functional Magnetic Resonance Imaging – Practical

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This lecture

1. Life after / other-than SPM
   many labs use a mix of tools
2. What kind of answer are you looking for?
   groups / individuals? localization only?
3. ... are you using the right tool for the job?
4. Some examples of things you can do

Many software packages...

AFNI! *

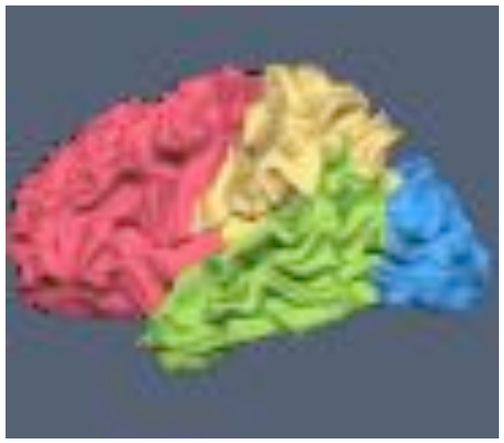
SPM

FSL *

FreeSurfer

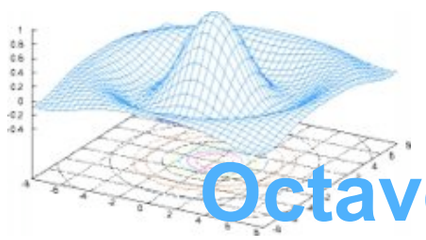
caret5

SurfRelax



BrainVoyager

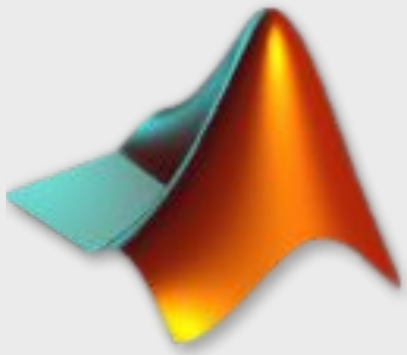
C/C++
GNU Scientific Library



Octave

SciPy.org

Python

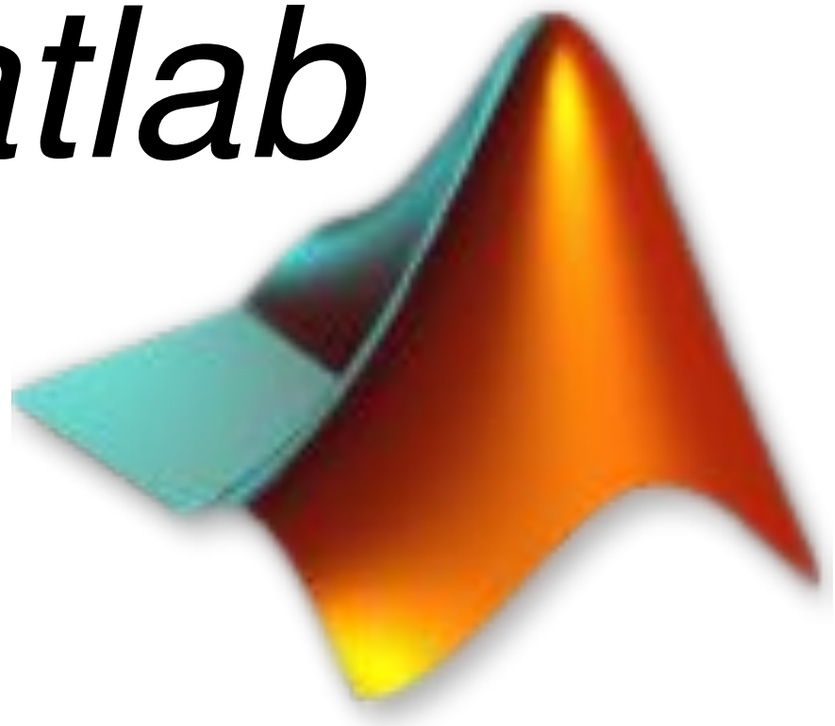


*

Matlab

mrTools
Stanford / NYU tools

Matlab



http://tinyurl.com/5kcvqv – ***links to tutorials***

For an overview of tools

60+ tools compatible with NIFTI-1

NITRC website

`http://www.nitrc.org/`

SPM (+related tools)

+ Large user base (many citations)
+ A lot of documentation
+ Code is open (so you can look + change)
  - but Code is nested / complicated
  - Hard to look at data / timecourses
  - Not good for exploratory analysis
  - surfaces / ROIs / non-standard analyses

Different approaches

Many cognitive studies: ***where***
are the areas more active in
Condition A *than* ***Condition B***

"Areas involved in discriminating two vibrotactile stimuli applied to index finger [versus stimuli only]"

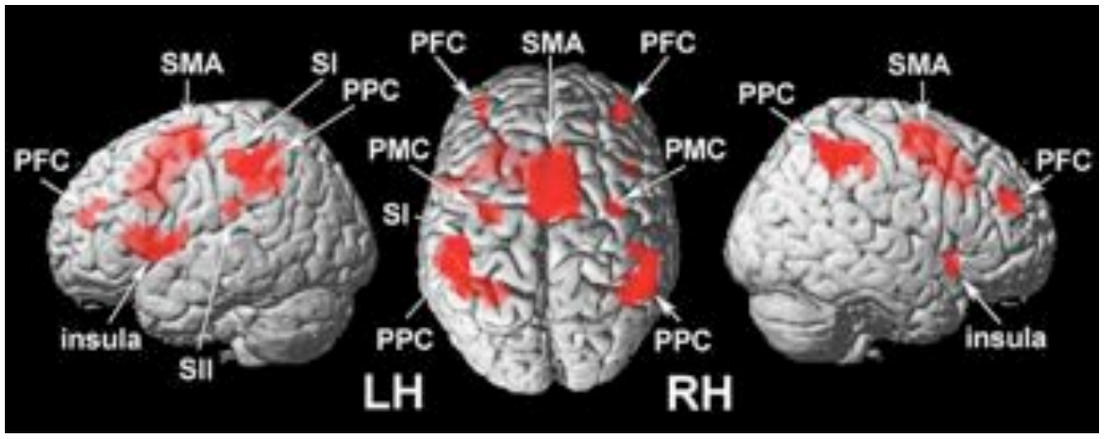


Figure 2. Cortical regions involved in frequency discrimination (contrast: discrimination trials > "null trials"). Significant signal changes were found in the SI and SII contralateral to the stimulated index finger. In addition, we found activation in the supplementary motor cortex (SMA), the premotor cortex (PMC), the posterior parietal cortex (PPC), the anterior insula, and the prefrontal cortex (PFC) of both hemispheres (MNI coordinates and *t* scores are listed in supplemental Table 1, available at www.jneurosci.org as supplemental material). LH, Left hemisphere; RH, right hemisphere.

10 subjects

Pleger et al (2006) J Neurosci

Different approaches

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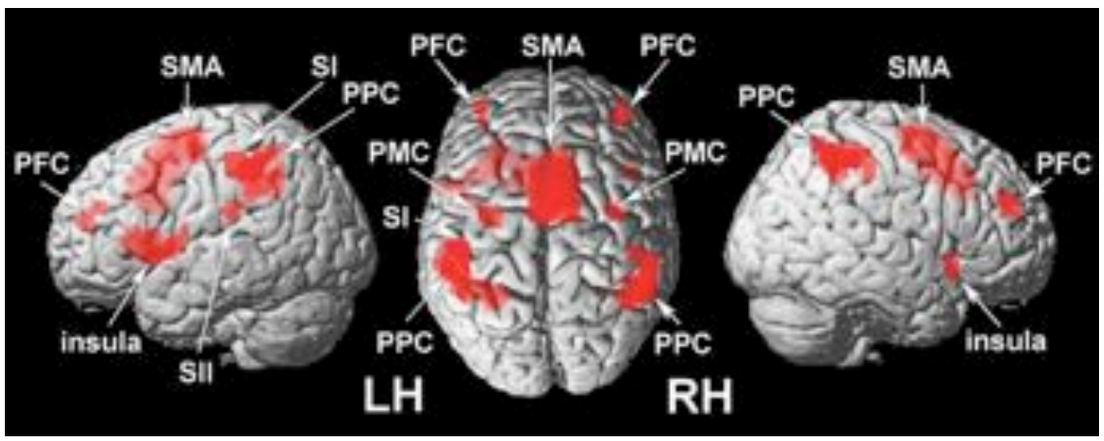

Figure 2. Cortical regions involved in frequency discrimination (contrast: discrimination trials > "null trials"). Significant signal changes were found in the SI and SII contralateral to the stimulated index finger. In addition, we found activation in the supplementary motor cortex (SMA), the premotor cortex (PMC), the posterior parietal cortex (PPC), the anterior insula, and the prefrontal cortex (PFC) of both hemispheres (MNI coordinates and *t* scores are listed in supplemental Table 1, available at www.jneurosci.org as supplemental material). LH, Left hemisphere; RH, right hemisphere.

