Answers to DTI Tutorial 1

The online tutorial can be found here:
http://www.diffusion-imaging.com/2015/10/dti-tutorial-1-from-scanner-to-tensor.html

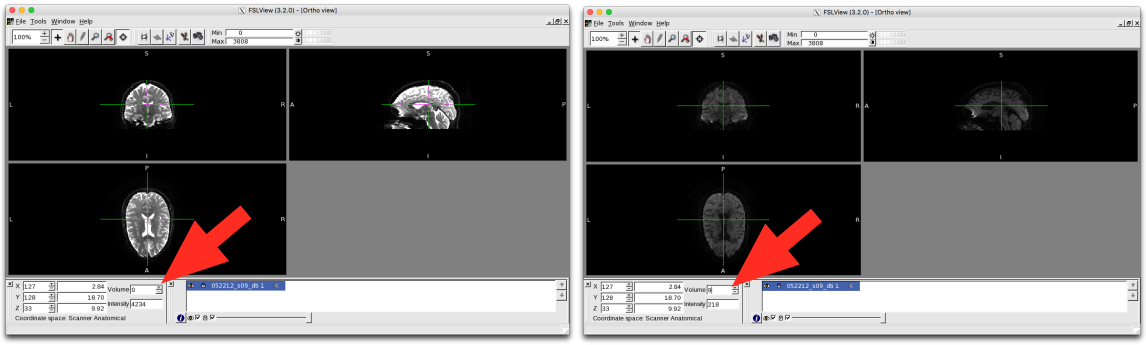
Q1: In your document write the command code to how show how you would convert your raw scanner image to NifTI, assume your data is in dicom format, and organized like this:

Example code:
dcm2nii -e y P001/dicoms/s12_dti

Q2: Download our example diffusion weighted image (052212_s09_dti.nii) through this link, or use your own data. Open the image in fslview (if you don't know how, look at the fslview documentation, or type fslview in your terminal after installing the software). Scroll through the different volumes. Can you identify how many volumes were acquired without diffusion weighting (b=0)?

```
fslview 052212_s09_dti.nii &
```

The example diffusion weighted image has 49 total volumes. The first 9 volumes are brighter than the rest and are thus the b=0 images. You can change the volume that you are viewing using the button indicated with an arrow.

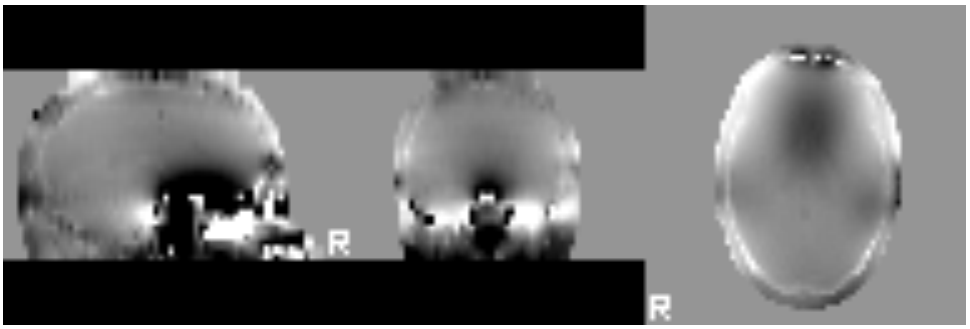


Q3: Run the command line code for the eddy correction as shown below. What does the output to the terminal look like? Does it take long to run? Why?

