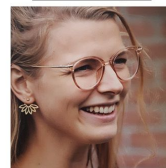
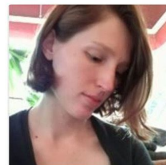


Nanosafety and the semantic web: from natural language to computational processing

8th and 9th of December 13.00-17.00h



Day 1 - Wednesday 8th of December 2021

13.00 - 13.15	Welcome
RDF and SPARQL	
13.15 - 13.45	Introduction to RDF and SPARQL - Lecture (Denise Slenter)
13.45 - 14.15	Gene variants in Wikidata - Hands on session
14.15 - 14.45	Drug Targets in Wikidata - Hands on session
14.45 - 15.15	Break
15.15 - 16.00	Overview of our SPARQL endpoints - Lecture (Marvin Martens) <ul style="list-style-type: none"> WikiPathways ChEMBL AOP-Wiki / AOP-DB Nanosafety Landscape
16.00 - 16.45	Querying your SPARQL endpoint of choice - Hands on session
16.45 - 17.00	Closing remarks

Day 2 - Thursday 9th of December 2021

13.00 - 13.15	Welcome and recap Day 1
Ontologies	
13.15 - 13.45	Introduction to ontologies - Lecture (Egon Willighagen)
13.45 - 14.10	Using the eNanMapper ontology - Hands on session
14.10 - 14.30	Extending the eNanMapper ontology - Hands on session
14.30 - 14.45	Entering and analysing nano safety data - Hands on session
14.45 - 15.15	Break
15.15 - 15.45	SbD4Nano landscape - Lecture (Jeaphianne van Rijn)
15.45 - 16.15	Querying the SbD4Nano SPARQL endpoint - Hands on session
16.15 - 16.45	Q&A session
16.45 - 17.00	Closing remarks



Maastricht University

SPARQL endpoints at BiGCaT

Workshop “Nanosafety and the semantic web”

Marvin Martens

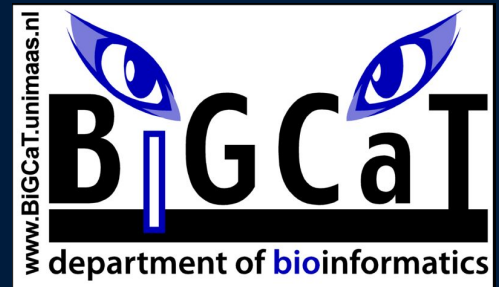
 0000-0003-2230-0840

 @mmarvinm2

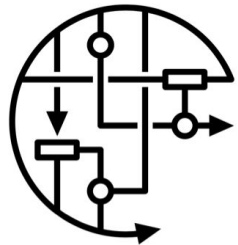
marvin.martens@maastrichtuniversity.nl



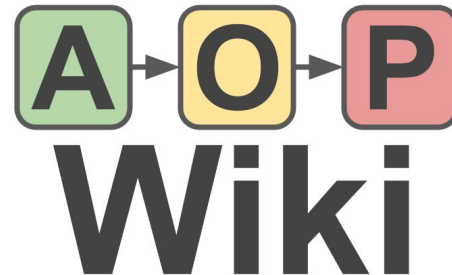
Maastricht University



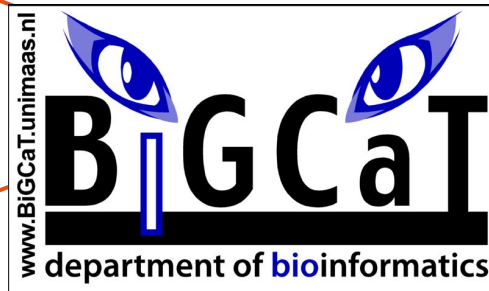
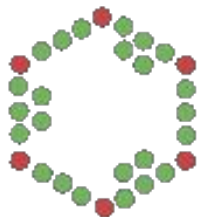
SPARQL endpoints



WIKIPATHWAYS
Pathways for the People



ChEMBL



SbD
Nano

SAFE BY DESIGN FOR NANO

NanoSafety
RDF



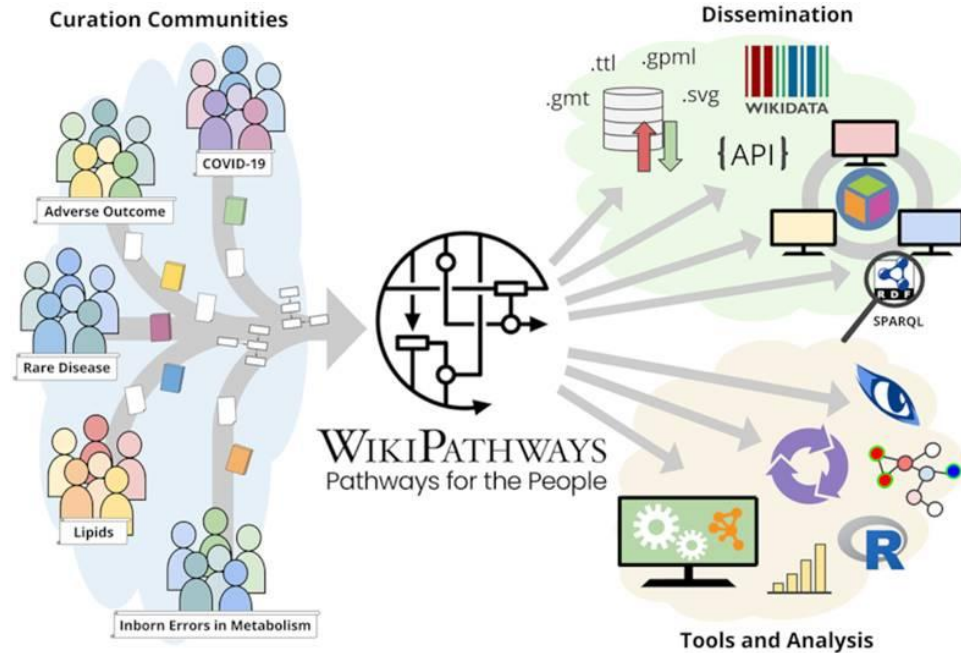
AOP-DB RDF

WikiPathways

What is WikiPathways?

