The brainlife.io cloud-services for functional network neuroscience

brainlife.io
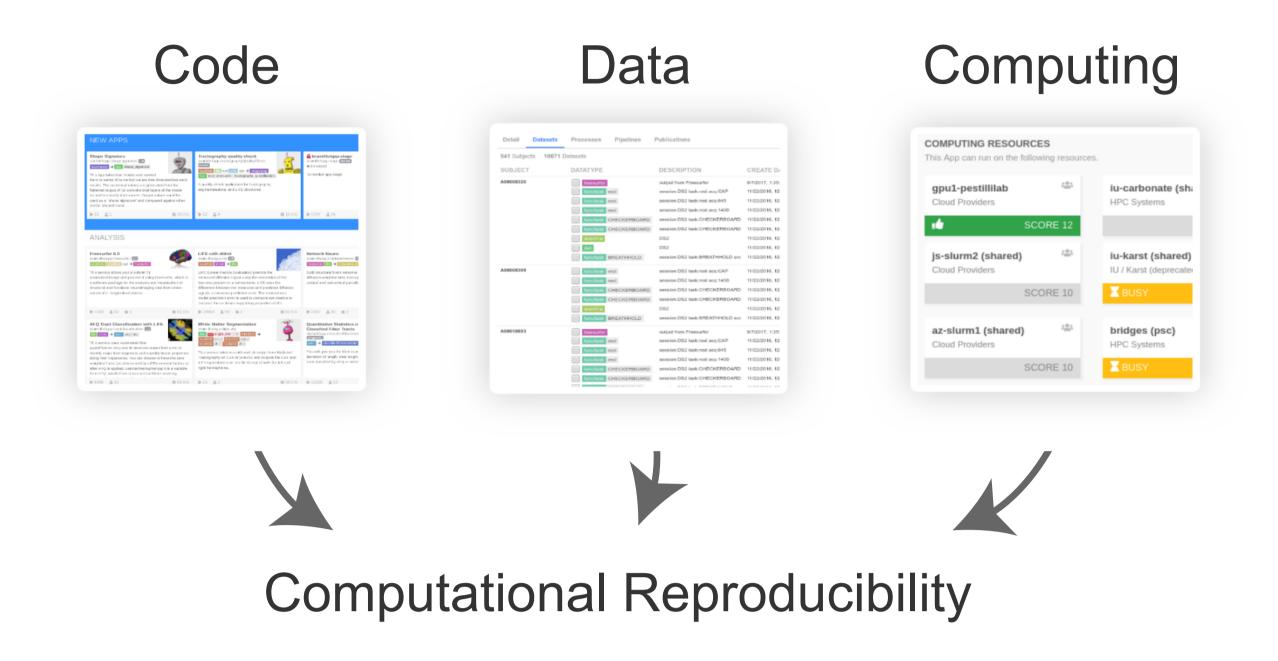
an online platform to accelerate scientific discovery by automated data management, large scale analyses, and visualization

