



Tools and standards to make neuroimaging derived data reusable

Camille Maumet

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Camille Maumet. Tools and standards to make neuroimaging derived data reusable. Neuroinformatics 2018, Aug 2018, Montreal, Canada. . inserm-01886089

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Submitted on 2 Oct 2018

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Tools and standards to make neuroimaging derived data reusable

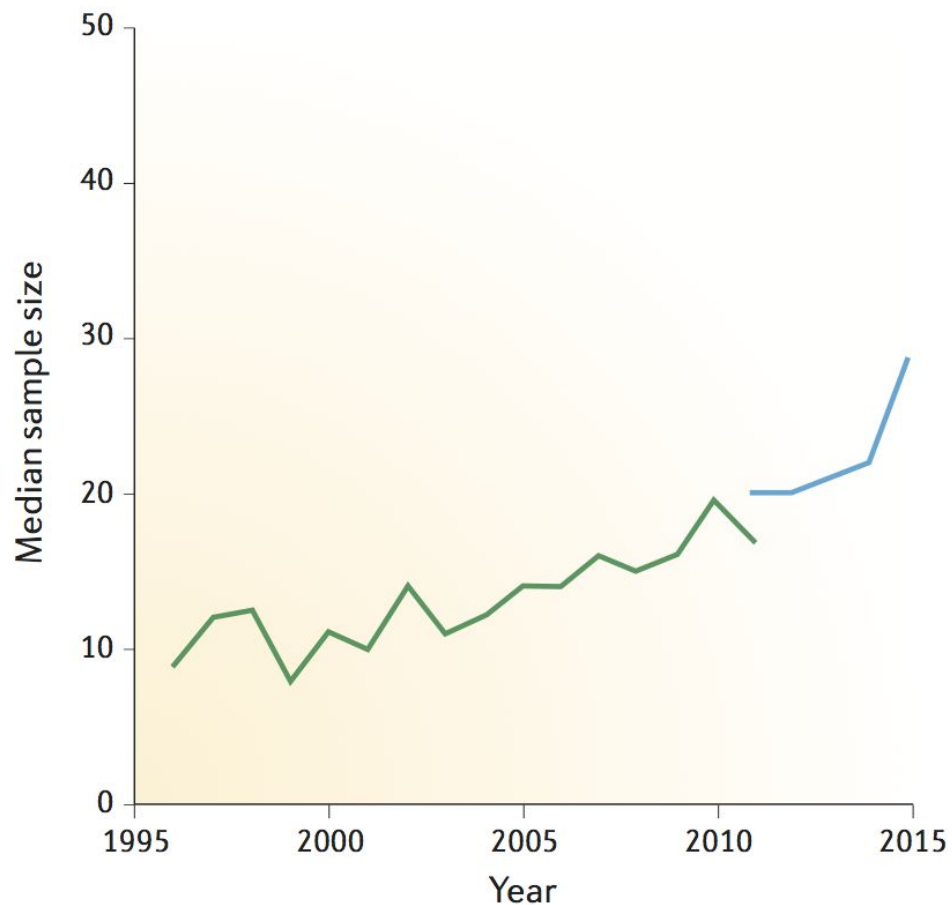
Camille Maumet



Univ Rennes, Inria, CNRS, Inserm, IRISA UMR 6074, VisAGeS ERL U-1228

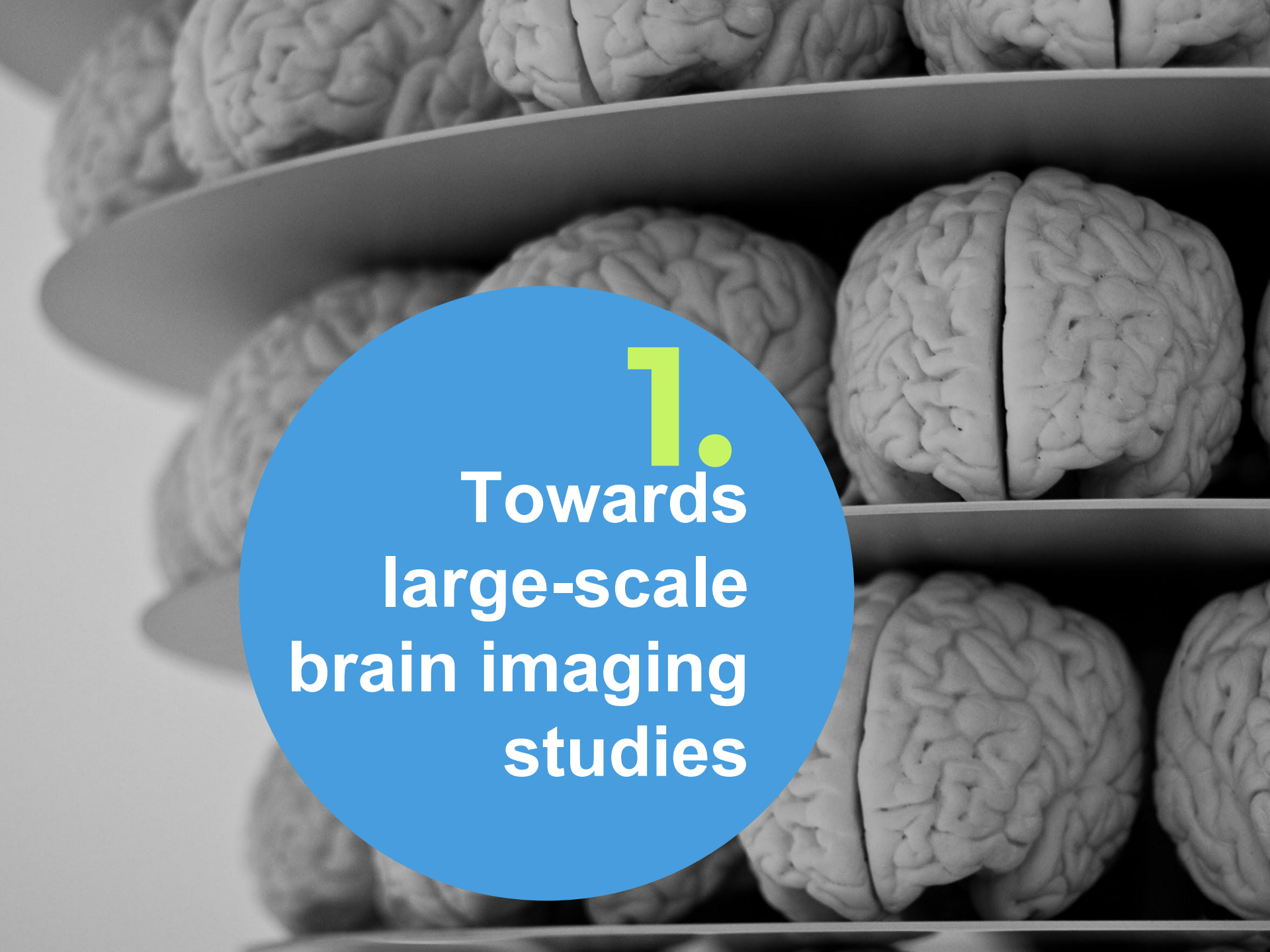


Sample sizes in neuroimaging



2015: 30 subjects / study

Poldrack et. al (2017)



1. Towards large-scale brain imaging studies

More and more shared data available

Single study

30 subjects



OpenNEURO

studyforrest.org



NEUROVAULT

L I E L N L F T Q K T Q R V
S M Y C O N N E C T O M E Q
G S P K K W A R R G K E H R



ABIDE
Autism Brain Imaging
Data Exchange

1000 Functional
Connectomes Project

NITRC



CORR
CONSORTIUM FOR
RELIABILITY AND
REPRODUCIBILITY



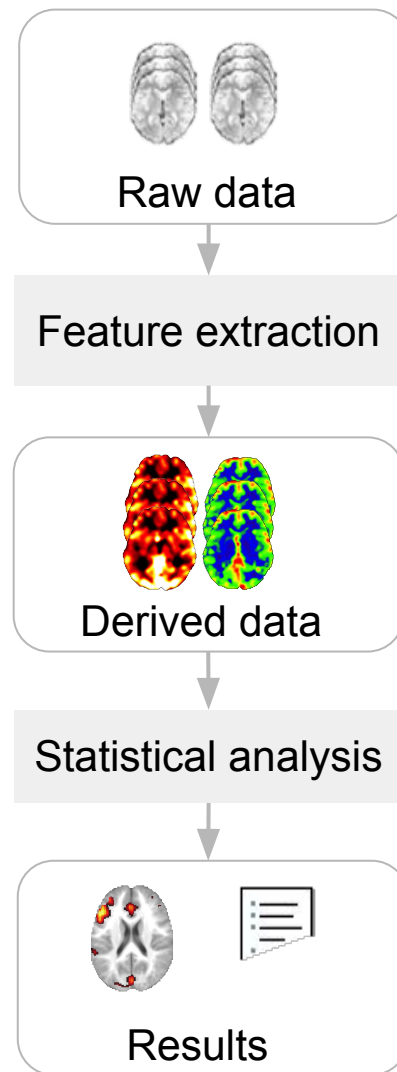
HUMAN
Connectome
PROJECT

OSF

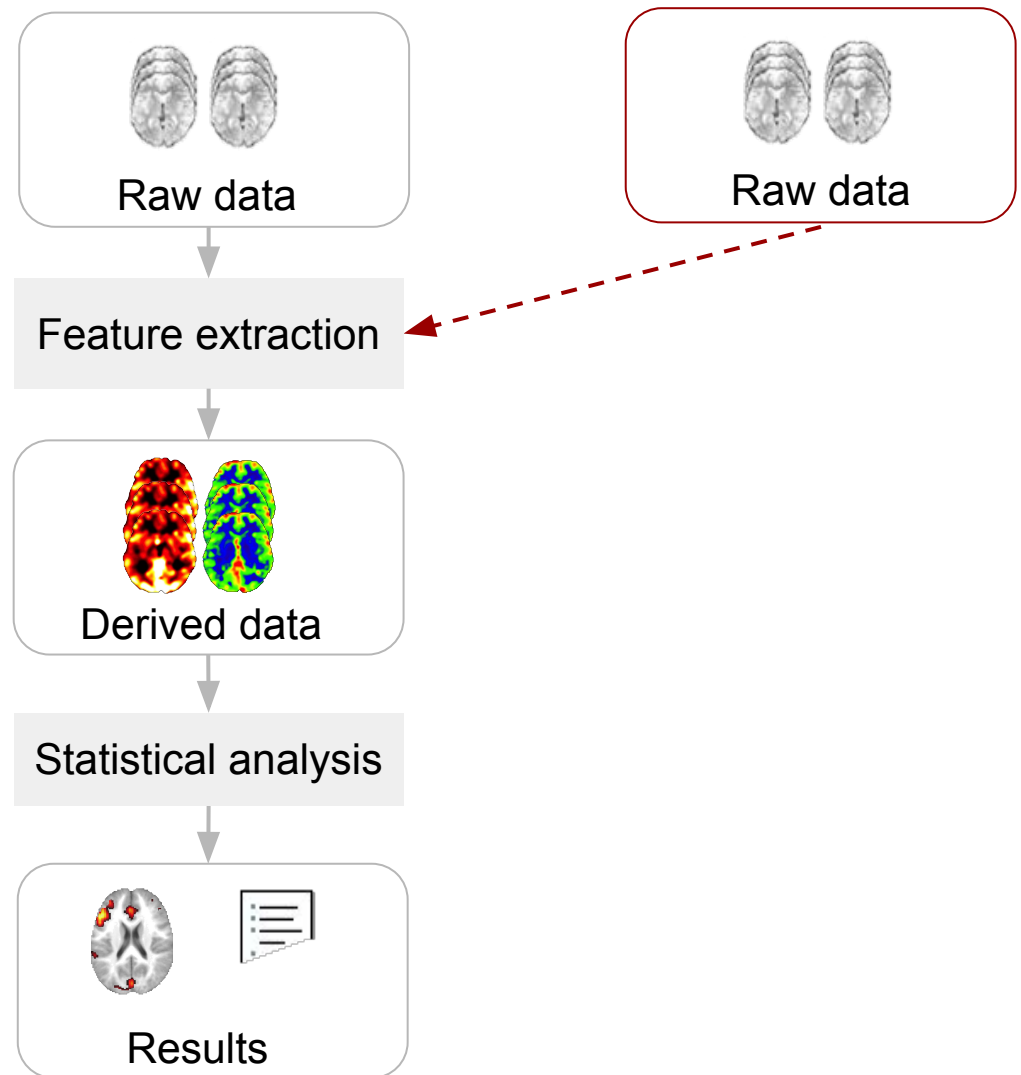
biobank^{uk}
Improving the health of future generations

- + Images
- + Homogeneous
- Fewer datasets

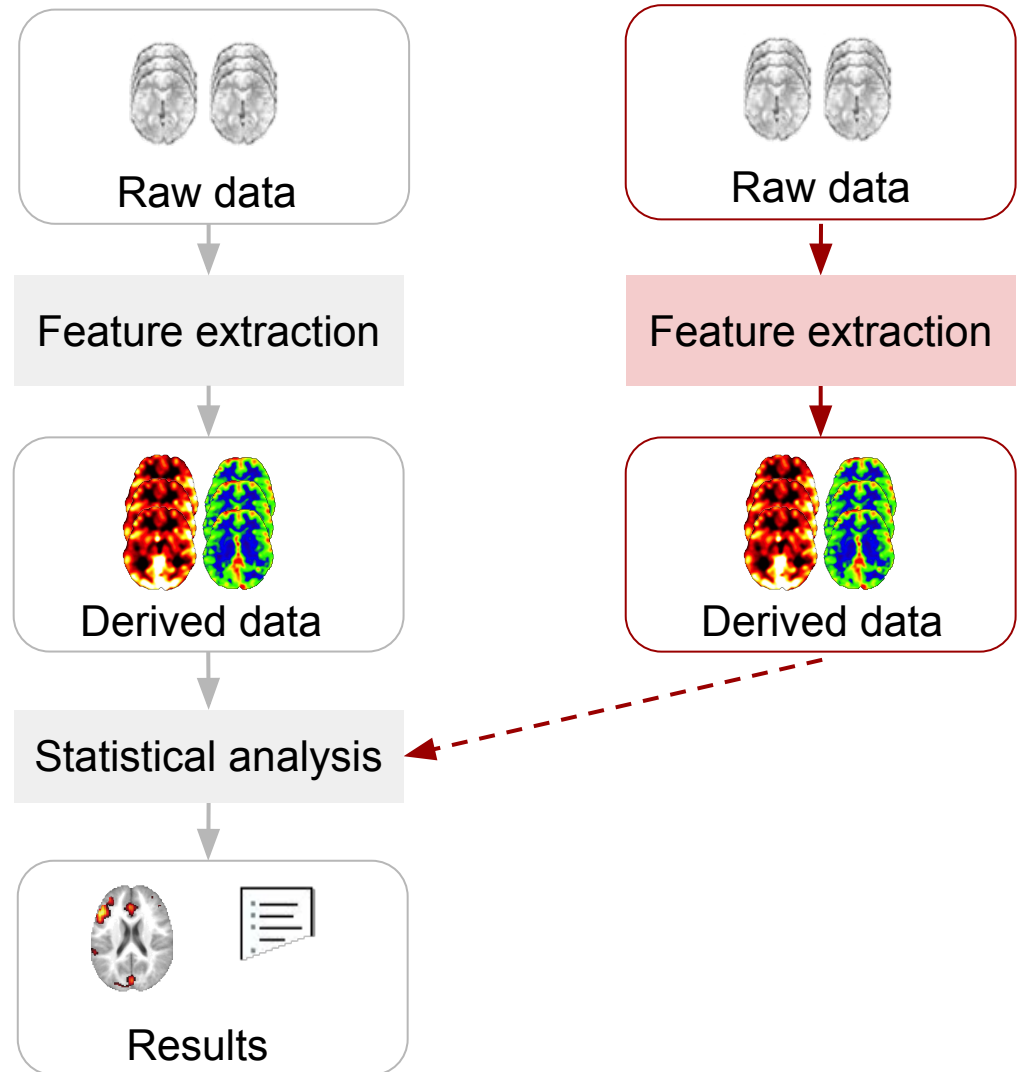
New challenges when working with open data



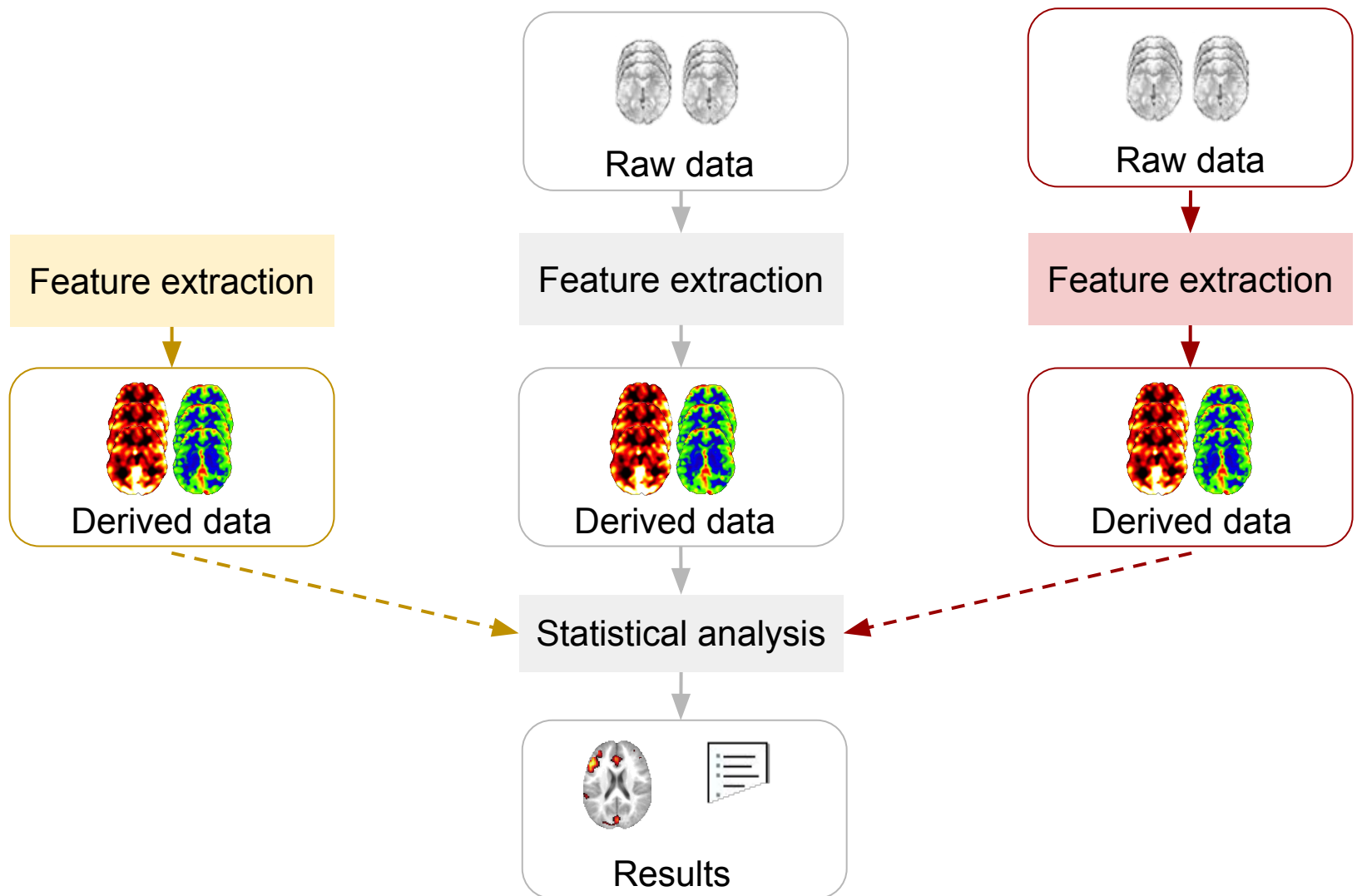
New challenges when working with open data



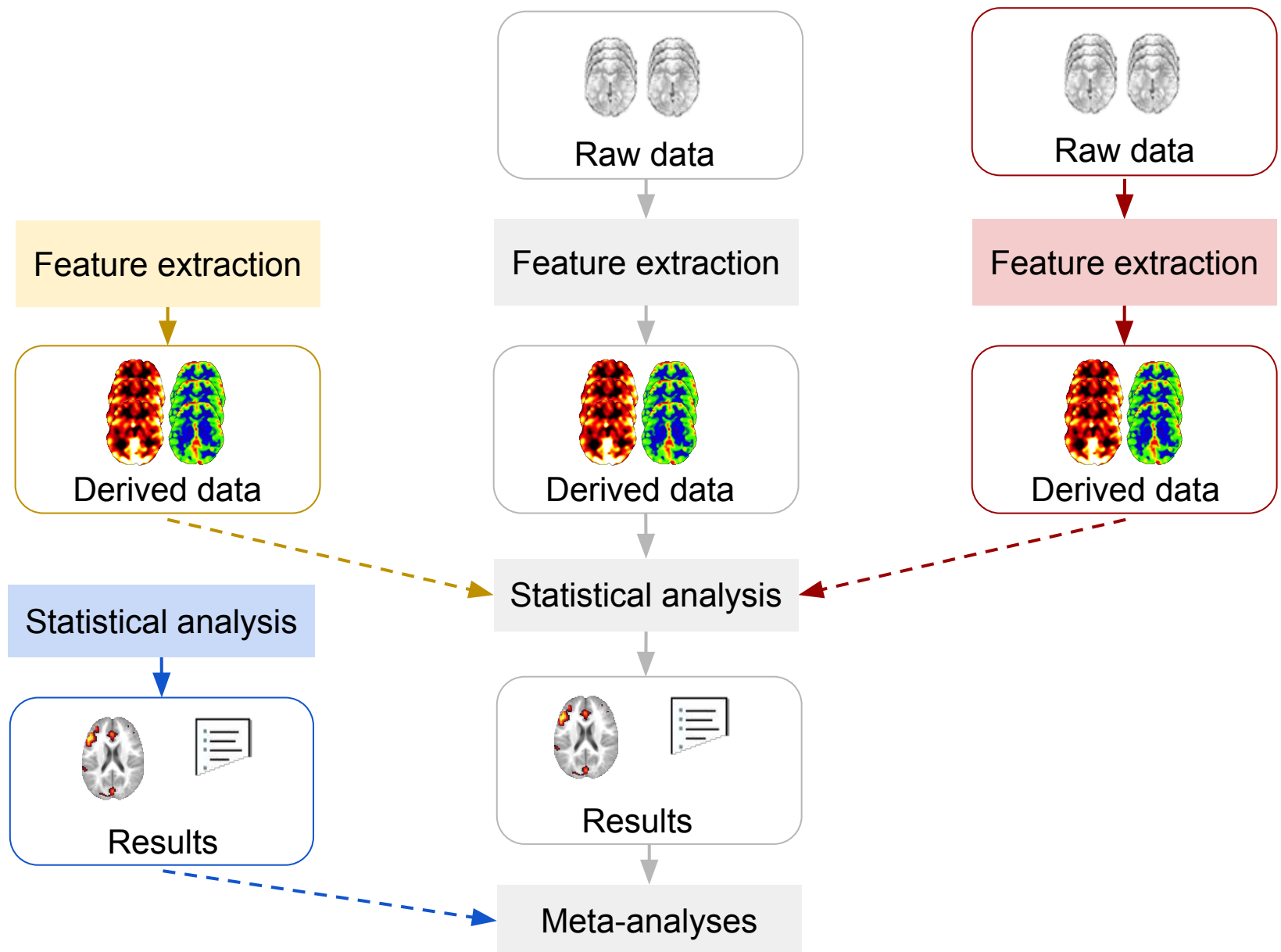
New challenges when working with open data



New challenges when working with open data



New challenges when working with open data

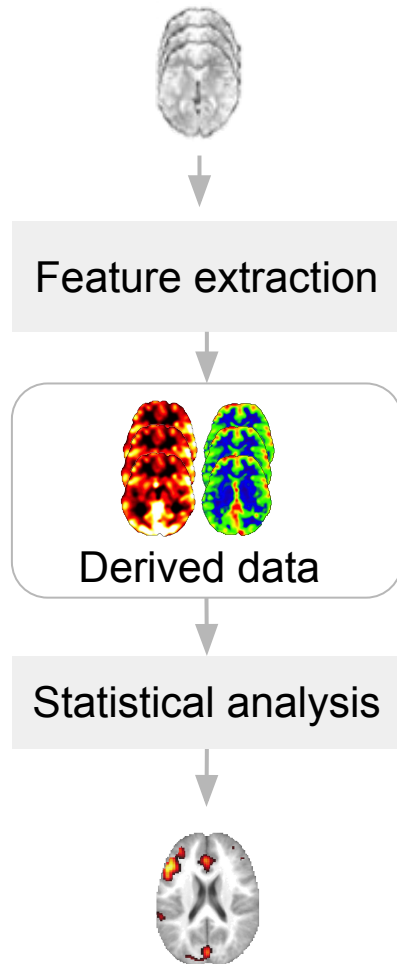


The background is a dark gray field featuring six vertical columns of circles. Each column contains ten circles, with colors ranging from light gray to white. The second column from the left includes a diamond shape at the top. A large blue circle is centered on the slide, containing the text '2. Analytic variability?'.

2.

**Analytic
variability?**

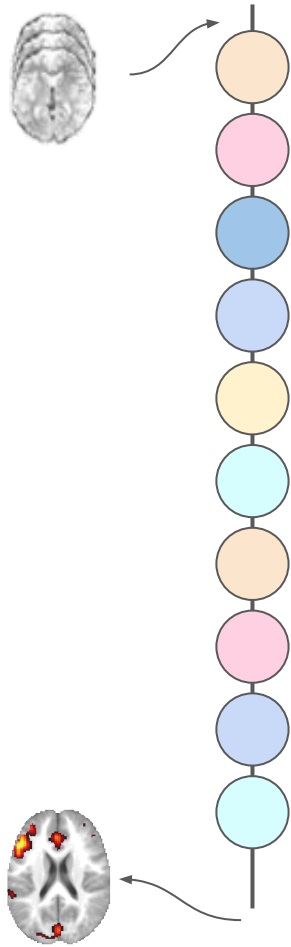
Analytic variability



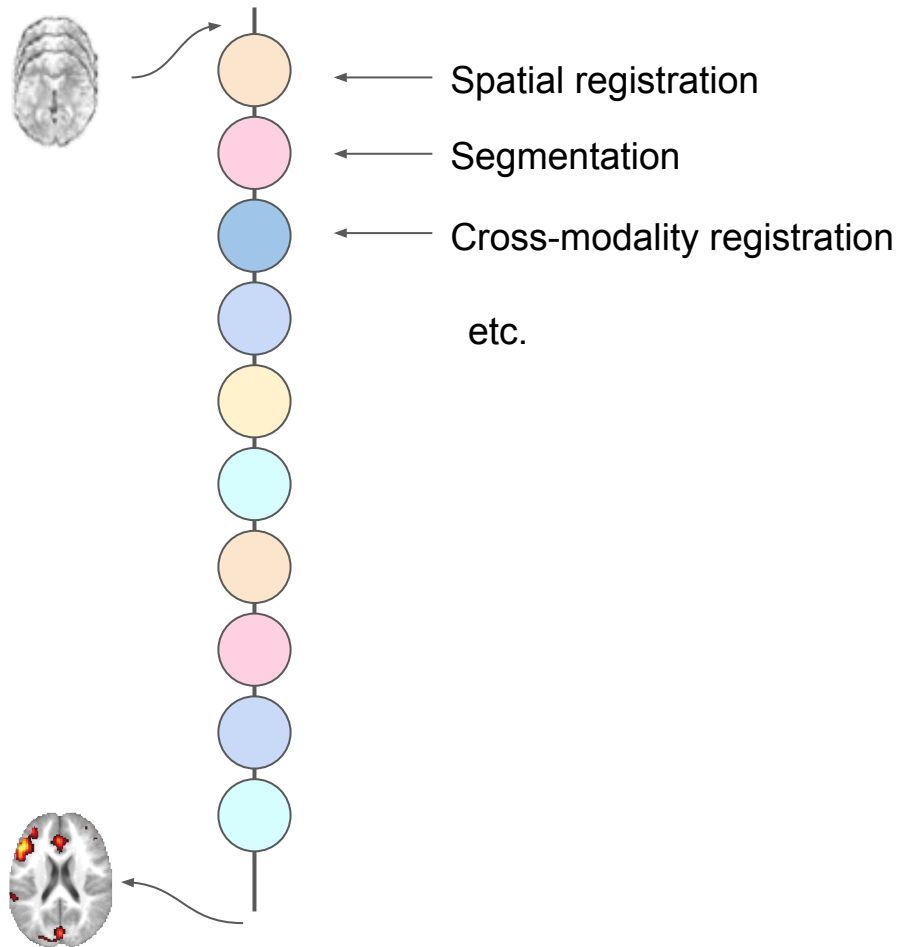
“Different **acceptable** analysis methods”

Carp et al. (2012)

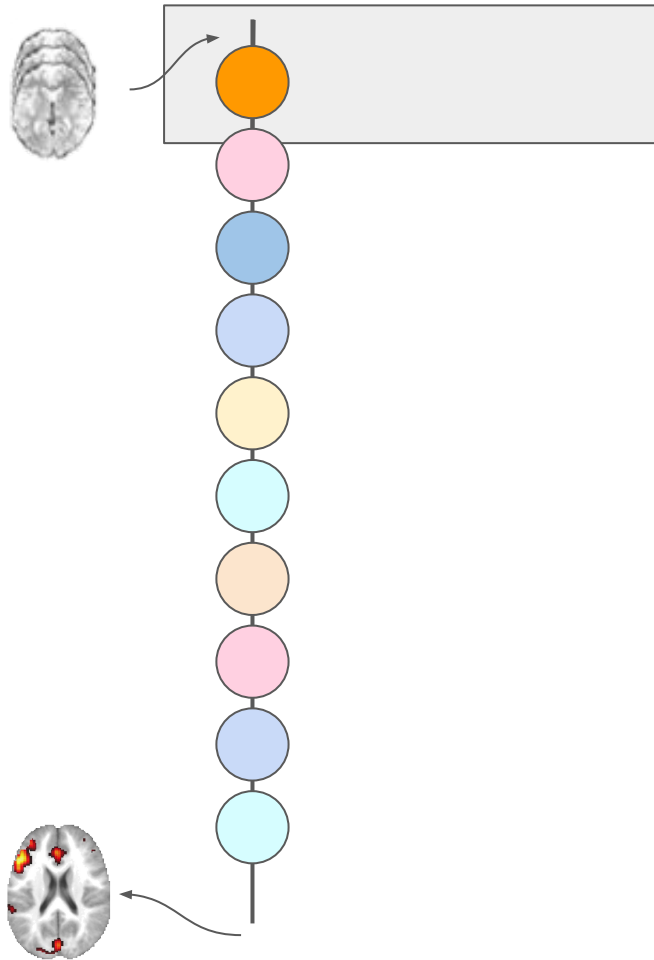
Analytic variability



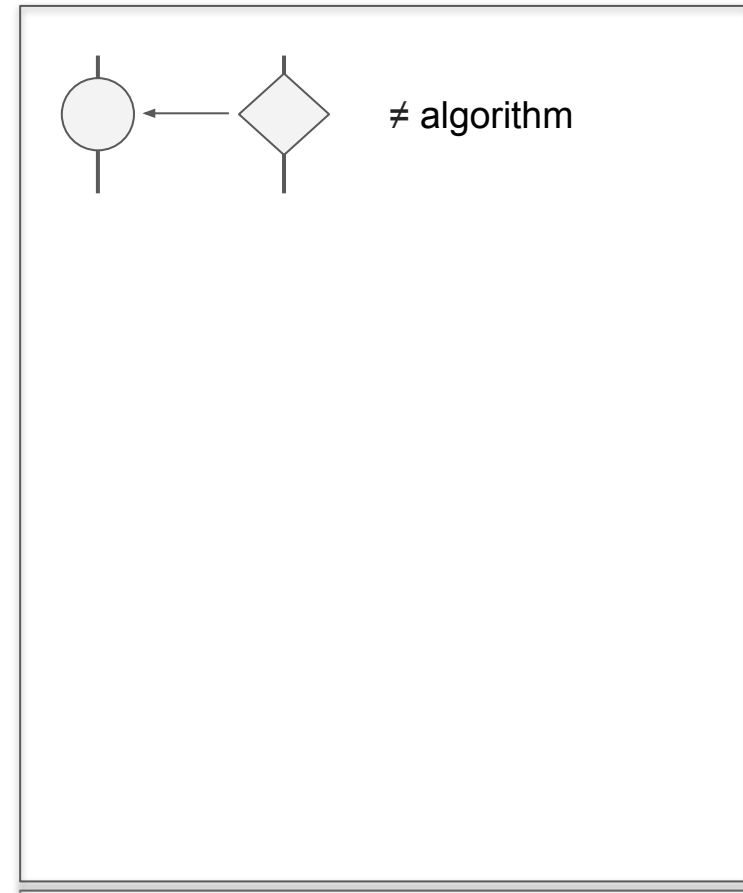
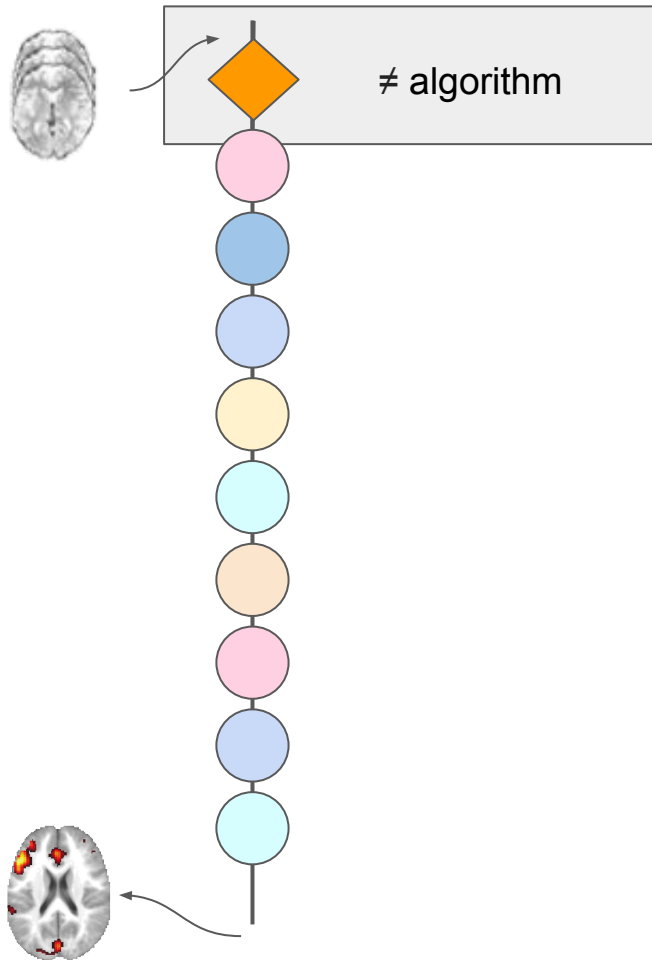
Analytic variability



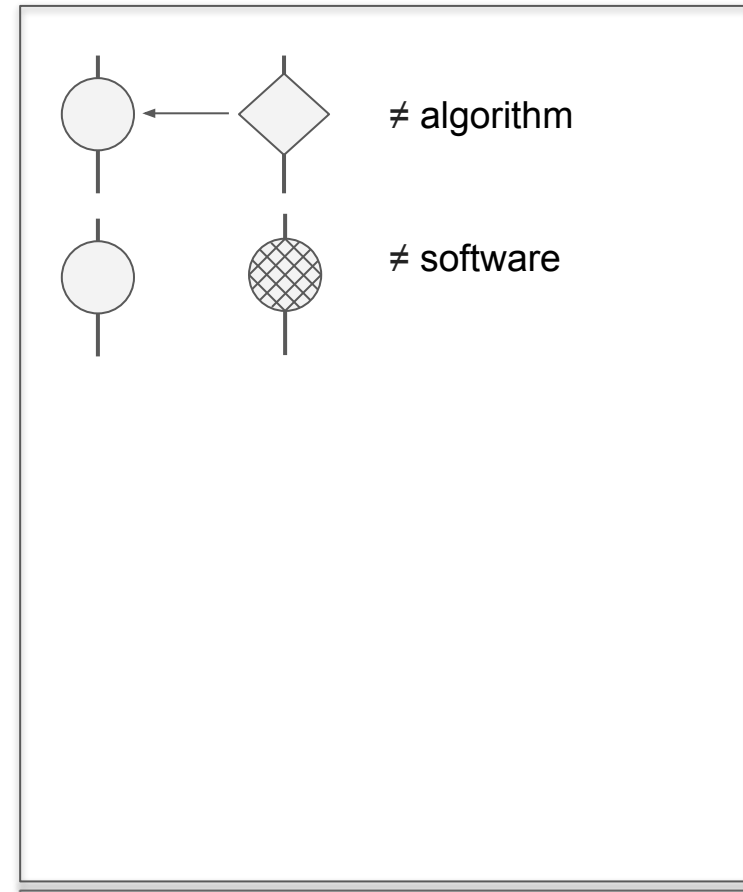
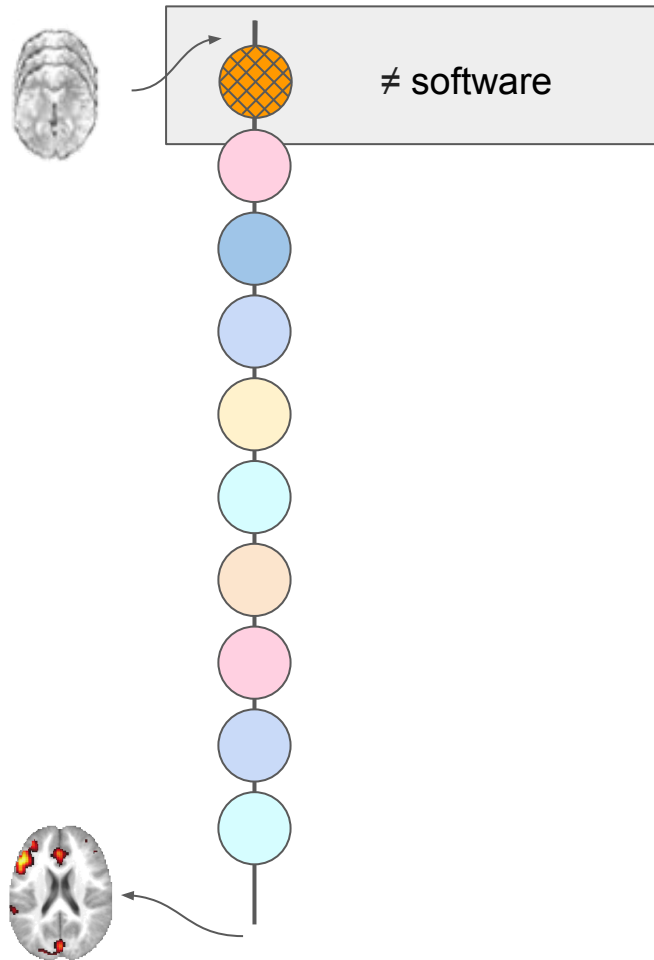
Analytic variability



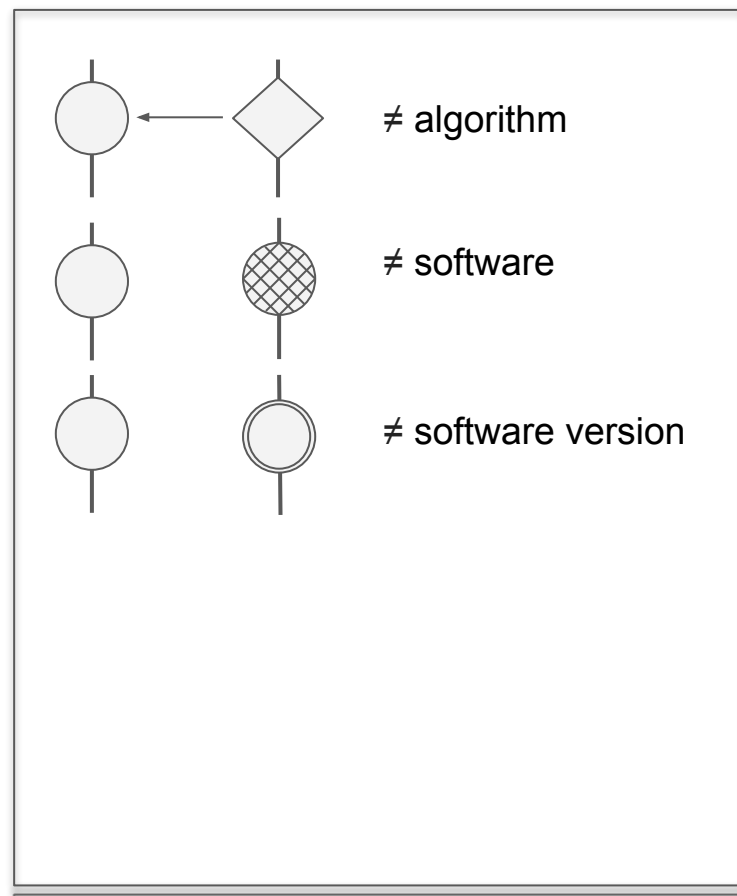
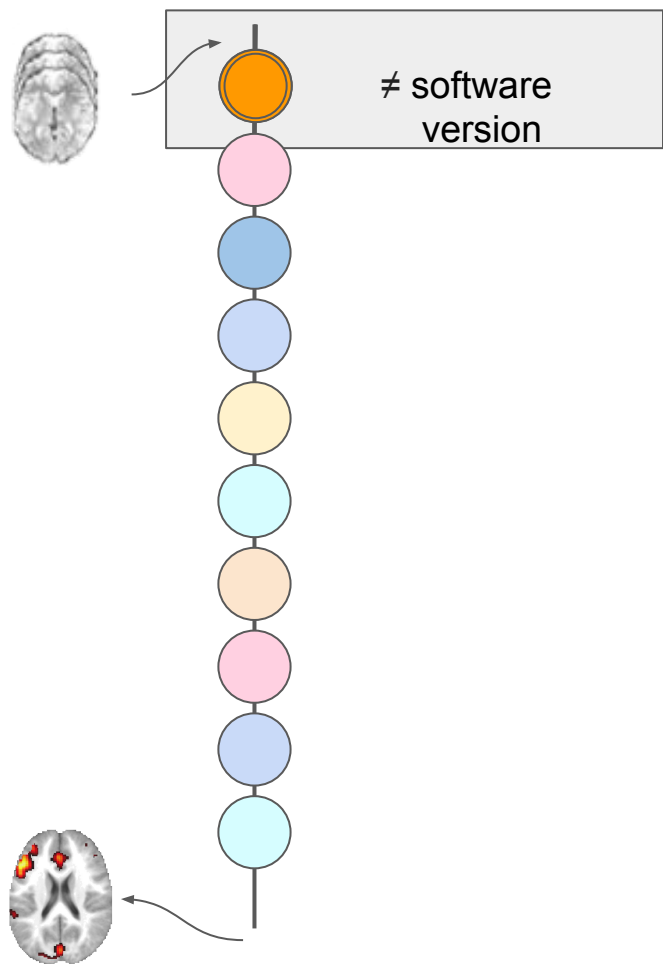
Analytic variability



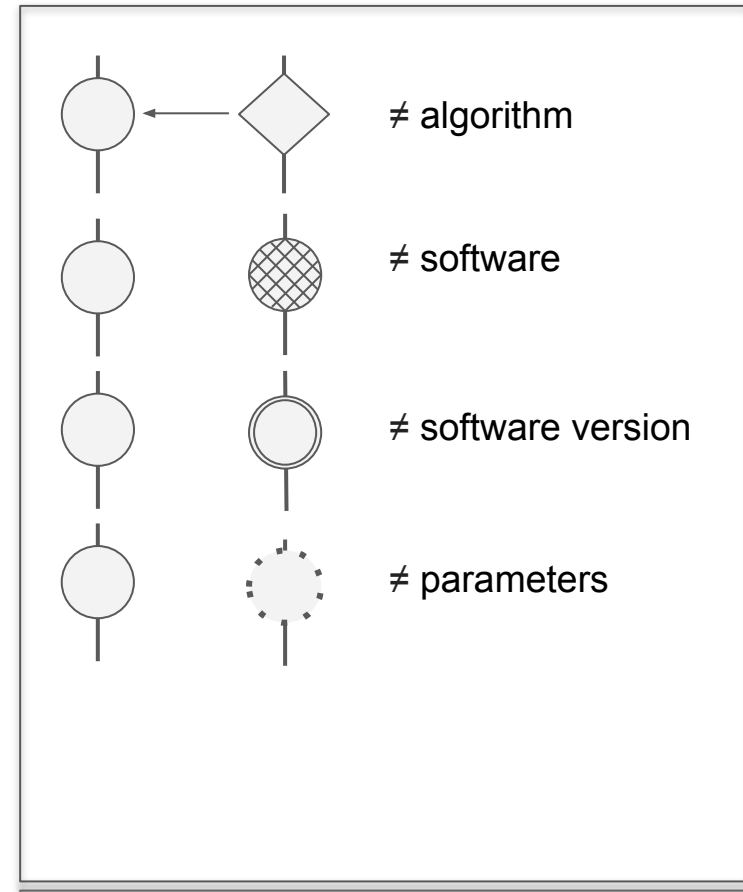
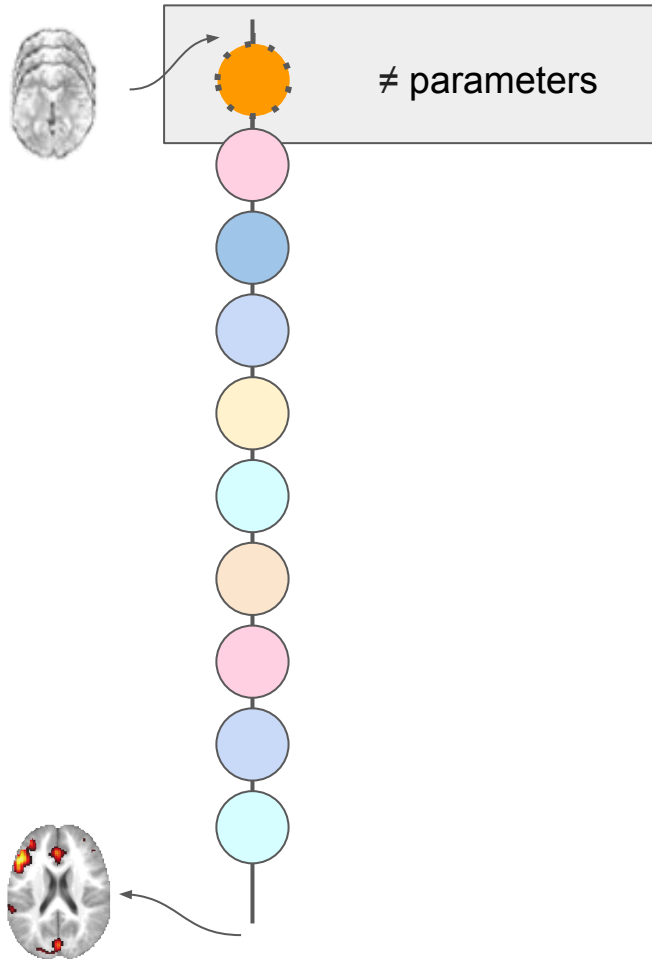
Analytic variability



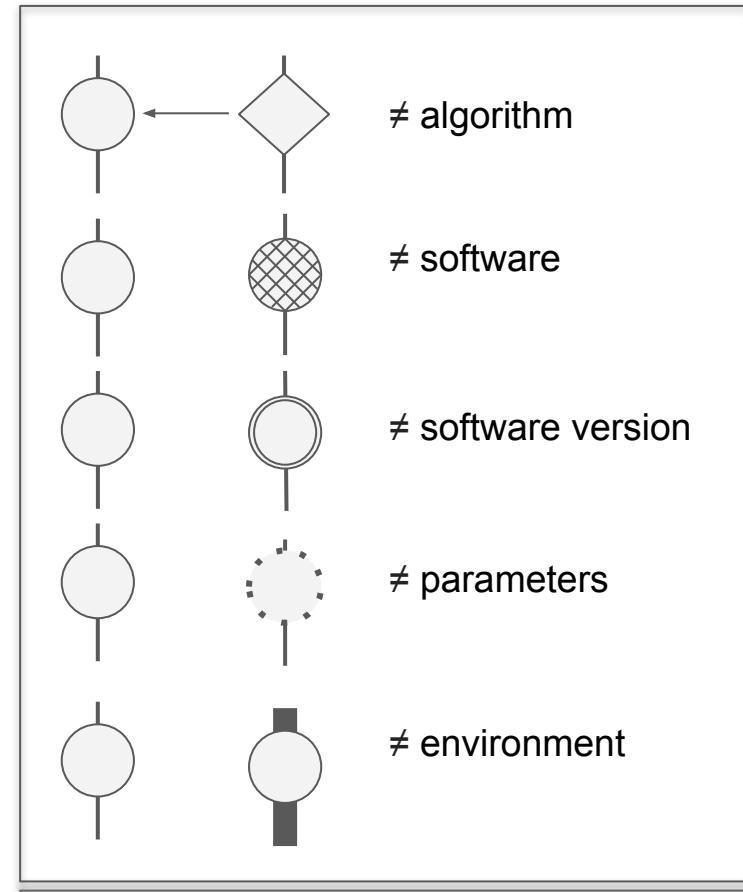
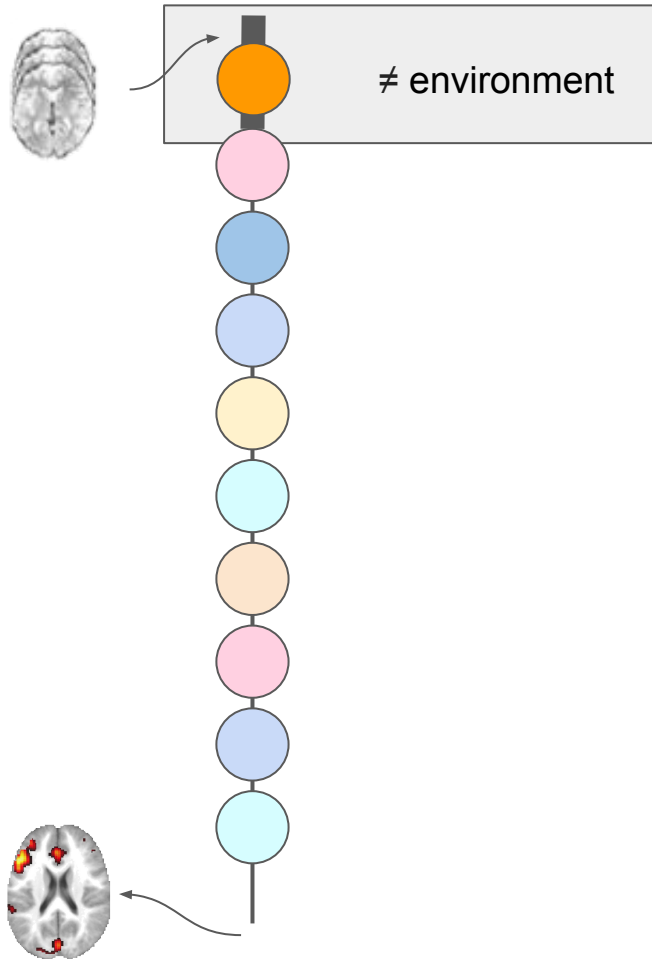
Analytic variability



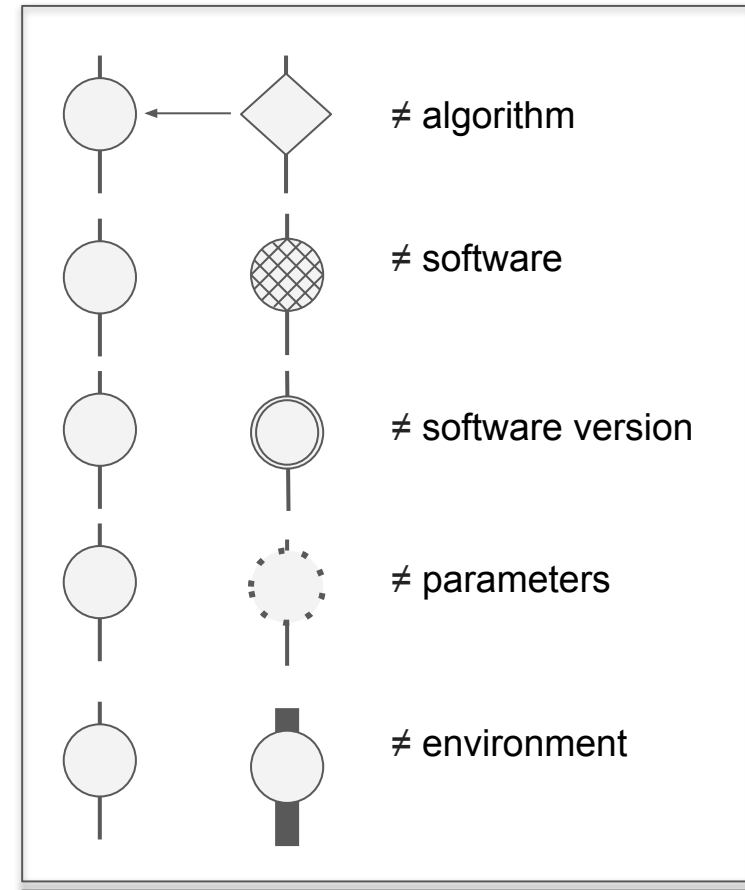
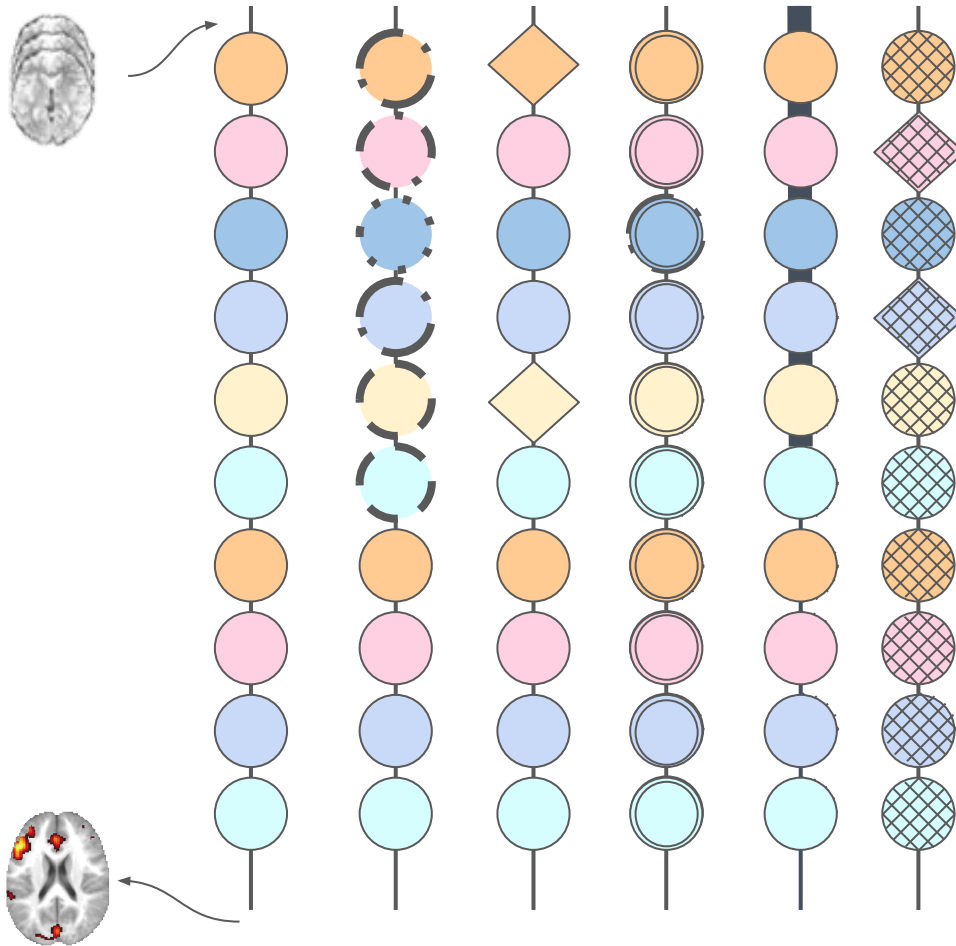
Analytic variability



Analytic variability



Analytic variability





Question?

**How does analytic variability impact
neuroimaging results?**

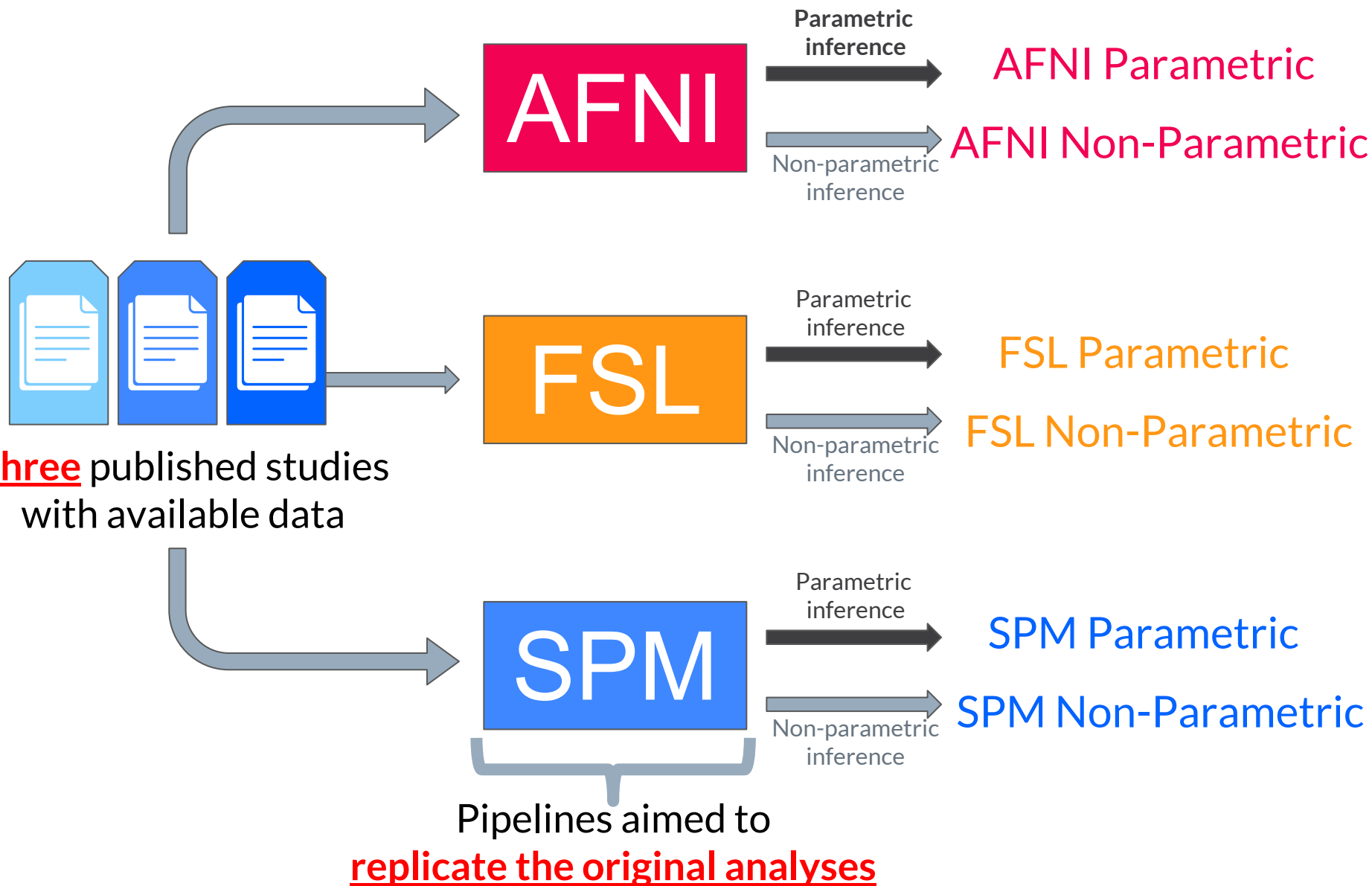
Background

- ▷ **Choice of Analysis Pipeline (functional MRI)**
Carp (2012)
- ▷ **Choice of Analysis Software Version**
Groenenschild et al (2012)
- ▷ **Choice of operating system**
Glatard et al (2015)
- ▷ **Choice of analysis software package**
Pauli et al (2016)
Bowring et al (2018) (preprint)

