

Functional Connectivity between Premotor and Motor Cortex

Diya Basrai, data from Miri Lab

Background

- Premotor cortex (PMC) and motor cortex (M1) are found to be major cortical areas associated with movement
- Older experiments found evidence pointing to a functional hierarchy, with PMC driving M1 activity, but recent experiments have complicated this story.
- Recent advances now allow simultaneous recordings of hundreds of neurons during complex tasks, allowing interrogation of whether this functional hierarchy exists.

Data Collection

- Mice perform a head-fixed climbing task, while Neuropixel probes record hundreds of neurons in RFA and CFA, mouse homologues of PMC and M1 respectively.

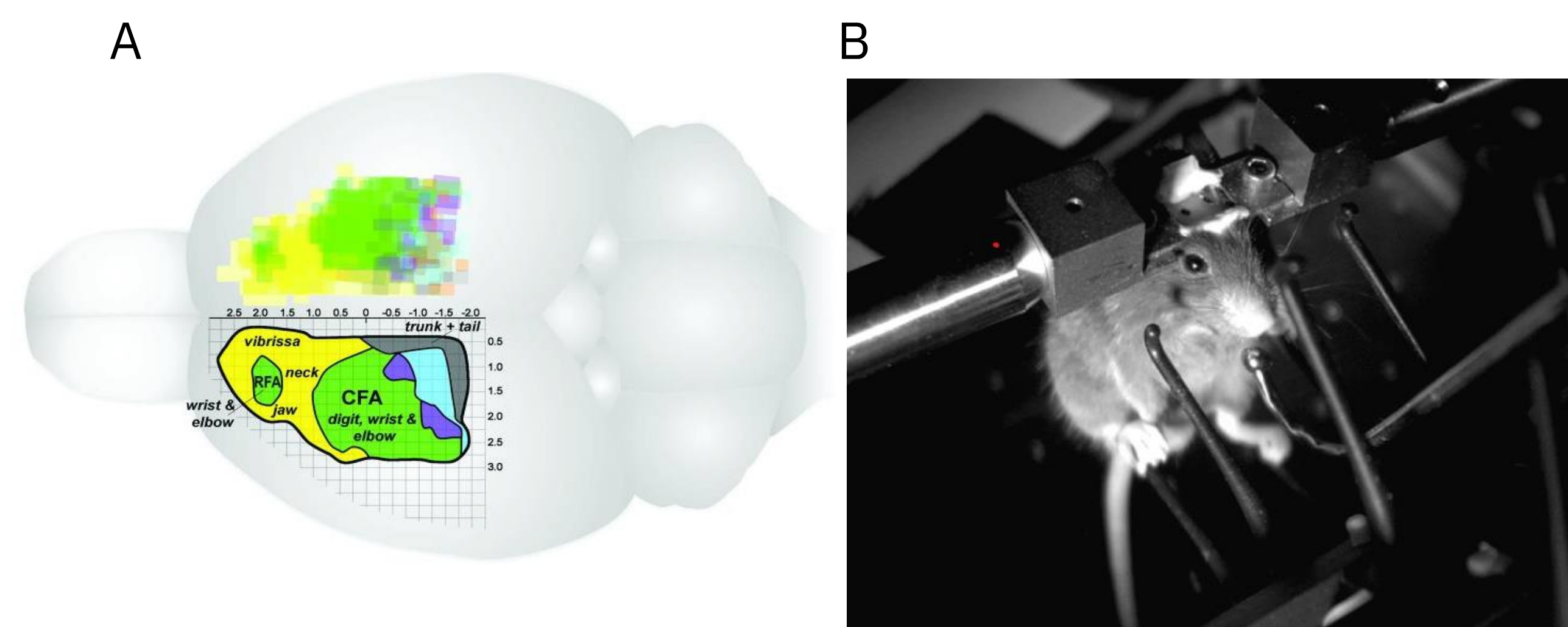


Figure 1. A) Locations of RFA (PMC) and CFA (M1) in mouse brain. B) Image of mouse performed climbing task

