Data analysis for Neuroimaging - PSYG4043 / C84DAN

Overview

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What's the plan?

1. Acquire some [functional] MRI data in a simple, but real experiment
2. Analyze the data with `fsl` (FMRIB webpage)
3. Learn a bit about `UNIX` and version control, in particular `git` and `github`
4. Use `Matlab` to inspect and visualise some data
5. [optional] anatomical, diffusion weighted +/- multi-echo data (T2*)

Timeline

Unit	Topic
1 ⭐	Introduction, Administrivia, computers, ...
2	Data acquisition (**scanning on 3T at SPMIC**)
3	Inspecting & analysing data in **FSL**
4	Version control (`git` and `github.com`)
5	Images in **Matlab**, display, analyze
6	Timeseries signals in **Matlab**
7	Reading/writing text, CSV, data files **Matlab**

What's the assignment?

A short, written report

> Summarise the experimental setup, analysis methodology and results. Need to have clearly written abstract (250w), methods, results and discussions (and **figures**).

Aim: Get you thinking about journal-style writing, rather than essays.
Plus: presenting your own data, identifying key points, a story/pitch.

When to work on this? 👷

Start as soon as we have the data

- explore your analysis ideas
- talk to us about questions you could address
- think about plots + data visualisations you'd like to make

Submission details 📎 📚

Currently w/ Student Services, *date to-be-confirmed*

- turn-it-in submission on moodle page
- **deadline: 27 March** (the week after last class of this module)

What's the assignment (2) 📊 📈 📉

- 250w abstract
- plus a main document (max 1500w)
- references / citations as for standard written work
- **max 5 figures**[1] illustrating
    - details of the experimental setup
    - analysis methodology
    - results

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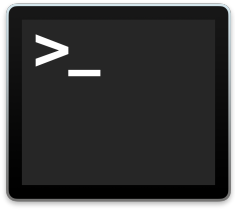
[1] figures can have sub-panels or subplots

❗ For next time (lab 2)

- sign up for 1 of 3 groups (max 7 people) - `moodle`
- complete visitor screening form
- we also need 3 volunteers (~40 min in scanner)

Setting up computers, logins



1. Each user (at a particular machine) needs to make sure that `Terminal/shell` is set up correctly by copying a set-up file the first time they use that computer.

```
# copy across new version of .bash_profile
cd ~ # make sure we are in ${HOMEDIR}

cp /Volumes/practicals/ds1/.bash_profile   ~/

# restart shell
```

Has setup worked? Reality check.

1. If you see `[ ran custom .bash_profile ]` in Terminal ✓
2. Also: look at some existing anatomies with `fslview` ✓

```
which fsl # see anything?

fslview & # File -> Open Standard -> Pick 1st or 2nd
```

Setting up computers, logins

If you have to do this again on another machine, you can use this shortcut. It's located in `/Volumes/practicals/ds1/`

Cheat: Double-click `Set up My Machine` icon

FSL analysis

- get data from sessions `S001` to `S004` into a common folder `data`
- make folders, copy files by "drag & drop"
- point & click version (like some of you have already done)
- digging into the details of how this is implemented
- inspecting analysis output, intermediate files, ...

```
cd ~/data/S001/  # for example
# run FSL analysis
```

Some UNIX

- only basics are needed for running FSL analysis
- lots of functionality is available through point-and-click
- **but** command line is helpful for organising (any) research data
- more complex analysis, e.g. `freesurfer`, require some working knowledge

```
# navigate file system
# cd, ls, pwd, which, ...

# some powerful commands for organising your data
# cp, rm, touch, mkdir, rmdir

# some stuff to show of how powerful
# grep, "lists", "wildcards (*, ., ?)"
# "regular expressions"
```

Version control `git`

- 30min lecture on principles of version control (`git`)
- start using your (free) `github.com` id by working on a simple project
- make your first modifications to a local copy of code and get it into a repo.

```
mkdir test && cd test # what does this do?
git init
# [[ create, edit a file, say my_first.md ]]
git add my_first.md  # add it to "staging area"
git commit # enter commit message
# - OR -
git commit -m 'adds first version of file'
git log
```

Version control (v2.0) 😉

Everyone should sign up for a free `github` account, so we can work together on this from session 4 onwards: https://github.com/join

- it's free and useful
- we'll want to play with this in lab #4
- once you have an username (pick one that I will recognise!), go to our github classroom at https://classroom.github.com/a/7ZwbkqLl

`matlab` - reading images (1)

- we'll learn how to read imaging data into `matlab` (`nifti` files)
- from `R2017b` onwards `nifti` support is native, but there are also functions provided by the `mrTools` toolbox for Matlab

```
% > R2017b
data = niftiread('file_from_scanner.nii');

% mrTools toolbox
help mlrImageReadNifti

% read in some data
data = mlrImageReadNifti('file_from_scanner.nii');
```

`matlab` - reading images (2)

- revisit indexing of arrays, "slicing", etc.

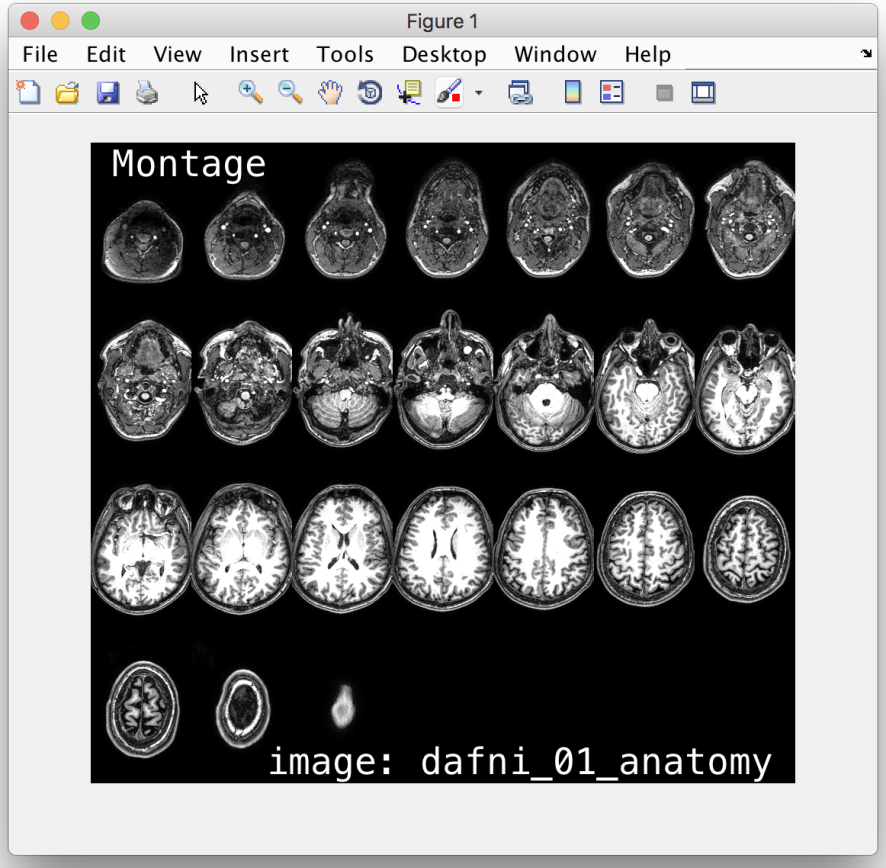
```
data(12, 24, :, 1) % what is this?
data(:, 24, 24, 1) % ... and this?
data(34, 44, 12, :) % ... or that?
```

- we built a `returnSlice()` function, to complete imageviewer:

```
% function signature
s = returnSlice(array, sliceNum, orientation);
```

