Towards reusable derived data in neuroimaging

Camille Maumet

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Submitted on 7 Dec 2023

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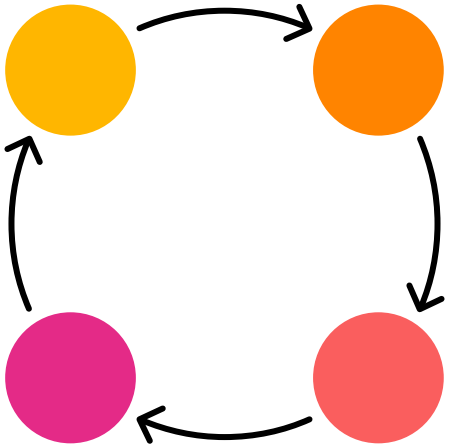
Session MRI data liberation: Sharing for a better future



Towards reusable derived data in neuroimaging

December 7, 2023

Camille Maumet

Inria, Univ Rennes, Inserm, CNRS, IRISA

FAIR neuroimaging

Findable **A**ccessible **I**nteroperable **R**eusable

Technical solutions: Standards, Databases, Good practices (version control, etc.)

Image credits: Community by Vkw.studiogood, Commons Wikimedia

FAIR neuroimaging

Findable **A**ccessible **I**nteroperable **R**eusable

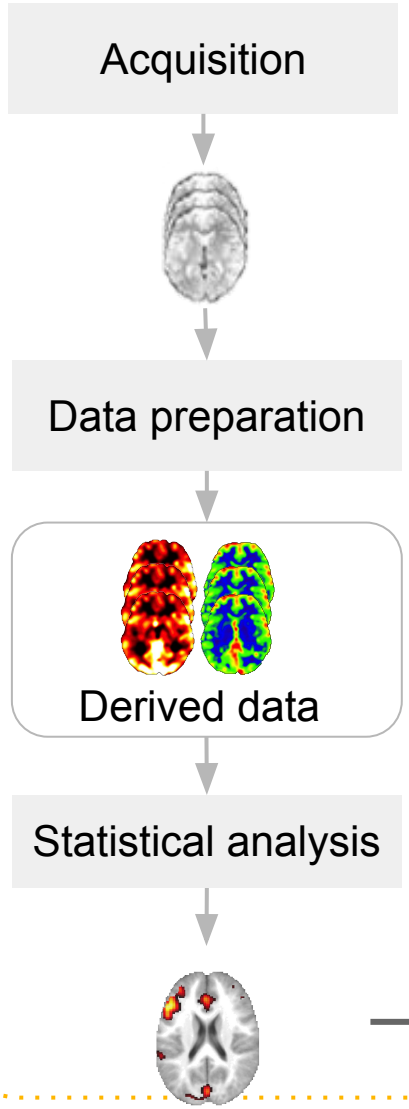
Technical solutions: Standards, Databases, Good practices (version control, etc.)

A culture change: towards community-driven research

- Making resources **available to the scientific community**
- **Reusing** existing resources (datasets, tools) that were created by others

Image credits: Community by Vkw.studiogood, Commons Wikimedia

Sharing FAIR research products



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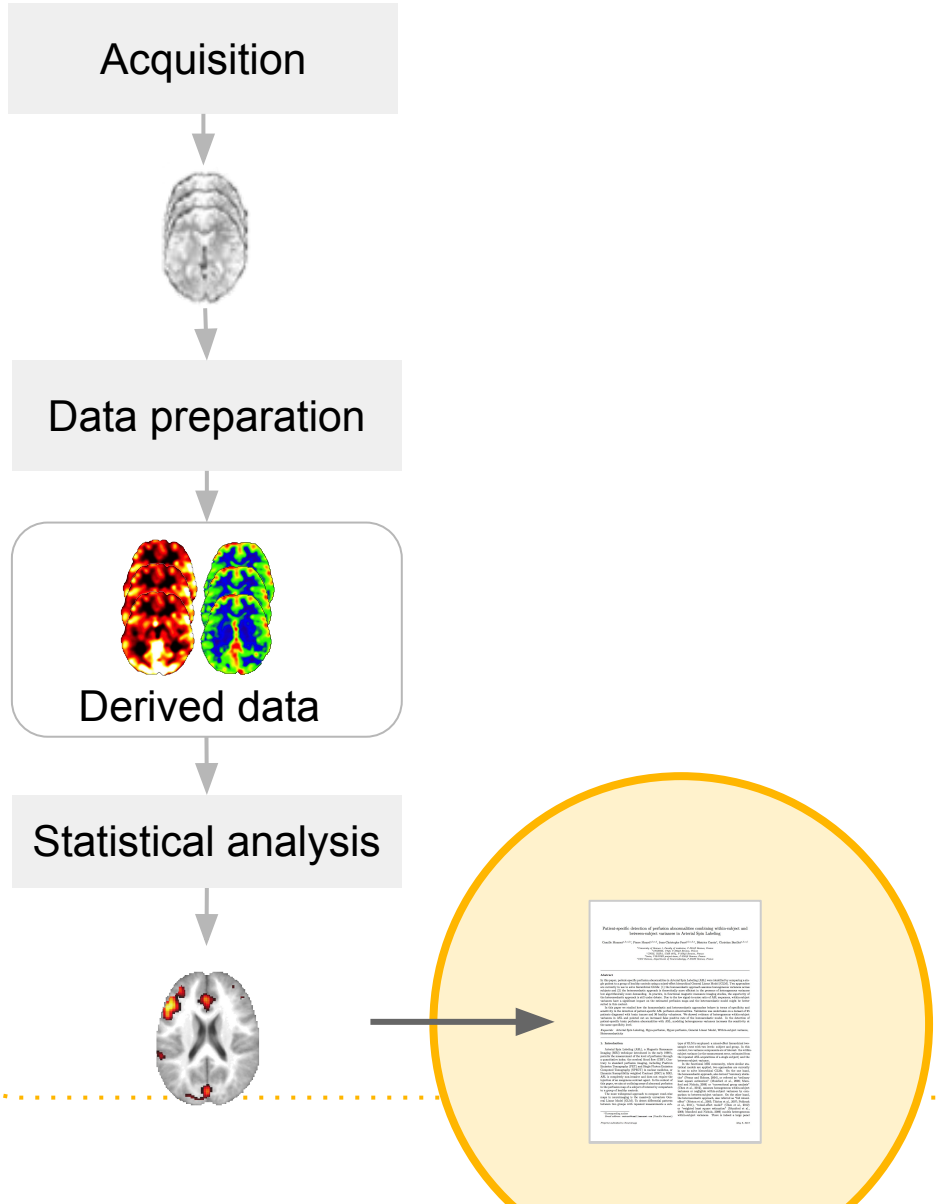

