



Let's do open neuroimaging sciences

Camille Maumet

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Let's do open neuroimaging sciences

Camille Maumet



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



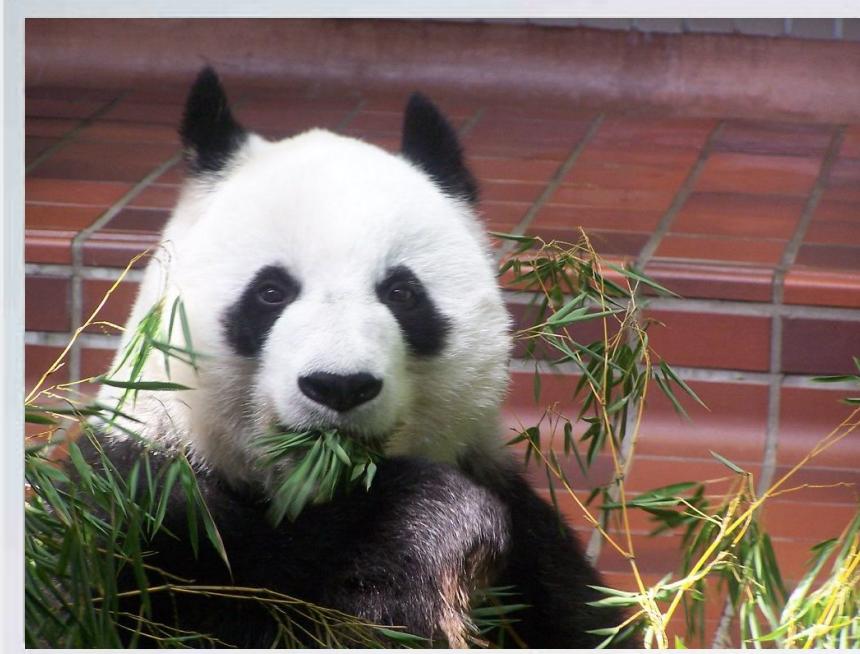
GEANT workshop
May 21st, 2019



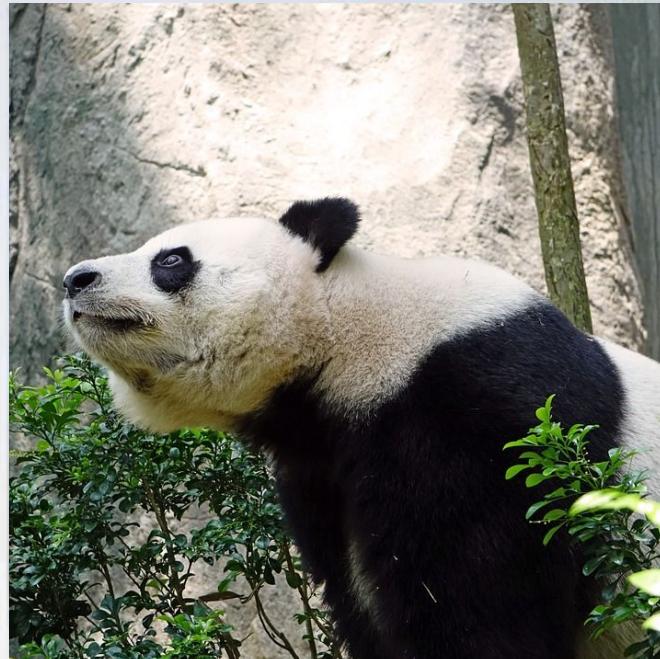
Why open?

Why open?

Thoughts on generalizability

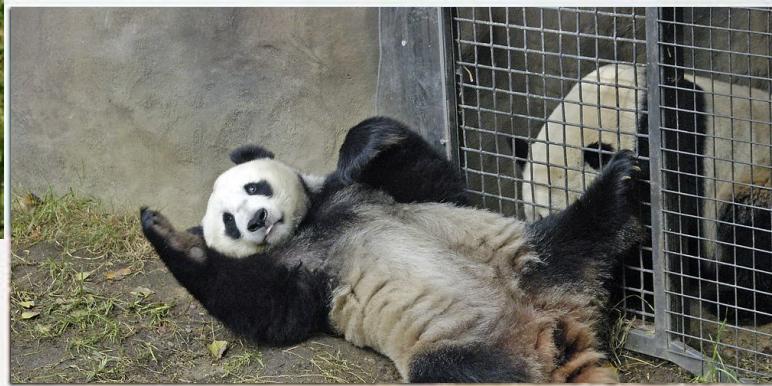
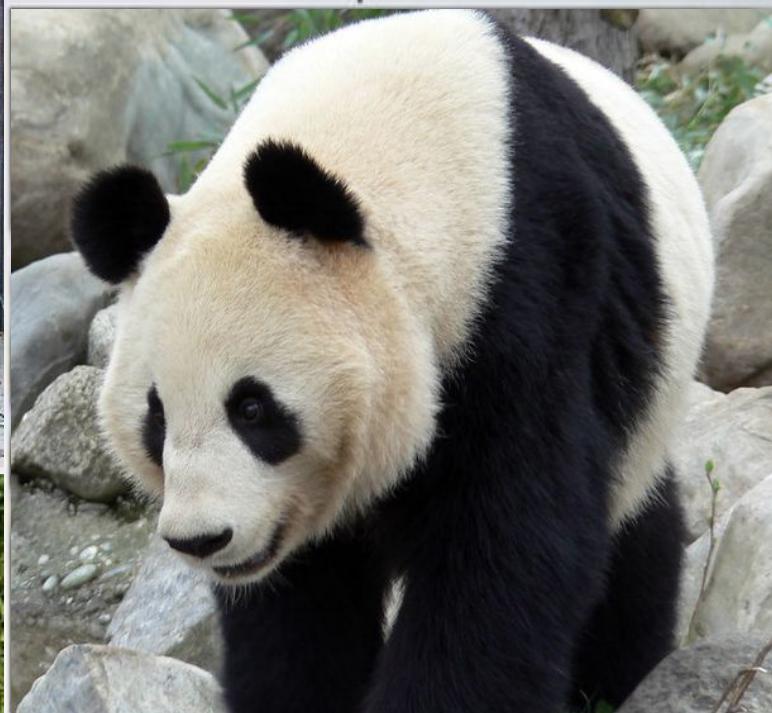


happy pandas



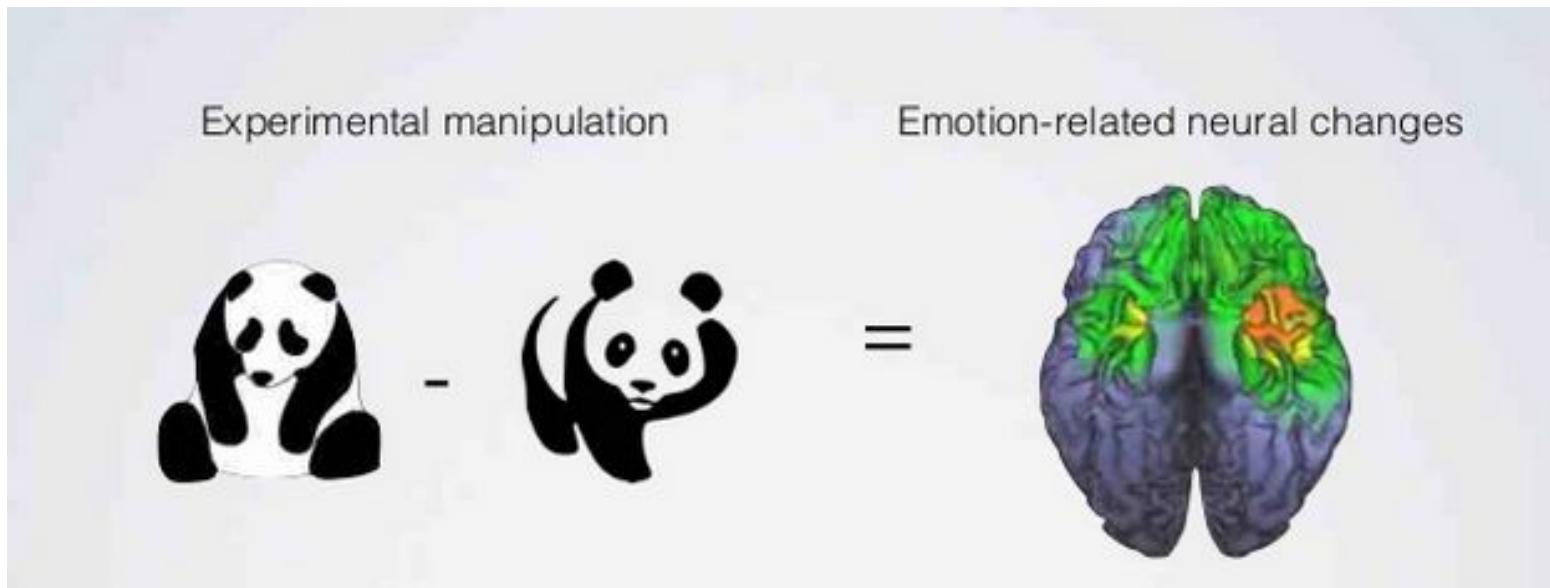
Slide by Tal Yarkoni (reused with permission), adapted.

Image credits: [Panda 1](#) by N. Rupert (CC BY-SA), [Panda 2](#) by Max Pixel (CC0), [Panda 3](#) by D. Silaraja (Free to use), [Panda 4](#) by N. Aishah (Free to use).



Slide by Tal Yarkoni (reused with permission), adapted.

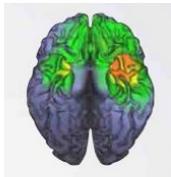
Image credits: [Panda 1](#) by Shizhao ([CC BY-SA](#)), [Panda 2](#) by mozzercork ([CC BY](#)), [Panda 3](#) by SevenLittleThings ([CC BY](#)), [Panda 4](#) by auntie rain ([CC BY-NC-SA](#)).



Greater amygdala activation in response to affective mammalian expressions relative to neutral mammalian expressions

Sed ut perspiciatis unde omnis iste natus error sit voluptatem accusantium doloremque laudantium, totam rem aperiam, eaque ipsa quae ab illo inventore veritatis et quasi architecto beatae vitae dicta sunt explicabo. Nemo enim ipsam voluptatem quia voluptas sit aspernatur aut odit aut fugit, sed quia consequuntur magni dolores eos qui ratione voluptatem sequi nesciunt. Neque porro quisquam est, qui dolorem ipsum quia dolor sit amet.

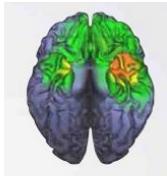
Consectetur, adipisci velit, sed quia non numquam eius modi tempora incident ut labore et dolore magnam aliquam quaerat voluptatem. Ut enim ad minima veniam, quis nostrum exercitationem ullam corporis suscipit laboriosam, nisi ut aliquid ex ea commodi consequatur? Quis autem vel eum iure reprehenderit qui in ea voluptate velit esse quam nihil molestiae consequatur, vel illum qui dolorem eum fugiat quo voluptas nulla pariatur?



Greater amygdala activation in response to affective mammalian expressions relative to neutral mammalian expressions

Sed ut perspiciatis unde omnis iste natus error sit voluptatem accusantium doloremque laudantium, totam rem aperiam, eaque ipsa quae ab illo inventore veritatis et quasi architecto beatae vitae dicta sunt explicabo. Nemo enim ipsam voluptatem quia voluptas sit aspernatur aut odit aut fugit, sed quia consequuntur magni dolores eos qui ratione voluptatem sequi nesciunt. Neque porro quisquam est, qui dolorem ipsum quia dolor sit amet.