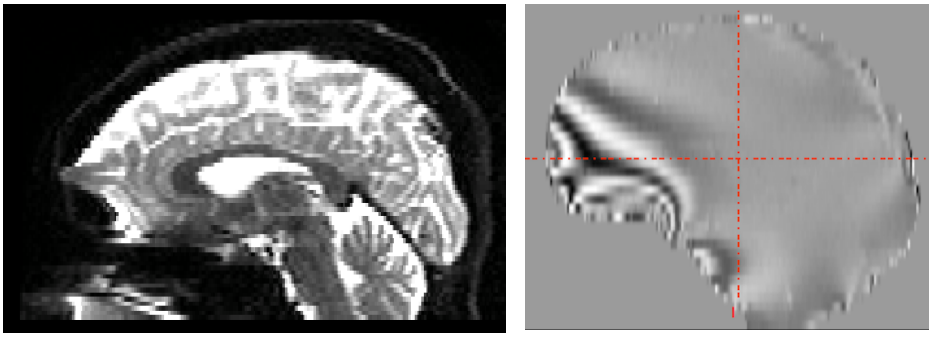
```
processing 052212_s09_dti_eddy_tmp0000
processing 052212_s09_dti_eddy_tmp0001
processing 052212_s09_dti_eddy_tmp0002
processing 052212_s09_dti_eddy_tmp0003
etc
```

Yes, it takes long to run as each individual volume needs to be registered to the first volume. Which means that FLIRT needs to run for 49 volumes/times.

Q4: On FSL's FUGUE website find the image that shows a real fieldmap image. Can you get an impression from that image where you would expect most distortion to be localized? Look at the field map from the provided example data (download 052212_FMAP.nii here). Does that agree with the distortion that you see in the raw diffusion image (052212_s09_dti.nii)?



Yes, it looks like the bright and dark areas indicate areas of distortion (stretch and squish). Which is also the case for 052212_FMAP.nii:



Q5: Note in the image above how the diffusion image is altered after the field map was applied (in green) and EPI distortion was corrected. Take a close look at the gif and indicate what brain regions show reductions in stretch distortion.

The anterior part of the brain got squished back, and specifically the anterior corpus callosum and ventricle are less stretched.

Q6: Investigate the command options in bet using the help function or the online documentation. Explain what executing the below command would entail. How would you alter these options if your output mask is too small? Run a brain extraction on the sample data (e.g. 052212_s09_dti_eddy_fm.nii) using the code below, add options in the command so that it will output a binary mask, and so that it will run multiple iterations for a robust output.

This command would extract the brain. Altering the -f value allows for a larger mask, make the value lower than 0.5 to increase the size of the mask. The -m option outputs both the stripped brain and the binary mask, while the -R option allows for a robust estimation. For example you could run this code to strip the skull:

```
bet 052212_s09_dti_eddy_fm.nii.gz 052212_s09_dti_eddy_fm_strip -m -f 0.3 -R
```

Q7: Investigate the documentation of fsl2scheme, provide example code of how to convert b-vectors and b-values from an FSL format to a Camino scheme file.

```
fsl2scheme -bvecfile ${prefix}.bvecs -bvalfile bvals.txt -flipx -flipy -usegradmod > ${prefix}.scheme
```

In this example this was the command used.

Q8: Download the necessary data from our example data. Using the example code shown above try to run the tensor fitting. Note that ${prefix} indicates a variable in bash, which is defined in line 1. Learning how to work with variables now will make it easier to transition to loops in scripts later on. This code will need a couple of minutes to run. Side note; to avoid a java error message (as shown below) we increased the java RAM usage allowed for Camino with the third line in the example script. Solution came from the camino help list.

Output (in order) is:
052212_s09_DWI.Bfloat
052212_s09_DTI.Bfloat
052212_s09_dti_eddy_fm_strip_dt.nii

Q9: Imagine that due to unforeseen reasons you collected noisy data, and you would like to run a robust tensor estimation as described by Chang, Jones & Pierpaoli (2005). Investigate the Camino list of available commands. What tool would be able to accommodate your aim?

Use the restore tool: http://cmic.cs.ucl.ac.uk/camino/index.php?n=Man.Restore
"Fits the diffusion tensor to diffusion MRI measurements robustly using the RESTORE algorithm by Chang et al MRM 53 2005."

Q10: Run the example code to investigate the tensor fit, compare the results to the examples from the quality control post and the Camino website, were the tensors fit correctly?

Data looks good: