

# bids\_apps\_slides

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## 1 BIDS Apps

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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 Who has heard of

- BIDS
- BIDS Apps
- Docker

## 4 Background

### 4.1 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**

## 4.2 What is BIDS

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

## 4.3 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](#)

## 4.4 What are software containers

- A box that has software in it
- You don't need to install single software packages
- You just need to install a software that executes containers

## 4.5 What is Docker

A software that executes software containers.

[Docker for beginners](#)

[Getting started with Docker](#)

## 4.6 Sharing neuroimaging pipelines

Without BIDS App	With BIDS Apps
Install Python	
Install nipype	
Install FSL	
Install FreeSurfer	
Install ANTs	
Download code for pipeline	

## 4.7 Sharing neuroimaging pipelines

Without BIDS App	With BIDS Apps
Install Python	Install Docker
Install nipype	Download container image
Install FSL	
Install FreeSurfer	
Install ANTs	
Download code for pipeline	

## 4.8 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} .
```

## 4.9 BIDS Apps examples

### 4.9.1 Data quality

- mriqc
- qap

### 4.9.2 Functional MRI

- cpac
- fmriprep
- niak

### 4.9.3 Structural MRI

- antsCorticalThickness
- baracus
- freesurfer
- mindboggle
- tracula

## 5 Running BIDS Apps

### 5.1 BIDS Apps are plug-and-play

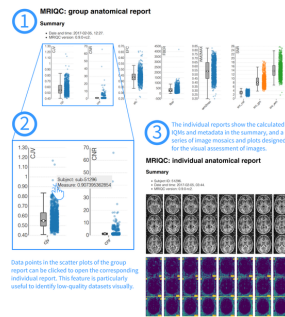
To process your data, you only need to specify

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

## 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_d...	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 990	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/](https://bids-apps.neuroimaging.io/apps/)



## 5.2 mriqc

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

## 5.3 mriqc

### Two analysis levels

- participant
- group

## 5.4 mriqc

### Results

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

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

## 5.5 BIDS Apps in the cloud

[OpenNeuro](#)

## 6 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
|-- derivatives
|-- sourcedata
```

### 6.0.1 BIDS sourcedata

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

### 6.0.2 Precomputed mriqc data

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

## 6.1 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
```

## 6.2 List of available mriqc tags

[hub.docker.com/r/poldracklab/mriqc/tags/](https://hub.docker.com/r/poldracklab/mriqc/tags/)

## 6.3 Get a list of locally available images

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

## 6.4 Running an analysis

### 6.4.1 mriqc help

To print help text for mriqc run

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

### 6.4.2 Architecture of a command

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

PUBLIC   AUTOMATED BUILD		
poldracklab/mriqc ☆		
Last pushed: a month ago		
<a href="#">Repo Info</a> <a href="#">Tags</a> <a href="#">Dockerfile</a> <a href="#">Build Details</a>		
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

### 6.4.3 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
```

### 6.4.4 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

### 6.4.5 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 your 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)

#### 6.4.6 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 your 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

#### 6.4.7 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)

#### 6.4.8 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**

#### 6.4.9 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
```



#### 6.4.10 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`.

#### 6.4.11 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**

#### 6.4.12 Group level outputs

Outputs in `derivates/mriqc_0.10.4_precomputed`

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

#### 6.4.13 Group level outputs

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

**Click on the outlier points**

## 7 Thanks!