Consectetur, adipisci velit, sed quia non numquam eius modi tempora incident ut labore et dolore magnam aliquam quaerat voluptatem. Ut enim ad minima veniam, quis nostrum exercitationem ullam corporis suscipit laboriosam, nisi ut aliquid ex ea commodi consequatur? Quis autem vel eum iure reprehenderit qui in ea voluptate velit esse quam nihil molestiae consequatur, vel illum qui dolorem eum fugiat quo voluptas nulla pariatur?

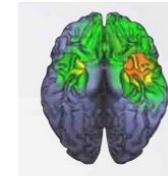


???

Greater amygdala activation in **22 UT-Austin undergraduates** when **viewing images angst_tree_panda.jpg and panda_delight.png than image pand_goes_meh.jpg**

Sed ut perspiciatis unde omnis iste natus error sit voluptatem accusantium doloremque laudantium, totam rem aperiam, eaque ipsa quae ab illo inventore veritatis et quasi architecto beatae vitae dicta sunt explicabo. Nemo enim ipsam voluptatem quia voluptas sit aspernatur aut odit aut fugit, sed quia consequuntur magni dolores eos qui ratione voluptatem sequi nesciunt. Neque porro quisquam est, qui dolorem ipsum quia dolor sit amet.

Consectetur, adipisci velit, sed quia non numquam eius modi tempora incident ut labore et dolore magnam aliquam quaerat voluptatem. Ut enim ad minima veniam, quis nostrum exercitationem ullam corporis suscipit laboriosam, nisi ut aliquid ex ea commodi consequatur? Quis autem vel eum iure reprehenderit qui in ea voluptate velit esse quam nihil molestiae consequatur, vel illum qui dolorem eum fugiat quo voluptas nulla pariatur?

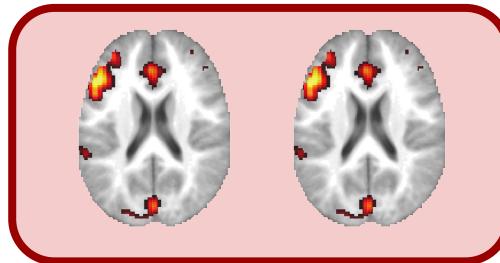


How can we get
there?

How can we get
there?

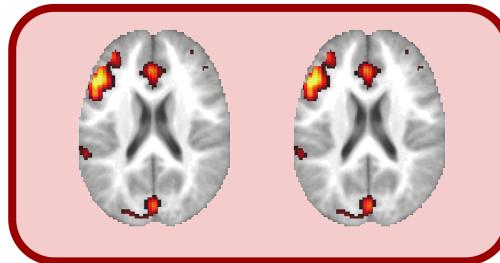
Variations on
reproducibility

Robustness to generalizability



Robustness → Generalizability

Robustness to generalizability



Repeat

Same lab
Same experiment
Same settings

Reproduce

Different lab
Same experiment
Different settings

Replicate

Different lab
Same experiment
Same settings

Robustness



Generalizability

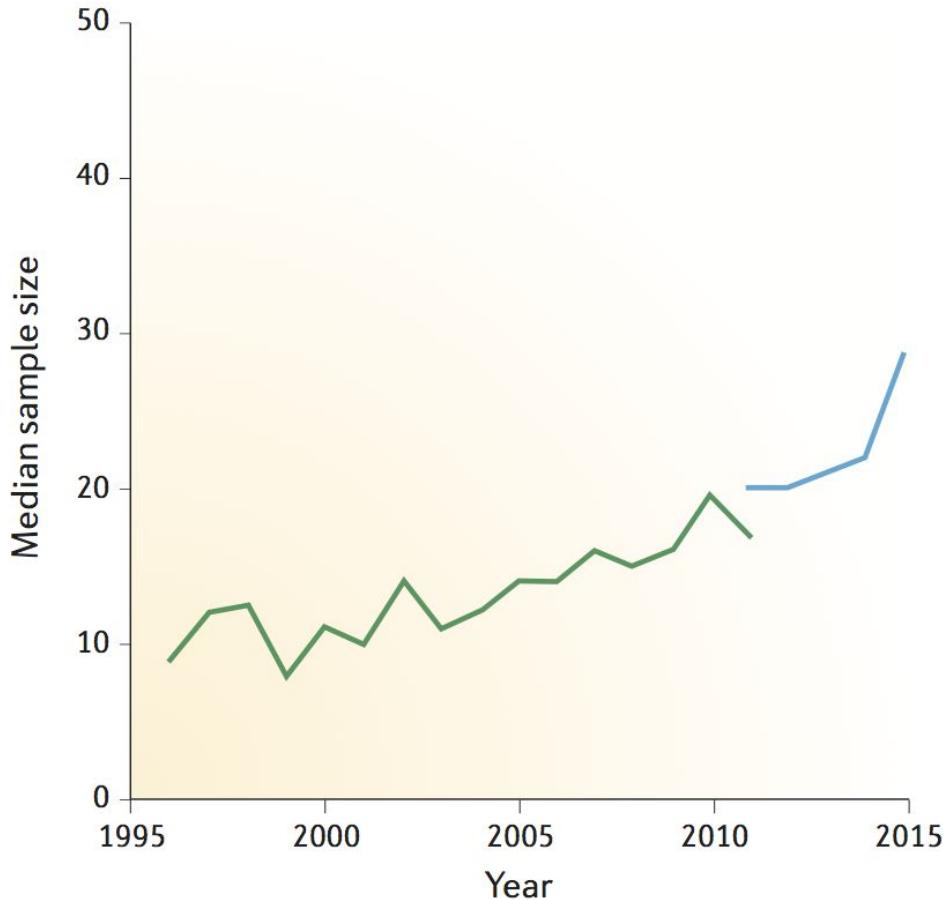
Table B1. Levels of Reproducibility

This table provides an incomplete taxonomy of types of consistency of neuroimaging results. For each type of consistency (row), the variable (column) that is held constant (•, bullet) or allowed to vary (D=different) is indicated. In each instance, a bullet (•) indicates the exact same setting; for the variable "Subject" this means the very same acquired data is used, while a double bullet (••) indicates the same subjects are scanned multiple times. Examples of different Experimental Methods include fundamental changes like an event-related design vs. a block design; examples of different Experimental Code/Stimuli, include different sets of pictures used in a visual working memory experiment, or using different paradigm software; an example of different Stimuli Type would be number vs. shape vs. image stimuli in a working memory experiment. An example of different analysis methods for intrasubject (first level) fMRI data would be a confirmatory regression-based modelling vs. an exploratory data-driven method like independent components analysis; examples of different analysis code would be intrasubject fMRI fit with a regression model in two different software packages.

Type of Stability	Investigator	Experimental Method	Stimuli Type	Experimental Code/Stimuli	Subject Population	Subjects	Scanner	Acquisition Day	Data Analyst	Analysis Method	Analysis Code
Measurement Stability											
ISO Repeatability e.g. 30-minute intra-scanner reliability	•	•	•	•	•	••	•	•	•	•	•
ISO Intermediate Reproducibility e.g. 7-day intra-scanner reliability	•	•	•	•	•	••	•	D	•	•	•
ISO Reproducibility e.g. 7-day inter-scanner reliability	•	•	•	•	•	••	D	D	•	•	•
Analytical Stability											
Analysis Replicability	•	•	•	•	•	•	•	•	•	•	•
Collegial Analysis Replicability	•	•	•	•	•	•	•	•	D	•	•
Peng's Reproducibility	D	•	•	•	•	•	•	•	D	•	•
Generalisability over ...											
Subjects (Near Replicability)	•	•	•	•	•	D	•	D	•	•	•
Labs (Intermediate Replicability)	D	•	•	D	•	D	D	D	D	•	D
Experimental & Analytical methods (Far Replicability)	D	D	•	D	•	D	D	D	D	D	D
Subject & Stimulus Populations (Hypothesis Generalisability)	D	D	D	D	D	D	D	D	D	D	D

[Nichols et. al, Nature Neuroscience 2017]

Sample sizes in neuroimaging

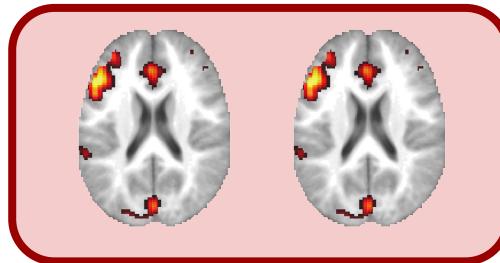


2015: 30 participants

Low diversity &
Low statistical power

[Poldrack et. al, Nature Neuroscience 2017]

Robustness to generalizability



Repeat

Same lab
Same experiment
Same settings

Reproduce

Different lab
Same experiment
Different settings

Replicate

Different lab
Same experiment
Same settings

Re-use

Different lab
Different experiment
Different settings

Robustness



Generalizability

On our way...

On our way...

Tools & standards to
publish our research

Publishing research artefacts

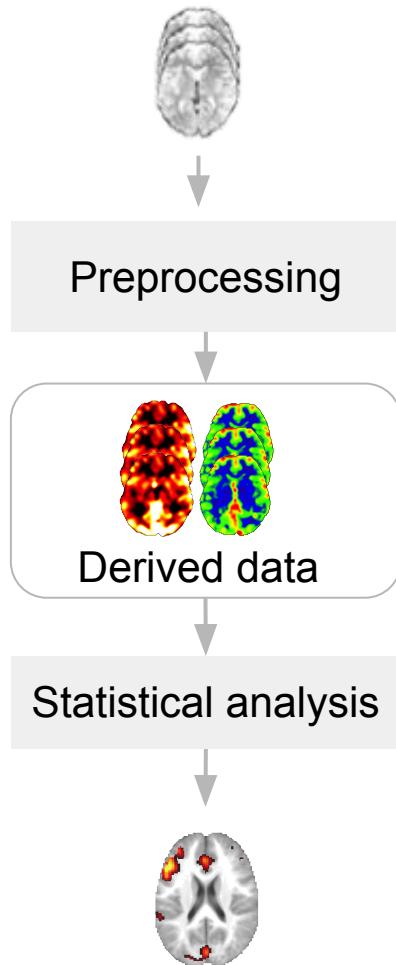


Image credits: [Parcels 1 2 & 4 \(CCo\)](#), [Parcel 3 \(CCo\)](#), [Parcel 5 \(CCo\)](#).

Publishing research artefacts

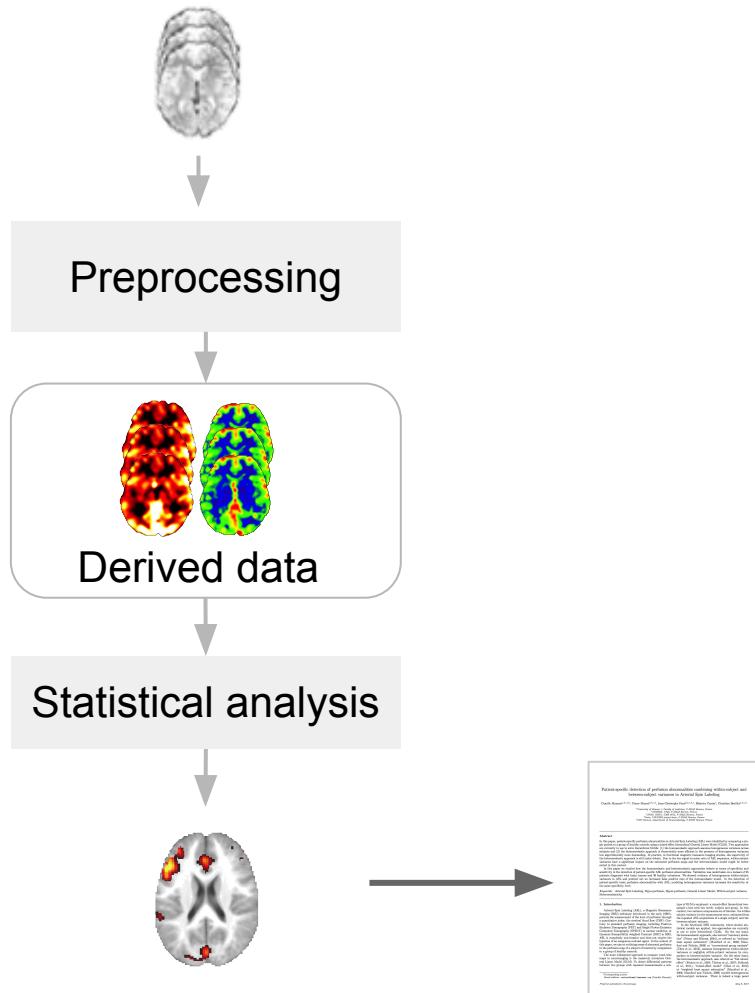


Image credits: [Parcels 1 2 & 4 \(CCo\)](#), [Parcel 3 \(CCo\)](#), [Parcel 5 \(CCo\)](#).