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Introduction

The field of Network Neuroscience exists at the intersection of human brain mappers and network science practitioners. These fields require both **advanced software skills** and **mathematical knowledge**. Whereas on the one hand, fMRI specialists learn to employ highly specialized image processing techniques and must make sure their data is artifact-free, on the other hand, network scientists focus on learning and developing innovative network science algorithms applicable across fields. To achieve **expert-level knowledge in both domains** is both a challenge and a barrier for investigators and trainees in either field.
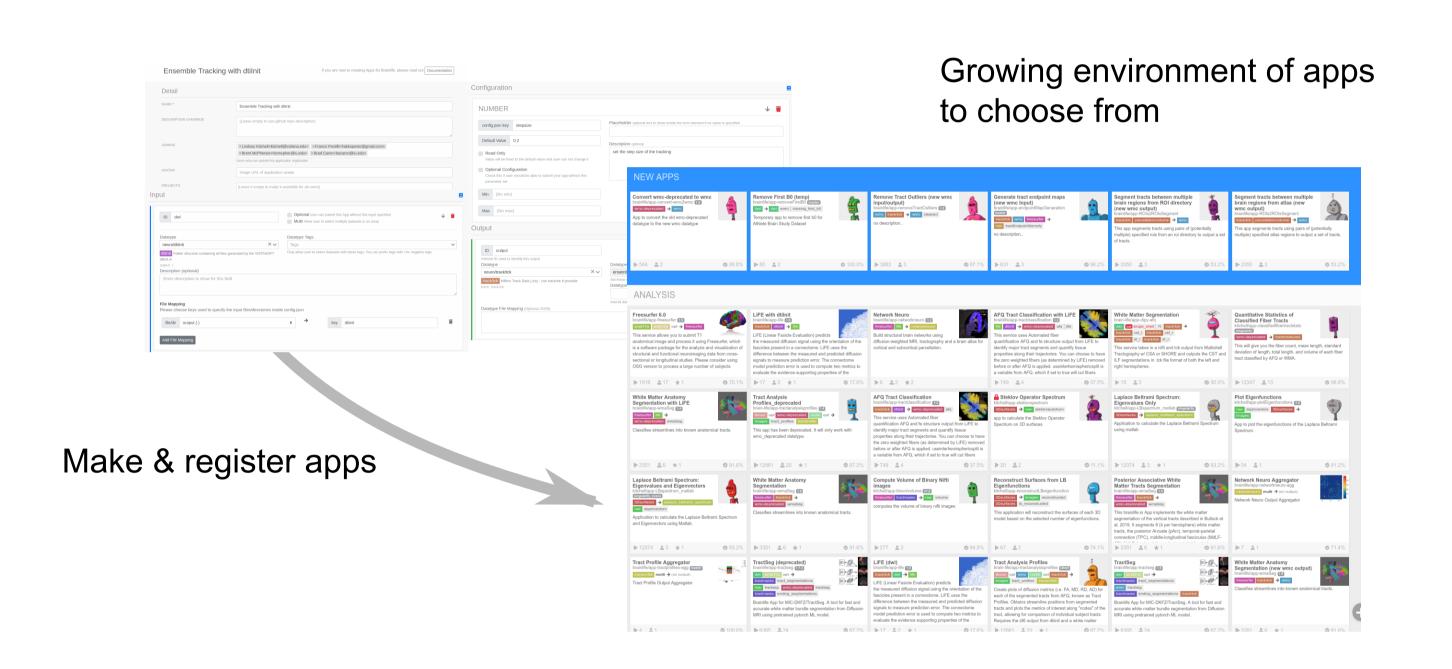
We present a series of cloud computing services that make network neuroscience more accessible by enabling the generation of functional brain networks in a streamlined, intuitive, and reproducible manner.
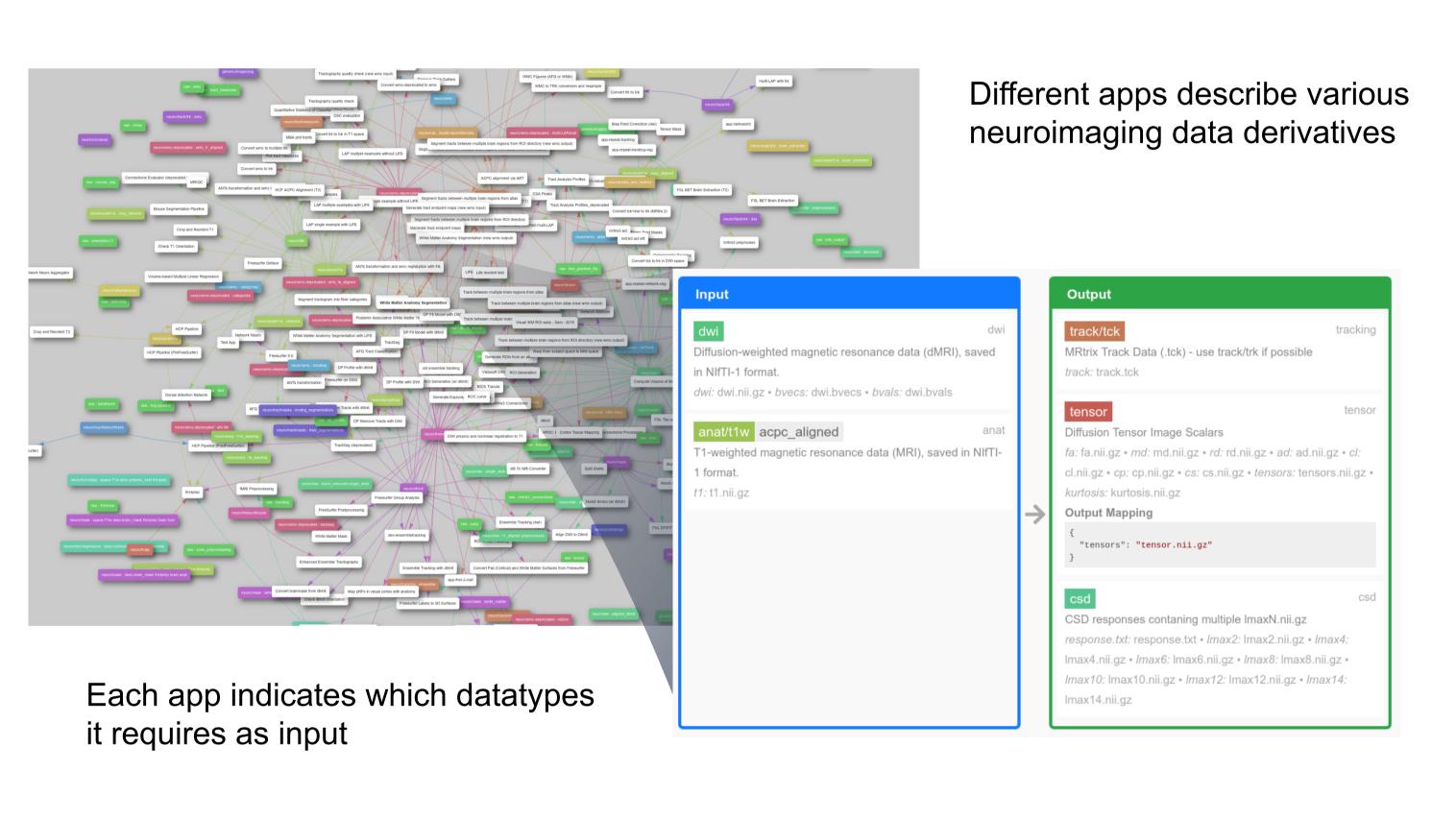
Code   Data   Computing

