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Let's do open neuroimaging sciences

Camille Maumet

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Let's do open neuroimaging sciences

Camille Maumet



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



GEANT workshop
May 21st, 2019

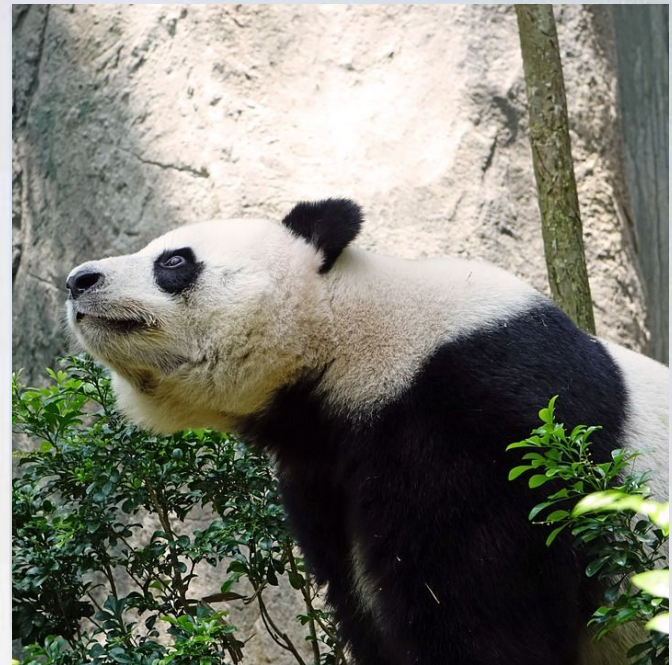
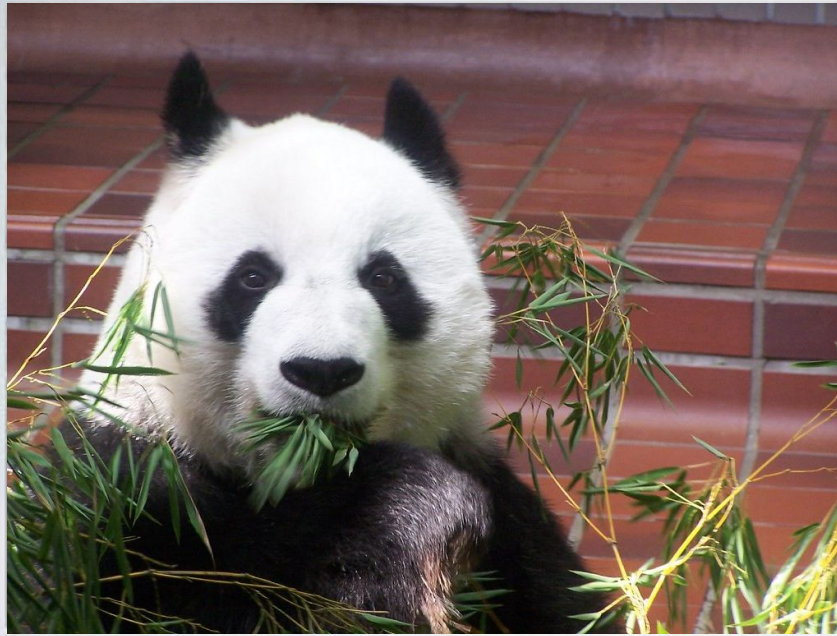


Why open?

Why open?

**Thoughts on
generalizability**

happy pandas

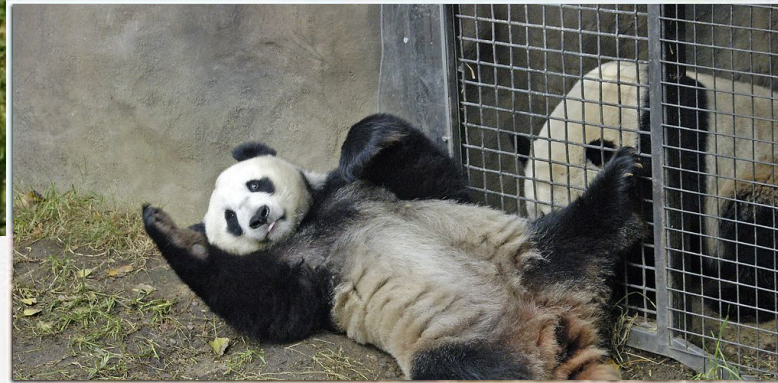


Slide by Tal Yarkoni (reused with permission), adapted.

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).



sad pandas



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).

Experimental manipulation



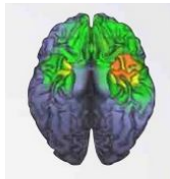
Emotion-related neural changes



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.

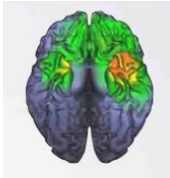
Consectetur, adipisci velit, sed quia non numquam eius modi tempora incidunt ut labore et dolore magnam aliquam quaerat voluptatem. Ut enim ad minima veniam, quis nostrum exercitationem ullam corporis suscipit laboriosam, nisi ut aliquid ex ea commodi consequatur? Quis autem vel eum iure reprehenderit 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 incidunt 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?

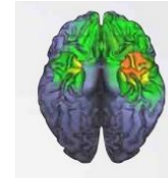


???

Greater amygdala activation in 22 UT-Austin undergraduates when viewing images **angsty_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 incidunt 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?

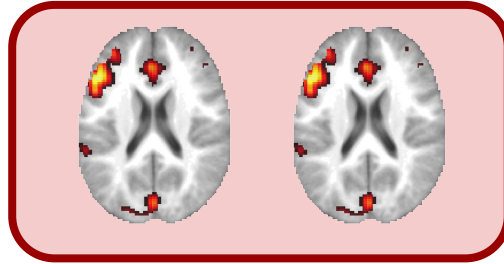


**How can we get
there?**

**How can we get
there?**

**Variations on
reproducibility**

Robustness to generalizability

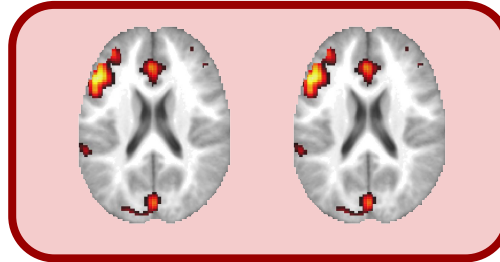


Robustness



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

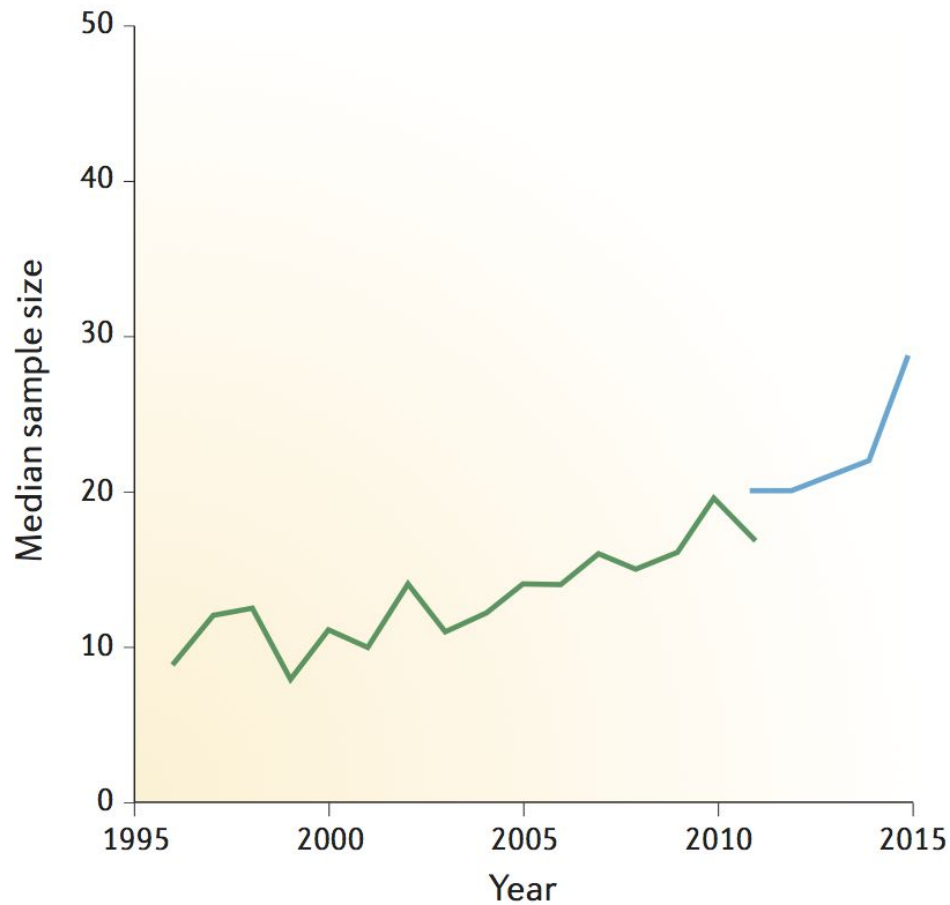
Table B1. Levels of Reproducibility

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

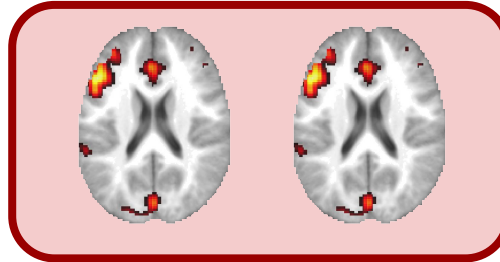


2015: 30 participants

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



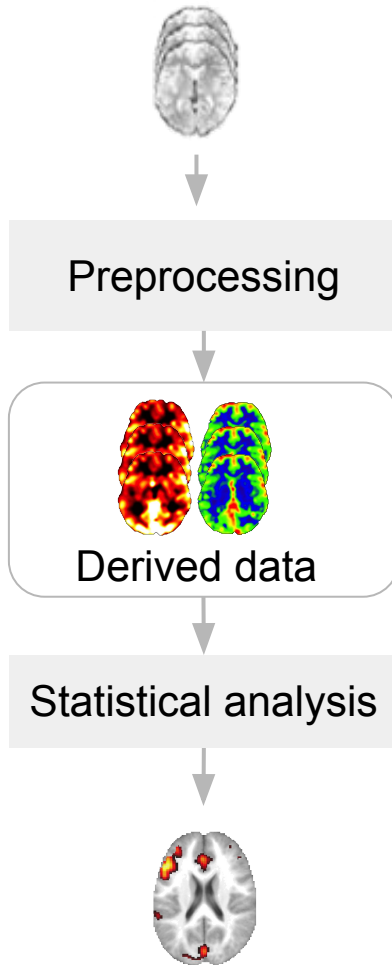
Generalizability

On our way...