Publishing research artefacts

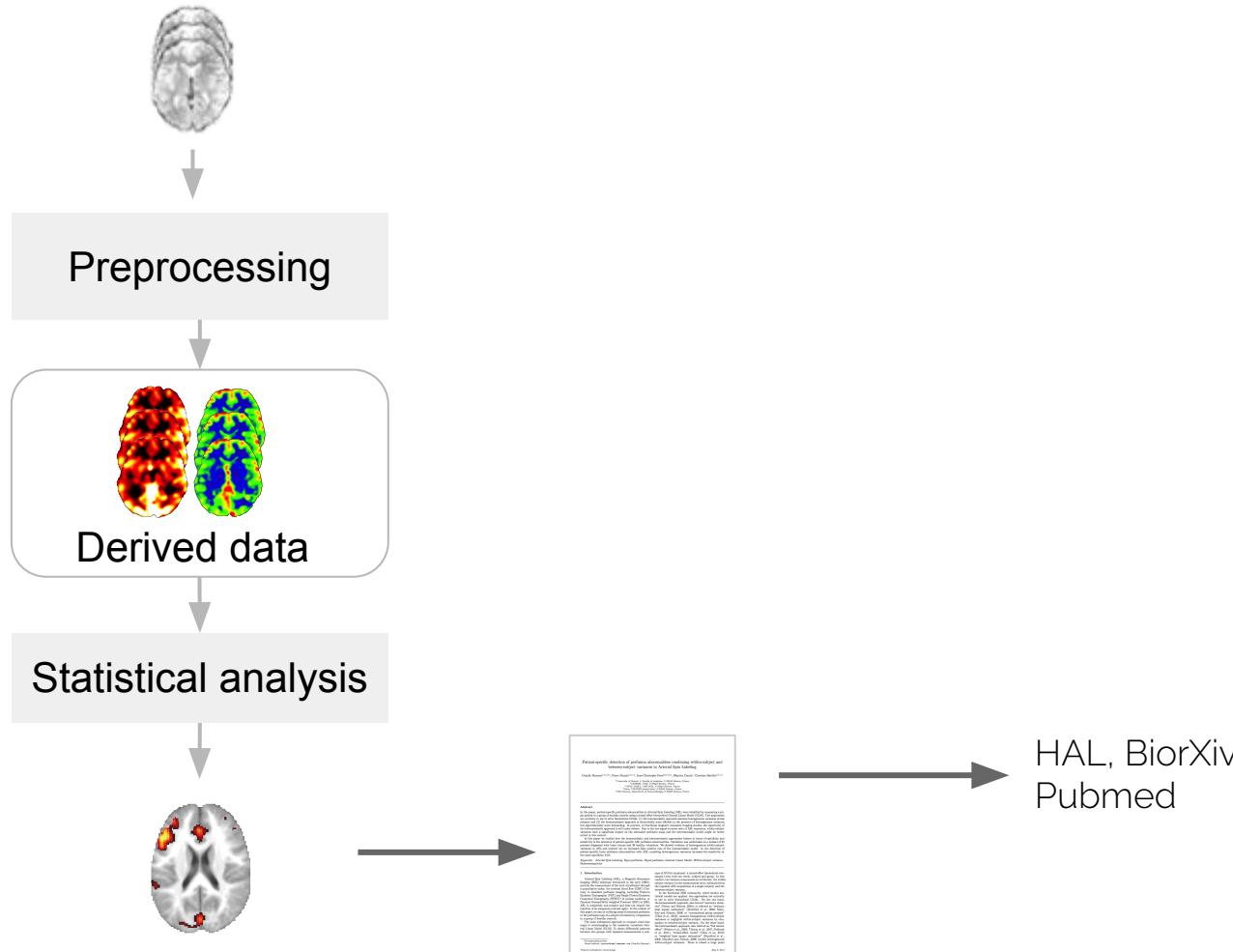


Image credits: [Parcels 1 2 & 4 \(CCo\)](#), [Parcel 3 \(CCo\)](#), [Parcel 5 \(CCo\)](#).

Publishing research artefacts

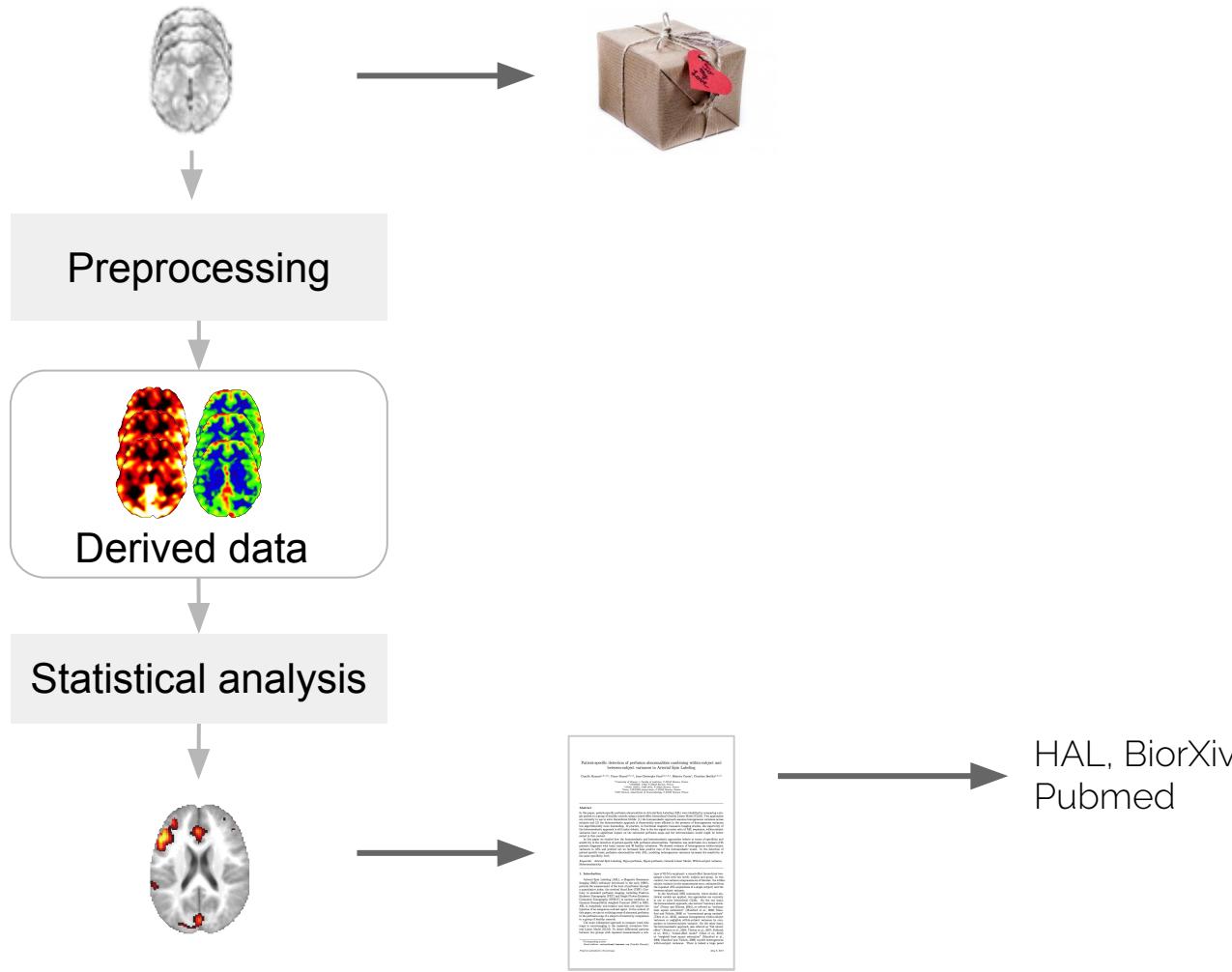


Image credits: [Parcels 1 2 & 4 \(CCo\)](#), [Parcel 3 \(CCo\)](#), [Parcel 5 \(CCo\)](#).

Brain Imaging Data Structure (BIDS)

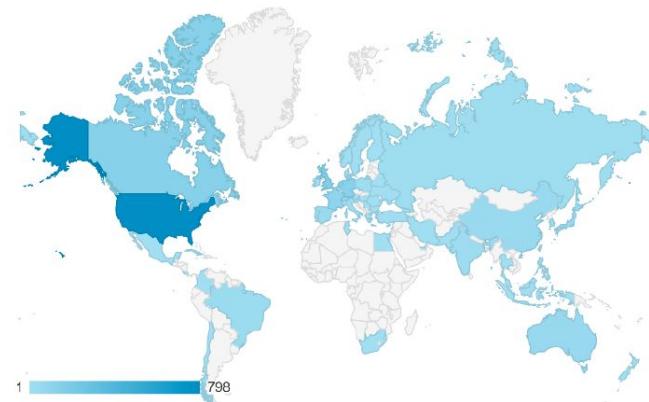
```
my_dataset/
  participants.tsv
  sub-01/
    anat/
      sub-01_T1w.nii.gz
    func/
      sub-01_task-rest_bold.nii.gz
      sub-01_task-rest_bold.json
    dwi/
      sub-01_dwi.nii.gz
      sub-01_dwi.json
      sub-01_dwi.bval
      sub-01_dwi.bvec
  sub-02/
  sub-03/
  sub-04/
```

[Gorgolewski et. al, Sci. Data 2016]

BIDS adoption

- Used in over 60 labs around the world
- Adopted by: FCP-INDI, Developing Human Connectome, SchizConnect and Donders Data repository.
- Anonymized data from over 20,000 participants formatted in BIDS are publicly available
- >300 members of mailing list
- Extensions: MEG, iEEG, EEG (just released)