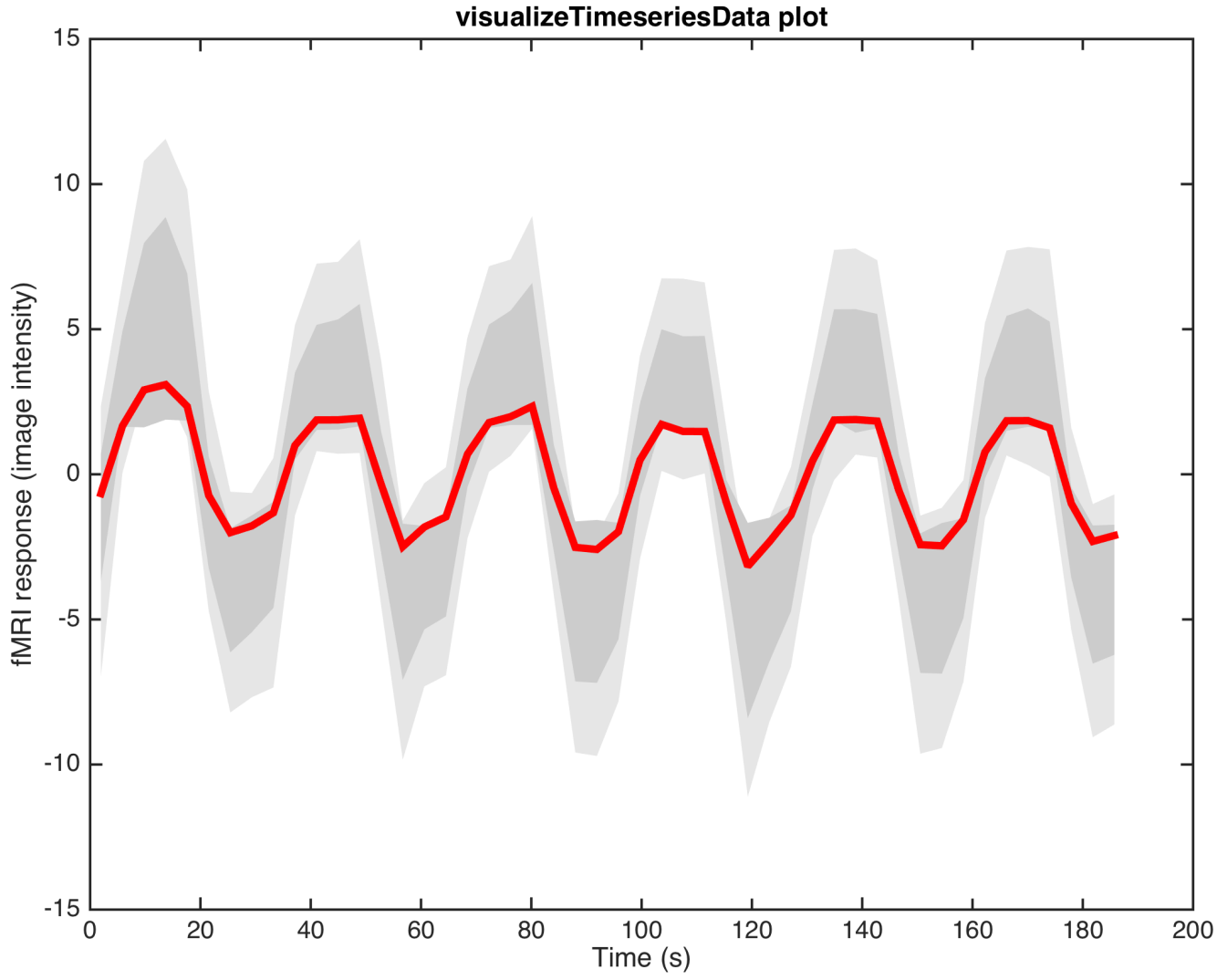
- some more coding along these lines

```
makeMontage('dafni_01_anatomy.nii', 25)
```




```
function [  ] = makeMontage(fname, nSamples)
%makeMontage - make a montage from 3d/4d image
```

`matlab` - timeseries and subplots



`matlab` - text / csv / other data

- think about data formats / interop with other analysis & tools (`R` , `python` , ... even UNIX tools). Sometimes a text file is best!

```
% read realistic behavioural data (mix of numbers, text)
table(), writetable(), ...

% read in a simple CSV file, skipping first row (r=0)
% csvread(file, R, C) % row R, column C (starting at 0!)
d = csvread('timecourse.csv', 1, 0)
```

Wrap-up (Lab 7)

- recap what have we covered in the last 7 weeks?
- where to go to from here (unleash your inner coding 🐯)
- try to approach each new problem, project with lots of repetition (analysis, writing, coding, ...):
  - there must be a better way!
  - what's the smallest unit that gets repeated all the time?
  - can I use `bash/unix`, `matlab` or another tool to automate?
- just try things out - you'll learn tons in the process

Notes

Small `awk` program for adding a counter `n` and time `t` and turn one column txt file into csv file:

```
awk 'NF    {print NR-1 ", " (NR-1)*1.5 ", "  $1}' \
     timecourse.txt > timecourse.csv
```

- with a headerline (matlab's `csvread()` doesn't like!)

```
awk 'BEGIN {print "n, t, response"}
     NF    {print NR-1 ", " (NR-1)*1.5 ", "  $1}' \
     timecourse.txt > timecourse.csv
```

Solution in `matlab`?

Turn `timecourse.txt` (column of y-values), into `timecourse.csv`:

- where first column is a counter that goes from `1...n`,
- the second column is `t` (in s), which goes up from `0..1.5s..` and
- the third column is the `y` values

What about something else?

- Excel? R? Another cool idea that's worth having in your set of tools?