Measuring Functional Connectivity

- Extended transfer entropy (TE) is used to see if activity in one region drives activity in another region after a time delay

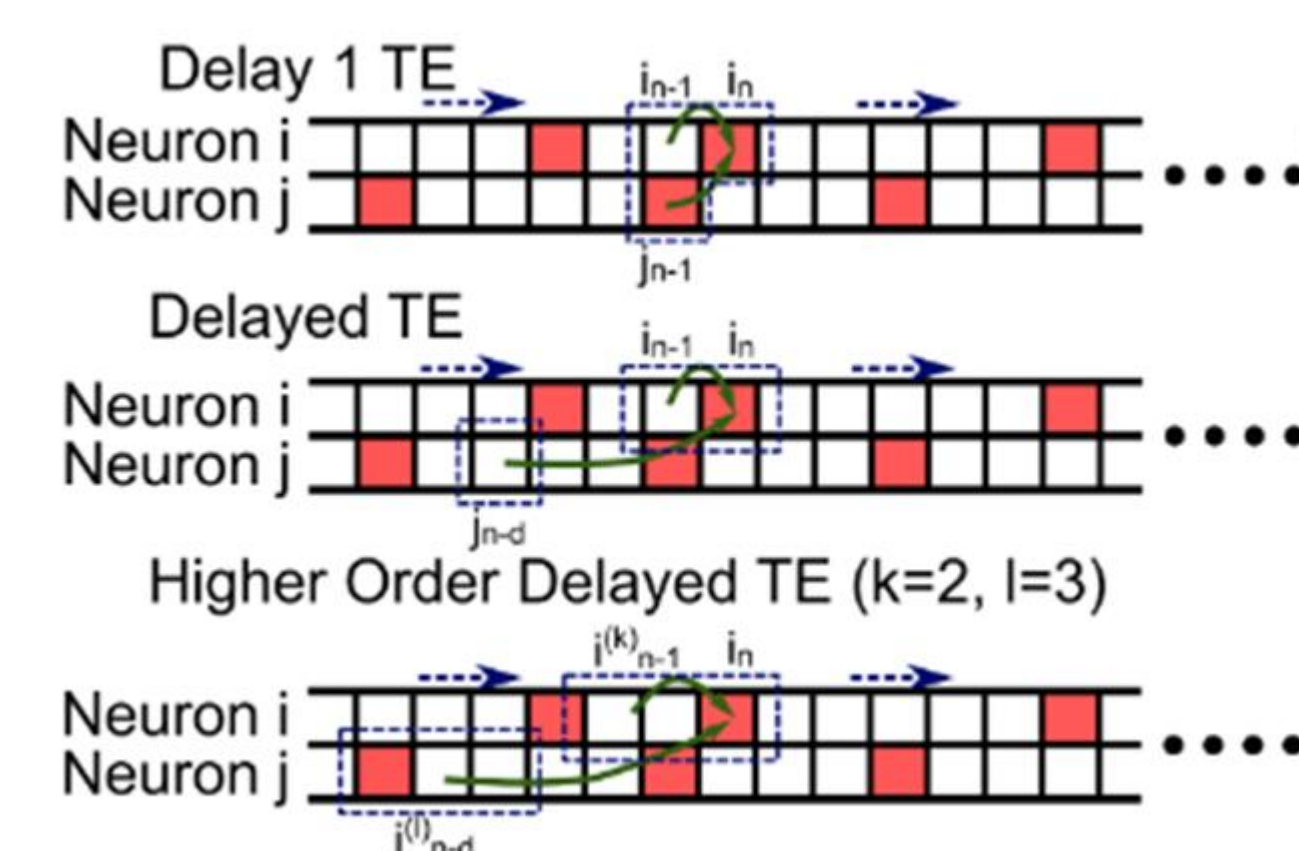


Figure 2. Schematic of using transfer entropy on spike trains between pairs of neurons

