

bids_apps_slides

April 24, 2018

1 BIDS Apps

This tutorial aims to introduce BIDS Apps. After briefly introducing some background, we will run the mriqc BIDS App on our laptops to get quality reports for MRI data.

2 Before we start

- Laptop with Docker installed (see guides for [mac](#), [windows](#), [linux](#))
- if possible, already download (pull) the docker container we will be using:
 - open a terminal window/command line
 - paste the following command: `docker pull poldracklab/mriqc:0.10.4`
 - press enter and wait for the download to be finished
- [download](#) the this BIDS-formatted example data set (430 MB)

3 Background

3.1 Neuroimaging software

- Installation of neuroimaging software can be painful
- Complex workflows might require to install multiple software packages
- Needs to be repeated for new system (e.g., cloud system)
- Different software version might give different results

Makes it more difficult to reproduce analyses

3.2 What is BIDS

- [Brain Imaging Data Structure](#)
- A standardized way to represent data and metadata from neuroimaging studies
- [Gorgolewski et al., 2016](#)

3.3 What are BIDS Apps

- Portable neuroimaging pipelines shipped as **software containers**
- Understand [BIDS](#)

Available BIDS Apps

BIDS-Apps/example	version 0.0.7	open bug issues 0	build passing	open bug pull requests 0	docker pulls 6k	439.5MB 23 layers
BIDS-Apps/freesurfer	version v6.0.1-4	open bug issues 0	build passing	open bug pull requests 0	docker pulls 3k	0B 52 layers
BIDS-Apps/ndmg	version v0.1.0	open bug issues 0	build passing	open bug pull requests 0	docker pulls 7k	920.9MB 31 layers
BIDS-Apps/BROCCOLI	version v1.0.1	open bug issues 1	build passing	open bug pull requests 0	docker pulls 257	3GB 21 layers
BIDS-Apps/FibreDensityAndCrosssection	version v0.0.1	open bug issues 0	build passing	open bug pull requests 0	docker pulls 72	576.8MB 31 layers
BIDS-Apps/SPM	version v0.0.14	open bug issues 0	build passing	open bug pull requests 0	docker pulls 929	1.6GB 24 layers
poldracklab/mriqc	version 0.10.4	open bug issues 23	build passing	open bug pull requests 0	docker pulls 19k	2.7GB 37 layers
BIDS-Apps/QAP	Image not found	open bug issues 0	build passing	open bug pull requests 0	docker pulls 7	Image not found
BIDS-Apps/CPAC	version v1.0.2-dl...	open bug issues 0	build passing	open bug pull requests 0	docker pulls 2k	1.4GB 38 layers
BIDS-Apps/hyperalignment	Image not found	open bug issues 0	build passing	open bug pull requests 0	docker pulls 3	Image not found
BIDS-Apps/mindboggle	version 0.0.4-1	open bug issues 2	build passing	open bug pull requests 0	docker pulls 389	1.9GB 81 layers
BIDS-Apps/MRtrix3_connectome	version 0.2.2	open bug issues 0	build passing	open bug pull requests 0	docker pulls 390	3.4GB 56 layers
BIDS-Apps/rs_signal_extract	version 0.1	open bug issues 0	build passing	open bug pull requests 0	docker pulls 75	240MB 17 layers
BIDS-Apps/aa	version enh_vario...	open bug issues 1	build failed	open bug pull requests 0	docker pulls 61	3.8GB 57 layers
BIDS-Apps/niak	version latest	open bug issues 1	build passing	open bug pull requests 0	docker pulls 113	2.7GB 103 layers
BIDS-Apps/opnpi	version v0.7.0-1	open bug issues 1	build passing	open bug pull requests 0	docker pulls 139	2.9GB 41 layers
poldracklab/fmriprep	version 1.0.11	open bug issues 11	build passing	open bug pull requests 0	docker pulls 34k	4.4GB 46 layers
BIDS-Apps/brainiak-srm	version latest	open bug issues 0	build failed	open bug pull requests 0	docker pulls 79	559.3MB 13 layers
BIDS-Apps/nipypelines	version 0.3.0	open bug issues 0	build passing	open bug pull requests 0	docker pulls 86	478.1MB 20 layers
BIDS-Apps/HCPPIpelines	version v3.17.0-15	open bug issues 0	build passing	open bug pull requests 0	docker pulls 517	2.5GB 62 layers
BIDS-Apps/MAGeTbrain	Image not found	open bug issues 1	build failed	open bug pull requests 0	docker pulls 149	Image not found
BIDS-Apps/tracula	version v6.0.0-4	open bug issues 0	build passing	open bug pull requests 0	docker pulls 386	3.4GB 57 layers
BIDS-Apps/baracus	Image not found	open bug issues 0	build passing	open bug pull requests 0	docker pulls 821	Image not found
BIDS-Apps/antsCorticalThickness	Image not found	open bug issues 0	build passing	open bug pull requests 0	docker pulls 21	Image not found
BIDS-Apps/DPARSF	version v4.3.12	open bug issues 0	build passing	open bug pull requests 0	docker pulls 110	1.4GB 28 layers
BIDS-Apps/afni_proc	Image not found	open bug issues 0	build passing	open bug pull requests 0	docker pulls 48	Image not found