Computational Reproducibility

The series of apps we present here are part of the larger brainlife.io environment[1], which enable computational reproducibility by combining code, data, and computing into a single platform. In this way, users can choose methods to run (code) on specific datasets (data) using the computational resources of a high performance computing environment (computing).

Apps & datatypes

Form the user's perspective, apps and datatypes are elements to interact with. Apps represent modular programs which run on your data. There are different apps to preform different functions, such as skull strip or run FreeSurfer. Datatypes help you keep track of the different neuroimaging data you have. Datatypes describe neuroimaging data in different froms, such as an anatomical volume, a brain mask, or even a fiber tract.
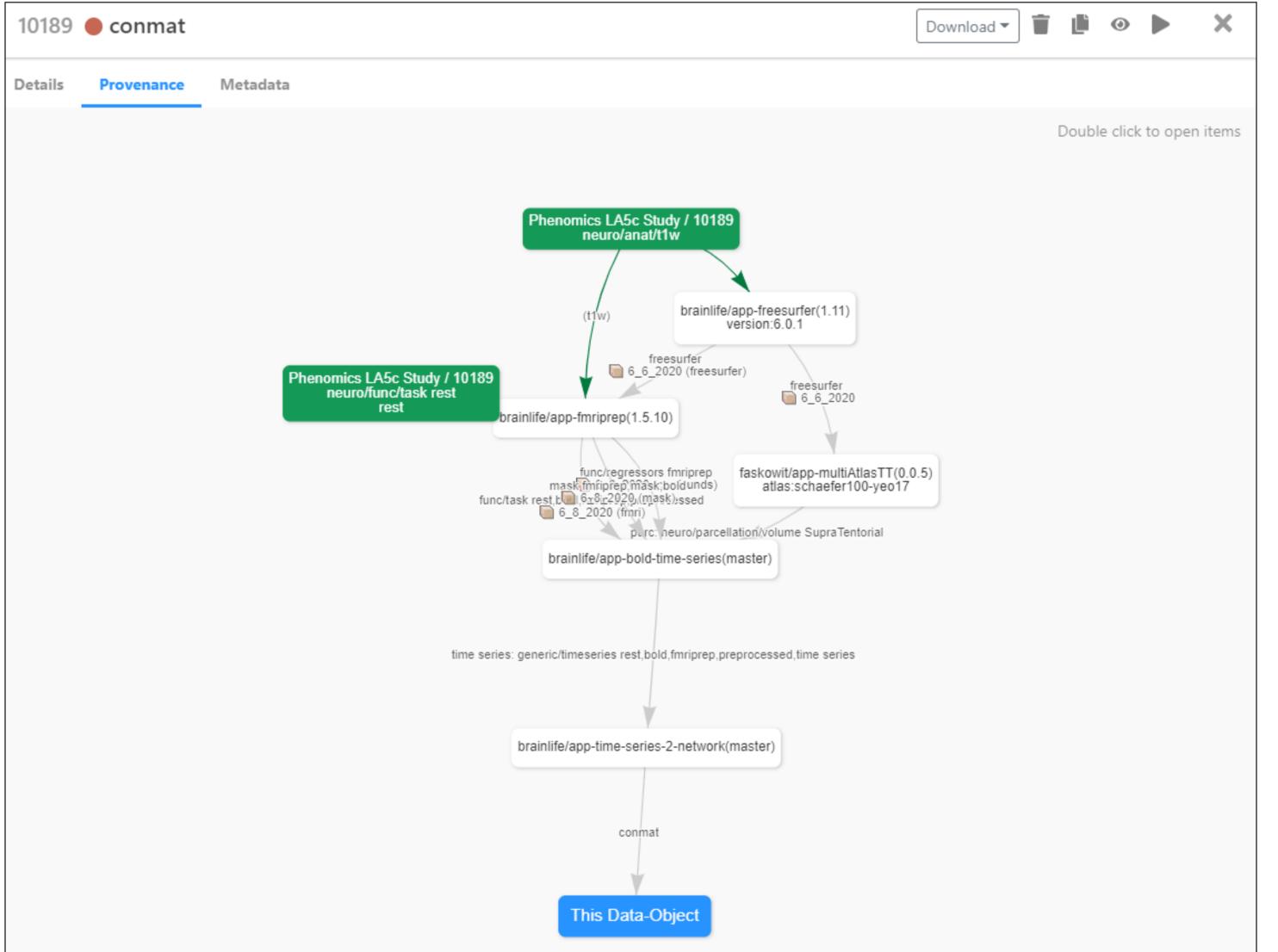
Growing environment of apps to choose from

Make & register apps

Different apps describe various neuroimaging data derivatives

Each app indicates which datatypes it requires as input
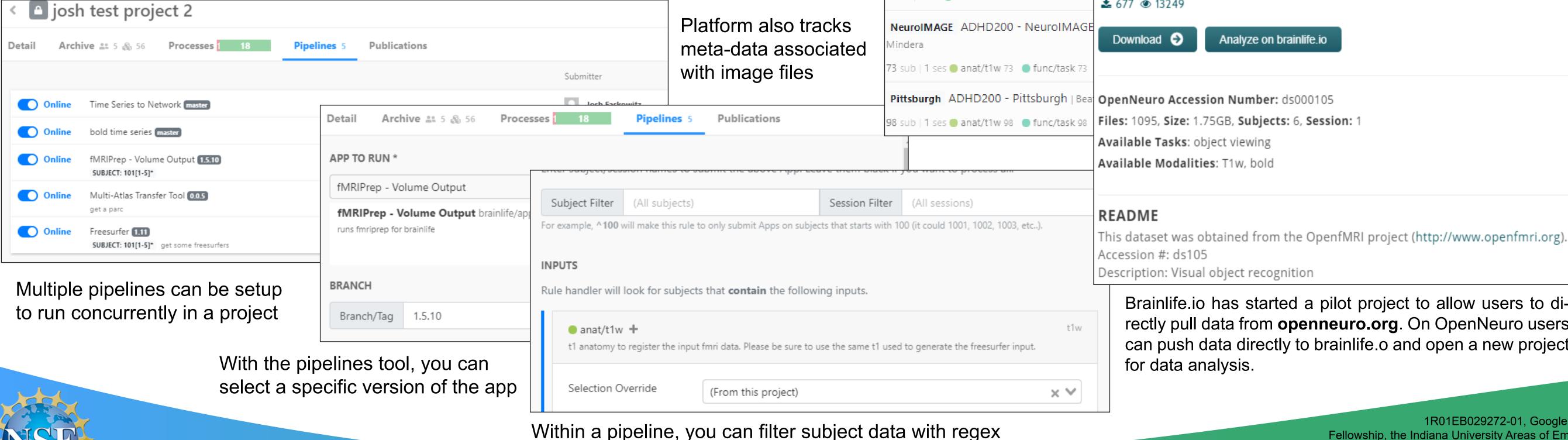
Running through data on brainlife.io

