Advanced Topics in Human Neuroimaging

W6: Inter-Subject Correlation

Welcome to week 6! For this assignment, you'll be:

- Calculating three types of inter-subject correlation:
  - temporal ISC, using a pairwise and leave-one-out approach
  - dynamic ISC
  - spatial ISC
- Calculating intra-subject correlation
- Calculating inter-subject functional connectivity
- Relating inter-subject representational similarity patterns to behavior

You'll submit your data and code by creating and sharing a private GitHub repository rather than recording your responses on this sheet. Make sure to save all code and `variables` in your repository.

1. Create a private GitHub repository, psyc42350_isc_yourlastname.

Your repository should have two folders: /scripts and /data. Store all MATLAB code in /scripts and input and output .mat files in /data. Add Profs Rosenberg and Bainbridge (mdrosenberg@uchicago.edu and wilma@uchicago.edu) as collaborators. Work on writing clean, efficient, and commented code.

2. Generate toy fMRI and behavioral data.

Generate the following two variables:

`roi_data`, a 4-D (*n*,*r*,*t*,*s*) matrix, where
n = 20 subjects
r = 5 ROIs
t = 50 time points
s = 2 scan sessions per subject

`behavior`, a (1,*n*) vector of trait-level behavioral scores, 1 for each subject

3. Calculate three types of ISC: temporal, dynamic, and spatial.

To calculate temporal, dynamic, and spatial ISC, first get a mean time-series for each subject and each ROI (i.e., average ROI time-series within-subjects across sessions). Consider writing a function that you can use in all ISC analyses.

- **Temporal ISC:** Calculate temporal ISC in two ways: pairwise and leave-one-out. Think about the pros and cons of each approach for measuring ISC.

- ***Pairwise temporal ISC:*** Calculate the (*n*,*n*,*r*) matrix, `pairwise_temporal_ISC`, that includes the correlation between all pairs of subjects' fMRI time-series in every ROI.

- ***Leave-one-out temporal ISC:*** Calculate the (*n*,*r*) matrix, `loo_temporal_ISC`, as the correlation between each subject's mean fMRI time-series with the average time-series from all other subjects in every ROI. Think about why this matrix is 2D whereas `pairwise_temporal_ISC` is 3D.

- **Dynamic ISC:** Use the leave-one-out approach to calculate sliding-window dynamic ISC (window size *w* = 10, step size = 10). Calculate the (*n*,*r*,*w*) matrix, `loo_dynamic_ISC`, as the correlation between each subject's fMRI time-series with the average time-series from all other subjects in each ROI in each of the 5 time windows. Write code that plots that change in temporal ISC for the first subject and first ROI, and save the plot as a .pdf or image file (just not a .fig) in /data.

- **Spatial ISC:** Use the leave-one-out approach to calculate spatial ISC. For each subject, get a single value for each ROI by averaging the ROI data over time. Next, get a single value for each ROI by averaging the ROI data from *all other subjects* over time. Finally, calculate the (*n*,*1*) matrix, `loo_spatial_ISC`, as the correlation between each subject's spatial pattern of activity across the 5 ROIs with the mean spatial pattern from all other subjects.

4. Calculate intra-subject correlation.

For each subject and ROI, calculate the intra-subject ISC from `roi_data` and store in an (*n*,*r*) matrix, `intrasubject_temporal_ISC`. This matrix will tell you, for each ROI, how correlated a subject's session 1 time-series is with their session 2 time-series.

5. Calculate inter-subject functional connectivity.

Again get the average time-series for each subject and each ROI across sessions. Calculate the (*n*,*r*,*r*) inter-subject functional connectivity matrix, `loo_ISFC`, as the correlation between each subject's mean fMRI time-series in every ROI with the mean fMRI time-series in every ROI from all other subjects. (Hint: This is an extension of leave-one-out temporal ISC.)

6. Relate inter-subject representational similarity patterns to behavior

Revisit your (*n*,*n*,*r*) matrix `pairwise_temporal_ISC`. Create a (*n*,*n*) matrix, `behavioral_similarity`, of similarity between all pairs of subjects' behavioral scores. In your code, write a comment explaining how you calculated similarity and what hypothesis you're testing with your chosen operationalization of similarity. Relate `pairwise_temporal_ISC` to `behavioral_similarity` in each ROI. Do the results in any ROI suggest that ISC is driven by behavioral similarity in the way you hypothesized?