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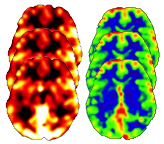
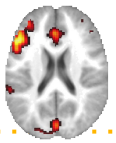
Acquisition

Data preparation

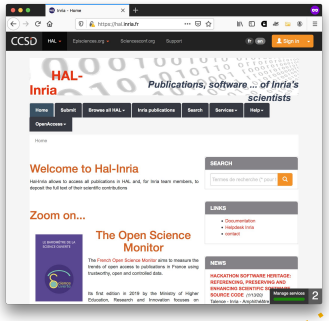


Derived data

Statistical analysis



Biorxiv, arxiv,
HAL,
Pubmed



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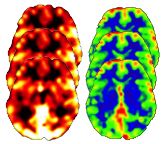

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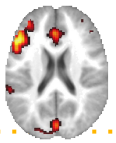

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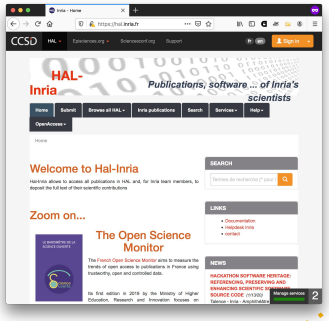

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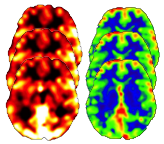

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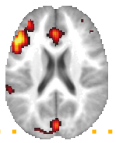

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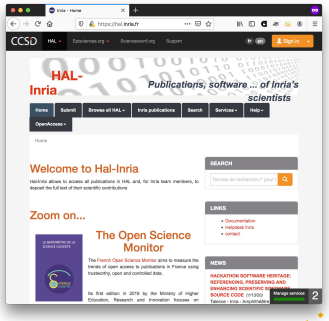

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Sharing FAIR datasets

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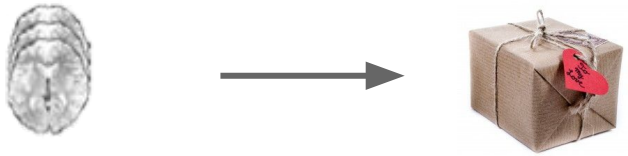
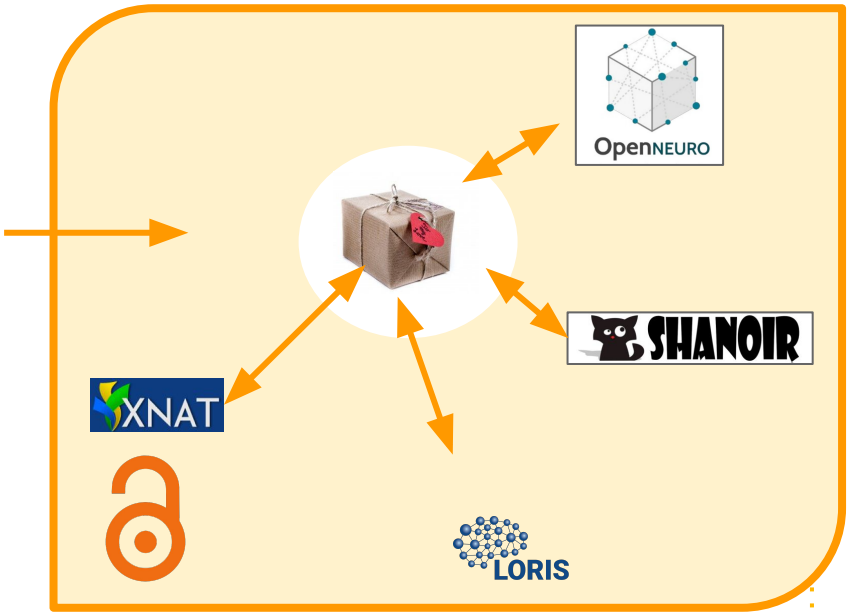
Standards for neuroimaging data sharing

- Data and **meta-data**
- A common “language”





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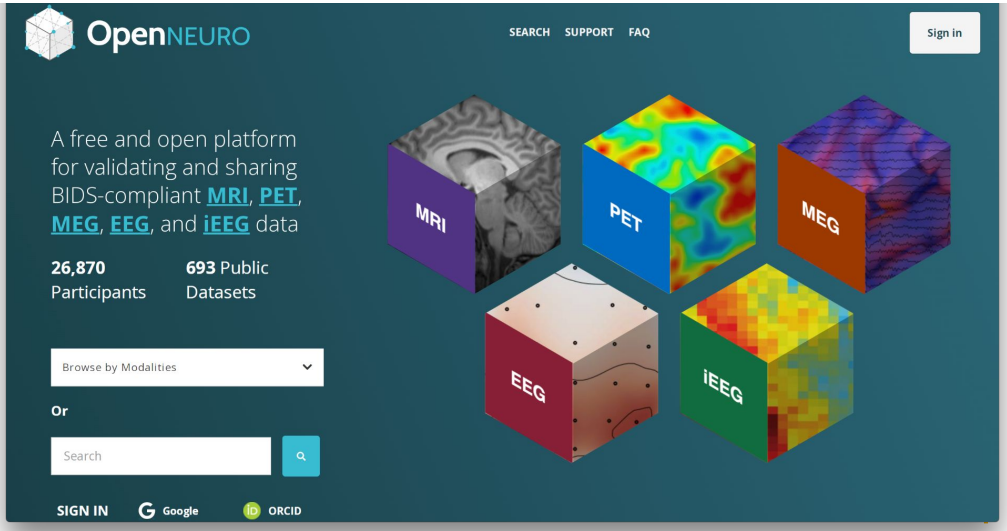
Brain Imaging Data Structure

