# AnatQC

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AnatQC is a high-resolution "anatomical" MRI quality control pipeline built on the FreeSurfer, MRIQC, and volumetric navigators software packages. Working closely with neuroimaging experts, we designed an ergonomic user interface for the XNAT informatics and data management platform that allows users to quickly assess image quality and use those insights to get ahead of issues within the data acquisition workflow.

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SNR Tot:		10.229
FC:		0.572
FWHM Avg:		3.094
GM SNR:		8.663
WM SNR:		21.85
CNR:		1.229
Hemi	ispheres	
Metric	Left	Right
Euler Holes	9	8
CNR	1.221	1.238
G/W CNR	1.599	1.653
G/CSF CNR	0.842	0.823
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Settings		4 → 168
Motion Score RMS	14	3.671
Motion Score Max		5.733
vNav Acq		144
vNav Reacq		0
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Segmentation a Brainmask axia		
vNav Motion Sc	cores RMS	
Cortical Laterali Subcortical Late		
MRIQC Report		

#### CHAPTER

## ONE

# **XNAT USER DOCUMENTATION**

# 1.1 Tagging your scans

For AnatQC to discover T1w and vNav scans to process, you need to add notes to those scans in XNAT. You can add notes using the Edit button located within the Actions box on the MR Session report page

Туре	Example series	Note
T1w	ABCD_T1w_MPR_vNav	#T1w_001, #T1w_002,, #T1w_N
vNav	ABCD_T1w_MPR_vNav_setter	<pre>#T1w_move_001, #T1w_move_002,, #T1w_move_N</pre>

The image below displays an MR Session report page with populated notes

**Note:** Note that if a T1w scan has a corresponding vNav scan, they should be assigned matching numbers. For example, #T1w\_move\_001 would correspond to #T1w\_001.

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							Actions				
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Tim Ope Sca Sca Acc Scan Bulk	re: erator: anner Name anner Type: quisition Si S Actions: Scan 12	15:34:09 Mair e: AWP6705 :: SIEMENS ite: CBS Neur	6 Prisma_fit oimaging Type ABCD_T1w_MPR setter	ge: S R_vNav A - R_vNav A	- Series Desc ABCD_T1w_MPR_vNav setter	usable	Manage Files Delete Run Containers Files 27.9 MB in 144 files	• •	#T1w_N	#T1w_ #T1w_ <sup>MOVE_001</sup>	

# **1.2 Running the pipeline**

To run the AnatQC pipeline, use the Run Containers > anatqc-session button located within the Actions box on the MR Session report page

Note: If you don't see the Run Containers menu, please refer to Setting up the container.

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Date Adde Date: Time: Operator: Scanner N Scanner T Acquisitio	ed: 05/04/2021 11/18/2019 15:34:09 Mair Name: AWP67056 Type: SIEMENS P on Site: CBS Neuroi	18:30:54 (admin) Gender: Handedne: Age: risma_fit maging Type ABCD_T1w_MPR_yNav	ss: Series Desc ABCD_T1w_MPR_vNav	-	Download anatqc-sess Defets Run Containers Files	sion anatec-session Note Note MOVE_001	
Date Adde Date: Time: Operator: Scanner N Scanner T Acquisitio Cans Bulk Actions Scar 2 12	ed: 05/04/2021 11/18/2019 15:34:09 Mair Name: AWP67056 Type: SIEMENS P on Site: CBS Neuroi	18:30:54 (admin) Gender: Handedne: Age: risma_fit maging Type ABCD_T1w_MPR_vNav _setter	ss: Series Desc ABCD_T1w_MPR_vNav _setter	usable	Download  Doloto Run Containers  Files 27.9 MB in 144	Note       files     ANAT_001	

This should bring up a small form with several configurable settings. Continue reading for a description of each setting

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□ 14		ABCD_T1w_MPR_vN	av ABCD_T1v	/_MPR_vNav	usable		42.9 MB in 176 files	ANAT_001	
□ 30		csMPR_1mmiso_CSx	6 csMPR_1m	miso_CSx6	usable		40.8 MB in 176 files	ANAT_002	
31		csMPR_1mmiso_CSx	6 csMPR_1m	imiso_CSx6	usable		40.8 MB in 176 files	ANAT_003	

### 1.2.1 run

This should be set to the integer value of the scan you want to process. If there's a corresponding move scan, that scan will also be processed

T1w scan	run
#T1w_001	1
#T1w_002	2
#T1w_999	999

#### 1.2.2 subtasks

Under most circumstances you'll want to leave this field set to its default value

morph mriqc vnav

#### 1.2.3 fslicense

This field should be set to a base64 encoded FreeSurfer license. If you have a license file on a Linux or macOS machine, you can use the openssl command

openssl base64 < license.txt</pre>

or you can use the base64 command, if that utility is installed

base64 license.txt

# 1.3 Understanding the report page

The following section will break down each section of the AnatQC report page.

