



NA-MIC

National Alliance for Medical Image Computing

<http://www.na-mic.org>

DTIPrep

Dave Welch, Joy Matsui

University of Iowa

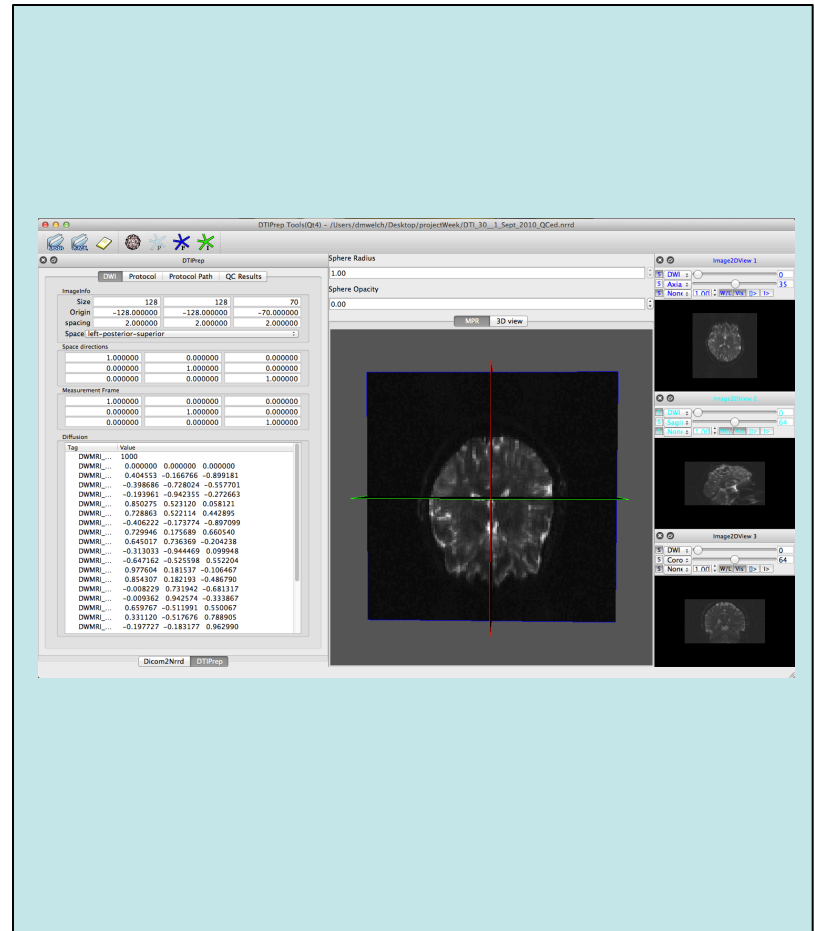
dmwelch@healthcare.uiowa.edu

NA-MIC Tutorial Contest: Summer 2013



Learning Objective

At the end of this tutorial, you will be able to create a protocol file for DTIPrep, run DTIPrep on DWI data from the GUI or the command line, and examine the output in Slicer





Pre-requisite Tutorials

- Data Loading & 3D Visualization tutorial
 - Author: Sonia Pujol, PhD
- Diffusion Tensor Imaging tutorial
 - Author: Sonia Pujol, PhD



Material

This tutorial requires the installation of DTIPrep and the tutorial dataset. They are available at the following locations:

DTIPrep download page

http://www.nitrc.org/snapshots.php?group_id=283

Tutorial dataset: DTIPrep_data_2013.zip

http://wiki.na-mic.org/Wiki/images/0/0c/DTIPrepData_TutorialContestSummer2013.zip



Platforms

- Mac – passes on 10.7 and 10.8
- Linux – passes on Redhat 6.0 and OpenSuse
- Windows – not tested



Overview

- **Building** – step-by-step build instructions
- **Protocol Creation** – creation of a typical protocol file by modifying the default parameters
- **GUI Interaction** – how to use the DTIPrep GUI
- **Command Line** – using the DTIPrep command line flags for batch processing
- **Protocol optimization** – how to examine the data in Slicer and modify the protocol



Building

1) Create an account with NITRC:

<http://www.nitrc.org/account/register.php>

2) Get the source code:

```
host$ mkdir ${source_dir}
```

```
host$ cd ${source_dir}
```

```
host$ svn checkout
```

```
https://www.nitrc.org/svn/dtiprep/trunk DTIPrep
```



Building

3) Build the code:

```
host$ mkdir ${build_dir} # (e.g. "DTIPrep-build")
```

```
host$ cd ${build_dir}
```

```
host$ cmake ${source_dir}/DTIPrep
```




Building

4) Run CMake

```
host$ cmake .
```

Type 'c' to configure. When successful, you will see a new option to generate the makefiles, 'g'. Enter 'g' and CMake will exit.

Run Make. To run Make multi threaded, use the "-j" flag:

```
host$ make #optional: "-j $  
{NUMBER_OF_CORES}"
```

```
Page 1 of 1  
BUILD_STYLE_UTILS      OFF  
BUILD_TESTING          ON  
CMAKE_BUILD_TYPE       Release  
CMAKE_INSTALL_PREFIX   /usr/local  
CMAKE_OSX_ARCHITECTURES  
CMAKE_OSX_DEPLOYMENT_TARGET  
CMAKE_OSX_SYSROOT      /Applications/Xcode.app/Contents/Developer/Platform  
EXTERNAL_PROJECT_BUILD_TYPE Release  
FORCE_EXTERNAL_BUILDS  OFF  
ITK_VERSION_MAJOR      4  
QT_QMAKE_EXECUTABLE    /usr/bin/qmake  
SuperBuild_DTIPrepTools_BUILD_ ON  
SuperBuild_DTIPrepTools_USE_GI ON  
USE_DTIPrep            ON  
USE_DTIPProcess        OFF  
USE_DTIREg             OFF  
USE_DTI_Tract_Stat     OFF  
USE_FVLight            OFF  
USE_NIRALUtilities     OFF  
USE_SYSTEM_DCMTK       OFF  
USE_SYSTEM_ITK         OFF  
USE_SYSTEM_SlicerExecutionMode OFF  
USE_SYSTEM_VTK         OFF  
VTK_GIT_TAG            v5.10.0  
VTK_REPOSITORY         git://vtk.org/VTK.git  
  
BUILD_STYLE_UTILS: Build uncrustify, cppcheck, & KwStyle  
Press [enter] to edit option  
Press [c] to configure  
Press [h] for help  
Press [q] to quit without generating  
Press [t] to toggle advanced mode (Currently Off)  
CMake Version 2.8.9
```



Building

To update DTIPrep:

```
host$ cd ${source_dir}/DTIPrep
```

```
host$ svn update
```

```
host$ cd ${build_dir}
```

```
host$ make # -j ${NUMBER_OF_CORES}
```



Create a protocol file

Protocol files are XML files that set the attributes for DTIPrep and control the criteria with which DTIPrep fails during processing, among other things.

Since DTIPrep is highly customizable, creating a custom protocol file is highly recommended.

Protocol files are created using the graphical user interface (GUI), i.e. “window”.



Create a protocol file

Protocol files are XML files that set the attributes for DTIPrep and control the criteria with which DTIPrep fails during processing, among other things.

Since DTIPrep is highly customizable, creating a custom protocol file is highly recommended.

Protocol files are created using the graphical user interface (GUI), i.e. “window”.



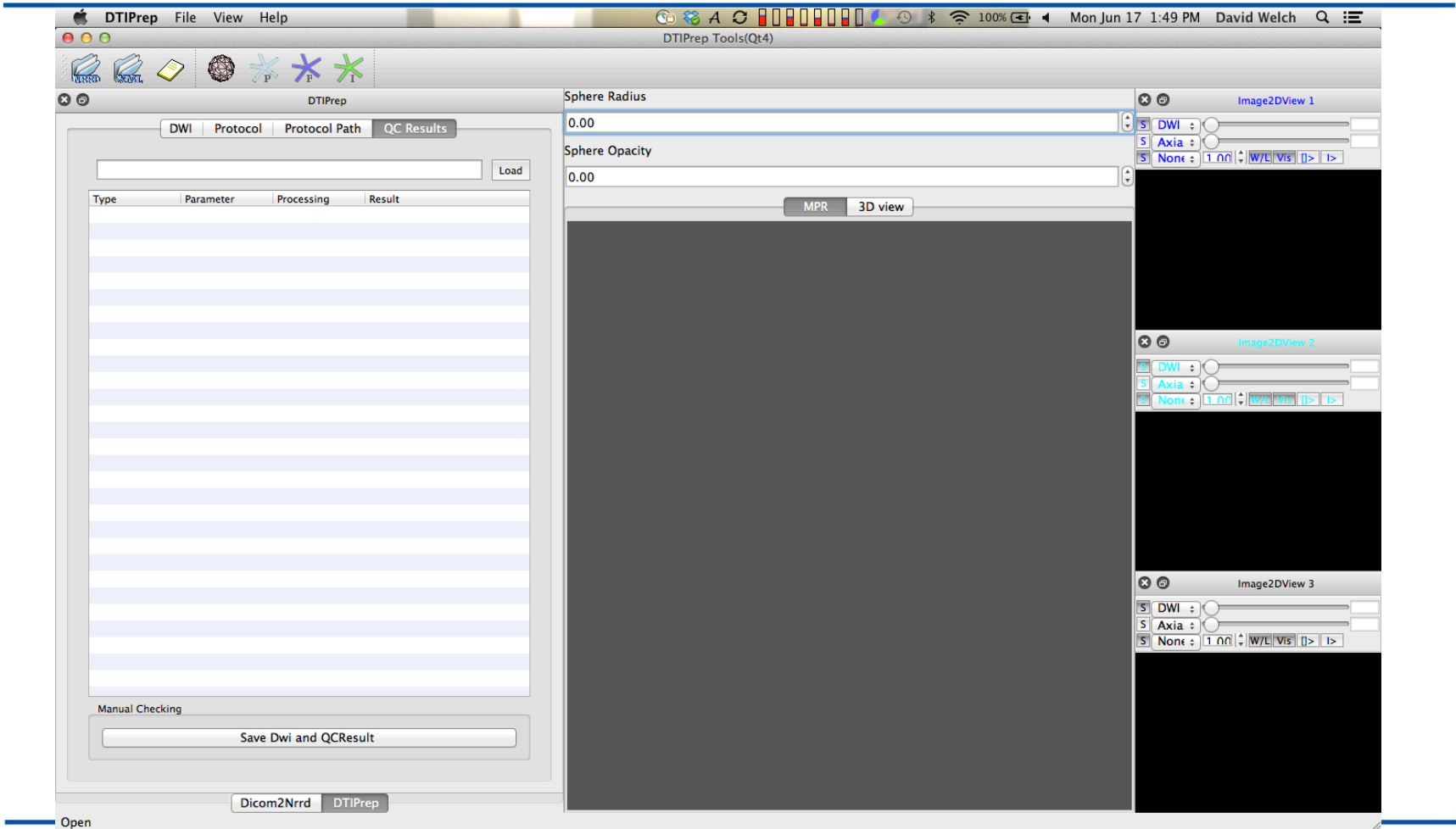
Create a protocol file

To use the DTIPrep GUI, run the executable file for your particular operating system:

Operating System	GUI executable
Windows	<code>\${build_dir}/bin/DTIPrep</code>
MacOS	<code>\${build_dir}/bin/DTIPrep.app/Contents/MacOS/DTIPrep</code>
Linux	<code>\${build_dir}/bin/DTIPrep</code>



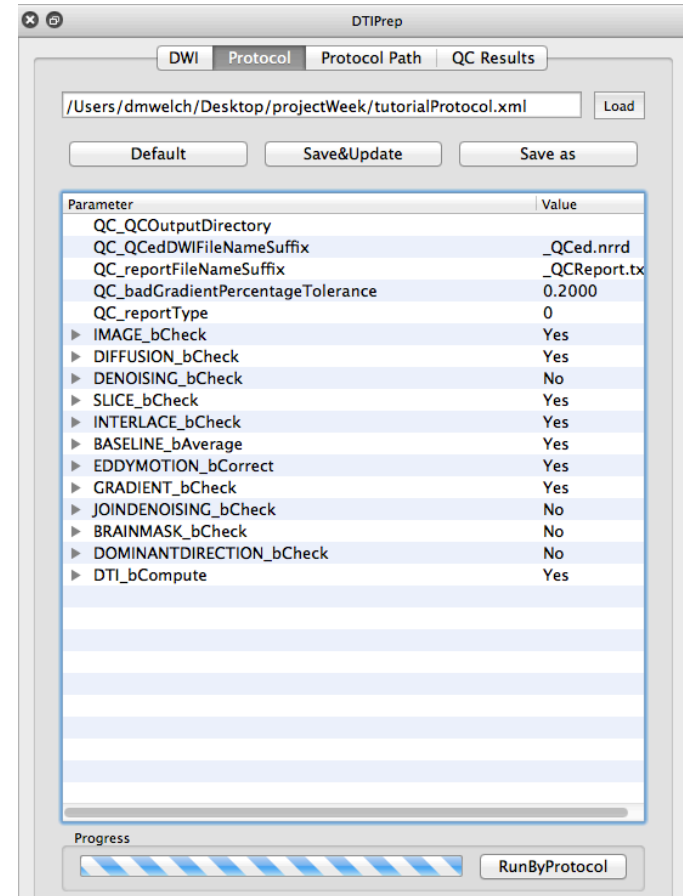
Create a protocol file





Create a protocol file

1. Navigate to the executable file and double-click OR call it on the command line
2. Click on the “Open NRRD” button in the top left corner and load the file “DTI_30_1_Sept_2010.nhdr”
3. Once the images load, click on the “Protocol” tab. Load the default protocol by clicking the “Default” button.





Create a protocol file

4) Replace the following values:

Protocol Heading	Protocol Subheading	Value
IMAGE_bCheck	IMAGE_bCrop	No
	IMAGE_croppedDWIFilenameSuffix	(blank)
	IMAGE_bQuitOnCheckSpacingFailure	Yes
	IMAGE_bQuitOnCheckSizeFailure	No
DIFFUSION_bCheck	DIFFUSION_diffusionReplacedDWIFilenameSuffix	(blank)
	DIFFUSION_bQuitOnCheckFailure	Yes
SLICE_bCheck	SLICE_bSubregionalCheck	Yes
	SLICE_bQuitOnCheckFailure	Yes
INTERLACE_bCheck	INTERLACE_bQuitOnCheckFailure	Yes
GRADIENT_bCheck	GRADIENT_bQuitOnCheckFailure	Yes



Create a protocol file

- 5) Click “Save as” and name the file “tutorialProtocol.xml”
- 6) Close DTIPrep



GUI Interaction

- 1) Navigate to the executable file and double-click OR call it on the command line
- 2) Click on the “Open NRRD” button in the top left corner and load the file
“DTI_30_1_Sept_2010.nhdr”
- 3) Load the protocol file “tutorialProtocol.xml” and click “RunByProtocol”

NOTE: Processing takes ~30 mins



Command Line

- 1) You will need the full path to three files:
 - a. input DWI file (`${DWI}`)
 - b. input protocol file (e.g. `“tutorialProtocol.xml”`)
 - c. output directory
- 2) Run the executable from the command line with the correct flags:

```
host$ ${build_dir}/bin/${executable_path} DTIPrep \  
  --DWINrrdFile ${test_data_dir}/DTI_30__1_Sept_2010.nhdr \  
  --xmlProtocol ${test_data_dir}/tutorialProtocol.xml \  
  --check \  
  --outputFolder ${output_dir}
```



Command Line

- 3) Once complete, you will have three files in `${output_dir}`:
- a. `DTI_30__1_Sept_2010_QCed.nhdr`
 - b. `DTI_30__1_Sept_2010_QCReport.txt`
 - c. `DTI_30__1_Sept_2010_XMLQCResult.xml`



Choosing parameters

Protocol parameters will depend on the quality of your data, the file organization you desire, the level of checking that you want to perform during the processing, etc., so experimentation is recommended. In this tutorial we will demonstrate a method to optimize the DTIPrep protocol using Slicer to explore the output data.



Choosing parameters

After running the dataset “DTI_30_1_Sept_2010.nhdr”, load the original file and the cleaned file in Slicer:

- 1) Select the “Volumes” module
- 2) Set the **Active Volume** to “DTI_30__1_Sept_2010”
- 3) Set the **DWI Component** to 1. Examine the volume in the Slice Views. You will notice that there are intensity artifacts in the coronal plane.

FYI: This data isn't particularly noisy for DWI, but if your data has too much noise you may need to discard the whole set if DTIPrep can't distinguish artifacts from the background noise...



Choosing parameters

4) Now load the cleaned data. Set the **Active Volume** to “DTI_30__1_Sept_2010_QCed”

As you click through the **DTI Component** values and the slice planes, you *should* notice that the data has less noise and no artifacts.

5) If artifacts remain, go back to protocol file in DTIPrep and change the value of SLICE_correlationDeviationThresholdGradient from 3.5000 -> 3.0000. Save this protocol file and rerun.



Choosing parameters

- 6) Examine the new cleaned file. If it is *still* noisy, you can further lower the SLICE_correlationDeviationThresholdGradient to 2.5000. We have empirically found that any value lower than 2.5000 results in data is highly unreliable.



Choosing parameters

DTIPrep puts the degree of noise (measured in correlation between corresponding slices) of DWI data into a Gaussian distribution

SLICE_correlationDeviationThresholdgradient sets how many standard deviations about the average correlation are considered acceptable

If a DWI file is very noisy overall, then data whose correlation values that are close to the average correlation value will still be noisy (even within 1 standard deviation!)

In this case, you might as well discard the whole DWI file



Acknowledgments

National Alliance for Medical Image Computing

NIH U54EB005149

UNC Neuro Image and Research Analysis Laboratories

Zhexing Liu, Cheryl Dietrich, Joseph Blocher, Mahshid Farzinfar, Martin Styner

General Electric Global Research Center

Xiaodong Tao

University of Iowa SINAPSE Lab

Hans Johnson, Mark Scully, Vince Magnotta, Kent Williams, Joy Matsui, Dave Welch