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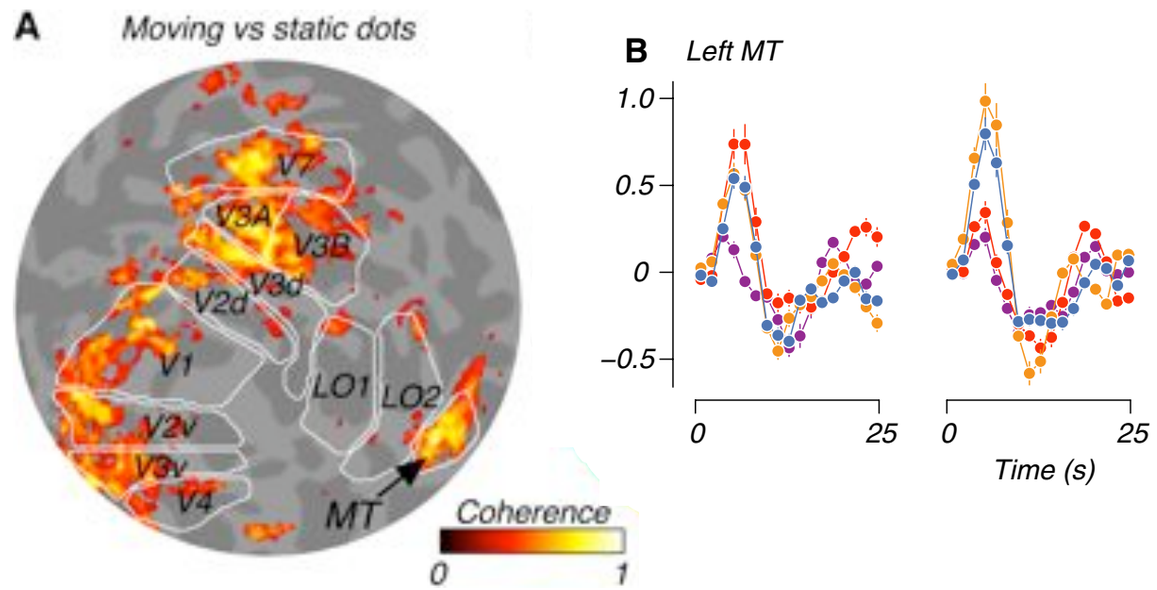
Pleger et al (2006) J Neurosci

Some studies are aimed at ***understanding processing in (pre-)defined regions***

"Is the reference frame of visual areas retinotopic (w.r.t. retinal coordinates) or spatiotopic (w.r.t. position in space)"



Gardner et al (2008) J Neurosci

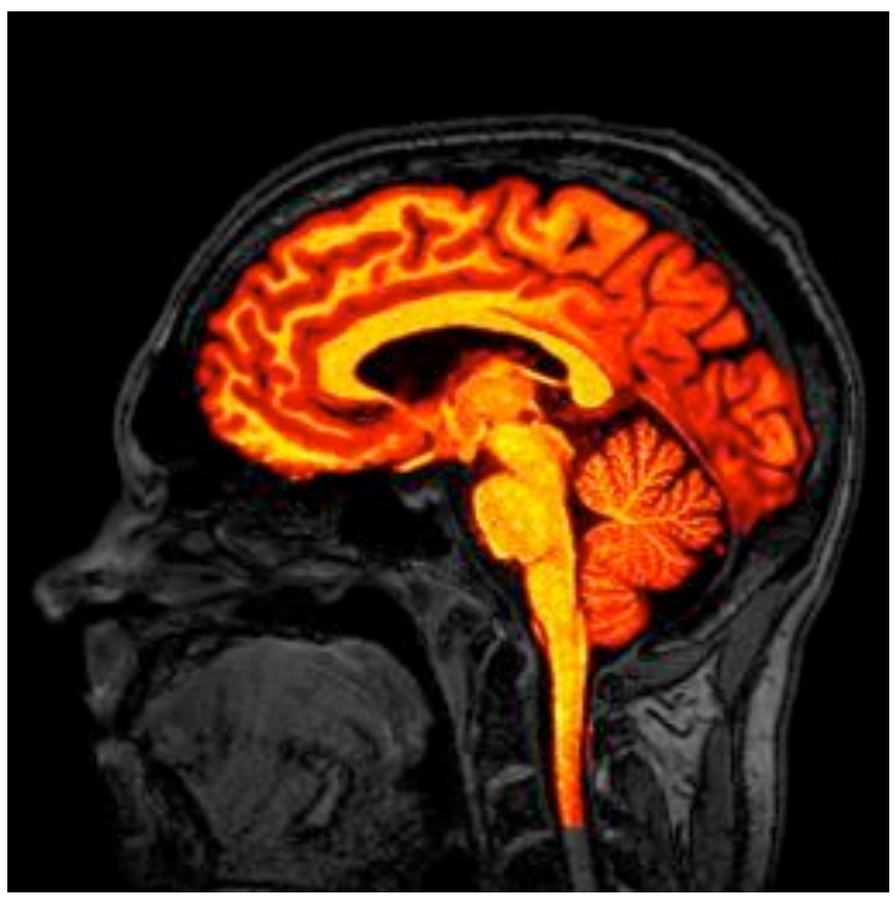
Today:

inspecting anatomies + an fMRI dataset with FSL and Matlab +

some pointers for individual subject analysis

Viewing anatomicals

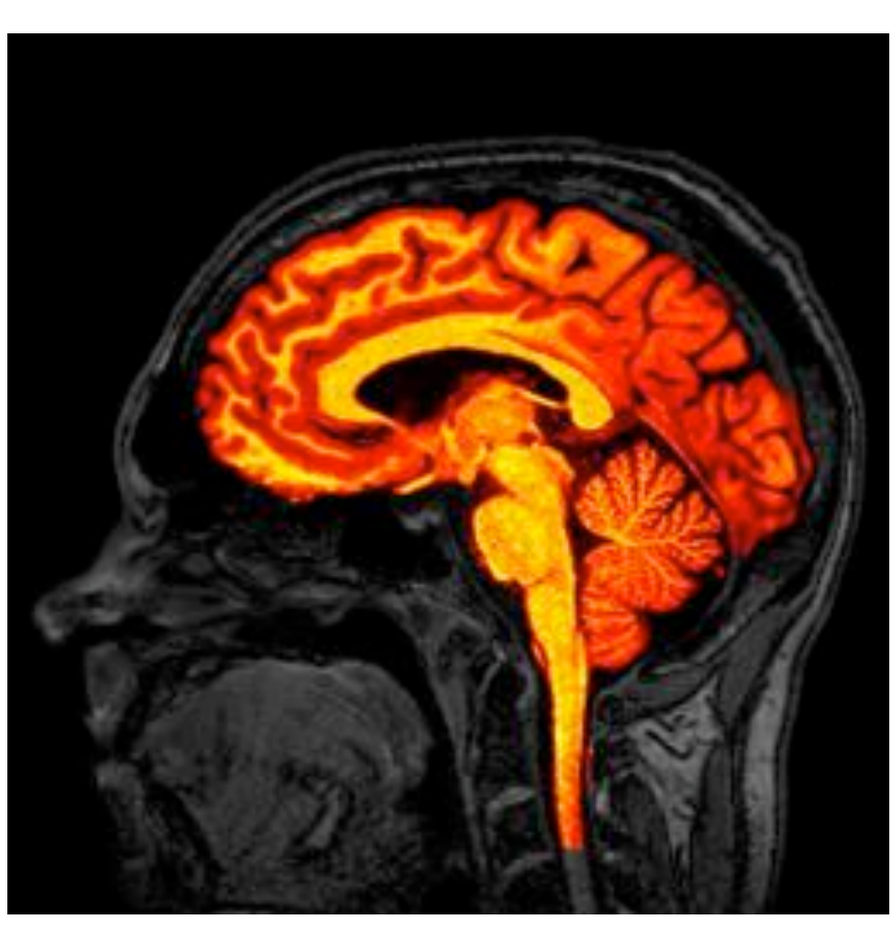
Whole head anatomy
+ ‘brain only’



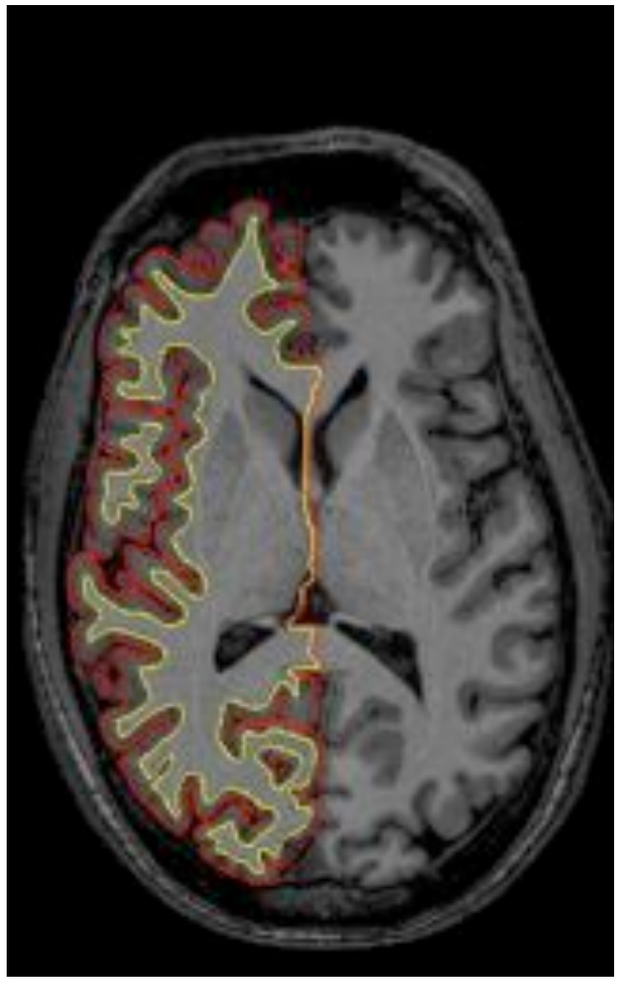
```
fslview om_intcorr.img

VolumeViewer om_intcorr.img
```

Viewing anatomicals

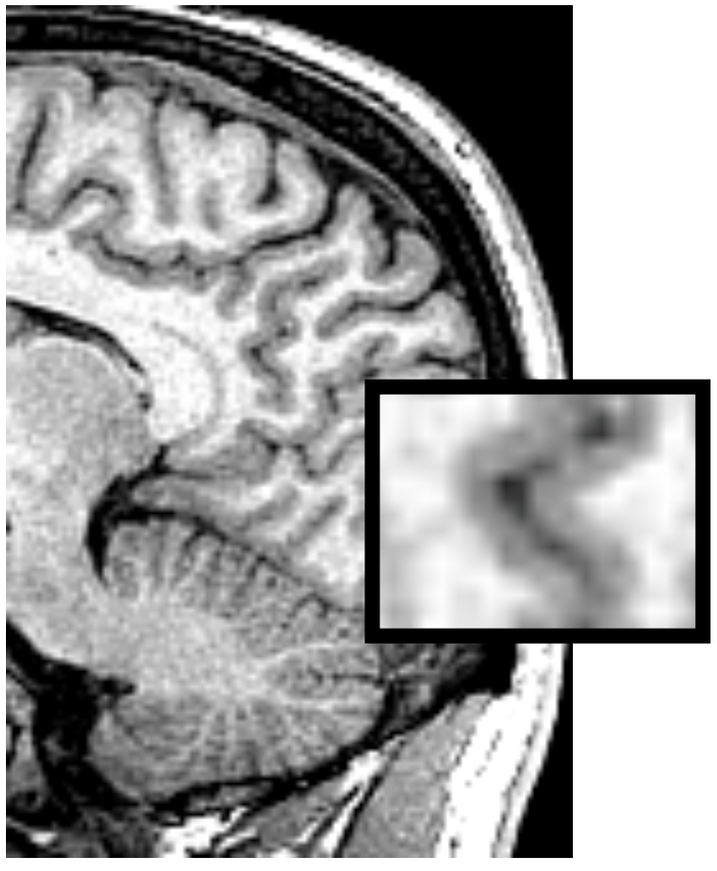
Whole head anatomy
+ ‘brain only’



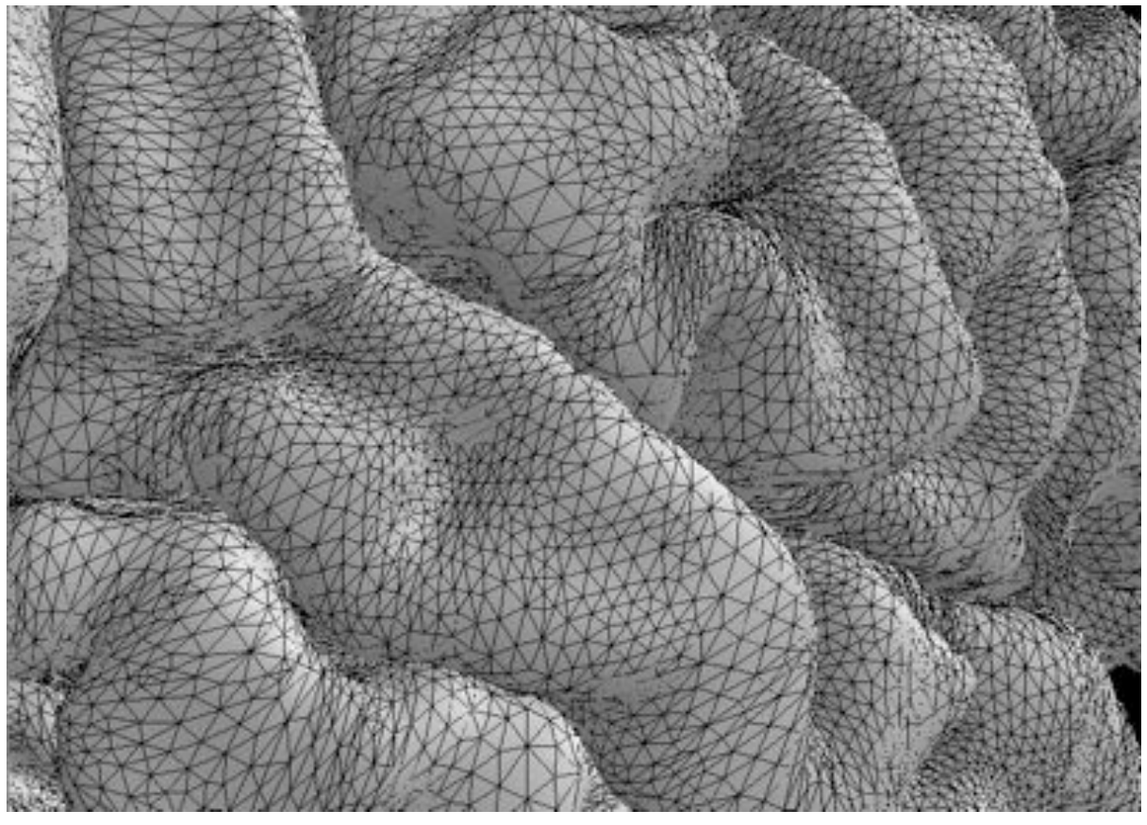
Whole head anatomy
+ white matter surface
+ pial surface



volume *versus* ***surface***

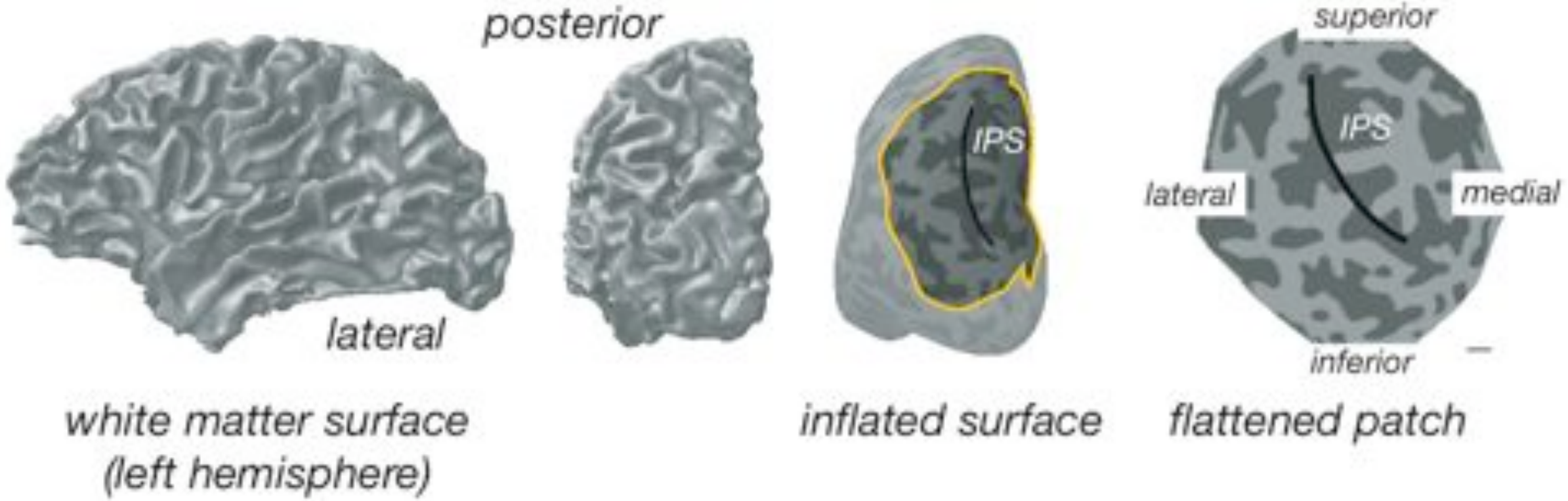


pixels / voxels in 3D (image)



vertices in 3D, connected to form triangles / polygons (mesh)