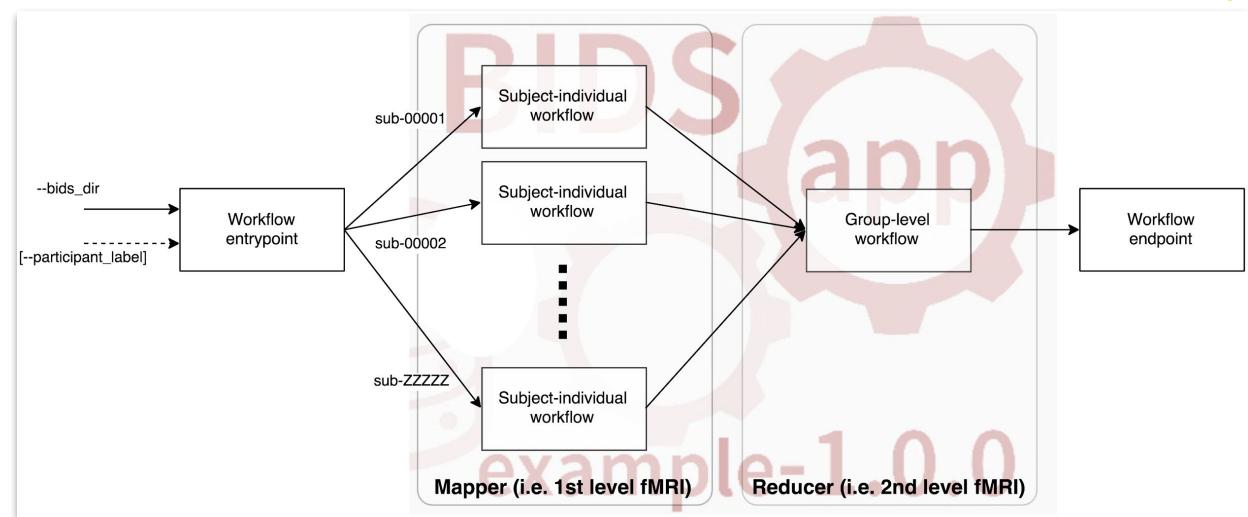
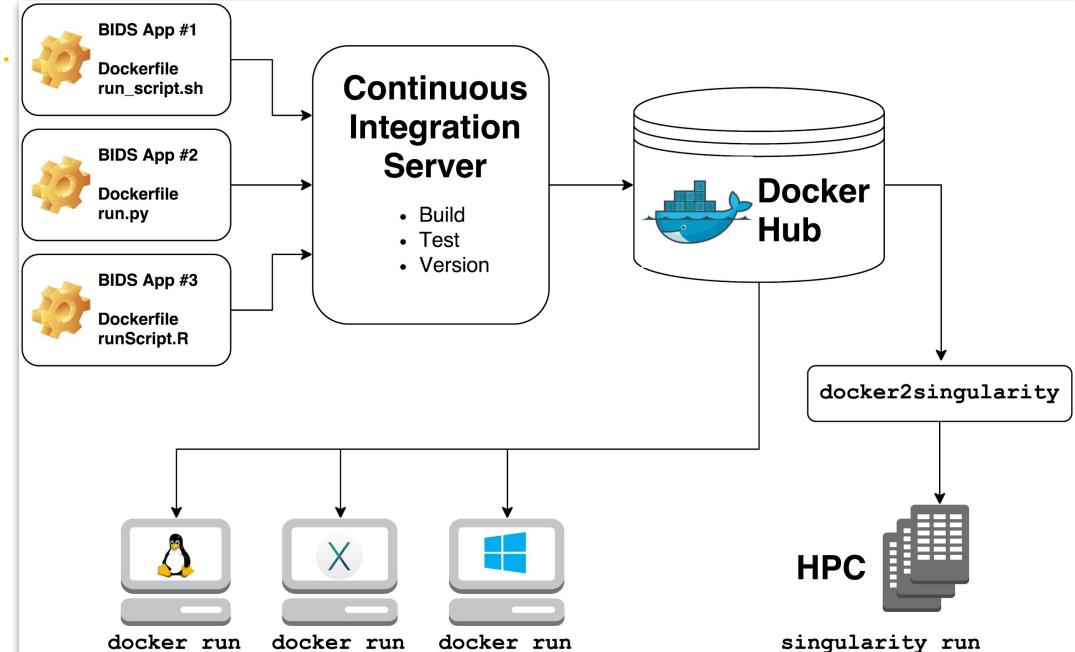
Traffic to bids.neuroimaging.io



~1.8K visitors per month

BIDS-apps

BIDS-Apps/example	<code>version 0.0.7</code>
BIDS-Apps/freesurfer	<code>version</code>
BIDS-Apps/ndmg	<code>version v0.1.0</code>
BIDS-Apps/BROCCOLI	<code>version v1.0.1</code>
BIDS-Apps/FibreDensityAndCrosssection	<code>version v0.0.1</code>
BIDS-Apps/SPM	<code>version v0.0.15</code>
poldracklab/mriqc	<code>version 0.15.0</code>
BIDS-Apps/QAP	<code>Image not found</code>
BIDS-Apps/CPAC	<code>version v1.0.1a_22</code>
BIDS-Apps/hyperalignment	<code>Image not found</code>
BIDS-Apps/mindboggle	<code>version 0.0.4-1</code>
BIDS-Apps/MRtrix3_connectome	<code>version latest</code>
BIDS-Apps/rs_signal_extract	<code>version 0.1</code>
BIDS-Apps/aa	<code>version v0.2.0</code>
BIDS-Apps/niak	<code>version latest</code>
BIDS-Apps/oppni	<code>version v0.7.0-1</code>
poldracklab/fmriprep	<code>version 1.4.1rc1</code>
BIDS-Apps/brainiak-srm	<code>version latest</code>
BIDS-Apps/nipypipelines	<code>version 0.3.0</code>
BIDS-Apps/HCPPipelines	<code>version v3.17.0-18</code>
BIDS-Apps/MAGeTbrain	<code>Image not found</code>
BIDS-Apps/tracula	<code>version v6.0.0-4</code>
BIDS-Apps/baracus	<code>Image not found</code>
BIDS-Apps/antsCorticalThickness	<code>version v2.2.0-1</code>
BIDS-Apps/DPARSF	<code>version v4.3.12</code>
BIDS-Apps/afni_proc	<code>Image not found</code>
BIDS-Apps/rsHRF	<code>version 1.0.0</code>



[Gorgolewski et. al, Plos Comp. Bio. 2017]

Publishing research artefacts

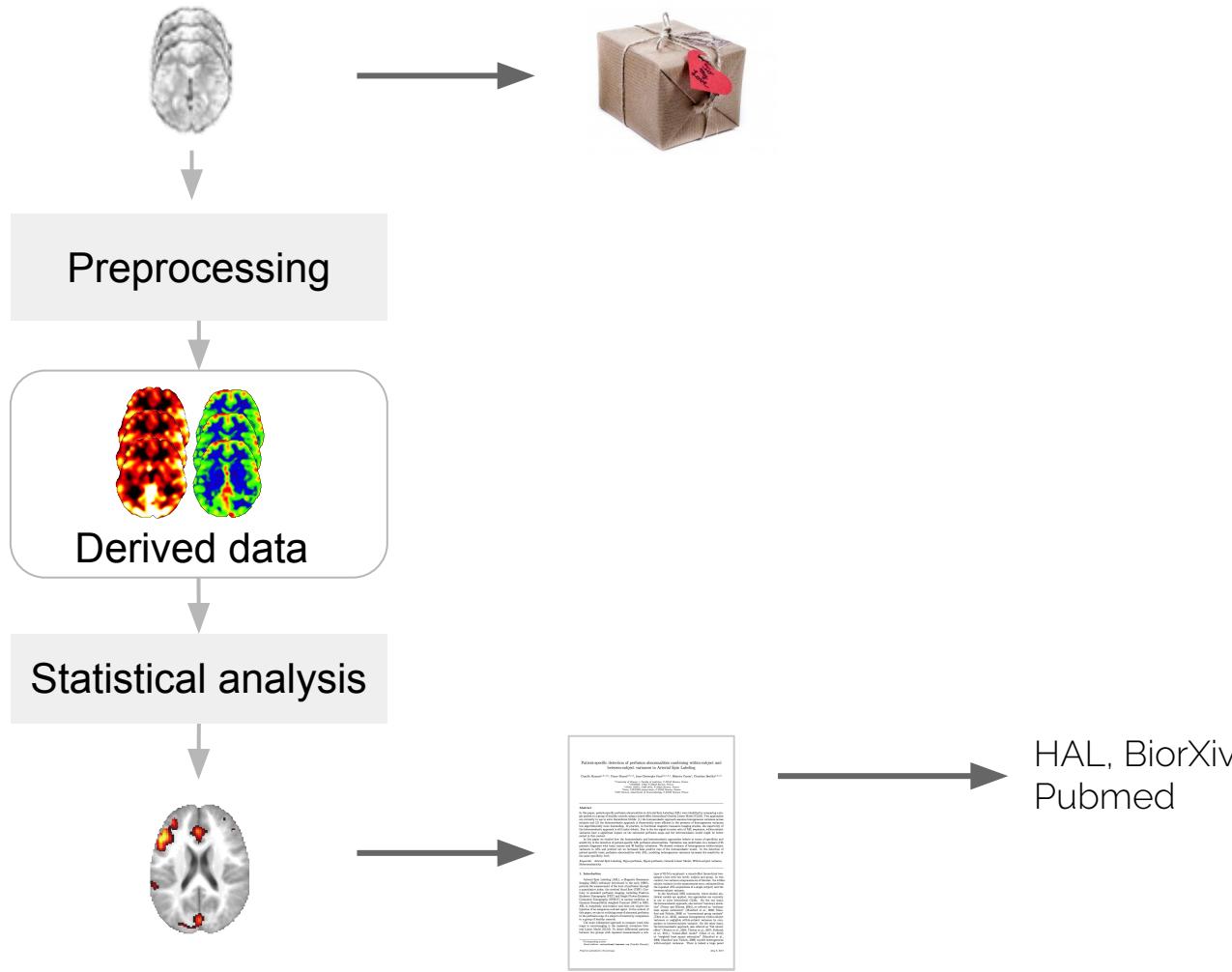


Image credits: [Parcels 1 2 & 4 \(CCo\)](#), [Parcel 3 \(CCo\)](#), [Parcel 5 \(CCo\)](#).