Background

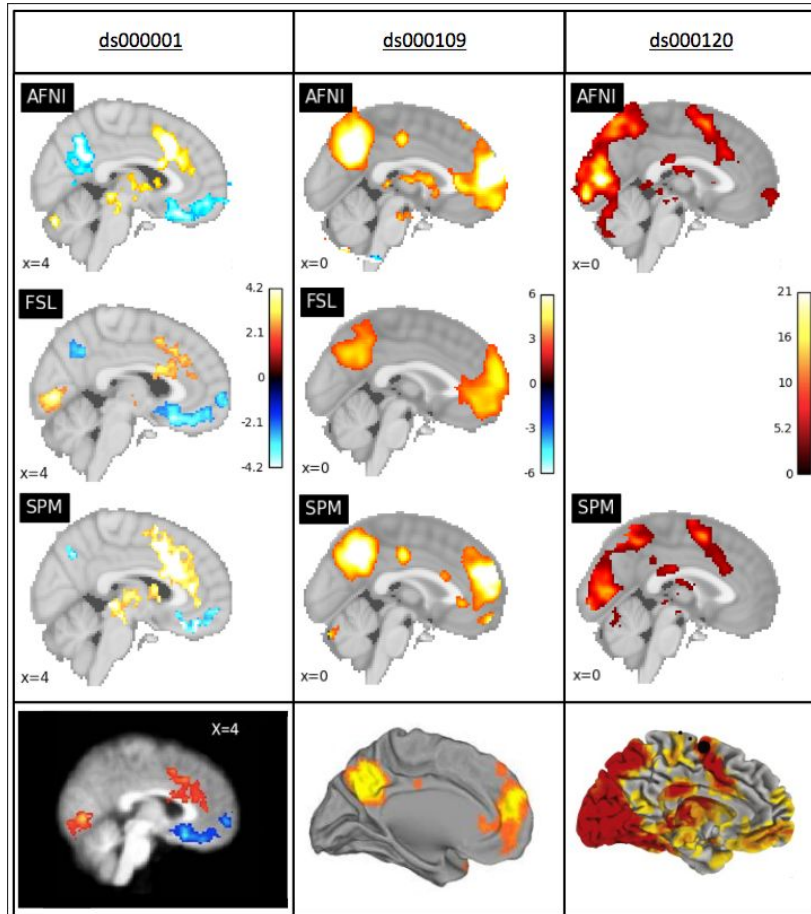
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Bowring et al (2018) (preprint)

Joint work with Alexander Bowring and Thomas Nichols



Impact of Analysis Software on Task fMRI Results

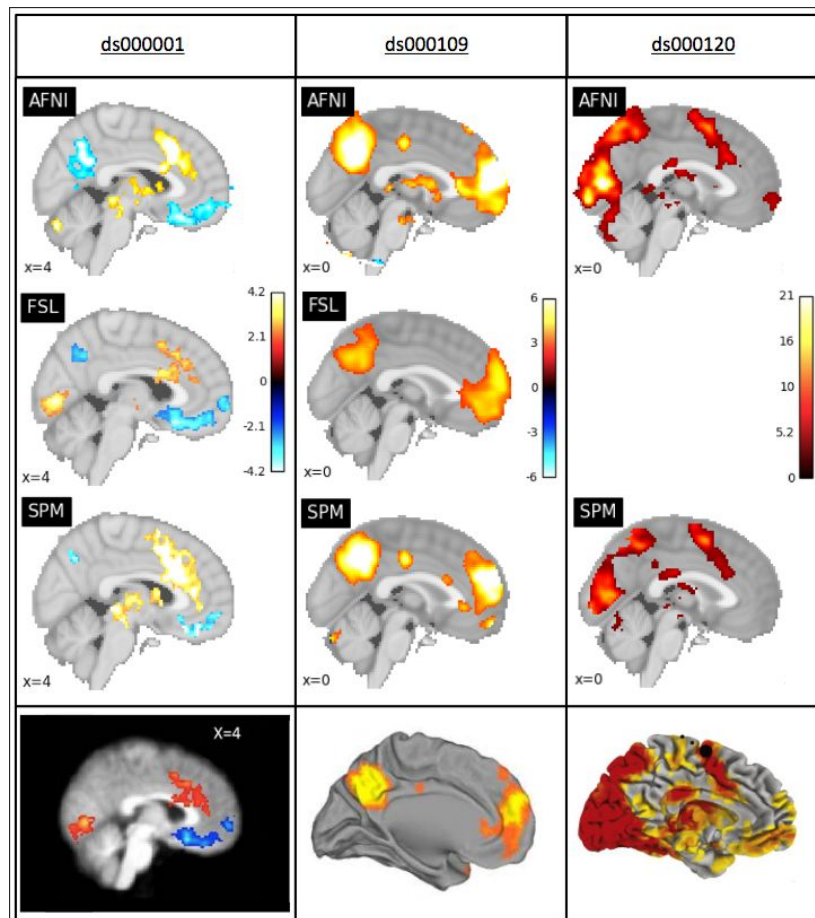
Reproducing the main figure



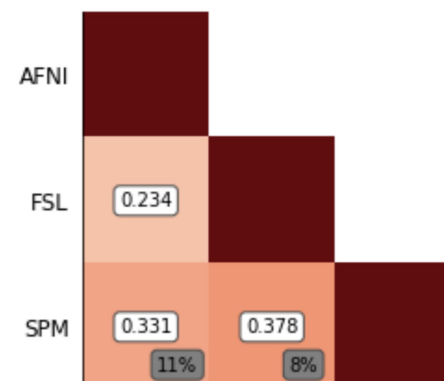
Bowring et al (2018) (preprint)

Impact of Analysis Software on Task fMRI Results

Reproducing the main figure

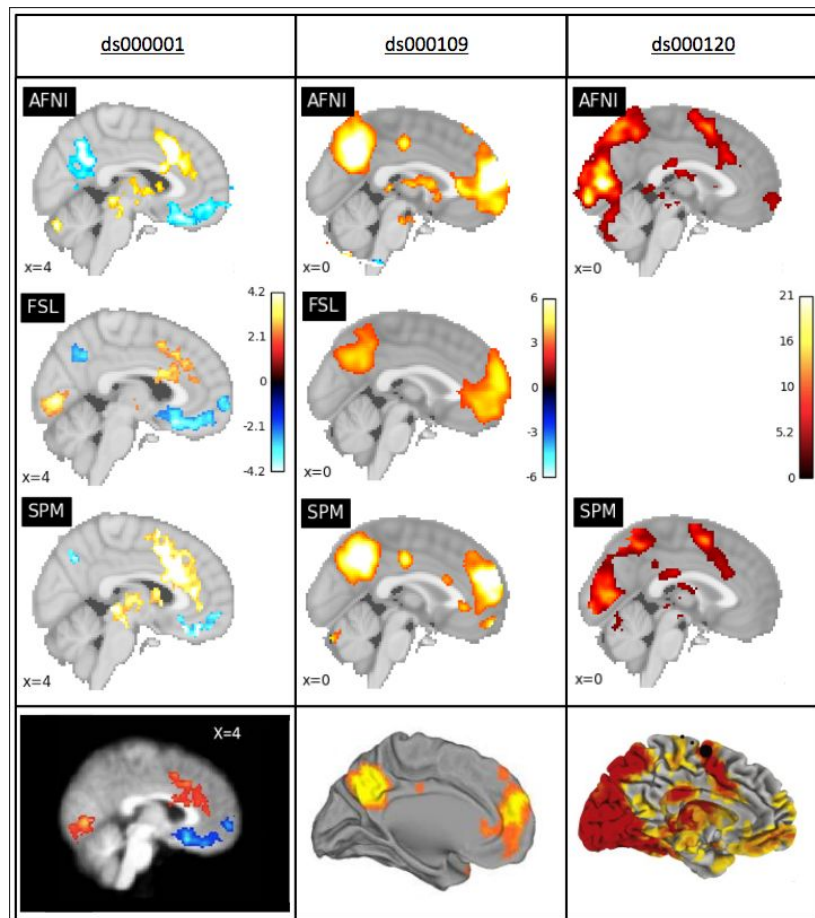


Dice coefficients

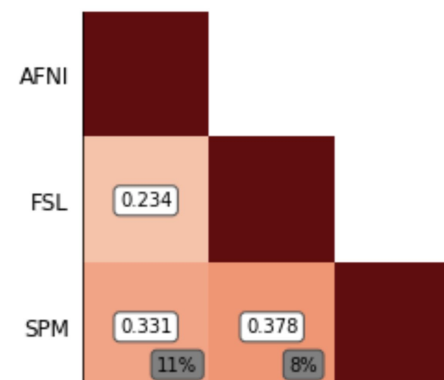


Impact of Analysis Software on Task fMRI Results

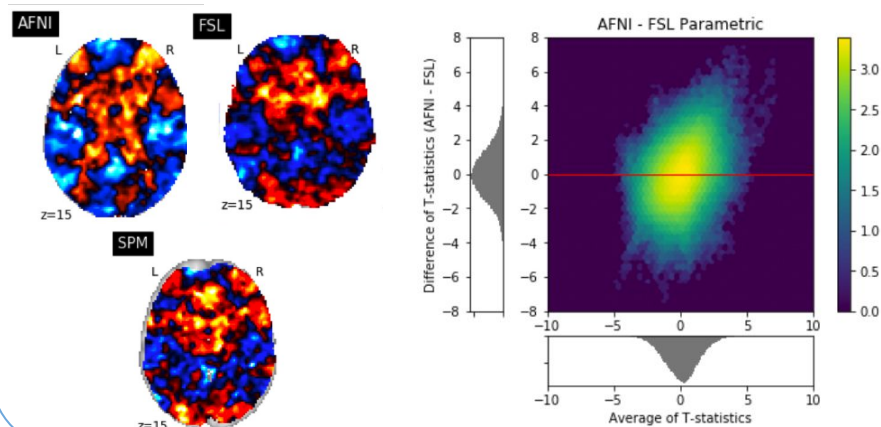
Reproducing the main figure



Dice coefficients



Unthresholded statistics

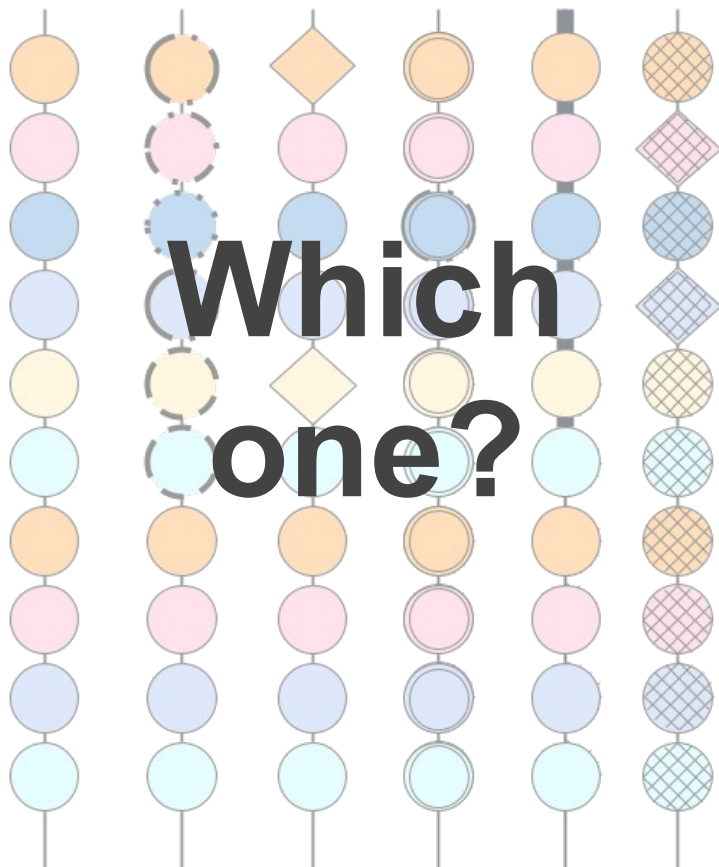




3.

Transparency

Disclosing analytical details



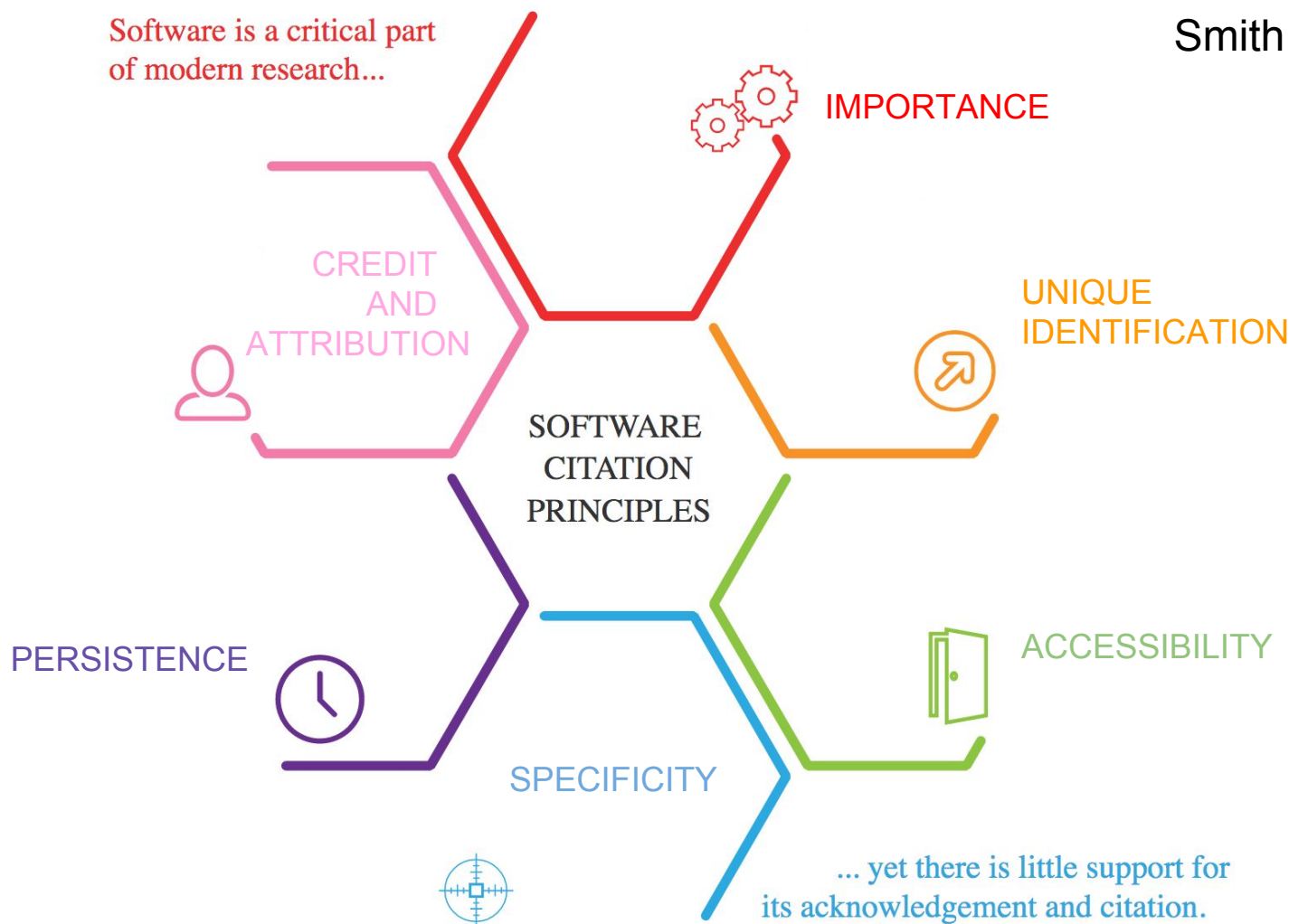
Details about the analysis pipeline are in the code.