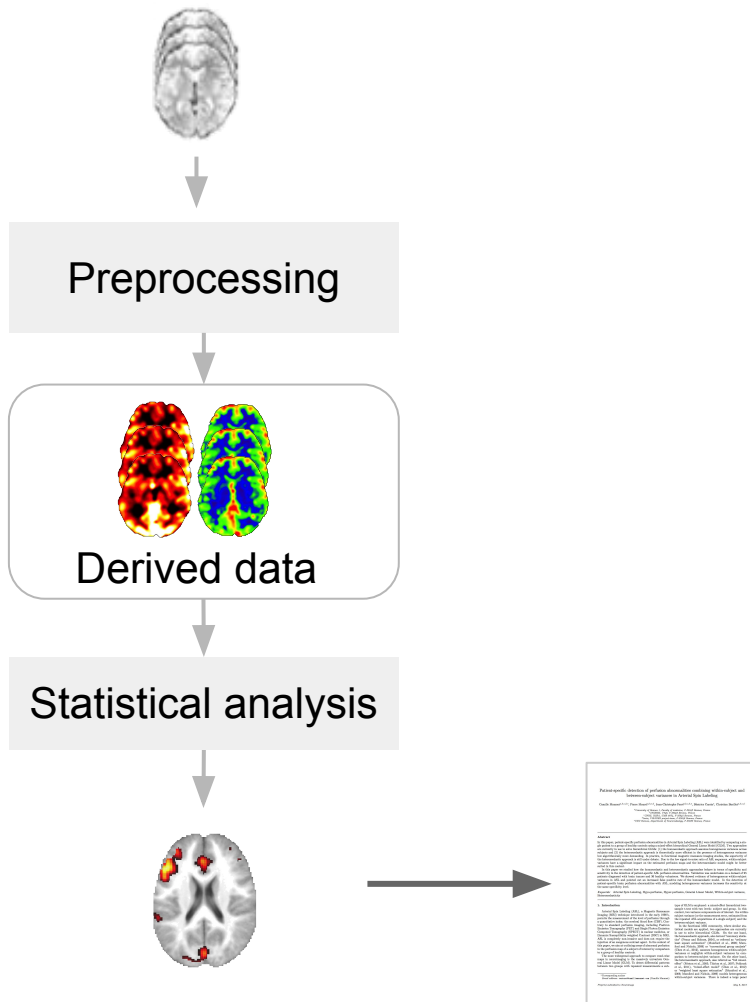
On our way...

**Tools & standards to
publish our research**

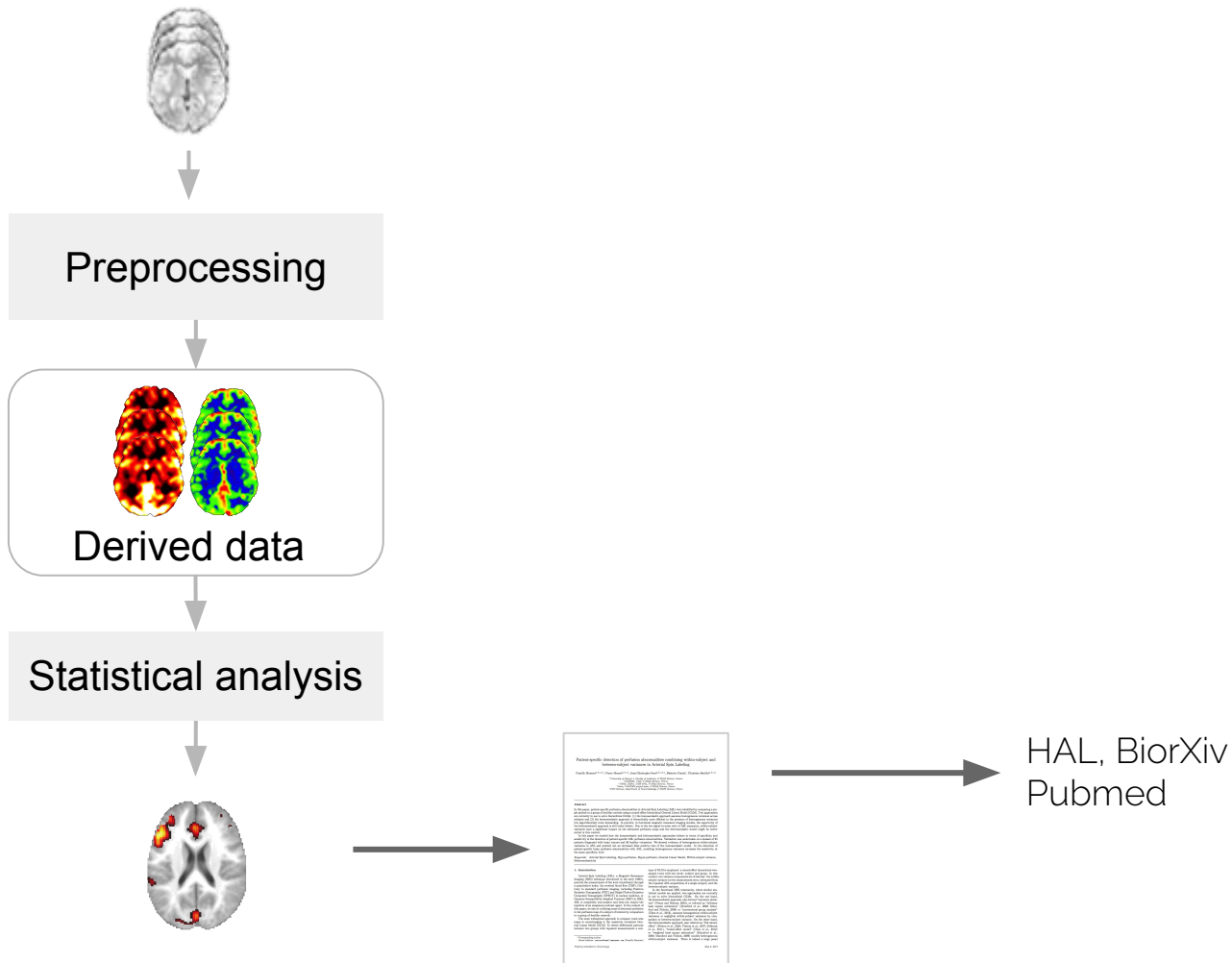
Publishing research artefacts



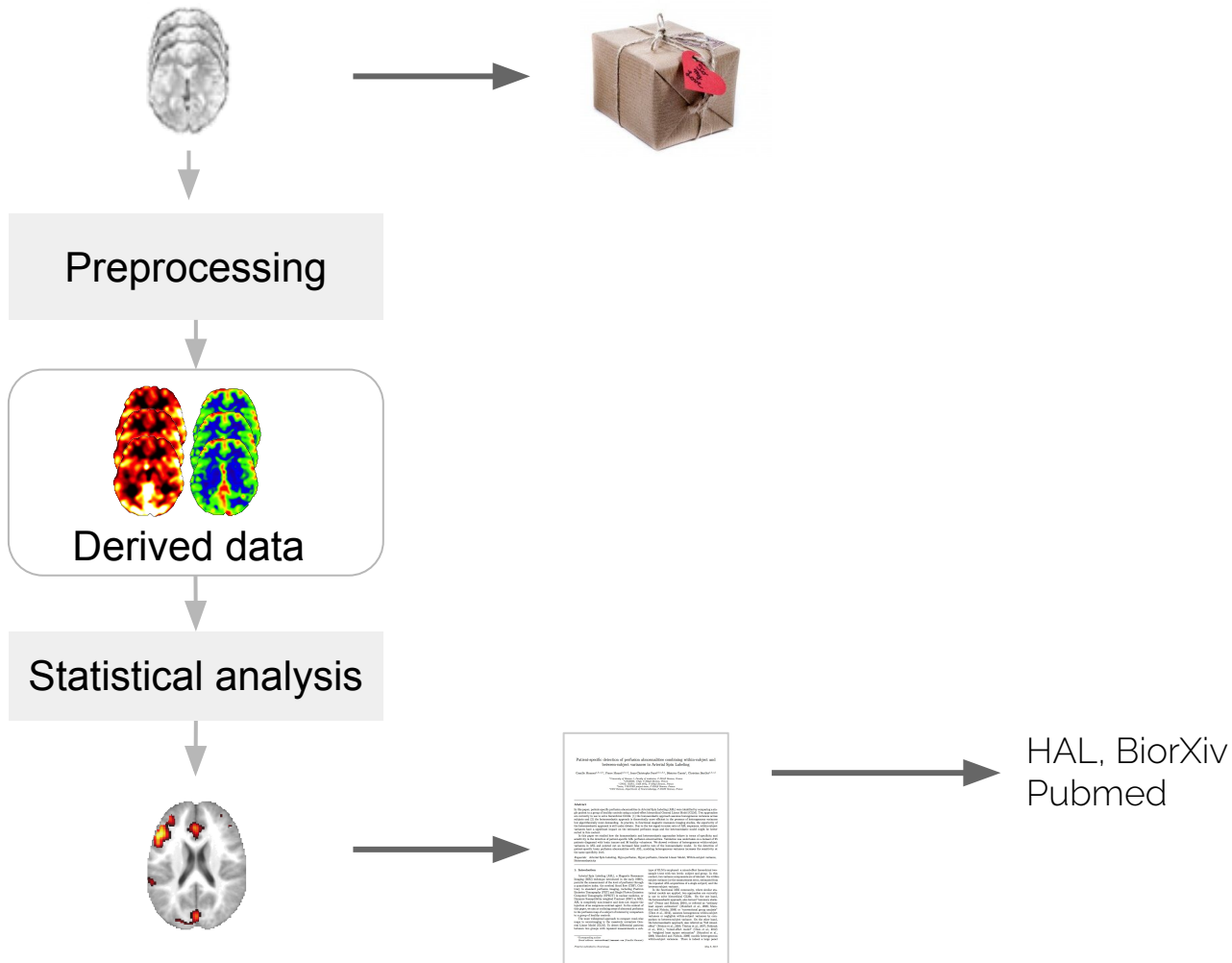
Publishing research artefacts



Publishing research artefacts



Publishing research artefacts



Brain Imaging Data Structure (BIDS)