Data provenance

After running a series of apps, users have access to the web of apps & datatypes that produced the current data. This is particularly helpful when trying to figure out where the data came from.
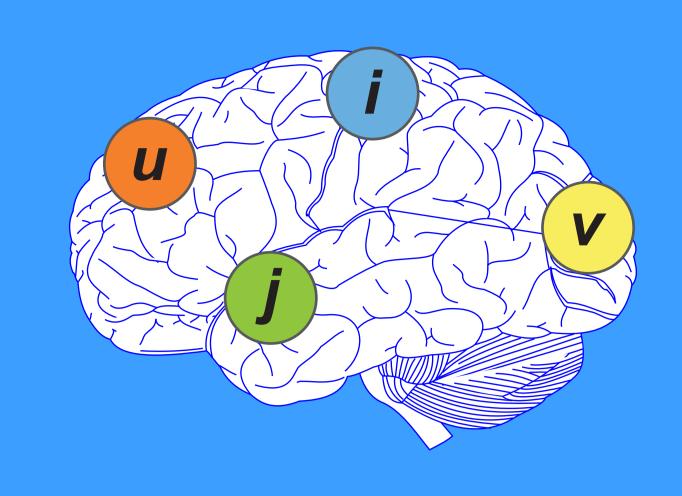
Pipelines

Once you have your workflow figured out, you can setup pipeline rules to automatically run apps on available data. Pipeline rules make running the same series of operations on hundreds of subject-level data a piece of cake!
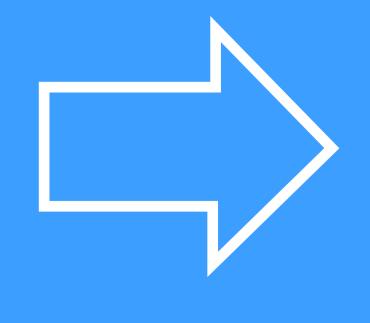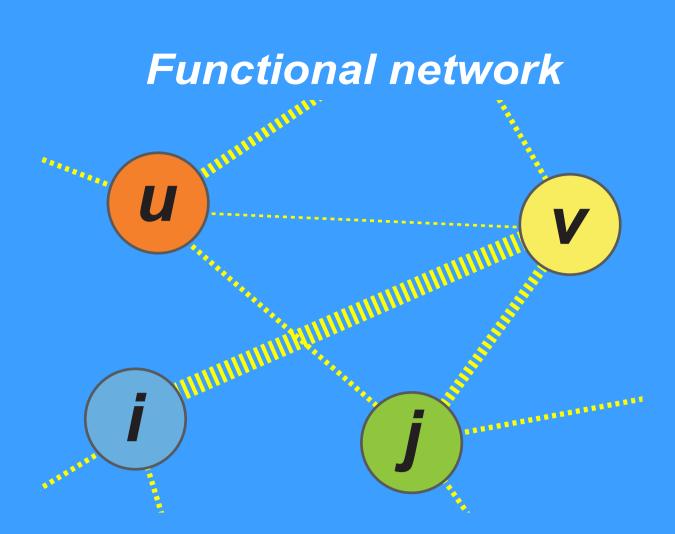
Platform also tracks meta-data associated with image files