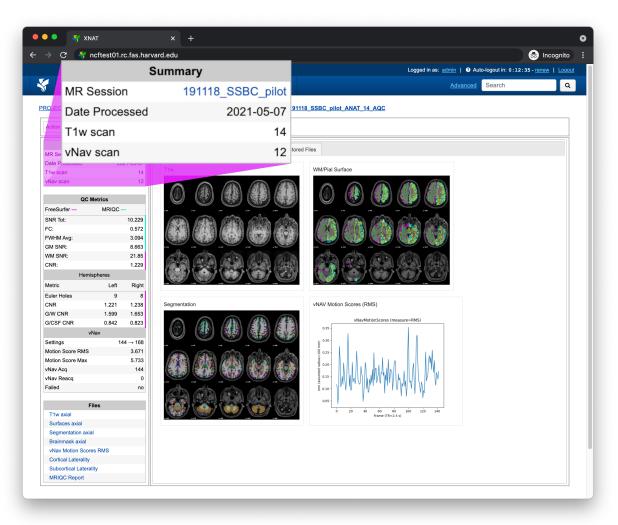
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ROJECT: TestProje	ect01 > <u>SUI</u>	BJECT: 1911	118_SSBC_pilot > SESSION: 191118_S	SBC_pilot > 191118_SSBC_pilot_A	NAT_14_AQC		
Action >							
e	mmary	]					
MR Session	mmary 191118_S	SBC pilot	Images MRIQC Report MRIQC	CIQMs All Stored Files			
Date Processed		021-05-07					
T1w scan	20	14	T1w	WM/Pial Surfac	ce		
vNav scan		12					
QC	Metrics						
FreeSurfer -	MRIQC	_					
SNR Tot:		10.229	(1) (1) (1) (1) (1)	also also	and also also		
FC:		0.572			118 11 18 10 18 10 10		
FWHM Avg:		3.094					
GM SNR:		8.663	alla bia bia	Alia Nia			
WM SNR:		21.85	do do do	100 ACT 100			
CNR:		1.229					
Hem	ispheres						
Metric	Left	Right	ent ent ent	- 204 - 204			
Euler Holes	9	8					
CNR	1.221	1.238	Segmentation	vNAV Motion S	cores (RMS)		
G/W CNR	1.599	1.653					
G/CSF CNR	0.842	0.823		243 E 43	vNavMotionScores (measure=RMS)		
	vNav			0.35 -			
Settings	1	44 → 168		E 0.30			
Motion Score RMS		3.671		9 0.25 ·			
Motion Score Max		5.733			LI LI A LI ML		
vNav Acq		144			LEALA MAALMAA THALLAND		
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Failed		no	do do so	E 0.10-	a char i chahar Mara		
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T1w axial				•	20 40 60 80 100 120 140 Frame (TR=2.5 s)		
Surfaces axial			4-88 012N 015N 015N				
Segmentation axi	al						
Brainmask axial							
vNav Motion Scor	res RMS						
Cortical Laterality							
Subcortical Latera	ality						
MRIQC Report							

#### 1.3.1 Left pane

The left pane is broken up into several distinct sections. Each section will be described below.

#### Summary

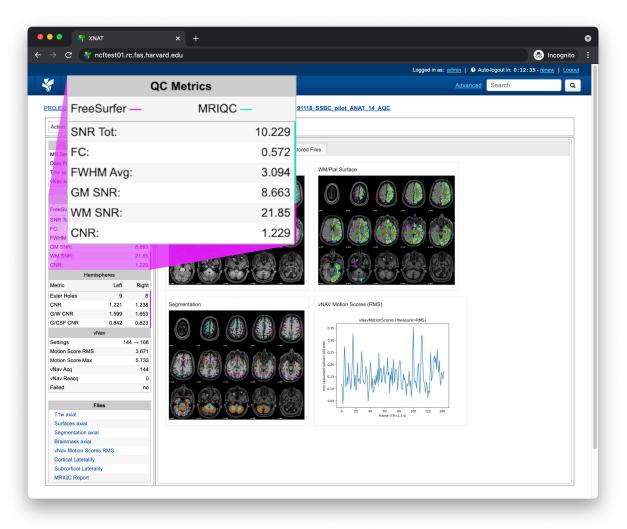
The Summary pane orients the user to what MR Session they're currently looking at and various processing details



