Descriptive Morphology of the Ant {Genus Procryptocerus} (Hymenoptera: Formicidae)

doi: 10.16/2010.1.1

Year: 2010

Authors: F. Senn

Journal: Journal of Insect Science

Publisher: Oxford University Press

has research topic: Hymenoptera: Formicidae

Research overview

- Research result
- Research objective
- Research method

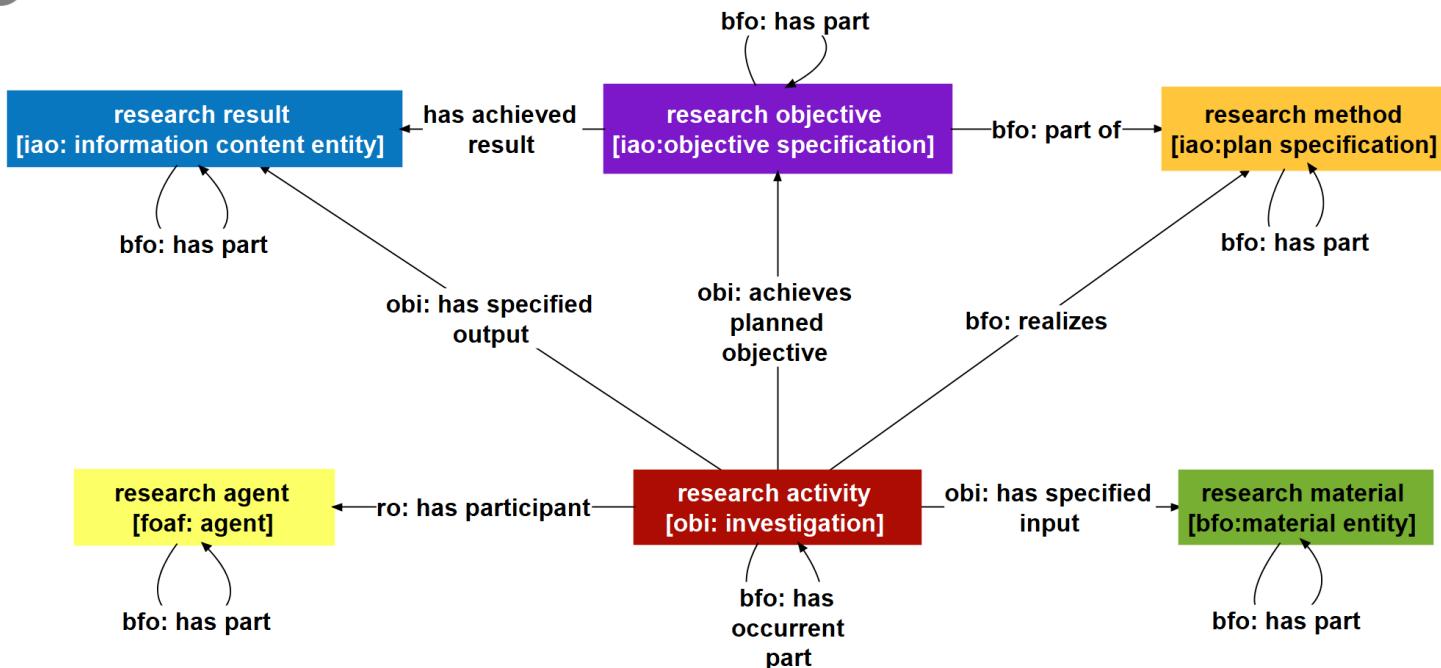
The diagram illustrates the semantic relationships between various research entities. At the top center is a blue circle labeled "A Descriptive Morphology of the Ant {Genus Procryptocerus} (Hymenoptera: Formicidae)". Arrows point from this central node to four red circles below it: "research objective", "research activity", "research result", and "research method". The "research objective" node has an arrow pointing to it from the left. The "research activity" node has arrows pointing to it from both the "research objective" and "research method" nodes. The "research result" node has arrows pointing to it from both the "research objective" and "research activity" nodes. The "research method" node has an arrow pointing to it from the right.

Return to Entry List

Return to Lobby

Python-Neo4j-based KGBB Prototype Application

Underlying data schema



the underlying basic
data schema

Vogt, L et al. (2020): Toward Representing Research Contributions in Scholarly Knowledge Graphs Using Knowledge Graph Cells. *Proceedings of the ACM/IEEE Joint Conference on Digital Libraries* in 2020, 107–116.
<https://doi.org/10.1145/3383583.3398530>



A Descriptive Morphology of the Ant {GenusPro} Entry Metadata: URI: 7f36cef5-48ca-49de-90a8-d76c12e25f0a; creator: ORKGuserORCID; created on: 2021-09-29T15:01:01.761000000; last updated on: 2021-09-29T15:01:01.761000000

Research overview

- Research result
- Research objective
- Research method

research result [ORKG]

Research result

has part: specify the type of research result [add](#)

resulted from: specify the type of research activity [add](#)

achieved objective: specify the type of research objective [add](#)

is about: specify the type of material entity [add](#)

I can start adding content without having to think about, how to model the data

[Return to Entry List](#)[Return to Lobby](#)



Add paper

A Descriptive Morphology of the Ant Genus Procryptocerus (Hymenoptera: Formicidae)

View graph



Specify research contributions

Abstract annotator

Contribution 1

Use template

- Transient absorption spectroscopy
- SEIR
- Case fatality rate estimate
- Basic reproduction number estimate
- Student's t-test
- Research Problem

No data yet

Start by adding a property from below

+ Add property

in the ORKG, a user must first think about, which ‘property’ or which ‘template’ to use, before they can enter data

What is a ‘property’ or a ‘template’?

Previous step

Finish



A Descriptive Morphology of the Ant {GenusPro} Entry Metadata: URI: 7f36cef5-48ca-49de-90a8-d76c12e25f0a; creator: ORKGUserORCID; created on: 2021-09-29T15:01:01.761000000; last updated on: 2021-09-29T15:01:01.761000000

Research overview

- Research result
- Research objective
- Research method

research result [ORKG]

Research result

has part: specify the type of research result add

resulted from: specify the type of research activity add

achieved objective: specify the type of research objective add

is about:

- multicellular organism
- multicellular organism development
- multicellular organismal reproductive process
- multicellular organismal signaling
- cellular process involved in reproduction in multicellular organism
- multicellular anatomical structure
- multicellular organismal movement

retrieving definitions...

copy

uses BioPortal API with autocomplete function for identifying ontology terms

The screenshot shows the ORKG (Open Research Knowledge Graph) interface for a research result entry. The sidebar on the left lists the project's structure: A Descriptive Morphology of the Ant {GenusPro}, Research overview, Research result (selected), Research objective, and Research method. The main content area is titled "Research result [ORKG]" and "Research result". It contains four input fields with "add" buttons: "has part:", "resulted from:", "achieved objective:", and "is about:". The "is about:" field has a dropdown menu with several options, one of which is highlighted in pink: "multicellular organism". A red arrow points from the text "no need for the user to decide between resource and other data types for their input" to this pink-highlighted item. The top right of the interface includes "versions" and "X" buttons.

no need for the user to decide between resource and other data types for their input

no need for the user to decide between resource and other data types for their input

The screenshot shows the ORKG (Open Research Knowledge Graph) interface in edit mode. A modal window is open over the main content area, prompting the user to "Enter a resource". The modal includes fields for "Resource" type (set to "Text") and "Value". A red arrow points from the text "this is different in the ORKG" to the "Resource" dropdown in the modal.

Number of entities 24000000 xsd:string

Provides API GraphQL

Uses identifier system DOI

Location

+ Add property

Similar contributions Failed to connect to the similarity service try again later

Comparisons

Comparison of Scholarly Identifier Systems
4 Contributions 1 Visualizations 29-03-2021
This comparison juxtaposes different persistent identifier systems for scholarly communication content.

Information Science

DOI ROR Ide...

Graph view Stop editing

Search... + Add new

versions X

dated on: 2021-09-29T15:01:01.761000000

this is different in the ORKG



A Descriptive Morphology of the Ant {GenusProcyptocerus}(Hymenoptera: Formicidae)

Entry Metadata: URI: 7f36cef5-48ca-49de-90a8-d76c12e25f0a; creator: ORKGUserORCID; created on: 2021-09-29T15:01:01.761000000; last updated on: 2021-09-29T15:29:40.455000000

Research overview

- Research result
 - multicellular organism [UBERON]
- Research objective
- Research method

research result [ORKG]

Research result

has part:

specify the type of research result [add](#)

resulted from:

specify the type of research activity [add](#)

achieved objective:

specify the type of research objective [add](#)

is about:

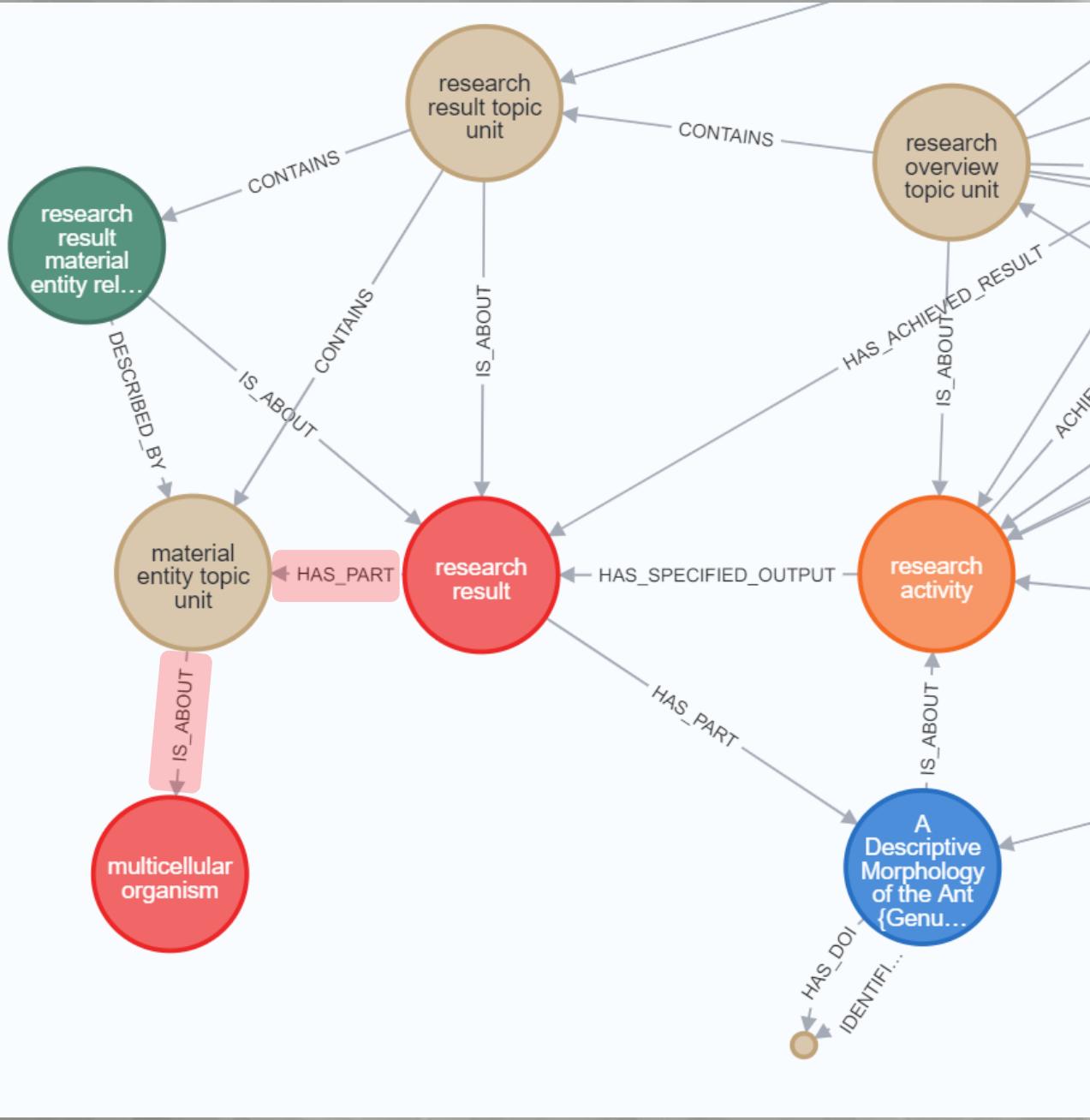
multicellular organism [UBERON] [edit](#) [delete](#)

multicellular organism [edit](#) [delete](#)

is about:

specify the type of material entity [add](#)

[Return to Entry List](#)[Return to Lobby](#)



The concept of a '**contribution**' is not required in this model.
 Clear **separation of discursive** and **ontological layer**.



Add paper

A Descriptive Morphology of the Ant Genus Procryptocerus (Hymenoptera: Formicidae)

View graph

Specify research contributions ?Contribution 1 +Use template ?