Multiple pipelines can be setup to run concurrently in a project

With the pipelines tool, you can select a specific version of the app

Within a pipeline, you can filter subject data with regex

Get functional brain networks using a series of apps that can be run on the cloud

Functional network
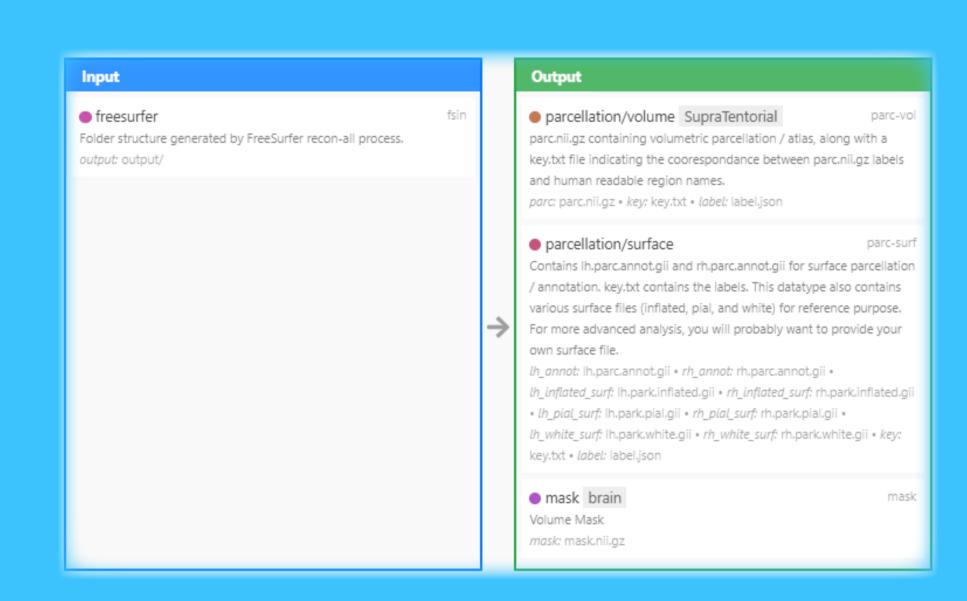
Prepare parcellation

Run FreeSurfer
https://doi.org/10.25663/bl.app.0

Get parcellation
https://doi.org/10.25663/bl.app.23

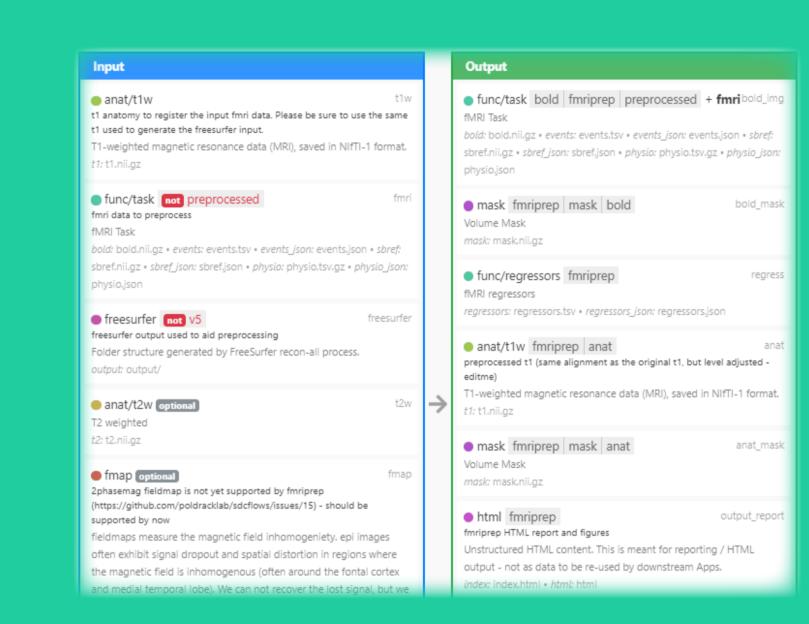- Fit {HCP-MMP, Schaefer[8], Yeo[10]....} parcellations to T1w anatomical data using FreeSurfer[4] classifier information
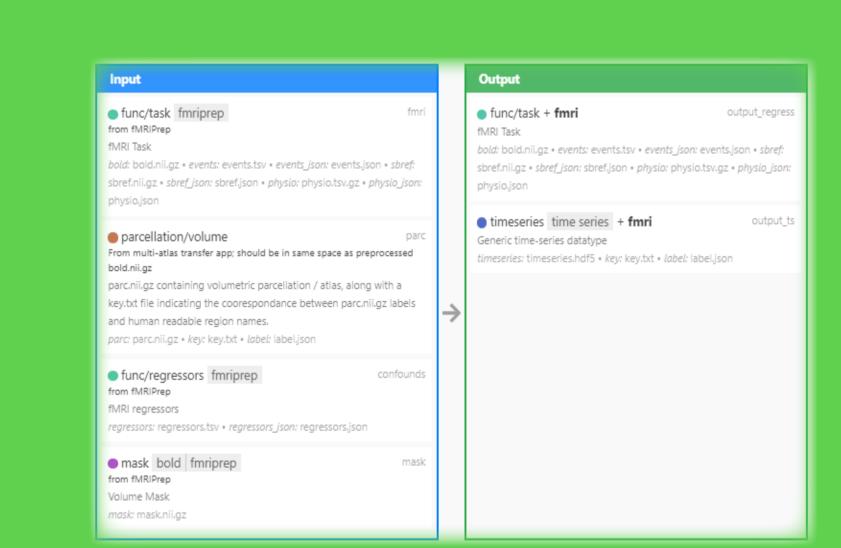
Run fMRIPrep
https://doi.org/10.25663/brainlife.app.160