Functional Connectivity Between RFA and CFA

- TE values are calculated for each pair of neurons between CFA and RFA, at an optimized message length and time delay. These are then compared to circular permutations of the same pair to test significance.
- Large number of statistically significant functional connectivities are found both from RFA->CFA and CFA->RFA

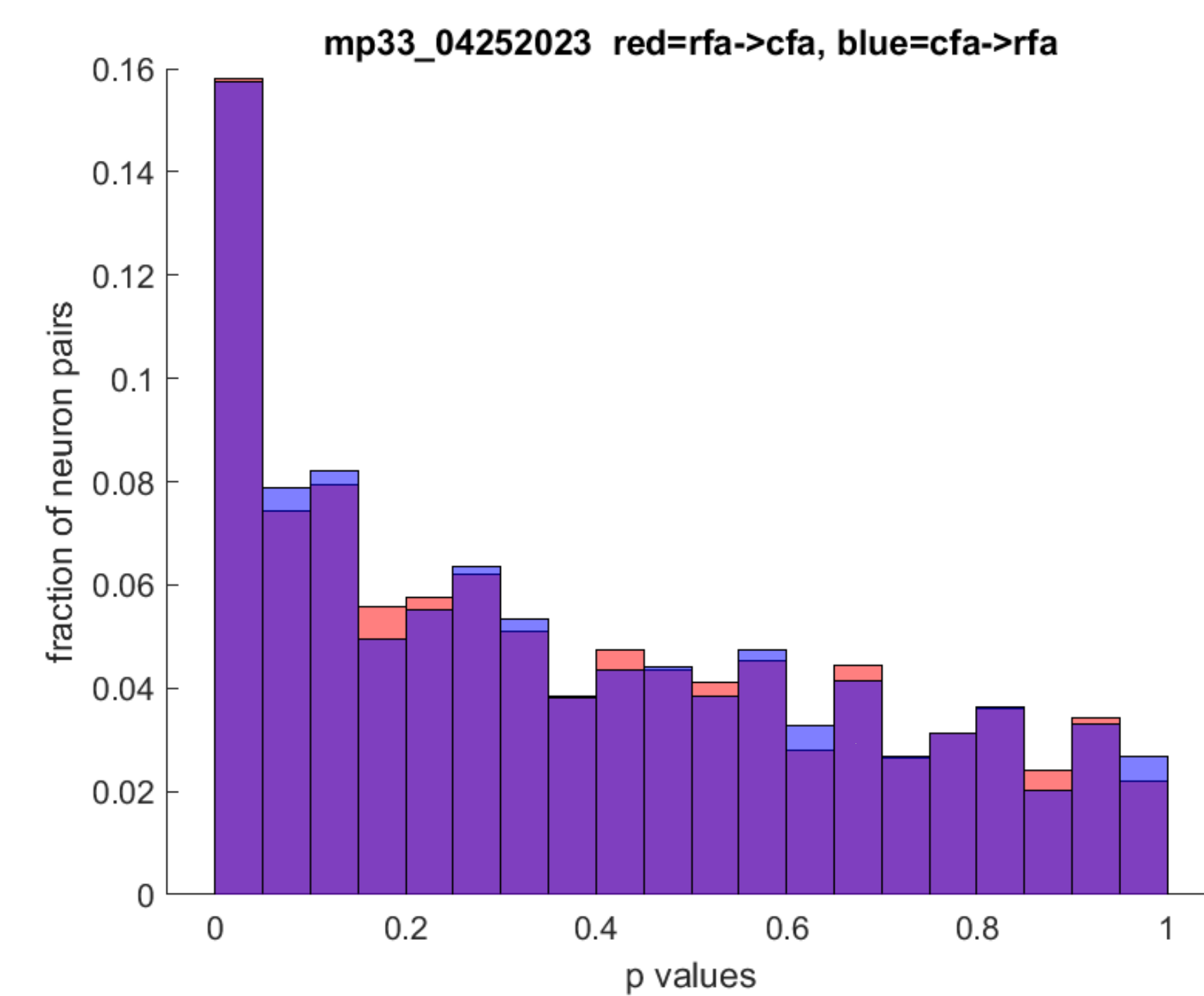


Figure 3. P-values from RFA->CFA and CFA->RFA are overlaid on top of each other. The large number of overlapping purple on the leftmost bin ($p < 0.05$) indicates a high number of statistically significant bidirectional functional connectivities.