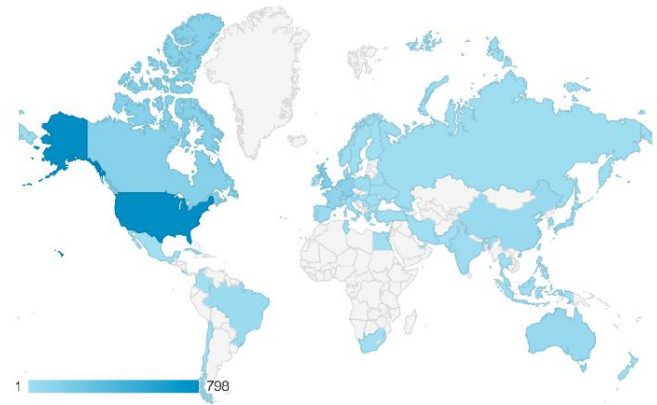
```
my_dataset/  
├── participants.tsv  
├── sub-01/  
│   ├── anat/  
│   │   └── sub-01_T1w.nii.gz  
│   ├── func/  
│   │   ├── sub-01_task-rest_bold.nii.gz  
│   │   └── sub-01_task-rest_bold.json  
│   └── dwi/  
│       ├── sub-01_dwi.nii.gz  
│       ├── sub-01_dwi.json  
│       ├── sub-01_dwi.bval  
│       └── 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)

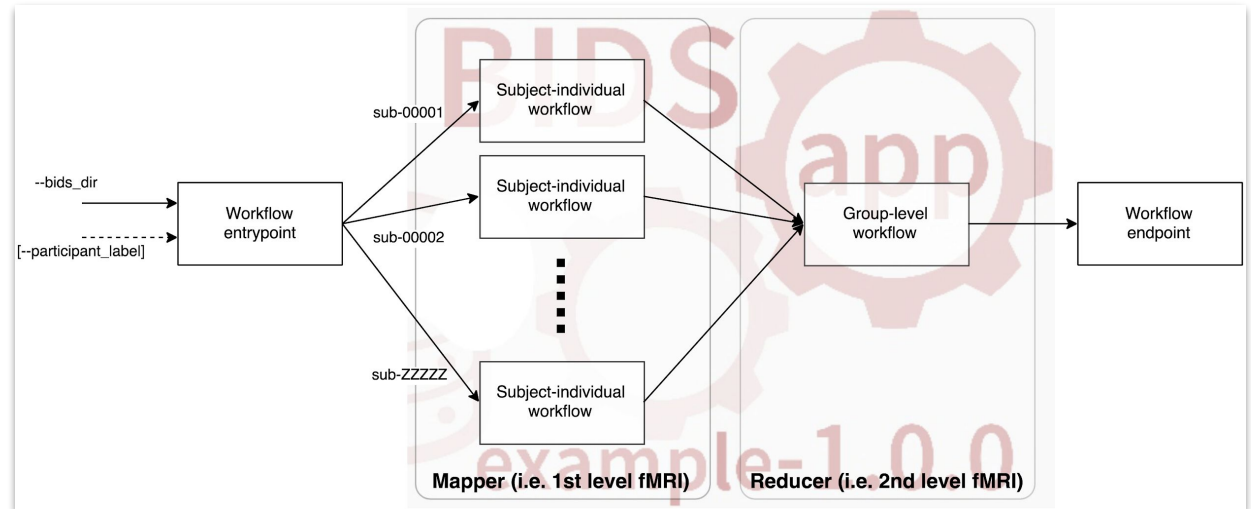
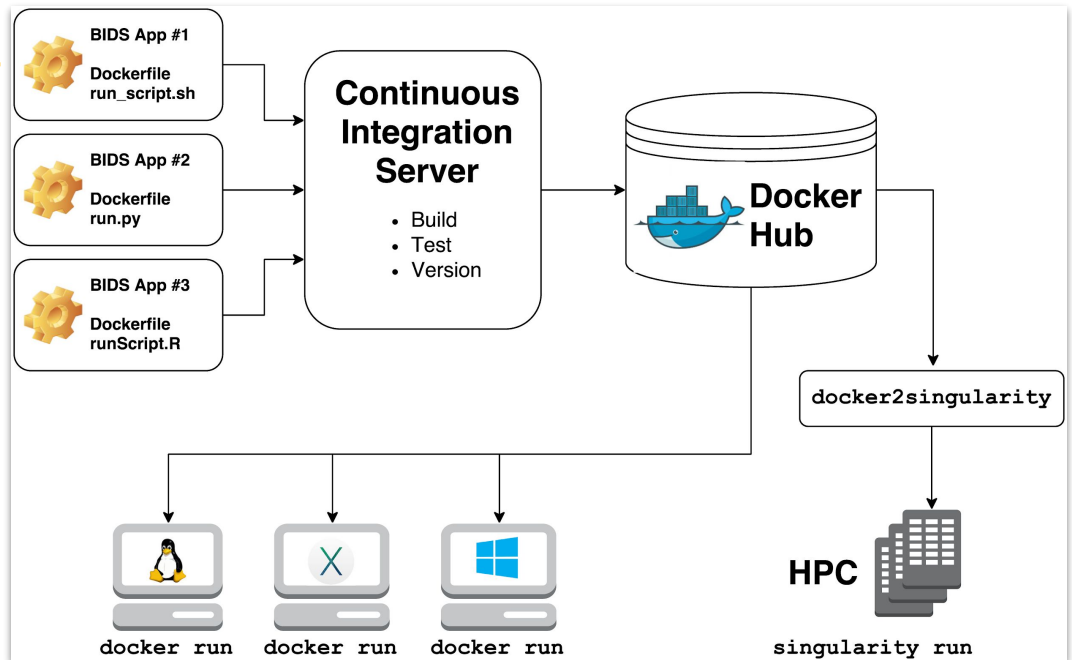
Traffic to bids.neuroimaging.io



~1.8K visitors per month

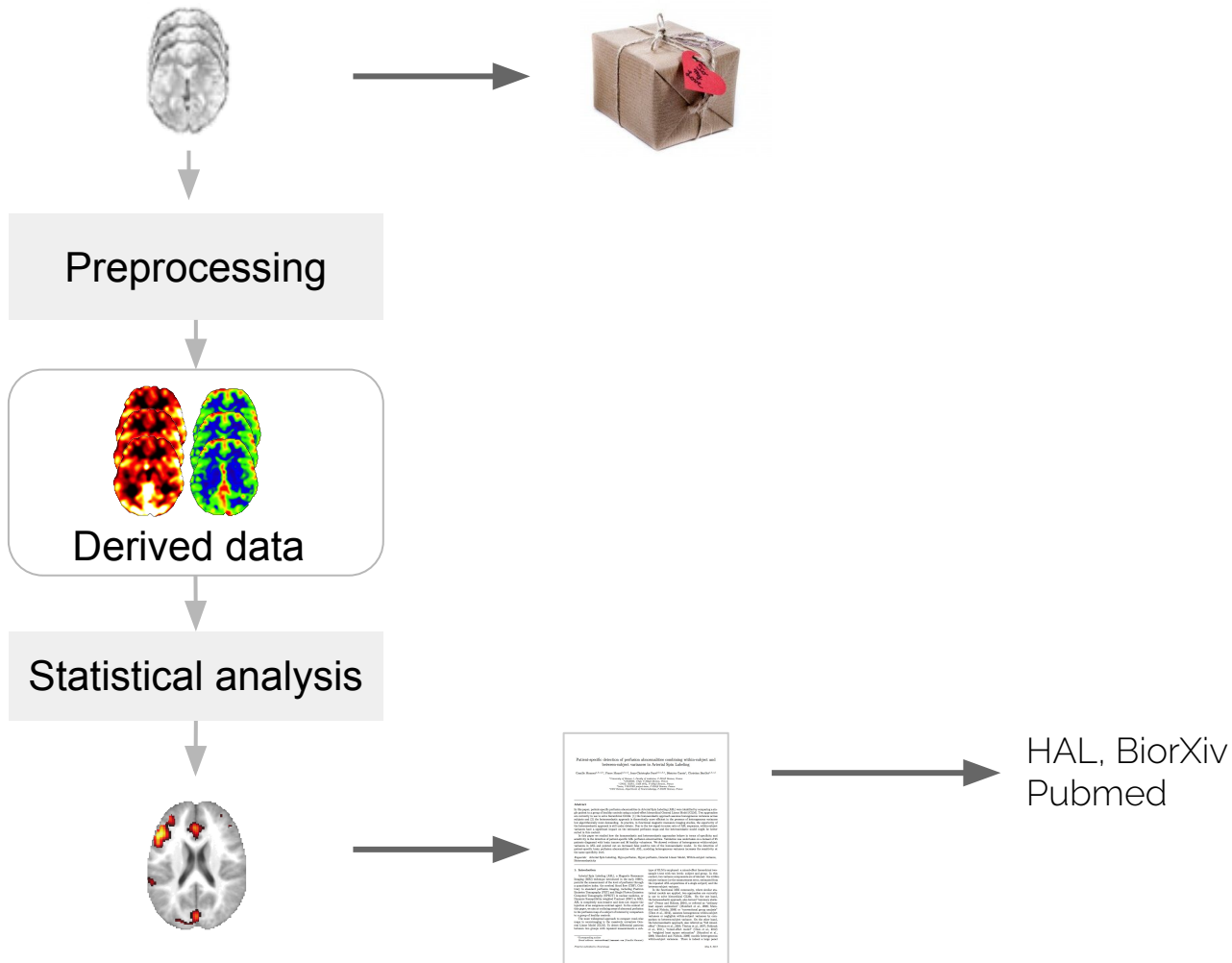
BIDS-apps

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

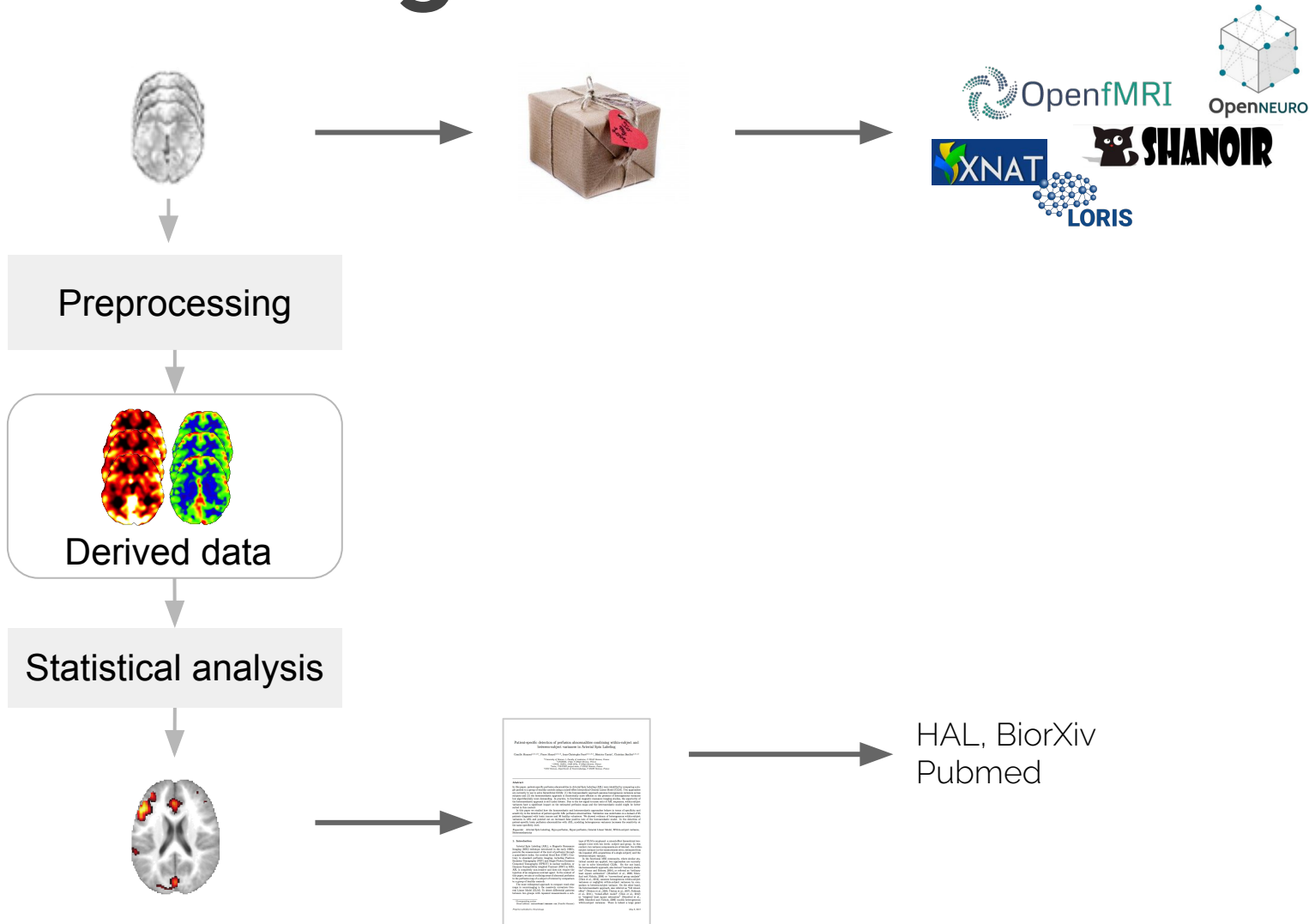


[Gorgolewski et. al, Plos Comp. Bio. 2017]

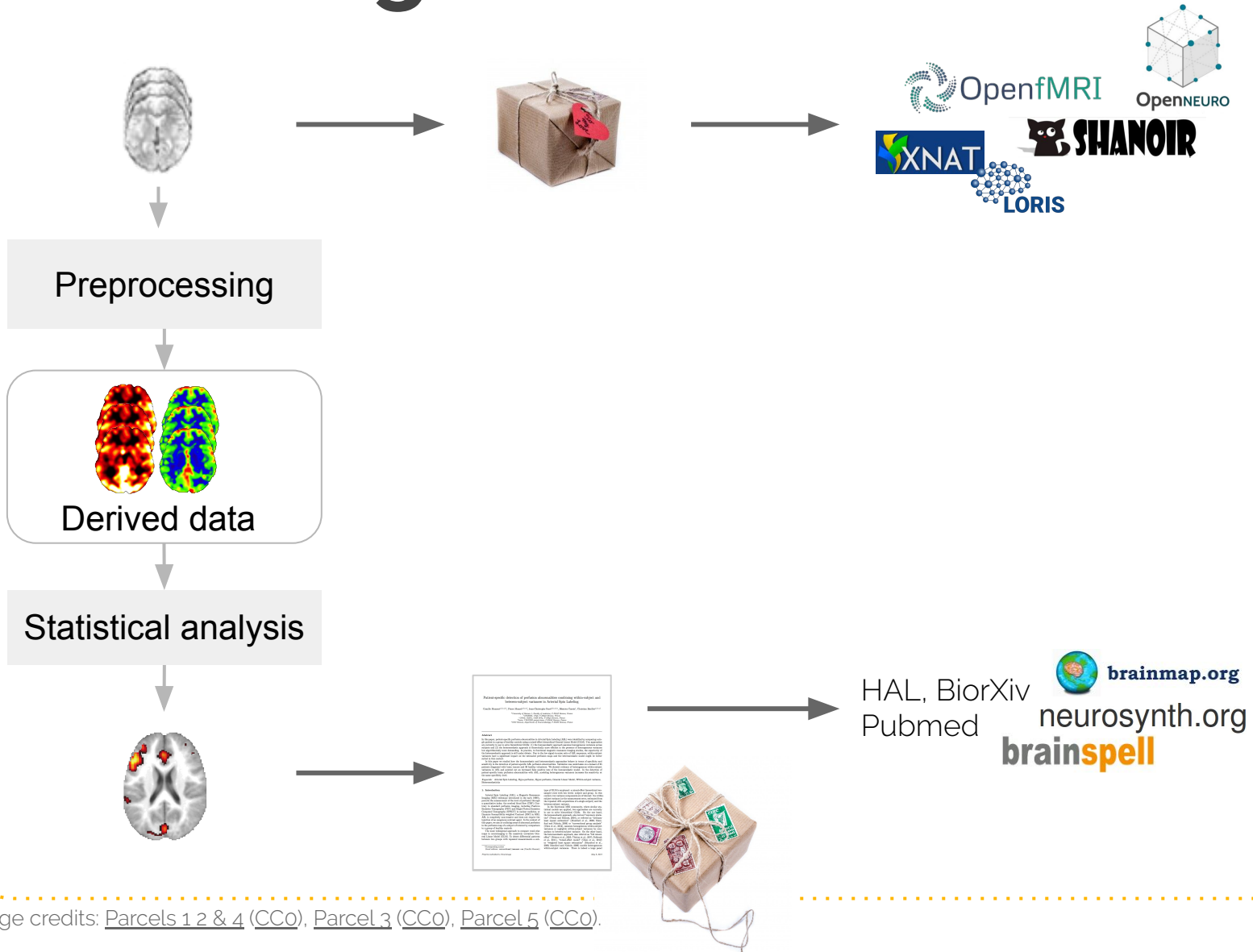
Publishing research artefacts



Publishing research artefacts

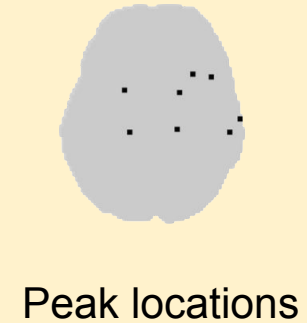
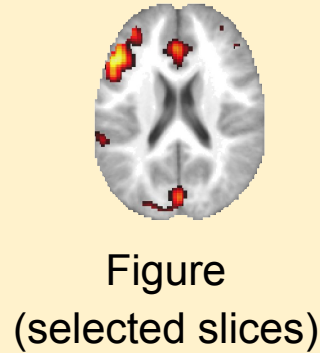