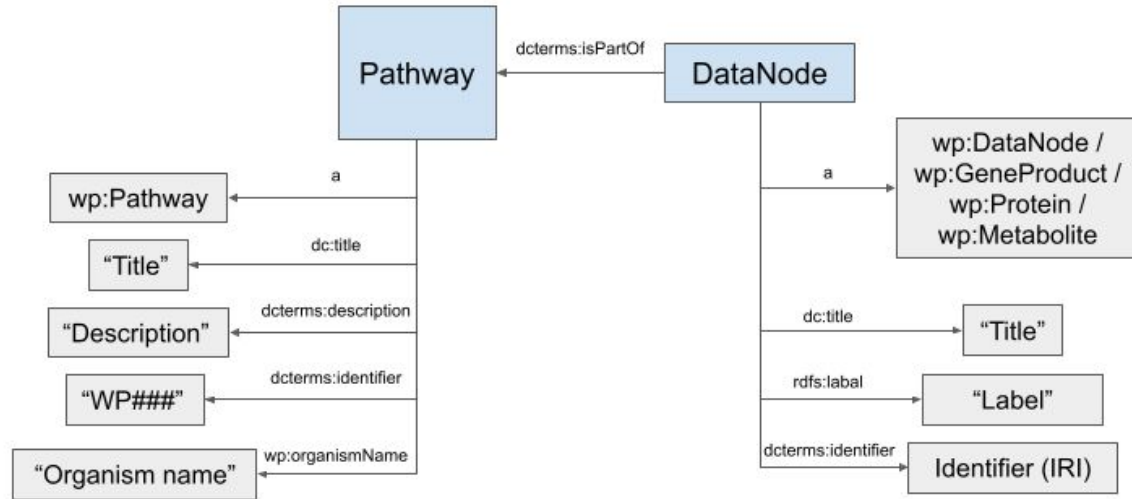
- Community-driven molecular pathway database
- Wide range of pathway types
- Supports a variety of ways to integrate and interact with pathway content

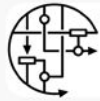
www.wikipathways.org



Very simplified RDF schema

- Vocabularies:
 - WP
 - GPML
- BridgeDb mapping
- References
- Authors
- Ontology tags





WIKIPATHWAYS
Pathways for the People

SPARQL Endpoint

<http://sparql.wikipathways.org/sparql>

SPARQL Query:

1

Query

Reset

Export CSV

Export JSON

Export XML

Get Permalink

Fullscreen Mode

SPARQL Examples:

<https://github.com/wikipathways/SPARQLC>



Type part of the query file name to search for..

Search

Clear

A. Metadata

B. Communities

C. Collaborations

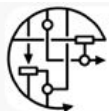
D. General

E. Literature

F. Datadump

G. Curation

SPARQL editor provides SPARQL syntax highlighting



WIKIPATHWAYS
Pathways for the People

SPARQL Endpoint

<http://sparql.wikipathways.org/sparql>

SPARQL Query:

```
1 SELECT DISTINCT ?DataNodeLabel ?PathwayTitle
2 WHERE {
3   ?DataNodes a wp:DataNode ; rdfs:label ?DataNodeLabel ; dcterms:isPartOf ?Pathway .
4   ?Pathway dc:title ?PathwayTitle .
5   FILTER (?PathwayTitle = "Apoptosis"@en) #replace to query other pathways
6 }
7
```

Query

Reset

Export CSV

Export JSON

Export XML

Get Permalink

Fullscreen Mode

SPARQL Examples:

<https://github.com/wikipathways/SPARQLC>

Type part of the query file name to search for..

Search

Clear

A. Metadata

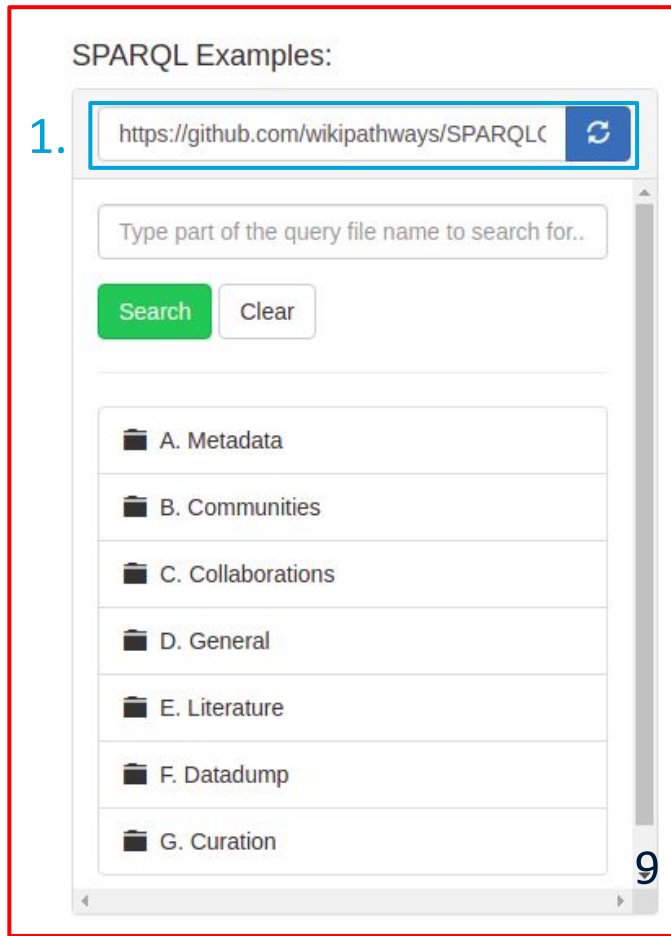
B. Communities

C. Collaborations

D. General

SPARQL Query Examples panel

1. GitHub repository to load queries



Search or jump to... Pull requests Issues Marketplace Explore

wiki**pathways** / **SPARQLQueries**

<> Code Issues 2 Pull requests

master 4 branches 0

DeniseSl22 Update to more descri

- A. Metadata
- B. Communities
- C. Collaborations/MeXtProt
- D. General
- E. Literature
- F. Datadump
- G. Curation
- README.md

SPARQLQueries / A. Metadata /

egonw Create linksets.rq

- datacounts
- datasources
- species
- linksets.rq
- metadata.rq

README.md

SPARQLQueries

Queries for the [WikiPathways Snorql UI](#) automated loading

master SPARQLQueries / A. Metadata / metadata.rq

marvinm2 restructure and more queries

1 contributor


7 lines (7 sloc) | 192 Bytes

```
1 SELECT DISTINCT ?dataset (str(?titleLit) as ?title) ?date ?license
2 WHERE {
3     ?dataset a void:Dataset ;
4     dcterms:title ?titleLit ;
5     dcterms:license ?license ;
6     pav:createdOn ?date .
7 }
```








SPARQL Query Examples panel

1. GitHub repository to load queries

SPARQL Examples:

1. 

