PSGY4009

Q+A about assessment, the GLM in more detail

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Attendance

Figure 1: qr code

Today

Assessment

- A bit more detail on the written assessment
- General advice on writing, structure

The General Linear Model (GLM)

- intuition / non-mathematical explanation
- (how to get hold of my *interactive* notebooks)
- some of the nitty-gritty (in `Matlab`)
- demo analysis in `fsl` (quick walk-through)

Kinds of designs

- task, resting state, connectivity, ...

Learning objectives

By the end of the lecture you should:

- know what's expected in coursework
- have all the information to get started on assessment
- understand the GLM in principle
- appreciate some of the technical details of GLM analysis
- have some knowledge of different kinds of "designs" / approaches to fMRI for neuroscience

Assessment

- Written assignment (max 3000 words) including a 250 word abstract.
- Details on moodle (2025/26).

> The written assignment for this module is an essay about how functional magnetic resonance imaging and/or brain stimulation can be used to study different neuroscience questions. It should cover two topics and/or methods from the course.

Not just a literature review

> One aim of the assignment is to make you think about the methodological choices the experimenters have to make. After a brief summary of the state of the literature in your area, there should be therefore be a component that talks about how you might extend some previous findings.

On moodle

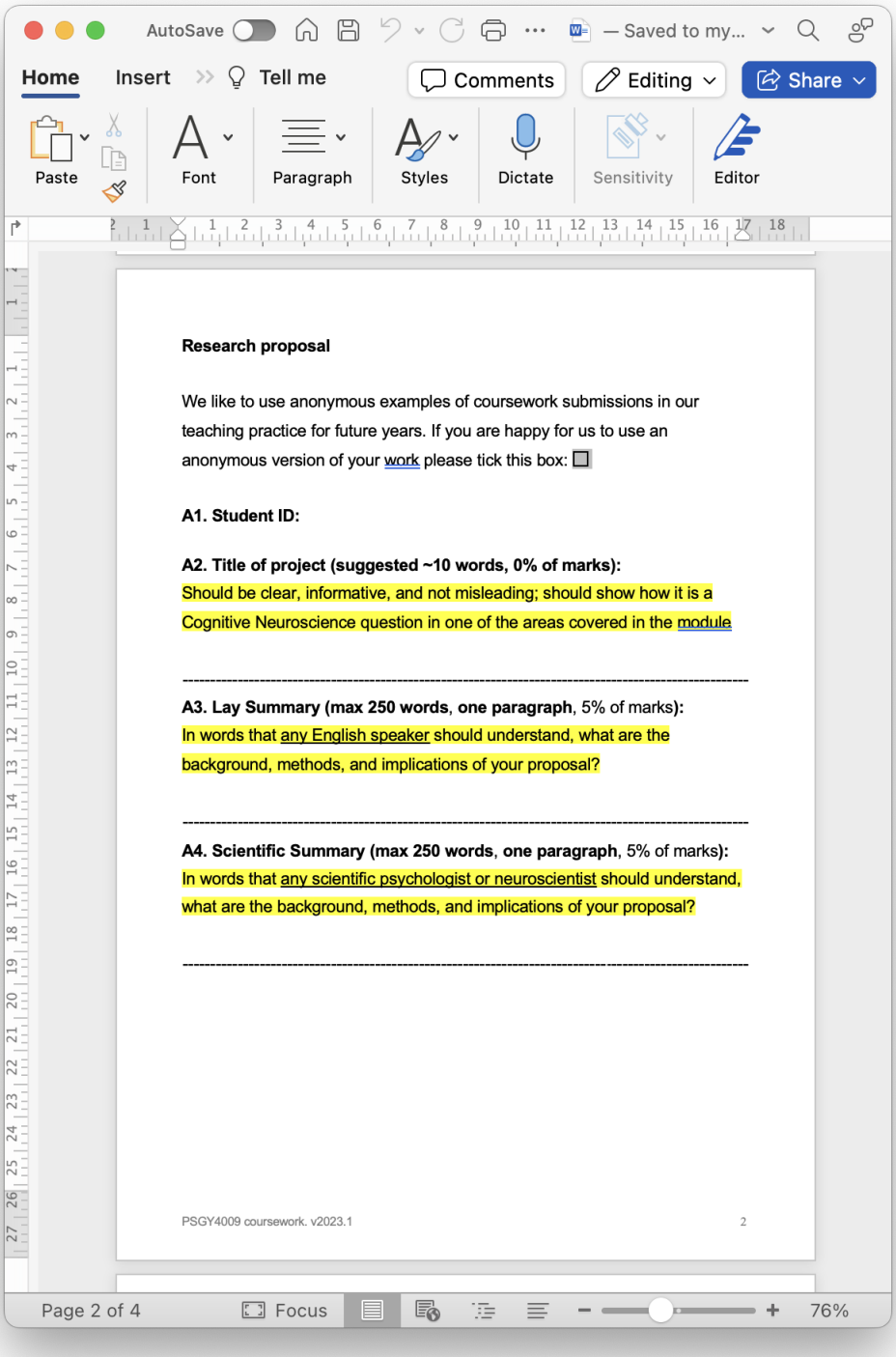


Figure 2: word doc template

Guided submission

There are very specific suggestions for how you can tackle each section in turn

overall word limit, 3000w - stick to this limit)

- Title of project (suggested ~10 words)
- Lay Summary (max 250 words, one paragraph)
- Scientific Summary (max 250 words, one paragraph)
- Background of the project (suggested 600 words)
- Questions to be answered (suggested 200 words)
- Plan of investigation (suggested 500 words)
- Details of data analysis (suggested 500 words)
- Expected outcomes (suggested 200 words & 1-2 figures)
- Theoretical & practical implications (suggested 500 words)
- References

Things that you might wonder about:

- Plan of investigation (suggested 500 words)
- Details of data analysis (suggested 500 words)
- Expected outcomes (suggested 200 words & 1-2 figures)

  But I don't have any data (yet?). How to square that circle??

What do we look for?

Content

The **content** of your coursework is (obviously) important - topic choice - methodological details included - facts correct?

... but writing!

- clear, concise, economic
- line of argument?
- structure easy to follow
- ...

Strunk & White - *Elements of Style*

If you haven't read this little book (26 pages), take the time!

free online PDF of the book

The GLM - a quick walk-through

Some notes for my demo

```
cd ~/projects/hands-on-brain-data
julia # which starts julia

julia> using Pluto
julia> Pluto.run()

# "what_is_linearReg.jl"
```