Publishing research artefacts

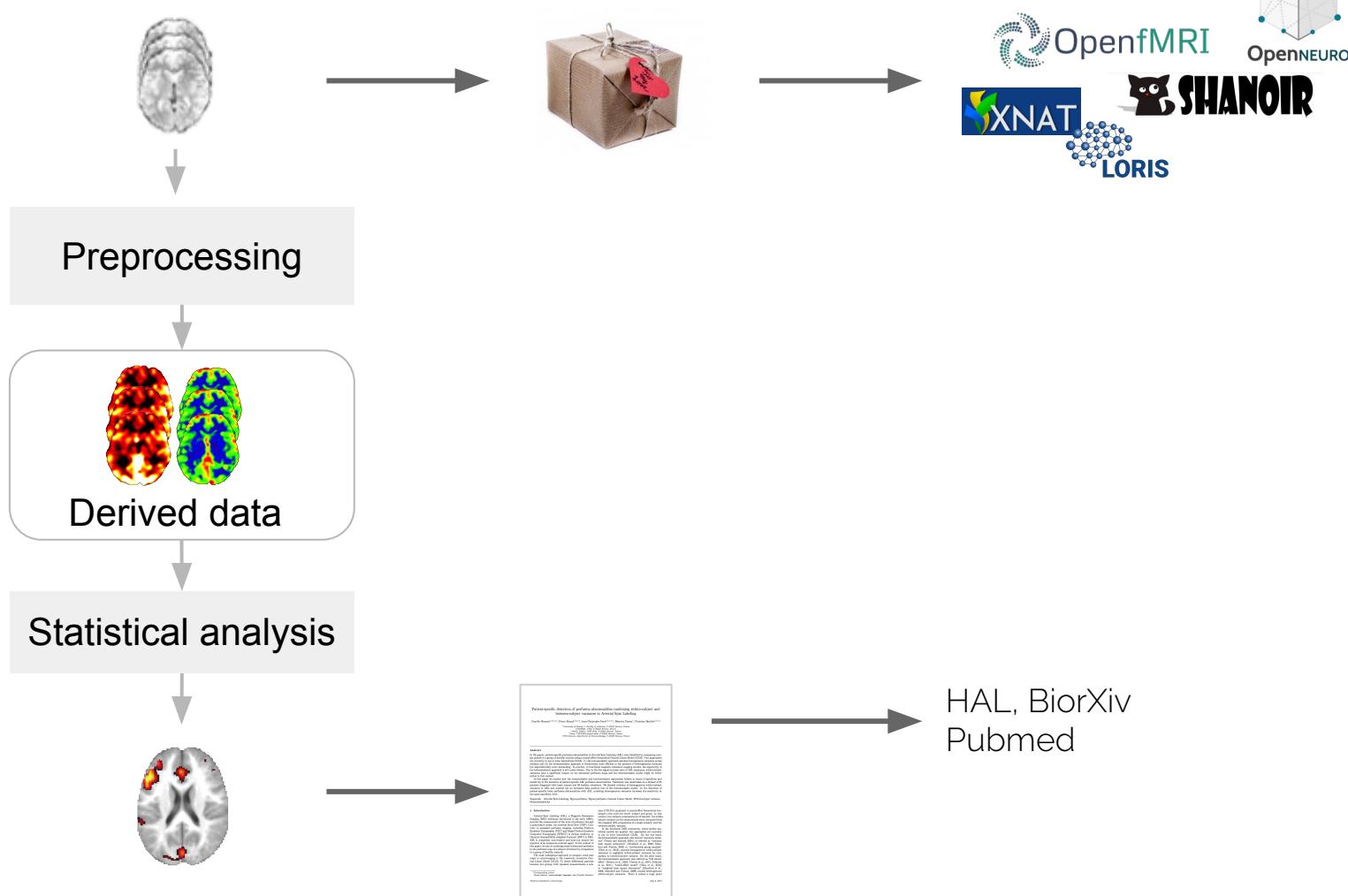
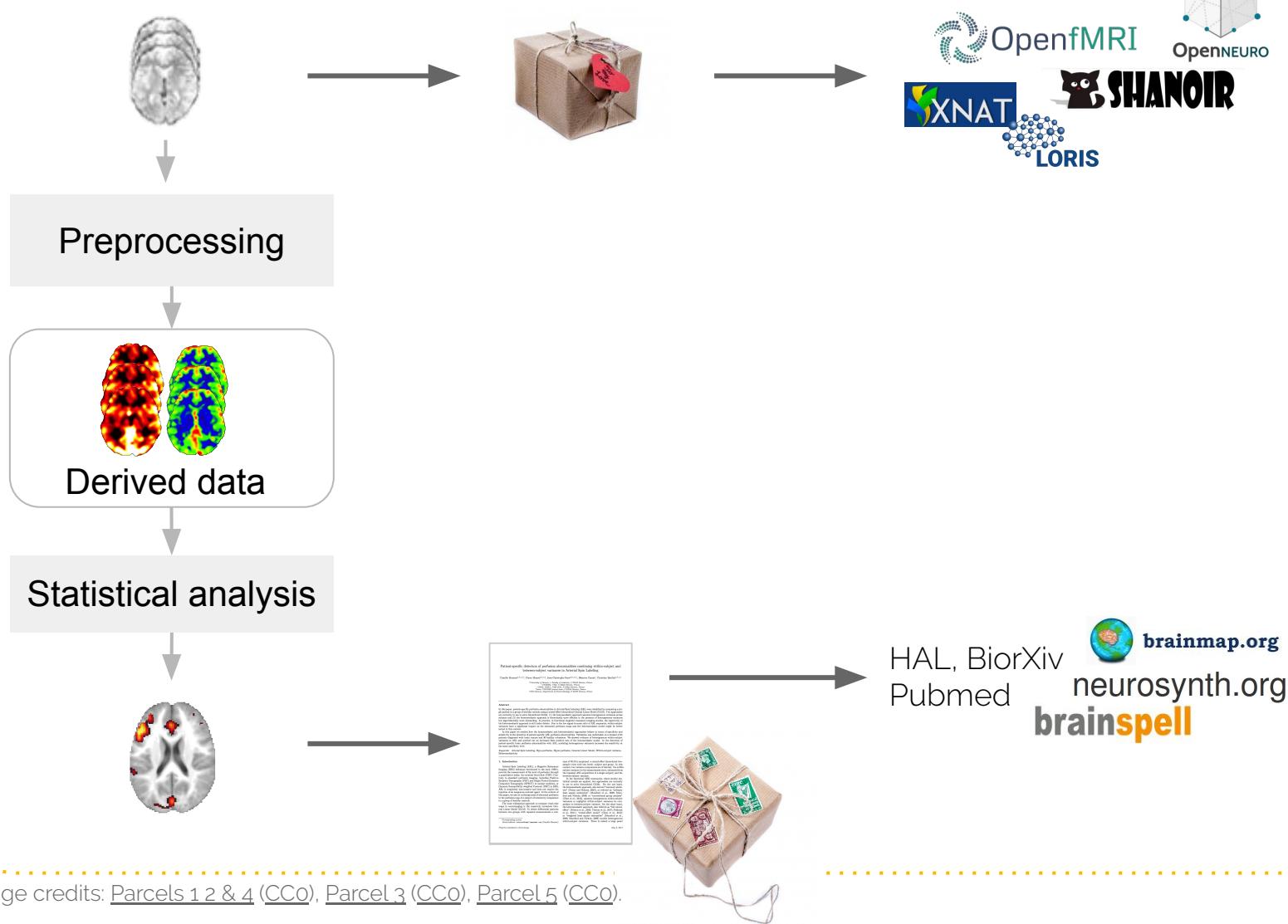


Image credits: [Parcels 1 2 & 4 \(CCo\)](#), [Parcel 3 \(CCo\)](#), [Parcel 5 \(CCo\)](#).

Publishing research artefacts

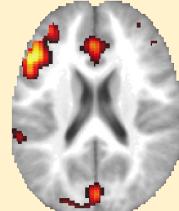


fMRI Results

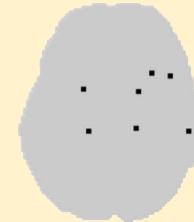
Publication



Figure
(selected slices)



Thresholded
statistics

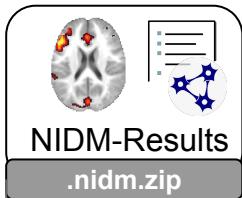


Peak locations



Incomplete statistical results
Ambiguous/incomplete methods
Metadata is not searchable

NIDM-Results pack



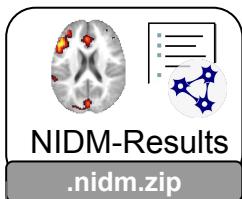
NIDM-Results

.nidm.zip

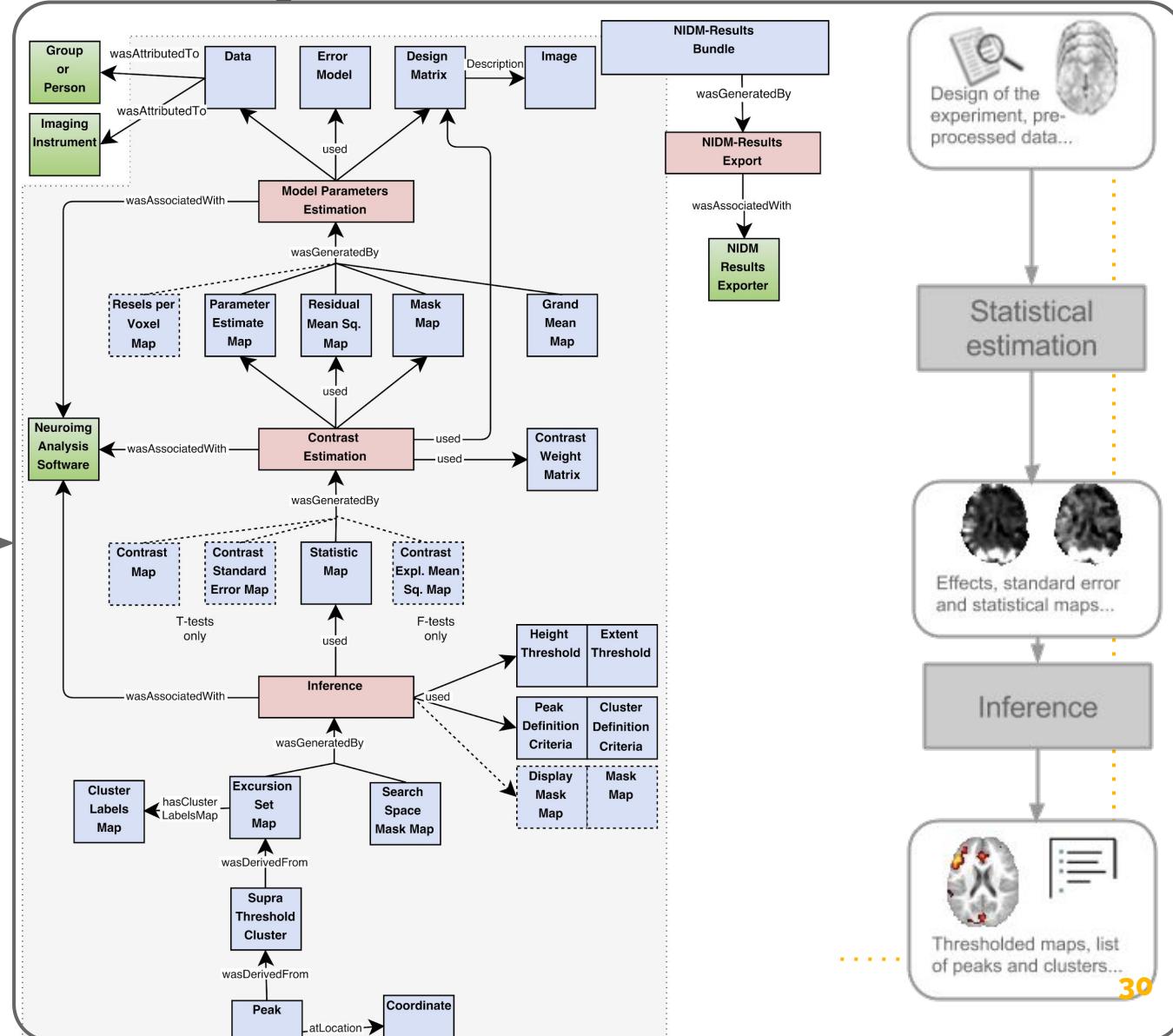
- ClusterLabels.nii.gz
- Contrast.nii.gz
- ContrastStandardError.nii.gz
- DesignMatrix.csv
- DesignMatrix.png
- ExcursionSet.nii.gz
- ExcursionSet.png
- GrandMean.nii.gz
- Mask.nii.gz
- nidm.json
- nidm.ttl
- ParameterEstimate_001.nii.gz
- ParameterEstimate_002.nii.gz
- ResidualMeanSquares.nii.gz
- SearchSpaceMask.nii.gz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

[Maumet et al.,
Sci. Data 2016]

NIDM-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]

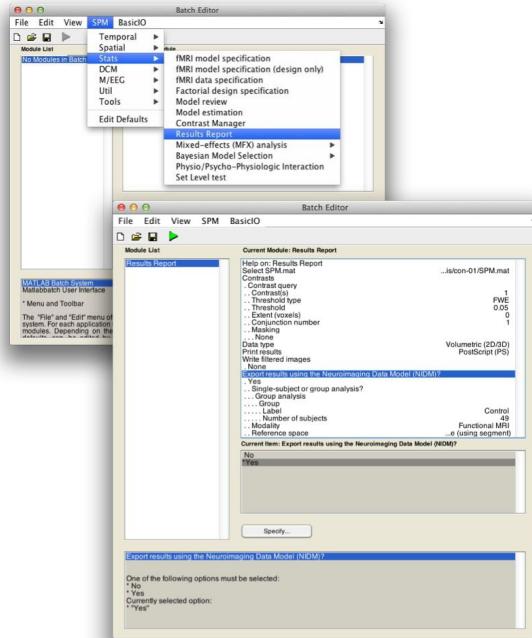
NIDM in SPM, FSL & NeuroVault

SPM

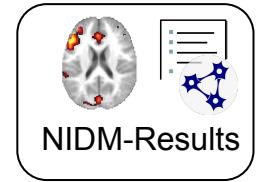
1. Export



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



2. Publication on NeuroVault



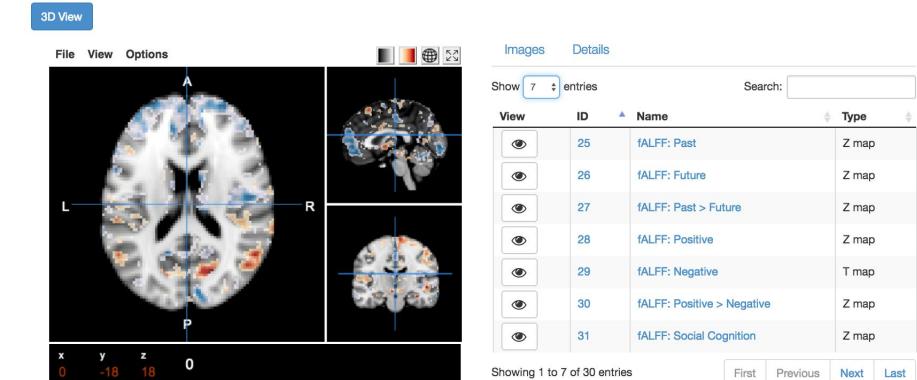
NeuroVault Collections FAQ Give feedback