Publishing research artefacts



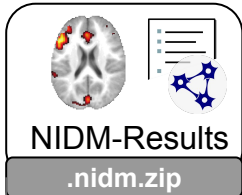
fMRI Results

Publication



- ✘ Incomplete statistical results
- ✘ Ambiguous/incomplete methods
- ✘ Metadata is not searchable

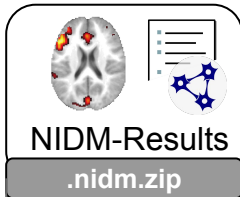
NIDM-Results pack



- 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

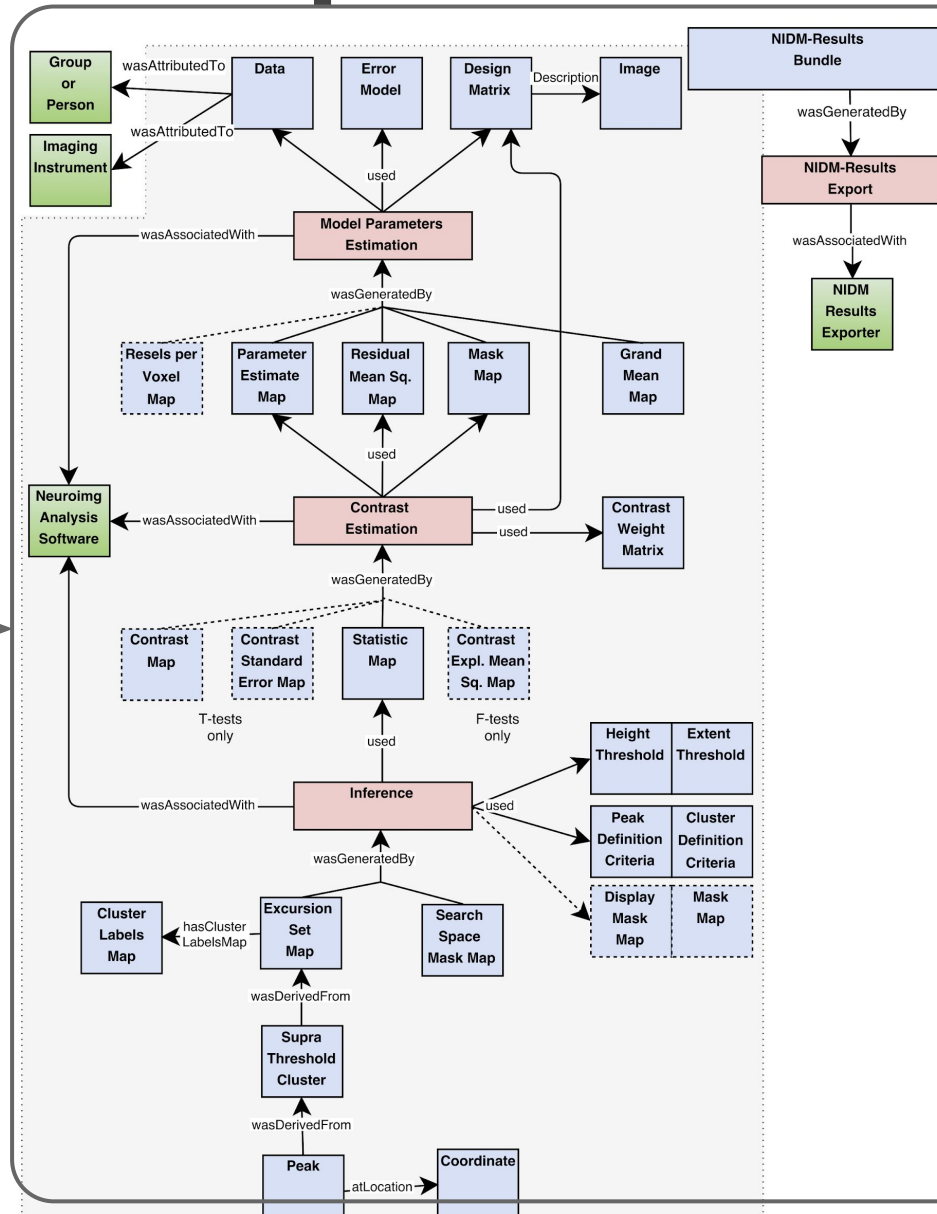
[Maumet et al.,
Sci. Data 2016]

NIDM-Results pack



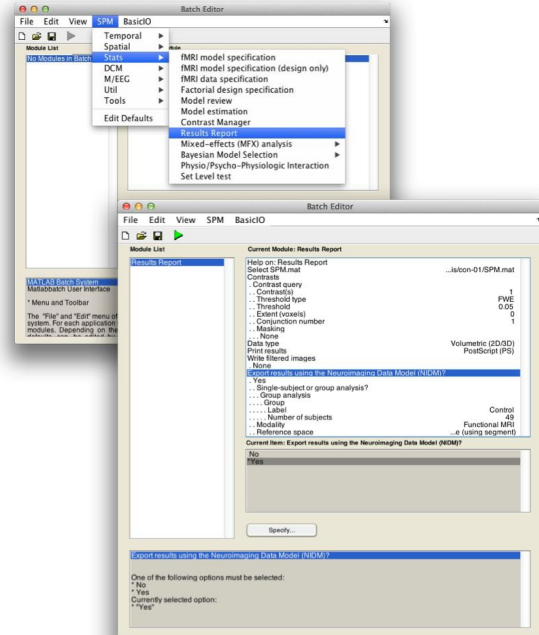
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- ContrastStandardError.nii.gz
- DesignMatrix.csv
- DesignMatrix.png
- ExcursionSet.nii.gz
- ExcursionSet.png
- GrandMean.nii.gz
- Mask.nii.gz
- nidm.json
- nidm.ttl
- ParameterEstimate_001.nii.gz
- ParameterEstimate_002.nii.gz
- ResidualMeanSquares.nii.gz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

[Maumet et al.,
Sci. Data 2016]



NIDM in SPM, FSL & NeuroVault

SPM

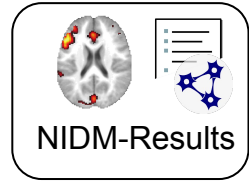


1. Export