- + Transient absorption spectroscopy
- + SEIR
- + Case fatality rate estimate
- + Basic reproduction number estimate
- + Student's t-test
- + Research Problem

? Help

No data yet

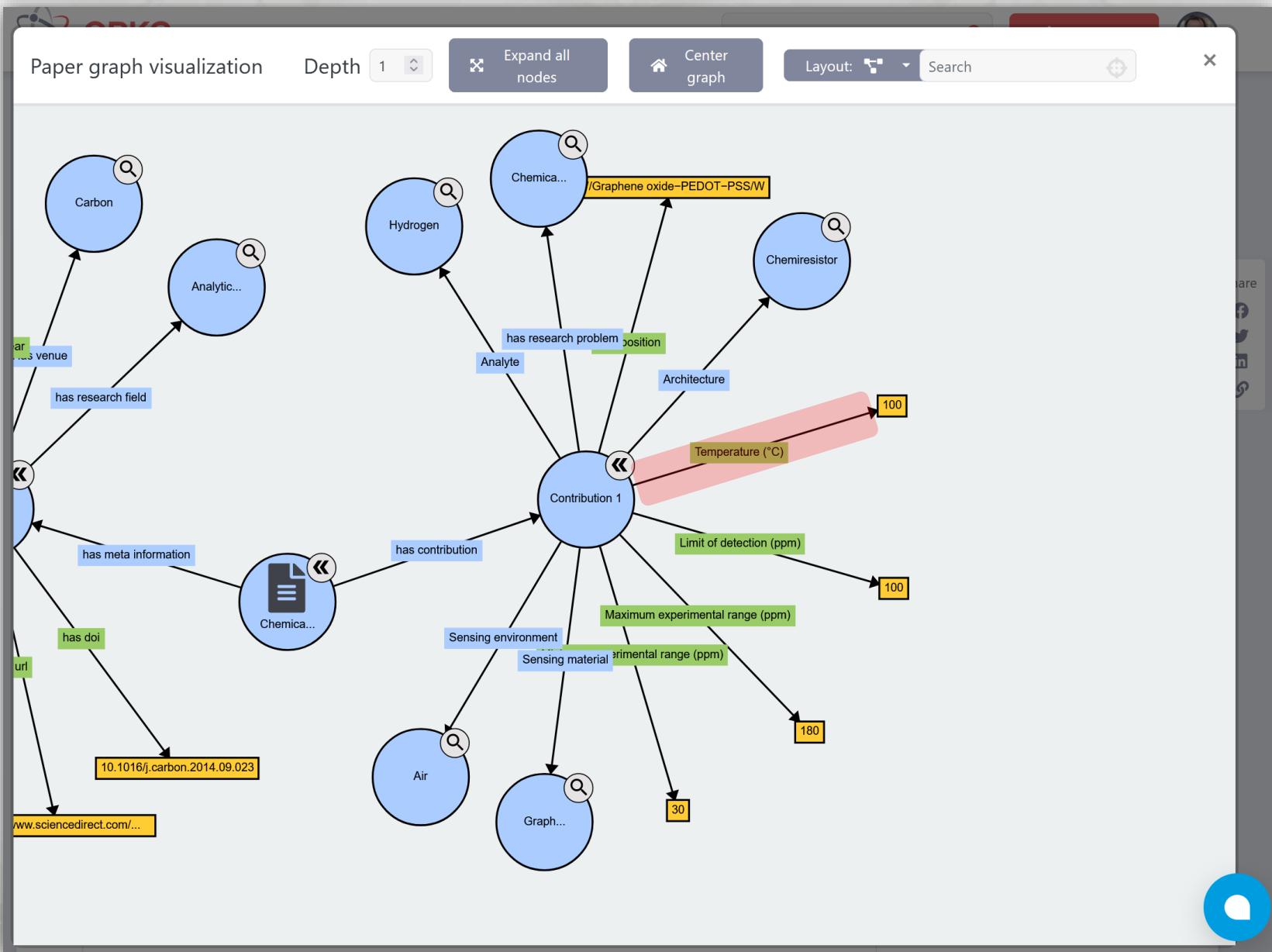
Start by adding a property from below

+ Add property?

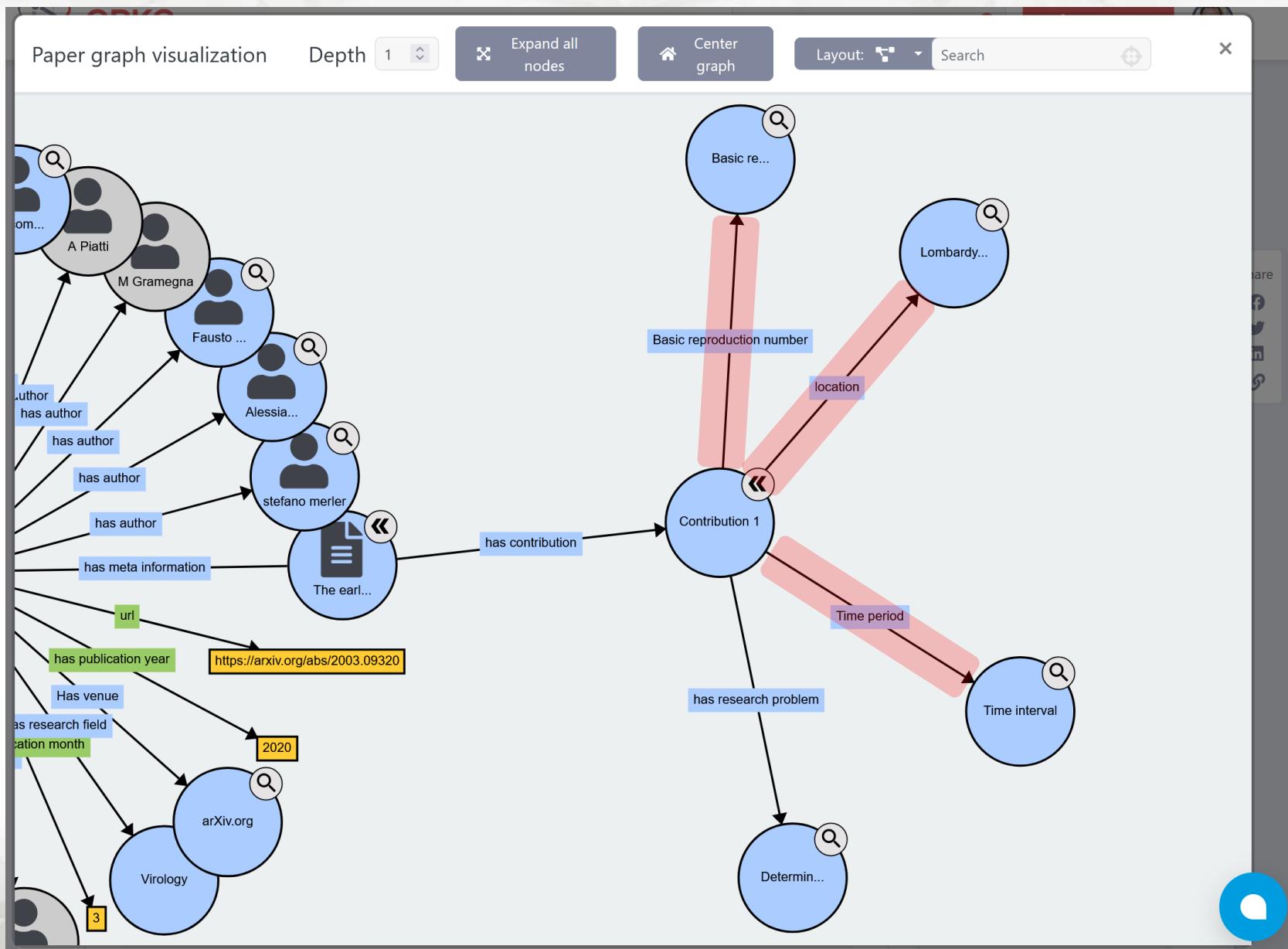
Previous step

Finish





Providing no starting structure and the central role of 'contribution' often results in bad modelling choices.



Providing no starting structure and the central role of 'contribution' often results in bad modelling choices.



A Descriptive Morphology of the Ant {GenusProcyptocerus}(Hymenoptera: Formicidae)

Entry Metadata: URI: 7f36cef5-48ca-49de-90a8-d76c12e25f0a; creator: ORKGUserORCID; created on: 2021-09-29T15:01:01.761000000; last updated on: 2021-09-29T15:29:40.455000000

Research overview

- Research result
 - multicellular organism [UBERON]
- Research objective
- Research method

versions X

research result [ORKG]

Research result

has part: specify the type of research result

resulted from: specify the type of research activity

multicellular organism [UBERON]

multicellular organism

indicates an instance resource

< > < >

[Return to Entry List](#) [Return to Lobby](#)



A Descriptive Morphology of the Ant {GenusPro}

Entry Metadata: URI: 7f36cef5-48ca-49de-90a8-d76c12e25f0a; creator: ORKGUserORCID; created on: 2021-09-29T15:01:01.761000000; last updated on: 2021-09-29T15:29:40.455000000

Research overview

- Research result
 - multicellular organism [UBERON]
- Research objective
- Research method

versions

research result [ORKG]

Research result

has part: specify the type of research result

resulted from: specify the type of research activity

multicellular organism [UBERON]

multicellular organism

instance label

< > < >

[Return to Entry List](#) [Return to Lobby](#)



A Descriptive Morphology of the Ant {GenusPro}

Entry Metadata: URI: 7f36cef5-48ca-49de-90a8-d76c12e25f0a; creator: ORKGUserORCID; created on: 2021-09-29T15:01:01.761000000; last updated on: 2021-09-29T15:29:40.455000000

Research overview

- Research result
 - multicellular organism [UBERON]
- Research objective
- Research method

versions X

research result [ORKG]

Research result

has part: specify the type of research result

resulted from: specify the type of research activity

multicellular organism [UBERON]

multicellular organism

class label

[Return to Entry List](#)[Return to Lobby](#)



A Descriptive Morphology of the Ant {GenusProcyptocerus}(Hymenoptera: Formicidae)

Entry Metadata: URI: 7f36cef5-48ca-49de-90a8-d76c12e25f0a; creator: ORKGUserORCID; created on: 2021-09-29T15:01:01.761000000; last updated on: 2021-09-29T15:29:40.455000000

Research overview

- Research result
 - multicellular organism [UBERON]
- Research objective
- Research method

versions X

research result [ORKG]

Research result

has part: specify the type of research result

resulted from: specify the type of research activity

multicellular organism [UBERON]

multicellular organism

ontology acronym

< > < >



A Descriptive Morphology of the Ant {GenusProcyptocerus}(Hymenoptera: Formicidae)

Entry Metadata: URI: 7f36cef5-48ca-49de-90a8-d76c12e25f0a; creator: ORKGUserORCID; created on: 2021-09-29T15:01:01.761000000; last updated on: 2021-09-29T15:29:40.455000000

Research overview

- Research result
 - multicellular organism [UBERON]
- Research objective
- Research method

research result [ORKG]

Research result

has part:

specify the type of research result [add](#)

resulted from:

specify the type of research activity [add](#)

is about:

multicellular organism [UBERON]

multicellular organism

specify the type of material entity [add](#)

Return to Entry List

Return to Lobby

indicates an instance of an assertion unit

90



A Descriptive Morphology of the Ant {GenusProcyptocerus}(Hymenoptera: Formicidae)

Entry Metadata: URI: 7f36cef5-48ca-49de-90a8-d76c12e25f0a; creator: ORKGUserORCID; created on: 2021-09-29T15:01:01.761000000; last updated on: 2021-09-29T15:29:40.455000000

Research overview

- Research result
 - multicellular organism [UBERON]
- Research objective
- Research method

research result [ORKG]

Research result

has part:

specify the type of research result [add](#)

resulted from:

specify the type of research activity [add](#)

is about:

multicellular organism [UBERON]

multicellular organism

is about:

specify the type of material entity [add](#)

example for making statements about this assertion unit

Return to Entry List

Return to Lobby



A Descriptive Morphology of the Ant {GenusProcyptocerus}(Hymenoptera: Formicidae)

Entry Metadata: URI: 7f36cef5-48ca-49de-90a8-d76c12e25f0a; creator: ORKGuserORCID; created on: 2021-09-29T15:01:01.761000000; last updated on: 2021-09-29T15:29:40.455000000

Research overview

- Research result
 - multicellular organism [UBERON]
- Research objective
- Research method

versions

research result [ORKG]

Research result

Statement: "Research result is about material entity:
multicellular organism [UBERON] :"

The statement has the following certainty/confidence:

certain likely uncertain not specified

multicellular organism [UBERON]

save

< > < >

[Return to Entry List](#)[Return to Lobby](#)



A Descriptive Morphology of the Ant {GenusPro

- Research overview
 - Research result
 - multicellular organism [UBERON]
 - Research objective
 - Research method

Entry Metadata: URI: 7f36cef5-48ca-49de-90a8-d76c12e25f0a; creator: ORKGuserORCID; created on: 2021-09-29T15:01:01.761000000; last updated on: 2021-09-29T15:29:40.455000000

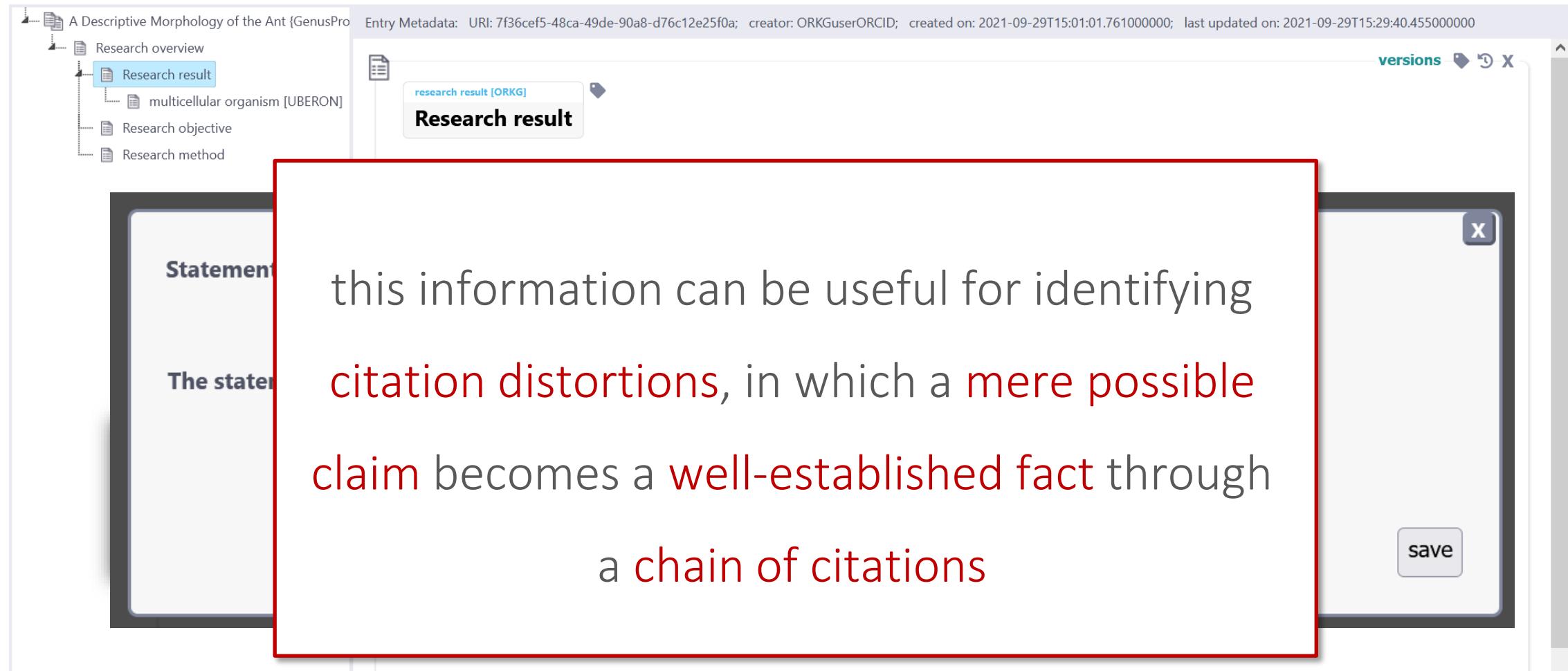
versions X

research result [ORKG]
Research result

Statement
The statement

this information can be useful for identifying
citation distortions, in which a mere possible
claim becomes a well-established fact through
a chain of citations

save

[Return to Entry List](#)[Return to Lobby](#)



A Descriptive Morphology of the Ant {GenusProcyptocerus}

Entry Metadata: URI: 56f73a83-ba42-4e00-894a-59284c7dc85e; creator: ORKGUserORCID; created on: 2021-09-29T15:59:55.050000000; last updated on: 2021-09-29T16:14:00.345000000

