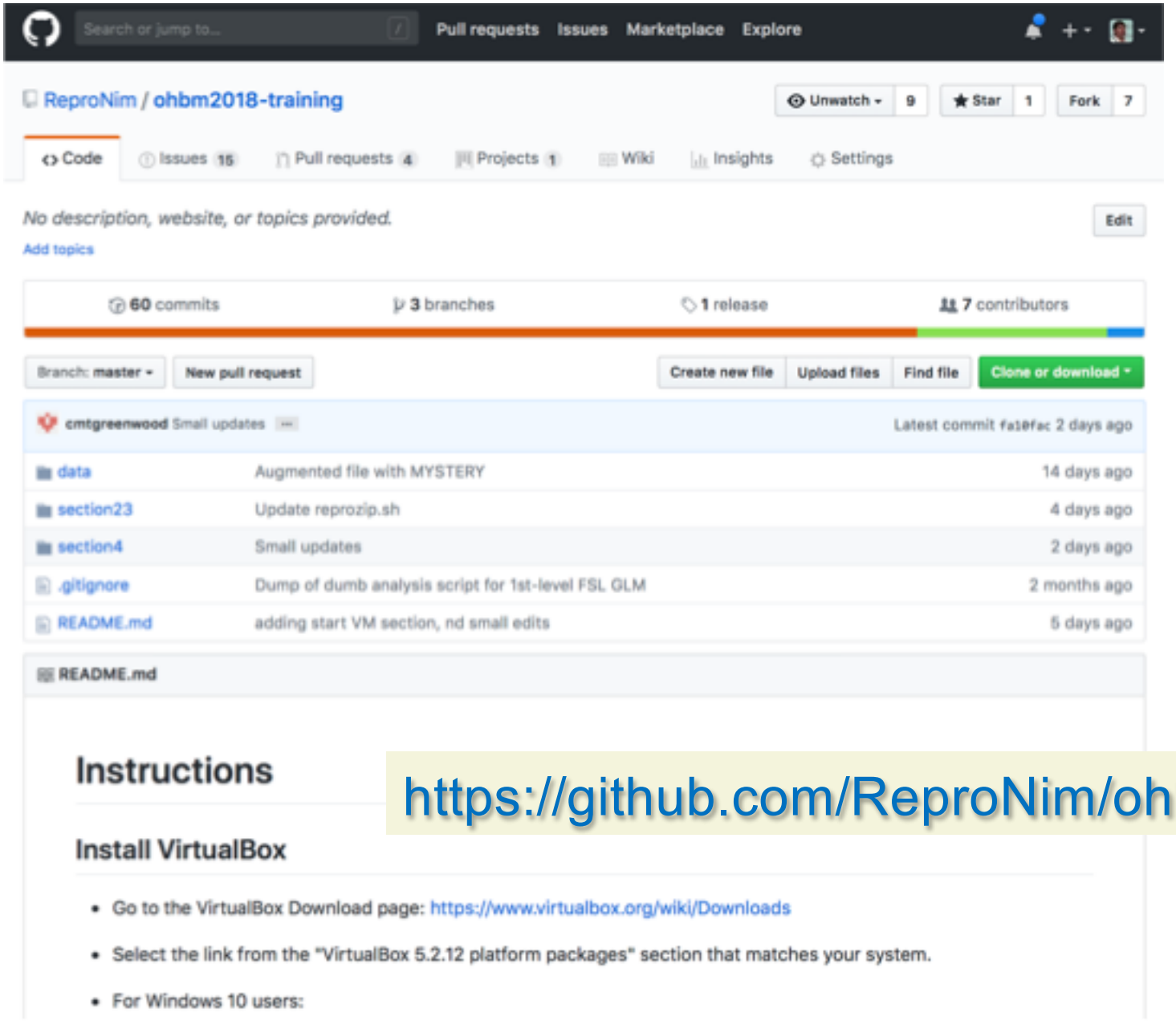
ReproNim: A Center for Reproducible Neuroimaging Computation

http://www.repronim.org

NIBIB P41 EB019936 “Center for Reproducible Neuroimaging Computation - CRNC” PI: Kennedy

Course Material



https://github.com/ReproNim/ohbm2018-training

FAIR Data

We will provide an introduction to the FAIR Data Principles and strategies for making research outputs that follow these principles - that data is Findable, Accessible, Interoperable and Re-Usable. This section will focus on making data FAIR via BIDS (Brain Imaging Data Structure) and NIDM (Neuroimaging Data Model) data structures, providing an overview of metadata, common data elements, terminologies/ontologies and semantic annotation of data. This section will also introduce pyNIDM, a Python library to manipulate the Neuro Imaging Data Model.

Section 1

Introduction to FAIR

What is open data?

"Open data is data that can be freely used, shared and built-on by anyone, anywhere, for any purpose."

Open definition;

Open Knowledge Foundation

Push for open science-open data

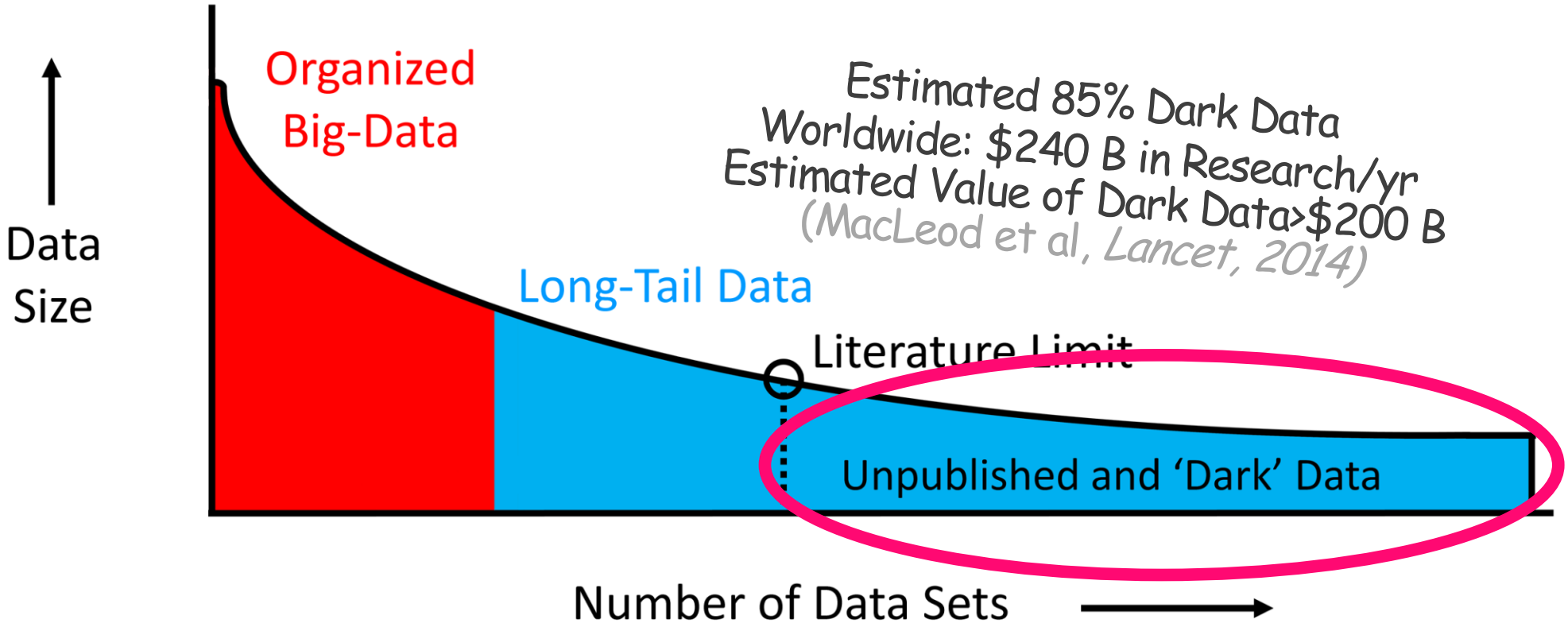
"The Administration is committed to ensuring that, to *the greatest extent* and *with the fewest constraints possible* and consistent with law and the objectives set out below, the direct results of federally funded scientific research are made available to and useful for the public, industry, and the scientific community. Such results include peer-reviewed publications and digital data. "

US Office of Science and Technology Policy
Increasing access to the *results* of federally funded scientific research
Memo, February 22, 2013

Why (publish) data?

- *Increase transparency and reproducibility of research*
- *Allow and encourage re-use of data sets, e.g., by informaticians, researchers, modelers*
- *Big data from small data: new insights from analysis across data*

TOWARD 'DATAFICATION' OF BIOMEDICINE



Ferguson et al., 2014, *Nature Neuroscience*

Data as a Research Product

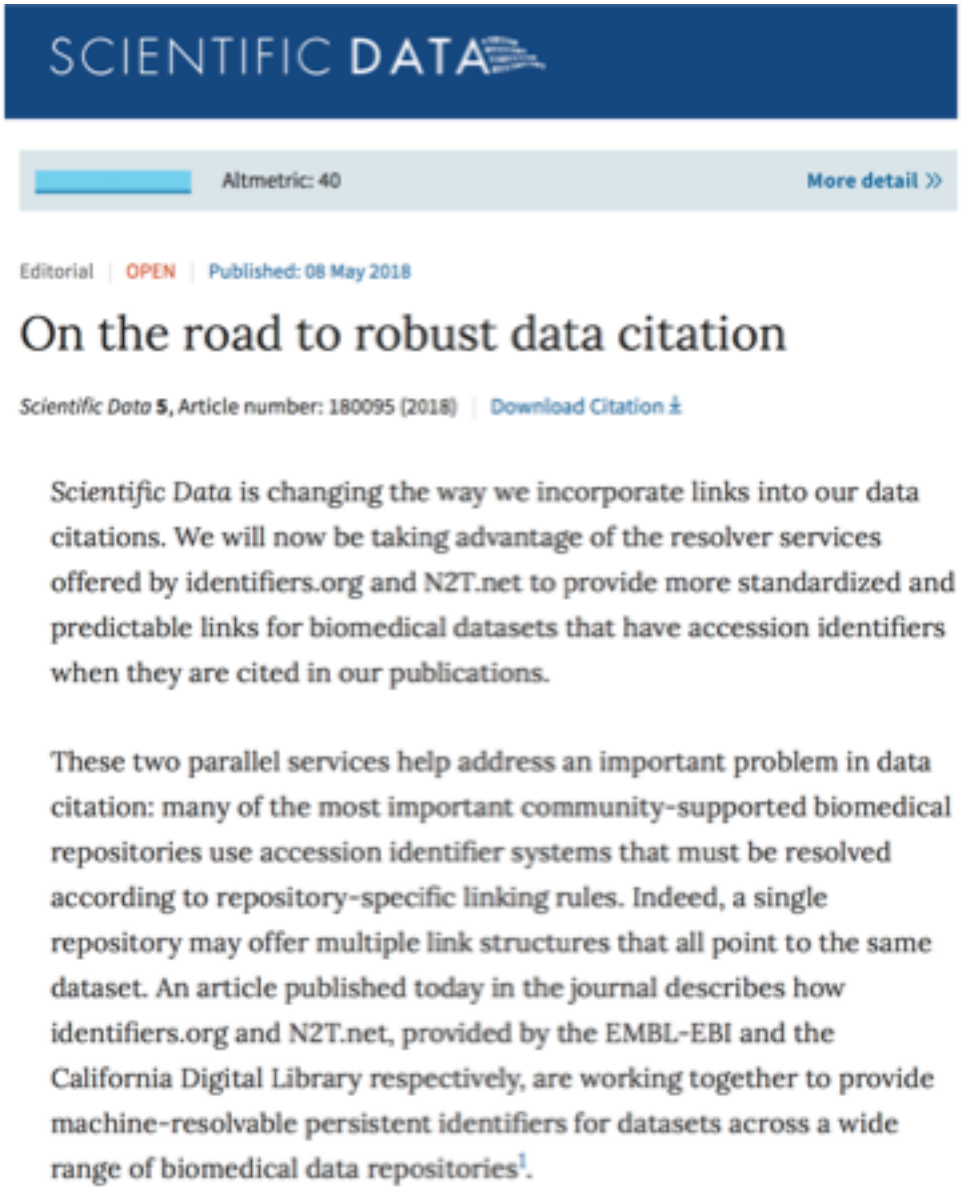
"Sound, reproducible scholarship rests upon a foundation of robust, accessible data. For this to be so in practice as well as theory, data must be accorded due importance in the practice of scholarship and in the enduring scholarly record…"

1. Data should be considered *legitimate, citable products of research*. Data citations should be accorded the same importance in the scholarly record as citations of other research objects, such as publications.
2. Data citations should facilitate giving scholarly credit and normative and legal attribution to all contributors to the data, recognizing that a single style or mechanism of attribution may not be applicable to all data.
3. In scholarly literature, whenever and wherever a claim relies upon data, the corresponding data should be cited.