bids-apps.neuroimaging.io/apps/

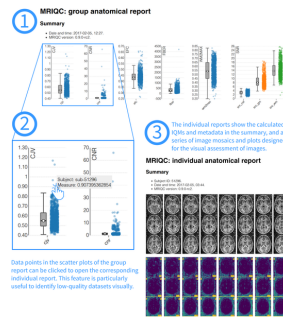
- Developed by different labs all over the world
- <http://bids-apps.neuroimaging.io>, Gorgolewski et al., 2017

3.4 What are software containers

- A box that has software in it
- You don't need to install single software packages
- You just need to download/install
 - the container
 - a software that runs the container

3.5 What is Docker

A software that executes software containers



4 Running BIDS Apps

4.1 BIDS Apps are plug-and-play

To process your data, you only need to specify

- BIDS App
- Input folder (with BIDS-formatted data)
- Output folder that stores the results

4.2 **mriqc**

- MRI quality control tool
- Developed by the [Poldrack Lab](#)
- Structural and functional MRI data

4.3 **mriqc**

Two analysis levels

- participant
- group

4.4 **mriqc**

Results

- visual reports
- IQMs (Image Quality Metrics; see [Esteban et al., 2017](#))

[Fig 5, Esteban et al., 2017](#)

4.5 BIDS Apps in the cloud

[OpenNeuro](#)

5 Hands-on

We will now run mriqc on example data from the [ABIDE](#) study.
See 00Info.txt for further details.

Data location [Download the example data](#) and unpack it into ~/data (or adapt the paths in the examples accordingly).

There should now be a folder ~/databids_apps_data with the data inside.

```
|-- 00Info.txt
|-- derivates
|-- sourcedata
```

5.0.1 BIDS sourcedata

```
|-- sourcedata
|   |-- T1w.json
|   |-- sub-0051160
|       |-- anat
|           |-- sub-0051160_T1w.nii.gz
```

5.0.2 Precomputed mriqc data

```
|-- derivates
|   |-- mriqc_0.10.4_precomputed
|       |-- 00INFO.txt
|       |-- derivatives
|           |-- sub-0051160_T1w.json
|           |-- ....
|       |-- logs
|       |-- reports
|           |-- sub-0051160_T1w.html
|           |-- ...
...
```

5.1 Download image with docker pull

- BIDS Apps provide images on [Docker Hub](#), e.g., [mriqc](#)
- Docker Hub images can be downloaded with the docker pull command

```
docker pull poldracklab/mriqc:0.10.4
downloads tag (version) 0.10.4 of image poldracklab/mriqc
```

5.2 Get a list of locally available images

```
docker images
gives you a list of all images that are downloaded to your computer
```

5.3 Running an analysis

5.3.1 mriqc help

To print help text for mriqc run

```
docker run --rm -ti poldracklab/mriqc:0.10.4 -h
```

5.3.2 Architecture of a command

```
docker run --rm -it \  
  -v [...] \  
  image_name bids_dir output_dir analysis_level
```

5.3.3 Participant level

```
docker run --rm -it \  
-v ~/data/bids_apps_data/sourcedata:/d/in:ro \  
-v ~/data/bids_apps_data/derivates/mriqc_0.10.4:/d/out \  
poldracklab/mriqc:0.10.4 /d/in /d/out participant
```