```
$ nidmfsfsl fsl_ds107_group 49 -g Control
```

2. Publication on NeuroVault



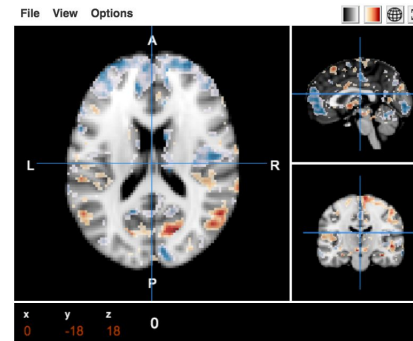
A Correspondence between Individual Differences in the Brain's Intrinsic Functional Architecture and the Content and Form of Self-Generated Thoughts

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

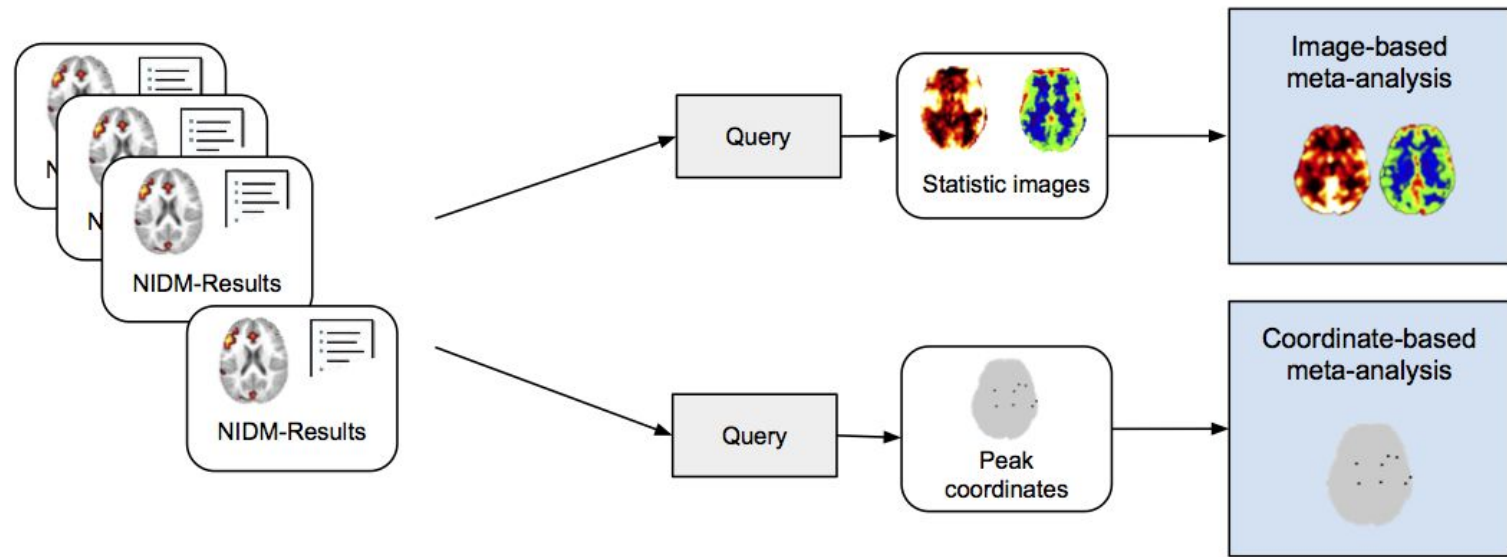
Show 7 entries Search:

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

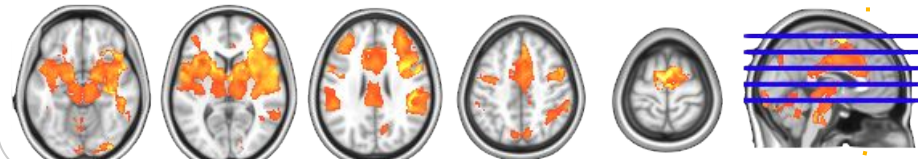
Meta-analysis w/ NIDM-Results



Coordinate-based meta-analysis



Image-based meta-analysis



Publishing research artefacts

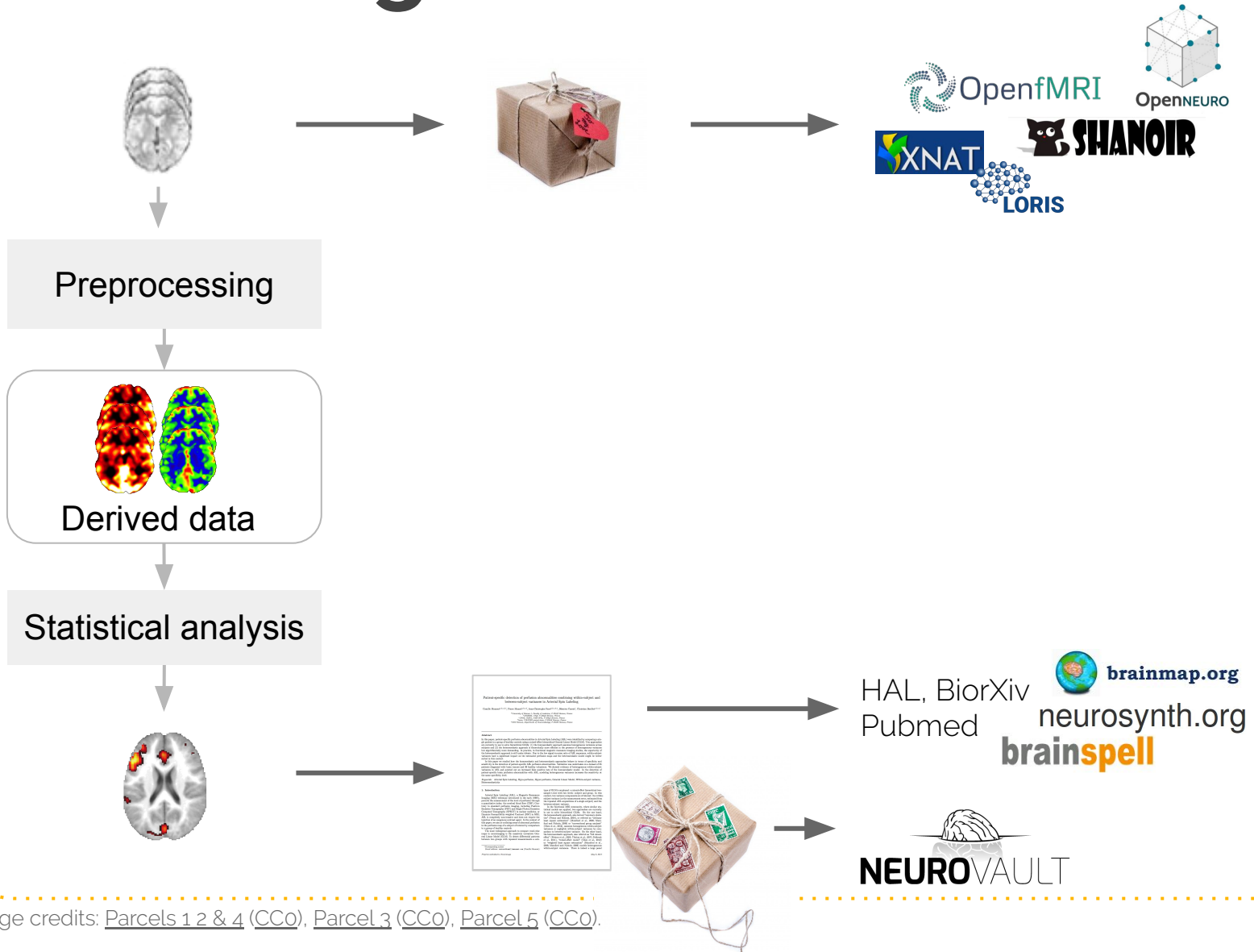
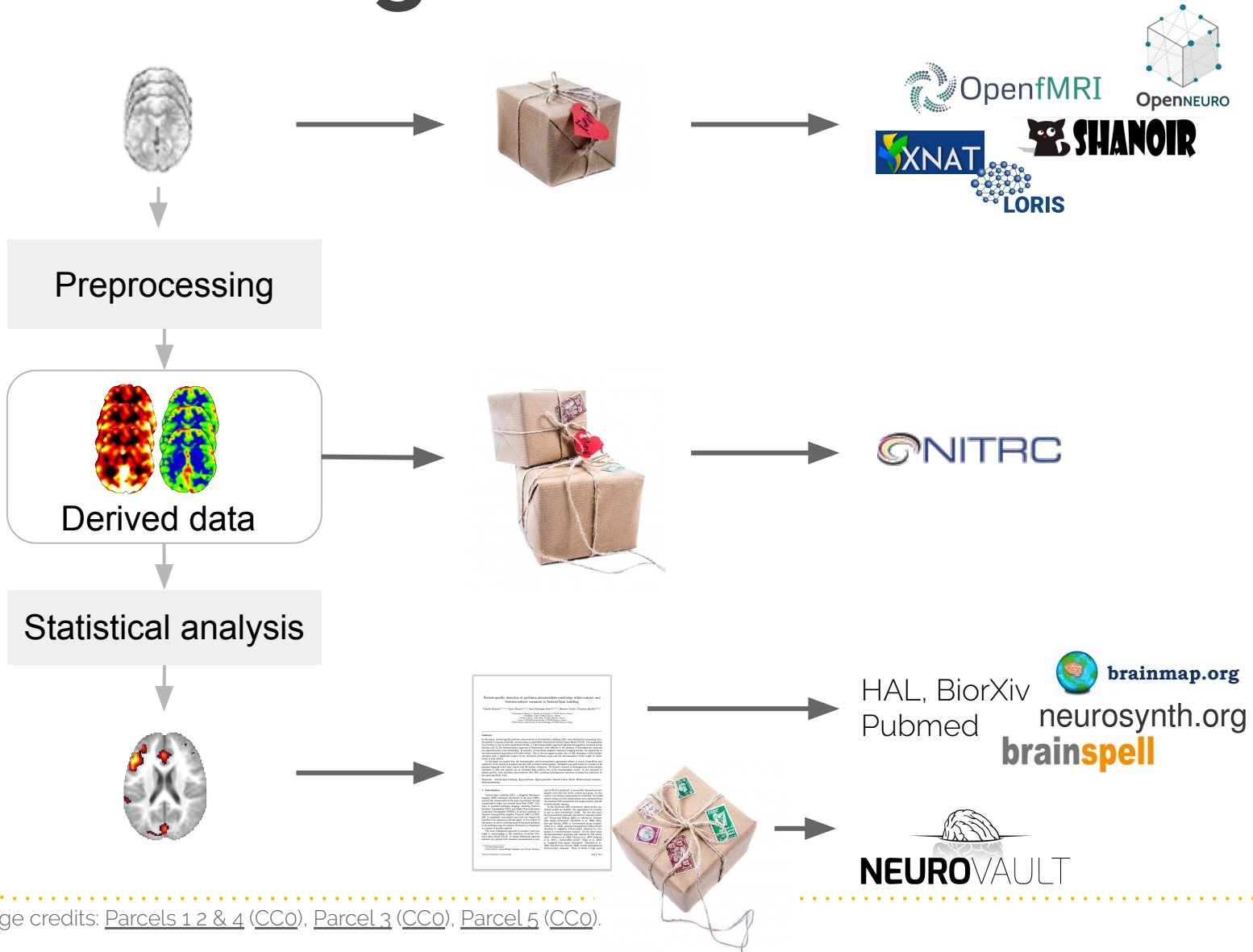
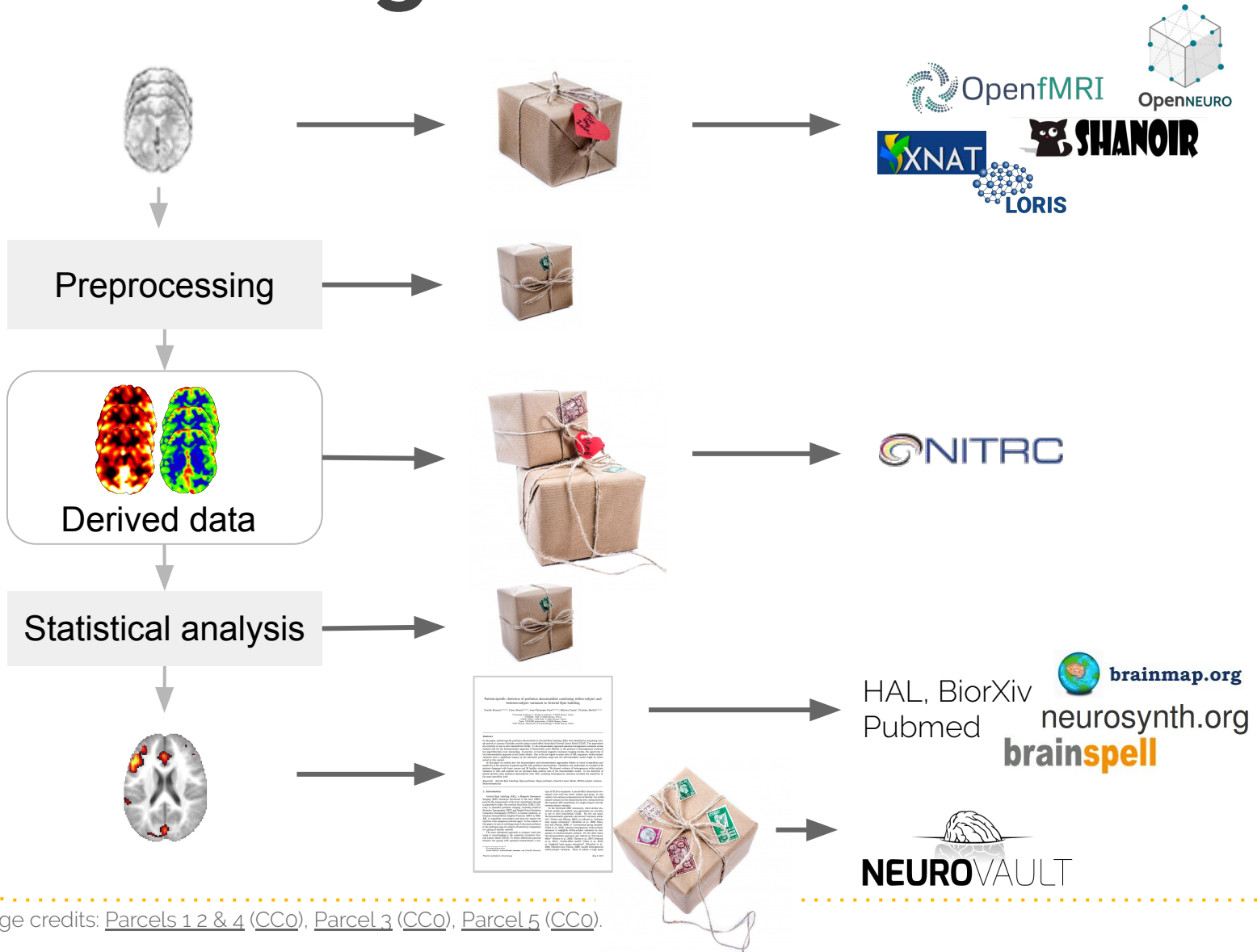


Image credits: [Parcels 1 2 & 4 \(CC0\)](#), [Parcel 3 \(CC0\)](#), [Parcel 5 \(CC0\)](#).

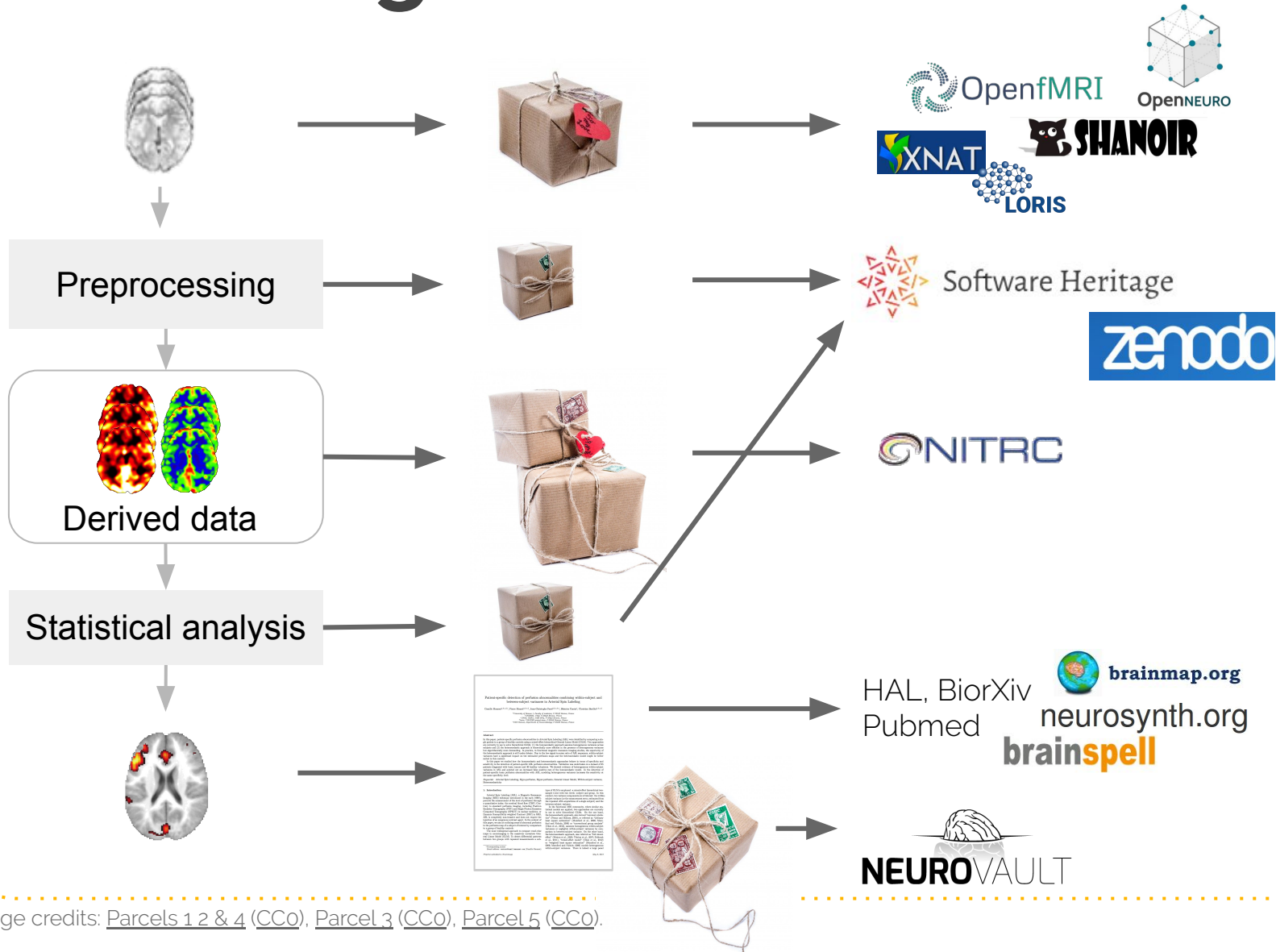
Publishing research artefacts



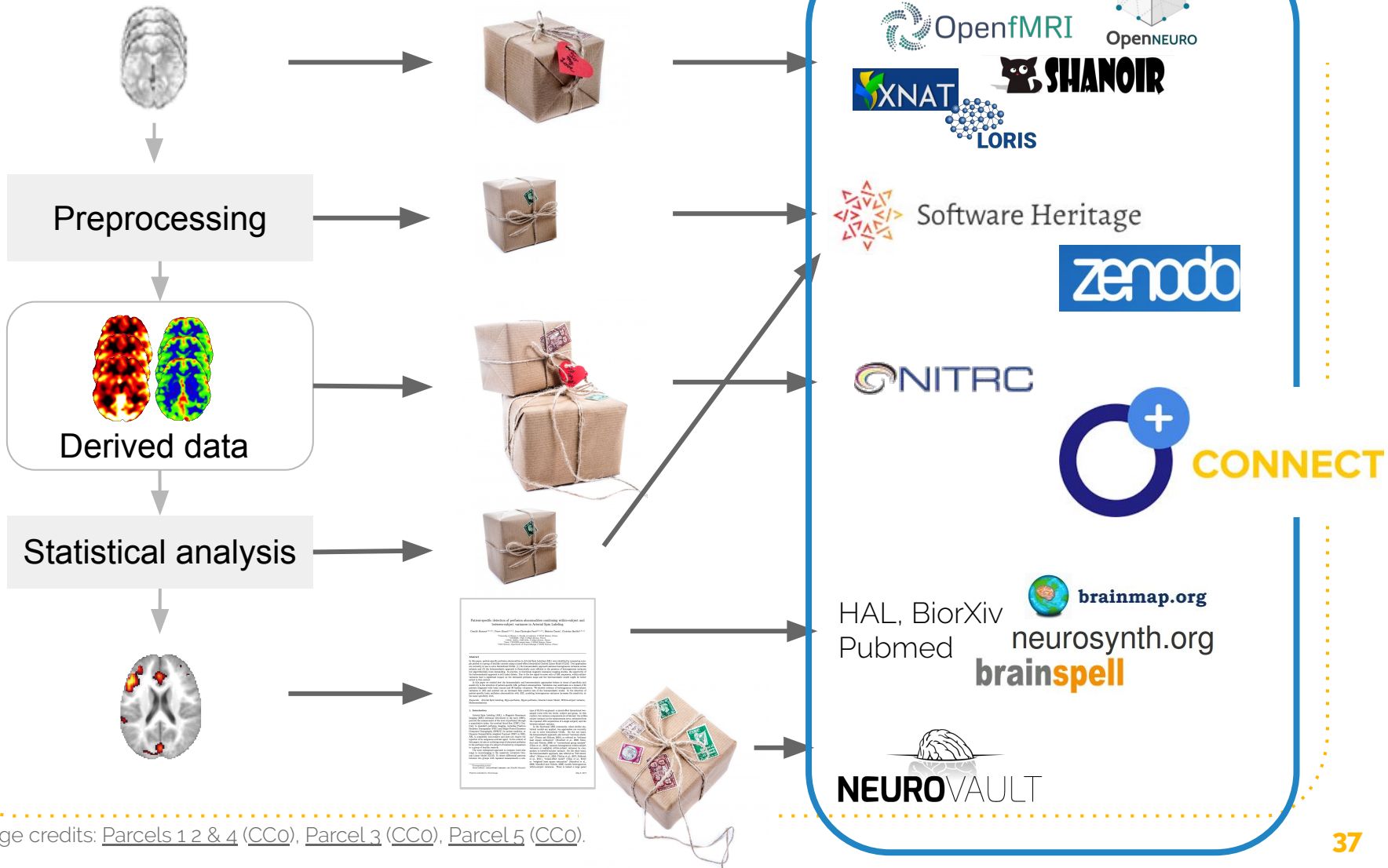
Publishing research artefacts



Publishing research artefacts



Publishing research artefacts



On our way...

**Linking it all with
openAIRE-Connect**

The background of the slide features silhouettes of several people running on a beach. The scene is overlaid with a semi-transparent blue filter. The people are captured in various dynamic poses, suggesting movement and energy. The beach and ocean are visible in the background, though slightly blurred.

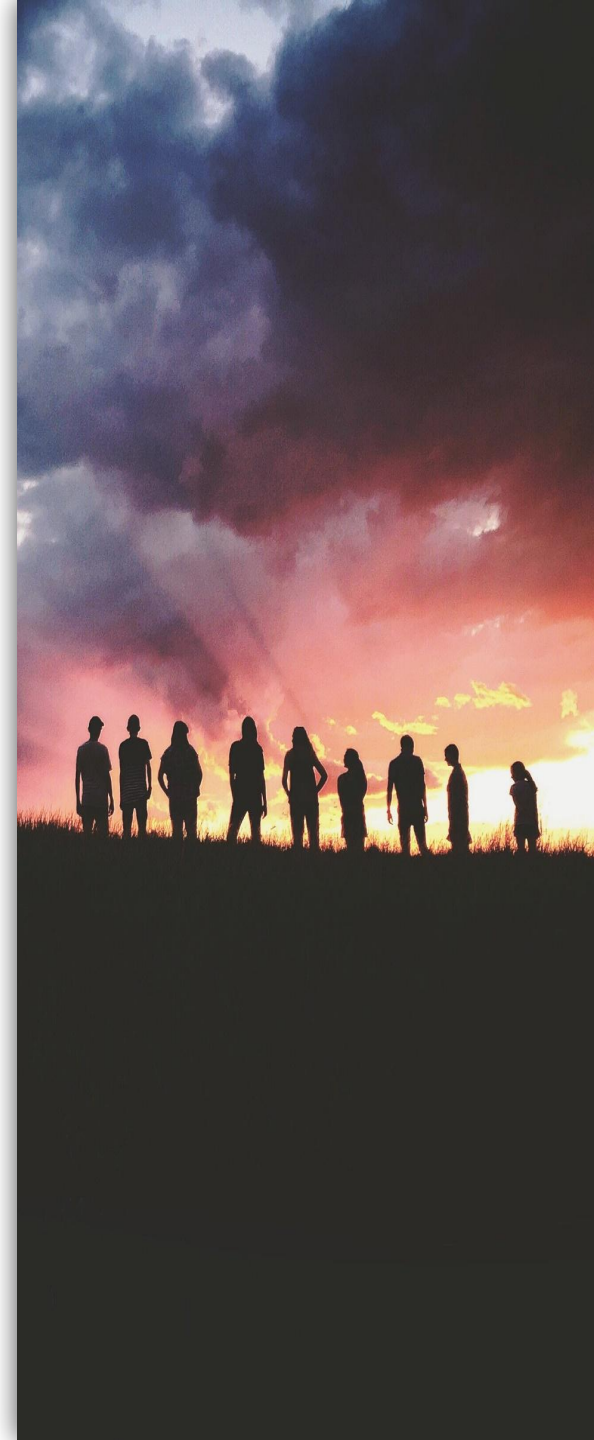
Research Community Dashboard

A window to community's research.

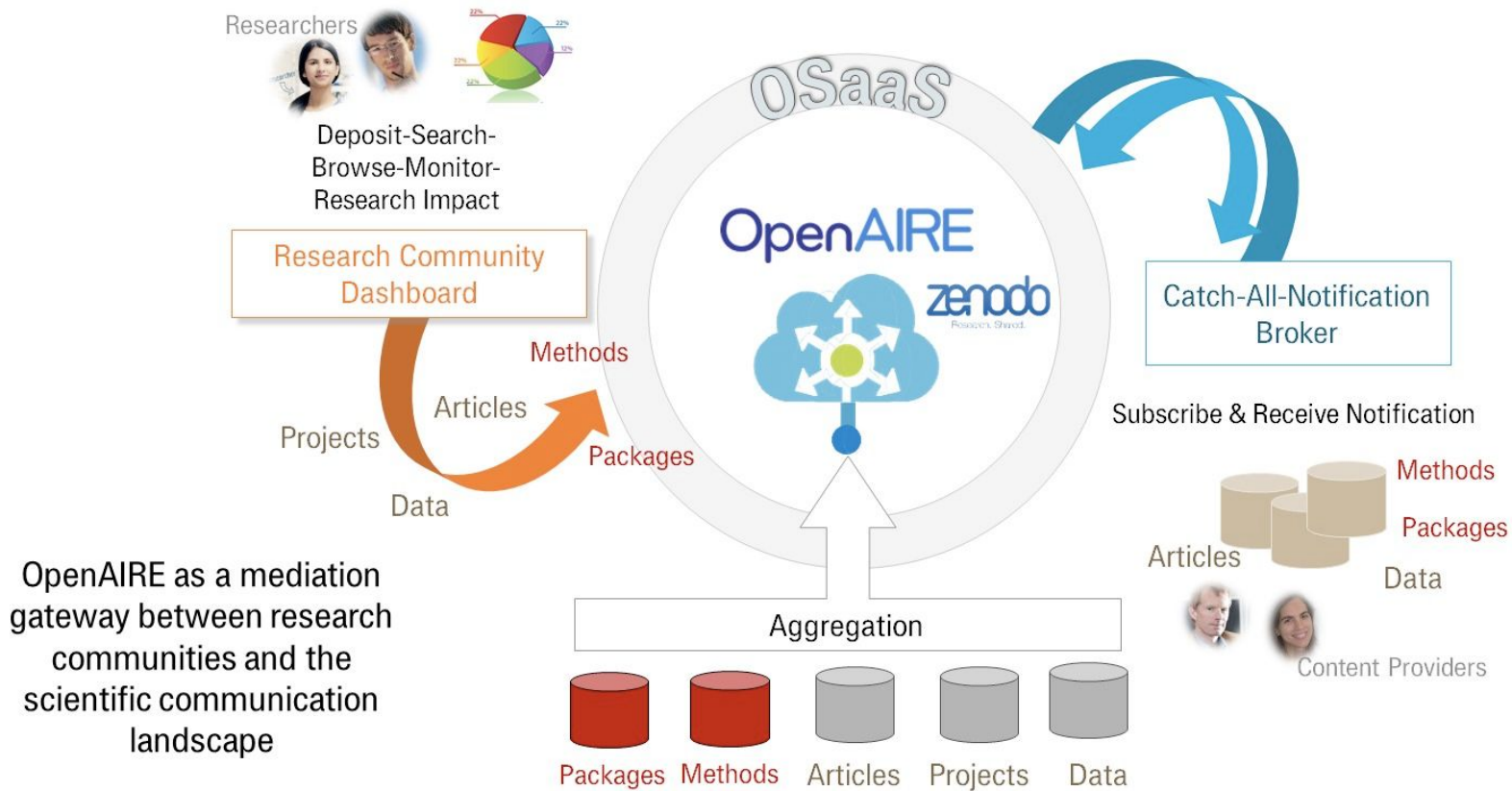
Open Science as a Service

**Open Science as-a-Service
for Research Communities**