Joint Declaration of Data Citation Principles

https://www.force11.org/group/joint-declaration-data-citation-principles-final

An Ecosystem for Data Citation



SCIENTIFIC DATA

Altmetric: 40 More detail »

Editorial | OPEN | Published: 08 May 2018

On the road to robust data citation

Scientific Data **5**, Article number: 180095 (2018) | Download Citation ±

Scientific Data is changing the way we incorporate links into our data citations. We will now be taking advantage of the resolver services offered by identifiers.org and N2T.net to provide more standardized and predictable links for biomedical datasets that have accession identifiers when they are cited in our publications.

These two parallel services help address an important problem in data citation: many of the most important community-supported biomedical repositories use accession identifier systems that must be resolved according to repository-specific linking rules. Indeed, a single repository may offer multiple link structures that all point to the same dataset. An article published today in the journal describes how identifiers.org and N2T.net, provided by the EMBL-EBI and the California Digital Library respectively, are working together to provide machine-resolvable persistent identifiers for datasets across a wide range of biomedical data repositories[1].

FAIR Principles

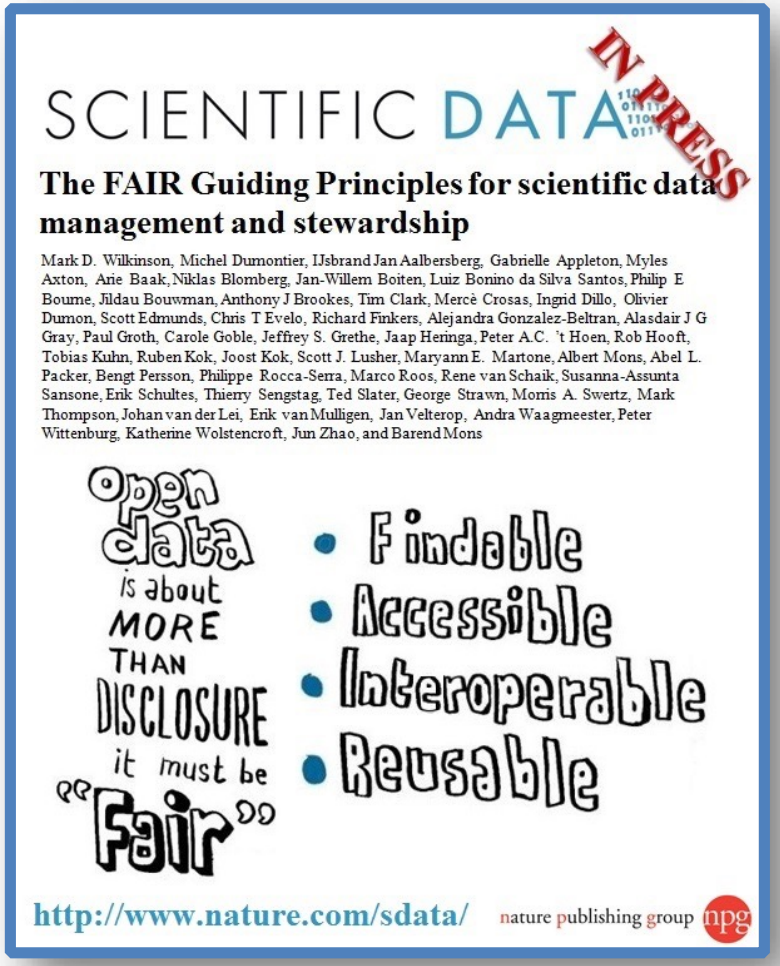
- **Findable:** A core aspect of an open data ecosystem - facilitate access to a collection of diverse research resources
- **Accessible:** Assist users by directing them to available resources for that researcher
- **Interoperable:** Provide unified views of certain data and information across resources
- **Reusable:** Supports community standards and develops standard representations for resources
- ***Attribution and Recognition:*** Initiatives to unambiguously cite resources and data

Assist researchers in ensuring that their resources (e.g. software tools, core facilities,…) and data are FAIR

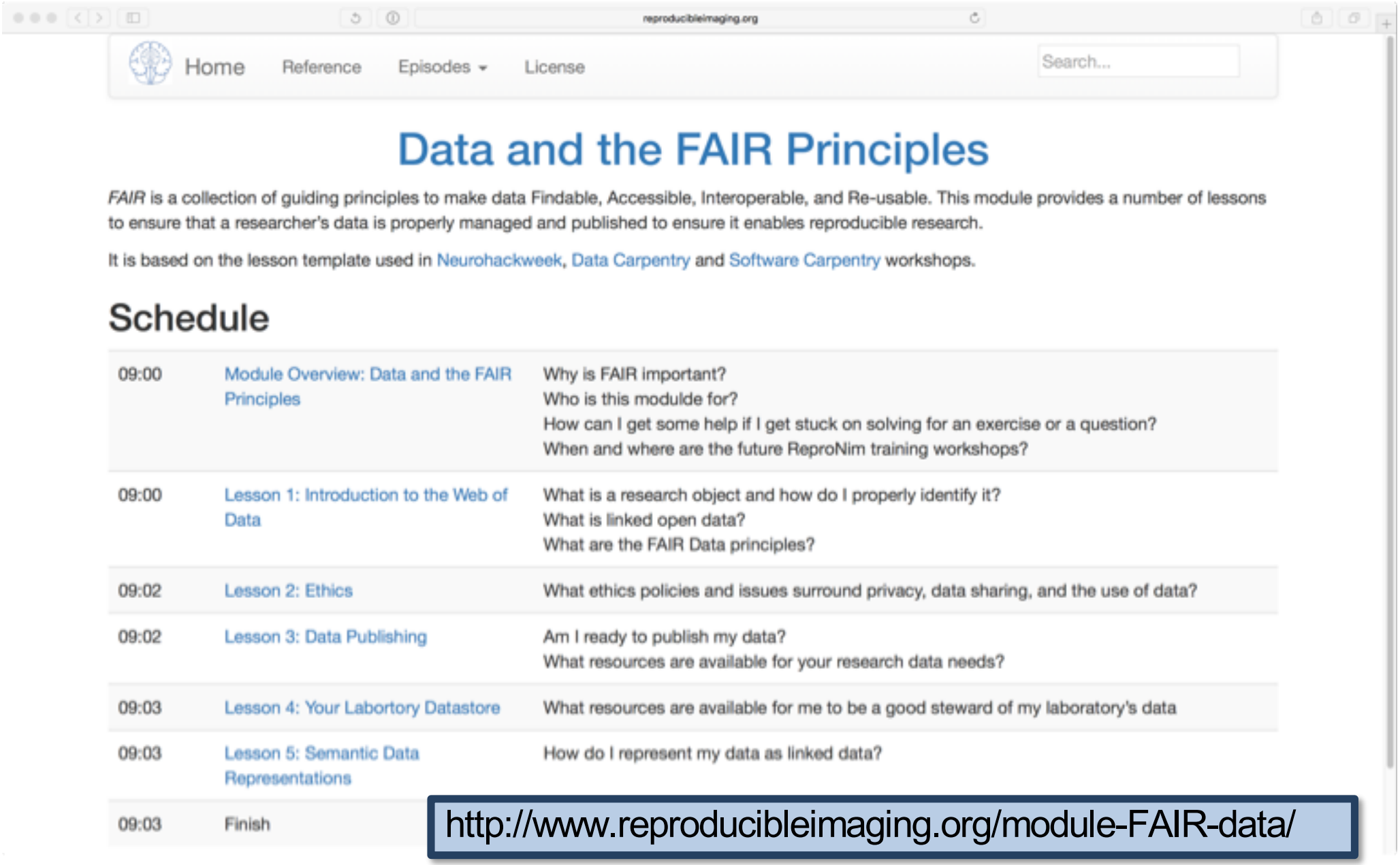
Wilkinson et al, 'The FAIR Guiding Principles scientific data management and stewardship," Nature Scientific Data, 2016

Making data FAIR

- FAIR data starts with good laboratory management
- Easiest way to make data FAIR is to submit it to a data repository
  - Specialized community repository
  - General repository
  - Institutional repository
- Journals are starting to post lists of repositories that are acceptable (e.g., http://journals.plos.org/plosone/s/data-availability).
- Data repositories act in the role of publishers for data:
  - links are stables
  - metadata is consistent
  - community standards are adhered to
- Data journals may have more stringent requirements

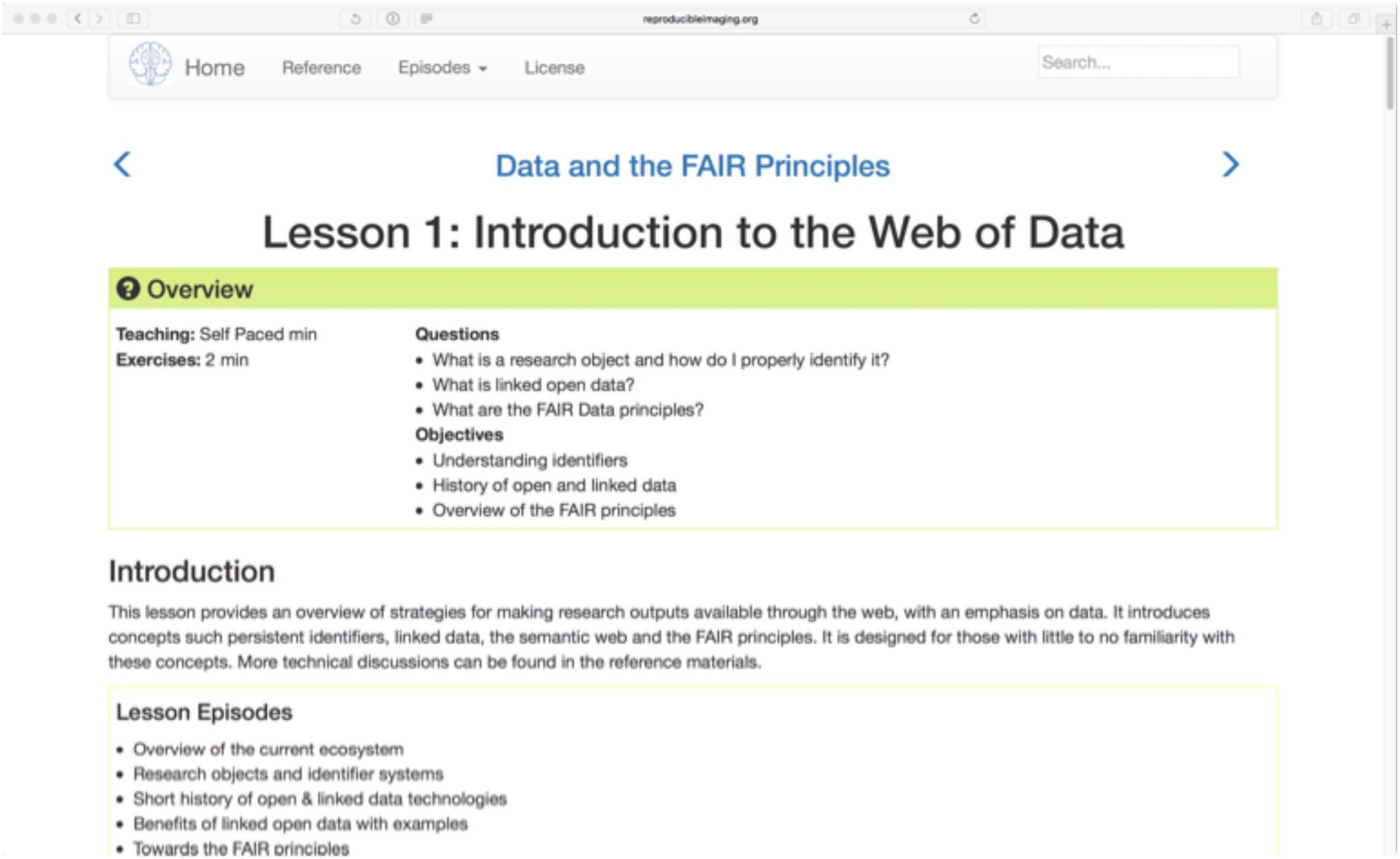


ReproNim Training



http://www.reproducibleimaging.org/module-FAIR-data/

ReproNim Training



Section 2

Interoperable Data and BIDS

Motivation

- Imaging experiments are complicated and can be organized in many different ways
- Many files/file types per subject
- Members of the same lab may use different ways to arrange data
- Difficulty sharing data within and across large scale projects

"Think this is bad? You should see the inside of my head."