- Run preprocessing pipeline[3] to obtain fMRI data that is: motion corrected, slice-time corrected, aligned to original anatomical space

- brainlife.io interface will use meta-data to populate BIDS structure, which is read by fMRIPrep program

- Visual reports from fMRIPrep are saved for review
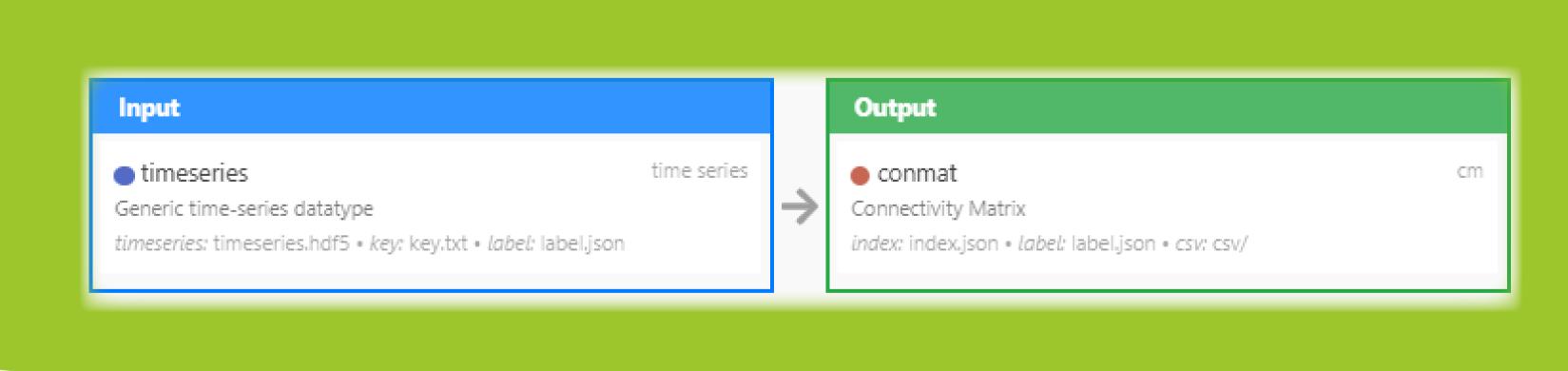
Nuisance regress + make time series
https://doi.org/10.25663/brainlife.app.369

- Use rotation, translation, and signal confounds computed from fMRIPrep to create nuisance regressors

- Choose from multiple nuisance regression strategies that include {yes/no} global signal regression[7]