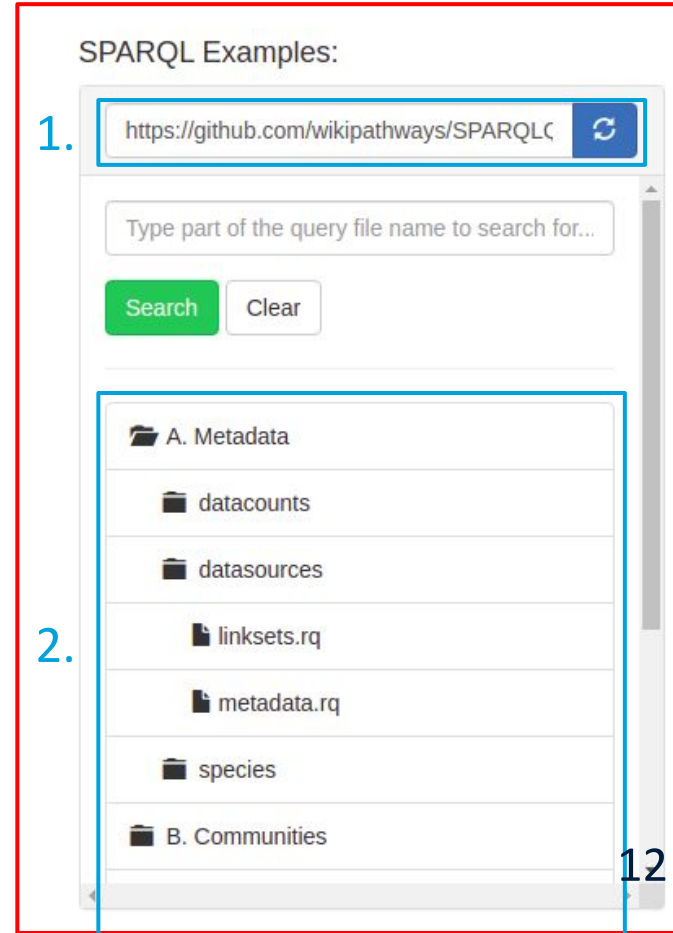
Type part of the query file name to search for...

-  A. Metadata
 -  datacounts
 -  datasources
 -  linksets.rq
 -  metadata.rq
 -  species
-  B. Communities

11

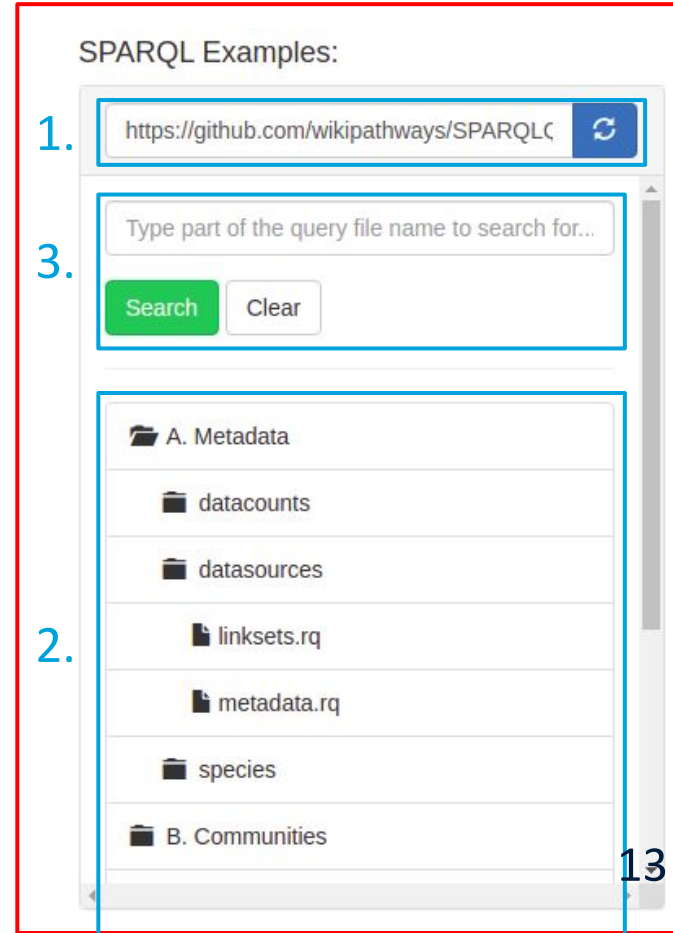
SPARQL Query Examples panel

1. GitHub repository to load queries
2. Folders are reflected in the browser



SPARQL Query Examples panel

1. GitHub repository to load queries
2. Folders are reflected in the browser
3. Search queries

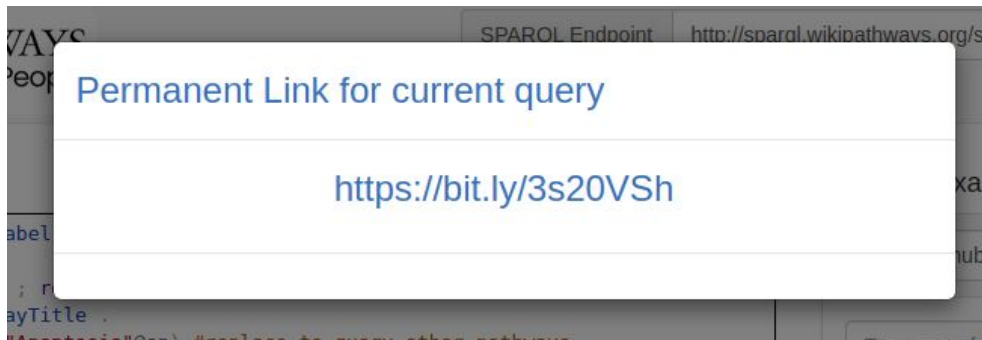
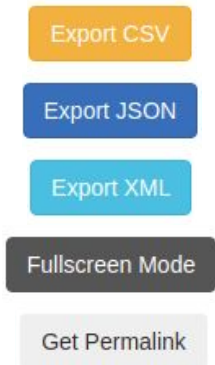


Exports, full screen mode, and permanent links

Download as:

- CSV
- JSON
- XML

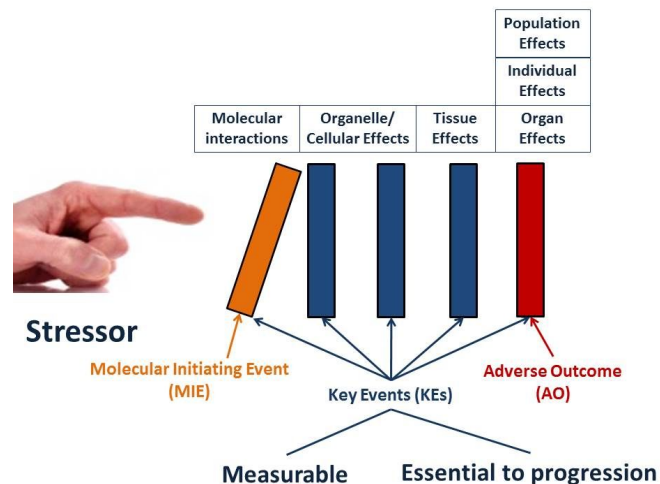
Enter full screen for spacious SPARQL query writing
Get a sharable link for current query