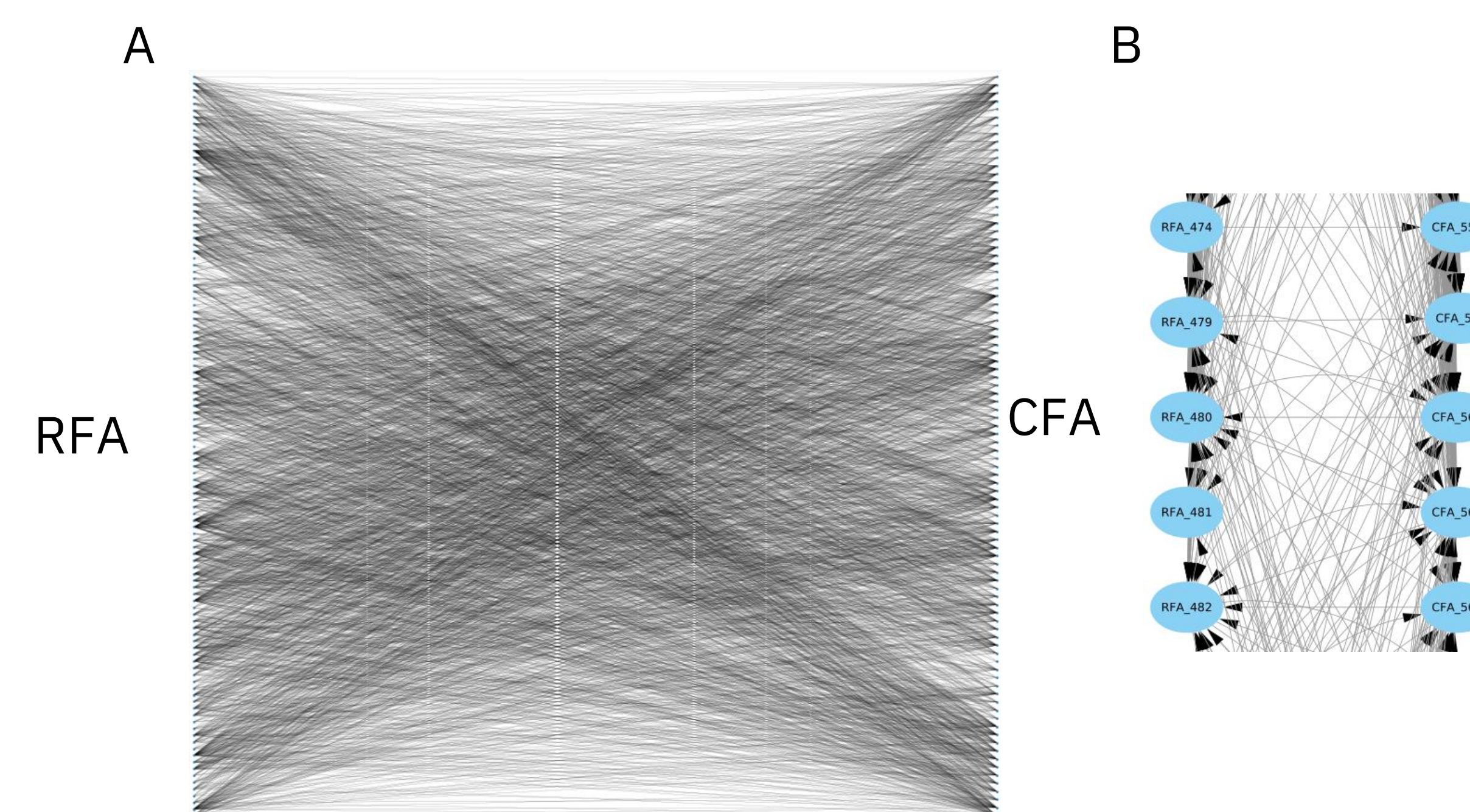


Figure 4. A) Visualization of bidirectional connections between RFA and CFA as bipartite graph. B) Zoomed in version on 5 neurons.