in `Matlab`

Some notes for my demo

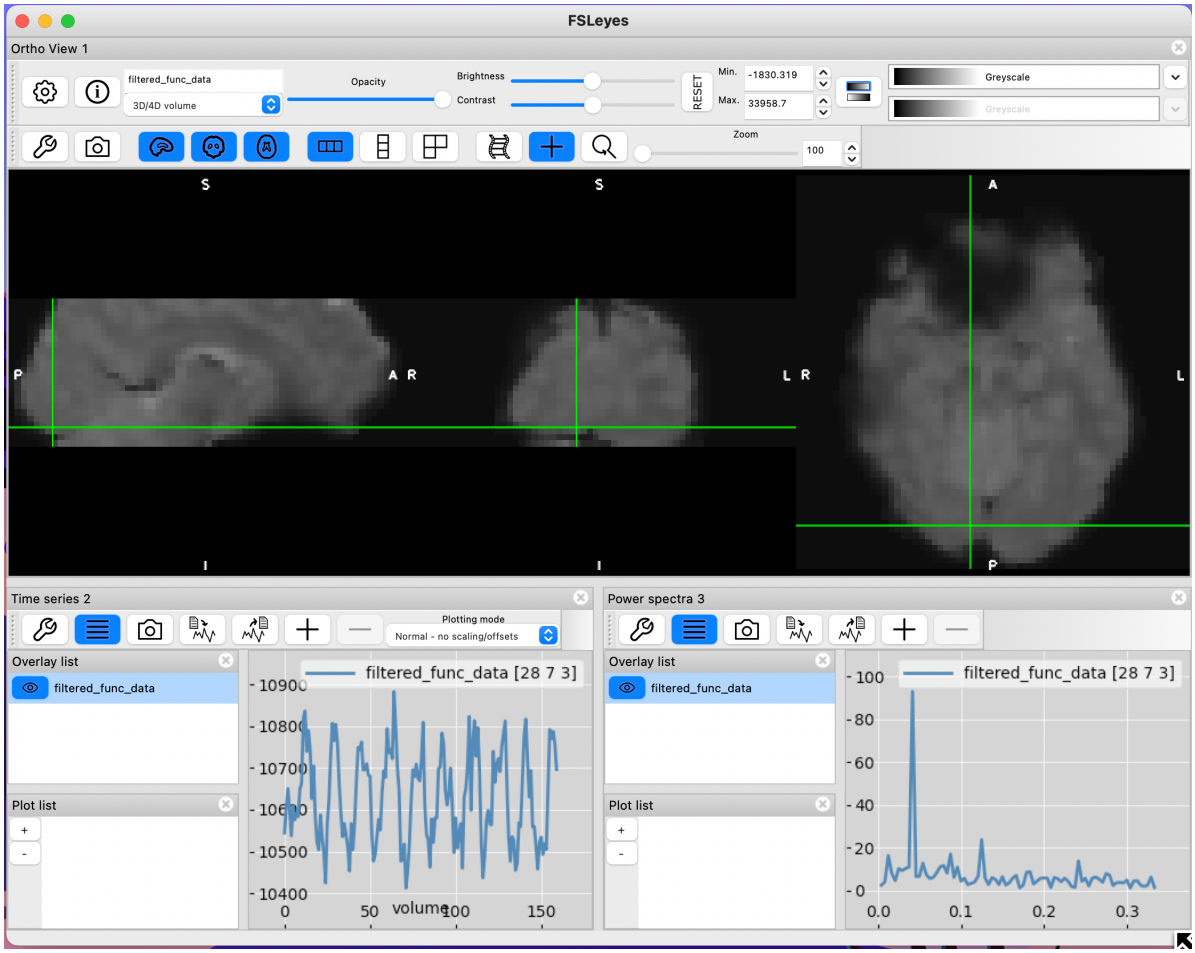
```
cd ~/projects/hands-on-brain-data
cd data
X = load('design-3.txt')
y = load('timecourse.txt')
X\y
% regress(), pinv()
```

in `fsl`

```
cd ~/projects/hands-on-brain-data-demo
cd data
fsleyes filtered_func_data
fsl &
# simple block design ... stats: 6, (12, 12, 12)
```

Link to Install instructions

in `fsl/fsleyes`



Kinds of designs / approaches

Two directions, in which people elaborate experiments:

1. **tasks, stimuli** have become more sophisticated
2. **data analysis methods** are changing all the time

Tasks

You can find lots of versions of these across all domains of cognitive neuroscience...

- task-based experiments
  - block designs, event-related designs, mixed, ...
  - "continuous" (eg watching movies)
- resting state fMRI (rsFMRI)