- Creates a time series datatype of mean signal at each spatial region-of-interest (node) from parcellation

Make network
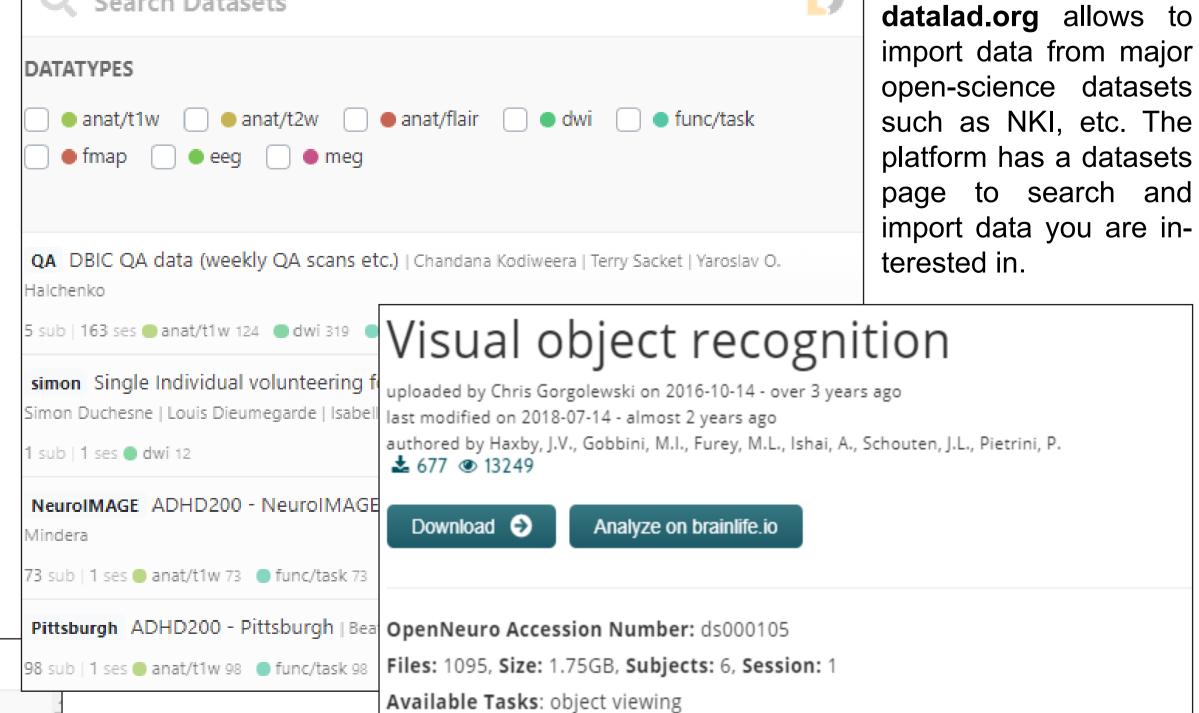https://doi.org/10.25663/brainlife.app.372

- Make a functional connectivity matrix using correlation, partial correlation, or covariance

- In development: we are making apps to process and analyze correlation matrices; such apps will include null modeling, community detection, network statistics, and visualization

Where can I get some data to make networks?

Users can upload their data to brainlife.io using the BIDS uploader. Also, brainlife.io interfaces with **openneuro.org** and **datalad.org**, to bring openly-available fMRI datasets to you. Vist **https://brainlife.io/datasets** for more!

A partnership between **datalad.org** allows to import data from major open-science datasets such as NKI, etc. The platform has a datasets page to search and import data you are interested in.

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brainlife.io has started a pilot project to allow users to directly pull data from openneuro.org. On OpenNeuro users can push data directly to brainlife.o and open a new project for data analysis.

Conclusion

Constructing functional brain networks requires specialized knowledge, creating a barrier to entry for network neuroscientists and a dearth of available data for network scientists. We address this barrier by building cloud-computing tools to construct these networks. Our future work will focus on: 1) adding fMRI quality control feedback[2] and 2) adding network analysis algorithms to Brainlife.io, so that full analytical pipelines, from raw data to p-value, can be run in a reproducible manner on the cloud.

References

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