- my_dataset/
  - participants.tsv
  - sub-01/
    - anat/
      - sub-01_T1w.nii.gz
    - func/
      - sub-01_task-rest_bold.nii.gz
      - sub-01_task-rest_bold.json
    - dwi/
      - sub-01_dwi.nii.gz
      - sub-01_dwi.json
      - sub-01_dwi.bval
      - sub-01_dwi.bvec
  - sub-02/
  - sub-03/
  - sub-04/

The Brain Imaging Data Structure (BIDS): As Easy as Baking a Cake

Patricia Clement, Ghent University Hospital, BE



[Gorgolewski et. al, Scientific Data 2016]

https://openneuro.org/

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Interoperable BIDS acts as a common languages across tools

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Reusable Metadata in BIDS were selected to enable reuse. *e.g. onsets of the task for task-based fMRI.*

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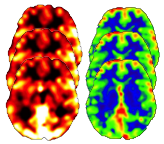
Sharing FAIR research products

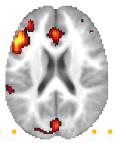
Acquisition

Data preparation



Derived data

Statistical analysis



Biorxiv, arxiv,
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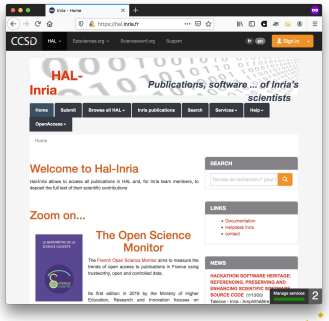

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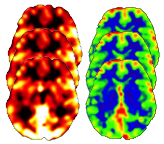

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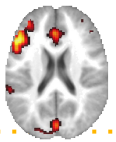

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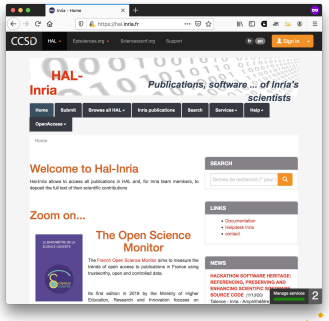

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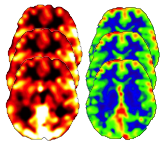

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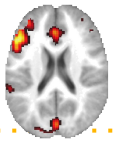

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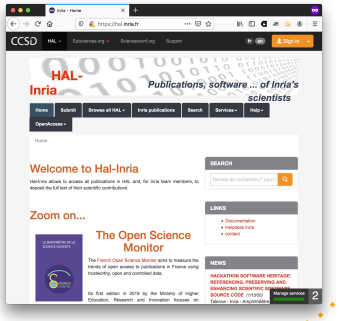

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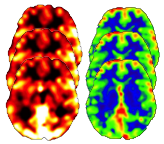

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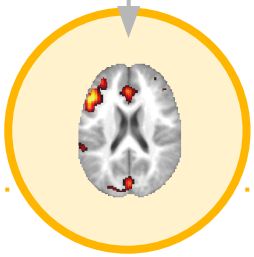

Biorxiv, arxiv,
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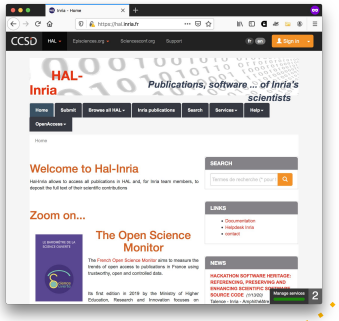

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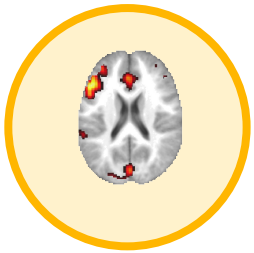
Sharing FAIR results



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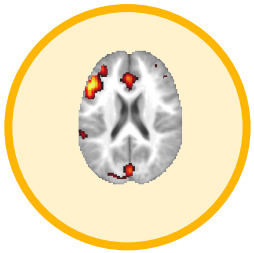
Sharing FAIR results (task fMRI)



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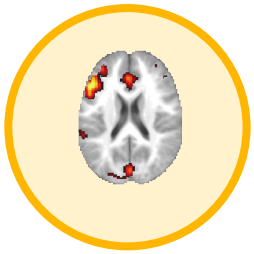

NEUROVAULT

Findable we can search for datasets on NeuroVault

Accessible Direct download

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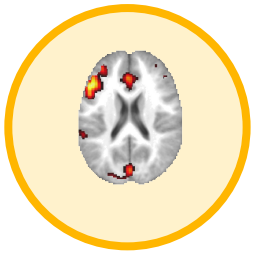
Sharing FAIR results (task fMRI)



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Interoperable?

Findable we can search for datasets on NeuroVault

Reusable?