In manuscripts, it is best practice to:

- Cite custom code
- Cite libraries and tools

How to cite software? The software citation principles

Smith et al (2016)



Citing custom code

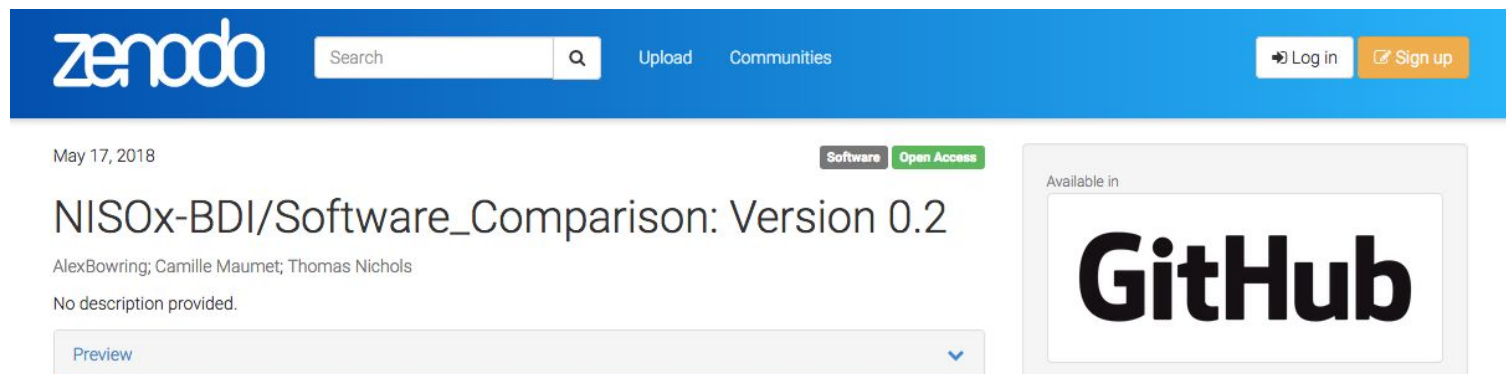
3. Results

Bowring et al (2018)

[...] All analysis scripts, results reports, and notebooks for each of study are available through Zenodo (Nielsen and Smith, 2014) at <https://zenodo.org/record/1203654> (Alexander Bowring et al., 2018).

Persistence

Accessibility



The screenshot shows the Zenodo website interface. At the top is a blue header with the Zenodo logo, a search bar, and links for 'Upload' and 'Communities'. On the right of the header are 'Log in' and 'Sign up' buttons. Below the header, the record details for 'NISOx-BDI/Software_Comparison: Version 0.2' are displayed. The record is dated 'May 17, 2018' and has tags for 'Software' and 'Open Access'. The authors listed are 'AlexBowring; Camille Maumet; Thomas Nichols'. A note states 'No description provided.' Below this is a 'Preview' button. To the right of the record details is a box labeled 'Available in' which contains the GitHub logo.



Let others cite your code

The screenshot shows a Zenodo repository page for the project 'NISOX-BDI/Software_Comparison: Version 0.2'. The page includes a header with the Zenodo logo, a search bar, and links for 'Upload' and 'Communities'. The main content area displays the project title, authors (AlexBowring, Camille Maumet, Thomas Nichols), and a 'No description provided' message. A file tree for 'Software_Comparison-0.2.0.zip' is shown, listing various files and folders. A table at the bottom lists the files and their sizes. On the right side, there are sections for 'Available in' (GitHub), 'Publication date' (May 17, 2018), 'DOI' (10.5281/zenodo.1248809), 'Related identifiers', 'License (for files)', 'Versions', and 'Share'. Annotations are present: an orange box labeled 'Attribution' points to the authors; a green box labeled 'Unique identifier' points to the DOI; a blue box labeled 'Specificity' points to the 'Versions' section.

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May 17, 2018 Software Open Access

NISOX-BDI/Software_Comparison: Version 0.2

AlexBowring; Camille Maumet; Thomas Nichols

No description provided.

Preview Attribution

Software_Comparison-0.2.0.zip

- Software_Comparison-0.2.0
 - .gitignore 482 Bytes
 - README.md 7.4 kB
 - ds001
 - AFNI
 - LEVEL2
 - euler_chars.csv 941 Bytes
 - permutation_test
 - euler_chars.csv 933 Bytes
 - SCRIPTS
 - level2.sh 7.7 kB
 - permutation_test.sh 4.8 kB
 - sub-01_level1.sh 4.3 kB
 - sub-02_level1.sh 4.3 kB
 - sub-03_level1.sh 4.3 kB
 - sub-04_level1.sh 4.3 kB
 - sub-05_level1.sh 4.3 kB
 - sub-06_level1.sh 4.3 kB

Files (11.3 MB)

Name	Size	Preview	Download
Software_Comparison-0.2.0.zip	11.3 MB		

md5:418825948cf76d92c4943714fcc96af0

Available in

GitHub

Publication date: May 17, 2018

DOI: 10.5281/zenodo.1248809 Unique identifier

Related identifiers: Supplement to: https://github.com/NISOX-BDI/Software_Comparison/tree/v0.1

License (for files): Other (Open)

Specificity

Versions

Version 0.2	10.5281/zenodo.1248809	May 17, 2018
Version v0.1	10.5281/zenodo.1203655	Mar 19, 2018

Cite all versions? You can cite all versions by using the DOI 10.5281/zenodo.1203654. This DOI represents all versions, and will always resolve to the latest one. Read more.

Share

Icons for social media sharing: GitHub, Twitter, Facebook, Print, and a plus sign for more options.

Citing libraries and tools

2.2 Data Analyses

Bowring et al (2018)

All data analyses were conducted using AFNI 17.0.18 (RRID:SCR_005927, (Cox, 1996)), FSL 5.0.10 (RRID:SCR_002823, (Jenkinson et al., 2012)), and SPM12 v6906 (RRID:SCR_007037, (Penny et al., 2011)).

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Specificity

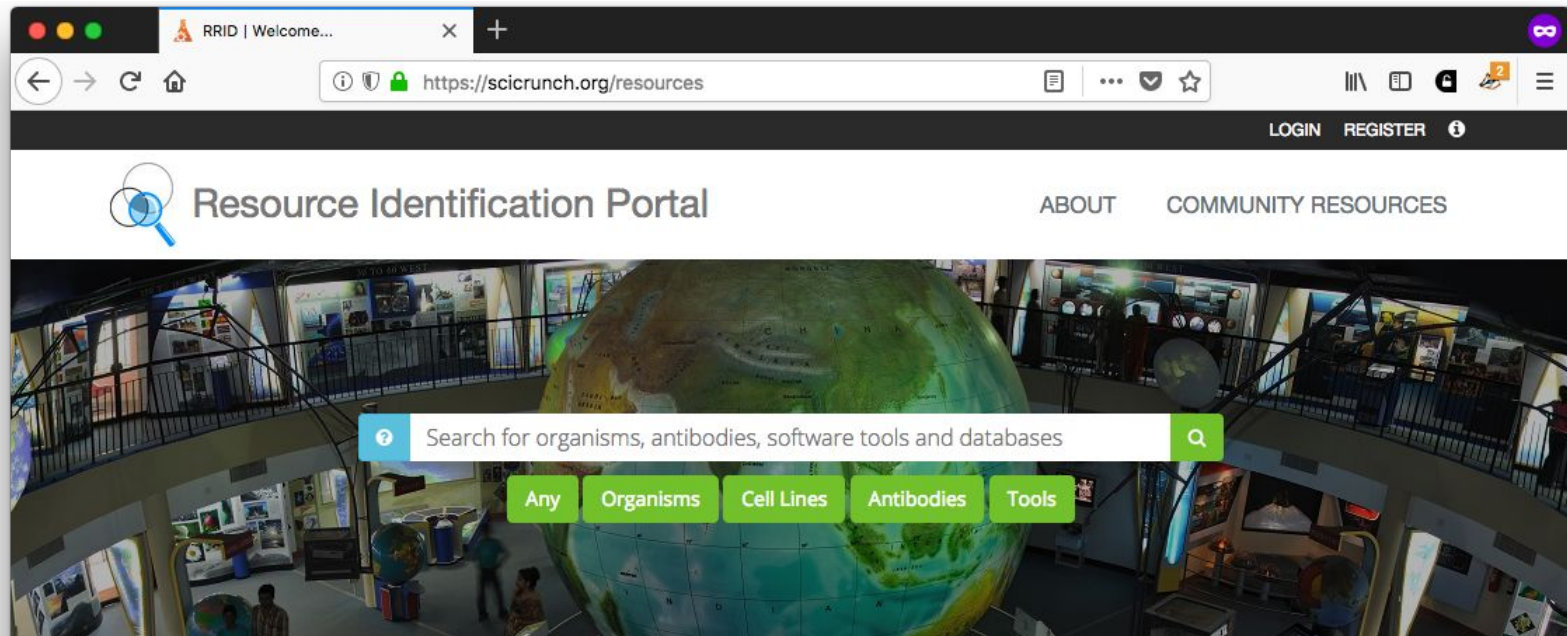
Unique identifier

Citing libraries and tools

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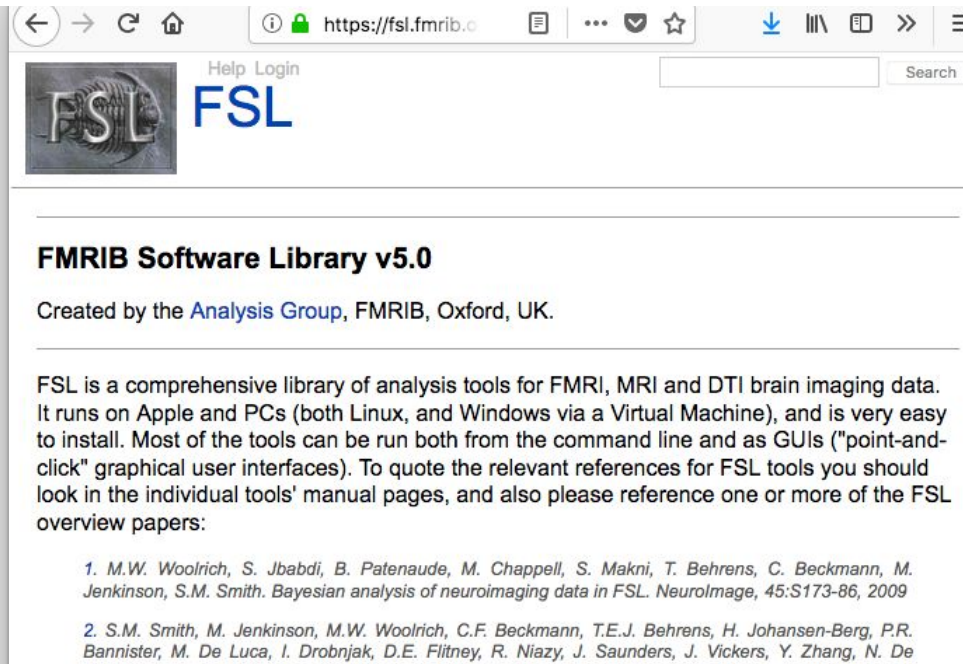


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Citing libraries and tools

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Also applies to other (non-neuroimaging) tools, repositories and libraries...

2.5 Scripting of analyses and figures

Bowring et al (2018)

A Python **Jupyter Notebook** (Kluyver et al., 2016) was created for each of the three studies. Each notebook harvests our results data from **Neurovault** (RRID:SCR_003806) and applies the variety of methods discussed in the previous section using **NiBabel** 2.2.0 (Brett et al., 2017), **NumPy** 1.13.3 (Walt et al., 2011) and **Pandas** 0.20.3 (McKinney and Others, 2010) packages. Figures were created using **Matplotlib** 2.1.0 (Hunter, 2007) and **Nilearn** 0.4.0 (Abraham et al., 2014).