Research overview

multicellular organism [UBERON]

- material entity parthood granularity tree [ORKG]
- head [UBERON]
- eye [UBERON]
- eye [UBERON]

Research objective

Research method

versions X

multicellular organism

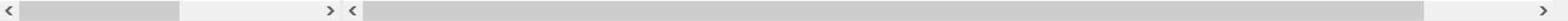
has granularity tree: multicellular organism parthood granularity tree

has part: head [UBERON] head

has part: specify the type of material entity add

has quality: select a quality add

added a head
and two eyes

[Return to Entry List](#)[Return to Lobby](#)



A Descriptive Morphology of the Ant {GenusProcyptocerus}

Entry Metadata: URI: 56f73a83-ba42-4e00-894a-59284c7dc85e; creator: ORKGUserORCID; created on: 2021-09-29T15:59:55.050000000; last updated on: 2021-09-29T16:14:00.345000000

Research overview

- Research result
 - multicellular organism [UBERON]
 - material entity parthood granularity tree
 - head [UBERON]
 - eye [UBERON]
 - eye [UBERON]

Research objective

Research method

versions ⌂ ⌚ X

multicellular organism [UBERON]

multicellular organism

has granularity tree: material entity parthood granularity tree [ORKG] multicellular organism parthood granularity tree

has part: head [UBERON] head

has part: specify the type of material entity add

has quality: select a quality add

parthood granularity tree unit - automatically added by the application

< > < >

Return to Entry List Return to Lobby



- A Descriptive Morphology of the Ant {GenusPro}
 - Research overview
 - Research result
 - multicellular organism [UBERON]
 - material entity parthood granularity tree
 - head [UBERON]
 - eye [UBERON]
 - eye [UBERON]
 - Research objective
 - Research method

Entry Metadata: URI: 56f73a83-ba42-4e00-894a-59284c7dc85e; creator: ORKGUserORCID; created on: 2021-09-29T15:59:55.050000000; last updated on: 2021-09-29T16:14:00.345000000

versions ⌂ ⌂ X

multicellular organism [UBERON]

multicellular organism

has granularity tree:

material entity parthood granularity tree [ORKG]

multicellular organism parthood granularity tree

has part:

head [UBERON]

head

specify the type of material entity **add**

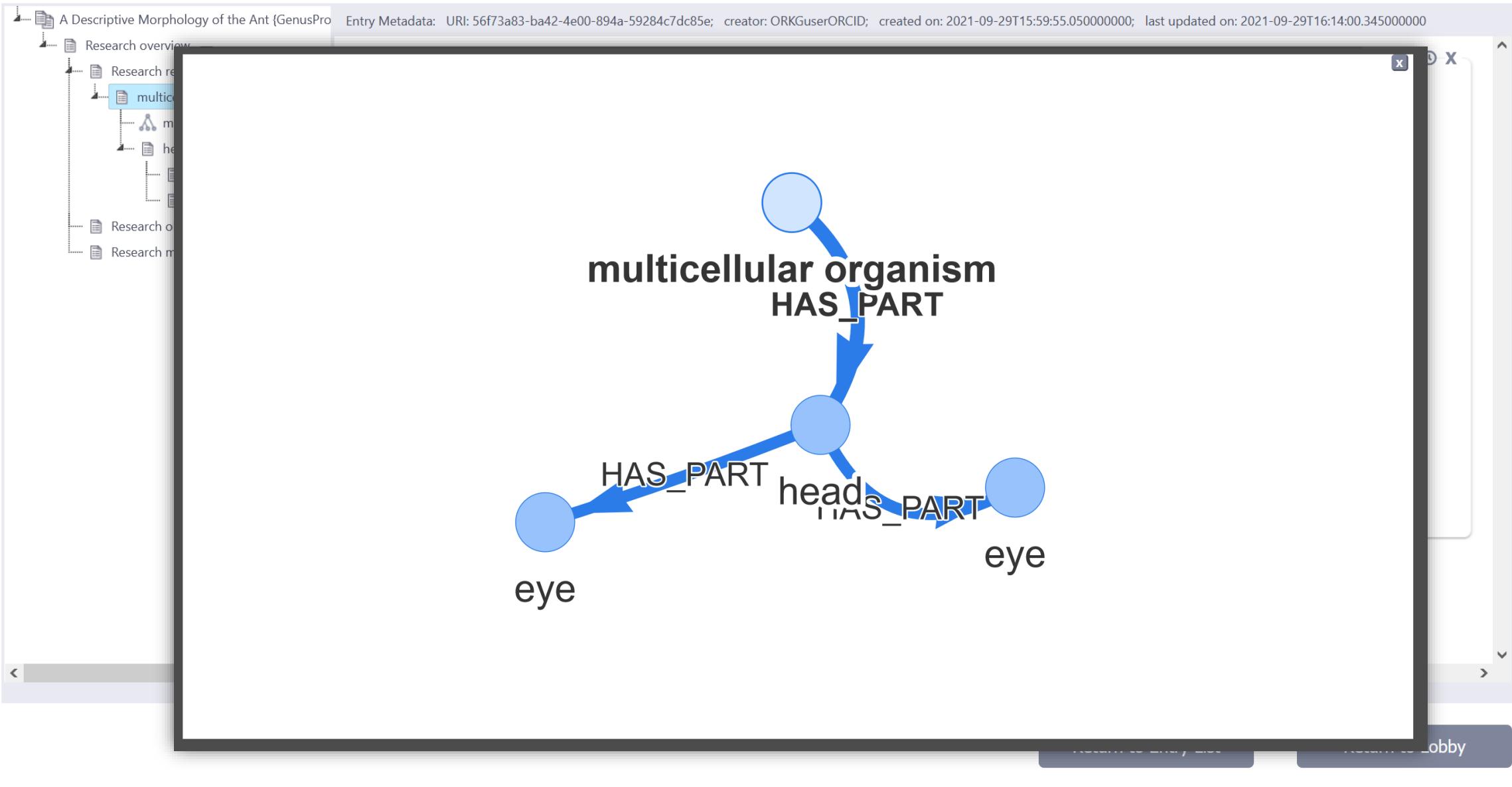
has quality:

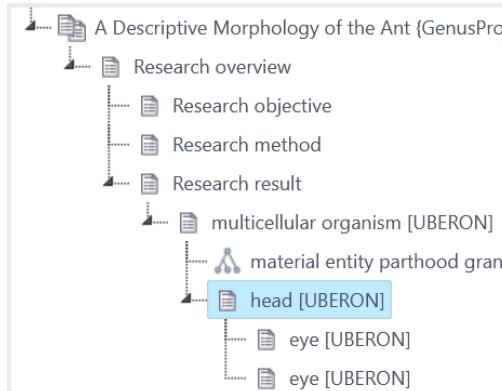
select a quality **add**

view parthood granularity
tree

Return to Entry List

Return to Lobby





Entry Metadata: URI: afa0dc64-b9c1-4f18-abc8-759dd3a3b658; creator: ORKGUserORCID; created on: 2021-09-30T07:48:11.559000000; last updated on: 2021-09-30T07:51:16.424000000

versions ⌂ ⌃ X

change
instance label

head [UBERON]

head

has part:

eye [UBERON]

eye

has part:

eye [UBERON]

eye

has part:

specify the type of material entity

add

has quality:

select a quality

add

[Return to Entry List](#)[Return to Lobby](#)

Scholarly Publication ORKG Entry: A Descriptive Morphology of the Ant {GenusProryptocerus}(Hymenoptera: Formicidae)

A Descriptive Morphology of the Ant {GenusProryptocerus}(Hymenoptera: Formicidae)

current resource label: eye

left eye save

000; last updated on: 2021-09-30T07:51:16.424000000

versions X

change instance label

Metadata about resource:

eye [UBERON]
eye

creator: ORKGuserORCID

created on: 2021-09-30T07:51:16.424000000

last updated on: 2021-09-30T07:51:16.424000000

instance URI: 17c10127-749f-4385-9b23-29d5f88260ee

type URI: http://purl.obolibrary.org/obo/UBERON_0000970

ontology ID: UBERON

type label: eye

type description: Bioportal API does not provide a description for this resource

Return to Entry List

Return to Lobby



A Descriptive Morphology of the Ant {GenusPro} Entry Metadata: URI: afa0dc64-b9c1-4f18-abc8-759dd3a3b658; creator: ORKGUserORCID; created on: 2021-09-30T07:48:11.559000000; last updated on: 2021-09-30T08:01:46.990000000

Research overview

- Research objective
- Research method
- Research result

multicellular organism [UBERON]

- material entity parthood graph
- head [UBERON]
 - eye [UBERON]
 - eye [UBERON]

head [UBERON] versions X

head

has part: **left eye**

has part: **right eye**

has part: specify the type of material entity

has quality: select a quality

instance labels changed

[Return to Entry List](#)[Return to Lobby](#)



A Descriptive Morphology of the Ant {GenusPro Entry Metadata: URI: afa0dc64-b9c1-4f18-abc8-759dd3a3b658; creator: ORKGUserORCID; created on: 2021-09-30T07:48:11.559000000; last updated on: 2021-09-30T08:05:14.015000000

Research overview

- Research objective
- Research method
- Research result
 - multicellular organism [UBERON]
 - material entity parthood graph
 - head [UBERON]
 - weight [PATO]
 - eye [UBERON]
 - eye [UBERON]

versions X

head [UBERON]
head

has part:
left eye

has part:
right eye

has part:
specify the type of material entity add

has quality:
weight
value select a gram-based unit

has quality:
select a quality

added a
quality assertion unit

[Return to Entry List](#)[Return to Lobby](#)



A Descriptive Morphology of the Ant {GenusProcyptocerus}

- Research overview
 - Research objective
 - Research method
 - Research result
- multicellular organism [UBERON]
 - material entity parthood gran
 - head [UBERON]
 - weight [PATO]
 - eye [UBERON]
 - eye [UBERON]

Entry Metadata: URI: afa0dc64-b9c1-4f18-abc8-759dd3a3b658; creator: ORKGuserORCID; created on: 2021-09-30T07:48:11.559000000; last updated on: 2021-09-30T08:07:06.910000000

head [UBERON]

head

has part: **left eye**

has part: **right eye**

has part: specify the type of material entity **add**

has quality: **weight**

: value **1 picogram** **picogram [UO]** **select a gram-based unit** **add**

has quality: select a quality **add**

versions

added a weight measurement assertion unit

Return to Entry List

Return to Lobby

Scholarly Publication ORKG Entry: A Descriptive Morphology of the Ant {GenusProcyptocerus}(Hymenoptera: Formicidae)

A Descriptive Morphology of the Ant {GenusProcyptocerus}(Hymenoptera: Formicidae) Entry Metadata: URI: afa0dc64-b9c1-4f18-abc8-759dd3a3b658; creator: ORKGUserORCID; created on: 2021-09-30T07:48:11.559000000; last updated on: 2021-09-30T08:07:06.910000000 versions X

Research overview

- Research objective
- Research method
- Research result
- multicellular organism [UBERON]
 - material entity parthood gran
 - head [UBERON]
 - weight [PATO]
 - eye [UBERON]
 - eye [UBERON]

head [UBERON]
head

has part:

 - left eye [UBERON]
 - right eye [UBERON]

has part:

specify the type of material entity add

has quality:

 - weight [PATO]

: value select a gram-based unit add

: 1 picogram edit

edit

< > < >

Return to Entry List

Return to Lobby

Entry Metadata: URI: afa0dc64-b9c1-4f18-abc8-759dd3a3b658; creator: ORKGUserORCID; created on: 2021-09-30T07:48:11.559000000; last updated on: 2021-09-30T08:07:06.910000000

Research overview

- Research objective
- Research method
- Research result
- multicellular organism
 - material entity p
 - head [UBERON]
 - weight [PATO]
 - eye [UBERON]
 - eye [UBERON]

head [UBERON]

has part:

0.5 picogram edit

picogram

Results provided by NCBO BioPortal

picovolt (synonyms:) retrieving definitions...

picomole (synonyms:) retrieving definitions...

picogram

picosecond (synonyms:) retrieving definitions...

picomolal (synonyms:) retrieving definitions...

picomolar (synonyms:) retrieving definitions...

picometer (synonyms:) retrieving definitions...

pico (synonyms:) retrieving definitions...

Results provided by NCBO BioPortal

has quality:

select a quality add

add

Return to Entry List

Return to Lobby

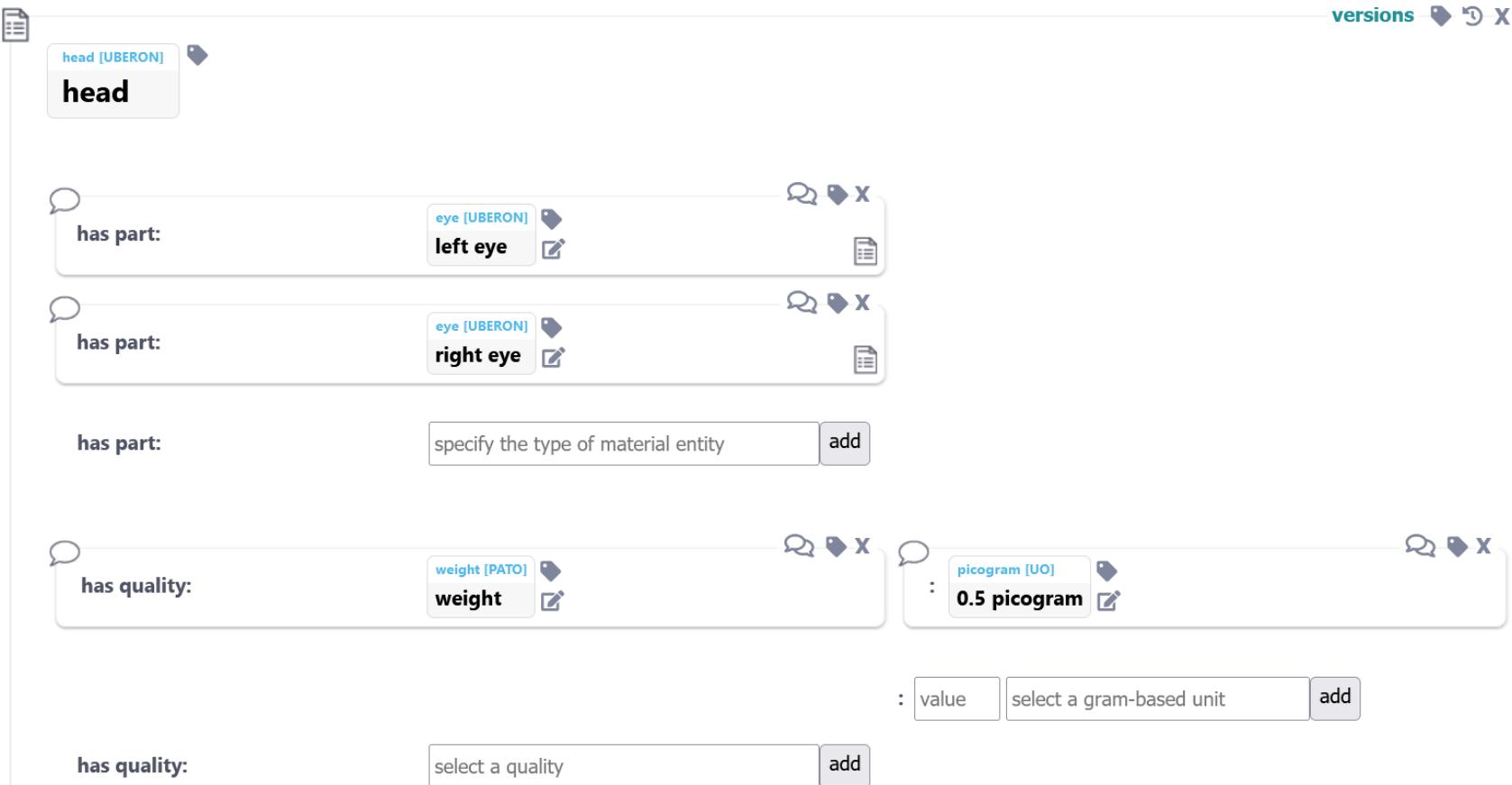


A Descriptive Morphology of the Ant {GenusPro}

- Research overview
 - Research objective
 - Research method
 - Research result
 - multicellular organism [UBERON]
 - material entity parthood graph
 - head [UBERON]
 - weight [PATO]
 - eye [UBERON]
 - eye [UBERON]