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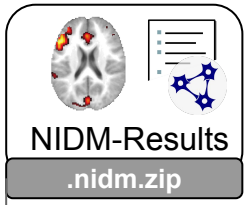
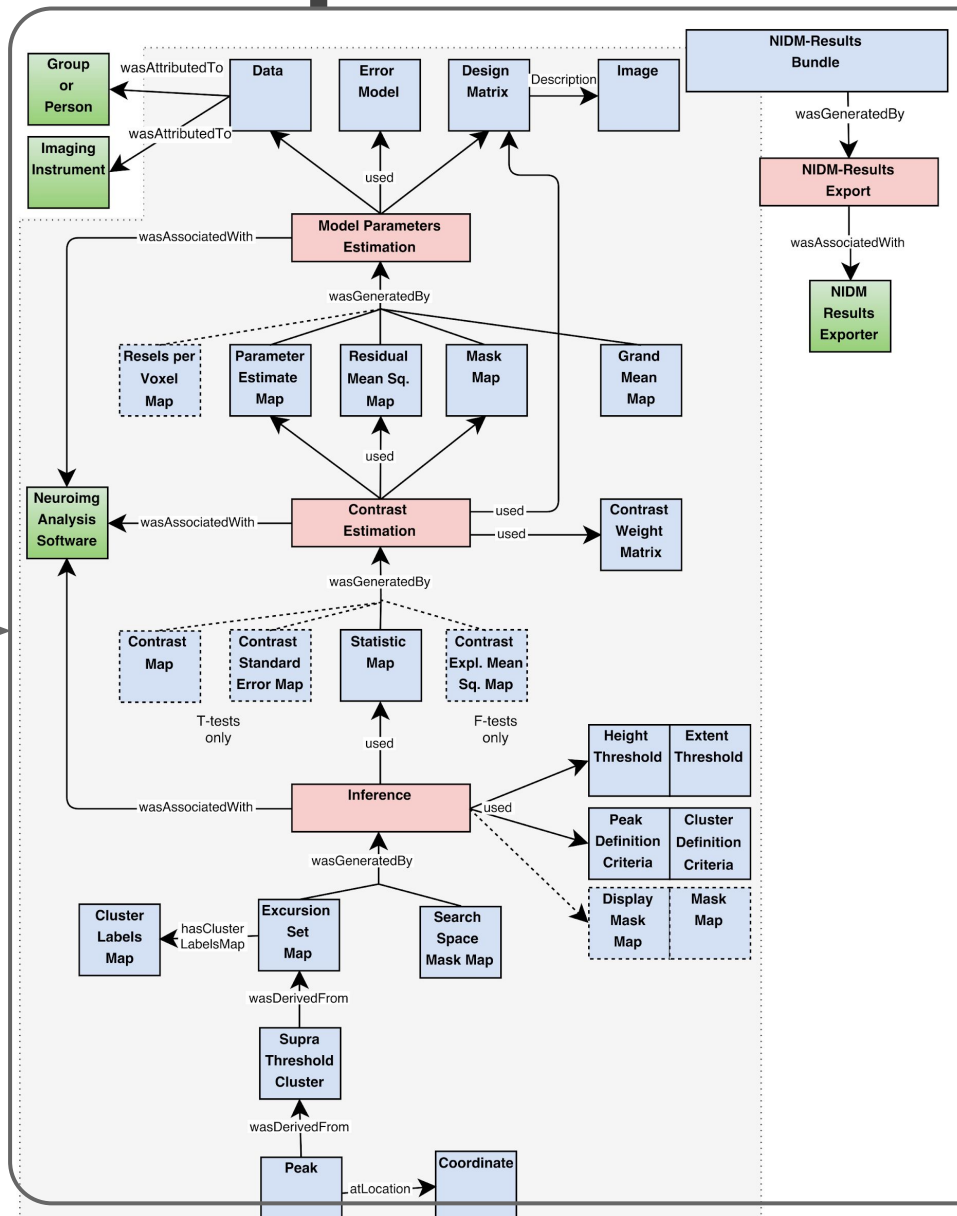
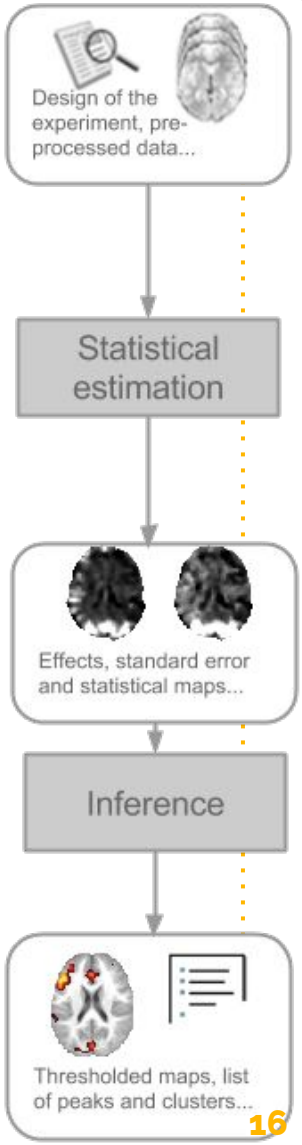
NIDM-Results pack



- ClusterLabels.nii.gz
- Contrast.nii.gz
- ContrastStandardError.nii.gz
- DesignMatrix.csv
- DesignMatrix.png
- ExcursionSet.nii.gz
- ExcursionSet.png
- GrandMean.nii.gz
- Mask.nii.gz
- nidm.json
- nidm.ttl
- ParameterEstimate_001.nii.gz
- ParameterEstimate_002.nii.gz
- ResidualMeanSquares.nii.gz
- SearchSpaceMask.nii.gz
- TStatistic.nii.gz
- ZStatistic.nii.gz

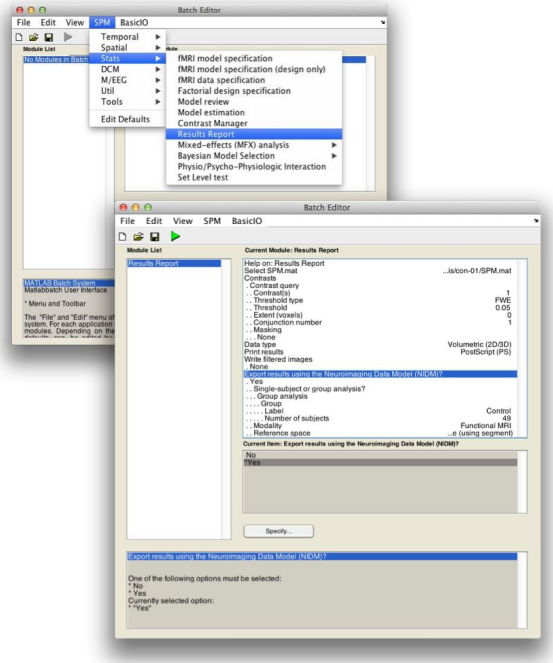
[Maumet et al., Sci. Data 2016]