5.3.4 Participant level command: line 1

```
docker run --rm -it \  
  -v ~/data/bids_apps_data/sourcedata:/d/in:ro \  
  -v ~/data/bids_apps_data/derivates/mriqc_0.10.4:/d/out \  
  poldracklab/mriqc:0.10.4 /d/in /d/out participant
```

- Run a docker container
- Clean up after the container exits
- Run it in interactive mode

5.3.5 Participant level command: line 2

```
docker run --rm -it \  
  -v ~/data/bids_apps_data/sourcedata:/d/in:ro \  
  -v ~/data/bids_apps_data/derivates/mriqc_0.10.4:/d/out \  
  poldracklab/mriqc:0.10.4 /d/in /d/out participant
```

- By default, docker does not have access to data on the HD
- -v (or --volume) makes a folder on your HD available inside the docker container
- -v {folder_name_on_HD}:{folder_name_inside_container}: [{mode, e.g., ro}]
- ~/data/bids_apps_data/sourcedata is a folder on my HD, it contains the input data
- the docker container will see this folder as /d/in
- it will not be able to write into this folder (ro: read only)

5.3.6 Participant level command: line 3

```
docker run --rm -it \  
  -v ~/data/bids_apps_data/sourcedata:/d/in:ro \  
  -v ~/data/bids_apps_data/derivates/mriqc_0.10.4:/d/out \  
  poldracklab/mriqc:0.10.4 /d/in /d/out participant
```

- ~/data/bids_apps_data/derivates/mriqc_0.10.4: is a folder on my HD, it will be populated with the output data
- the docker container will see this folder as /d/out
- no other option is given: docker will be able to write into this folder

5.3.7 Participant level command: line 4

```
docker run --rm -it \  
-v ~/data/bids_apps_data/sourcedata:/d/in:ro \  
-v ~/data/bids_apps_data/derivates/mriqc_0.10.4:/d/out \  
poldracklab/mriqc:0.10.4 /d/in /d/out participant
```

- poldracklab/mriqc:0.10.4: software image to use
- /d/in: bids_dir, folder with input data (has to be visible inside container)
- /d/out: output_dir, folder for output data (has to be visible inside container)
- participant: analysis level (options are: participant, group)

5.3.8 Running the participant level analysis on your laptop

```
docker run --rm -it \  
-v ~/data/bids_apps_data/sourcedata:/d/in:ro \  
-v ~/data/bids_apps_data/derivates/mriqc_0.10.4:/d/out \  
poldracklab/mriqc:0.10.4 /d/in /d/out participant
```

This might take 15 min

5.3.9 Adding options

Take a look at mriqc's help for a list of options

```
docker run --rm -it \  
-v ~/data/bids_apps_data/sourcedata:/d/in:ro \  
-v ~/data/bids_apps_data/derivates/mriqc_0.10.4:/d/out \  
poldracklab/mriqc:0.10.4 /d/in /d/out participant \  
--participant_label 0051160 --n_procs 2
```

5.3.10 Participant level outputs

Outputs in derivates/mriqc_0.10.4

- derivatives/sub-{subject}_T1w.json
- reports/sub-{subject}_T1w.html

Open one of the precomputed outputs in bids_apps_data/derivates/mriqc_0.10.4_precomputed/reports.

5.3.11 Running the group level analysis on your laptop

Requires participant level analysis. To speed things up, the example data has precomputed participant level data in derivates/mriqc_0.10.4_precomputed.

To run the group analysis, just replace **participant** with **group**.

```
docker run --rm -it \  
-v ~/data/bids_apps_data/sourcedata:/d/in:ro \  
-v ~/data/bids_apps_data/derivates/mriqc_0.10.4_precomputed:/d/out \  
poldracklab/mriqc:0.10.4 /d/in /d/out group
```

This will take a couple of seconds

5.3.12 Group level outputs

Outputs in `derivates/mriqc_0.10.4_precomputed`

- `T1w.csv`
- `reports/T1w_group.html`

5.3.13 Group level outputs

Let's look at `reports/T1w_group.html`

Click on the outlier points