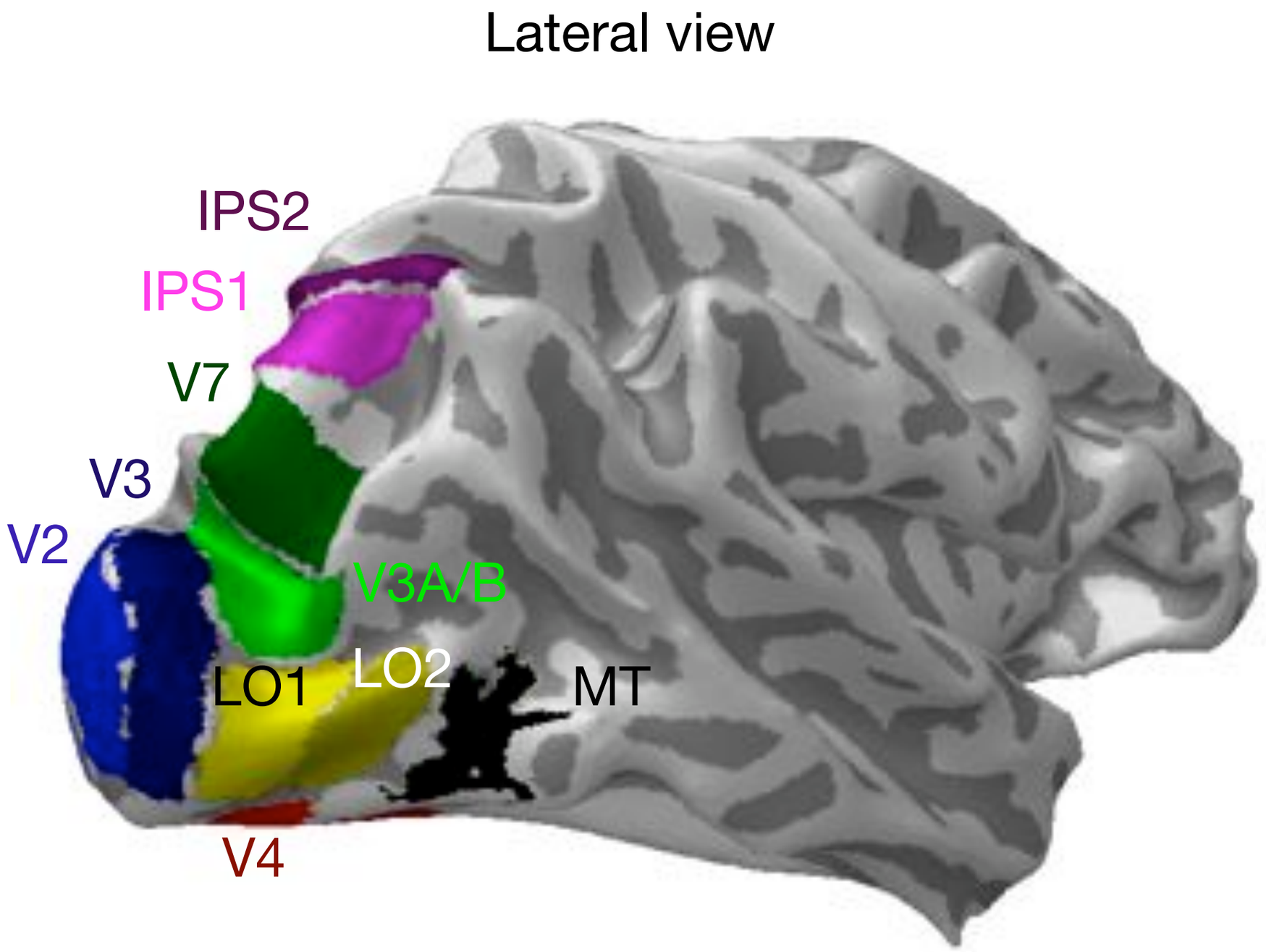
Segmentation – Flattening



Jonas Larsson's Tools

www.cns.nyu.edu/~jonas

Human visual areas



LO1 and LO2:

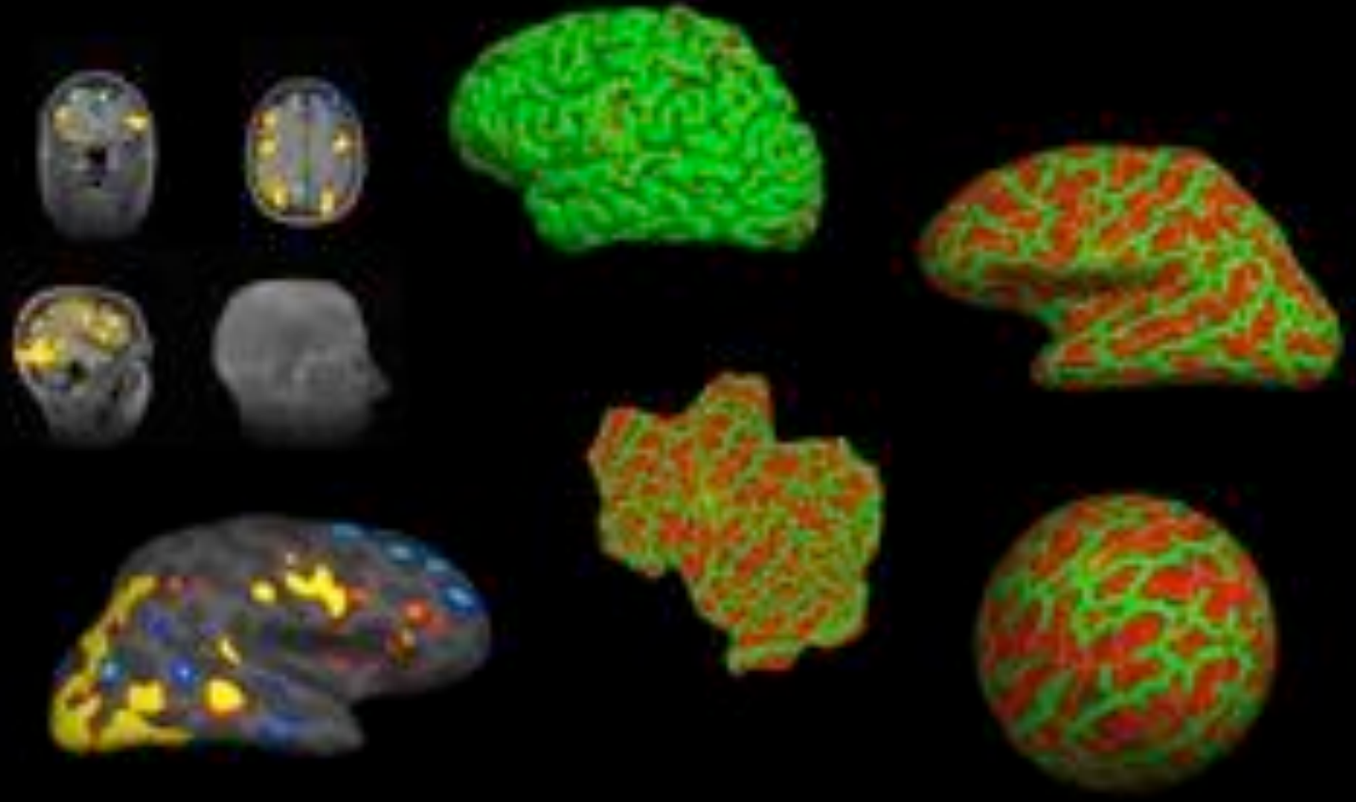
Larsson & Heeger, J Neurosci (2006)

IPS1 and IPS2:

Schluppeck, Glimcher, & Heeger, J Neurophysiol (2005)

Silver, Ress, & Heeger, J Neurophysiol (2005)