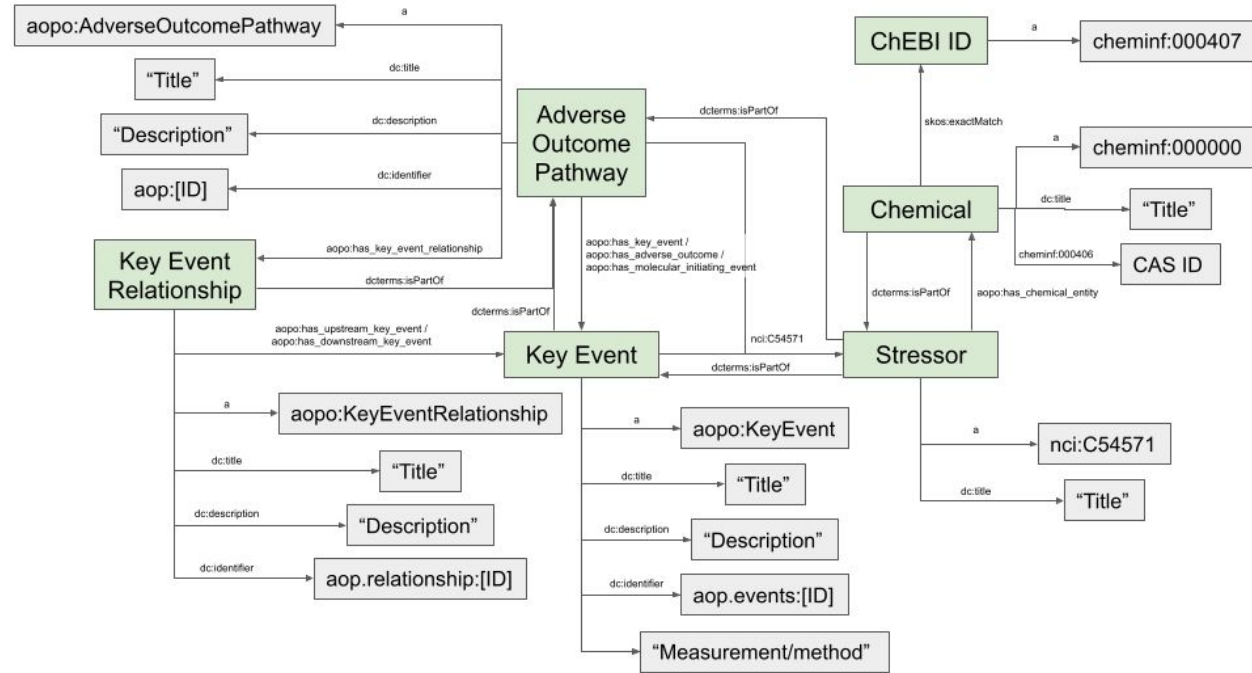
AOP-Wiki

What is AOP-Wiki?


- Stores Adverse Outcome Pathways (AOPs)
 - Framework that captures mechanistic knowledge of toxicological processes to support decision making in risk assessments
- Part of the AOP Knowledge Base
- Developed by EC JRC and US EPA



Simplified figure of the AOP-Wiki RDF



Adverse Outcome Pathway	Predicate	Object	Object example
	a	aopo:AdverseOutcomePathway	
	dc:identifier	Adverse Outcome Pathway (IRI)	aop:38
	rdfs:label	Label (literal)	"AOP 38"
	dc:title	Title (literal)	"Protein Alkylolation leading to Liver Fibrosis"
	dcterms:alternative	Alternative title (literal)	"Protein Alkylolation to Liver Fibrosis"
	dc:creator	Author (literal)	""Brigitte Landesmann...
	dcterms:abstract	Abstract (literal)	""Hepatotoxicity in general is of special interest...
	nci:C54571	Stressor (IRI)*	aop.stressor:9,aop.stressor:13,aop.stressor:60,...
	aopo:has_key_event	Key Event (IRI)*	aop.events:55,aop.events:1492,aop.events:1493,...
	aopo:has_molecular_initiating_event	Key Event (IRI)*	aop.events:244
	aopo:has_adverse_outcome	Key Event (IRI)*	aop.events:344
	aopo:has_key_event_relationship	Key Event Relationship (IRI)*	aop.relationships:269,aop.relationships:1718,...
	dc:description	Description (literal)	""Two prototypical chemicals acting via protein alkylolation are...
	pato:0000047	Sex applicability (literal)	"Unspecific"
	aopo:LifeStageContext	Life stage applicability (literal)	"Not Otherwise Specified"
	aopo:AopContext	Applicability (literal)	""The described AOP is valid for both sexes and any life stage...
	edam:operation_3799	Quantitative considerations (literal)	""More advanced in vitro models systems are needed...
	aopo:has_evidence	Weight of Evidence (literal)	""Support for Essentiality of KEs...
	nci:C25725	Potential applications (literal)	""This systematic and coherent display of currently available...
	nci:C25217	Overall assessment (literal)	""Assessment of the Weight-of-Evidence supporting the AOP...
	nci:C48192	Key Event essentiality (literal)	""The essentiality of each of the KEs for this AOP...
	dc:accessRights	AOP status (literal)	"Open for citation & comment"
	foaf:page	Webpage (URL)	<https://identifiers.org/aop/38>
	dcterms:created	Date of creation (literal)	"2016-11-29T18:41:16"
	dcterms:modified	Date of latest modification (literal)	"2019-04-30T12:53:51"
	dc:source	Source (literal)	"AOPWiki"

SPARQL Endpoint

SPARQL Query:

1

Query

Reset

Get Permalink

Export as:


CSV

JSON

XML


Fullscreen Mode


SPARQL Examples:





Search


Clear


 A. Metadata


 B. Datadump


 C. Search


 D. Simpleconversions


 E. Chemical-centered

 F. Federated

 allAOPs.rq


www.BIGCaT.unimaas.nl
department of bioinformatics

 NUTRIM

 Maastricht University

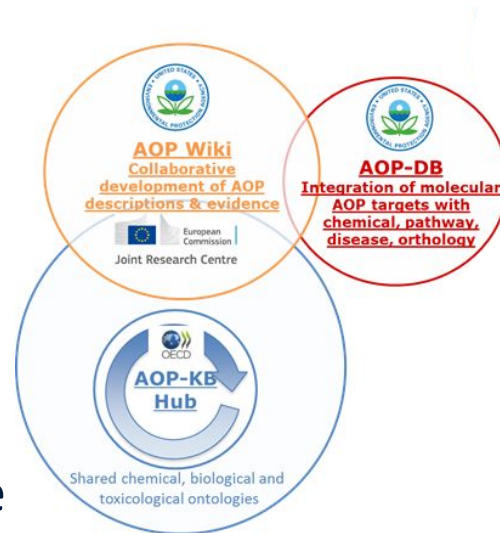
20

AOP-DB

What is the US EPA AOP-DB?