Key	Description
MR Session	MR Session label
Date Processed	Processing date
T1w scan	T1-weighted scan used
vNav scan	vNav setter scan used (if present)

#### **QC Metrics**

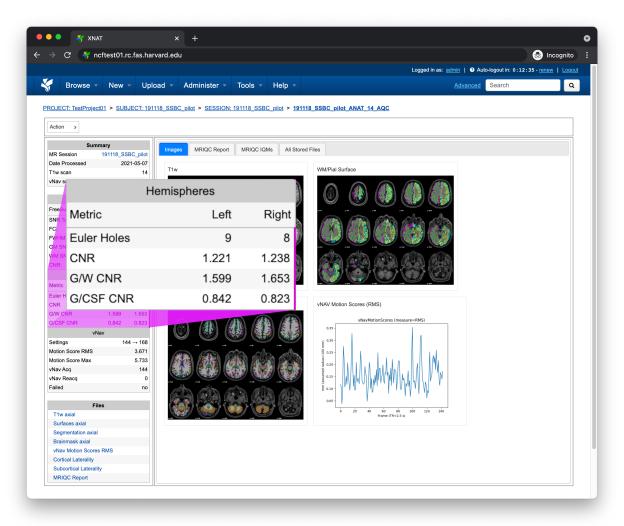
The QC Metrics pane displays quality control metrics computed over the entire volume



Metric	From	Description
SNR Tot	MRIQC	Signal-to-noise ratio
EFC	MRIQC	Entropy Focus Criterion
FWHM Avg	MRIQC	FWHM of spatial distribution of voxel intensities
GM SNR	MRIQC	Gray matter signal-to-noise ratio
WM SNR	FreeSurfer	White matter signal-to-noise ratio
CNR	FreeSurfer	Contrast-to-noise ratio

#### Hemispheres

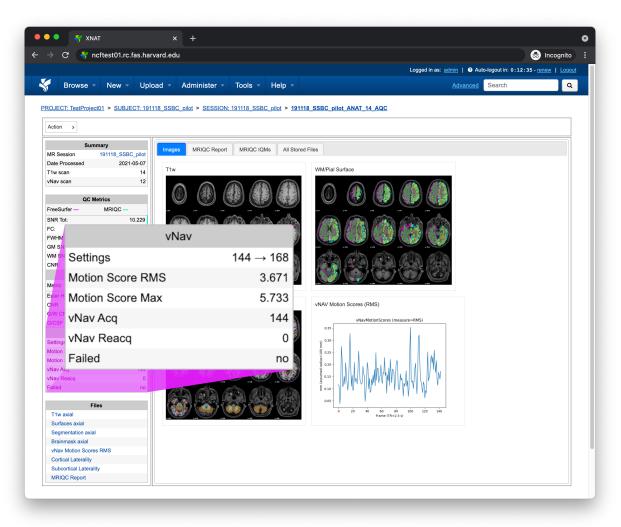
The Hemispheres pane displays quality control metrics computed over each hemisphere



Metric	From	Description
Euler Holes	FreeSurfer	Estimate of the number of surface defects
CNR	FreeSurfer	Global contrast-to-noise ratio
G/W CNR	FreeSurfer	Gray and white matter contrast-to-noise ratio
G/CSF CNR	FreeSurfer	Gray matter and cerebrospinal fluid contrast-to-noise ratio

#### vNav

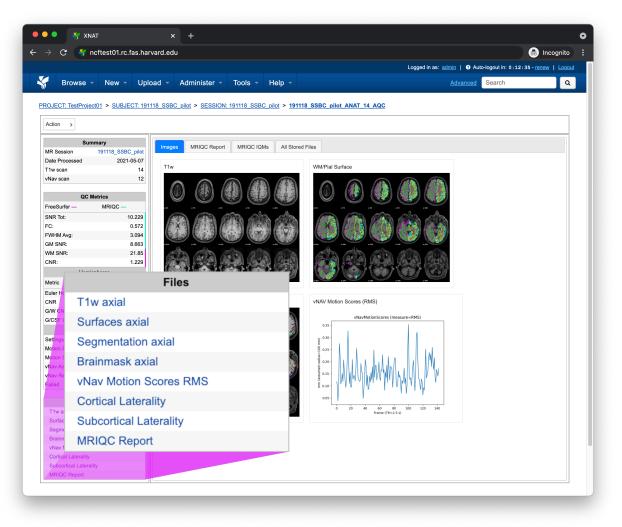
The vNav pane displays vNav specific quality control metrics, but only if a vNav scan was processed