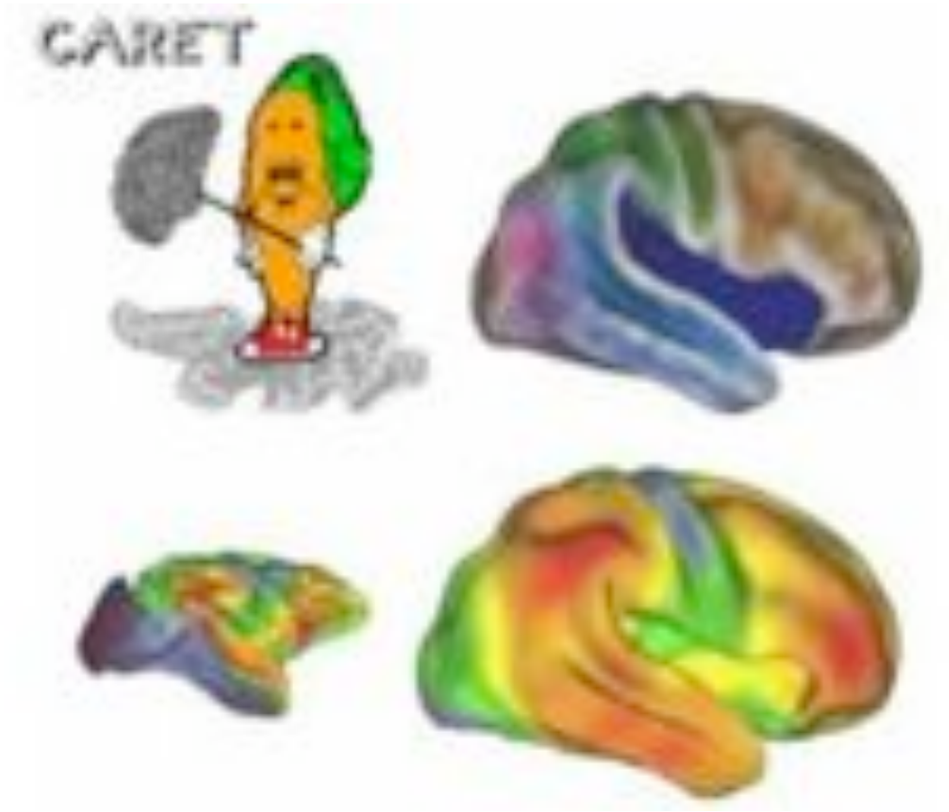
FreeSurfer

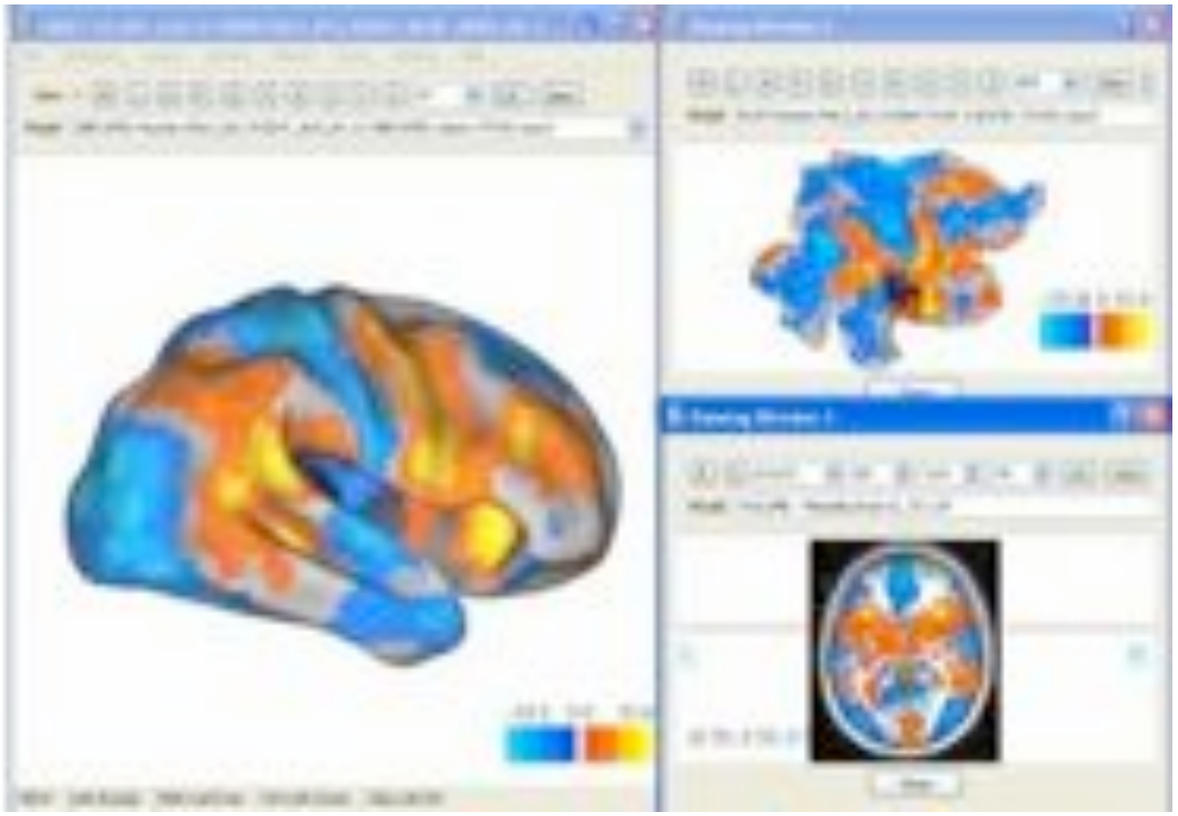


fully automated !

http://surfer.nmr.mgh.harvard.edu/

Caret

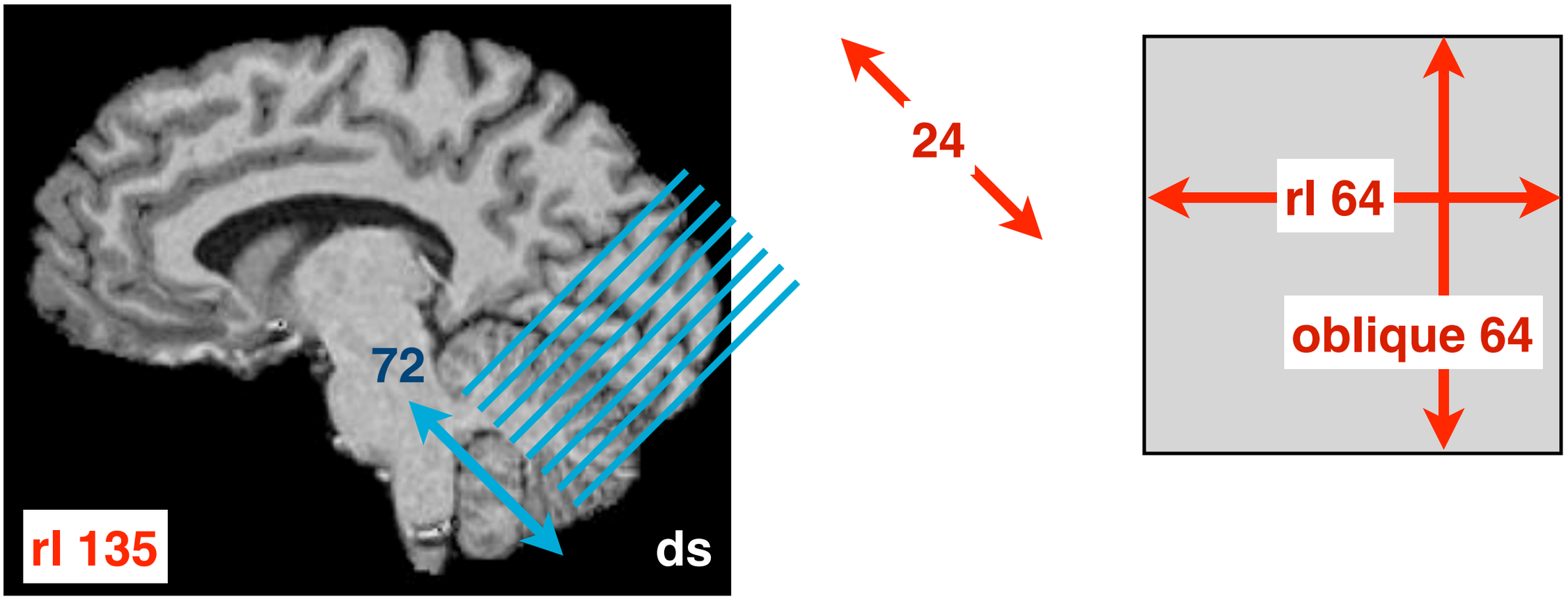




A functional data set

1. Some details about the data set
2. using FSL related tools for a quick analysis
3. exploring data in Matlab
4. pointers to a tutorial (your own time)
5. exploring data in AFNI (not currently in A5)

dataset: visual cortex



~dimensions (mm)