NIDM in SPM, FSL & NeuroVault

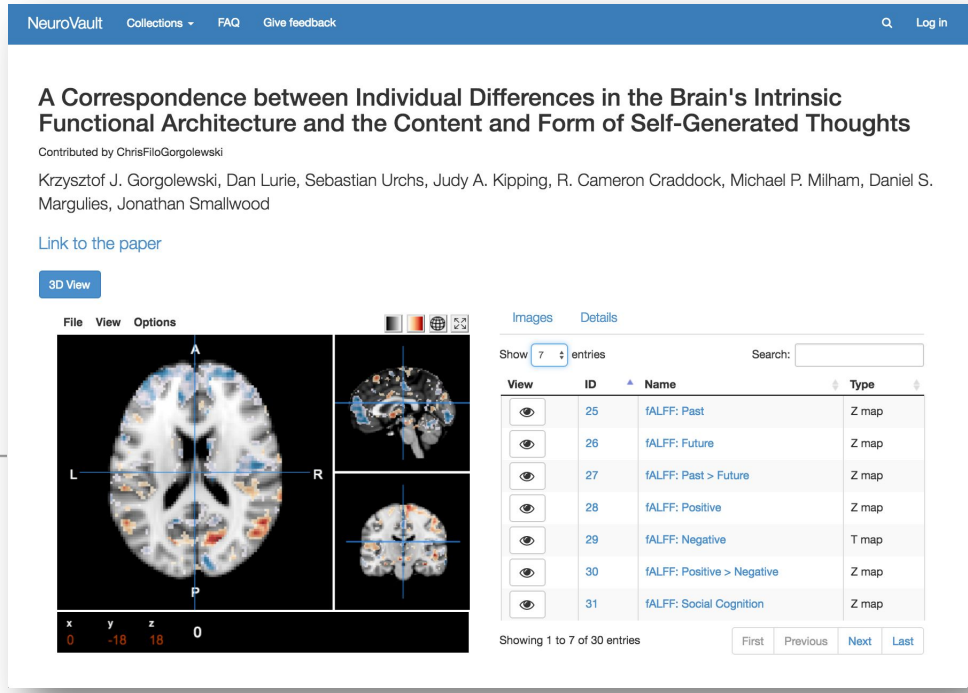
SPM



1. Export

2. Publication on NeuroVault

NIDM-Results

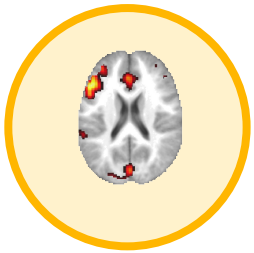


FSL

```
$ nidmfsl fsl_ds107_group 49 -g Control
```

https://github.com/incf-nidash/nidmresults-spm, https://github.com/incf-nidash/nidmresults-fsl

Sharing FAIR results (task fMRI)



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Interoperable NIDM-Results acts as a common languages across tools

Findable we can search for datasets on NeuroVault

Reusable Metadata in NIDM-Results selected to enable meta-analyses

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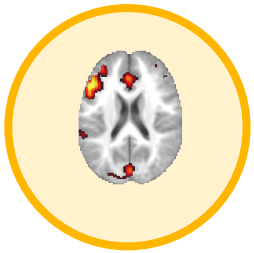
Sharing FAIR results (task fMRI)



NEUROVAULT

Interoperable NIDM-Results acts as a common languages across tools

Findable we can search for datasets on NeuroVault

Reusable Metadata in NIDM-Results selected to enable meta-analyses

Accessible Direct download

Image credits: Parcels 1 2 & 4 (CC0), Parcel 3 (CC0), Parcel 5 (CC0).

Sharing FAIR research products

Acquisition

OpenNEURO

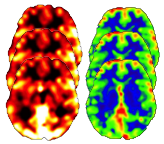
Donders Repository

XNAT

SHANOIR

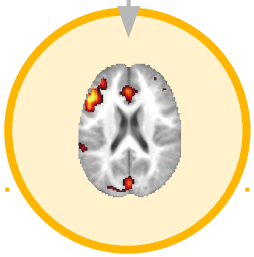
LORIS

Data preparation

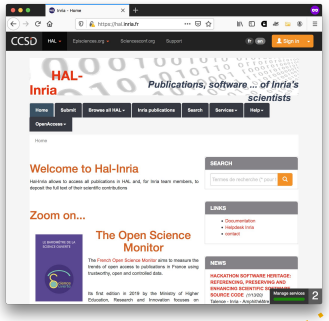


Derived data

Statistical analysis



Biorxiv, arxiv,
HAL,
Pubmed



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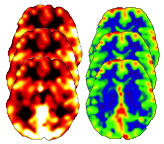

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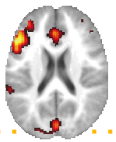

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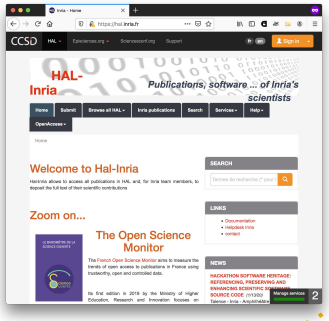

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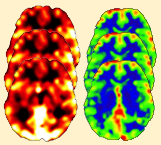

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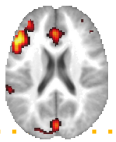

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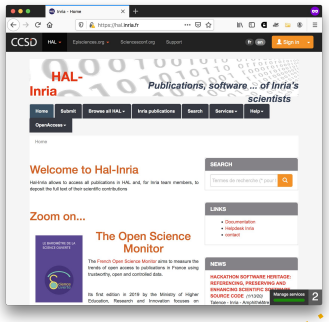

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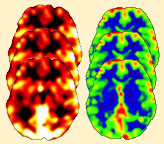
Sharing FAIR intermediary datasets



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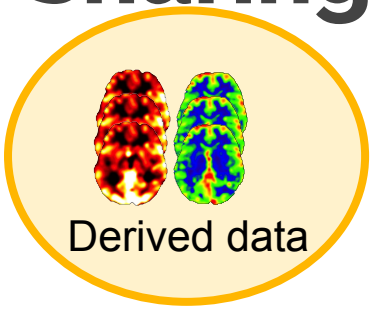

NITRC

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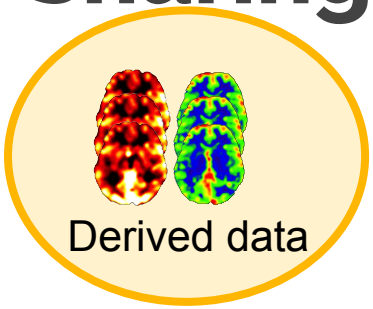
General purpose repositories