Metric	Description
Settings	Minimum and maximum number of navigators allowed
Motion Score RMS	Root mean square of motion scores
Motion Score Max	Maximum motion score
vNav Acq	Total number of navigators collected
Failed	vNav failure detected

#### Files

The Files pane contains the most commonly requested files. Clicking on any of these files will display that file in the browser



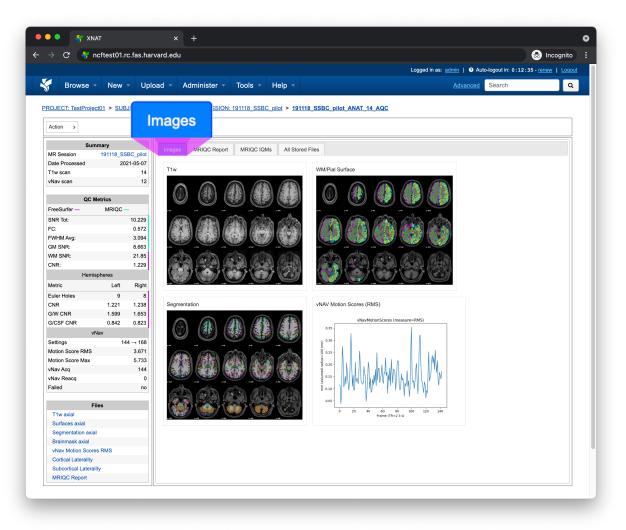
File	Description
T1w axial	T1-weighted image, axial plane
Surfaces axial	FreeSurfer surface boundaries, axial plane
Segmentation axial	FreeSurfer segmentations, axial plane
Brainmask axial	FreeSurfer brain mask, axial plane
vNav Motion Scores RMS	vNav motion scores RMS plot
Cortical Laterality	Cortical region volume laterality plot
Subcortical Laterality	Subcortical region volume laterality plot
MRIQC Report	MRIQC HTML report

#### 1.3.2 Tabs

To the right of the *left pane* you'll find a tab container. The following section explains the contents of each tab.

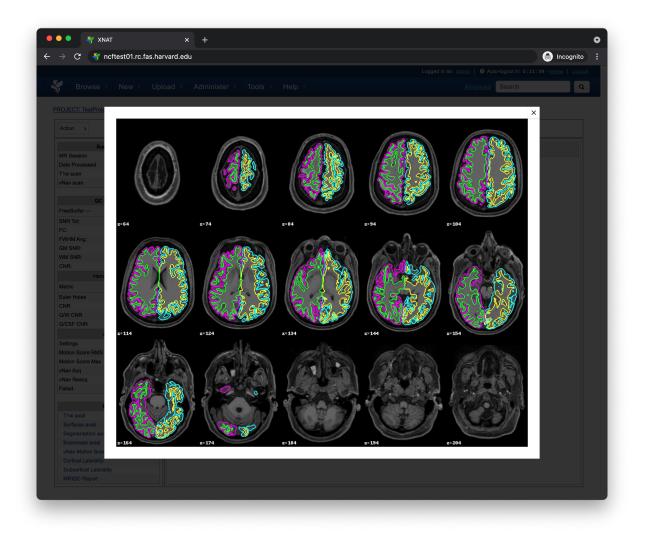
#### Images

The Images tab displays a zoomed out view of the T1-weighted image, FreeSurfer surface boundaries, FreeSurfer segmentations, and vNav RMS motion scores



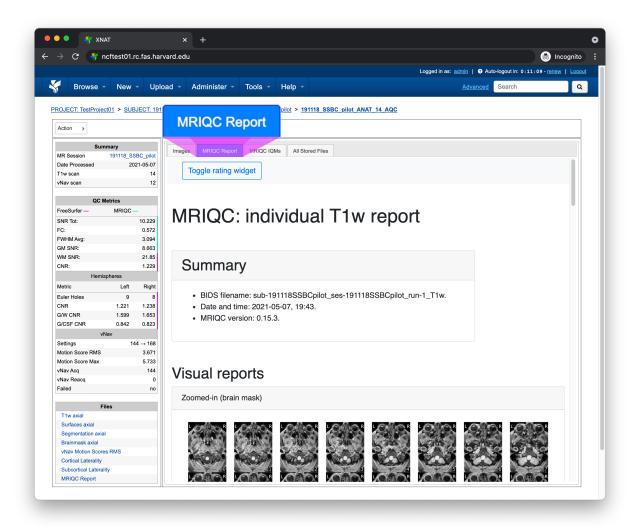
Clicking on an image within the Images tab will display a larger version of that image in the browser

**Note:** AnatQC automatically crops and centers each brain slice for improved visibility. For this reason, slices will often appear larger than their native size.