Degree Distributions

- Degree distributions between CFA and RFA are similar, although CFA has a slight skew for higher degree nodes.
- Pk and K are linearly correlated

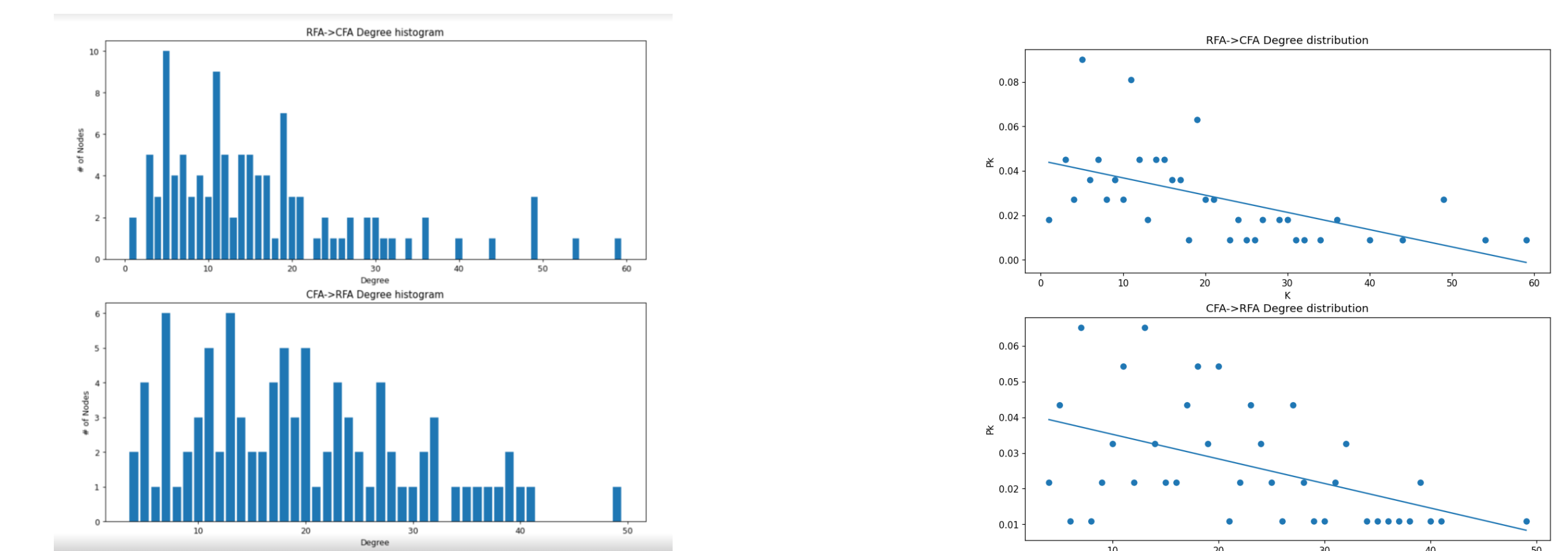


Figure 5. Degree distributions of RFA->CFA and CFA->RFA

Projecting Functional Connectivity Onto Individual Regions

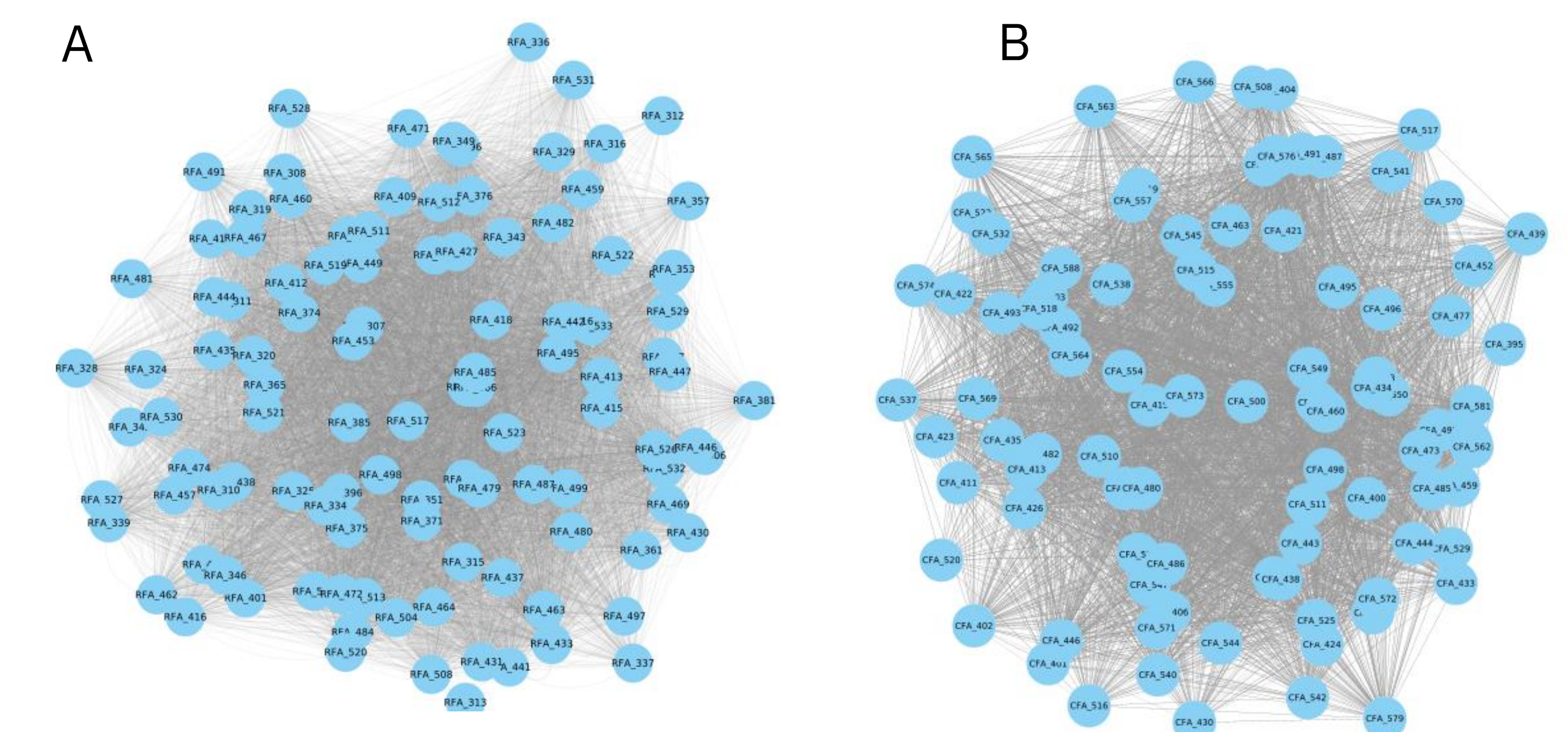


Figure 6. A) Projection of bipartite network onto RFA. B) Projection onto CFA

Conclusions

- 1) RFA and CFA have bidirectional functional connectivity... and they are extremely interconnected!
- 2) Their degree distributions are mostly similar, although CFA->RFA seems to have a slight skew for higher degree nodes
- 3) Further investigation using network theory on graphlets can be done to gauge direct vs indirect connections.