Benefits of BIDS

- Standardized organization and format makes it easy to share data within/across labs
- More software tools are available that use this structure
- OpenNeuro and others can accept this format
- Validation tools are available to check data integrity
- Focus is on **raw data** (minimally processed), but source (e.g., DICOM) and derived data (e.g., a contrast map, post processed images) can be included as well

BIDS Resources

BIDS Specification

http://bids.neuroimaging.io/bids_spec.pdf

BIDS Starter Kit

https://github.com/INCF/bids-starter-kit

BIDS Validator

https://github.com/INCF/bids-validator

OpenNEURO

A free and open platform for analyzing and sharing neuroimaging data

https://openneuro.org

Multi-echo fMRI replication sample of autobiographical memory, prospection and theory of mind reasoning tasks

uploaded on 03/26/2018 - 3 months ago
last modified 04/09/2018 - 2 months ago
authored by Elizabeth DuPre, Wen-Ming Luh and R. Nathan Spreng

★ 1 2 173 3

Files: 848, Size: 19.16GB, Subjects: 31, Session: 1
Available Tasks : cuedSGT, rest
Available Modalities : bold, T1w

Published Uploader is Following

AUTHORS

Elizabeth DuPre

Wen-Ming Luh

https://openneuro.org/datasets/ds000210/versions/00002

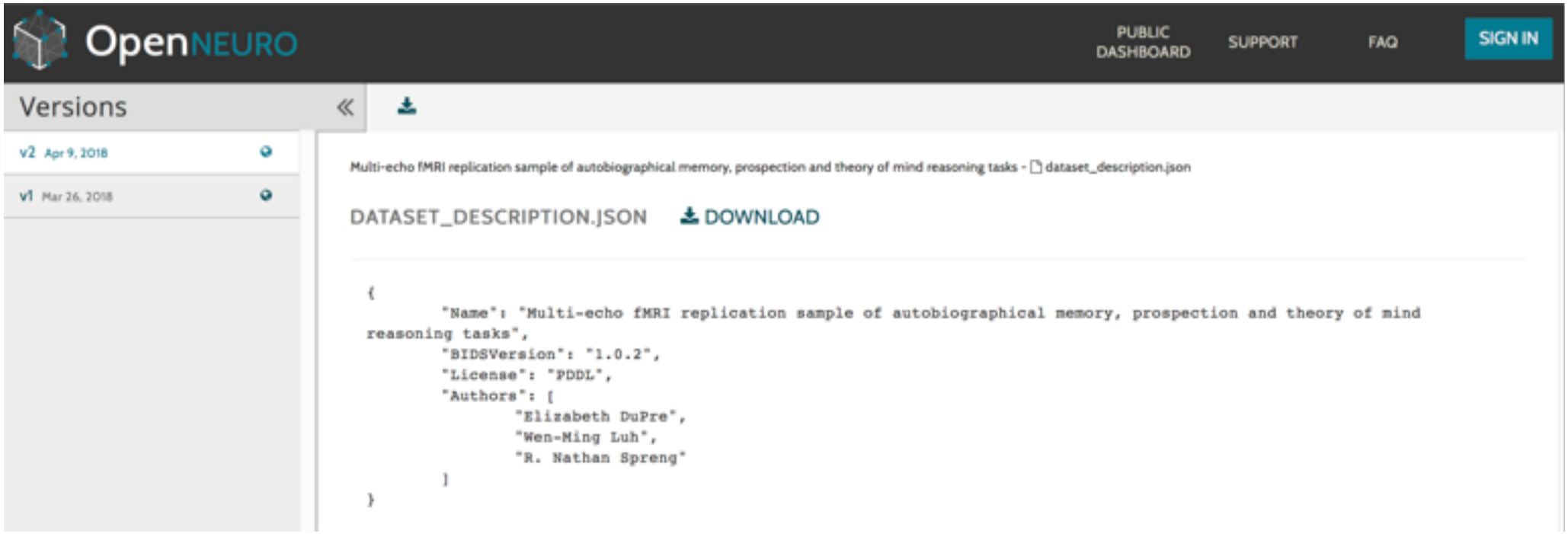
BIDS Validation

Valid 2 WARNINGS

Dataset File Tree

- dataset_description.json
  DOWNLOAD VIEW
- participants.tsv
  DOWNLOAD VIEW
- README
  DOWNLOAD VIEW
- T1w.json
  DOWNLOAD VIEW
- task-cuedSGT_echo-1_bold.json
  DOWNLOAD VIEW
- task-cuedSGT_echo-2_bold.json
  DOWNLOAD VIEW
- task-cuedSGT_echo-3_bold.json
  DOWNLOAD VIEW
- task-rest_echo-1_bold.json
  DOWNLOAD VIEW
- task-rest_echo-2_bold.json
  DOWNLOAD VIEW
- task-rest_echo-3_bold.json
  DOWNLOAD VIEW
- sub-01
- sub-02
- sub-03
- sub-04

Dataset_Description.json



BIDS Specifications

7 Directory structure

Overall directories hierarchy is

- `sub-<participant_label>[/ses-<session_label>]/<data_type>/`
- `[code/]`
- `[derivatives/]`
- `[stimuli/]`
- `[sourcedata/]`

where [] depicts OPTIONAL content (the same nomenclature is used throughout the spec). Session level is OPTIONAL, first we detail single session example. See below (section 9) for an example with multiple sessions.

7.1 Single session example

This is an example of the folder and file structure. Because there is only one session, the session level is not required by the format. For details on individual files see descriptions in the next section:

- **`sub-control01`**
  - **`anat`**
    - `sub-control01_T1w.nii.gz`
    - `sub-control01_T1w.json`
    - `sub-control01_T2w.nii.gz`
    - `sub-control01_T2w.json`

http://bids.neuroimaging.io/bids_spec.pdf

BIDS Specifications

8.1.1 dataset_description.json

The file `dataset_description.json` is a JSON file describing the dataset. Every dataset MUST include this file with the following fields:

`Name`	REQUIRED. Name of the dataset.
`BIDSVersion`	REQUIRED. The version of the BIDS standard that was used.
`License`	RECOMMENDED. What license is this dataset distributed under? The use of license name abbreviations is suggested for specifying a license. A list of common licenses with suggested abbreviations can be found in Appendix II.
`Authors`	OPTIONAL. List of individuals who contributed to the creation/curation of the dataset.
`Acknowledgements`	OPTIONAL. List of individuals who contributed to the creation/curation of the dataset.
`HowToAcknowledge`	OPTIONAL. Instructions how researchers using this dataset should acknowledge the original authors. This field can also be used to define a publication that should be cited in publications that use the dataset.

BIDS Specifications

Example:

```
{
    "Name": "The mother of all experiments",
    "BIDSVersion":  "1.0.1",
    "License": "CC0",
    "Authors": ["Paul Broca", "Carl Wernicke"],
    "Acknowledgements": "Special thanks to Korbinian Brodmann for help in formatting this
dataset in BIDS. We thank Alan Lloyd Hodgkin and Andrew Huxley for helpful comments and
discussions about the experiment and manuscript; Hermann Ludwig Helmholtz for
administrative support; and Claudius Galenus for providing data for the medial-to-lateral
index analysis.",
    "HowToAcknowledge": "Please cite this paper:
https://www.ncbi.nlm.nih.gov/pubmed/001012092119281",
    "Funding": ["National Institute of Neuroscience Grant F378236MFH1", "National
Institute of Neuroscience Grant 5RMZ0023106"],
    "ReferencesAndLinks": ["https://www.ncbi.nlm.nih.gov/pubmed/001012092119281",
"Alzheimer A., & Kraepelin, E. (2015). Neural correlates of presenile dementia in humans.
Journal of Neuroscientific Data, 2, 234001. http://doi.org/1920.8/jndata.2015.7"],
    "DatasetDOI": "10.0.2.3/dfjj.10"
}
```

http://bids.neuroimaging.io/bids_spec.pdf

Exercise #1
Basic BIDS

Basic BIDS Data

Step 1: Setup work folder

```
vagrant@nitricce:~$ mkdir section1
vagrant@nitricce:~$ cd section1
```

Step 2: Copy anatomical images

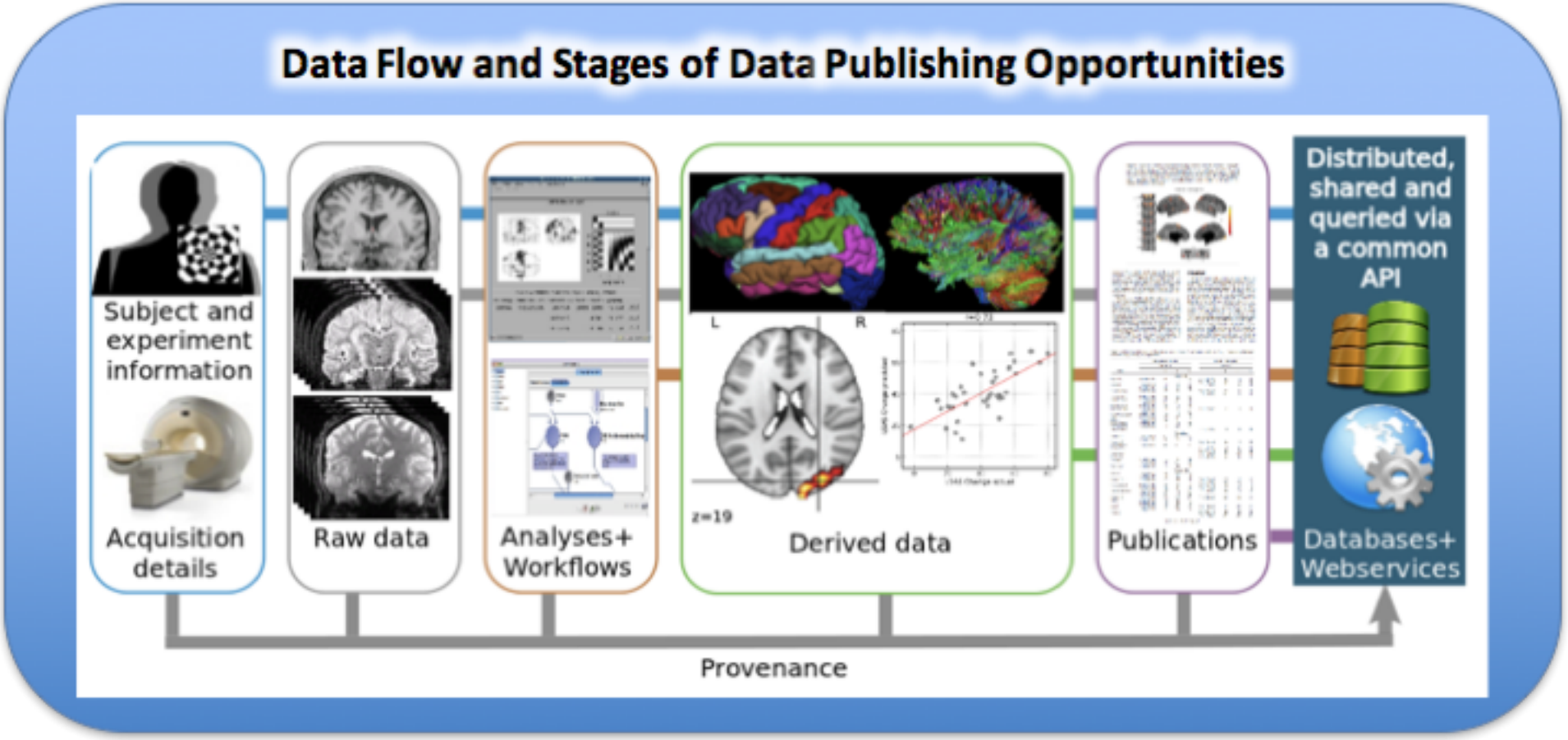
```
vagrant@nitricce:~$ cp ~/workspace/Indiv_Diffs_ReadingSkill/sub-0?/anat/* .
vagrant@nitricce:~$ mkdir Repro_BIDS
```

Step 3: Create a structured BIDS dataset

Section 3

FAIR Metadata and CDEs

General Neuroimaging Workflow



Metadata Descriptions

BIDS Specifications

8.9 Participant file

Template:

(single session case)

`participants.tsv`

`participants.json`

`phenotype/<measurement_tool_name>.tsv`

`phenotype/<measurement_tool_name>.json`

Optional: Yes

The purpose of this file is to describe properties of participants such as age, handedness, sex, etc. In case of single session studies this file has one compulsory column `participant_id` that consists of `sub-<participant_label>`, followed by a list of optional columns describing participants. Each participant needs to be described by one and only one row.