#### **MRIQC** Report tab

The MRIQC Report tab displays the complete MRIQC HTML report



#### **MRIQC IQMs**

The MRIQC IQMs tab displays all of the MRIQC Image Quality Metrics. These metrics can also be found within the MRIQC HTML Report

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MR Session	191118_SS	_			(IQO IQUIS	All Otorou Tiles					
Date Processed	20	21-05-07	#	Metric					Value		
T1w scan		14 12	1	cjv					0.53		
vNav scan		12	2	cnr					2.31		
QC M	etrics		3	efc					0.572		
FreeSurfer —	MRIQC -	-	4	fber					3671.582		
SNR Tot:		10.229									
FC:		0.572	5	fwhm_avg					3.094		
FWHM Avg:		3.094	6	fwhm_x					3.143		
GM SNR:		8.663	7	fwhm_y					3.169		
WM SNR:		21.85	8	fwhm_z					2.969		
CNR:	pheres	1.229	9	icvs_csf					0.179		
Metric	Left	Right									
Euler Holes	9	Right 8	10	icvs_gm					0.422		
CNR	1.221	o 1.238	11	icvs_wm					0.399		
G/W CNR	1.599	1.653	12	inu_med					1.706		
G/CSF CNR	0.842	0.823	13	inu_range					0.607		
vN	lav		14	qi_1					0		
Settings	14	4 → 168									
Motion Score RMS		3.671	15	qi_2					0.002		
Motion Score Max		5.733	16	rpve_csf					30.803		
vNav Acq vNav Reacq		144 0	17	rpve_gm					14.311		
Failed		no	18	rpve_wm					18.364		
1 dilod			19	size x					176		
Fi	les		20	size_y					256		
T1w axial											
Surfaces axial			21	size_z					256		
Segmentation axial Brainmask axial			22	snr_csf					3.341		
vNav Motion Score	s RMS		23	snr_gm					8.663		
Cortical Laterality			24	snr_total					10.229		
Subcortical Laterali			25	snr_wm					18.684		

#### All Stored Files

The All Stored Files tab contains a list of *every file* stored by AnatQC

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Browse -	New	- Upl	oad	A	Administer → Tools → Help →	Advanced	Search
ROJECT: TestProje	<u>xt01</u> > <u>SUB</u>	JECT: 191	<u>118_SS</u>	<u>SBC_pi</u>	All Stored Files		
Sum	mary						
MR Session	191118_SS	_		ages	MRIQC Report MRIQC IQMs All Stored Files		
Date Processed	20	21-05-07	#	File		Description	Туре
T1w scan		14	1	19111	18_SSBC_pilot_ANAT_14_AQC_T1w_axial.png	T1w axial image	image/png
vNav scan		12	2	19111	18_SSBC_pilot_ANAT_14_AQC_aseg_axial.png	Segmentation axial image	image/png
OC N	letrics		3		18_SSBC_pilot_ANAT_14_AQC_brainmask_axial.png	Brainmask axial image	image/png
FreeSurfer —	MRIQC -						
SNR Tot:		10.229	4		18_SSBC_pilot_ANAT_14_AQC_surface_axial.png	Surfaces axial image	image/png
FC:		0.572	5	19111	18_SSBC_pilot_ANAT_14_AQC_aparc_laterality.png	Cortical laterality plot	image/png
FWHM Avg:		3.094	6	19111	18_SSBC_pilot_ANAT_14_AQC_aseg_laterality.png	Subcortical laterality plot	image/png
GM SNR:		8.663	7	19111	18_SSBC_pilot_ANAT_14_AQC_mriqc.html	MRIQC Report	text/html
WM SNR:		21.85	8	19111	18_SSBC_pilot_ANAT_14_AQC_freesurfer.tar.gz	FreeSurfer results	application/gzip
CNR:		1.229	9			vNav Report	
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	Leπ 9	Right	10	19111	18_SSBC_pilot_ANAT_14_AQC_vNavMotionScoresMax.png	vNav Motion Scores Max	text/png
Euler Holes CNR	1.221	8 1.238	11	19111	18_SSBC_pilot_ANAT_14_AQC_vNavMotionScoresRMS.png	vNav Motion Scores RMS	text/png
G/W CNR	1,599	1.653					
G/CSF CNR	0.842	0.823					
tv.	√av						
Settings	14	4 → 168					
Motion Score RMS		3.671					
Motion Score Max		5.733					
vNav Acq		144					
vNav Reacq Failed		0 no					
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	les						
T1w axial Surfaces axial							
Surfaces axial Segmentation axia							
Brainmask axial							
vNav Motion Score	s RMS						
Cortical Laterality							
Subcortical Lateral	ity						
MRIQC Report							