Sharing FAIR intermediary datasets



NITRC

zenodo

General purpose repositories

Findable can search for open datasets (less specific queries)

Accessible Direct download or Data User Agreement

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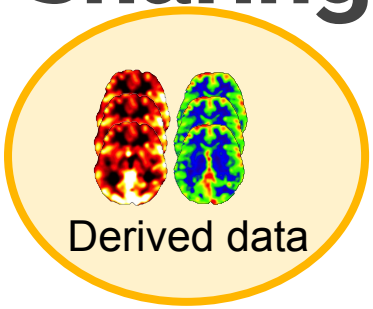

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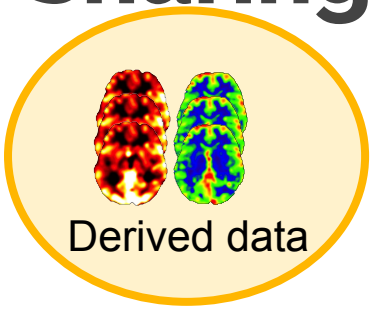

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General purpose repositories

Interoperable?

Findable can search for open datasets (less specific queries)

Reusable?

Accessible Direct download or Data User Agreement

Image credits: Parcels 1 2 & 4 (CC0), Parcel 3 (CC0), Parcel 5 (CC0).

Sharing other FAIR datasets

1- Look for existing standards and databases:

2- You can help develop the next standards

BIDS Derivatives

https://bids.neuroimaging.io/

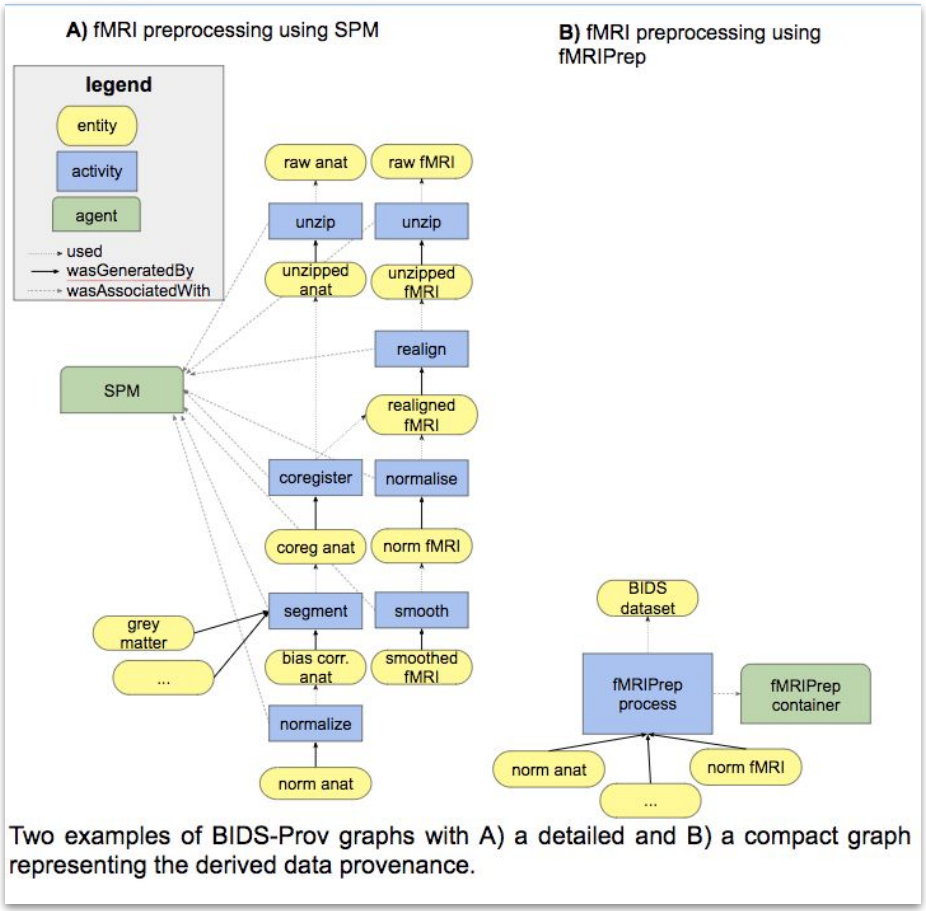
Derivatives are outputs of common processing pipelines, capturing data and meta-data sufficient for a researcher to understand and (critically) reuse those outputs in subsequent processing. Standardizing derivatives is motivated by use cases where formalized machine-readable access to processed data enables higher level processing.

BEP011	The structural preprocessing derivatives
BEP012	The functional preprocessing derivatives
BEP013	The resting state fMRI derivatives
BEP016	The diffusion weighted imaging derivatives
BEP017	Generic BIDS connectivity data schema
BEP021	Common Electrophysiological Derivatives

And more!

BIDS Provenance

Satra Ghosh



Two examples of BIDS-Prov graphs with A) a detailed and B) a compact graph representing the derived data provenance.

https://github.com/bids-standard/BEP028_BIDSprov

Image credits: Parcels 1 2 & 4 (CC0), Parcel 3 (CC0), Parcel 5 (CC0).

Provenance Use Case 1 **An unambiguous description of the methods**

Provenance Use Case 1 **An unambiguous description of the methods**

Which release of SPM was used?

Which registration algorithm was selected?

How was the brain mask computed?

Image credits: Questions (CC BY-SA)

Provenance Use Case 1 **An unambiguous description of the methods**

Can we **reproduce exactly the same results** (same data, same methods)?