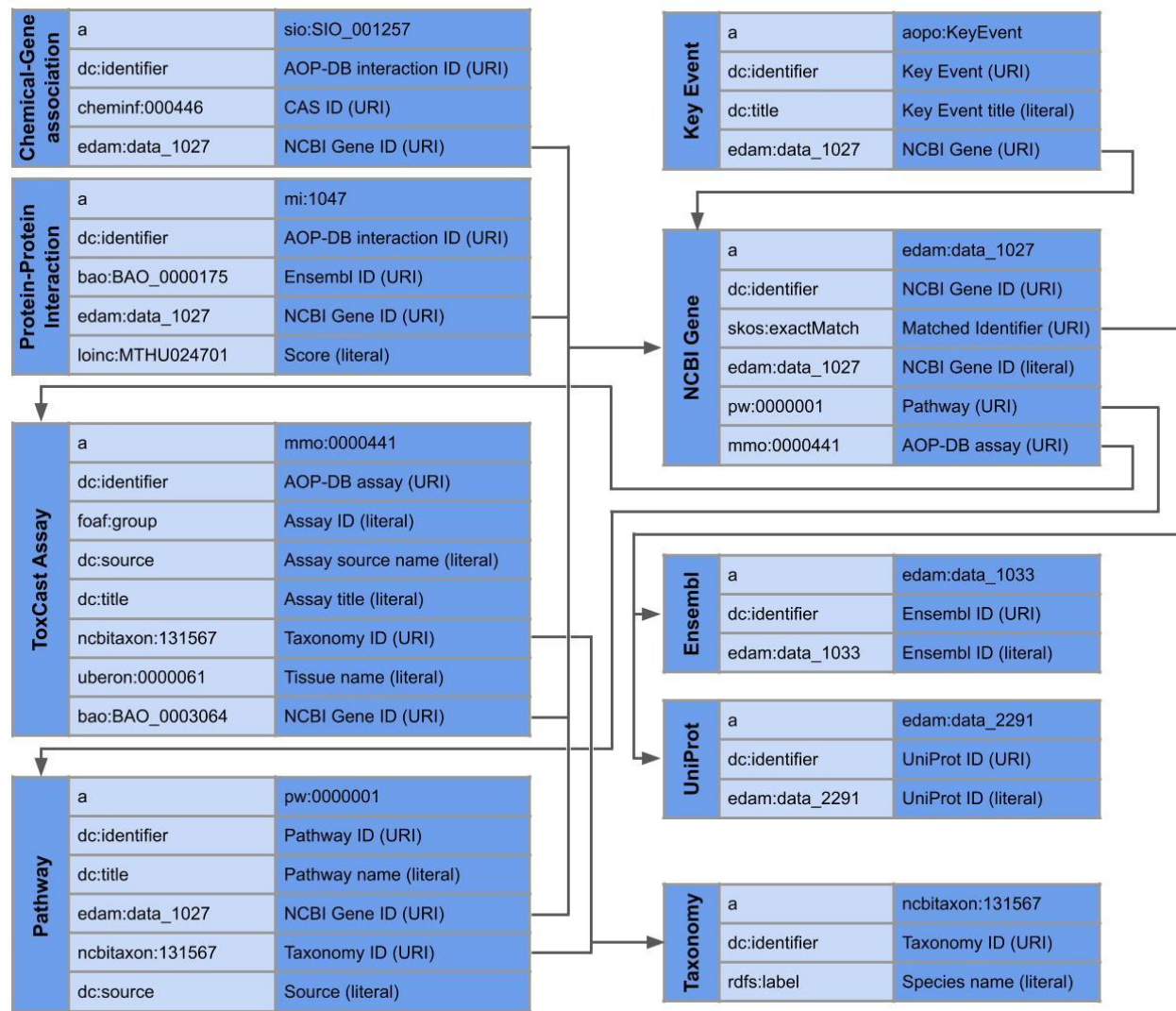


- A decision support tool for risk assessment
- Combines data types:
 - Adverse Outcome Pathways
 - Genes, Chemicals
 - Diseases, Pathways
 - ToxCast assays
- Won the OpenRiskNet implementation challenge
 - AOP-DB was converted into RDF



AOP-DB RDF

- Subset of the data
- Is an extension of the AOP-Wiki RDF



SPARQL endpoint

- OpenLink Virtuoso
- All our endpoints run on the same software
- Simple Docker setup

Virtuoso SPARQL Query Editor

[About](#) | [Namespace Prefixes](#) | [Inference rules](#) | [RDF views](#)

Default Data Set Name (Graph IRI)

Query Text

#This is the AOP-DB SPARQL endpoint

(Security restrictions of this server do not allow you to retrieve remote RDF data, see [details](#).)

Results Format:

Execution timeout:

 milliseconds (values less than 1000 are ignored)

Options:

- ☒ Strict checking of void variables
- ☐ Log debug info at the end of output (has no effect on some queries and output formats)
- ☐ Generate SPARQL compilation report (instead of executing the query)

(The result can only be sent back to browser, not saved on the server, see [details](#))

Run Query

Reset

Copyright © 2021 [OpenLink Software](#)

Virtuoso version 07.20.3230 on Linux (x86_64-generic_glibc25-linux-gnu), Single Server Edition

Nanosafety

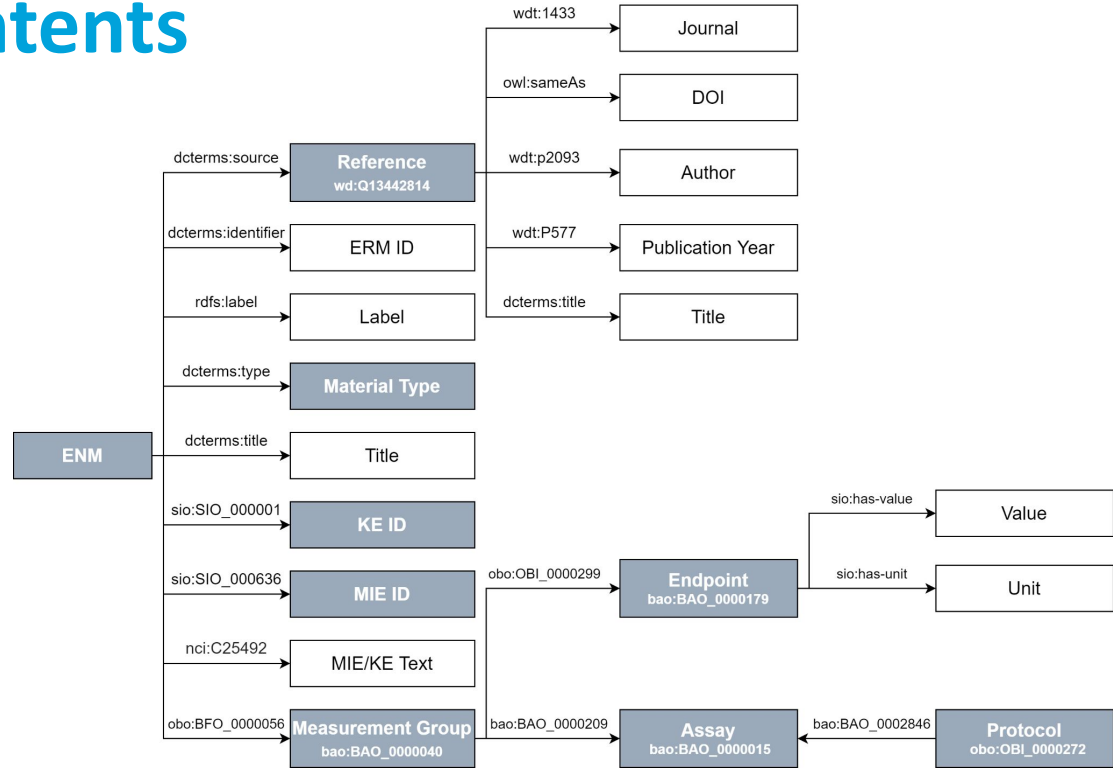
What is the Nanosafety RDF?