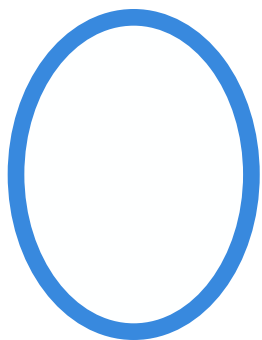
**Facilitate Research Communities
adoption of Open Science
publishing principles by supporting
artefact publishing tools
as-a-Service**



Open Science as-a-Service (OSaaS)

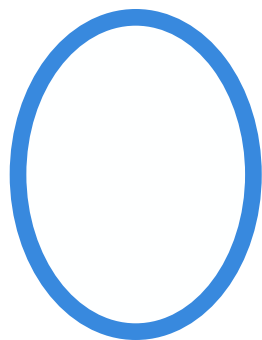


A virtual environment designed for your Community



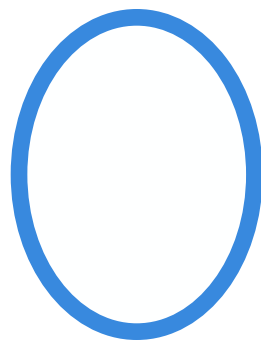
Implement

the latest Open Science trends:
FAIR data, open data



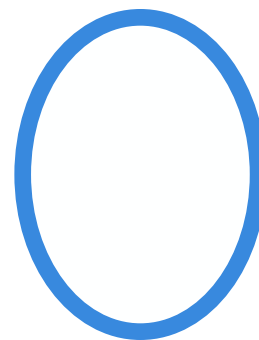
Share

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



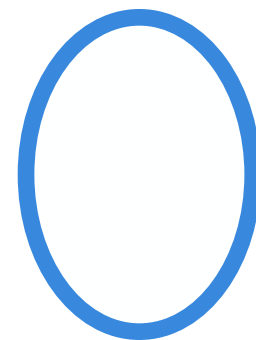
Link

all your research effectively



Gather

all your research results in one place



Monitor

and report your community's progress

Community dashboards



Sustainable Development Solutions Network - Greece

RESEARCH COMMUNITY

The Greek United Nations (UN) Sustainable Development Solutions Network (SDSN)

Subscribe



Agricultural and Food Sciences

RESEARCH COMMUNITY

The scope of this community is to provide access to publications, research data, projects and software that are related to agricultural and food sciences

Subscribe



Common Language Resources and Technology Infrastructure

RESEARCH INITIATIVE

CLARIN

Subscribe



Fisheries and Aquaculture Management

RESEARCH COMMUNITY

Conservation of marine resources for sustainable development

Subscribe



European Marine Science

RESEARCH COMMUNITY

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

RESEARCH COMMUNITY

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Neuroinformatics: monitor

24,024

publications

5,083

research data

150

software

2,375

other research
products

8

