

A Review of Biotic Interactions and Taxon Names Found in Big-Bee-Network/select-bee-interactions.sh

by Nomer and Elton, two naive review bots
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<https://github.com/Big-Bee-Network/select-bee-interactions.sh/issues>

2024-06-11

Abstract

Life on Earth is sustained by complex interactions between organisms and their environment. These biotic interactions can be captured in datasets and published digitally. We present a review process of such an openly accessible digital interactions dataset of known origin, and discuss its outcome. The dataset under review, named Big-Bee-Network/select-bee-interactions.sh, is 916MiB in size and contains 559120 interactions with 21 unique types of associations (e.g., visitsFlowersOf) between 3723 primary taxa (e.g., *Apis mellifera*) and 9523 associated taxa (e.g., *Solidago*). The report includes detailed summaries of interactions data as well as a taxonomic review from multiple catalogs.

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Introduction

Data Review

Data review can be a time consuming process, especially when done manually. This review report aims to help facilitate data review of species interaction claims made in datasets registered with Global Biotic Interactions (Poelen, Simons, and Mungall 2014). The review includes summary statistics of, and observations about, the dataset under review:

Seltmann KC, Poelen JH (2024) Likely Bee Interactions
 Extracted from Global Biotic Interactions Verbatim Data
 Product v0.6 hash://md5/89797a5a325ac5c50990581689718edf
 hash://sha256/946178b36c3ea2f2daa105ad244cf5d6cd236ec8c99956616557cf4e6666545b
 using Nomer’s DiscoverLife Support. file:///home/runner/work/select-
 bee-interactions.sh/select-bee-interactions.sh/examples/2023-08-
 25/./

For additional metadata related to this dataset, please visit <https://github.com/Big-Bee-Network/select-bee-interactions.sh> and inspect associated metadata files including, but not limited to, *README.md*, *eml.xml*, and/or *globi.json*.

Methods

The review is performed through programmatic scripts that leverage tools like Preston, Elton, Nomer combined with third-party tools like grep, mlr, tail and head.

Table 1: Tools used in this review process

tool name	version
elton	0.13.4
nomer	0.5.9
mlr	6.0.0
pandoc	3.1.6.1

The review process can be described in the form of the script below ¹.

¹Note that you have to first get the data (e.g., via `elton pull Big-Bee-Network/select-bee-`

```
# get versioned copy of the dataset (size approx. 916MiB) under review
elton pull Big-Bee-Network/select-bee-interactions.sh

# generate review notes
elton review Big-Bee-Network/select-bee-interactions.sh\
> review.tsv

# export indexed interaction records
elton interactions Big-Bee-Network/select-bee-interactions.sh\
> interactions.tsv

# export names and align them with the Catalogue of Life using Nomer
elton names Big-Bee-Network/select-bee-interactions.sh\
| nomer append col\
> name-alignment.tsv
```

or visually, in a process diagram.

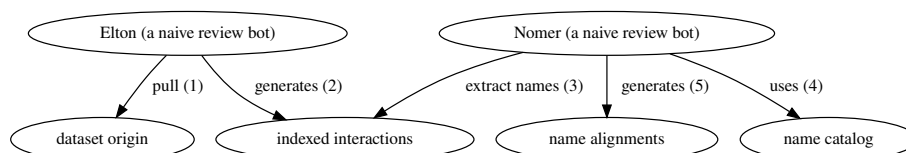


Figure 1: Review Process Overview

You can find a recent copy of the full review script at [check-data.sh](#).

Results

In the following sections, the results of the review are summarized ². Then, links to the detailed review reports are provided.

Biotic Interactions

In this review, biotic interactions (or biotic associations) are modeled as a primary (aka subject, source) organism interacting with an associate (aka object, target) organism. The dataset under review classified the primary/associate organisms with specific taxa. The primary and associate organisms The kind of interaction is documented as an interaction type.

interactions.sh) before being able to generate reviews (e.g., `elton review Big-Bee-Network/select-bee-interactions.sh`), extract interaction claims (e.g., `elton interactions Big-Bee-Network/select-bee-interactions.sh`), or list taxonomic names (e.g., `elton names Big-Bee-Network/select-bee-interactions.sh`)

²Disclaimer: The results in this review should be considered friendly, yet naive, notes from an unsophisticated robot. Please keep that in mind when considering the review results.

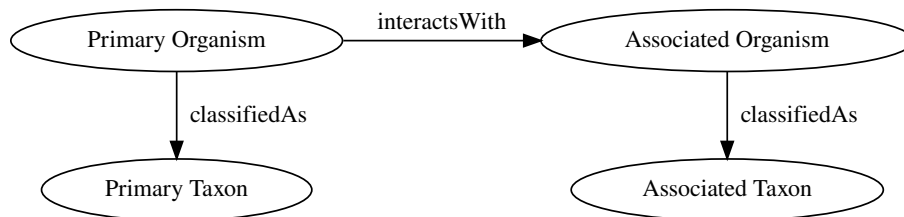


Figure 2: Biotic Interaction Data Model

The dataset under review, named Big-Bee-Network/select-bee-interactions.sh, is 916MiB in size and contains 559120 interactions with 21 unique types of associations (e.g., visitsFlowersOf) between 3723 primary taxa (e.g., *Apis mellifera*) and 9523 associated taxa (e.g., *Solidago*).

An exhaustive list of indexed interaction claims can be found in csv and tsv archives. To facilitate discovery, the first 500 claims available on the html page at indexed-interactions.html are shown below.

The exhaustive list was used to create the following data summaries below.

Table 2: Sample of Indexed Interaction Claims

sourceTaxonName	interactionTypeNam	targetTaxonName	referenceCitation
Clausicella neomexicana	hemiparasiteOf	Bombus fervidus	Arnaud, Paul Henri. A Host-parasite Catalog of North American Tachinidae (Diptera). Washington, D.C.: U.S. Dept. of Agriculture, Science and Education Administration, 1978.

sourceTaxonName	interactionTypeNam	targetTaxonName	referenceCitation
Clausicella neomexicana	hemiparasiteOf	Bombus fervidus	Arnaud, Paul Henri. A Host-parasite Catalog of North American Tachinidae (Diptera). Washington, D.C.: U.S. Dept. of Agriculture, Science and Education Administration, 1978.
Tachina	hemiparasiteOf	Bombus	Arnaud, Paul Henri. A Host-parasite Catalog of North American Tachinidae (Diptera). Washington, D.C.: U.S. Dept. of Agriculture, Science and Education Administration, 1978.
Tachina	hemiparasiteOf	Bombus	Arnaud, Paul Henri. A Host-parasite Catalog of North American Tachinidae (Diptera). Washington, D.C.: U.S. Dept. of Agriculture, Science and Education Administration, 1978.

Table 3: Most Frequently Mentioned Interaction Types (up to 20 most frequent)

interactionTypeName	count
visitsFlowersOf	110242
hasHost	47344
eats	39184
interactsWith	26564
visits	10446
pollinates	3843
preysOn	2657
endoparasiteOf	543
kleptoparasiteOf	332
adjacentTo	319
coOccursWith	208
pathogenOf	169
parasiteOf	168
createsHabitatFor	93
parasitoidOf	53
hemiparasiteOf	49
commensalistOf	14
ectoparasiteOf	14
hasVector	12

Table 4: Most Frequently Mentioned Primary Taxa (up to 20 most frequent)

sourceTaxonName	count
Apis mellifera	24463
Andrena	19080
Acari	12572
Bombus impatiens	10747
Bombus	10160
Megachile	5670
Bombus griseocollis	4945
Bombus melanopygus	4043
Bombus pensylvanicus	3990
Bombus vosnesenskii	3378
Bombus flavifrons	3170
Bombus terrestris	2961
Pyrobombus	2800
Bombus bimaculatus	2788
Bombus perplexus	2602

sourceTaxonName	count
Hylaeus	2394
Halictus ligatus	2340
Halictus tripartitus	2256
Apis cerana	2216

Table 5: Most Frequently Mentioned Associate Taxa (up to 20 most frequent)

targetTaxonName	count
Solidago	3696
Rubus	3268
Pycnanthemum muticum	3144
Apis mellifera	2880
Megachile	2595
Trifolium repens	2488
Monarda fistulosa	2405
Heliomeris multiflora	2116
Symphotrichum	2065
Taraxacum officinale	1922
Heterotheca villosa	1913
Centaurea stoebe	1787
Cirsium	1757
Andrena	1620
Bombus	1555
Trifolium pratense	1503
Achillea millefolium	1396
Bidens alba	1393
Helianthus	1378

Table 6: Most Frequent Interactions between Primary and Associate Taxa (up to 20 most frequent)

sourceTaxonName	interactionTypeName	targetTaxonName	count
Andrena	hasHost	Rubus	1740
Acari	hasHost	Megachile	1320
Bombus	hasHost	Centaurea stoebe	1130
Vespa velutina	eats	Apis mellifera	836
Bombus bifarius	visitsFlowersOf	Heliomeris multiflora	794
Bombus	hasHost	Solidago	780
Bombus flavifrons	visitsFlowersOf	Heliomeris multiflora	720

sourceTaxonName	interactionTypeName	targetTaxonName	count
Bombus bifarius	visitsFlowersOf	Heterotheca villosa	626
Andrena	visitsFlowersOf	Sonchus tenerrinus	540
Andrena	hasHost	Trifolium	540
Andrena	hasHost	Geranium maculatum	540
Bombus flavifrons	visitsFlowersOf	Heterotheca villosa	532
Apis mellifera	eats	Salvia rosmarinus	513
Acari	hasHost	Bombus	510
Halictus	hasHost	Achillea millefolium	486
Bombus	hasHost	Symphotrichum	480
Andrena	interactsWith	Andrena	450
Apis	hasHost	Cirsium	426
Bombus	hasHost	Cichorium intybus	400

Interaction Networks

The figures below provide a graph view on the dataset under review. The first shows a summary network on the kingdom level, and the second shows how interactions on the family level. It is important to note that both network graphs were first aligned taxonomically using the Catalogue of Life. Please refer to the original (or verbatim) taxonomic names for a more original view on the interaction data.

You can download the indexed dataset under review at [indexed-interactions.csv](#). A tab-separated file can be found at [indexed-interactions.tsv](#)

Learn more about the structure of this download at GloBI website, by opening a GitHub issue, or by sending an email.

Another way to discover the dataset under review is by searching for it on the GloBI website.

Taxonomic Alignment

As part of the review, all names are aligned against various name catalogs (e.g., col, ncbi, discoverlife, gbif, itis, wfo, mdd, tpt, and pbdb). These alignments can help review name usage or aid in selecting of a suitable taxonomic name resource.

Table 7: Sample of Name Alignments

providedName	relationName	resolvedCatalogName	resolvedName
Anaphalis	HAS_ACCEPTED_BY	COL	Anaphalis
margaritacea			margaritacea
Agastache	HAS_ACCEPTED_BY	COL	Agastache
Aka	HAS_ACCEPTED_BY	COL	Aka

providedName	relationName	resolvedCatalogName	resolvedName
Aka	SYNONYM_OF	col	Siphonodictyon

Table 8: Distribution of Taxonomic Ranks of Aligned Names by Catalog. Names that were not aligned with a catalog are counted as NAs. So, the total number of unaligned names for a catalog will be listed in their NA row.

resolvedCatalogName	resolvedRank	count
col	NA	1837
col	class	4
col	family	94
col	form	1
col	genus	1065
col	gigaclass	1
col	kingdom	1
col	order	25
col	phylum	3
col	section	1
col	species	8673
col	subfamily	33
col	subgenus	8
col	suborder	1
col	subspecies	295
col	subterclass	2
col	superfamily	2
col	superorder	1
col	tribe	13
col	variety	72
discoverlife	NA	8815
discoverlife	family	6
discoverlife	genus	108
discoverlife	phylum	1
discoverlife	species	2885
discoverlife	subfamily	7
discoverlife	subgenus	147
discoverlife	subspecies	38
discoverlife	tribe	13
gbif	NA	1303
gbif	class	4
gbif	family	97
gbif	form	5
gbif	genus	1170

resolvedCatalogName	resolvedRank	count
gbif	kingdom	1
gbif	order	25
gbif	phylum	3
gbif	species	8979
gbif	subspecies	454
gbif	variety	206
itis	NA	3471
itis	class	5
itis	division	2
itis	family	96
itis	genus	979
itis	infrakingdom	1
itis	kingdom	2
itis	order	25
itis	phylum	1
itis	species	7154
itis	subclass	1
itis	subfamily	10
itis	suborder	2
itis	subspecies	106
itis	superclass	1
itis	superfamily	2
itis	superorder	2
itis	tribe	13
itis	variety	63
mdd	NA	11924
ncbi	NA	3408
ncbi	clade	5
ncbi	class	4
ncbi	family	95
ncbi	genus	1032
ncbi	infraorder	1
ncbi	order	25
ncbi	phylum	2
ncbi	section	2
ncbi	species	7138
ncbi	species group	1
ncbi	subclass	1
ncbi	subfamily	36
ncbi	subgenus	56
ncbi	subspecies	51
ncbi	subtribe	10
ncbi	superclass	1
ncbi	superfamily	2

resolvedCatalogName	resolvedRank	count
ncbi	superorder	2
ncbi	tribe	54
ncbi	varietas	16
pbdb	NA	11193
pbdb	class	7
pbdb	family	96
pbdb	genus	352
pbdb	kingdom	2
pbdb	order	28
pbdb	phylum	4
pbdb	species	209
pbdb	subfamily	15
pbdb	suborder	3
pbdb	subtribe	1
pbdb	superclass	1
pbdb	superfamily	2
pbdb	superorder	1
pbdb	superphylum	1
pbdb	tribe	11
pbdb	unranked clade	9
tpt	NA	11755
tpt	genus	7
tpt	species	162
wfo	NA	5404
wfo	class	1
wfo	family	75
wfo	form	1
wfo	genus	874
wfo	order	19
wfo	section	2
wfo	species	5450
wfo	subfamily	8
wfo	subsection	1
wfo	subspecies	100
wfo	subtribe	12
wfo	tribe	16
wfo	variety	56

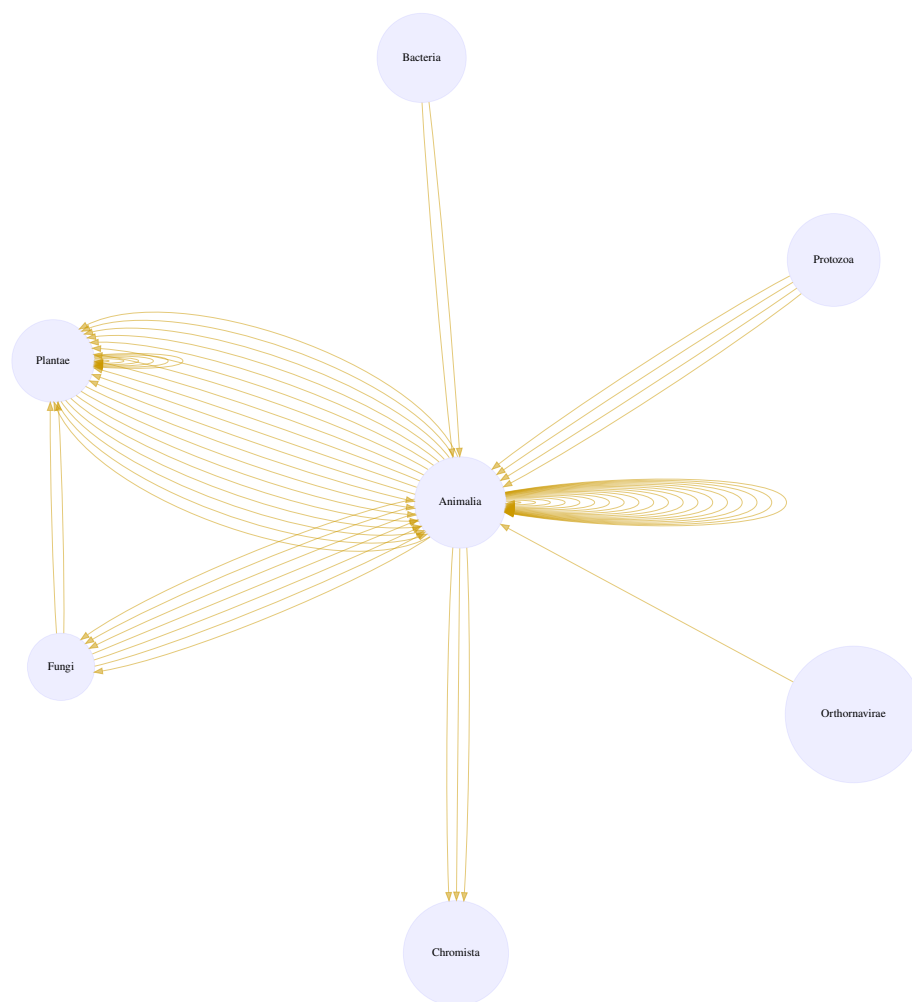


Figure 3: Interactions on taxonomic kingdom rank as interpreted by the Catalogue of Life download svg