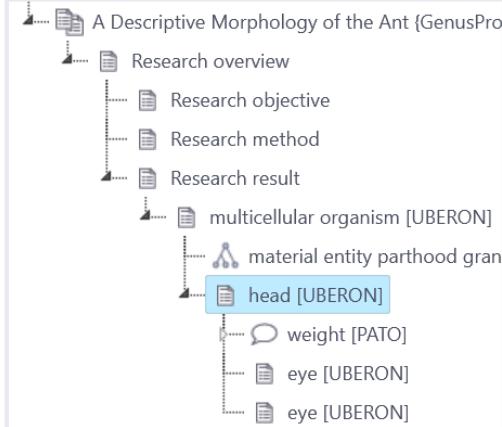
Entry Metadata: URI: afa0dc64-b9c1-4f18-abc8-759dd3a3b658; creator: ORKGUserORCID; created on: 2021-09-30T07:48:11.559000000; last updated on: 2021-09-30T08:16:08.387000000

versions X



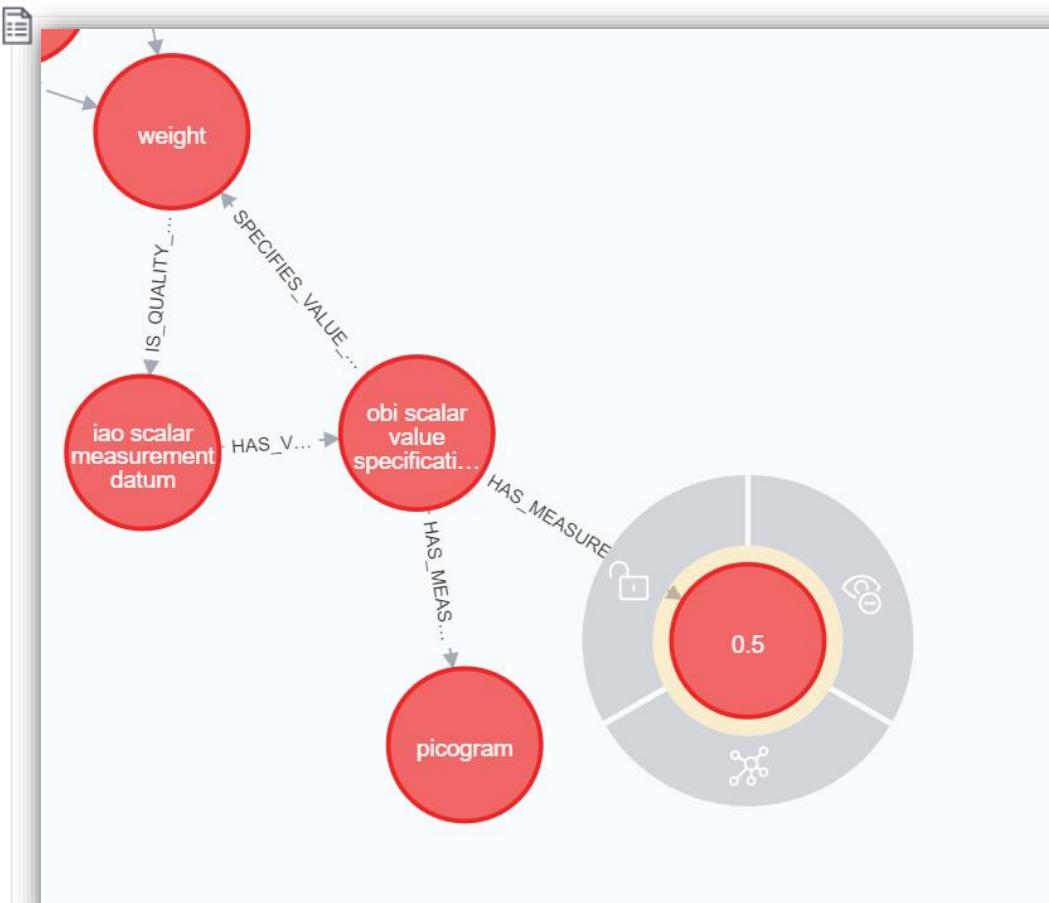
Return to Entry List

Return to Lobby



Entry Metadata: URI: afa0dc64-b9c1-4f18-abc8-759dd3a3b658; creator: ORKGUserORCID; created on: 2021-09-30T07:48:11.559000000; last updated on: 2021-09-30T08:16:08.387000000

versions ⌂ ⌚ X

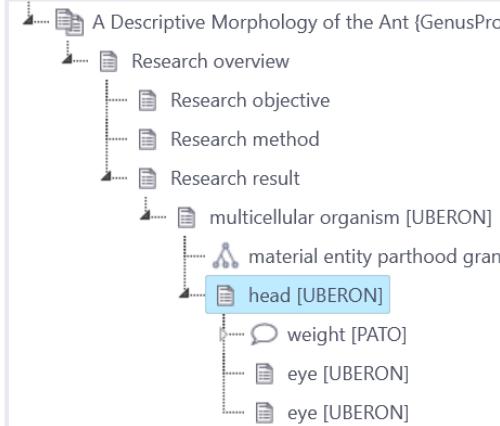


node identified
as **input 1** node
of this **assertion**
unit

gram [UO] picogram
select a gram-based unit

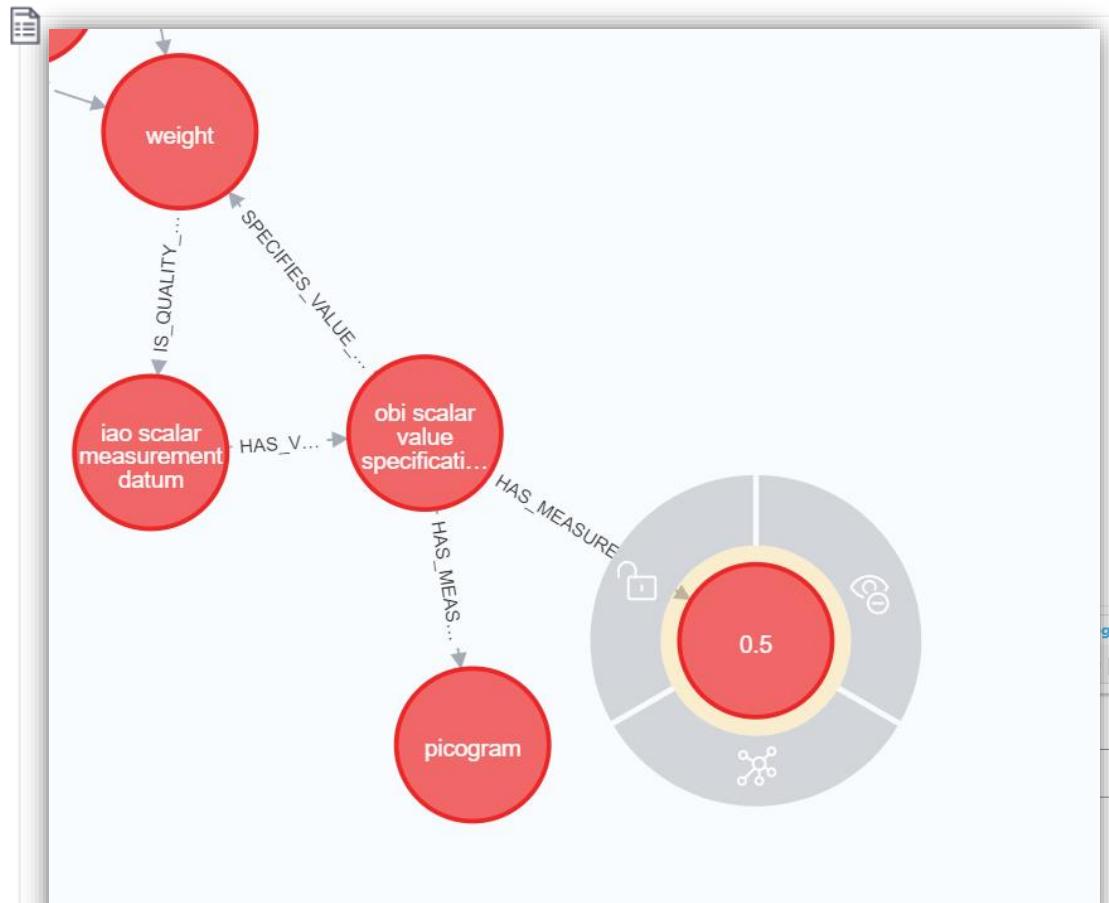
Entity **Literal_IND** **NamedIndividual** **Value_IND** **<id>**: 438 **URI**: 901a9e1e-8e2e-43d2-90b9-4554757c5a8e **assertion_URI**: 92438b61-aa49-41e6-af0f-9175318f1b04 **category**: NamedIndividual
contributed_by: ORKGUserORCID **created_by**: ORKGUserORCID **created_on**: "2021-09-30T08:16:08.387000000" **created_with**: ORKG **current_version**: true **data_node_type**: input1
data_type: xsd:float **data_view_information**: true **dataset_doi**: NULL **description**: The value of a weight measurement **entry_URI**: afa0dc64-b9c1-4f18-abc8-759dd3a3b658 **input**: true
inputVariable: 1 **input_info_URI**: InputInfo1WeightMeasurementAssertionIND_URI **input_source**: input1 **input_version_ID**: 0 **last_updated_on**: "2021-09-30T08:16:08.387000000" **name**: 0.5
topic_URI: 6d3d4b3a-1d0d-4bac-827a-2fc1a46cd5c7 **type**: orkg_value_URI **user_input**: 92438b61-aa49-41e6-af0f-9175318f1b04 **value**: 0.5 **versioned_doi**: NULL





Entry Metadata: URI: afa0dc64-b9c1-4f18-abc8-759dd3a3b658; creator: ORKGUserORCID; created on: 2021-09-30T07:48:11.559000000; last updated on: 2021-09-30T08:16:08.387000000

[versions](#)

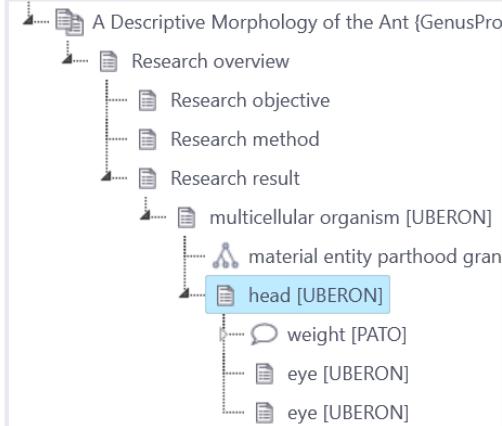


current input

gram [UO]

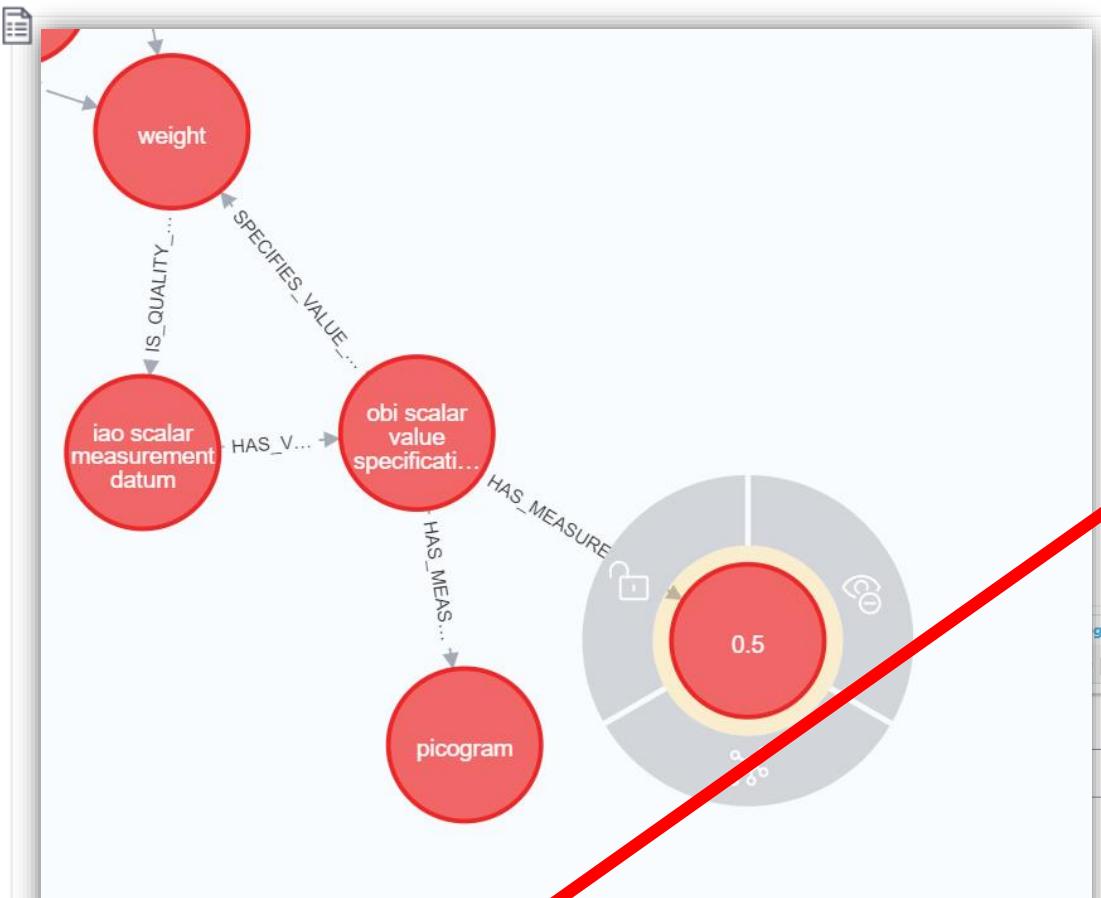
picogram

Entity **Literal_IND** **NamedIndividual** **Value_IND** **<id>**: 438 **URI**: 901a9e1e-8e2e-43d2-90b9-4554757c5a8e **assertion_URI**: 92438b61-aa49-41e6-af0f-9175318f1b04 **category**: NamedIndividual
contributed_by: ORKGUserORCID **created_by**: ORKGUserORCID **created_on**: "2021-09-30T08:16:08.387000000" **created_with**: ORKG **current_version**: true **data_node_type**: input1
data_type: xsd:float **data_view_information**: true **dataset_doi**: NULL **description**: The value of a weight measurement **entry_URI**: afa0dc64-b9c1-4f18-abc8-759dd3a3b658 **input**: true
inputVariable: 1 **input_info_URI**: InputInfo1WeightMeasurementAssertionIND_URI **input_source**: input1 **input_version_ID**: 0 **last_updated_on**: "2021-09-30T08:16:08.387000000" **name**: 0.5
topic_URI: 6d3d4b3a-1d0d-4bac-827a-2fc1a46cd5c7 **type**: orkg_value_URI **user_input**: 92438b61-aa49-41e6-af0f-9175318f1b04 **value**: 0.5 **versioned_doi**: NULL