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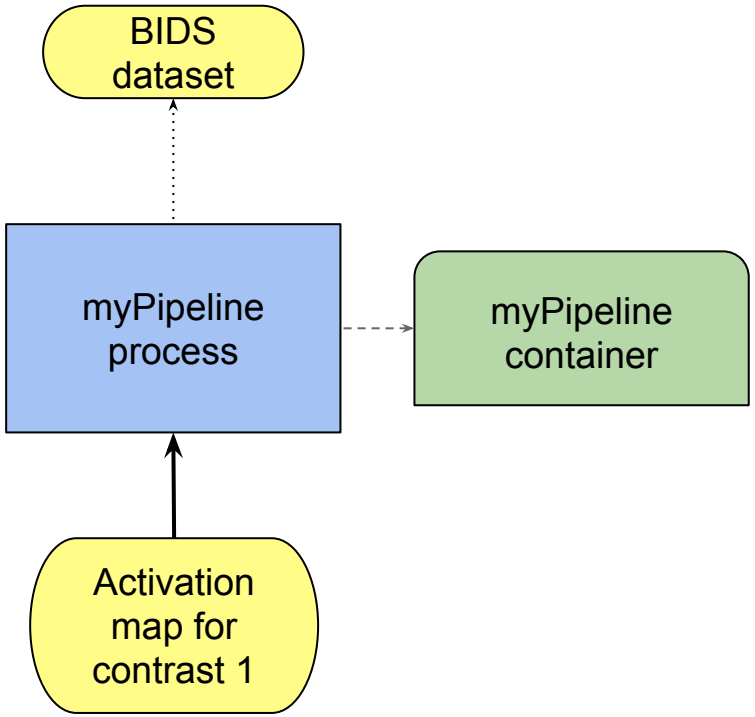

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Provenance Use Case 2 **Dealing with unwanted variability**

A previously widely-used **parameter is no longer considered as best practice**

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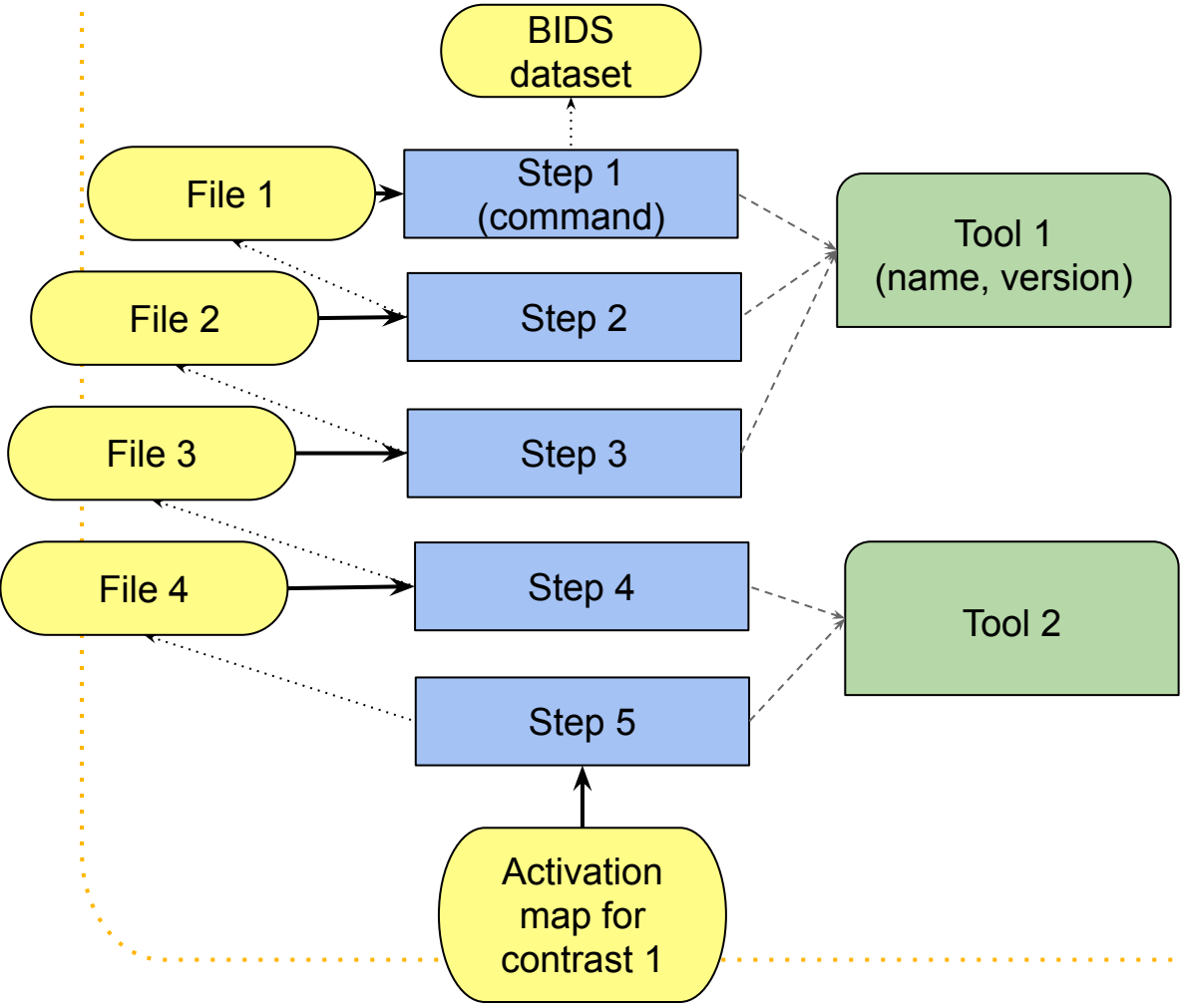