~# of slices

~# of voxels

64×3mm=**192mm**

❖ *our MR scanner ~13slices/s, so can run with a TR of ~1.5s*

stimulus + timing

- *rotating wedge checkerboard*
- *subject fixates*
- *24s for one cycle of rotation*
- *10 cycles per scan*
- *TR = 1.5s*
- *# of dynamics = 168*
- *initial 8 dynamics are ‘dummies’*

stimulus + timing

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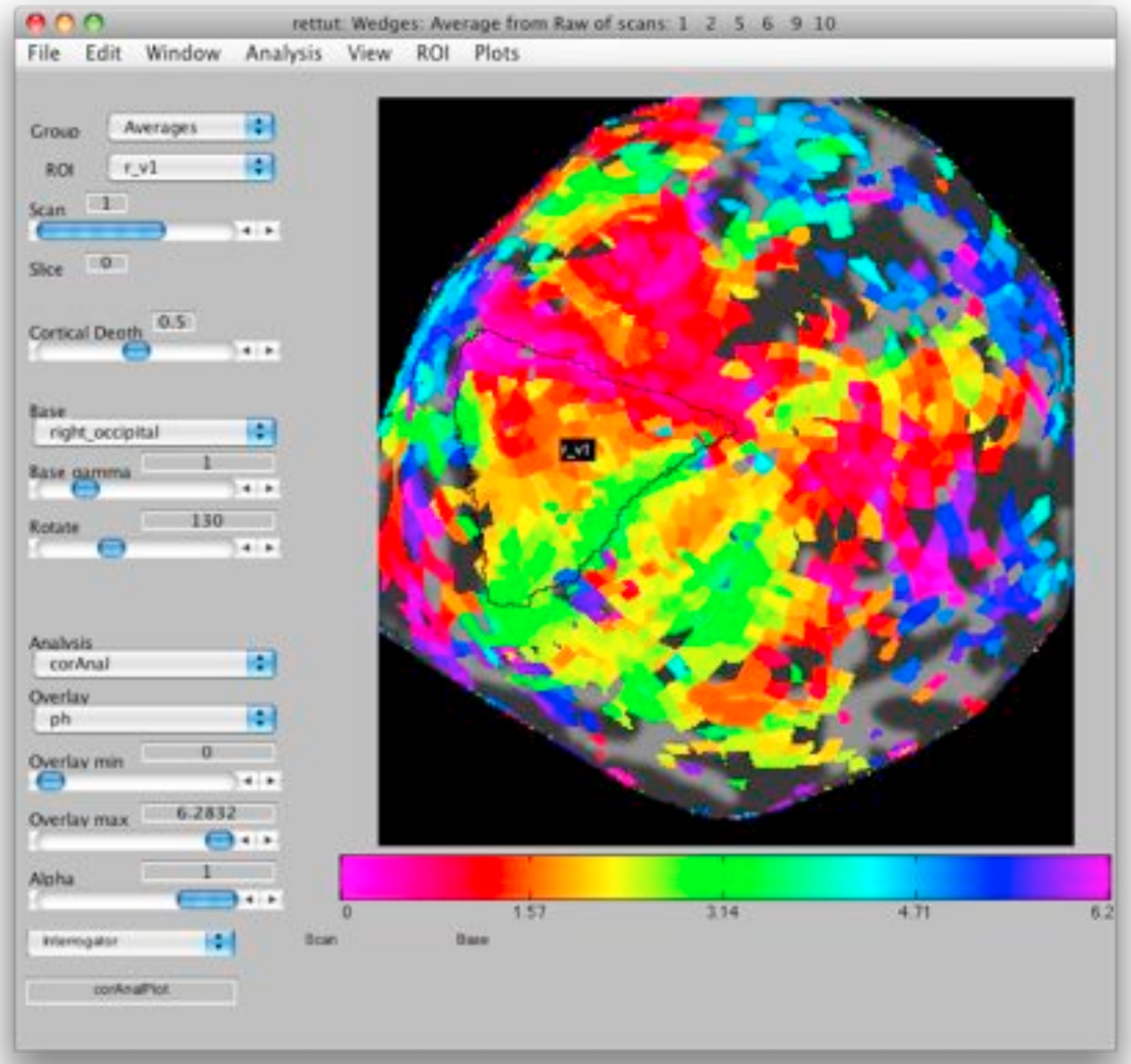
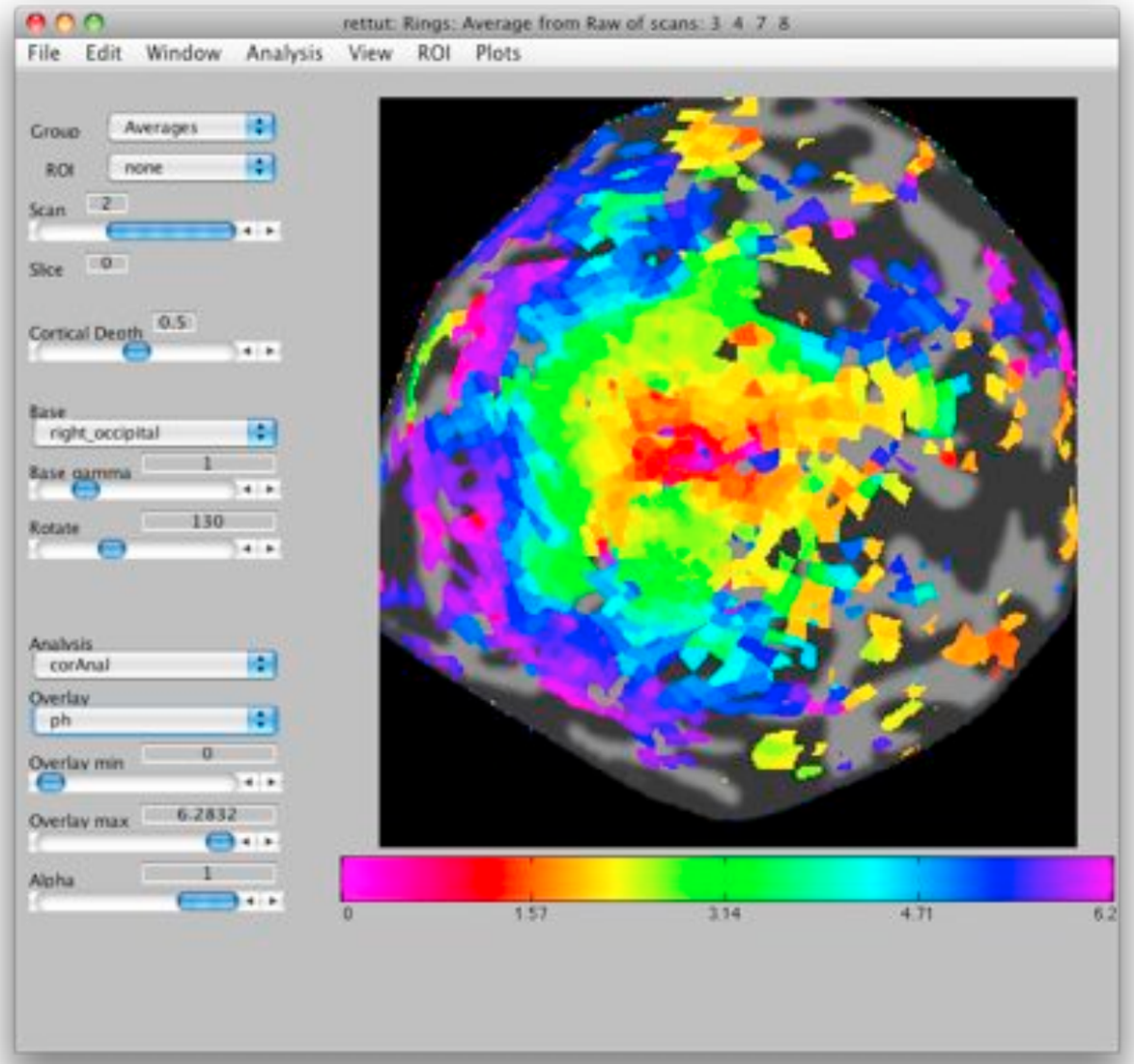
(Retinotopy)