Using semantic web approaches to report NMs, their physicochemical characteristics and their interactions with biomolecules and biological systems.

Nanosafety RDF contents

- 83 unique NMs
 - 34 types of NMs
 - NPO 29%
 - ChEBI 23%
 - eNM 48%
- 9 types of Molecular Initiating Events activated by NMs



SPARQL Query:

```
1 PREFIX wd: <http://www.wikidata.org/entity/>
2 PREFIX dcterms: <http://purl.org/dc/terms/>
3 PREFIX owl: <http://www.w3.org/2002/07/owl#>
4 PREFIX wdt: <http://www.wikidata.org/prop/direct/>
5 PREFIX obo: <http://purl.obolibrary.org/obo/>
6
7 select distinct ?DOI ?sourcetitle ?ID ?materialname ?materialtype where {
8   ?source a wd:Q13442814 ;
9   dcterms:title ?sourcetitle ;
10  owl:sameAs ?DOI ;
11  wdt:1433 ?journal ;
12  wdt:P2093 ?author ;
13  wdt:P577 ?year .
14  ?s a obo:CHEBI_59999 ;
15  dcterms:identifier ?ID ;
16  rdfs:label ?materialname ;
17  dcterms:type ?materialtype ;
18  dcterms:source ?source.
19 }
20
```

Query Reset Get Permalink Export as: CSV JSON XML Fullscreen Mode

SPARQL Examples:

<https://github.com/h2020-riskgone/SPARQ>

- Count-assays.rq
- Count-material-names.rq
- Count-material-types.rq
- Count-per-materialtype.rq
- List-assays.rq
- List-material-names.rq
- List-material-types.rq
- List-materials-per-publication.rq
- List-publications.rq
- test.rq

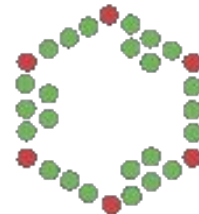
SPARQL results (87 results)

DOI	sourcetitle	ID	materialname	materialtype
https://doi.org/10.1021/acssuschemeng.8b01744	Multihierarchically Profiling the Biological Effects	https://nanocommons.github.io/identifiers/registry#ERM00000197	nLa2O3	http://purl.enanom

ChEMBL

What is ChEMBL?

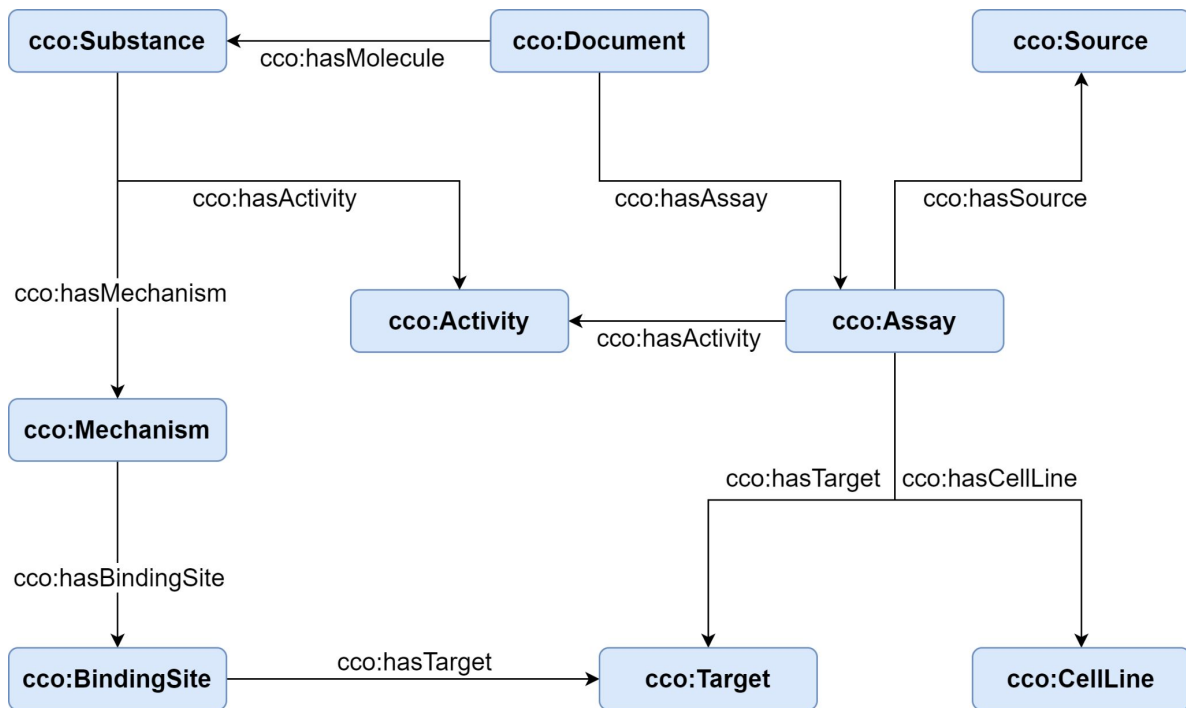
ChEMBL



- A manually curated database of bioactive molecules with drug-like properties
- Brings together chemical, bioactivity and genomic data
 - Aid translation of genomic information into effective new drugs
- ChEMBL RDF produced by EBI
 - Available for download
 - No SPARQL endpoint
- BiGCaT is hosting a mirror SPARQL endpoint

Description of RDF (simplified model)