Entry Metadata: URI: afa0dc64-b9c1-4f18-abc8-759dd3a3b658; creator: ORKGUserORCID; created on: 2021-09-30T07:48:11.559000000; last updated on: 2021-09-30T08:16:08.387000000

versions ⌂ ⌂ X



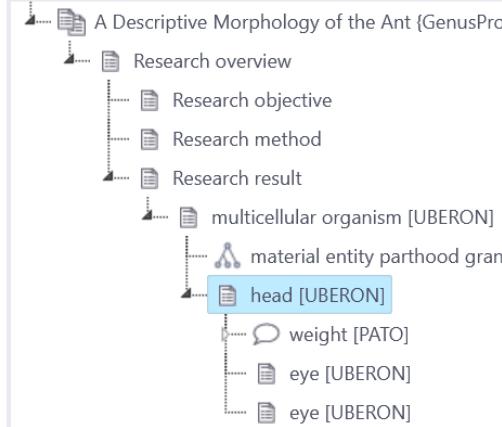
metadata for
this particular
input

gram [UO] picogram

select a gram-based unit

Entity **Literal_IND** **NamedIndividual** **Value_IND** <id>: 438 **URI**: 901a9e1e-8e2e-43d2-90b9-4554757c5a8e **assertion_URI**: 92438b61-aa49-41e6-af0f-9175318f1b04 **category**: NamedIndividual
contributed_by: ORKGUserORCID **created_by**: ORKGUserORCID **created_on**: "2021-09-30T08:16:08.387000000" **created_with**: ORKG **current_version**: true **data_node_type**: input1
data_type: xsd:float **data_view_information**: true **dataset_doi**: NULL **description**: The value of a weight measurement **entry_URI**: afa0dc64-b9c1-4f18-abc8-759dd3a3b658 **input**: true
inputVariable: 1 **input_info_URI**: InputInfo1WeightMeasurementAssertionIND_URI **input_source**: input1 **input_version_ID**: 0 **last_updated_on**: "2021-09-30T08:16:08.387000000" **name**: 0.5
topic_URI: 6d3d4b3a-1d0d-4bac-827a-2fc1a46cd5c7 **type**: orkg_value_URI **user_input**: 92438b61-aa49-41e6-af0f-9175318f1b04 **value**: 0.5 **versioned_doi**: NULL





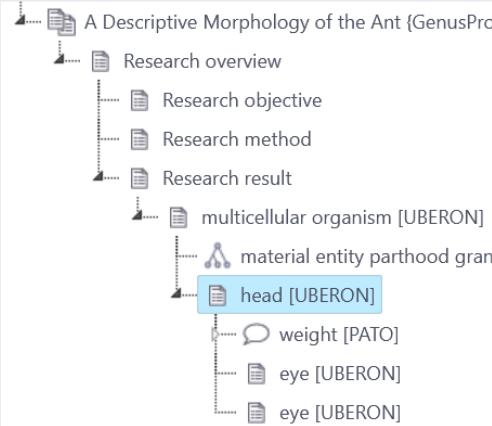
Entry Metadata: URI: afa0dc64-b9c1-4f18-abc8-759dd3a3b658; creator: ORKGUserORCID; created on: 2021-09-30T07:48:11.559000000; last updated on: 2021-09-30T08:16:08.387000000

versions



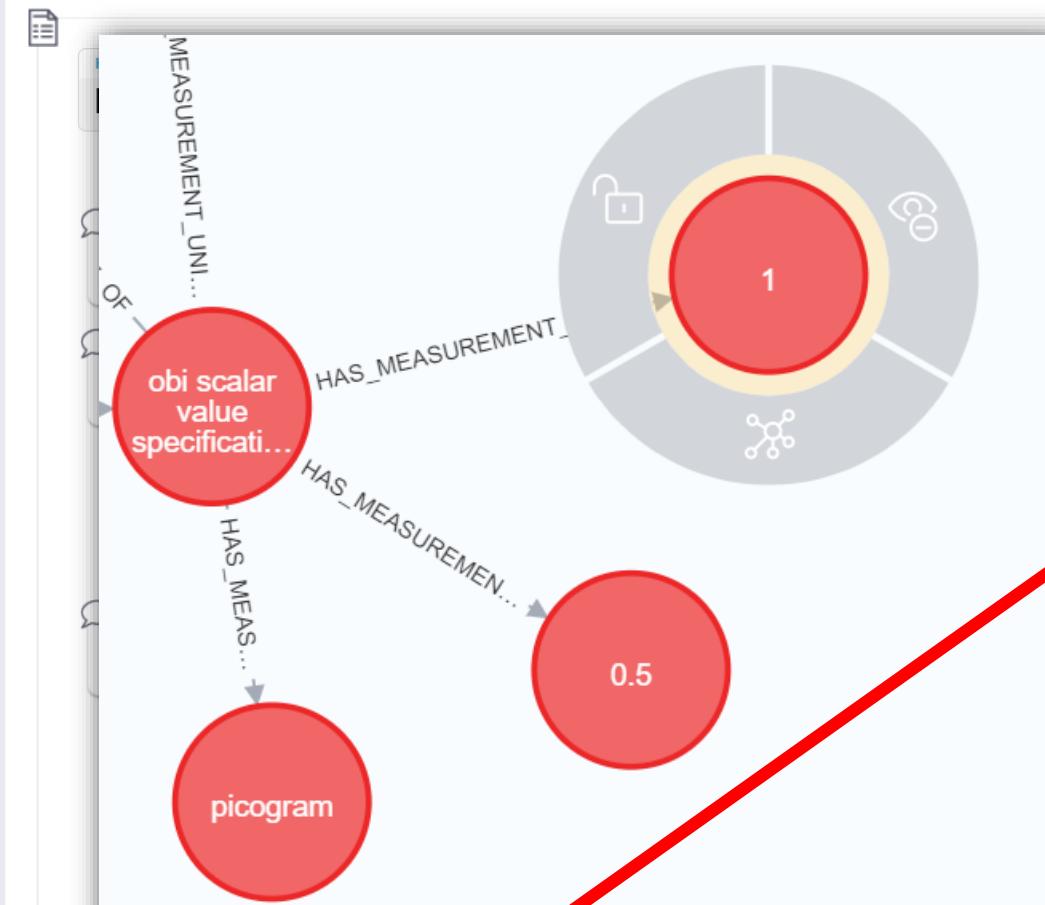
Return to Entry List

Return to Lobby



Entry Metadata: URI: afa0dc64-b9c1-4f18-abc8-759dd3a3b658; creator: ORKGUserORCID; created on: 2021-09-30T07:48:11.559000000; last updated on: 2021-09-30T08:16:08.387000000

versions X



metadata for
past input

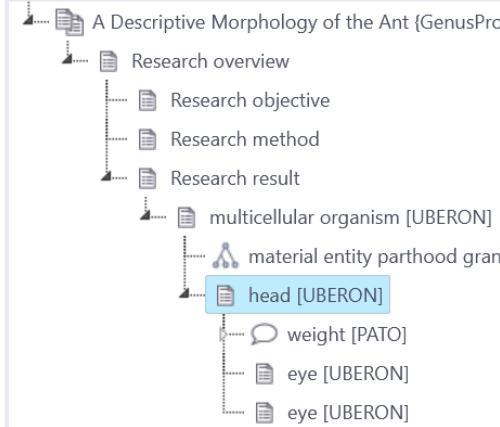
picogram [UO] X

0.5 picogram

value select a gram-based unit

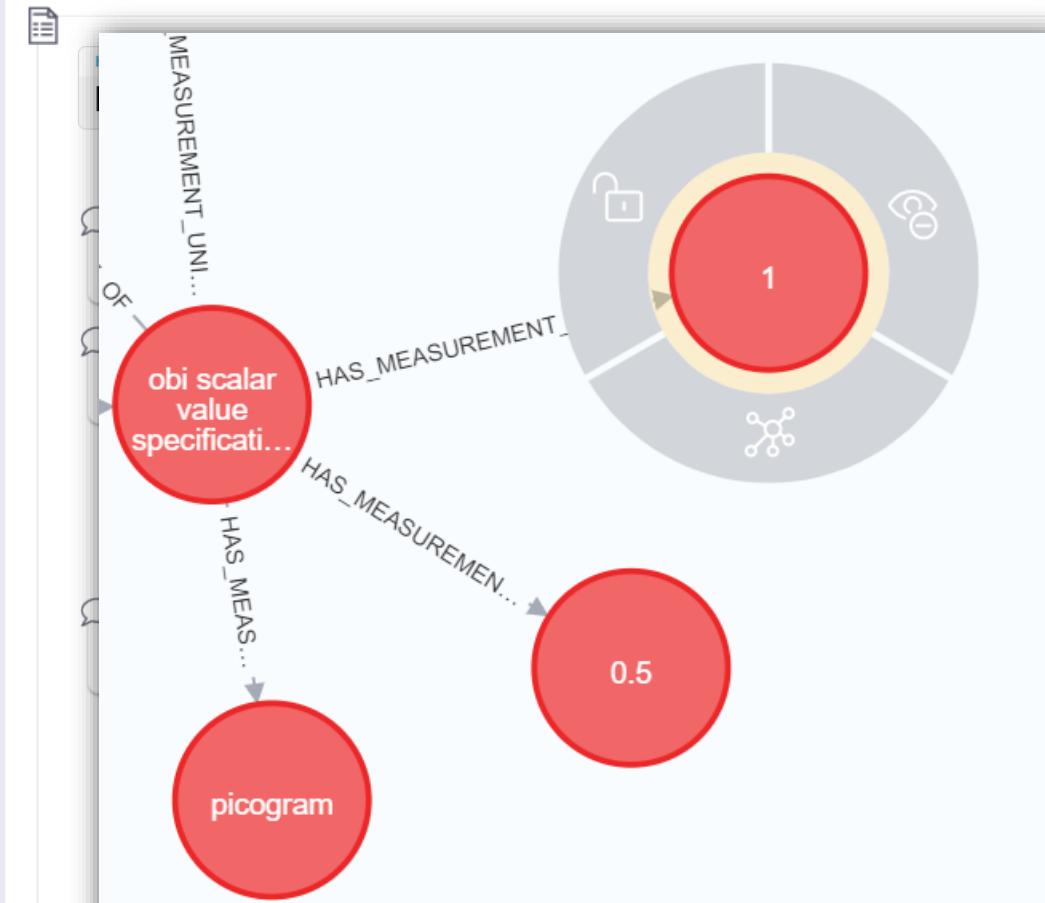
Entity **Literal_IND** **NamedIndividual** **Value_IND** **<id>**: 436 **URI**: 93db805d-de05-4aa1-87c6-89180a60ed88 **assertion_URI**: 92438b61-aa49-41e6-af0f-9175318f1b04 **category**: NamedIndividual
contributed_by: ORKGUserORCID **created_by**: ORKGUserORCID **created_on**: "2021-09-30T08:07:06.910000000" **created_with**: ORKG **current_version**: false **data_node_type**: input1
data_type: xsd:float **data_view_information**: true **dataset_doi**: NULL **description**: The value of a weight measurement **entry_URI**: afa0dc64-b9c1-4f18-abc8-759dd3a3b658 **input**: true
inputVariable: 1 **input_info_URI**: InputInfo1WeightMeasurementAssertionIND_URI **input_source**: input1 **input_version_ID**: 0 **last_updated_on**: "2021-09-30T08:07:06.910000000" **name**: 1
topic_URI: 6d3d4b3a-1d0d-4bac-827a-2fc1a46cd5c7 **type**: orkg_value_URI **user_input**: 92438b61-aa49-41e6-af0f-9175318f1b04 **value**: 1 **versioned_doi**: NULL





Entry Metadata: URI: afa0dc64-b9c1-4f18-abc8-759dd3a3b658; creator: ORKGUserORCID; created on: 2021-09-30T07:48:11.559000000; last updated on: 2021-09-30T08:16:08.387000000

[versions](#)



not current
input anymore

| | |
|---------------------|-------------------------------------|
| picogram [UO] | <input checked="" type="checkbox"/> |
| 0.5 picogram | <input checked="" type="checkbox"/> |
| value | select a gram-based unit |
| add | |

Entity **Literal_IND** **NamedIndividual** **Value_IND** **<id>**: 436 **URI**: 93db805d-de05-4aa4-87c6-89180a60ed88 **assertion_URI**: 92438b61-aa49-41e6-af0f-9175318f1b04 **category**: NamedIndividual
contributed_by: ORKGUserORCID **created_by**: ORKGUserORCID **created_on**: "2021-09-30T08:07:06.910000000" **created_with**: ORKG **current_version**: false **data_node_type**: input1
data_type: xsd:float **data_view_information**: true **dataset_doi**: NULL **description**: The value of a weight measurement **entry_URI**: afa0dc64-b9c1-4f18-abc8-759dd3a3b658 **input**: true
inputVariable: 1 **input_info_URI**: InputInfo1WeightMeasurementAssertionIND_URI **input_source**: input1 **input_version_ID**: 0 **last_updated_on**: "2021-09-30T08:07:06.910000000" **name**: 1
topic_URI: 6d3d4b3a-1d0d-4bac-827a-2fc1a46cd5c7 **type**: orkg_value_URI **user_input**: 92438b61-aa49-41e6-af0f-9175318f1b04 **value**: 1 **versioned_doi**: NULL