Example

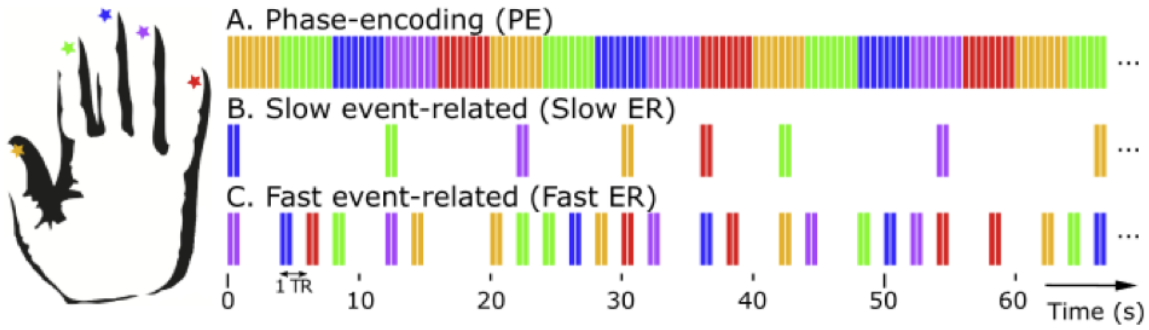


Figure 1: Fingertip stimulation sequence for the three experimental designs. In all three designs, stimulations were 400 ms, 50 Hz vibrotactile stimulation at the tip of the five fingers of the left hand (corresponding to the five colors in this figure). In the phase-encoding design (A), each fingertip was stimulated for 4 s (inter-stimulation interval = 100 ms) in clockwise (thumb to pinky, shown in this figure) or counter-clockwise order (not shown). In the slow and fast ER designs, each event consisted of two stimulations separated by 100 ms, but were presented in random order, with an inter-event interval of 4 to 12s in the slow ER design (B) or 2 s in the fast ER design (C). In addition, the fast ER sequence included 28% of null events.

Analysis methods

- GLM, linear regression (the "workhorse" of fMRI analysis)
- data-driven methods (search for patterns in the data)
  - *independent component analysis*, ICA (dimensionality reduction techniques)
  - seed-based correlation methods
  - network analysis, ...
- machine learning, *decoding*