8.9.1 participants.tsv example:

participant_id	age	sex	group
sub-control01	34	M	control
sub-control02	12	F	control
sub-patient01	33	F	patient

http://bids.neuroimaging.io/bids_spec.pdf

Exercise #2
BIDS Participants.tsv

Basic BIDS Data

Step 1: Setup work folder

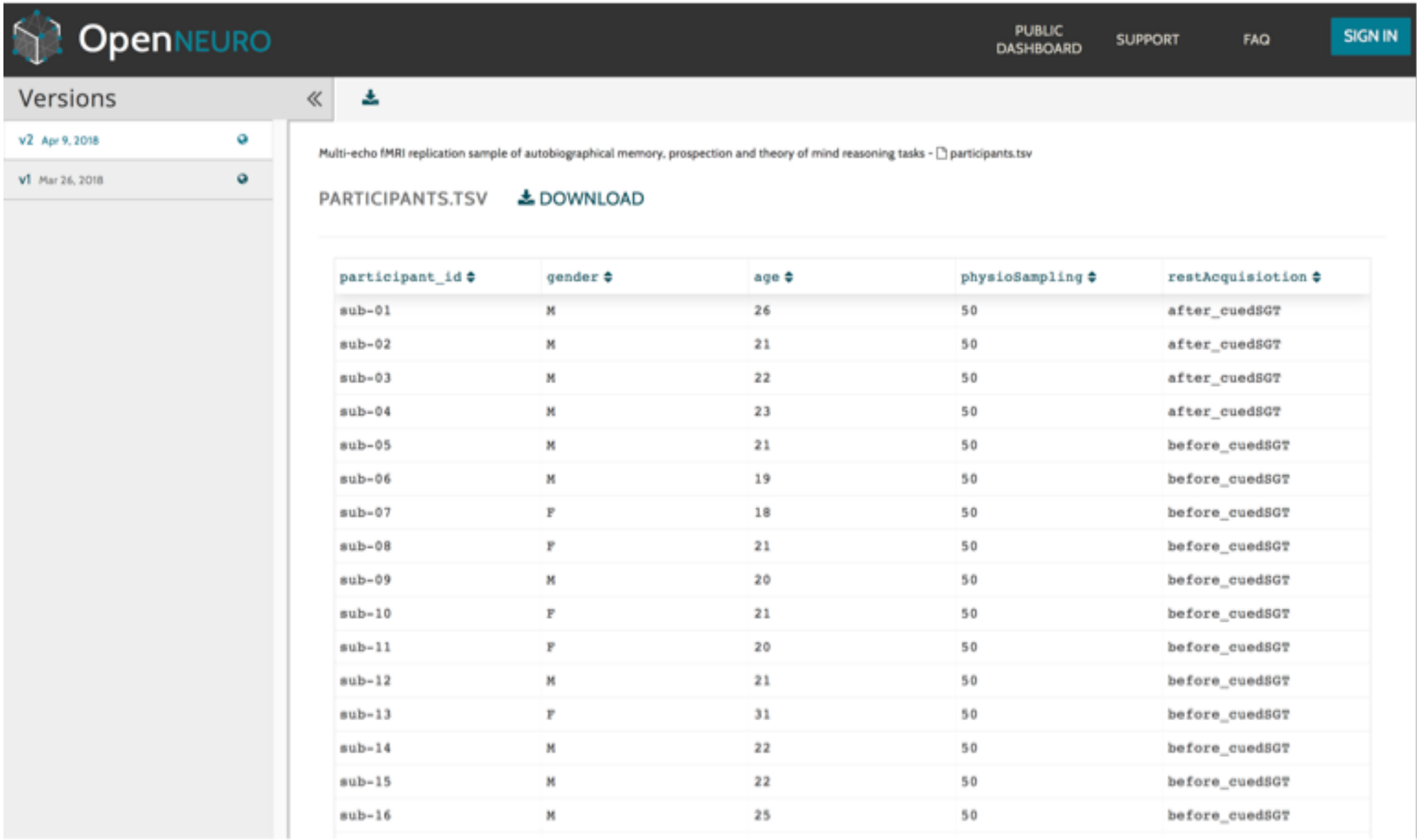
```
vagrant@nitricce:~$ cd ~/section1
```

Step 2: Create a participants.tsv file

Step 3: Validate your BIDS dataset

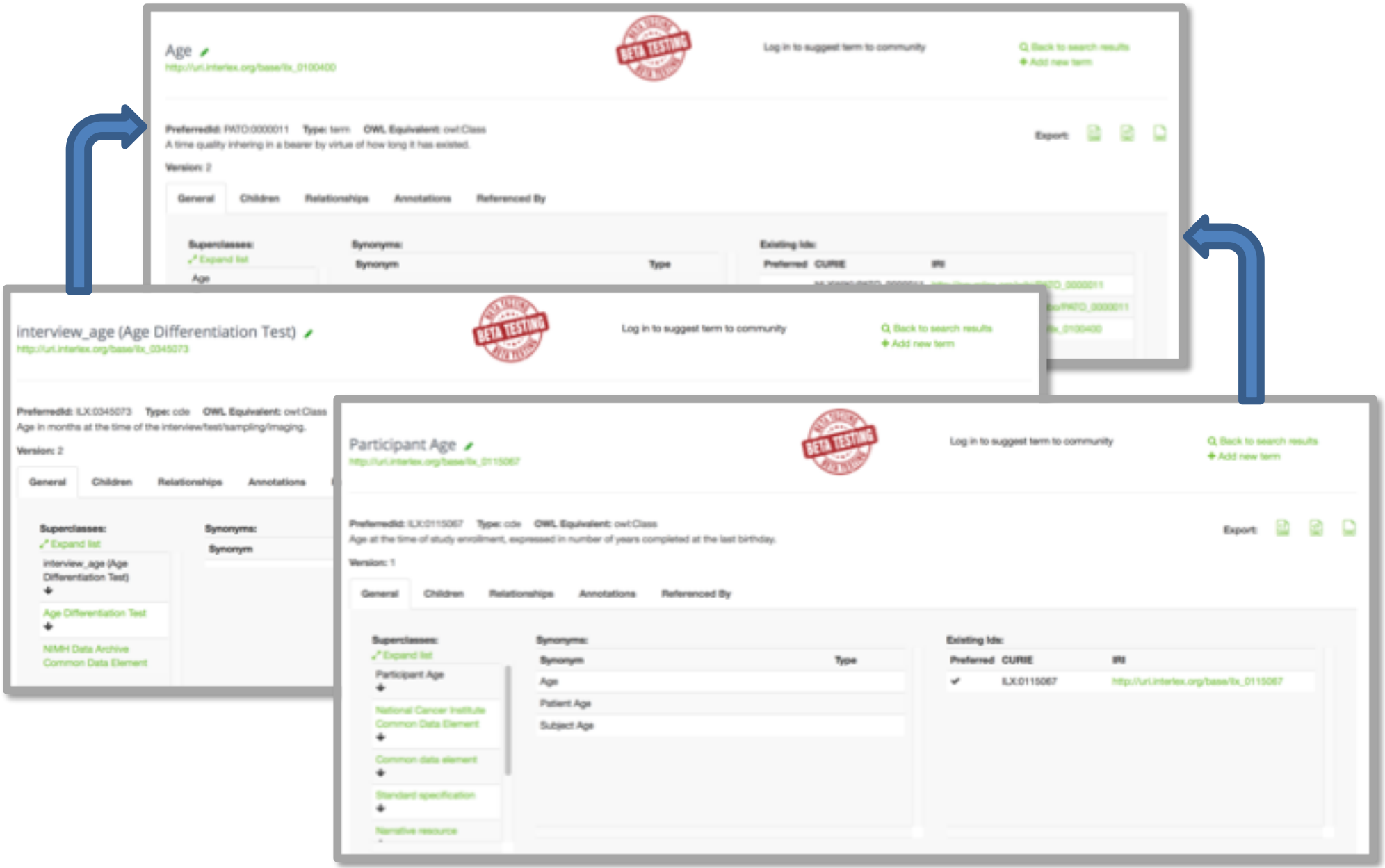
https://github.com/INCF/bids-validator

Participants.tsv

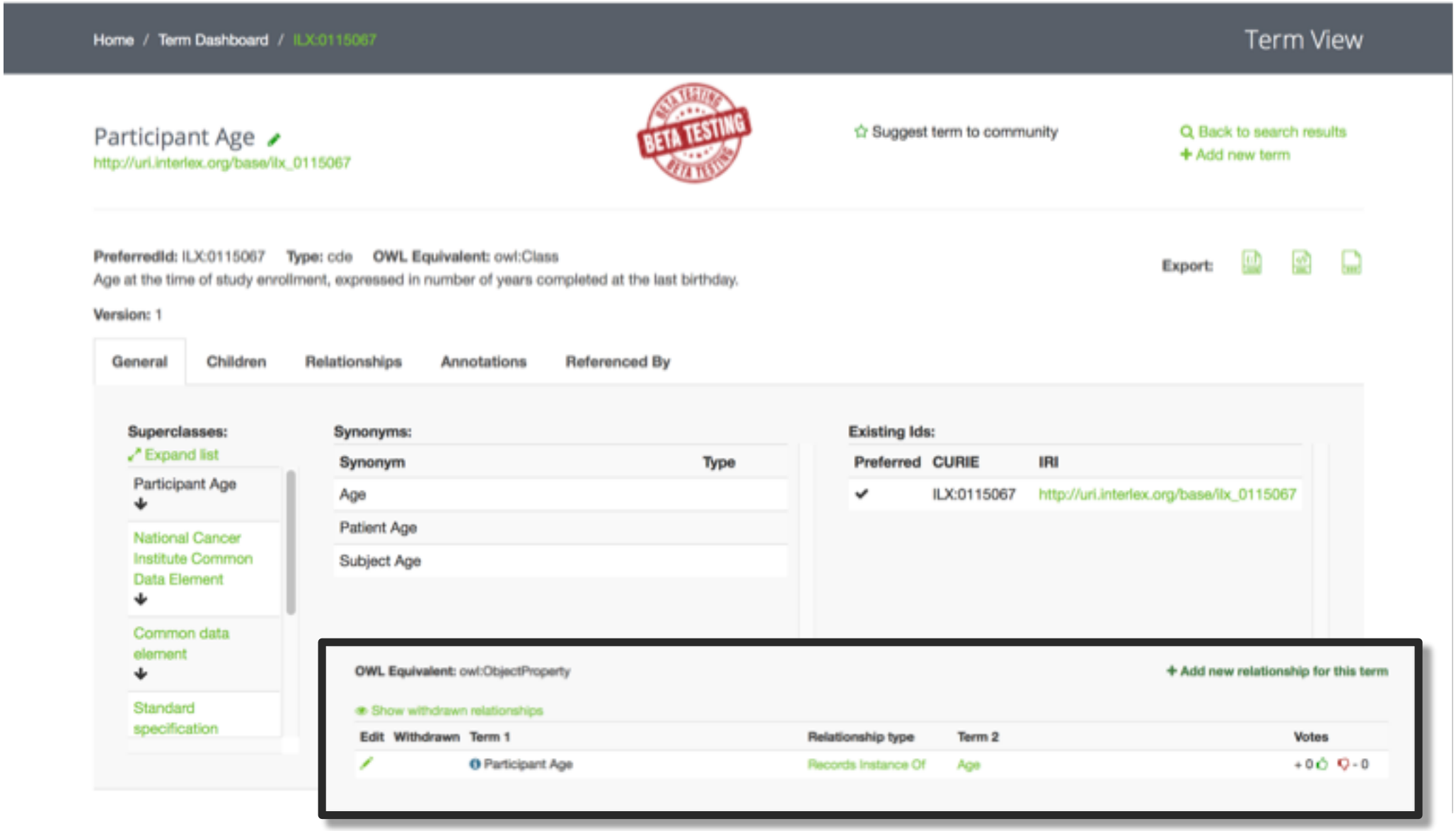


participant_id	gender	age	physioSampling	restAcquisiotion
sub-01	M	26	50	after_cuedSGT
sub-02	M	21	50	after_cuedSGT
sub-03	M	22	50	after_cuedSGT
sub-04	M	23	50	after_cuedSGT
sub-05	M	21	50	before_cuedSGT
sub-06	M	19	50	before_cuedSGT
sub-07	F	18	50	before_cuedSGT
sub-08	F	21	50	before_cuedSGT
sub-09	M	20	50	before_cuedSGT
sub-10	F	21	50	before_cuedSGT
sub-11	F	20	50	before_cuedSGT
sub-12	M	21	50	before_cuedSGT
sub-13	F	31	50	before_cuedSGT
sub-14	M	22	50	before_cuedSGT
sub-15	M	22	50	before_cuedSGT
sub-16	M	25	50	before_cuedSGT