A Descriptive Morphology of the Ant {GenusProcryptocerus}
Research overview

Entry Metadata: URI: afa0dc64-b9c1-4f18-abc8-759dd3a3b658; creator: ORKGuserORCID; created on: 2021-09-30T07:48:11.559000000; last updated on: 2021-09-30T08:16:08.387000000



entry versions: no version saved yet

Save snapshot of live version



Title:

A Descriptive Morphology of the Ant {GenusProcryptocerus}(Hymenoptera: Formicidae)

doi

10.1673/031.010.11101

Year:

no version has
been saved so far

20

Authors:

F. Sama, W. Mackay

Journal:

Journal of Insect Science

Publisher:

Oxford University Press (OUP)

has research topic:

specify the research topic

add



Return to Entry List

Return to Lobby



A Descriptive Morphology of the Ant {GenusProcryptocerus}

Research overview

Entry Metadata: URI: afa0dc64-b9c1-4f18-abc8-759dd3a3b658; creator: ORKGUserORCID; created on: 2021-09-30T07:48:11.559000000; last updated on: 2021-09-30T08:16:08.387000000



entry versions: no version saved yet

Save snapshot of live version**Title:**

A Descriptive Morphology of the Ant {GenusProcryptocerus}(Hymenoptera: Formicidae)

doi

10.1673/031.010.11101

Year:

2010

Authors:

F. Serna, W. Mackay

Journal:

Journal of Insect Science

Publisher:

Oxford University Press (OUP)

has research topic:

specify the research topic

add

saves current
state of the entry
unit as a **version**
with its own
identifier

**Return to Entry List****Return to Lobby**



A Descriptive Morphology of the Ant {GenusProcryptocerus}(Hymenoptera: Formicidae)
Research overview

Entry Metadata: URI: afa0dc64-b9c1-4f18-abc8-759dd3a3b658; creator: ORKGuserORCID; created on: 2021-09-30T07:48:11.559000000; last updated on: 2021-09-30T08:16:08.387000000

entry versions: version 1,

Save snapshot of live version

Title:

A Descriptive Morphology of the Ant {GenusProcryptocerus}(Hymenoptera: Formicidae)

doi

10.1673/031.010.11101

Year:

one version has
been saved now

Authors:

E. Serna, W. Mackay

Journal:

Journal of Insect Science

Publisher:

Oxford University Press (OUP)

has research topic:

add

< > < >

Return to Entry List

Return to Lobby

A Descriptive Morphology of the Ant {GenusPro

- Research overview
 - Research result
 - multicellular organism [UBERON]
 - Research objective
 - Research method

Entry Metadata: URI: 56f73a83-ba42-4e00-894a-59284c7dc85e; creator: ORKGUserORCID; created on: 2021-09-29T15:59:55.050000000; last updated on: 2021-09-29T16:23:55.122000000

versions

research result [ORKG]

Research result

has part: specify the type of research result

resulted from: specify the type of research activity

achieved objective: specify the type of research objective

is about: **multicellular organism [UBERON]**

is about: specify the type of material entity

< > < >

Return to Entry List

Return to Lobby

delete material entity topic unit and all semantic units it contains

A Descriptive Morphology of the Ant {GenusPro

- Research overview
 - Research result
 - multicellular organism [UBERON]
 - Research objective
 - Research method

Entry Metadata: URI: 56f73a83-ba42-4e00-894a-59284c7dc85e; creator: ORKGUserORCID; created on: 2021-09-29T15:59:55.050000000; last updated on: 2021-09-29T16:23:55.122000000

versions X

research result [ORKG]

Research result

has part:

resulted from:

achieved objective

is about:

is about:

URI: 3b712268-dcb0-46aa-8c6e-aa18a2703bbb category: NamedIndi
created_with: ORKG current_version: false dataset_doi: NULL
last_updated_on: "2021-09-30T08:35:28.680000000" name: materia

'soft delete' – the topic unit and all semantic units and the triples they contain are set to 'false'



A Descriptive Morphology of the Ant {GenusPro}

Entry Metadata: URI: 56f73a83-ba42-4e00-894a-59284c7dc85e; creator: ORKGUserORCID; created on: 2021-09-29T15:59:55.050000000; last updated on: 2021-09-29T16:39:49.334000000

Research overview

Research result

infectious agent population [IDO]

Basic Reproduction Number [OMIT]

Research objective

Research method

versions ↗ ⓘ X

infectious agent population

has part:

specify the type of material entity add

has quality:

Basic Reproduction Number [OMIT]

Basic Reproduction Number

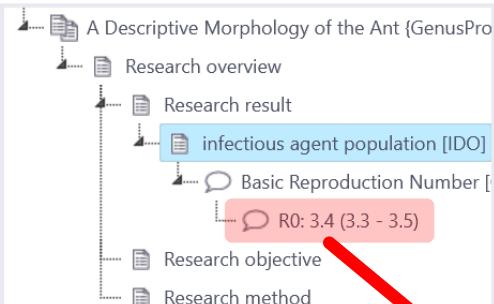
95% confidence interval: value lower limit upper limit add

select a quality add

added a population with a basic reproduction number quality

< > < >

[Return to Entry List](#)[Return to Lobby](#)



Entry Metadata: URI: 56f73a83-ba42-4e00-894a-59284c7dc85e; creator: ORKGuserORCID; created on: 2021-09-29T15:59:55.050000000; last updated on: 2021-09-29T16:43:00.152000000

versions ⌂ X

infectious agent population

has part:

specify the type of material entity

add

has quality:

Basic Reproduction Number [OMIT]

Basic Reproduction Number

: 3.4 (95% confidence interval: 3.3-3.5)

added a basic
reproduction
number value

95% confidence interval: value

lower limit

upper limit

add

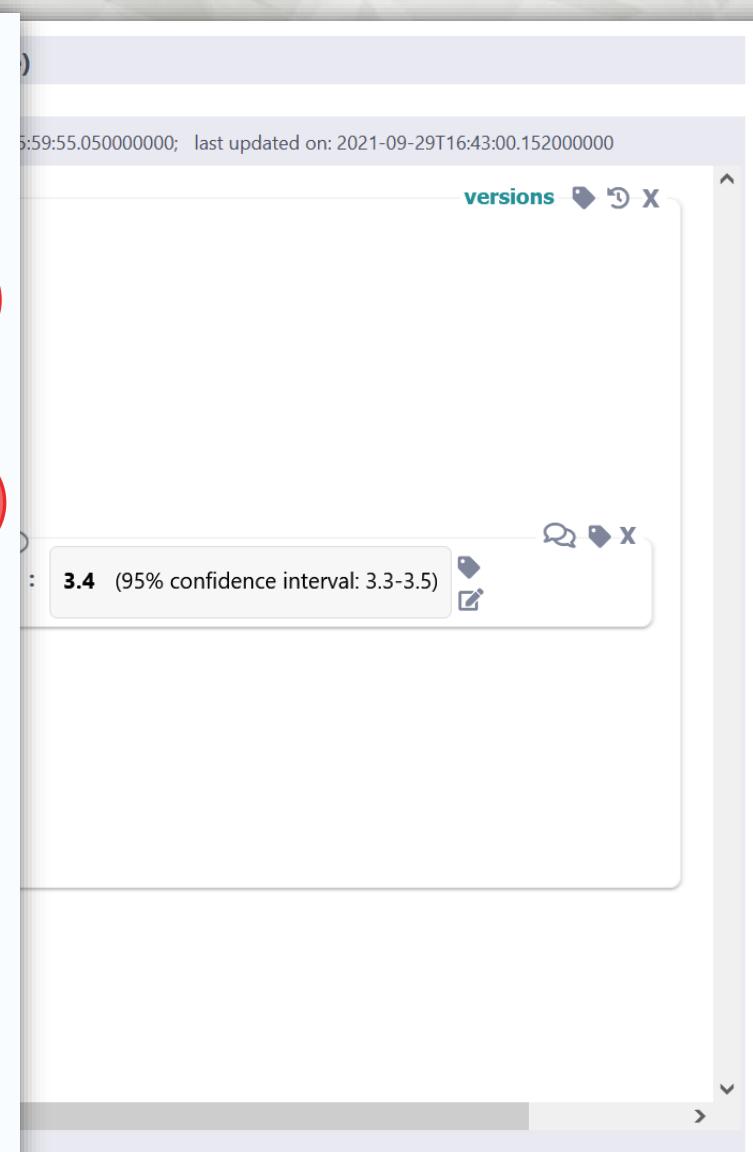
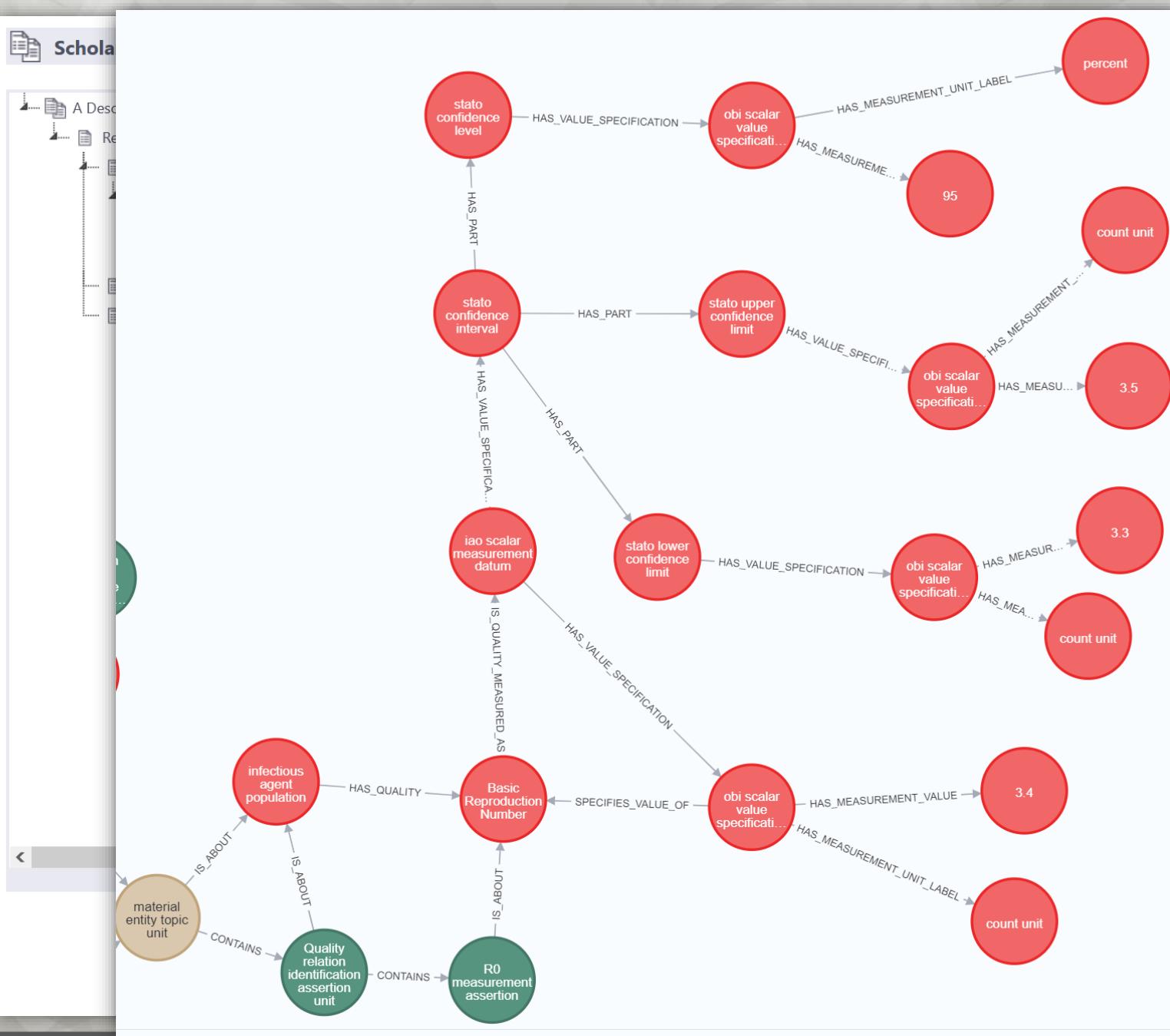
select a quality

add



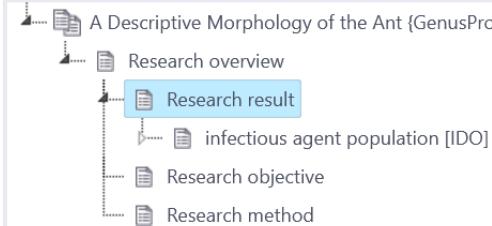
Return to Entry List

Return to Lobby



[Return to Entry List](#)

[Return to Lobby](#)



Entry Metadata: URI: 56f73a83-ba42-4e00-894a-59284c7dc85e; creator: ORKGUserORCID; created on: 2021-09-29T15:59:55.050000000; last updated on: 2021-09-29T16:43:00.152000000

versions ⌂ X

research result [ORKG]

Research result

has part:

specify the type of research result

add

resulted from:

specify the type of research activity

add

achieved objective:

specify the type of research objective

add

is about:

infectious agent population [IDO]

infectious agent population

is about:

specify the type of material entity

add

editing history
track with fully
tracked changes
for this research
result topic unit