A previously widely-used **parameter is no longer considered as best practice**

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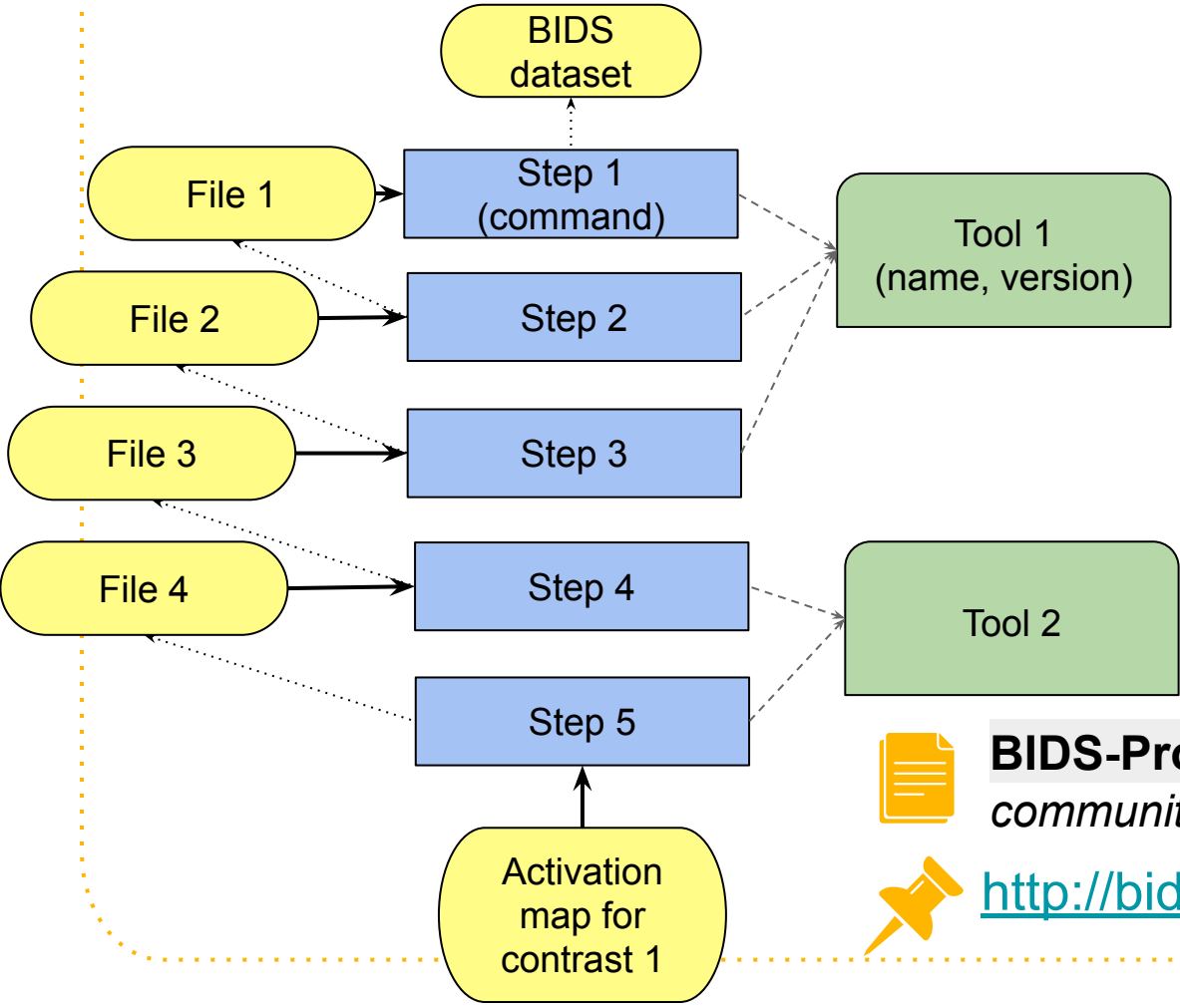
Provenance Use Case 3 **Exploring factors impacting analytical variability**



Are my conclusions dependant on the **size of the smoothing kernel** used at Step 5?

BIDS-Prov *will soon be open for community feedback!*

http://bids.neuroimaging.io/bep028

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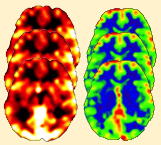

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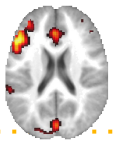

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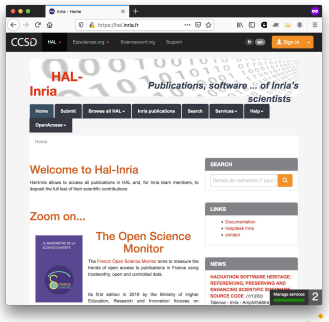

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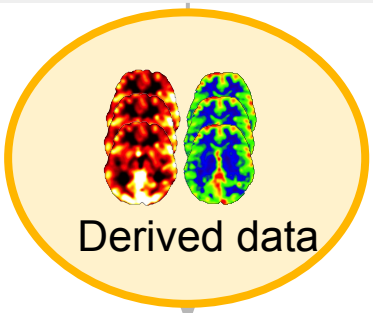

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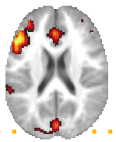

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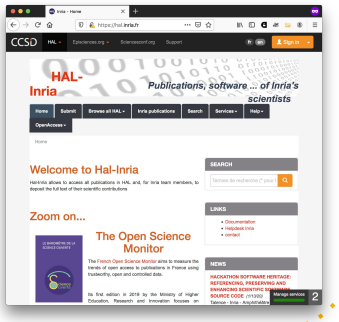

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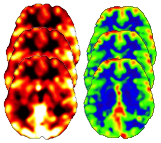

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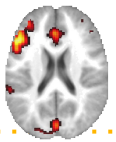

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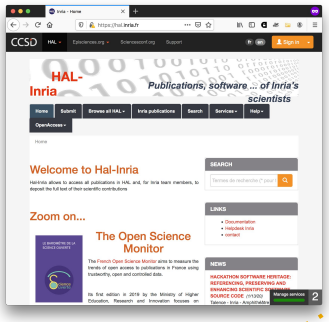

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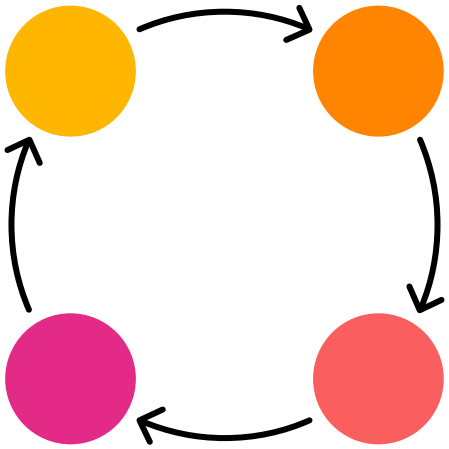
Session MRI data liberation: Sharing for a better future



Reusing neuroimaging derived data?

Camille Maumet

Thank you!

@cmaumet.bsky.social

@cmaumet@fediscience.org

Credit: Presentation template and icons by SlidesCarnival, adapted