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

Contributed by ChrisPilatGorgolewski

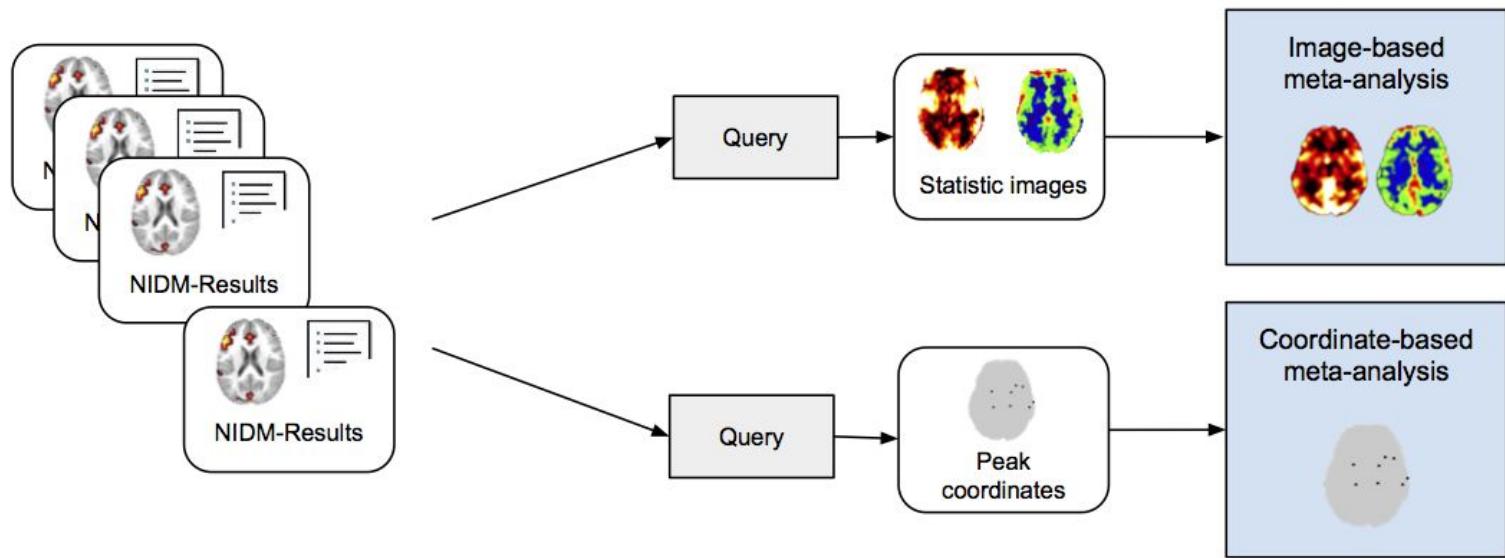
Krzysztof J. Gorgolewski, Dan Lurie, Sebastian Urchs, Judy A. Kipping, R. Cameron Craddock, Michael P. Milham, Daniel S. Margulies, Jonathan Smallwood

[Link to the paper](#)