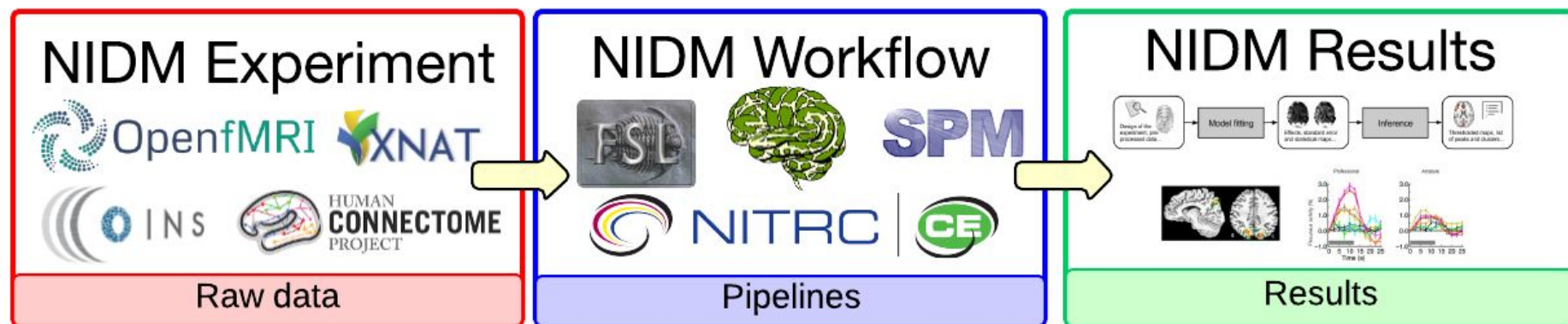


Provenance

“Provenance is information about entities, activities, and people involved in producing a piece of data or thing” — W3C PROV

Machine-readable provenance

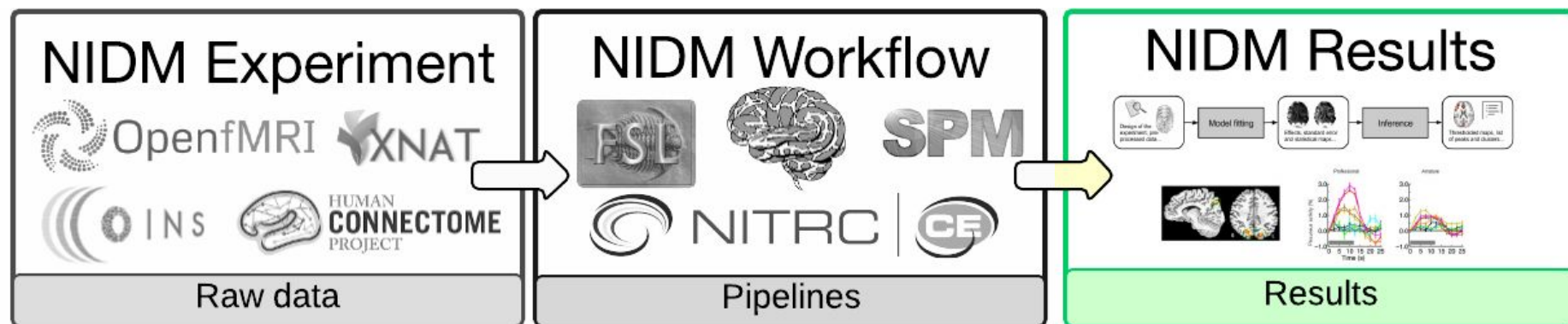
Machine-readable provenance



NIDM: neuroimaging data model

International collaboration with INCF SIG on Reproducibility and Best Practices in Human Brain Imaging

Machine-readable provenance



NIDM: neuroimaging data model

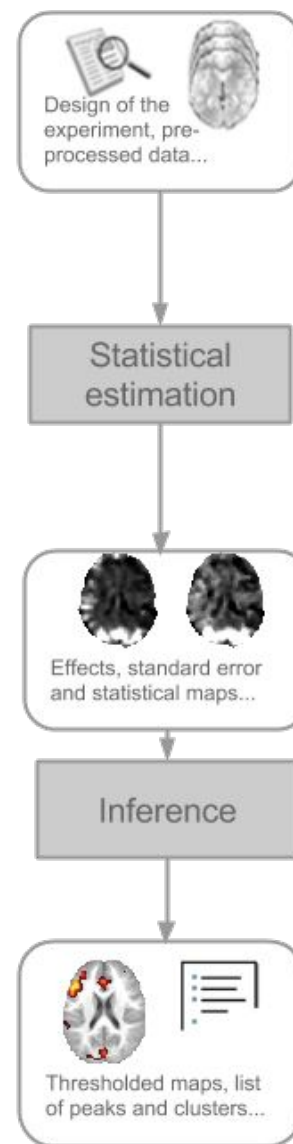
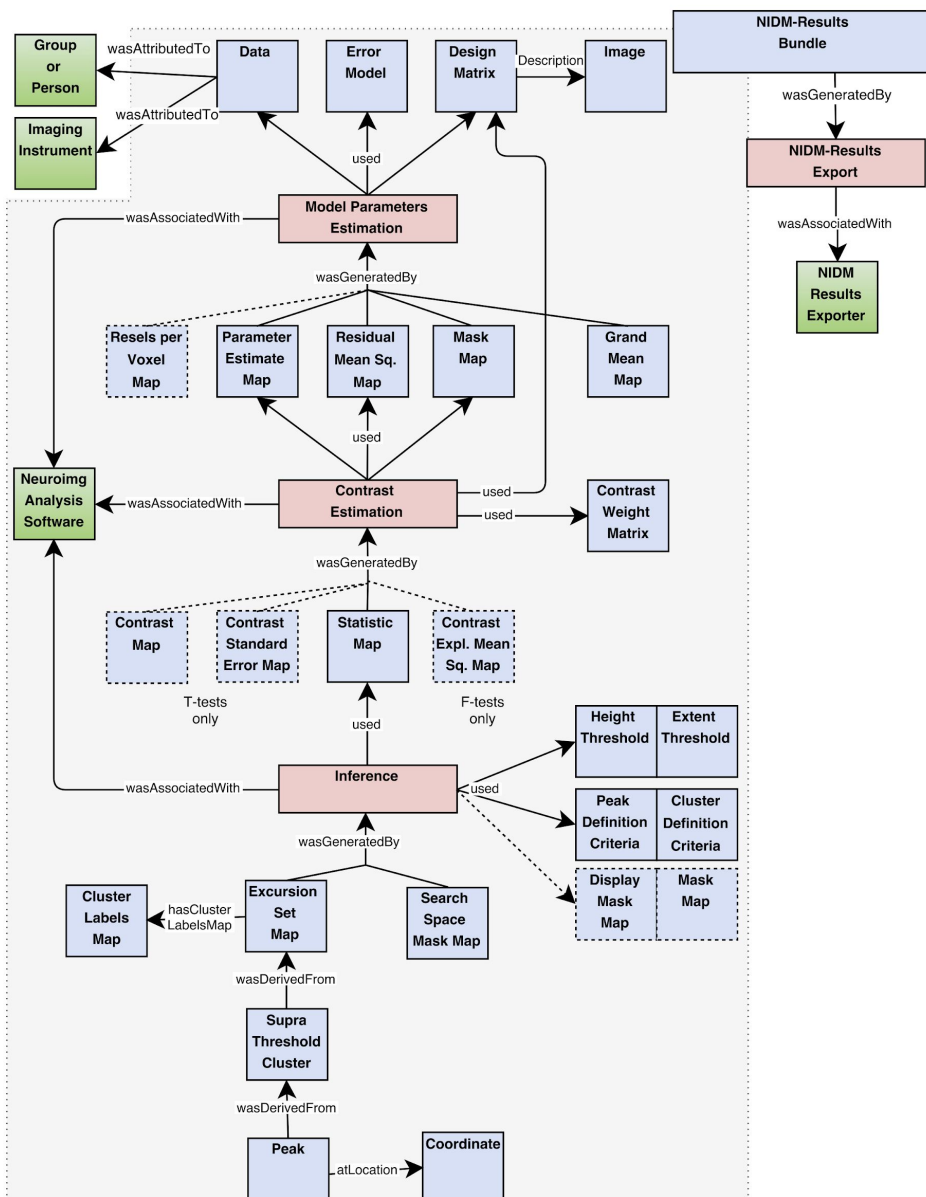
International collaboration with INCF SIG on Reproducibility and Best Practices in Human Brain Imaging.

NIDM-Results → fMRI, VBM results

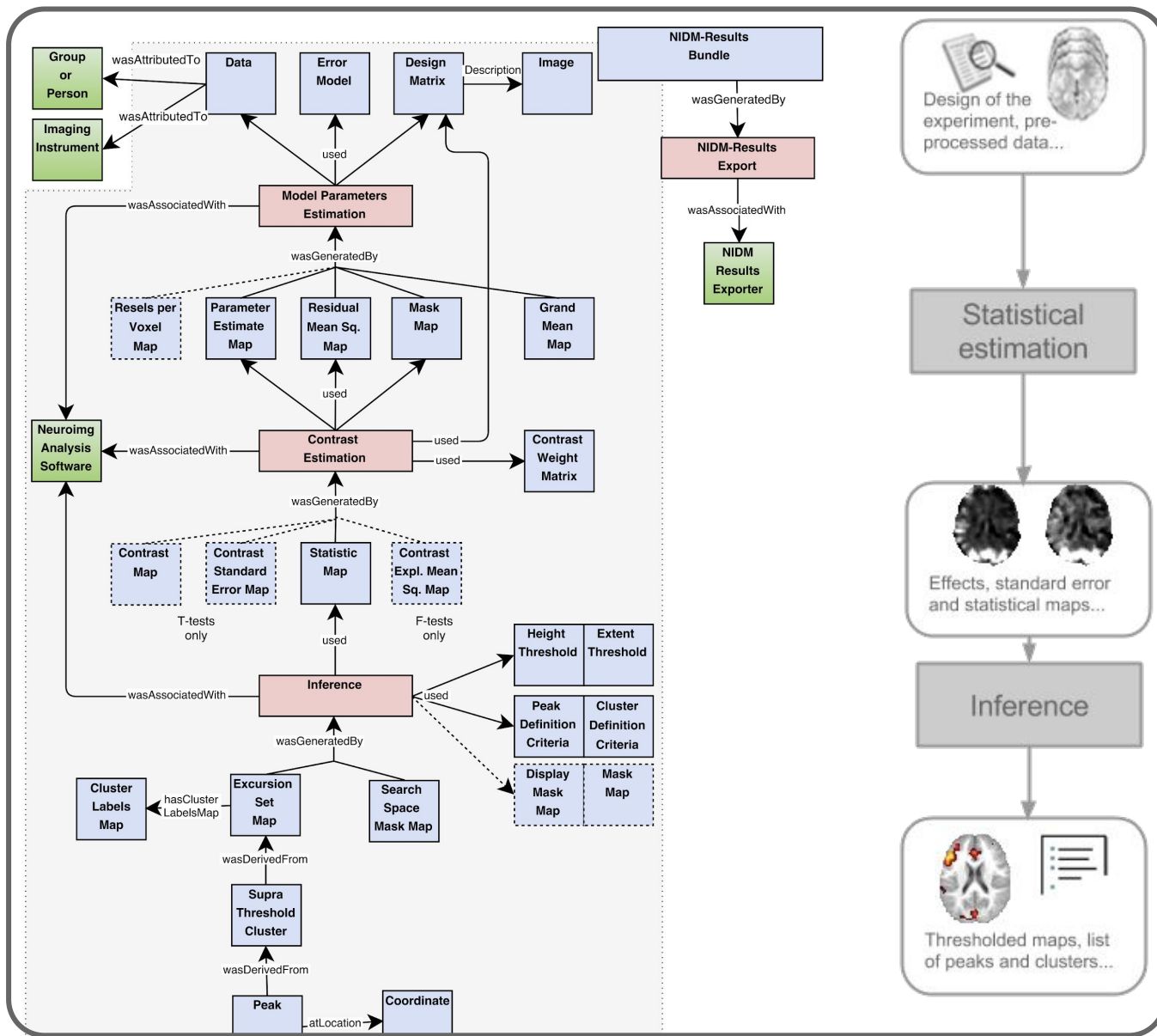
Harmonised model and provenance.

Joint work with INCF NIDASH working group - <https://github.com/incf-nidash/>

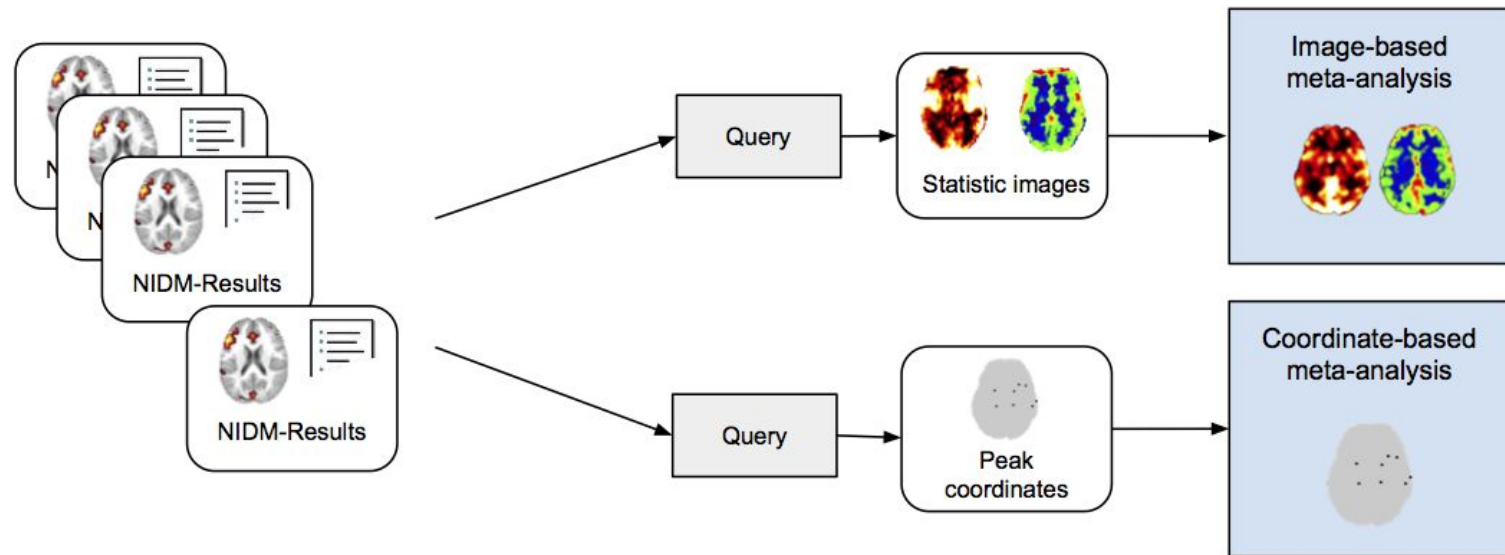
NIDM-Results in brief



NIDM-Results in brief



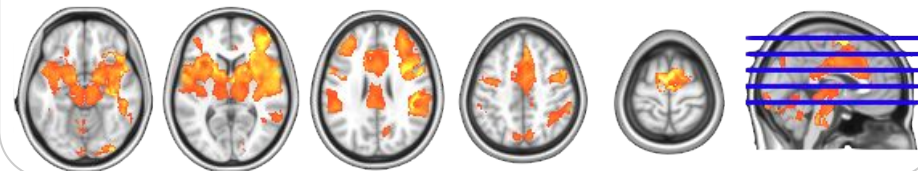
Derived data reuse with NIDM-Results: meta-analysis