GLM

We have just seen a bit more of this in action

Resting state fMRI

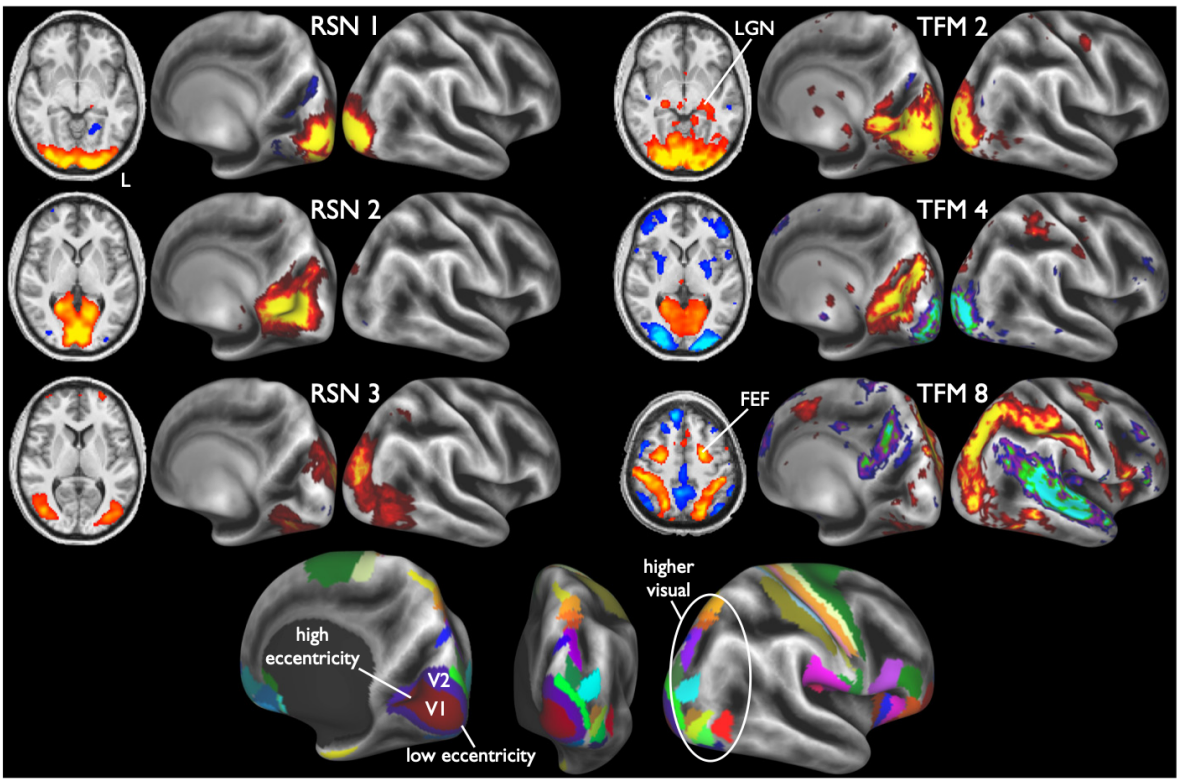


Fig. 1. Three visual components from a 21-dimensional spatial ICA decomposition of the complete dataset, as well as three components from the 21-dimensional TFM analysis. To help localize the maps structurally, they are shown on the partially inflated cortical surface, with sulci indicated by darker background intensity. To help localize the maps functionally, the bottom row shows several cytoarchitecturally based (V1 and V2) and retinotopically based (higher visual) areas from the "FS_LR" atlas (11). LGN, lateral geniculate nucleus. FEF, frontal eye fields.

Figure 3: example rs analysis

Smith et al, 2012, PNAS

Decoding, multivariate analysis

Variously: *classification*, SVM (support vector machines), decoding, even "mind reading", ...

Aim: try to use **data** - the pattern of activity across many voxels (and trials) - to figure out which stimulus was being displayed.

First use, classic reference

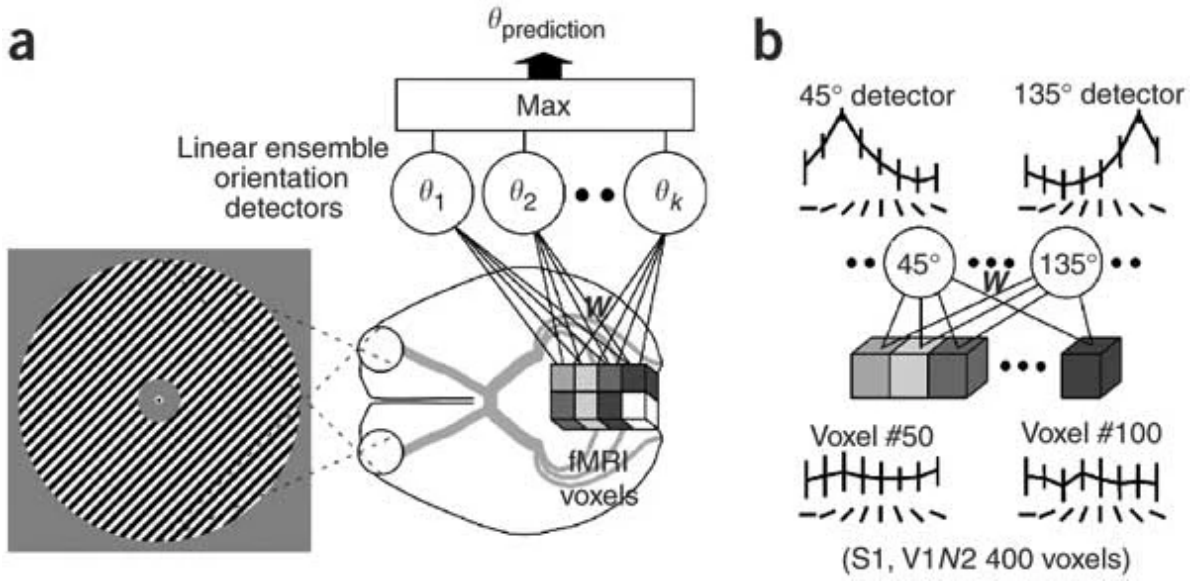


Figure 4: Kamitani and Tong, 2005

Kamitani & Tong, 2005

Thanks

Hope you found this helpful.

See you soon!

Colophon

- This presentation was made with `quarto` and `revealjs`.
- Uses a font called `Atkinson Hyperlegible`, which was designed to work better for people with low vision: available via google fonts.