

Outcome of Interest

The primary objective of this project is to elucidate causal mechanisms in functional connectivity that differentiate ASD from neurotypical individuals. The focus is on identifying key regions with altered causal roles, particularly within networks implicated in socio-emotional processing, such as the amygdala, medial prefrontal cortex (mPFC), anterior insula, and anterior cingulate cortex (ACC).

Data

I am going to use the fMRI dataset that contains fMRI brain scan results from 27 individuals aged 19-40 (14 ASD, 13 controls), with 160 regions of interest (ROIs) derived from the Dosenbach 160 parcellation. Preprocessing via the NIAK pipeline includes motion artifact removal and standardization. Diagnostic information is also provided.

Methods

1. Graphical Model Construction

For causal discovery, I will use the Fast Greedy Equivalence Search (FGES) algorithm to construct causal graphs from fMRI time series data. FGES identifies directed edges that reflect potential causal influences and provides a framework for understanding functional interactions between brain regions.

As an alternative, I will also implement Bayesian network structure learning, focusing on constraint-based algorithm and compare the outputs to FGES results.

2. Validation

I will conduct functional connectivity analysis based on Pearson correlations to compare overall connectivity patterns between ROIs. While not causal, this analysis provides complementary insights into group differences in connectivity strength. Causal graph metrics such as edge density, hub centrality, and modularity will be evaluated to identify differences in network topology between groups.

3. Statistical Analysis

- a. Perform sensitivity analyses adjusting for potential confounders (e.g., age, head motion) using regression models
- b. I am also planning to perform bootstrapping to estimate the stability of edges in the discovered graphs

4. Implementation and Software

FGES, Bayesian network structure learning, and all the data handling, analysis and visualization will be done by R.

Expected Outcome

This analysis is expected to reveal distinct causal connectivity profiles in ASD, with alterations in socio-emotional and executive networks. Such findings could advance the understanding of ASD pathophysiology and inform future interventions targeting network-level dysfunction. By combining data-driven and hypothesis-driven approaches, the study aims to establish robust insights into causal mechanisms.