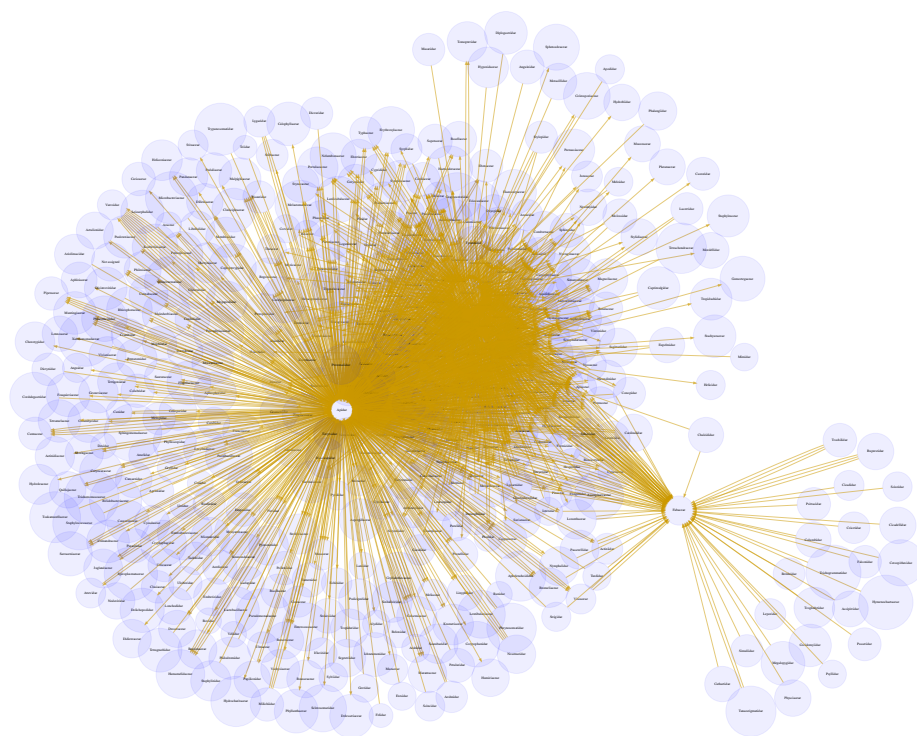


Figure 4: Interactions on the taxonomic family rank as interpreted by the Catalogue of Life. [download svg](#)

Table 9: Name relationship types per catalog. Name relationship type “NONE” means that a name was not recognized by the associated catalog. “SAME_AS” indicates either a “HAS_ACCEPTED_NAME” or “SYNONYM_OF” name relationship type. We recognize that “SYNONYM_OF” encompasses many types of nomenclatural synonymies (ICZN 1999) (e.g., junior synonym, senior synonyms).

resolvedCatalogName	relationName	count
col	HAS_ACCEPTED_NAME	13869
col	SYNONYM_OF	3337
col	NONE	1984
discoverlife	NONE	11459
discoverlife	HAS_ACCEPTED_NAME	5069
discoverlife	SYNONYM_OF	1865
discoverlife	HOMONYM_OF	831
gbif	HAS_ACCEPTED_NAME	17369
gbif	SYNONYM_OF	5781
gbif	NONE	1422
itis	HAS_ACCEPTED_NAME	12214
itis	NONE	3746
itis	SYNONYM_OF	1131
mdd	NONE	16674
mdd	HAS_ACCEPTED_NAME	15
ncbi	SAME_AS	12623
ncbi	NONE	3787
ncbi	COMMON_NAME_OF	4
ncbi	SYNONYM_OF	503
pbdb	NONE	15312
pbdb	HAS_ACCEPTED_NAME	1379
pbdb	SYNONYM_OF	55
tpt	NONE	16504
tpt	HAS_ACCEPTED_NAME	182
tpt	SYNONYM_OF	6
wfo	HAS_ACCEPTED_NAME	8435
wfo	HAS_UNCHECKED_NAME	1250
wfo	NONE	7652
wfo	SYNONYM_OF	1710

Table 10: List of Available Name Alignment Reports

catalog name	alignment results
col	associated names alignments (first 500, full csv/tsv)
ncbi	associated names alignments (first 500, full csv/tsv)
discoverlife	associated names alignments (first 500, full csv/tsv)
gbif	associated names alignments (first 500, full csv/tsv)
itis	associated names alignments (first 500, full csv/tsv)
wfo	associated names alignments (first 500, full csv/tsv)
mdd	associated names alignments (first 500, full csv/tsv)
tpt	associated names alignments (first 500, full csv/tsv)
pbdb	associated names alignments (first 500, full csv/tsv)

Additional Reviews

Elton, Nomer, and other tools may have difficulties interpreting existing species interaction datasets. Or, they may misbehave, or otherwise show unexpected behavior. As part of the review process, detailed review notes are kept that document possibly misbehaving, or confused, review bots. An sample of review notes associated with this review can be found below.

