

bids_apps_slides

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1 BIDS Apps

Franz Liem (franziskus.liem@uzh.ch)

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](#)

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-di... | 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/oppni | 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/

3.3 What are BIDS Apps

- Portable neuroimaging pipelines shipped as **software containers**
- Understand [BIDS](#)
- Developed by different labs all over the world
- <http://bids-apps.neuroimaging.io>, Gorgolewski et al., 2017

3.4 BIDS Apps examples

3.4.1 Data quality

- mriqc
- qap

3.4.2 Functional MRI

- cpac

- fmriprep
- niak

3.4.3 Structural MRI

- antsCorticalThickness
- baracus
- freesurfer
- mindboggle
- tracula

3.5 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

3.6 BIDS Apps: software containers for neuroimaging data analysis

- Simple to apply analysis to
 - new data
 - separate samples (e.g., collaboration where each site does not share raw data)
- Simple to create for new applications
 1. Dockerfile with recipe for installation

```
[...]
RUN apt-get install [...]
RUN conda install[...]
[...]
```

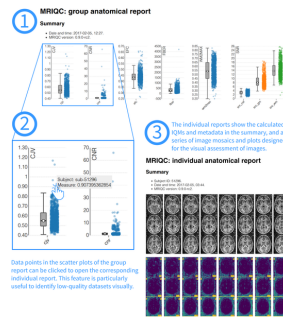
1. Build image

```
docker build -t {name} .
```

3.7 What is Docker

A software that executes software containers.

[Getting started with Docker](#)



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 ~/data/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 List of available mriqc tags

hub.docker.com/r/poldracklab/mriqc/tags/

5.3 Get a list of locally available images

```
docker images
```

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

| PUBLIC AUTOMATED BUILD | | |
|---|-----------------|--------------|
| poldracklab/mriqc ☆ | | |
| Last pushed: a month ago | | |
| Repo Info Tags Dockerfile Build Details | | |
| Tag Name | Compressed Size | Last Updated |
| 0.10.4 | 3 GB | a month ago |
| latest | 3 GB | a month ago |
| 0.10.3 | 3 GB | 2 months ago |
| 0.10.2 | 3 GB | 2 months ago |
| 0.10.1 | 3 GB | 3 months ago |

5.4 Running an analysis

5.4.1 mriqc help

To print help text for mriqc run

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

5.4.2 Architecture of a command

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

5.4.3 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
```

5.4.4 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

5.4.5 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)

5.4.6 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

5.4.7 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)

5.4.8 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

5.4.9 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
```

5.4.10 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.

5.4.11 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

5.4.12 Group level outputs

Outputs in derivates/mriqc_0.10.4_precomputed

- T1w.csv
- reports/T1w_group.html

5.4.13 Group level outputs

Let's look at reports/T1w_group.html

Click on the outlier points