Return to Entry List

Return to Lobby



Editing History:

| last updated on | name of resource | editing user | part of current version | created on | uuid of resource |
|-------------------------------|---|---------------|-------------------------|-------------------------------|--------------------------------------|
| 2021-09-29T16:38:49.422000000 | research result topic unit | ORKGuserORCID | true | 2021-09-29T15:59:55.050000000 | 04e00bc8-9029-4589-9530-018e9f11e |
| 2021-09-29T16:38:49.422000000 | research result material entity relation assertion unit | ORKGuserORCID | false | 2021-09-29T16:00:30.146000000 | 9dc81ab2-8912-48c1-8c7e-030ae5b2a03d |
| 2021-09-29T16:38:49.422000000 | material entity parthood assertion unit | ORKGuserORCID | false | 2021-09-29T16:12:24.381000000 | 7c163ee9-92f1-4fb0-a52d-4920943ca1de |
| 2021-09-29T16:38:49.422000000 | material entity topic unit | ORKGuserORCID | false | 2021-09-29T16:13:04.328000000 | e51c7116-cef1-4ea0-9900-7c78a1e7f95a |
| 2021-09-29T16:38:49.422000000 | eye | ORKGuserORCID | false | 2021-09-29T16:13:04.328000000 | 11d558f1-5b83-47cf-9a16-43b5795afb69 |
| 2021-09-29T16:38:49.422000000 | material entity parthood assertion unit | ORKGuserORCID | false | 2021-09-29T16:13:04.328000000 | 2cefd571-9e60-4c2d-91d4-03c06051bf00 |
| 2021-09-29T16:38:49.422000000 | Weight measurement assertion unit | ORKGuserORCID | false | 2021-09-29T16:23:55.122000000 | c479858e-ceb3-4561-8028-402a70245393 |
| 2021-09-29T16:38:49.422000000 | iao scalar measurement datum | ORKGuserORCID | false | 2021-09-29T16:23:55.122000000 | 8973c07e-3759-46e9-9062-11902093d1bc |
| 2021-09-29T16:38:49.422000000 | obi scalar value specification | ORKGuserORCID | false | 2021-09-29T16:23:55.122000000 | 1ac23d5b-8d39-4d17-9378-ee13c202cc81 |
| 2021-09-29T16:38:49.422000000 | milligram | ORKGuserORCID | false | 2021-09-29T16:23:55.122000000 | 4d930717-20ab-4561-bea4-5f6e6d7bc270 |
| 2021-09-29T16:38:49.422000000 | 5.56 | ORKGuserORCID | false | 2021-09-29T16:23:55.122000000 | 8ea4315d-9bc9-4f47-95c4-d42ac6500434 |
| 2021-09-29T16:38:49.422000000 | material entity parthood assertion unit | ORKGuserORCID | false | 2021-09-29T16:14:00.345000000 | 9cd88c2c-113c-4c2b-a19a-c0fff5dfc66d |
| 2021-09-29T16:38:49.422000000 | material entity parthood granularity tree | ORKGuserORCID | false | 2021-09-29T16:13:04.328000000 | 2cefd571-9e60-4c2d-91d4-03c06051bf00 |
| 2021-09-29T16:38:49.422000000 | material entity topic unit | ORKGuserORCID | false | 2021-09-29T16:12:24.381000000 | 8881b756-be94-4d2a-9d5f-e65974e2c63f |





A Descriptive Morphology of the Ant {GenusProcryptocerus}(Hymenoptera: Formicidae)
Research overview

entry versions: [version 2](#), [version 1](#)[Save snapshot of live version](#)

saved another
version

Title:

A Descriptive Morphology of the Ant {GenusProcryptocerus}(Hymenoptera: Formicidae)

^{doi}

10.1673/031.010.11101

Year:

2010

Authors:

F. Serna, W. Mackay

Journal:

Journal of Insect Science

Publisher:

Oxford University Press (OUP)

has research topic:[add](#)[Return to Entry List](#)[Return to Lobby](#)

Scholarly Publication ORKG Entry: A Descriptive Morphology of the Ant {GenusProcyptocerus}(Hymenoptera: Formicidae)

A Descriptive Morphology of the Ant {GenusProcyptocerus}(Hymenoptera: Formicidae)

Entry Metadata: URI: 56f73a83-ba42-4e00-894a-59284c7dc85e; creator: ORKGUserORCID; created on: 2021-09-29T15:59:55.050000000; last updated on: 2021-09-29T16:55:20.688000000

Save snapshot of live version

entry versions: version 3, version 2, version 1,

Title: A Descriptive Morphology of the Ant {GenusProcyptocerus}(Hymenoptera: Formicidae)

doi: 10.1673/031.010.11101

Year: 2010

Authors: F. Serna, W. Mackay

Journal: Journal of Insect Science

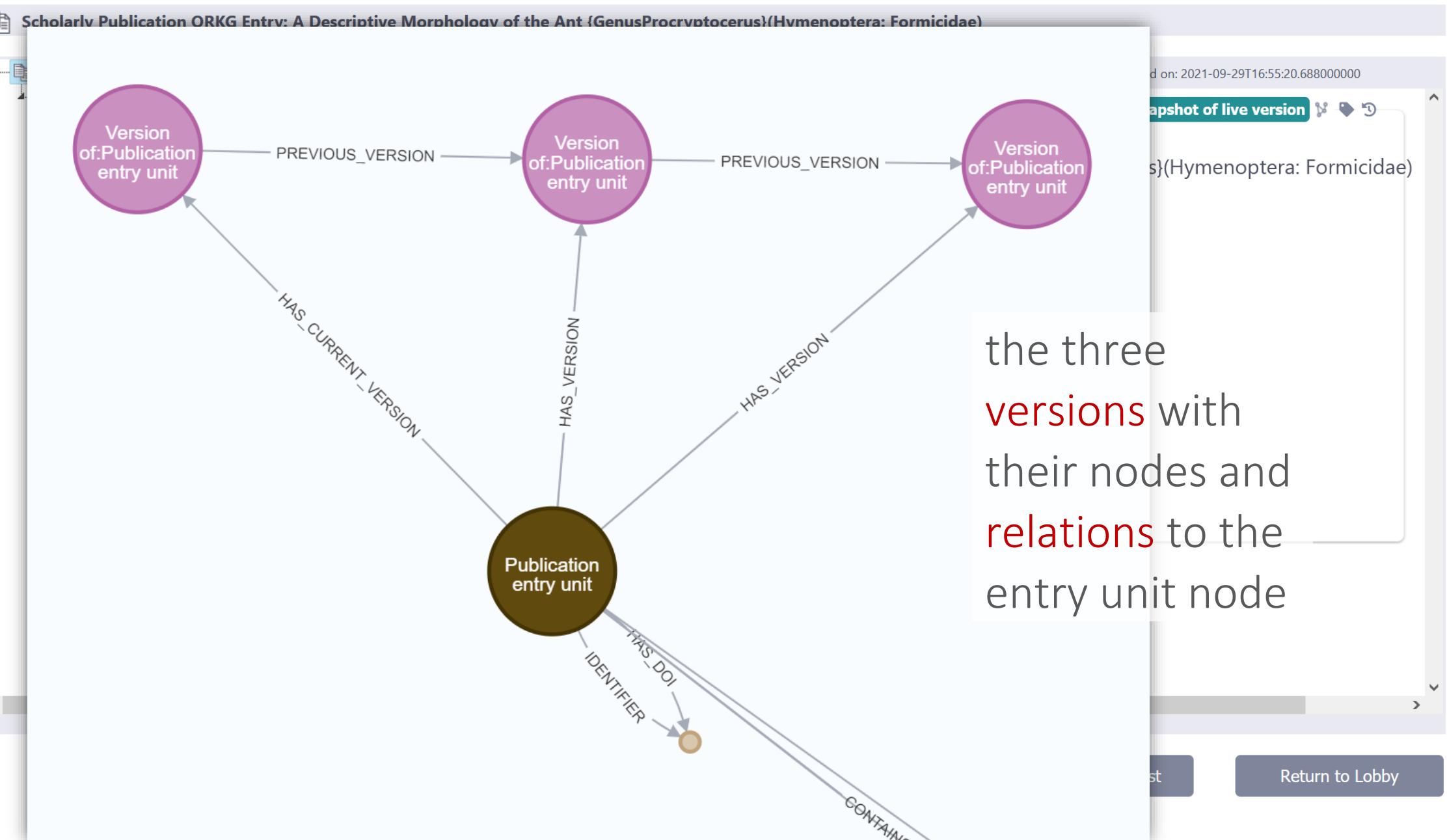
Publisher: Oxford University Press (OUP)

has research topic: specify the research topic add

deleted the population data and saved another version

Return to Entry List

Return to Lobby



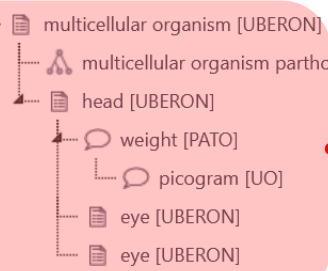


A Descriptive Morphology of the Ant {GenusProcryptocerus}

Entry Version Metadata: URI: ede4fa82-5f25-4797-94ea-c81f56723dc4; creator: ORKGuserORCID; created on: 2021-09-30T08:33:46.203000000+00:00; version number: 1

Research overview

- Research objective
- Research method
- Research result



This is a saved Entry Version (version number 1)

[Return to live version](#)

Title:

A Descriptive Morphology of the Ant {GenusProcryptocerus}(Hymenoptera: Formicidae)

doi

10.1673/031.010.11101

Year:

2010

Authors:

F. Serna, W. Mackay

Journal:

Journal of Insect Science

Publisher:

Oxford University Press (OUP)

Version 1 showing
no editing possible



[Return to Entry List](#)

[Return to Lobby](#)



A Descriptive Morphology of the Ant {GenusPro

Entry Version Metadata: URI: 455e719a-be89-41d1-a3ed-548e72d4cd0d; creator: ORKGUserORCID; created on: 2021-09-30T08:42:31.181000000+00:00; version number: 2

Research overview

Research objective

Research method

Research result

infectious agent population [IDO]

Basic Reproduction Number [

R₀: 3.4 (3.3 - 3.5)

This is a saved Entry Version (version number 2)

[Return to live version](#)**Title:**

A Descriptive Morphology of the Ant {GenusProcryptocerus}(Hymenoptera: Formicidae)

doi

10.1673/031.010.11131

Year:

2010

Authors:

F. Serna, W. Mackay

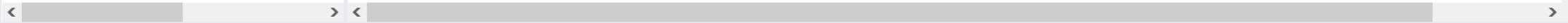
Journal:

Journal of Insect Science

Publisher:

Oxford University Press (OUP)

Version 2 showing
no editing possible

[Return to Entry List](#)[Return to Lobby](#)

Version 3 of: Scholarly Publication ORKG Entry: A Descriptive Morphology of the Ant {GenusProcryptocerus}(Hymenoptera: Formicidae)

A Descriptive Morphology of the Ant {GenusProcryptocerus}(Hymenoptera: Formicidae)

Entry Version Metadata: URI: edf96a5e-6497-4e44-92d3-3180aca98205; creator: ORKGUserORCID; created on: 2021-09-30T08:43:01.457000000+00:00; version number: 3

Research overview

- Research objective
- Research method
- Research result

This is a saved Entry Version (version number 3)

Return to live version

Title: A Descriptive Morphology of the Ant {GenusProcryptocerus}(Hymenoptera: Formicidae)

doi: 10.1673/031.010.1110

Year: 2010

Authors: F. Serna, W. Mackay

Journal: Journal of Insect Science

Publisher: Oxford University Press (OUP)

Version 3 showing no editing possible

< > < >

Return to Entry List Return to Lobby

Python-Neo4j-based KGBB Prototype Application

Search Result for Material Entity Topic Unit Class

I deleted the entry and added two new papers, one describing a crane fly and the other one a frog, both with weight specifications.

The search for all instances of the Material Entity Topic Class can be visualized in a tabular format, analog to the Comparisons in ORKG.

Python-Neo4j-based KGBB Prototype Application

Se

Search Result Page

Material Entity Topic Comparison

| | | | | |
|---------------------|--|--|--|--|
| publication title | Tipula (Vestiplex) crane flies (Diptera, Tipulidae) of Korea | Tipula (Vestiplex) crane flies (Diptera, Tipulidae) of Korea | Tipula (Vestiplex) crane flies (Diptera, Tipulidae) of Korea | Tipula (Vestiplex) crane flies (Diptera, Tipulidae) of Korea |
| entry URI | 187aed5a-5142-4a8a-9c17-b5bc23576d86 | 187aed5a-5142-4a8a-9c17-b5bc23576d86 | 187aed5a-5142-4a8a-9c17-b5bc23576d86 | 187aed5a-5142-4a8a-9c17-b5bc23576d86 |
| topic resource | Diptera [UBERON] crane fly | insect adult head [UBERON] head | trunk [UBERON] trunk | abdomen [UBERON] abdomen |
| quality measurement | weight [PATO] milligram [UO] weight 2.45 milligram | weight [PATO] milligram [UO] weight 0.18 milligram | weight [PATO] milligram [UO] weight 1.01 milligram | weight [PATO] milligram [UO] weight 1.26 milligram |
| has part | abdomen [UBERON] abdomen | | | |
| has part | trunk [UBERON] trunk | | | |
| has part | insect adult head [UBERON] head | | | |

search page

Return to Lobby

Python-Neo4j-based KGBB Prototype Application

Sea

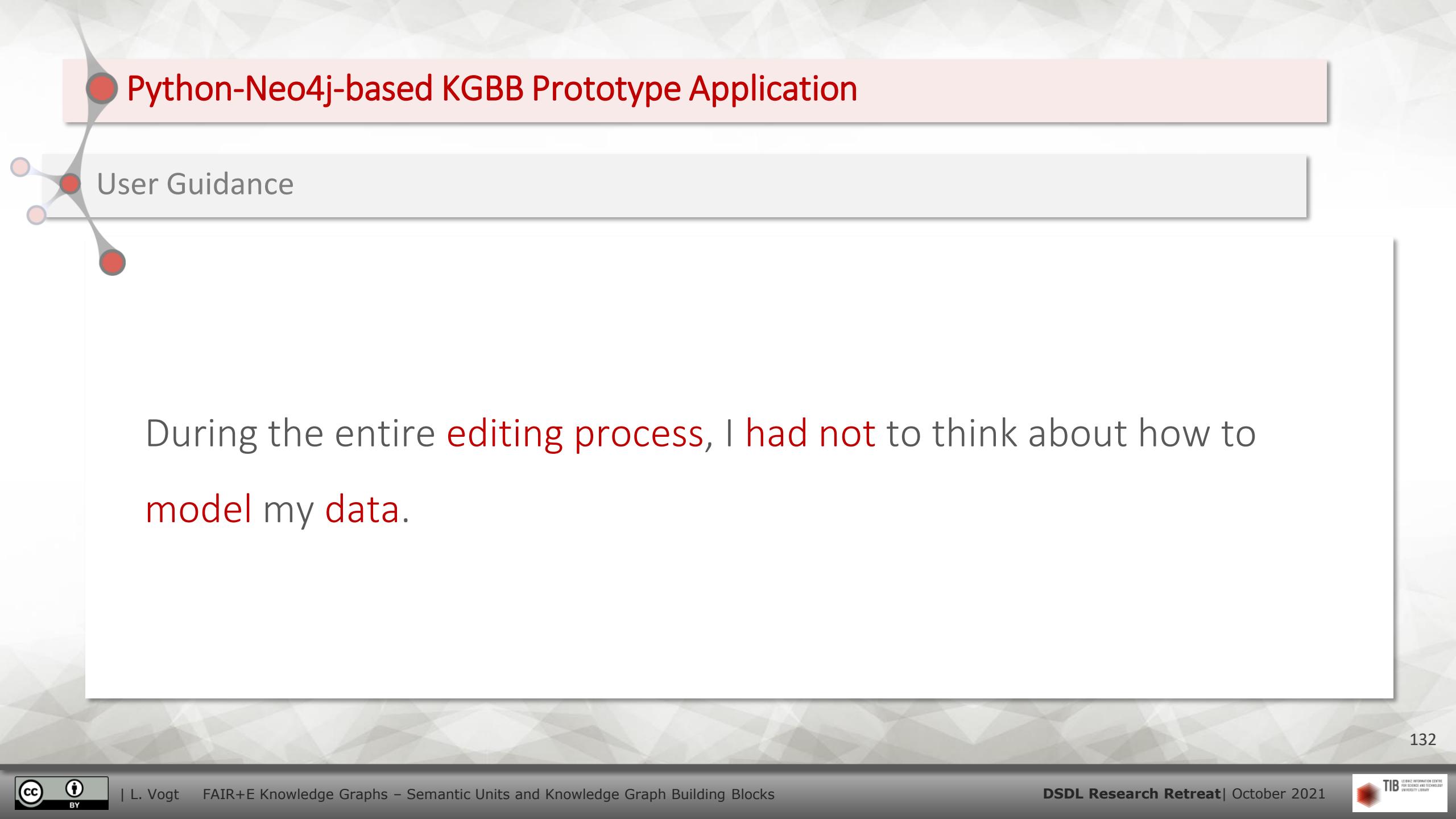
Search Result Page

Material Entity Topic Comparison

| | | | |
|------------|--|--|-------------------------------------|
|) of Korea | Amphibians and reptiles of the Atlantic Forest in Reconcavo Baiano, east Brazil: Cruz das Almas municipality | Amphibians and reptiles of the Atlantic Forest in Reconcavo Baiano, east Brazil: Cruz das Almas municipality | Amphibians and reptiles of the Atla |
| 86 | a9095957-a8bf-433c-a0f7-82183c86f1cf | a9095957-a8bf-433c-a0f7-82183c86f1cf | a9 |
| | frog Anura [UBERON] weight [PATO] gram [UO] 22.7 gram | head head [UBERON] weight [PATO] gram [UO] 7.1 gram | |
| | trunk trunk [UBERON] | | |
| | head head [UBERON] | | |

< >

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Python-Neo4j-based KGBB Prototype Application

User Guidance

During the entire editing process, I had not to think about how to model my data.