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

Meta-analysis w/ NIDM-Results



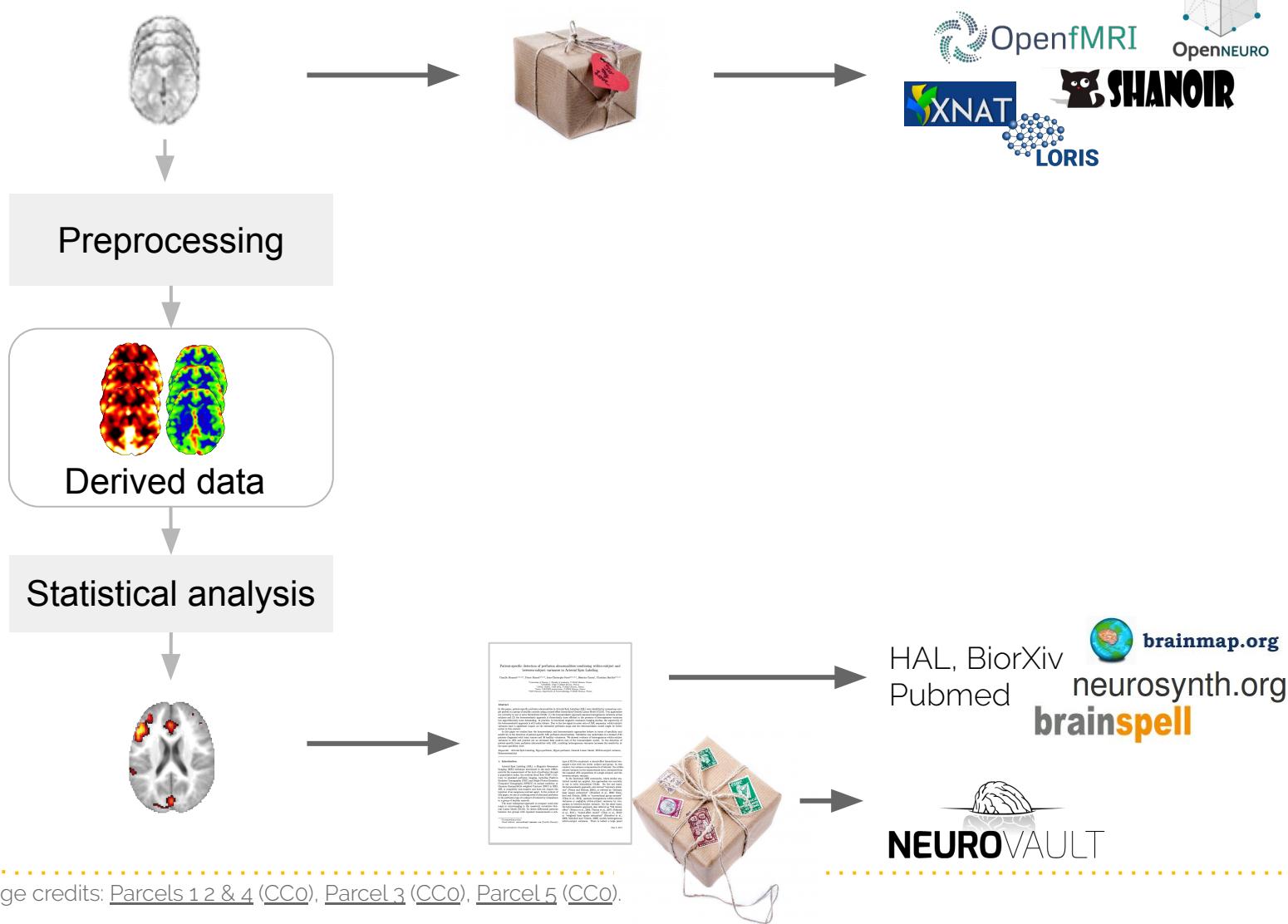
Coordinate-based meta-analysis



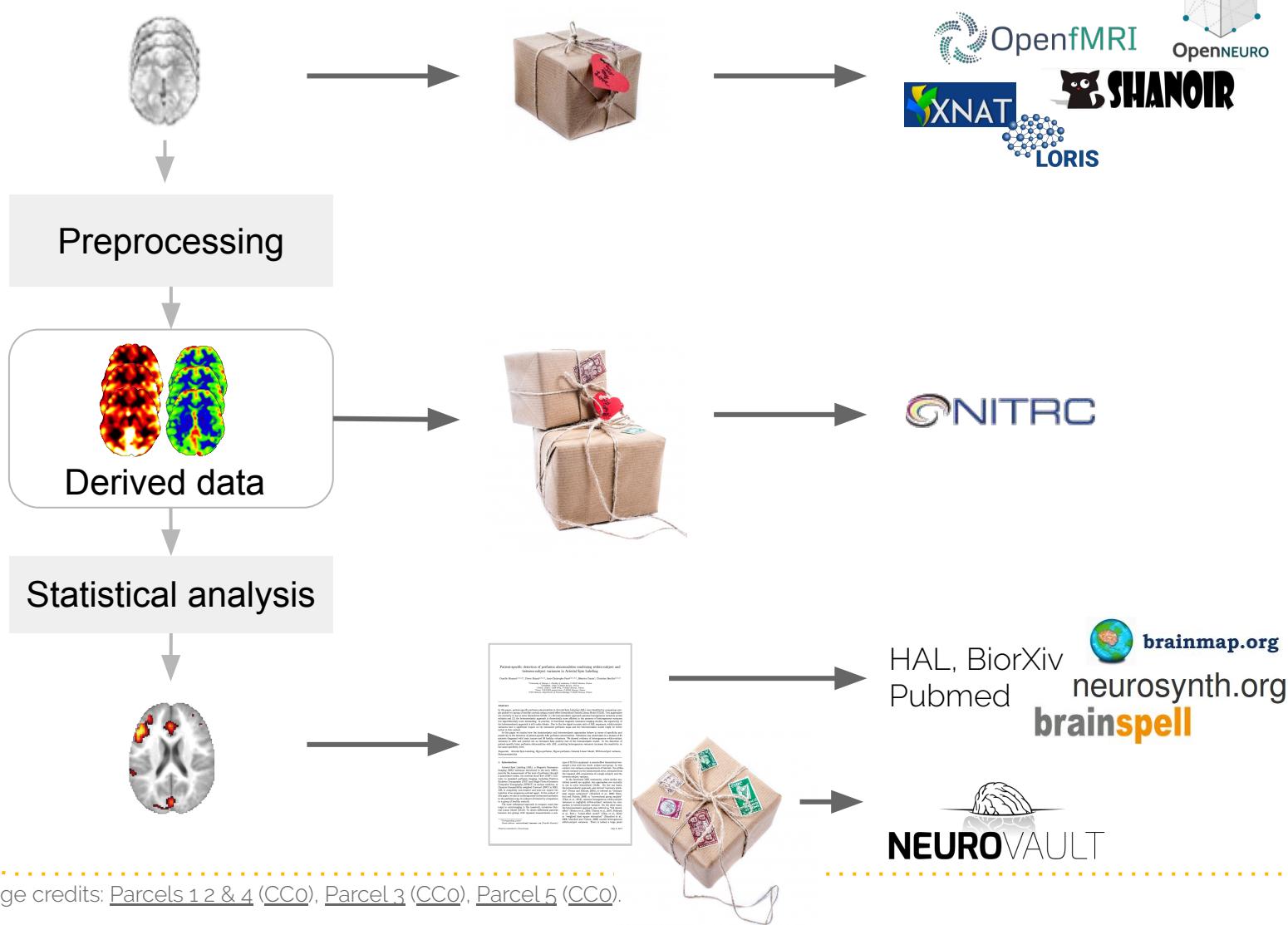
Image-based meta-analysis



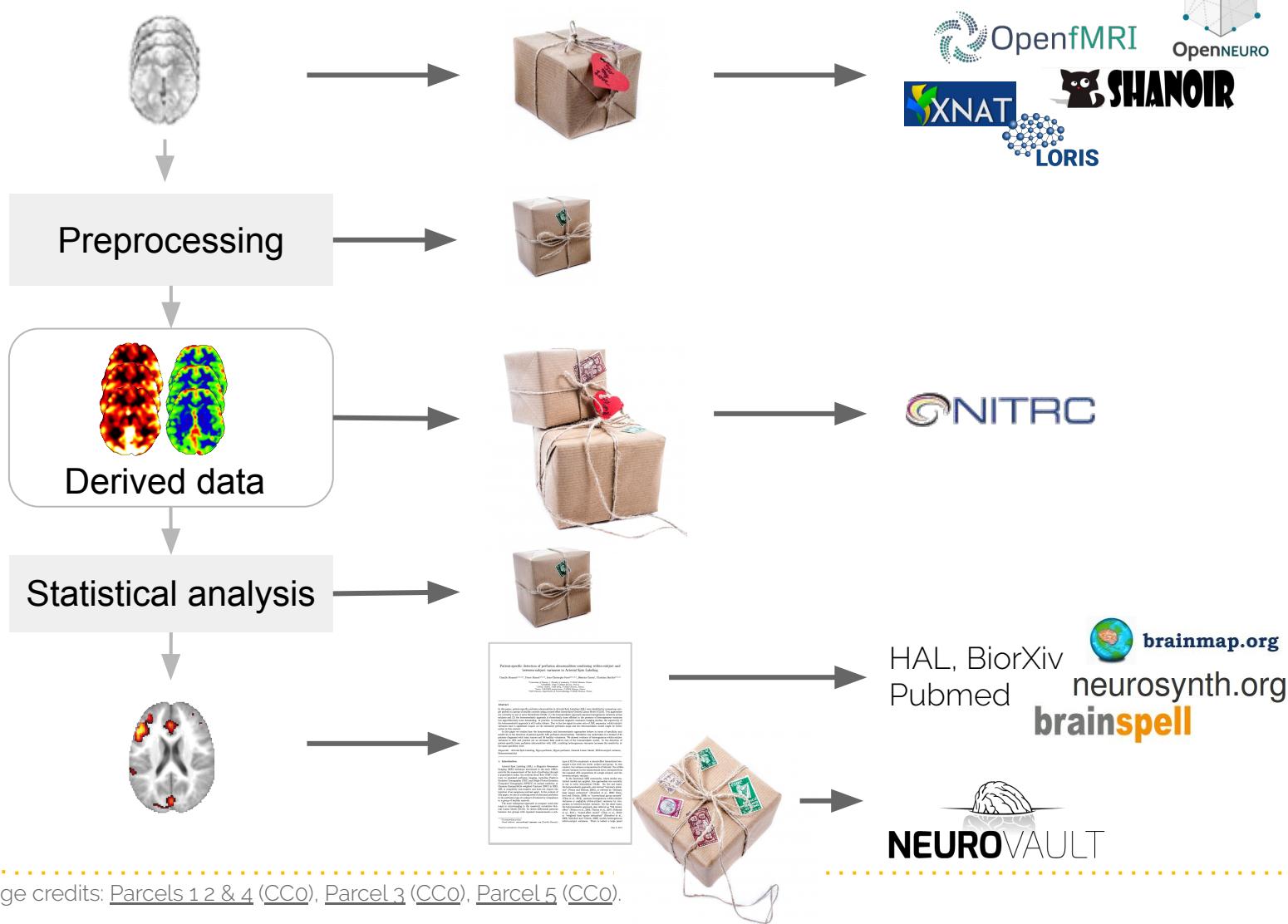
Publishing research artefacts



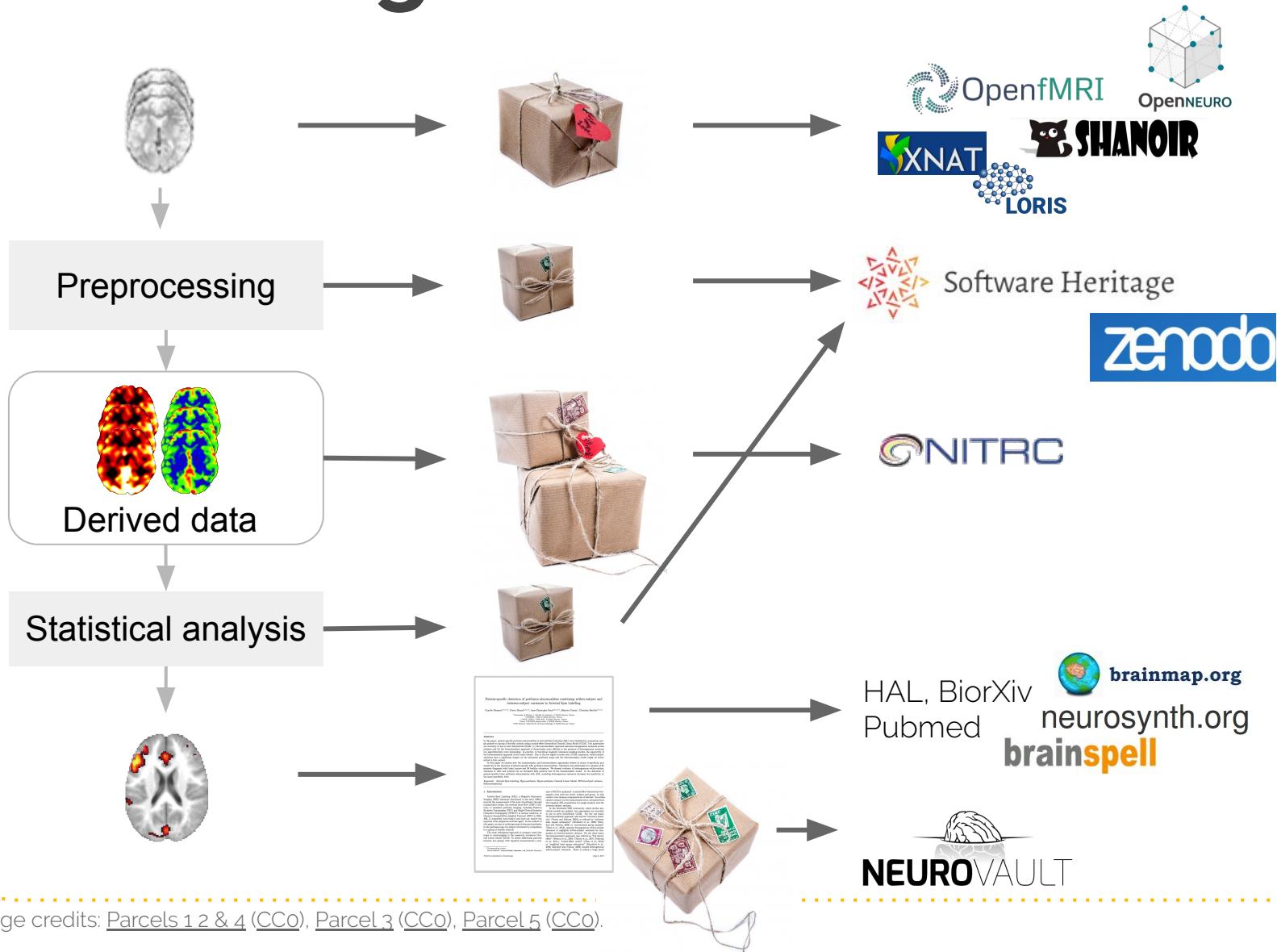
Publishing research artefacts



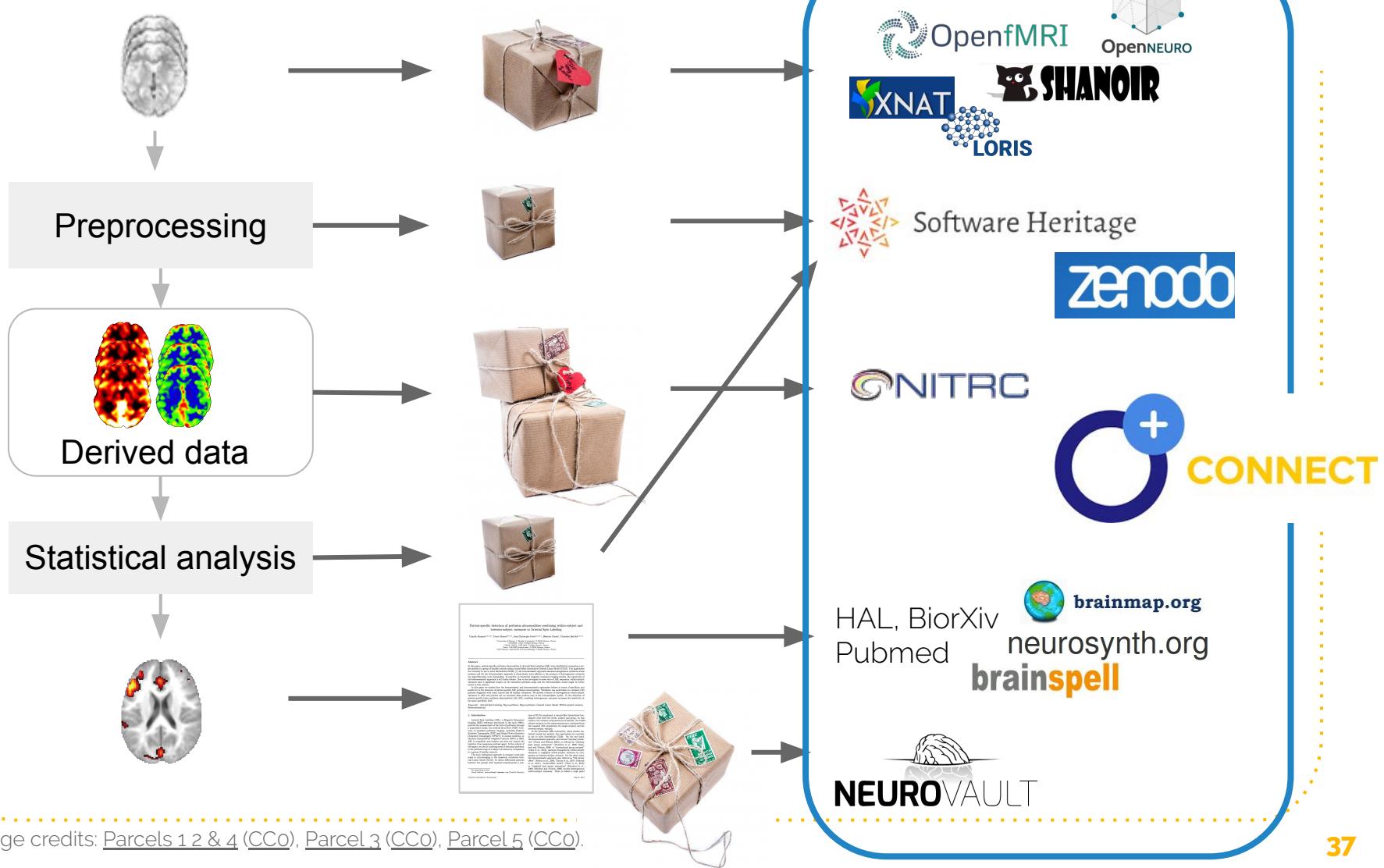
Publishing research artefacts



Publishing research artefacts



Publishing research artefacts



On our way...

Linking it all with
openAIRE-Connect

Research Community Dashboard

A window to community's research.