projects

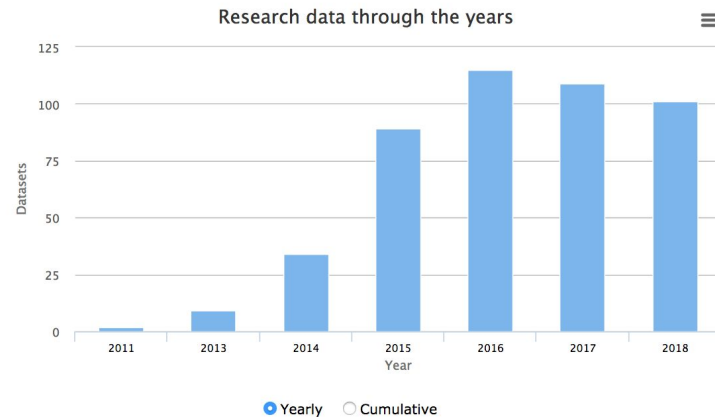
6

content providers

Research Data statistics

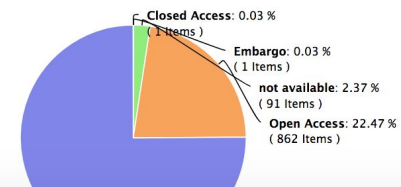
789 DATASETS LINKED TO 1 PROJECT.

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 publically 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 reanalyse the published studies, and highlight our own efforts to make this research reproducible.

Metrics 

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 [OpenAIRE](#) via [OpenAIRE](#) (Preprint, 2018) 




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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 +

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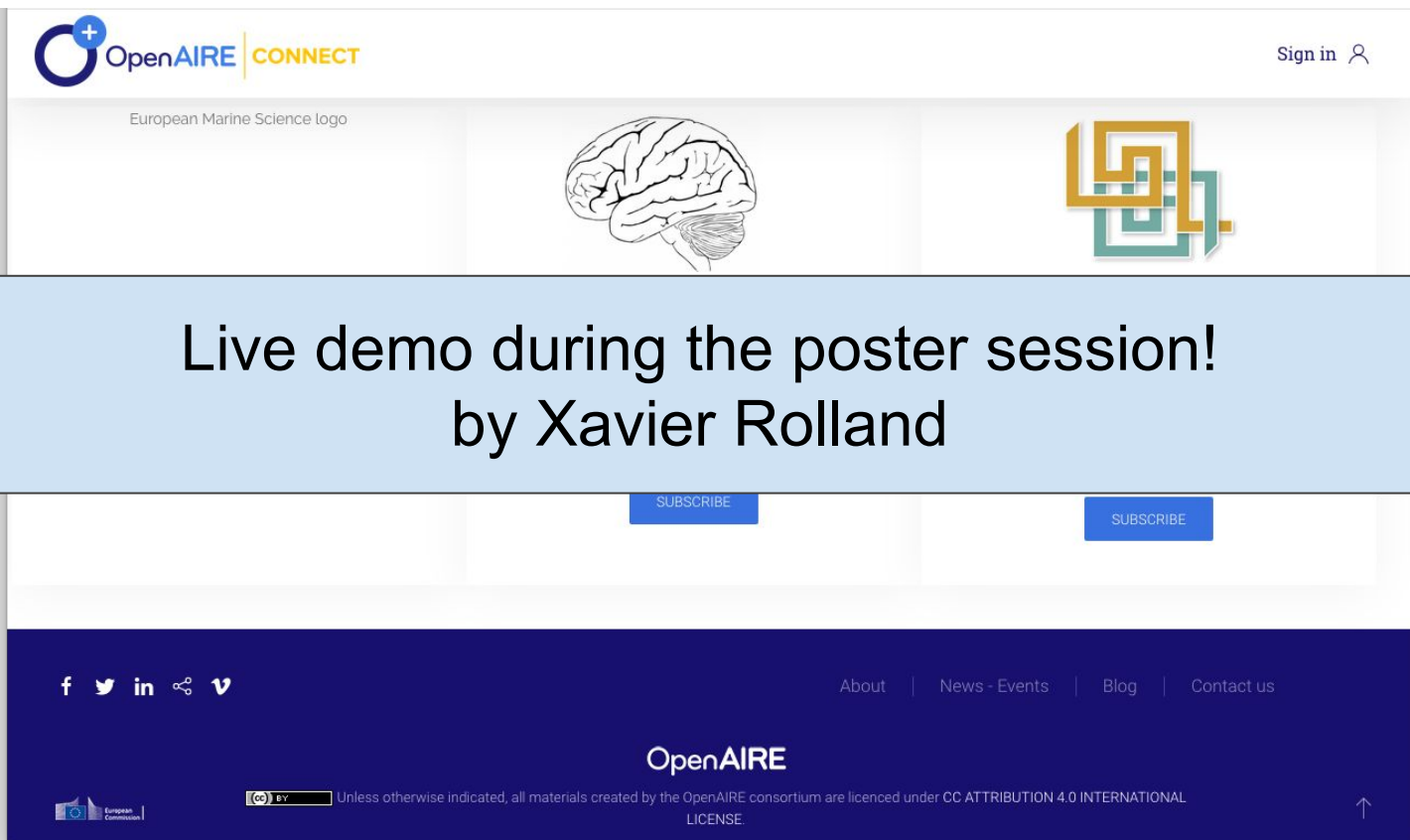
Application Box

Publications Research Data

[< > Include in your site \(HTML\)](#)
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“Gather, view and monitor all research outcomes”



Live demo during the poster session!
by Xavier Rolland

Going further

Going further

Join the community!

Taking part in Standards & Best practices INCF Special Interest Groups

Active groups

The SIGs listed below are all active and open to new members. If you are interested in joining a SIG, please contact them on the listed address.

- 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 → BIDS, NIDM & more!
- Reproducible Research and Open Neuroscience
- Standardised Representations of Network Structures
- Neuroimaging Quality Control (niQC) →

Survey open now!

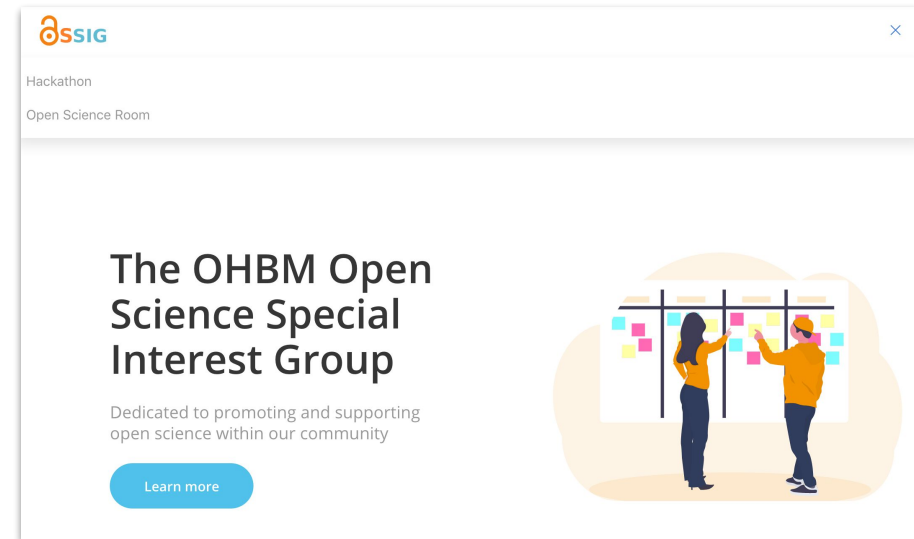
<http://tinyurl.com/WeNeedNiQC>

Create your own SIG!

Getting started & spreading open science