- ChEMBL RDF contains compound bioactivity data against drug targets
- Bioactivity is reported in K_i , K_d , IC_{50} , and EC_{50}
- ChEMBL 29 (2021) contains:
 - ~2 million compounds
 - ~14500 targets
 - ~18.6 million activities
 - ~81500 publications



ChEMBL RDF Snorql Interface

<https://chemblmirror.rdf.bigcat-bioinformatics.org/>

Snorql: A SPARQL Explorer for ChEMBL RDF

SPARQL Endpoint

<https://chemblmirror.rdf.bigcat-bioinformatics.org/sparql>

SPARQL Query:

```
1 PREFIX chembl: <http://rdf.ebi.ac.uk/terms/chembl#>
2
3 SELECT distinct ?targetLabel ?molLabel ?assayLabel ?type ?value WHERE {
4
5   ?assay chembl:hasTarget ?target.
6
7   ?activity chembl:hasAssay ?assay.
8   ?activity chembl:hasMolecule ?molecule .
9
10  ?target rdfs:label ?targetLabel.
11  ?molecule rdfs:label ?molLabel.
12  ?assay rdfs:label ?assayLabel.
13
14  ?activity chembl:type ?type.
15  ?activity chembl:standardValue ?value.
16
```

Query

Reset

Export CSV

Export JSON

Export XML

Get Permalink

Fullscreen Mode

If you like to do chemical substructure searching on the ChEMBL data, try [IDSM](#).

SPARQL Examples:

<https://github.com/BIGCAT-UM/ChEMBL-S>

Type part of the query file name to search for..

Search

Clear

BindingAffinity

MoleculeTargetBindingAffinity.rq

Metadata

SPARQL results (100 results)

targetLabel	molLabel	assayLabel	type	value
GABA-A receptor; anion channel	CHEMBL100897	CHEMBL652360	IC50	2700.0
Thrombin	CHEMBL101855	CHEMBL812829	Ki	9.6
Thrombin	CHEMBL108447	CHEMBL813568	Ki	6440.0
Thrombin	CHEMBL1159687	CHEMBL813569	Ki	0.003
Thrombin	CHEMBL103862	CHEMBL813626	Ki	0.66
Thrombin	CHEMBL101855	CHEMBL879195	Ki	12.0
Beta-2 adrenergic receptor	CHEMBL110969	CHEMBL647103	IA	5.0

SbD4Nano Landscape

SbD4Nano Landscape

- Semantic annotation of data sources
- Shape expressions
 - Shared between projects
- Sources separated → flexible dissemination
- One repository, one license

The screenshot displays the SbD4Nano Landscape repository page. It features a list of sub-repositories, each with a title, a 'Private' badge, a description, and statistics (forks, stars, issues, pull requests, and update date). A sidebar on the right shows 'Top languages' (Groovy, HTML, Jupyter Notebook) and 'People' (a group of avatars with an 'Invite someone' button).

Repository	Private	Description	Forks	Stars	Issues	Pull Requests	Updated
sbd-data-nanowiki	Private	landscape knowledge derived from NanoWiki	0	0	0	0	Updated on Mar 11
use-case-vocabulary	Private		0	0	2	0	Updated on Mar 10
sbd-data-landscape	Private	Project to build a semantic knowledge base about data and computational (model) resources that can tell us about biological aspects of nanomaterials.	0	0	8	0	Updated on Mar 10
sbd-data-aopwiki	Private		0	0	0	0	Updated on Mar 10
sbd4nano-notebooks	Private	Jupyter notebooks	0	0	0	0	Updated on Feb 1
sbd-data-diamonds	Private		0	0	1	0	Updated on Jan 21
specifications			0	0	0	0	Updated on Jan 4
sbd-data-book	Private		0	0	0	0	Updated on Dec 10, 2020
sbd4nano-materials	Private	Private repository with information about the SbD4Nano materials	0	0	0	0	Updated on Nov 9, 2020

Top languages

- Groovy
- HTML
- Jupyter Notebook

People 7 >

Invite someone

SPARQL Query:


```
1 PREFIX sbd: <https://www.sbd4nano.eu/rdf/#>
2 PREFIX sbdbel: <https://www.sbd4nano.eu/bel/#>
3 PREFIX dc: <http://purl.org/dc/elements/1.1/>
4 PREFIX dcterms: <http://purl.org/dc/terms/>
5
6 SELECT DISTINCT ?sourceLabel ?databases ?datasets ?model ?relationships
7 WHERE {
8   ?source dcterms:title ?sourceLabel .
9   {
10     SELECT ?source (COUNT(DISTINCT ?relationship) AS ?relationships) WHERE {
11       ?source ^dc:source ?relationship . ?relationship a sbdbel:CausalAssertion .
12     } GROUP BY ?source
13   } UNION
14   {
15     SELECT ?source (COUNT(DISTINCT ?dataset) AS ?datasets) WHERE {
16       ?source ^dc:source ?dataset . ?dataset a sbd:Dataset .
17     } GROUP BY ?source
18   } UNION
19   {
20     SELECT ?source (COUNT(DISTINCT ?database) AS ?databases) WHERE {
21       ?source ^dc:source ?database . ?database a sbd:Database .
22     } GROUP BY ?source
23   } UNION
24   {
25     SELECT ?source (COUNT(DISTINCT ?model) AS ?models) WHERE {
```

Query Reset Get Permalink Export as: CSV JSON XML Fullscreen Mode

SPARQL results (3 results)

sourceLabel	databases	datasets	model	relationships
NanoWiki v6 causal relationships	-	-	-	11
SbD4Nano WP1 Sheet 2	19	-	-	-
SbD4Nano WP1 Sheet 4	25	-	-	-



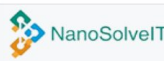

SPARQL Examples:

<https://github.com/h2020-sbd4nano/Lands> 

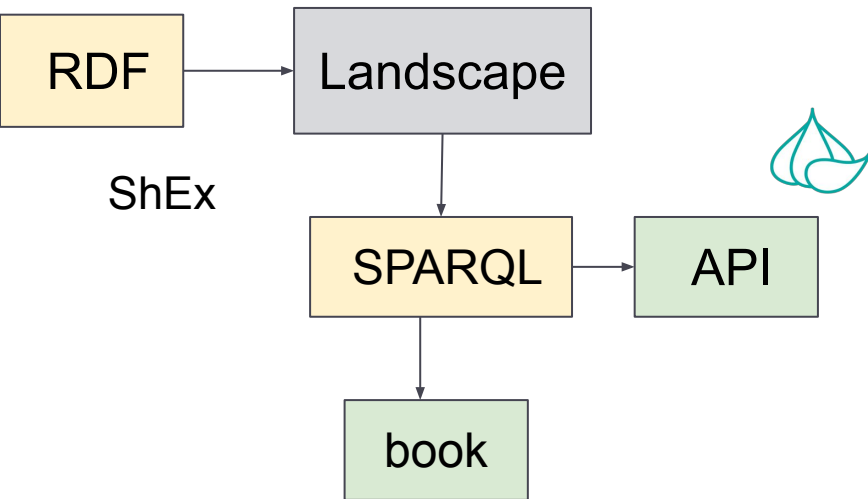
Type part of the query file name to search for...

