16/06/2020 minutes

Outline for approach to dissertation

1) Perform the analysis used in the 'Dynamic reconfiguration…' paper - reproduce their graphs, then check sensibility of reproduced results with David / Camille
2) Understand their methods thoroughly (in order to write about them in the dissertation)
3) Explore sideways - any more meaningful results to be got other than exactly what they have produced in their paper?
4) *(Robustness analysis - leave for now as difficult to do?)*
5) Effect of temporal frequencies (e.g. more clusters or fewer clusters)
6) Play with thresholds - show that changing thresholds doesn't change the results or investigate why it does

Key question for paper

- It has been shown in the paper in the paper on aging, for example, that 'In conclusion, we have shown that human brain functional networks, derived from a connectivity analysis of fMRI data acquired in a no-task state, have a non-random modular organization or community structure'
    - But, does this modular organization change over time, or remain the same? This is what we want to examine in our research

Frequency band investigation

- Each frequency band represents the correlation between frequencies at different wavelengths
- Question: for higher frequencies do we observe smaller or larger structures?
    - Look into the dispersion relation (our networks may not be a uniform space but still correlations at different frequencies)
    - One way to do this is as in Bassett et al. - optimise modularity (look at clusters - more or less clusters at higher frequencies?)

Classify subjects by their graphs

- Does the sex or age of subjects affect the results
    - a previous paper shows that young subjects have segregated brains, adults brains becomes less segregated, and then older subjects have segregated brains again (Meunier et al.)

Donnat et al. distance metric paper

- Could argue that 1 metric is better if it shows the correlation that you want it to show
    - e.g. if 1 metric highlights the most difference between the graphs of a young subject and an old subject, then it could be the most appropriate
- One approach would be to look at how distances change over time for period time x + t, then compare this with time x + 2t, x + 3t...x + 28t etc., then see if the correlation reduces as the time window increases (and does it die off fast or slow?)

Converting correlation matrix to adjacency matrix

- We want to convert dense correlation matrices to sparse adjacency matrices (e.g. this is done in the Donnat el al. for fMRI data) to extract the most important information
    - This is a common approach, as it is easier to work with metrics and more graph theory techniques are valid (e.g. modularity)
- Donnat et al. creates sparse adjacency matrices by choosing the 3% largest elements (i.e. those with the highest correlation)
- Other techniques include:
    - Converting negative correlations to 0 since negative correlations don't work with distance metrics (e.g.how would you define the shortest distance?)
    - Converting negative correlations to positive by taking their absolute value
    - Removing edges 1 at a time until a graph becomes disconnected (starting with the lowest correlation) as you do not want a disconnected graph
- Note that these approaches are quite crude and don't have much theoretical grounding - so this could be something to explore - does changing this thresholding affect the results?
    - Often in the appendix or near the back, papers will test a different thresholding method and show that the same results were produced so it didn't matter too much with threshold they used
- In order to compare graphs, we often have to ensure they are the same edge density (controlled by thresholding), otherwise, the difference in results may be due to the change in density
    - So keeping the density the same, what else is different?

In dissertation we have to address the weakness in methodology - for instance, thresholding is a weakness

Verifying the robustness of our reproduced results (leave for now)

- The method of the Karolina Finc paper is used on fMRI data - is it valid to use the methods on MEG data?
- Length of time windows used - each graph represents a short period of time (10 second time windows) rather than a point in time. If this period changes, does the results change? If so, our method is not robust
- We want to choose a period long enough to be able to estimate graph structure but not too large so we are still able to observe the evolution of the system
- Unfortunately, the data is pre-processed and this the time windows are specified so we cannot investigate this

Papers to read

https://pubmed.ncbi.nlm.nih.gov/19027073/
https://journals.plos.org/plosone/article/file?id=10.1371/journal.pone.0008694&type=printable
https://advances.sciencemag.org/content/6/4/eaav1478/tab-article-info