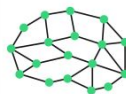

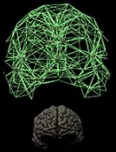
ReproNim: A Center for Reproducible
Neuroimaging Computation

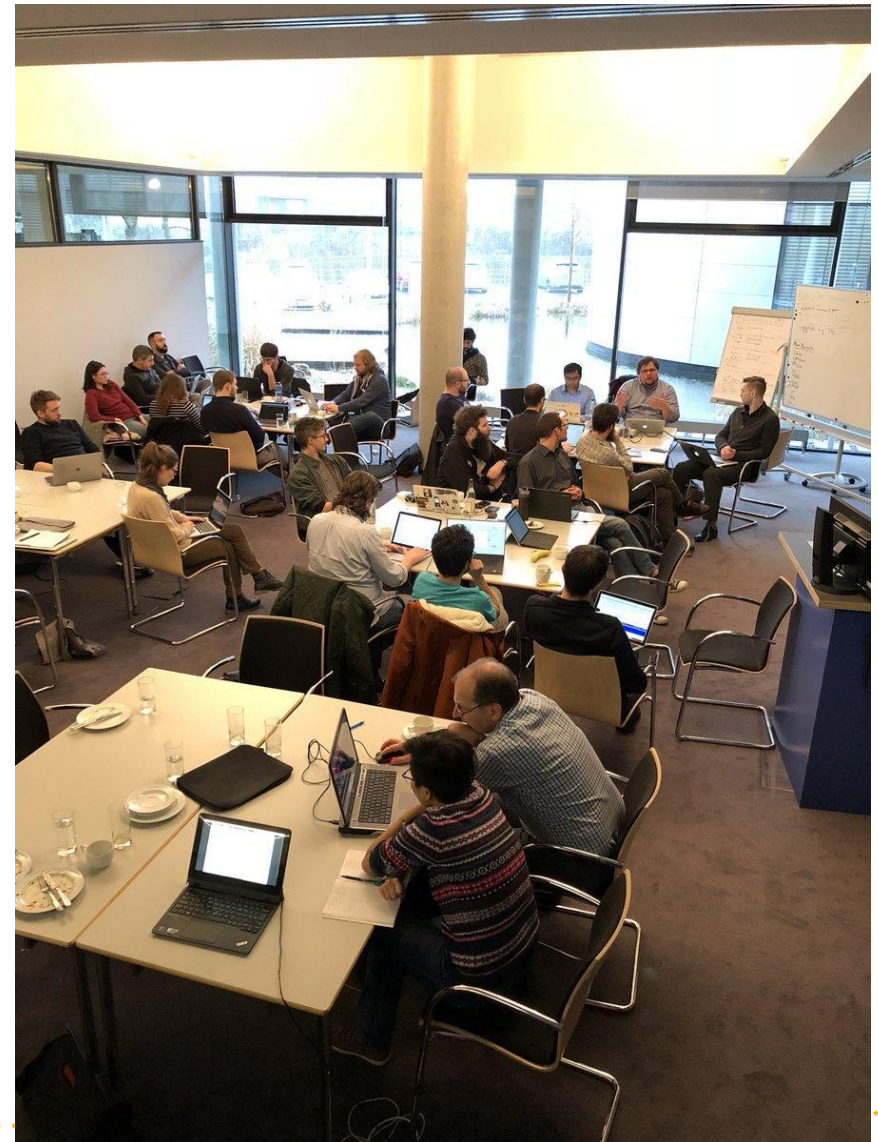


Mozilla Open Leaders

Work Open, Lead Open

Researching collaboratively Hackathons

<p>BRAIN HACK OPEN GENEVA 2019</p>  <p>BRAIN HACK OPEN GENEVA 2019 EVENTS 2019</p> <p>Brainhack Open Geneva will take place from March 22-23, 2019</p>	<p>BRAIN HACK IN PADOVA: EVOLUTION</p>  <p><i>BrainHack: Evolution of the Mind and the Brain</i></p> <p>Brainhack in Padova will take place from December 5-7, 2018</p>
<p>LA BRAINHACK 2018</p>  <p>LA BRAINHACK 2018 EVENTS 2018</p> <p>The LA Brainhack 2018 will take place November 18 - 19 at the Information Sciences Institute, Marina del Rey.</p>	<p>BRAIN HACK ZURICH 2018</p>  <p>BRAIN HACK Oct ZURICH 2018 EVENTS 2018</p> <p>Brainhack Zurich 2018 will take place from October 24-26 at ETH Zurich & University Hospital Zurich.</p>
<p>2018 OHBM HACKATHON</p>  <p>OHBM Brainhack 2018 Singapore June 14-16, 2018 EVENTS 2018</p> <p>The 2018 OHBM Hackathon will take place June 14 - 16 at the National University of Singapore, U-Town campus, Singapore.</p>	<p>BRAIN HACK NETWORKS</p>  <p>9 & 10 of June 2018, Brain and Spine Institute, Paris</p>



Acknowledgements

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OpenAIRE neuroinformatics

Christian Barillot, Axel Bonnet, Xavier Rolland, Sorina Caramasu Pop.

Let's do open neuroimaging sciences



Thank you!

Any questions?

Camille Maumet

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<http://camillemaumet.com>

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