Search Clear

- All-Databases-labels.rq
- All-Datasets-names-webpages.rq
- Statistics.rq
- All-Databases-labels.rq
- All-Datasets-names-webpages.rq
- Statistics.rq

resource	img
SbD4Nano Carbon Nanoforms Causal Relationships	
SbD4Nano WP1 Causal Relationships	
SbD4Nano WP1 Sheet ECOTOX_DB	
SbD4Nano WP1 Sheet HAZARD_TnM	
SbD4Nano WP1 Sheet PCHEM_DB	
SbD4Nano WP1 Sheet RA_TnM	
SbD4Nano WP1 Sheet REGULATION	
SbD4Nano WP1 Sheet RELEASE_EXPOSURE_T_DBNM	
SbD4Nano WP1 Sheet RM_TnM	
SbD4Nano WP1 Sheet SEAnCBA	
NanoWiki v6 causal relationships	
Overview of open datasets released by NanoSafety Cluster projects	
NanoSolveIT Tools	
AOP-Wiki data	

What is in the landscape



main
sbd-data-book / docs / index.md
Go to

egonw Added overall statistics table
Latest commit ae561aa 11 days ago

1 contributor

24 lines (19 sloc) | 1011 Bytes
<>
Raw
Blame

SbD4Nano Resources

This book provides a summary of the semantic landscape of data sources that support the safe-by-design development of nanomaterials. The book is enriched with SPARQL queries, written in the SPARQL query language. To learn more about this query language, consider reading [SPARQLing Biology: a beginners course](#).

Contents

1. A Semantic landscape
 - 1.1. General requirements
 - 1.2. Information sources and plugins
 - 1.3. Data sources
 - 1.4. Statistics
2. Data
 - 2.1. Databases
 - 2.2. Datasets
3. Models
4. Websites
 - 4.1. Landscape

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source	sourceLabel	databases	datasets	models	relationships	frameworks	guidancetools	guidancedocs	lcanalyses
https://h2020-sbd4nano.github.io/sbd-data-landscape/w01/ECOTOX_DB/	SbD4Nano WP1 Sheet ECOTOX_DB	22	0	0	0	6	2	0	0
https://h2020-sbd4nano.github.io/sbd-data-landscape/w01/HAZARD_TnM/	SbD4Nano WP1 Sheet HAZARD_TnM	0	0	0	0	10	3	19	1
https://h2020-sbd4nano.github.io/sbd-data-landscape/w01/PCHEM_DB/	SbD4Nano WP1 Sheet PCHEM_DB	19	0	0	0	4	2	3	0
https://h2020-sbd4nano.github.io/sbd-data-landscape/w01/RA_TnM/	SbD4Nano WP1 Sheet RA_TnM	2	0	0	0	7	4	8	10
https://h2020-sbd4nano.github.io/sbd-data-landscape/w01/REGULATION/	SbD4Nano WP1 Sheet REGULATION	12	0	0	0	2	5	24	3
https://h2020-sbd4nano.github.io/sbd-data-landscape/w01/RELEASE_EXPOSURE_T_DbnM/	SbD4Nano WP1 Sheet RELEASE_EXPOSURE_T_DbnM	14	0	0	0	3	4	14	1
https://h2020-sbd4nano.github.io/sbd-data-landscape/w01/RM_TnM/	SbD4Nano WP1 Sheet RM_TnM	1	0	0	0	0	0	19	0
https://h2020-sbd4nano.github.io/sbd-data-landscape/w01/SEANCBA/	SbD4Nano WP1 Sheet SEANCBA	4	0	0	0	13	2	0	5
https://nanosolveit.eu/resources/tools-services/	NanoSolveIT Tools	0	0	6	0	0	0	0	0
https://h2020-sbd4nano.github.io/sbd-data-landscape/w01/nanowiki/	NanoWiki v6 causal relationships	0	0	0	11	0	0	0	0
https://nanocommons.github.io/datasets/	Overview of open datasets released by NanoSafety Cluster projects	0	7	0	0	0	0	0	0
https://h2020-sbd4nano.github.io/sbd-data-landscape/w01/bel_ralph/	SbD4Nano Carbon Nanoforms Causal Relationships	0	0	0	8	0	0	0	0
https://h2020-sbd4nano.github.io/sbd-data-landscape/w01/bel/	SbD4Nano WP1 Causal Relationships	0	0	0	500	0	0	0	0
https://h2020-sbd4nano.github.io/sbd-data-aowiki/	AOP-Wiki data	0	3	0	0	0	0	0	0

What is currently in the landscape

sourceLabel	databases	datasets	models	relationships	frameworks	guidancetools	guidancedocs	lcanalyses
SbD4Nano WP1 Sheet ECOTOX_DB	22	0	0	0	6	2	0	0
SbD4Nano WP1 Sheet HAZARD_TnM	0	0	0	0	10	3	19	1
SbD4Nano WP1 Sheet PCHEM_DB	19	0	0	0	4	2	3	0
SbD4Nano WP1 Sheet RA_TnM	2	0	0	0	7	4	8	10
SbD4Nano WP1 Sheet REGULATION	12	0	0	0	2	5	24	3
SbD4Nano WP1 Sheet RELEASE_EXPOSURE_T_DBNM	14	0	0	0	3	4	14	1
SbD4Nano WP1 Sheet RM_TnM	1	0	0	0	0	0	19	0
SbD4Nano WP1 Sheet SEAnCBA	4	0	0	0	13	2	0	5
NanoSolveIT Tools	0	0	6	0	0	0	0	0
NanoWiki v6 causal relationships	0	0	0	11	0	0	0	0
Overview of open datasets released by NanoSafety Cluster projects	0	7	0	0	0	0	0	0
SbD4Nano Carbon Nanoforms Causal Relationships	0	0	0	8	0	0	0	0
SbD4Nano WP1 Causal Relationships	0	0	0	500	0	0	0	0
AOP-Wiki data	0	3	0	0	0	0	0	0

And new things being added: AOPs, KERs, nano-MIE, QSAR models and new datasets coming in, e.g. NanoSolveIT T1.3 data sets.

Thank you!

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Maastricht University

Next: hands-on with the SPARQL endpoints

<https://nanocommons.github.io/workshops/2021-12-08/SPARQLEndpoint/>

- Sessions:
 - 8th December 15.15-16.00
 - 9th December 15.45-16.15
- Instructions and exercises on the SPARQL endpoints
 - WikiPathways
 - AOP-Wiki RDF
 - Nanosafety RDF
 - ChEMBL RDF