Terms versus Common Data Elements

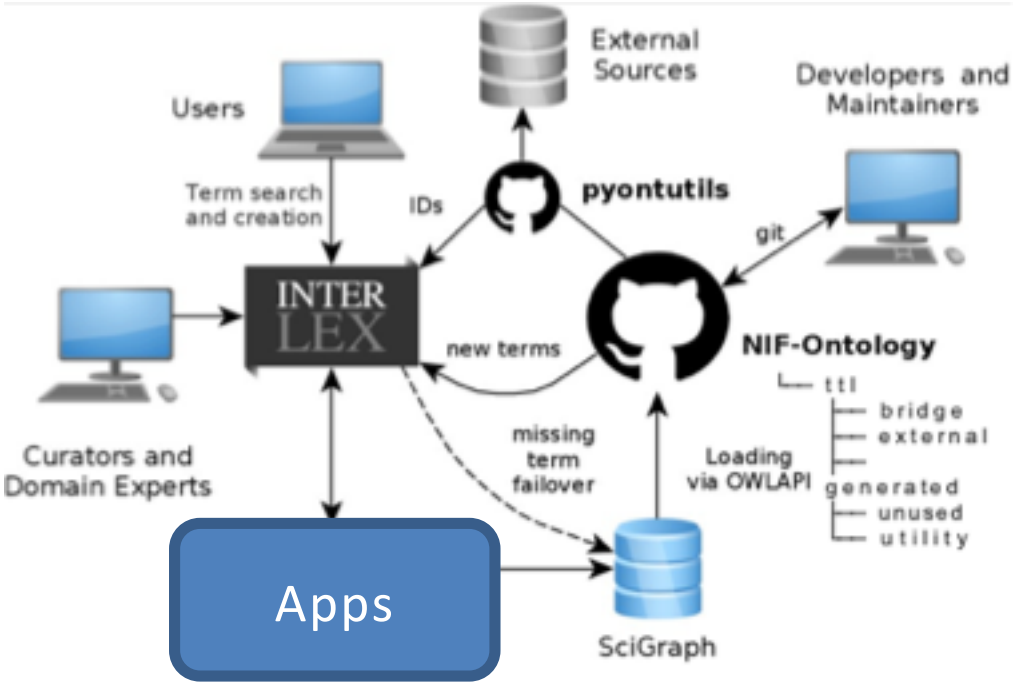


Common Data Elements



InterLex
Community Managed Terminologies

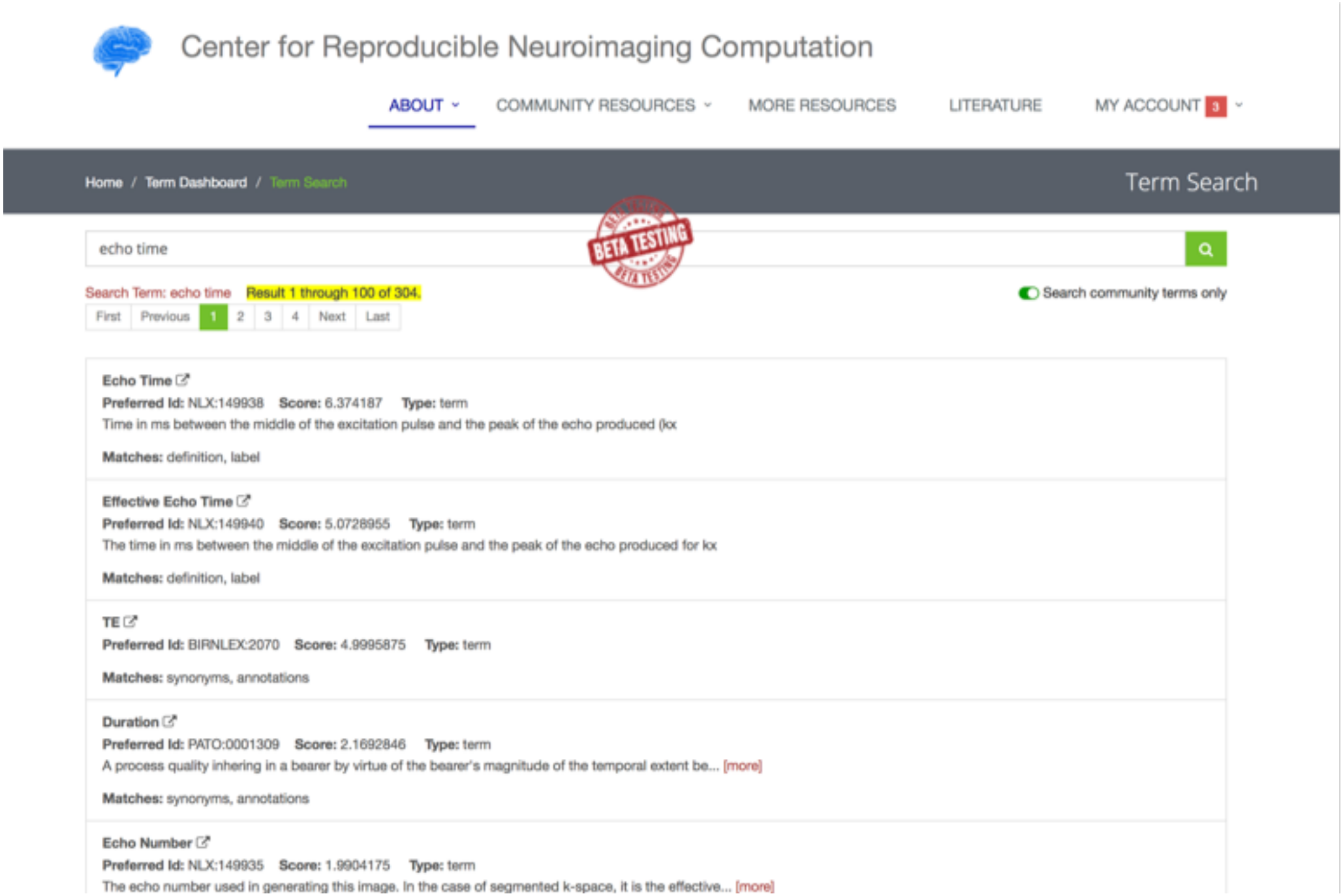
- Dynamic lexicon of biomedical terms
- Constructed to help improve the way scientists communicate about their data
- Provide more powerful means of integrating data across distributed resources.
- InterLex allows for the association of data values (i.e. the value of a field or text within a field) to terminologies enabling the crowdsourcing of data-terminology mappings within and across communities.