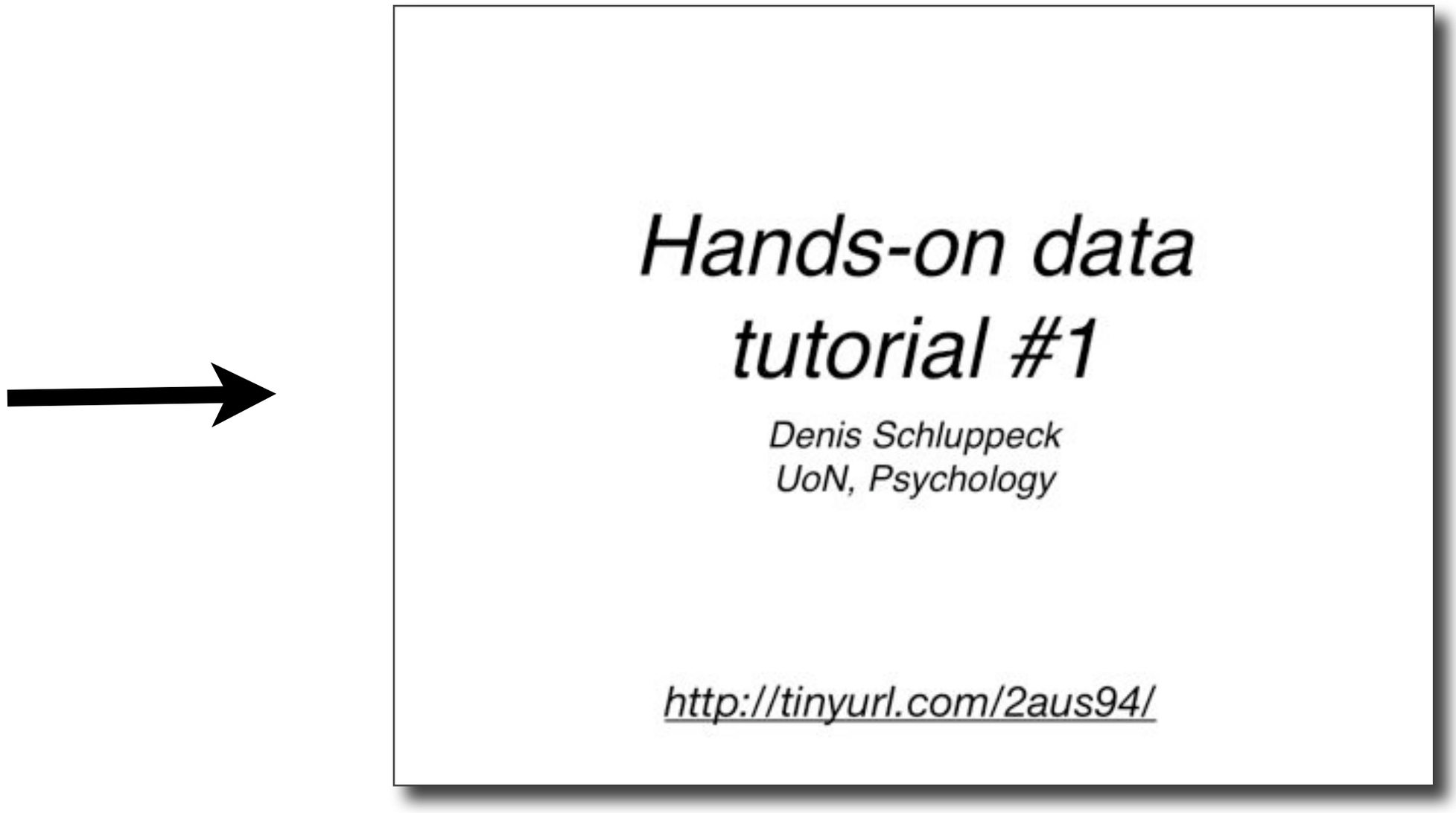


angle map



eccentricity map

some setup...


Hands-on data
tutorial #1
Denis Schluppeck
UoN, Psychology
http://tinyurl.com/2aus94/

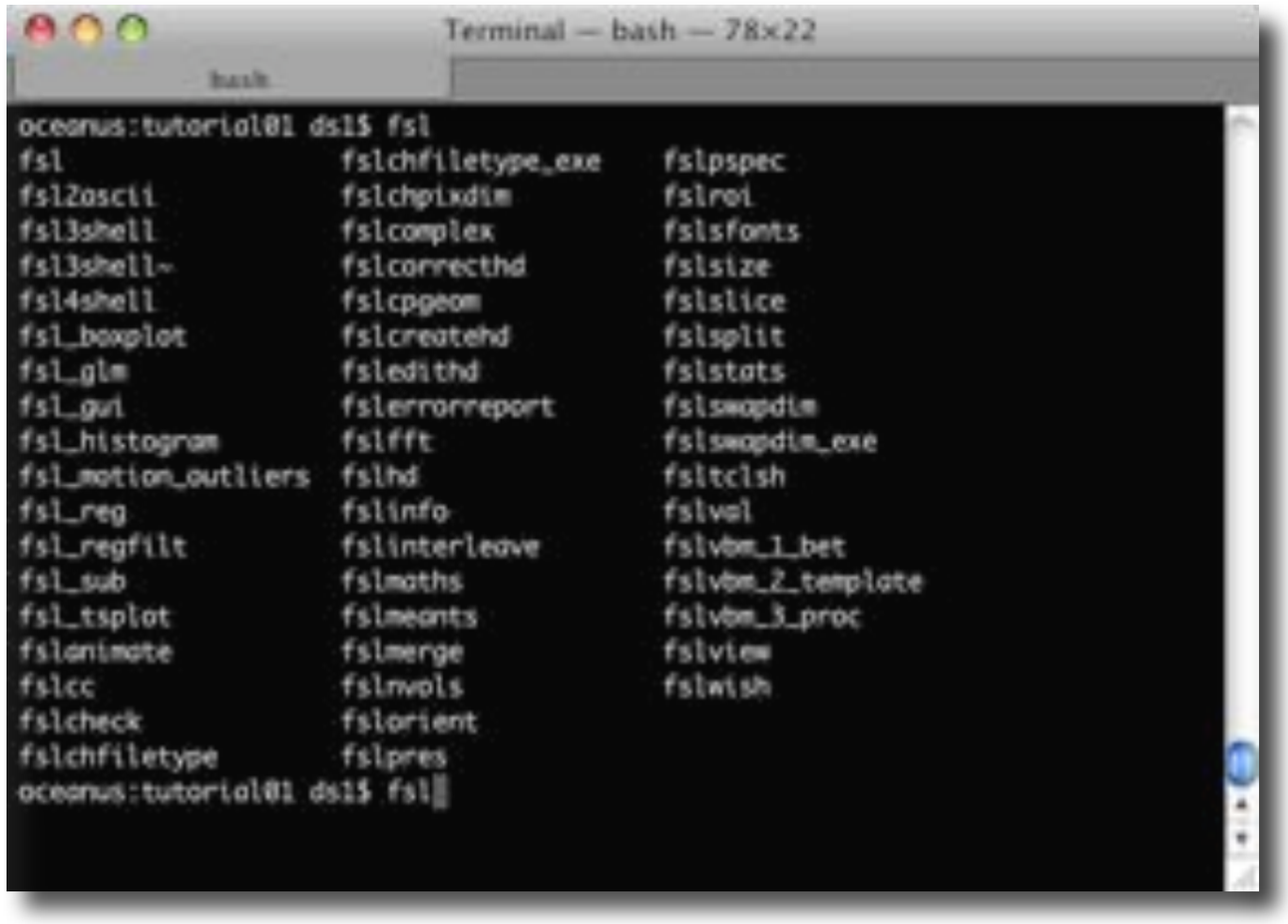
info about the data...

```
ds1$  fslinfo

ds1$  fslinfo retino01.img

ds1$  fslhd retino01.img
```

- **fslinfo** gives succinct info about data
- try **fslhd** for more detail

FSL command line tools for analysis

```
ds1$  fsl<bla>

ds1$  fslview &
```



- **... next few steps for a quick and dirty Fourier analysis (for free / no $)**

simple image stats

```
ds1$  fslstats
ds1$  fslstats retino01.img -R
ds1$  fslstats retino01.img -r
```

- **fslstats** can do descriptive stats
- how about the mean value for all non-zero voxels?? std??

splitting / combining data

```
ds1$  fslroi
ds1$  fslsplit
ds1$  fslmerge
```

```
ds1$    fslroi retino01 retino01cut 0 64 0 64 0 24 8 160
```

- use **fslroi** to get rid of first 8 dynamics...

simple arithmetic

```
ds1$   fslmaths
ds1$    fslmaths retino01cut.img -Tmean retino01mean.img
```

- **fslmaths** is a 3D/4D image calculator
- e.g. calculate the mean 3D image of the 4D timeseries... (how about the std??)

timeseries to % signal change...

```
ds1$    fslmaths retino01cut.img -div retino01mean.img
        -sub 1 -mul 100 retino01psc.img
```