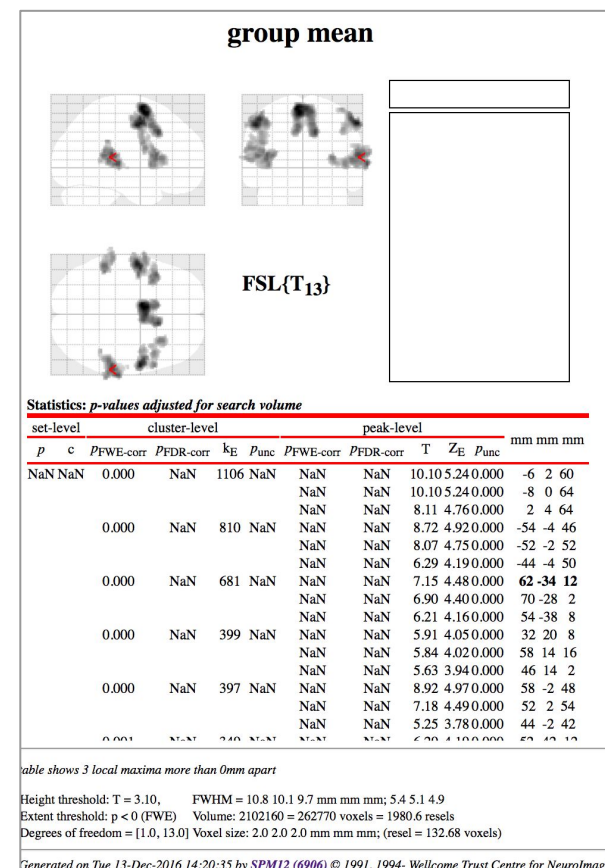
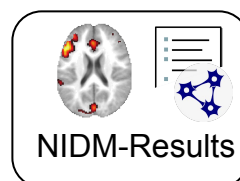
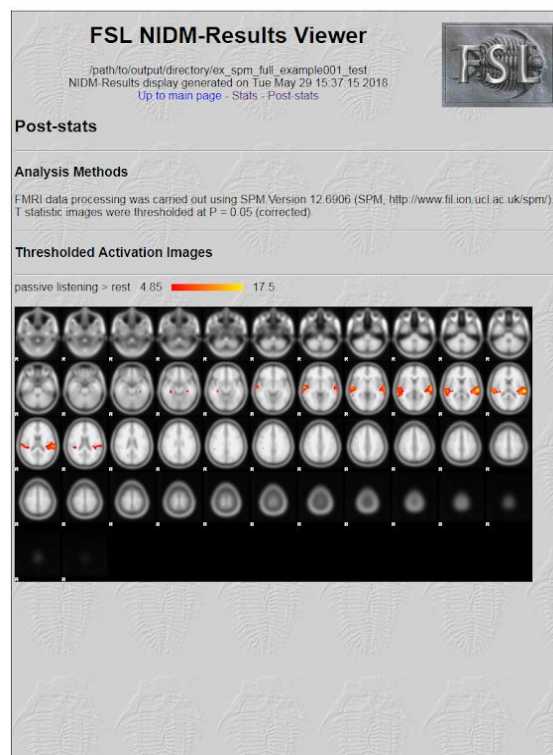
Coordinate-based meta-analysis



Image-based meta-analysis



Derived data inspection with NIDM-Results: SPM- and FSL-like views

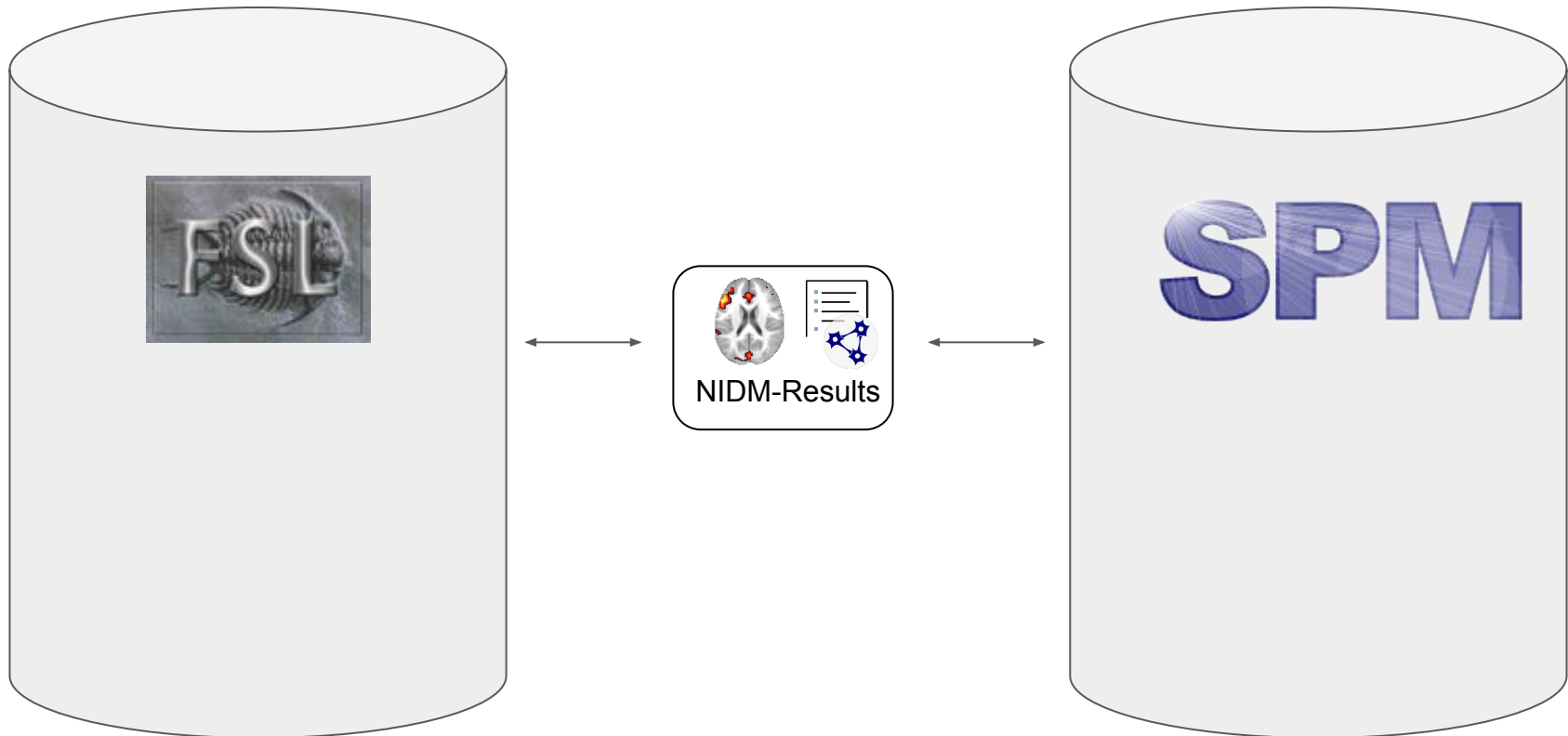


<https://github.com/incf-nidash/nidmresults-spmhtml>

<https://github.com/incf-nidash/nidmresults-fslhtml>

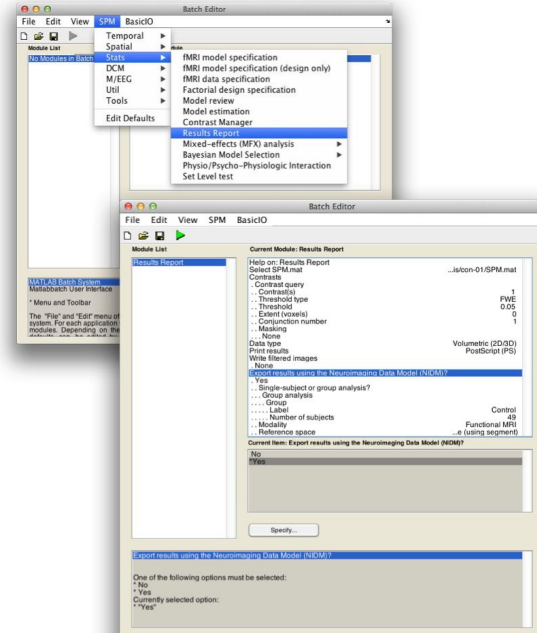
Maullin-Sapey et al (2017)

Derived data inspection with NIDM-Results: SPM- and FSL-like views



How to use NIDM-Results for my study?

SPM



1. Export



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

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

2. Publication on NeuroVault

NeuroVault Collections FAQ Give feedback

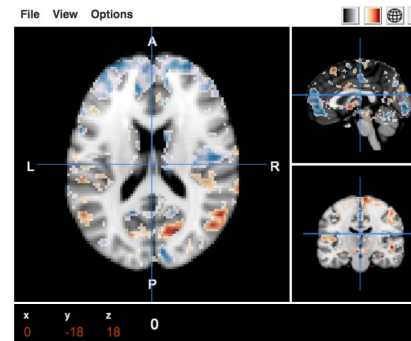
A Correspondence between Individual Differences in the Brain's Intrinsic Functional Architecture and the Content and Form of Self-Generated Thoughts

Contributed by ChrisFilioGorgolewski

Krzysztof J. Gorgolewski, Dan Lurie, Sebastian Urchs, Judy A. Kipping, R. Cameron Craddock, Michael P. Milham, Daniel S. Margulies, Jonathan Smallwood

[Link to the paper](#)

3D View



Images Details

Show 7 entries Search:

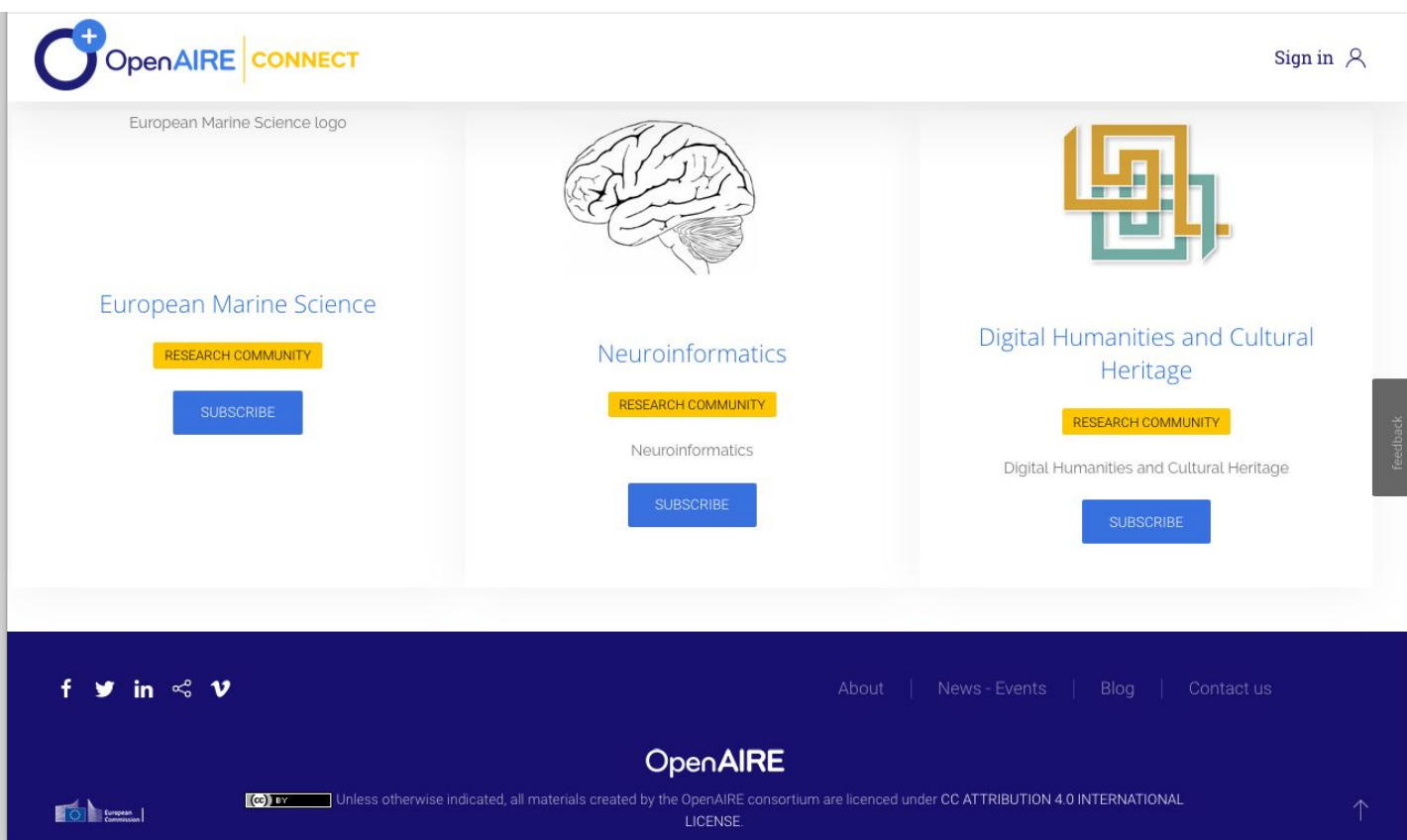
View	ID	Name	Type
	25	fALFF: Past	Z map
	26	fALFF: Future	Z map
	27	fALFF: Past > Future	Z map
	28	fALFF: Positive	Z map
	29	fALFF: Negative	T map
	30	fALFF: Positive > Negative	Z map
	31	fALFF: Social Cognition	Z map

Showing 1 to 7 of 30 entries

First Previous Next Last

One step further: linking it all together!

“Gather, view and monitor all research outcomes”



One step further: linking it all together!

“Gather, view and monitor all research outcomes”



The screenshot shows the Neuroinformatics dashboard on the OpenAIRE CONNECT platform. At the top, there is a navigation bar with a brain icon, the title "Neuroinformatics", and links for "Search", "Monitor", "Share", and "Link". On the right, there are links for "Sign in" and a "SUBSCRIBE" button. Below the navigation bar, the dashboard displays a list of tags for neuroinformatics research, including "BRAIN MAPPING", "BRAIN IMAGING", "ELECTROENCEPHALOGRAPHY", "ARTERIAL SPIN LABELLING", "BRAIN FINGERPRINTING", "BRAIN", "NEUROIMAGING", "MULTIMODAL BRAIN IMAGE ANALYSIS", "FMRI", and "NEUROINFORMATICS". A "show more" link is provided. Below the tags, the dashboard shows the number of publications (87), research data (1), software (0), projects (10), and content providers (5). The "Recent publications" section lists a paper titled "TOWARDS INTEGRATING SPATIAL LOCALIZATION IN CONVOLUTIONAL NEURAL NETWORKS FOR BRAIN IMAGE SEGMENTATION" by UNKNOWN (2018). The "Recent research data" section lists a software package titled "BROCCOLI: SOFTWARE FOR FAST FMRI ANALYSIS ON MANY-CORE CPUS AND GPUS" by Anders Eklund (2014). The "Recent software" section shows "No results found". A "feedback" button is located on the right side of the dashboard.

Many ways to contribute

You can...

- Make your research outputs available and citable
- Cite existing software
- Use derived data standards and tools
- Contribute to the development of new specifications and their ecosystems
- Make datasets in neuroimaging data repository discoverable

Join the NIDASH community! <https://github.com/incf-nidash/nidm-specs>

OpenAIRE-connect portal: <https://beta.ni.connect.openaire.eu/> and
guidelines for data repository managers:

<https://www.openaire.eu/openaire-guide-for-repository-managers>

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Presentation template by [SlidesCarnival](#), adapted.

Acknowledgements

NIDM working group

Tibor Auer, Alexander Bowring, Samir Das, Fariba Fana, Guillaume Flandin, Satra Ghosh, Tristan Glatard, Chris Gorgolewski, Karl Helmer, Dorota Jarecka, David Keator, Tom Maullin-Sapey, Nolan Nichols, Tom Nichols, Smruti Padhy, Jean-Baptiste Poline, Vanessa Sochat, Jason Steffener, Jessica Turner.

Neuroimaging software teams

Gang Chen, Richard Reynolds, Robert Cox (AFNI), Mark Jenkinson, Matthew Webster, Paul McCarthy, Eugene Duff, Steve Smith (FSL), Guillaume Flandin (SPM).

Meta-analysis datasets Tracey group at FMRIIB.

Thank you! To all INCF NIDASH task force members.

Thank you!




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