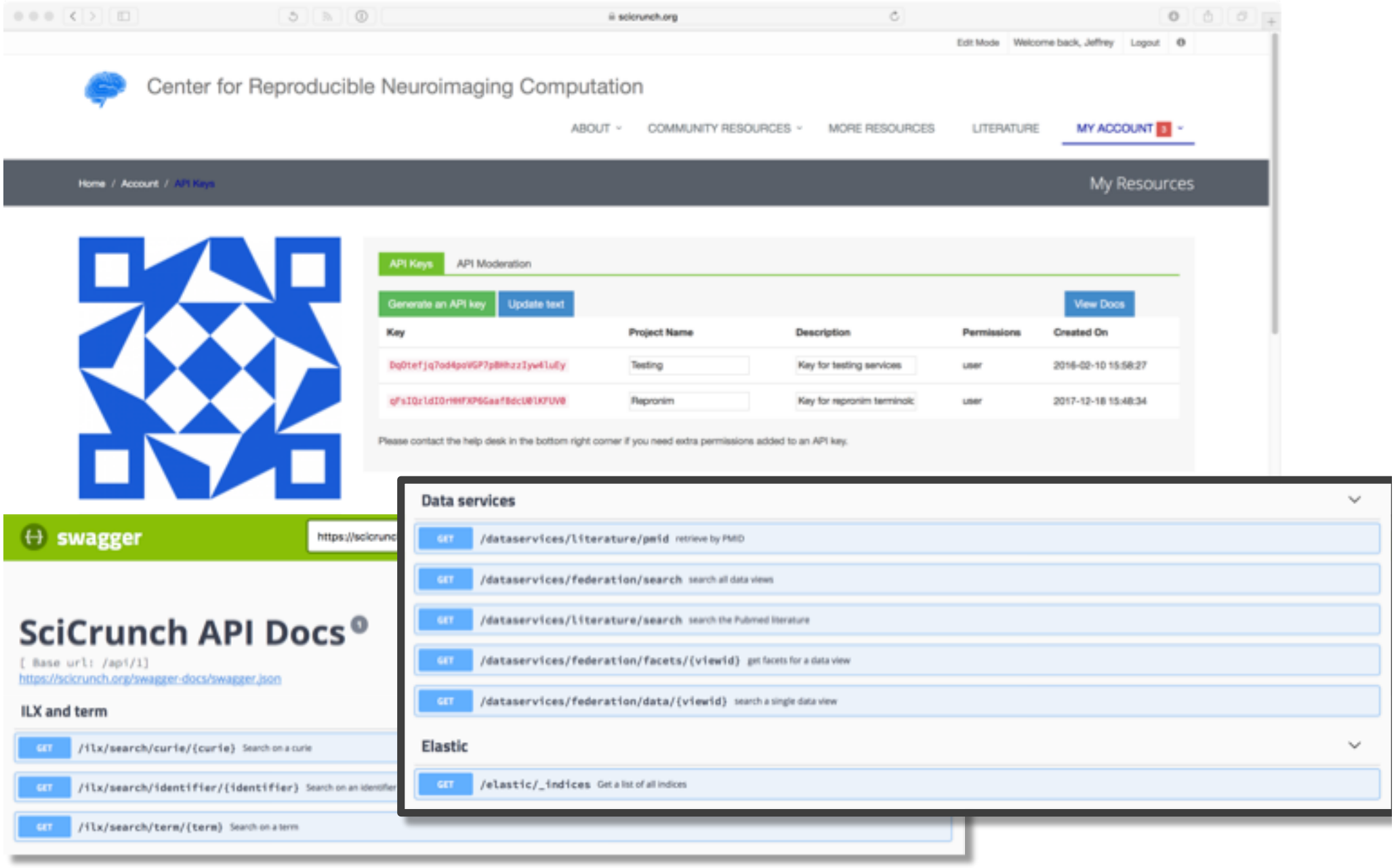
Built on the foundation of NeuroLex

https://interlex.org

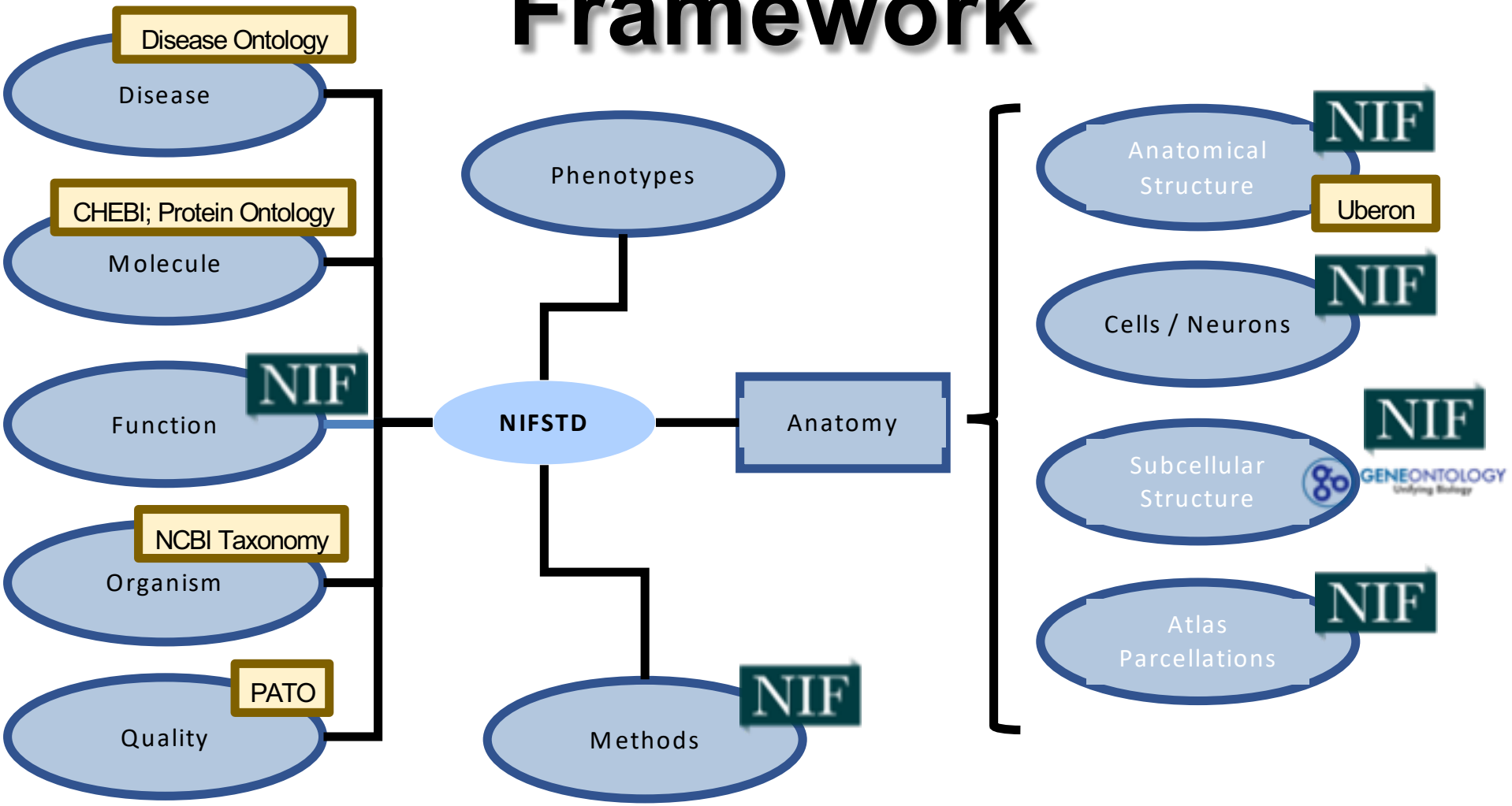
Term Search


Center for Reproducible Neuroimaging Computation
ABOUT
COMMUNITY RESOURCES
MORE RESOURCES
LITERATURE
MY ACCOUNT 3
Home / Term Dashboard / Term Search
Term Search
BETA TESTING
echo time
Search Term: echo time
Result 1 through 100 of 304.
Search community terms only
First Previous 1 2 3 4 Next Last
Echo Time
Preferred Id: NLX:149938 Score: 6.374187 Type: term
Time in ms between the middle of the excitation pulse and the peak of the echo produced (kx
Matches: definition, label
Effective Echo Time
Preferred Id: NLX:149940 Score: 5.0728955 Type: term
The time in ms between the middle of the excitation pulse and the peak of the echo produced for kx
Matches: definition, label
TE
Preferred Id: BIRNLEX:2070 Score: 4.9995875 Type: term
Matches: synonyms, annotations
Duration
Preferred Id: PATO:0001309 Score: 2.1692846 Type: term
A process quality inhering in a bearer by virtue of the bearer's magnitude of the temporal extent be... [more]
Matches: synonyms, annotations
Echo Number
Preferred Id: NLX:149935 Score: 1.9904175 Type: term
The echo number used in generating this image. In the case of segmented k-space, it is the effective... [more]

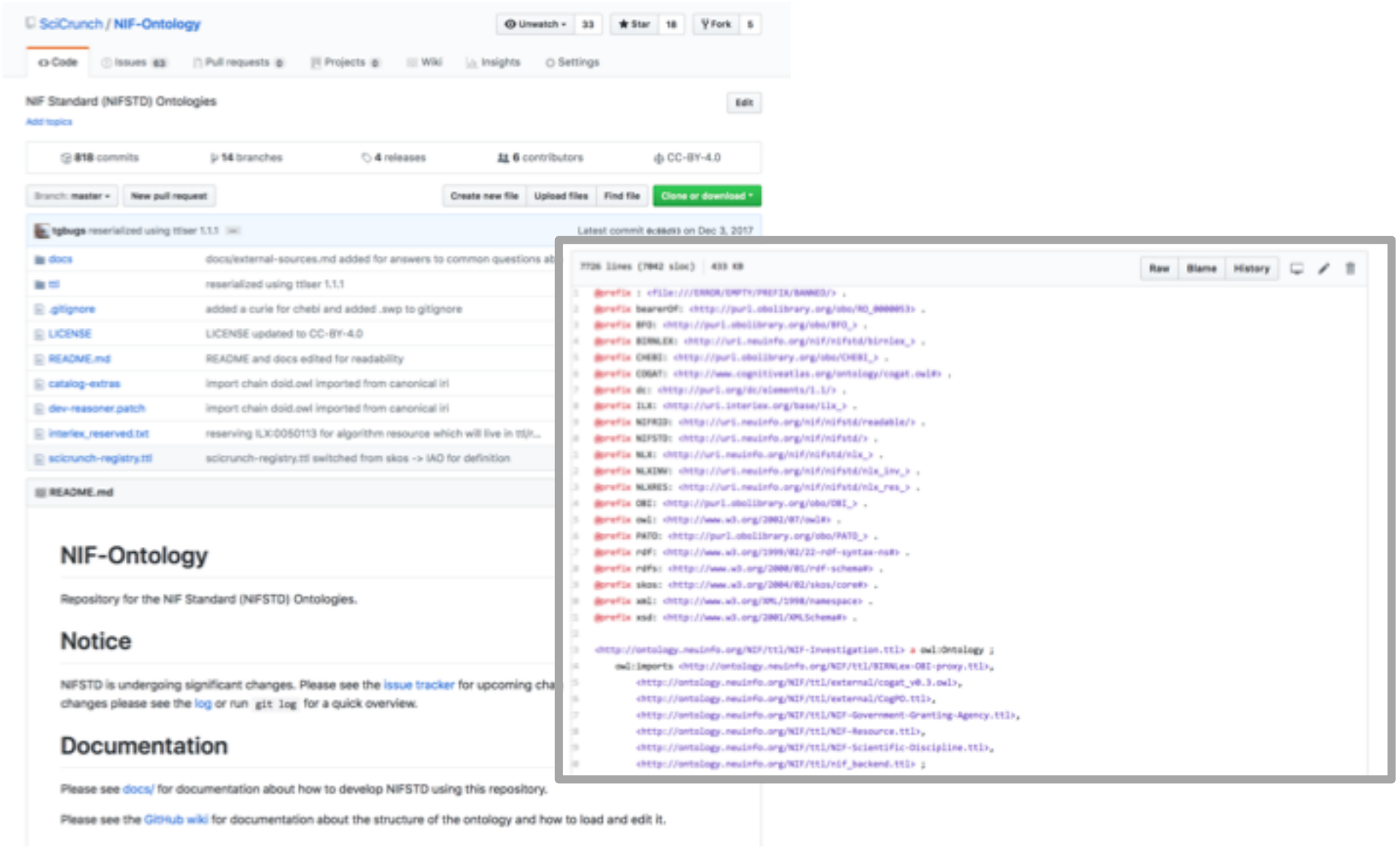
Access to Services



The NIF Ontologies and Semantic Framework

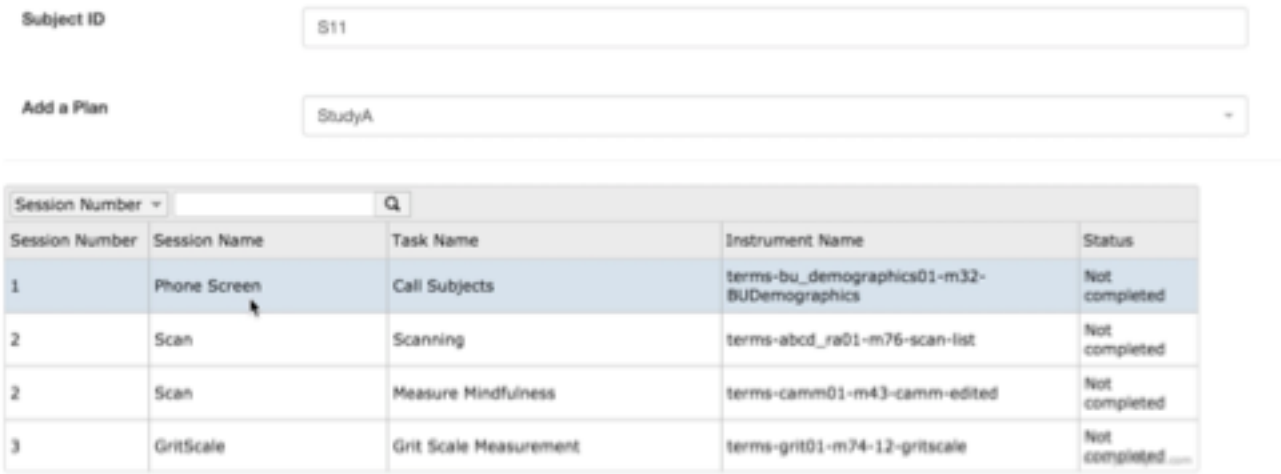


Github Management of Ontology



BrainVerse

- An **electronic laboratory notebook** built as a cross platform desktop application
- Enables users to **plan experiments, collect, analyze and reuse data, and collaborate**
- **Adds semantic annotation to data** with relevant metadata based on NeuroImaging data Model (NIDM) making experimental neuroimaging study more ***reproducible***, and making data ***FAIR***
- Addresses the limitations of existing Electronic Data Capture systems, such as REDCap and OpenClinica
  - Lack of semantic annotation, do not use underlying graph model, limited query capabilities, do not integrate with other desktop applications, integration and management of specific data types.

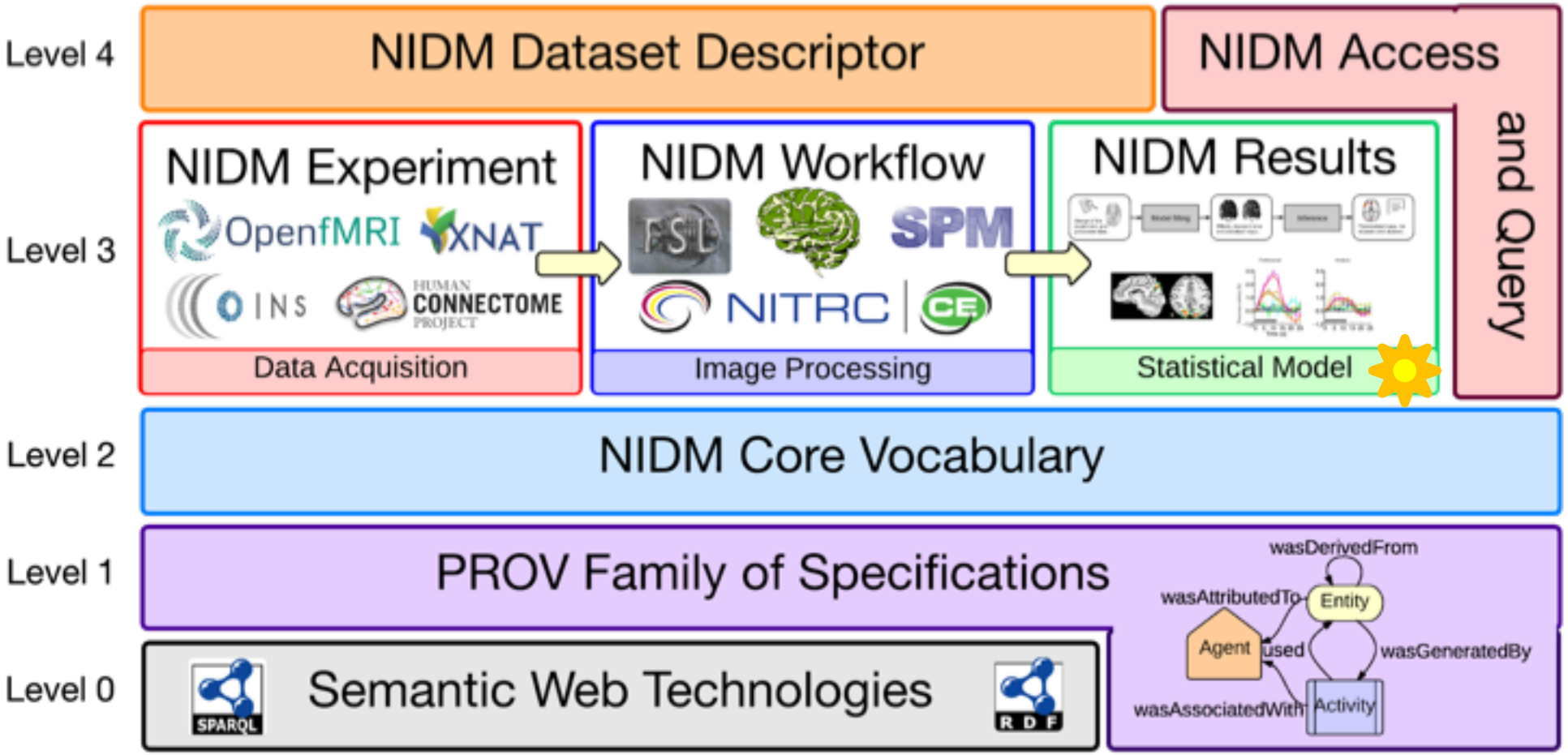


https://github.com/ReproNim/brainverse

Section 4

Re-Usable Data and NIDM

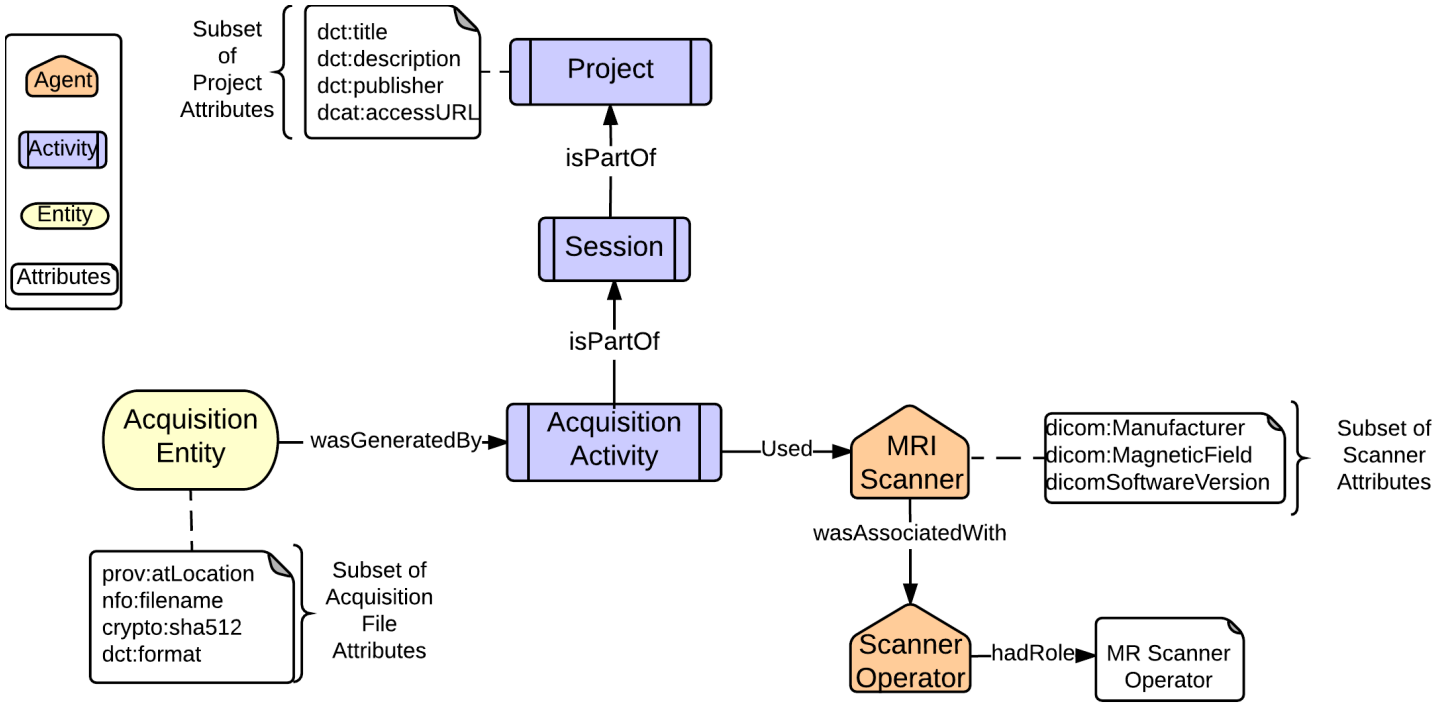
Neuroimaging Data Model



http://nidm.nidash.org/

NIDM Experiment

- Representation of the experiment design, source data descriptions, and information on the participants and acquisition information.
- Metadata stored using simple Project->Session->Acquisition hierarchy
- Based on W3C Linked Data (www.w3.org/RDF/) and PROV (www.w3.org/TR/prov-overview/) models.
- Metadata described using subject-predicate-object tuples.
- Tuples composed of namespace:term where “namespace” is web-accessible ontology/terminology containing the precise, unambiguous definition of the “term”.



PyNIDM

build passing

A Python library to manipulate the Neuro Imaging Data Model.

Dependencies

- graphviz (native package):
  - Fedora: `dnf install graphviz`
  - OS-X: `brew install graphviz`

creating a conda environment and installing the library (tested with OSX)

- `conda create -n pynidm_py3 python=3 pytest graphviz -y`
- `source activate pynidm_py3`
- `cd PyNIDM`
- `pip install -e .`
- you can try to run a test: `pytest`

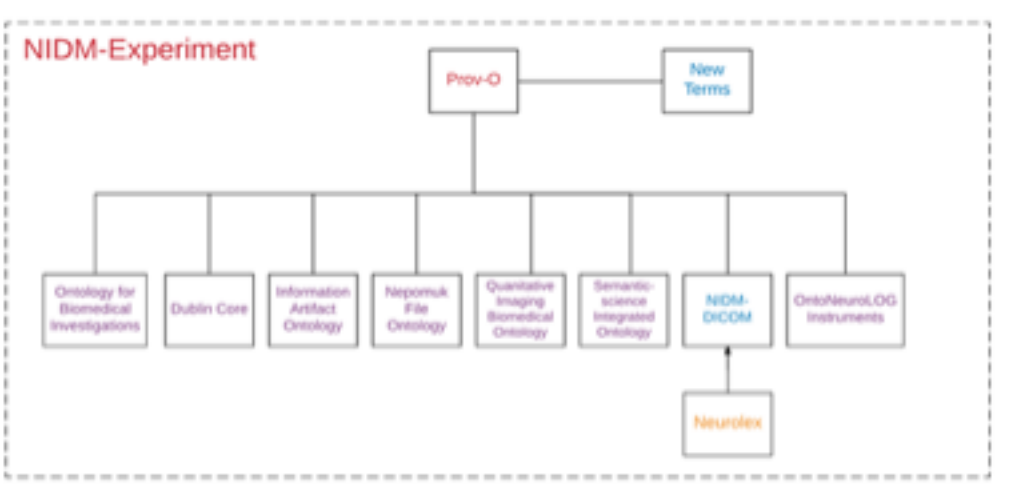
NIDM Experiment Tools

BIDSMRI2NIDM.py

- **Location:** PyNIDM/nidm/experiment/tools/BIDSMRI2NIDM.py
- **Description:** This tool will convert a BIDS MRI directory tree to a NIDM-Experiment document. Currently does not properly handle arbitrary Phenotype files. Will encode in NIDM document but namespace set to BIDS (http://bids.neuroimaging.io/) and term to simply variable name from phenotype file which won't de-reference....work in progress....

PyNIDM – API + Terminology

- Python-based API (github.com/incf-nidash/PyNIDM) following the simple organizational structure of NIDM-Experiment documents.
  - Functions to create, query, export, import, and transform NIDM-Experiment documents.



- NIDM Terminology / Ontology
  - NIDM ontology reuses existing terms from several other where appropriate definitions exist.
  - NIDM-Experiment ontology: github.com/incf-nidash/nidm/tree/master/nidm/nidm-experiment/terms
  - DICOM-tag ontology: github.com/incf-nidash/dicom-ontology

PyNIDM Terminology Alignment

```
#BIDS Participants file -> NIDM constants
mappingsparticipants = {    "participant_id" :
Constants.NIDM_SUBJECTID,    "sex" :
Constants.NIDM_GENDER,    "age" :
Constants.NIDM_AGE,    "gender" :
Constants.NIDM_GENDER,    "diagnosis" :
Constants.NIDM_DIAGNOSIS}
```

```
NIDM_SUBJECTID =
QualifiedName(provNamespace("ndar",NDAR),
"src_subject_id")

nidm:_88f65012-e44b-11e7-b9e2-6c4008b8f03e a
prov:Agent,
        prov:Person ;
ndar:src_subject_id "sub-10159"^^xsd:string .
```

```
DICOM =
Namespace("http://neurolex.org/wiki
/Category:DICOM_term/")

nidm:_88f8dcec-e44b-11e7-8ba0-
6c4008b8f03e a sio:file,
        prov:Entity ;
dicom:EchoTime 3.31e-03 ;
```

```
json_keys = {    ##Image terms    "run" :
Constants.NIDM_ACQUISITION_ENTITY,    "ImageType" :
Constants.DICOM["ImageType"],
"ManufacturerModelName" :
Constants.DICOM["ScanningSequence"],
"SequenceVariant" : Constants.DICOM["SequenceVariant"],
"ScanOptions" : Constants.DICOM["ScanOptions"],
"MRAcquisitionType" :
Constants.DICOM["MRAcquisitionType"],
"SequenceName" : Constants.DICOM["SequenceName"],
"RepetitionTime" : Constants.DICOM["RepetitionTime"],
"EchoTime" : Constants.DICOM["EchoTime"],
```

What is Linked Data?

"The term Linked Data is used to describe a *method* of exposing, sharing, and connecting data via dereferenceable URIs on the Web." – Wikipedia

Linked Data is a protocol component of the Semantic Web, using URIs, Real World Objects, Content Negotiation and RDF documents to share information on the web.

The Semantic Web

- “The semantic web is a vision of information that is understandable by computers, so computers can perform more of the tedious work involved in finding, combining, and acting upon information on the web.” – Wikipedia

- “I have a dream for the Web [in which computers] become capable of analyzing all the data on the Web – the content, links, and transactions between people and computers.”

– Tim Berners-Lee

Linked Data Principles

1. Use URIs as names for things
2. Use HTTP URIs so that people can look up (dereference) those names.
3. When someone looks up a URI, provide useful information.
4. Include links to other URIs so that they can discover more things.

"The Semantic Web isn't just about putting data on the web. It is about making links, so that a person or machine can explore the web of data. With linked data, when you have some of it, you can find other, related, data.Like the web of hypertext, the web of data is constructed with documents on the web.

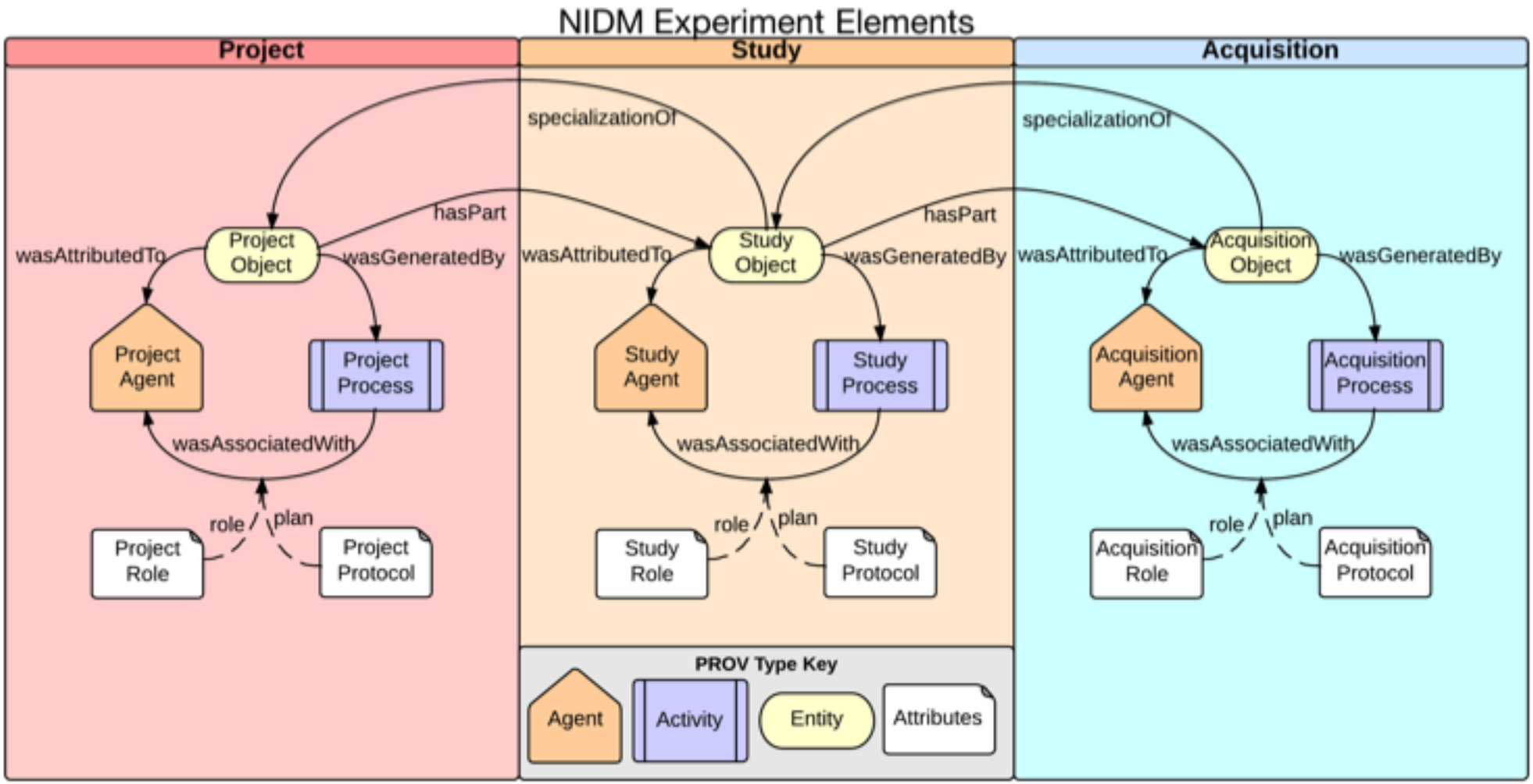
However, unlike the web of hypertext, where links are relationships anchors in hypertext documents written in HTML, for data they links between arbitrary things described by RDF,. The URIs identify any kind of object or concept. But for HTML or RDF, the same expectations apply to make the web grow."

Tim Berners-Lee
http://www.w3.org/DesignIssues/LinkedData.html

Resource Description Framework (RDF)

- A data model
  - A way to model data
  - i.e. Relational databases use relational data model
- RDF is a triple data model
- Labeled Graph
- Subject, Predicate, Object
- <Cerebellum> <is part of> <Hind Brain>

NIDM Graph Model



NIDM Resources

NIDM Overview

http://nidm.nidash.org/specs/nidm-overview.html

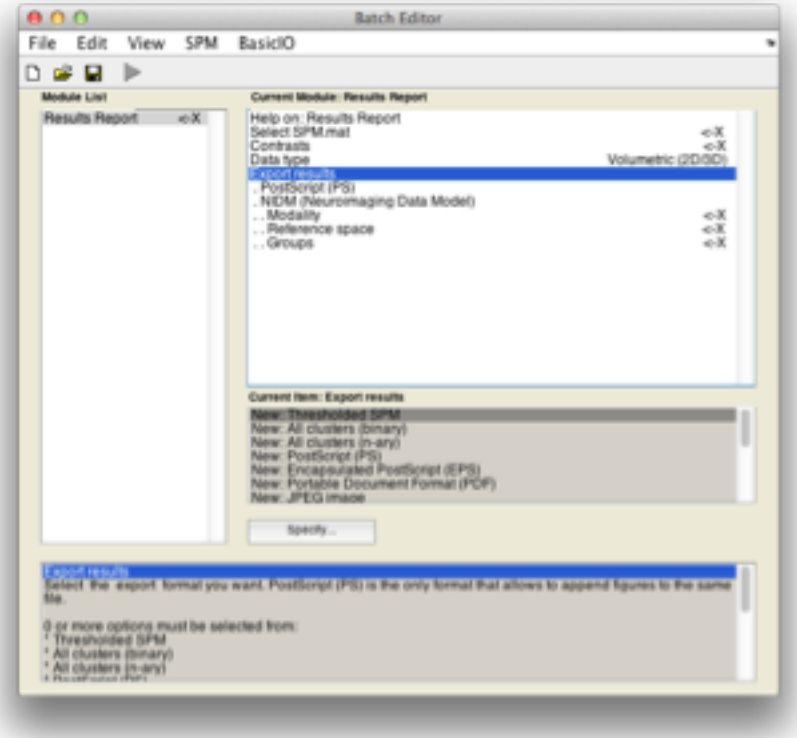
NIDM Primer

http://nidm.nidash.org/specs/nidm-primer.html

Getting Started with NIDM-Results

http://nidm.nidash.org/getting-started/

NIDM Results



SCIENTIFIC DATA

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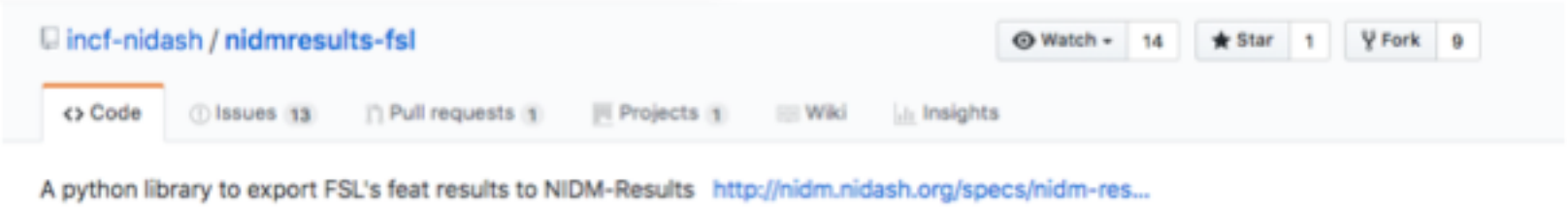


Exercise #3
BIDS to NIDM

Setup PyNIDM Environment

Step 1: Setup Conda environment

```
vagrant@nitricce:~$ cd ~
vagrant@nitricce:~$ source activate section1
```

Step 2: Convert BIDS to NIDM

```
vagrant@nitricce:~$ cd ~/section1/Repro_BIDS/
vagrant@nitricce:~$ ~/PyNIDM/bin/BIDSMRI2NIDM.py -d
~/section1/Repro_BIDS
```

Step 3: Review nidm.ttl file

NIDM.TTL

reprotraining_2018JUN16 [Running]

Terminal

vagrant@nitrcce: ~

```
    ncicb:Age "0.556"^^xsd:string ;
    prov:wasGeneratedBy nidm:_61ee85c6-717f-11e8-b46b-0800277be888 .

nidm:_61ee85cb-717f-11e8-b46b-0800277be888 a onli:assessment-instrument,
        nidm:AcquisitionObject,
        prov:Entity ;
    bids:ctopp.pa.comp "1.198531065"^^xsd:string ;
    bids:ctopp.rln.raw "-1.104109688"^^xsd:string ;
    bids:mcdecode "1.514966059"^^xsd:string ;
    bids:mcpassfluency "1.680192391"^^xsd:string ;
    bids:mrt "1.358940694"^^xsd:string ;
    bids:piat.l.raw "0.766663412"^^xsd:string ;
    bids:piat.r.raw "1.07060038"^^xsd:string ;
    bids:ppvt.raw "1.303491936"^^xsd:string ;
    bids:sspan2.raw "1.876107955"^^xsd:string ;
    bids:wasi.matr.raw "1.413554228"^^xsd:string ;
    ncicb:Age "1.416"^^xsd:string ;
    prov:wasGeneratedBy nidm:_61ee85ca-717f-11e8-b46b-0800277be888 .

nidm:_61ee85ce-717f-11e8-b46b-0800277be888 a nidm:AcquisitionObject,
        prov:Entity ;
    nidm:AcquisitionModality nidm:MagneticResonanceImaging ;
    nidm:hasImageContrastType nidm:T1Weighted ;
    nidm:hasImageUsageType nidm:Anatomical ;
    nfo:filename "/sub-01/anat/sub-01_T1w.nii.gz"^^xsd:string ;
    prov:wasGeneratedBy nidm:_61ee85cd-717f-11e8-b46b-0800277be888 .

nidm:_61ee85d0-717f-11e8-b46b-0800277be888 a nidm:AcquisitionObject,
        prov:Entity ;
    nidm:AcquisitionModality nidm:MagneticResonanceImaging ;
    nidm:hasImageContrastType nidm:T1Weighted ;
    nidm:hasImageUsageType nidm:Anatomical ;
```

Exercise #4
SPARQL Query

Basic BIDS Data

Step 1: Locate RDFLIB Qeury File

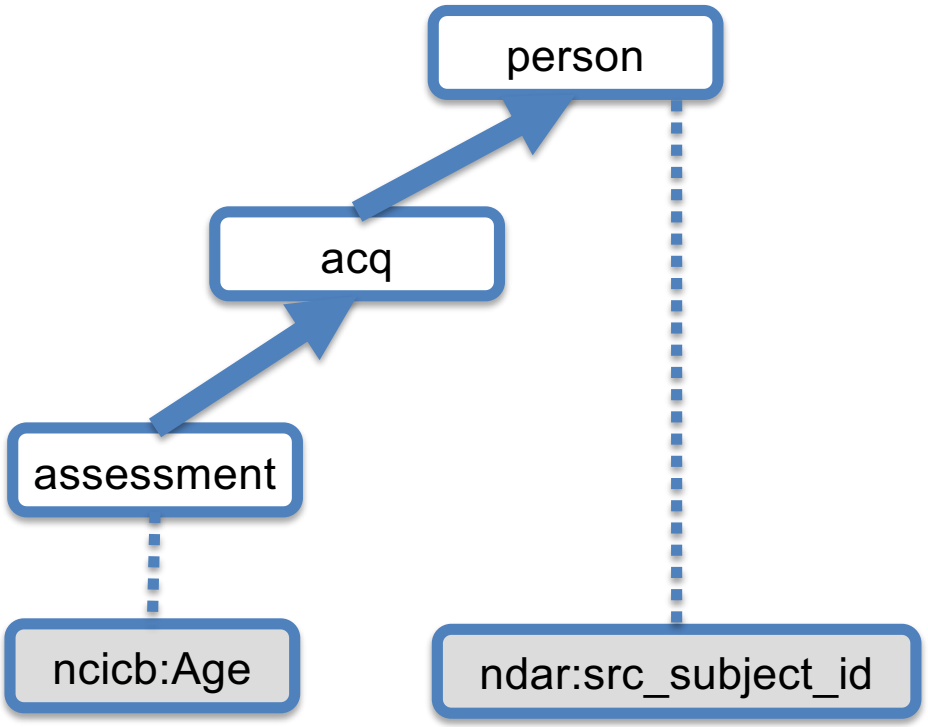
```
vagrant@nitricce:~$ cd ~/nidm-training
vagrant@nitricce:~$ ls
```

Step 2: Review rdf-age-query.py

```
vagrant@nitricce:~$ more rdf-age-query.py
```

RDFLIB SPARQL Query

```
import rdflib

from argparse import ArgumentParser

parser = ArgumentParser()
# parse command line arguments
parser.add_argument('-nidm', dest='nidm_file', required=True, help="NIDM-Exp RDF File to import")
args = parser.parse_args()


g=rdflib.Graph()
g.parse(args.nidm_file, format='ttl')

qres = g.query(
       """SELECT DISTINCT ?id ?age ?assessment
              WHERE {
                  ?assessment prov:wasGeneratedBy ?acq .
                  ?acq prov:wasAssociatedWith ?person .
                  ?assessment ncicb:Age ?age .
                  ?person ndar:src_subject_id ?id
              }""")


for row in qres:
       print("%s - %s - %s" % row)
```



Run SPARQL Query

Step 1: Locate RDFLIB Qeury File

```
vagrant@nitricce:~$ cd ~/nidm-training
vagrant@nitricce:~$ ls
```

Step 2: Run Query

```
vagrant@nitricce:~$ python rdf-age-query.py –nidm
~/section1/Repro_BIDS/nidm.ttl
```

Experiment:

FILTER (xsd:float(?age) >= 20)


شكراً جزيلاً
ngiyabonga
рахмат
danke
謝謝
teşekkür ederim
Баярлалаа
mersi
kia ora
barka
welalin
tack
spas
mahalo
tapadh leat
спасибо
faafetai lava
vinaka
спасибі
blagodaram
dank je
misaotra
matondo
paldies
grazzi
gracias
хвала
thank you
kiitos
dankie
nanni
nandri
dhanyavad
maururu
köszönöm
bedankt
hvala
bayarlalaa
gràçie
enkosi
akun
dankon
aciú
asante
manana
obrigada
tenki
djiere dieuf
tau
mochchakkeram
murakoze
дякую
mamnun
chokrane
dziękuję
chnorakaloutioun
gratias ago
gràcies
sulpáy
go raibh maith agat
sobodi
dēkuji
obrigado
sagolun
sukriya
kop khun krap
taiku
arigatô
takk
dakujem
trugarez
mèsi
didi madloba
najis tuke
ありがとう
tanemirt
grazie
rahmet
kam sah hamnida
rahmat
terima kasih
diolch
dhanyavadagalu
shukriya
mercé
мерси
তোমাকে ধন্যবাদ
감사합니다
xièxie
ευχαριστώ
merci