- divide the timeseries by the mean and subtract 1
- e.g. calculate the mean 3D image of the 4D

power spectrum...

```
ds1$    fslpspec
ds1$    fslpspec retino01psc.img retino01power.img
ds1$    fslinfo retino01power
```

- calculate the voxelwise power spectrum from the % signal change timeseries...
- NB! new image dimensions??

power spectrum...

```
ds1$    fslview &

ds1$    fslroi retino01power.img retino01comp10.img 0
        64 0 64 0 24 9 1

ds1$    fslmaths retino01power.img -Tmean -mul 80
        retino01sumPower.img
```

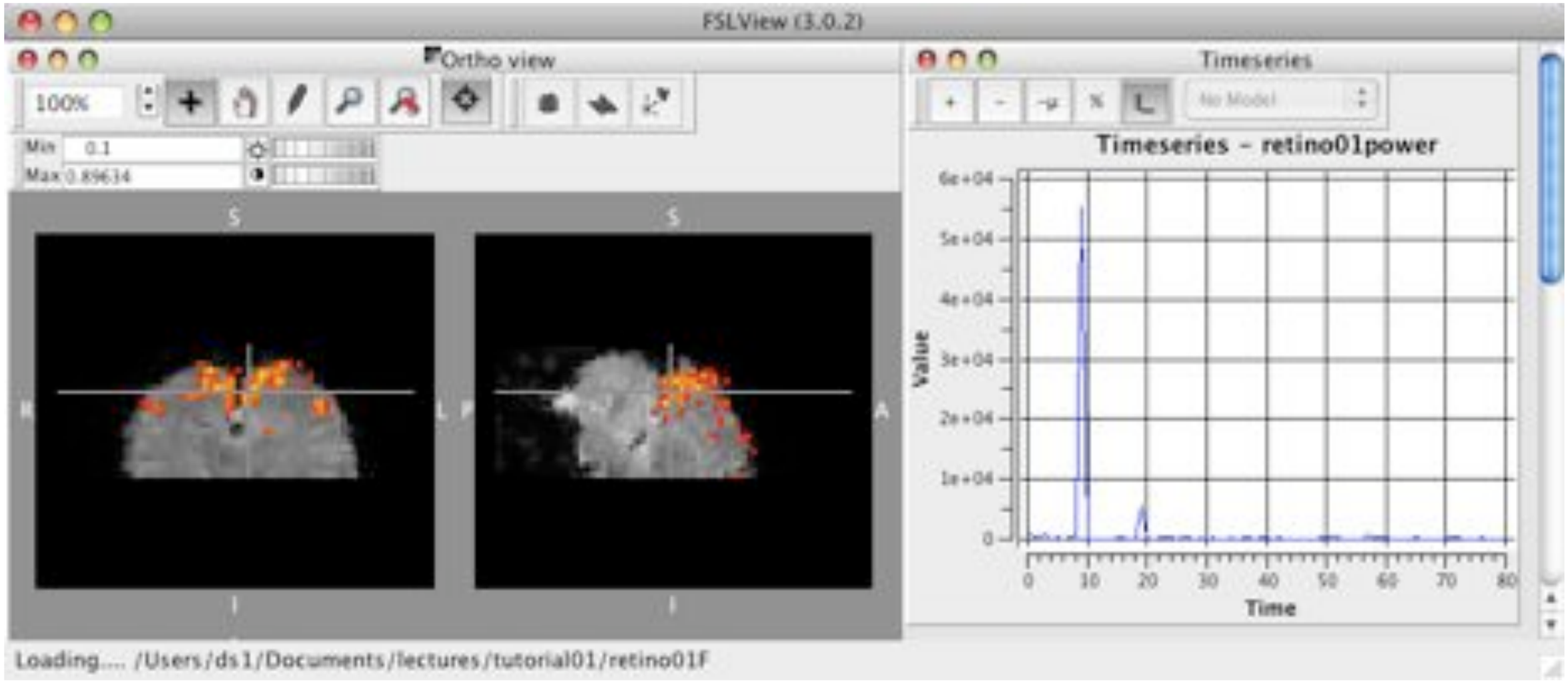
- extract the component in spectrum corresponding to 10 cycles per scan (index = 9)
- ... and also the summed power spectrum.

F / c statistic

```
ds1$    fslmaths retino01comp10.img -div
        retino01sumPower.img statisticImage.img
ds1$    fslview &
```

- compare power at stimulus component to rest of spectrum. The ratio gives us an idea abut signal and noise...

F / c statistic

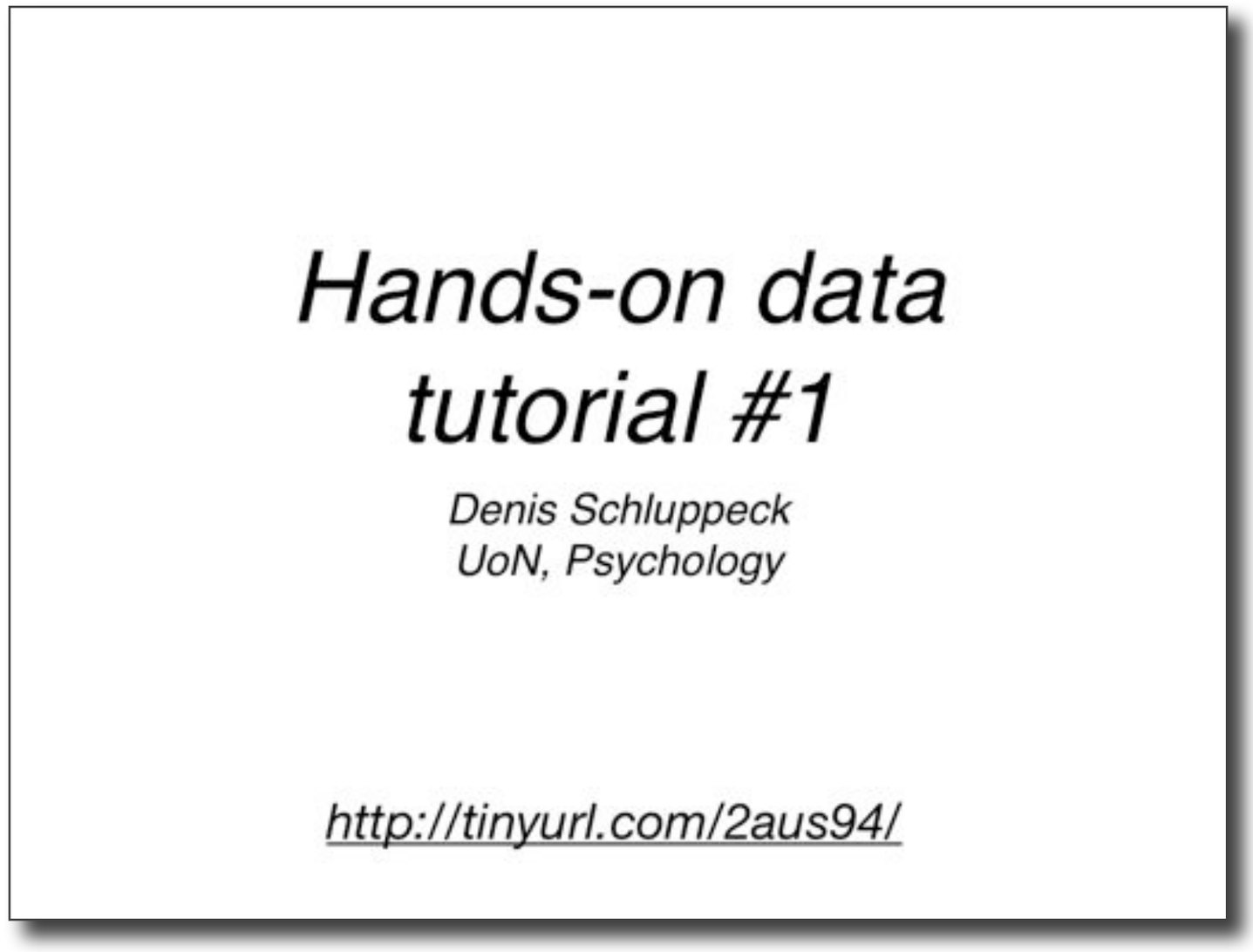


Anatomy

```
ds1$    fslview &
```

- load in file om_intcorr.img
- NB! this is a different subject than for the functional data set

For the rest of today...



skip AFNI related demos

For the rest of today...

1. Spatial filtering with **fslmaths**
   e.g. apply gaussian filtering to anatomy
   -kernel gauss 2 -fmean

2. other statistics on functional data set?

3. other mathematical operations on fMRI data?

4. **advanced ...**
   create the F statistic image (Fourier method)
   use **cluster** command to find spatial clusters

Thanks –

have a go...