**Note:** Clicking on a file within the All Stored Files tab will download that file.

File	Description
*_AQC_T1w_axial.png	T1-weighted image, axial plane
*_AQC_aseg_axial.png	FreeSurfer segmentations, axial plane
*_AQC_brainmask_axial.png	FreeSurfer brain mask image, axial plane
<pre>*_AQC_surface_axial.png</pre>	FreeSurfer surface boundaries, axial plane
*_AQC_aparc_laterality.png	FreeSurfer parcellation laterality plot
*_AQC_aseg_laterality.png	FreeSurfer segmentation laterality plot
*_AQC_mriqc.html	MRIQC HTML report
*_AQC_freesurfer.tar.gz	FreeSurfer results
*_AQC_vNav_Motion.json	vNav processing output
*_AQC_vNavMotionScoresMax.png	vNav motion max plot
*_AQC_vNavMotionScoresRMS.png	vNav motion RMS plot

CHAPTER

TWO

# **DEVELOPER DOCUMENTATION**

#### 2.1 Installation

At the moment, the only supported way to install AnatQC is *within a container*.

#### 2.1.1 downloading a container

There are prebuilt versions of AnatQC on Docker Hub. You can pull the latest version by running

docker pull neuroinformatics/anatqc

or you can pull a specific version e.g., 0.4.0 by running

docker pull neuroinformatics/anatqc:0.4.0

#### 2.1.2 building a container

To build AnatQC as a container, grab the latest Dockerfile from the repository and run

docker build -t anatqc:latest - < Dockerfile</pre>

Now you can run anatQC.py using docker run

docker run anatqc:latest --help

# 2.2 XNAT Installation

The following section will describe how to build and configure AnatQC as a XNAT plugin.

#### 2.2.1 building the plugin

Clone the xnat-1.7.6 branch from the github.com/harvard-nrg/anatqc repository

git clone -b xnat-1.7.6 --single-branch https://github.com/harvard-nrg/anatqc

Change into the repository directory and compile the plugin using Gradle

```
./gradlew jar
```

Once the plugin has been compiled, move the resulting . jar into your XNAT plugins directory

```
mv ./build/libs/anatqc-plugin-1.0.0.jar ${XNAT_HOME}/plugins/
```

#### 2.2.2 setting up the container

**Note:** This documentation assumes you have successfully *built the container* and that the container is being served from a local Docker daemon e.g., unix:///var/run/docker.sock on your XNAT server.

To setup the container within XNAT, go to Administer > Plugin Settings > Images & Commands, find the AnatQC container, and click Add New Command

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You should see a small dialog box where you can configure your command. Paste the content from command.json.

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	1-1				
Plugin Settin	2 " 3 " 4 " 5 "	name": "anatqc-session", label": "anatqc-session", description": "Runs anatQC on MR Session's scans with MOVE and ANAT notes", version": "1.0.0",			
Container Service	7 "	<pre>schema-version": "1.0", image": "anatqc:latest", type": "docker",</pre>			
Images & Com	9 " 10 "	working-directory": "/sw/apps/anatąc/", command-line": "-v tandem #SESSION_LABEL# #RUN#bids-dir /bids #SUBTASKS#	xnat-upload #FSLICENSE#",		
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Navigate to your Project's home page and click on Project Settings in the Actions box. Select Configure Commands and enable the new command for your project

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	XNAT Command Label	Container	Enabled	Actions	
	Enable / Disable All Commands				
	Run anatQC on a Session	anatqc:latest		Set Defaults	

#### CHAPTER

# THREE

# **INDICES AND TABLES**

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