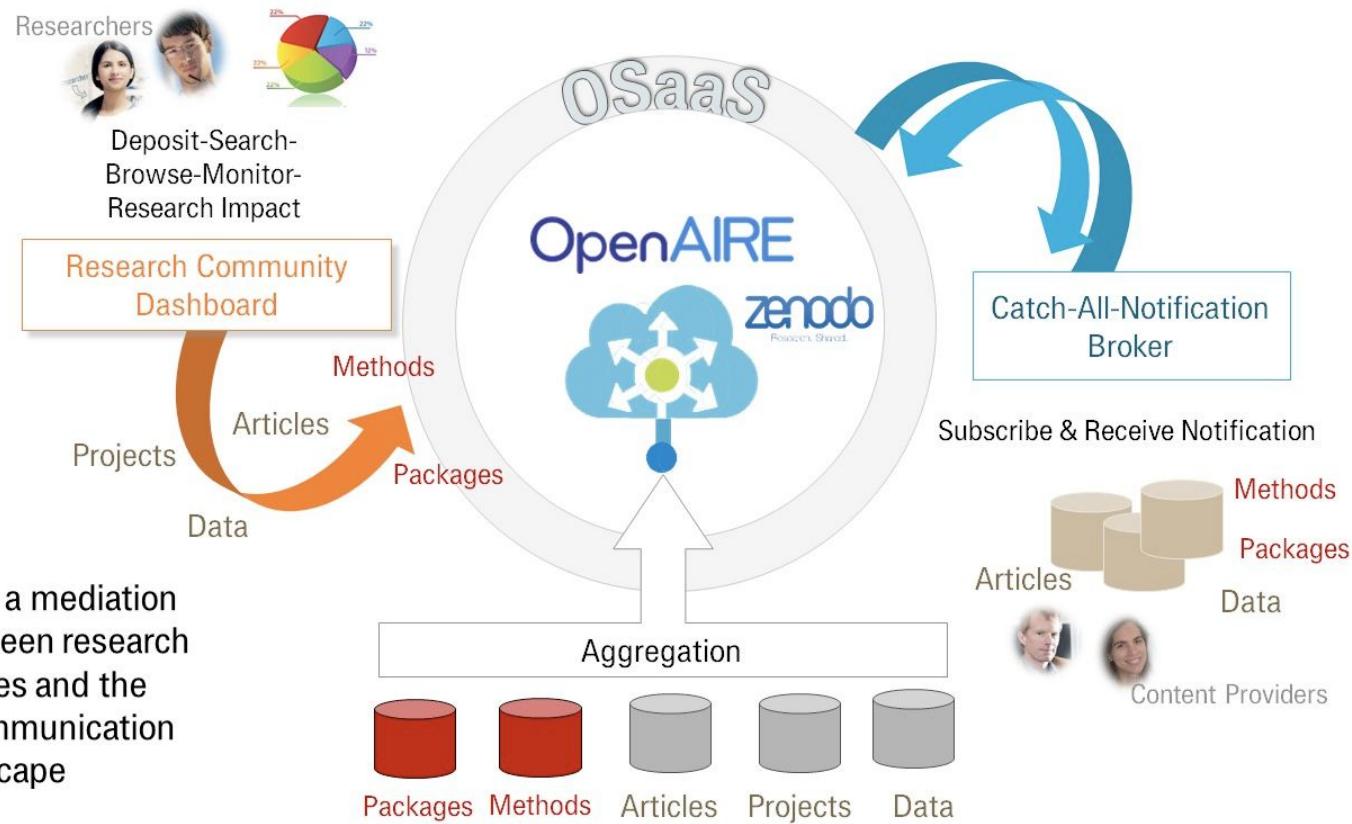
Open Science as a Service

Open Science as-a-Service for Research Communities

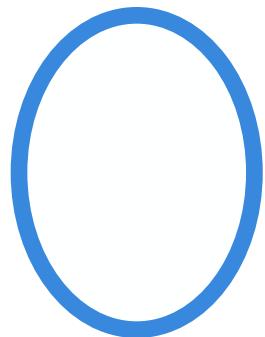
**Facilitate Research Communities
adoption of Open Science
publishing principles by supporting
artefact publishing tools
as-a-Service**



Open Science as-a-Service (OSaaS)

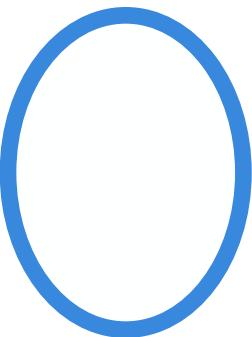


A virtual environment designed for your Community



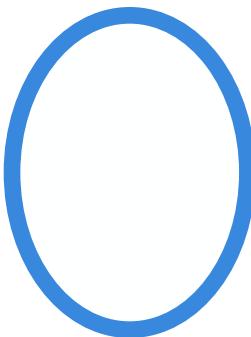
Implement

the latest Open Science trends:
FAIR data, open data



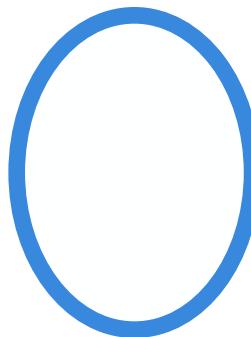
Share

all your research results:
publications, data, software, methods



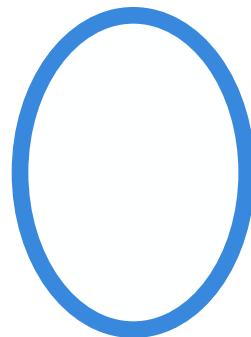
Link

all your research effectively



Gather

all your research results in one place



Monitor

and report your community's progress

Community dashboards



**SDSN
GREECE**

**Sustainable Development
Solutions Network -
Greece**

[RESEARCH COMMUNITY](#)

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Conservation of marine resources for sustainable development

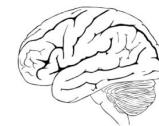
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European Marine Science

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This community was initially defined to include a very broad range of topics, with the intention to generate a number of more focused and sustainable dashboards for research communities and initiatives. As outlined in the logo of this community, we intend to setup a community dashboard for EuroMarine (a consortium of 56 research and academic organisations) and monitoring dashboards for marine research initiatives,



Neuroinformatics

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Neuroinformatics: monitor

24,024

publications

5,083

research data

150

software

2,375

other research
products

8

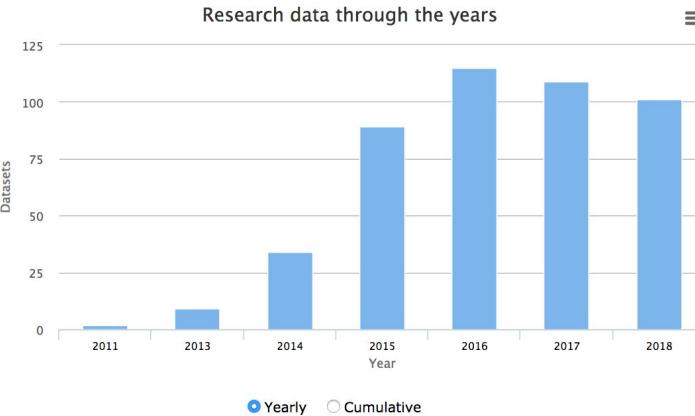
projects

6

content providers

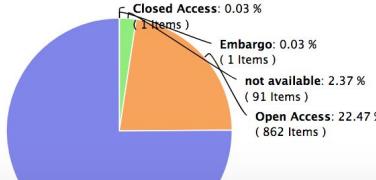
Research Data statistics

789 DATASETS LINKED TO 1 PROJECT.
681 ARE OA , 1 IS CLOSED AND 1 IS STILL IN EMBARGO.



from OpenAIRE via HighCharts (date: 20/5/2019)

Research data by access mode



Neuroinformatics: link



Neuroinformatics

SEARCH MONITOR SHARE LINK CAMILLE MAUMET 

Exploring the Impact of Analysis Software on Task fMRI Results

 PREPRINT  ENGLISH  OPEN

Nichols, Thomas ; Maumet, Camille ; Bowring, Alexander (2018)

Publisher: HAL CCSD
Subject: [SDV.NEU] Life Sciences [q-bio]/Neurons and Cognition [q-bio.NC]

A wealth of analysis tools are available to fMRI researchers in order to extract patterns of task variation and, ultimately, understand cognitive function. However, this 'methodological plurality' comes with a drawback. While conceptually similar, two different analysis pipelines applied on the same dataset may not produce the same scientific results. Differences in methods, implementations across software packages, and even operating systems or software versions all contribute to this variability. Consequently, attention in the field has recently been directed to reproducibility and data sharing. Neuroimaging is currently experiencing a surge in initiatives to improve research practices and ensure that all conclusions inferred from an fMRI study are replicable. In this work, our goal is to understand how choice of software package impacts on analysis results. We use publicly shared data from three published task fMRI neuroimaging studies, reanalyzing each study using the three main neuroimaging software packages, AFNI, FSL and SPM, using parametric and nonparametric inference. We obtain all information on how to process, analyze, and model each dataset from the publications. We make quantitative and qualitative comparisons between our replications to gauge the scale of variability in our results and assess the fundamental differences between each software package. While qualitatively we find broad similarities between packages, we also discover marked differences, such as Dice similarity coefficients ranging from 0.000-0.743 in comparisons of thresholded statistic maps between software. We discuss the challenges involved in trying to reanalyze the published studies, and highlight our own efforts to make this research reproducible.

Metrics 

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Neuroinformatics: project view



Neuroinformatics

SEARCH MONITOR SHARE LINK CAMILLE MAUMET 

Large-scale Automated Synthesis of Functional Neuroimaging Data (1R01MH096906-01A1)

PROJECT NIH

Funding: NATIONAL INSTITUTE OF MENTAL HEALTH

Start Date: 2012-08-10

End Date: 2016-05-31

Open Access mandate for Publications: no

Open Access mandate for Research Data: no

Organization: UCB

Publications (8) +

Research Data (0) +

Software (0) +

Other Research Products (0) +

Statistics +

Metrics +

Share - Bookmark 

Application Box

Publications Research Data

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“Gather, view and monitor all research outcomes”

A screenshot of the OpenAIRE CONNECT homepage. At the top left is the logo. On the right is a 'Sign in' button. In the center, there's a graphic of a brain and a stylized geometric logo. A large blue callout box in the middle contains the text: 'Live demo during the poster session! by Xavier Rolland'. Below this box are two 'SUBSCRIBE' buttons. At the bottom, there are social media icons (Facebook, Twitter, LinkedIn, YouTube), navigation links ('About', 'News - Events', 'Blog', 'Contact us'), and a European Commission logo. A small CC BY license icon and text are also present.

European Marine Science logo

Sign in

Live demo during the poster session!
by Xavier Rolland

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Going further

Going further

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Taking part in Standards & Best practices INCF Special Interest Groups

Active groups

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- Biophysically based Computational Models of Glial - Neuron Coupling
- Neuroinformatics for Aging
- Neuroinformatics for Cell Types
- Neuroshapes: Open SHACL schemas for FAIR neuroscience data
- Reproducibility & Best Practices in Human Brain Neuroimaging
- Reproducible Research and Open Neuroscience
- Standardised Representations of Network Structures
- Neuroimaging Quality Control (niQC)



BIDS, NIDM & more!



Survey open now!

<http://tinyurl.com/WeNeedNiQC>

Create your own SIG!

Getting started & spreading open science



ReproNim: A Center for Reproducible Neuroimaging Computation

The OHBM Open Science Special Interest Group

Dedicated to promoting and supporting open science within our community

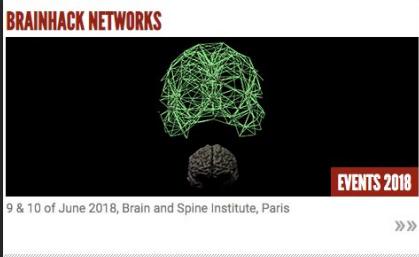
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Acknowledgements

Thank you!

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OpenAIRE neuroinformatics

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Let's do open neuroimaging sciences



Thank you!

Any questions?

Camille Maumet

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