Table 11: First few lines in the review notes.

reviewDate	reviewCommentType	reviewComment
2024-06-11T18:53:57Z	note	failed to lookup [GEONAMES:5434527] because of: [resource [http://api.geonames.org/getJSON?formatted=true&geo not found]
2024-06-11T18:53:57Z	note	failed to lookup [GEONAMES:5434527] because of: [resource [http://api.geonames.org/getJSON?formatted=true&geo not found]

reviewDate	reviewCommentType	reviewComment
2024-06-11T18:53:57Z	note	failed to lookup [GEONAMES:5434527] because of: [resource [http://api.geonames.org/getJSON?formatted=true&geonameId=5434527&username=globi&style=full] not found]
2024-06-11T18:53:57Z	note	failed to lookup [GEONAMES:5434527] because of: [resource [http://api.geonames.org/getJSON?formatted=true&geonameId=5434527&username=globi&style=full] not found]

In addition, you can find the most frequently occurring notes in the table below.

Table 12: Most frequently occurring review notes, if any.

reviewComment	count
failed to lookup [GEONAMES:5539795] because of: [resource [http://api.geonames.org/getJSON?formatted=true&geonameId=5539795&username=globi&style=full] not found]	27711
failed to lookup [GEONAMES:5434527] because of: [resource [http://api.geonames.org/getJSON?formatted=true&geonameId=5434527&username=globi&style=full] not found]	752
failed to lookup [GEONAMES:3895114] because of: [resource [http://api.geonames.org/getJSON?formatted=true&geonameId=3895114&username=globi&style=full] not found]	677
failed to lookup [GEONAMES:4896861] because of: [resource [http://api.geonames.org/getJSON?formatted=true&geonameId=4896861&username=globi&style=full] not found]	511

For addition information on review notes, please have a look at the first 500 Review Notes or the download full csv or tsv archives.

GloBI Review Badge

As part of the review, a review badge is generated. This review badge can be included in webpages to indicate the review status of the dataset under review.



Figure 5: Picture of a GloBI Review Badge ³

Note that if the badge is green, no review notes were generated. If the badge is yellow, the review bots may need some help with interpreting the species interaction data.

GloBI Index Badge

If the dataset under review has been registered with GloBI, and has been successfully indexed by GloBI, the GloBI Index Status Badge will turn green. This means that the dataset under review was indexed by GloBI and is available through GloBI services and derived data products.



Figure 6: Picture of a GloBI Index Badge ⁴

If you'd like to keep track of reviews or index status of the dataset under review, please visit [GloBI's dataset index ^[At time of writing (2024-06-11) the version of the GloBI dataset index was available at <https://globalbioticinteractions.org/datasets> for badge examples.

Discussion

This review aims to provide a perspective on the dataset to aid in understanding of species interaction claims discovered. However, it is important to note that this review does *not* assess the quality of the dataset. Instead, it serves as an indication of the open-ness⁵ and FAIRness (Wilkinson et al. 2016; Trekels et al. 2023) of the dataset: to perform this review, the data was likely openly available, **F**indable, **A**ccessible, **I**nteroperable and **R**eusable. The current Open-FAIR assessment is qualitative, and a more quantitative approach can be implemented with specified measurement units.

³Up-to-date status of the GloBI Review Badge can be retrieved from the GloBI Review Depot

⁴Up-to-date status of the GloBI Index Badge can be retrieved from GloBI's API

⁵According to <http://opendefinition.org/>: "Open data is data that can be freely used, re-used and redistributed by anyone - subject only, at most, to the requirement to attribute and sharealike."

This report also showcases the reuse of machine-actionable (meta)data, something highly recommended by the FAIR Data Principles (Wilkinson et al. 2016). Making (meta)data machine-actionable enables more precise processing by computers, enabling even naive review bots like Nomer and Elton to interpret the data effectively. This capability is crucial for not just automating the generation of reports, but also for facilitating seamless data exchanges, promoting interoperability.

Acknowledgements

We thank the many humans that created us and those who created and maintained the data, software and other intellectual resources that were used for producing this review. In addition, we are grateful for the natural resources providing the basis for these human and bot activities.

Author contributions

Nomer was responsible for name alignments. Elton carried out dataset extraction, and generated the review notes.

References

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