Python-Neo4j-based KGBB Prototype Application

Features missing in prototype

- Exports
- KGBB Editor

Knowledge Graph Building Block (KGBB)



Knowledge Graph Building Blocks (KGBBs)

Characterization

A KGBB is a knowledge processing module. Each type of semantic unit has its own KGBB. Combined with other KGBBs, they manage a knowledge graph application.



Knowledge Graph Building Blocks (KGBBs)

Characterization

KGBBs implement ...

... semantic units and with them the organization of the data
into FAIR Digital Objects.



Knowledge Graph Building Blocks (KGBBs)

Characterization

A KGBB provides ...

... a common **graph pattern** for a specific type of semantic unit,
resulting in a **FAIR knowledge graph** and **FAIR semantic units**;



Knowledge Graph Building Blocks (KGBBs)

Characterization

A KGBB provides ...

... information for **input control** for the frontend
for restricting user input;

Knowledge Graph Building Blocks (KGBBs)

Characterization

Measurement Assertion KGBB Storage Model

assertion subject
some instance of
class *weight*

:HAS_INPUT_2

input 2
some unit class

:HAS_INPUT_1

input 1
float value

Knowledge Graph Building Blocks (KGBBs)

Characterization

Measurement Assertion KGBB Storage Model





Knowledge Graph Building Blocks (KGBBs)

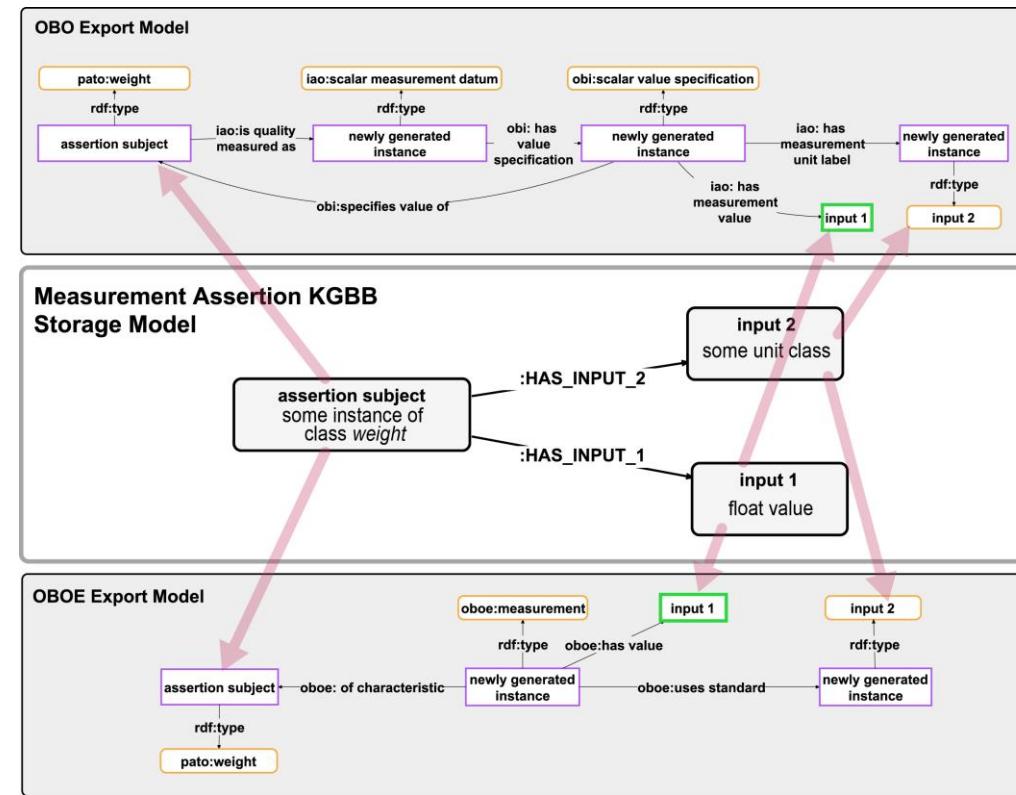
Characterization

A KGBB provides ...

... different **schemata** for exporting data of a semantic unit into various formats;

Knowledge Graph Building Blocks (KGBBs)

Characterization



Knowledge Graph Building Blocks (KGBBs)

Characterization

... further **export schemata** can be added **anytime**, including CSV,
Java, Python, JSON formats, using a **KGBB editor**;



Knowledge Graph Building Blocks (KGBBs)

Characterization

A KGBB provides ...

... predefined Cypher/SPARQL queries for finding data belonging
to a given type of semantic unit —



Knowledge Graph Building Blocks (KGBBs)

Characterization

A KGBB provides ...

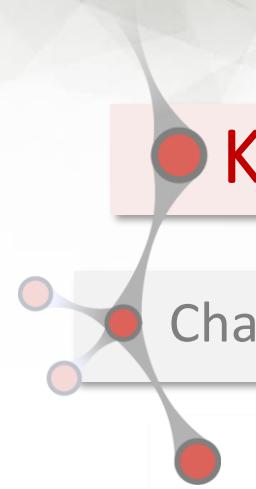
... predefined Cypher/SPARQL queries for finding data belonging to a given type of semantic unit — users can combine these like Lego Bricks to create more complicated queries without having to write Cypher/SPARQL themselves.



Knowledge Graph Building Blocks (KGBBs)

Characterization

A KGBB editor will allow the specification of new KGBBs and adding new export schemata for existing KGBBs.



Knowledge Graph Building Blocks (KGBBs)

Characterization

Each KGBB is **independent** of all other KGBBs. But KGBBs can be **linked** to other KGBBs, so that their semantic units can **instantiate** other semantic units. E.g., a material entity topic unit can instantiate a parthood assertion unit that instantiates another material topic unit.

Conclusion



Semantic Units & Knowledge Graph Building Blocks for the ORKG

Problem of high expressivity of RDF/OWL and Neo4j

Problem: RDF/OWL and property graphs are **highly expressive** and therefore **do not automatically** provide **FAIR data**. Adequate **data models** must be applied consistently, and developing adequate models requires **semantic expertise**, which most users of the ORKG do not have.

Semantic Units & Knowledge Graph Building Blocks for the ORKG

Problem of high expressivity of RDF/OWL and Neo4j

Problem:

therefore

models n

requires

KGBBs provide **common data models** and, thus, FAIR data and metadata, **without users** having to make their own **modelling choices**.

ssive and
ate data
quate models
KG do not have.



Semantic Units & Knowledge Graph Building Blocks for the ORKG

Problem of high expressivity of RDF/OWL and Neo4j

Problem: RDF/O

therefore **do no**

models must be

requires **semantic expertise**, which most users of the ORKG do not have.

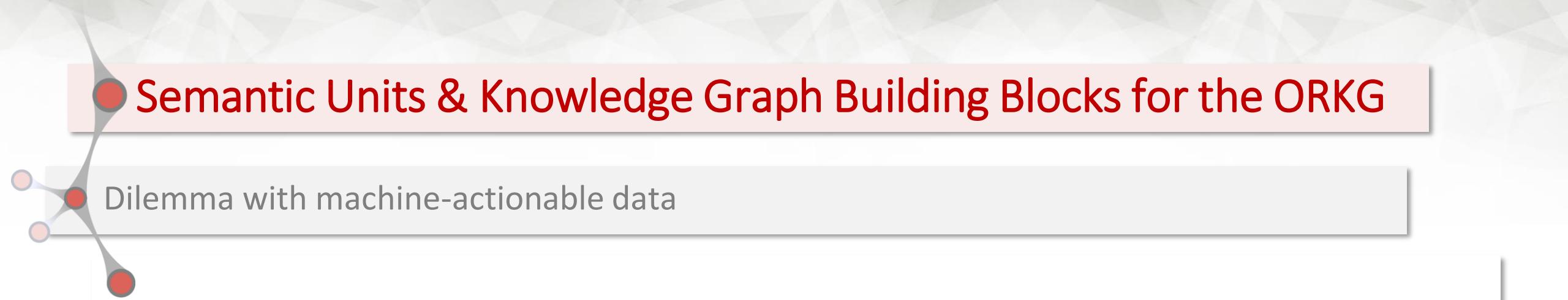
Semantic units can form

FAIR Digital Objects.

y expressive and

Adequate **data**

using adequate models



Semantic Units & Knowledge Graph Building Blocks for the ORKG

Dilemma with machine-actionable data

Problem: Users do **not** want to look at large, **complex graphs** but the ORKG needs FAIR data and thus **machine-actionable data**.

Machines cannot handle **fuzziness** and need **contextual information**.

Dilemma: The more users push data representations toward machine-actionability, the **less human-readable** they become.

Semantic Units & Knowledge Graph Building Blocks for the ORKG

Dilemma with machine-actionable data

Problem: Users do not want to look at large complex graphs but the ORKG needs FAIR data.

Machines cannot handle this dilemma represents an impedance mismatch toward machine-actionability, the less human-readable they become.

Dilemma: The need for FAIR data is in conflict with the desire for user-friendliness. This is because machines can only process structured data, while humans prefer unstructured data. This creates an "impedance mismatch" between the two systems.

Semantic Units & Knowledge Graph Building Blocks for the ORKG

Dilemma with machine-actionable data

Problem: Users
ORKG needs FAIR

Machines cannot

Dilemma: The need
actionability, the

Knowledge Graph Building Blocks
clearly decouple data display in
the UI from the underlying data
graph structure

graphs but the
data.
ual information.
toward machine-



Semantic Units & Knowledge Graph Building Blocks for the ORKG

KGBBs and semantic units would improve the ORKG...

... by **guiding** the user throughout the editing process, e.g., by letting users **not** having to decide when to use a **resource** and when a **literal**.



Semantic Units & Knowledge Graph Building Blocks for the ORKG

KGBBs and semantic units would improve the ORKG...

... regarding making statements about statements:

- 1) Semantic Units represent semantically meaningful subgraphs that are represented as nodes in the graph;
- 2) Would even allow making statements relating different papers; (e.g., *data from paper A supports hypothesis from paper B*)



Semantic Units & Knowledge Graph Building Blocks for the ORKG

KGBBs and semantic units would improve the ORKG...

... by differentiating and mediating between **ontological** and
discursive information;



Semantic Units & Knowledge Graph Building Blocks for the ORKG

KGBBs and semantic units would improve the ORKG...

... regarding the **explorability** of the Knowledge Graph:

using **Semantic Units** opens a **new framework** for
developing innovative UIs for **navigating** and **exploring**
the graph;



Semantic Units & Knowledge Graph Building Blocks for the ORKG

KGBBs and semantic units

Knowledge Graph Building Blocks represent a **refinement** of the ORKG templates, making them more flexibly applicable, implement Semantic Units, and relieve users of decisions about how the contents from scholarly publications should best be modeled semantically.



Semantic Units & Knowledge Graph Building Blocks for the ORKG

KGBBs and semantic units

They structure and classify the graph into semantic units, which can be utilized for various tasks involving, e.g., AI-based NLP methods, by providing categorized training datasets.



Semantic Units & Knowledge Graph Building Blocks for the ORKG

Importing Data to the ORKG

KGBBs with their clear identification of different **types of user inputs** and their associated **semantic units** can be used to establish simple workflows for **importing data** from various sources by mapping, e.g., columns in tables to user-input types.

Semantic Units & Knowledge Graph Building Blocks for the ORKG

Importing Data to the ORKG

KGBBs will take inputs and establish sources by

this can even be combined with NLP approaches for (semi) automatically extracting data from publications

types of user used to from various user-input types.



Semantic Units & Knowledge Graph Building Blocks for the ORKG

KGBBs and semantic units

Knowledge Graph Building Blocks come with **versioning** and with **provenance tracking**, and **detailed editing history** on the level of individual semantic units and individual input nodes.



Semantic Units & Knowledge Graph Building Blocks for the ORKG

Managing KGBBs in the ORKG

With a good **KGBB Editor**, ORKG Observatories could specify **new domain-specific KGBBs** together with adequate data schemata for exporting the data. They could also recommend, which **export schemata** to use.



Semantic Units & Knowledge Graph Building Blocks for the ORKG

KGBBs and semantic units

Their **modular architecture** allows for **reuse** of individual Knowledge Graph Building Blocks by making them openly available, enabling third parties to specify their own knowledge graph application by **combining** different **Building Blocks** and creating new ones.

Outlook



Semantic Units & Knowledge Graph Building Blocks

Outlook

- Currently preparing MS for Semantic Units and FAIR+E Knowledge Graphs (first draft done)
- Currently preparing MS for KGBBs and my small prototype
- Planning to write a proposal for KGBBs and a KGBB Editor, with ORKG as a use case (?)

FAIR+E Knowledge Graphs

Semantic Units and Knowledge Graph Building Blocks

L. Vogt

October 4, 2021

Thank you for your attention!

If there should be interest, I can demonstrate the prototype on my laptop. Just ask me about it.

