Write-up on some network construction results (May11)

Contents

1 Data and Methods

957 subjects, 68 brain regions, 2278 pairs of regions.

Structural connectomic data

* multiple subjects share the same pattern (a cluster of values close to 0, existence of extreme large values)

* densely connected, all subjects have more than 50% pairs with a nonzero value

Structural connectivity network

Procedure 1. sum over all 957 connectomic data first and perform thresholding/sign test

Procedure 2. threshold/test on each subject first and get 957 subject-level networks, then sum over and find patterns in edge selection

Methods: global thresholding, local thresholding, binomial sign test. All 957 subjects are used.

Functional time series data

* 4 sessions, 1200 time points

* apply methods on 1200 time points and 200 time points (1 in every 6 time points to account for autocorrelation)

Functional connectivity network

Procedure 1. correlation-based methods: for every subject in every session, construct networks by selecting regions with 136 greatest correlations (so every subject has 4 networks). For every subject, count how many edges are selected $0, 1, 2, 3, 4$ times in 4 sessions and make a boxplot. Sum over all subjects' edge selection and plot the aggregated matrix (entries representing proportions).

Procedure 2. correlation-based methods: for every subject in every session, construct networks by selecting regions with p-values (obtained from fisher transformation) lower than 0.05 (multiple comparison corrected, so select p-values below 0.05/2278). For every subject, count how many edges are selected $0, 1, 2, 3, 4$ times in 4 sessions and make a boxplot. Sum over all subjects' edge selection and plot the aggregated matrix (entries representing proportions).

Procedure 3. glasso: for every subject in every session, construct networks by selecting regions with 136 greatest correlations. For every subject, count how many edges are selected $0, 1, 2, 3, 4$ times in 4 sessions and make a boxplot. Sum over all subjects' edge selection and plot the aggregated matrix (entries representing proportions).

Methods: marginal correlation, partial correlation, first-order partial correlation, graphical lasso

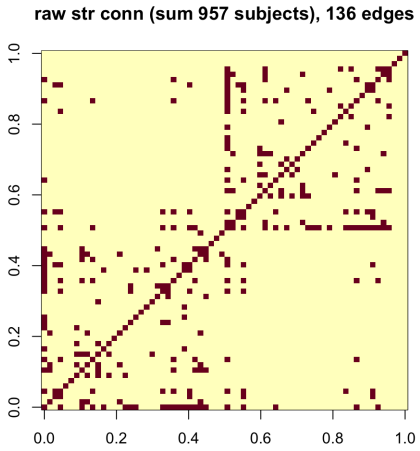
Due to computational complexity, 300 subjects are currently used.

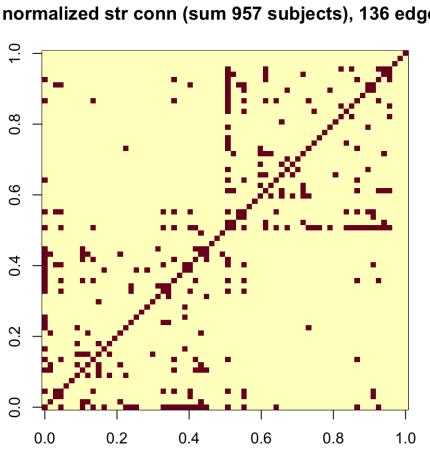
2 Structural connectivity

2.1 Global thresholding

sum → thresholding

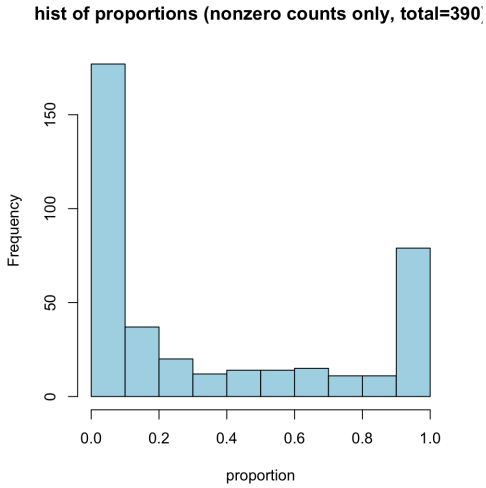
Sum over all 957 subjects and preserve 136 edges. Both have 12 regions unconnected with any other region. Differing by 2 edges (Hamming distance=2).

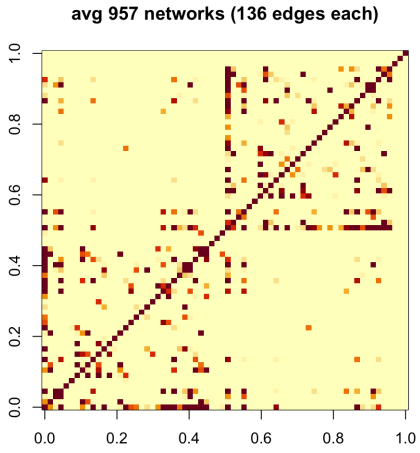




thresholding → aggregate (calculate each edge's occurrence%)

Threshold each subject first (keeping 136 edges each) and sum over the 957 networks.

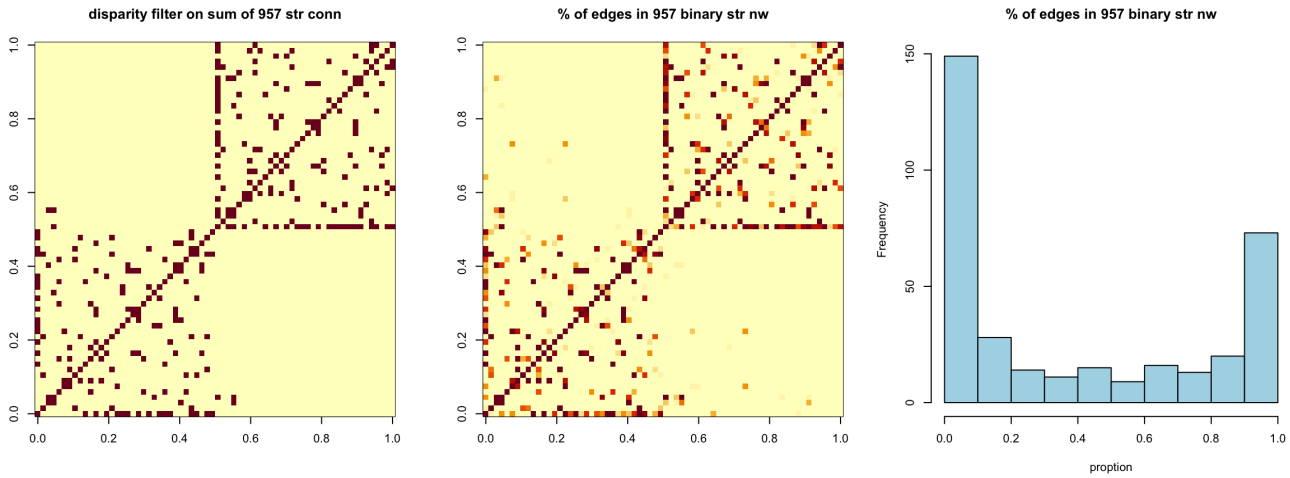




2.2 Local thresholding - disparity filter

Leftmost: sum connectomic data first, and perform thresholding on the aggregated data matrix.

Middle and rightmost: perform thresholding on each subject's matrix first, and sum over 957 networks, showing proportions of edge selection.

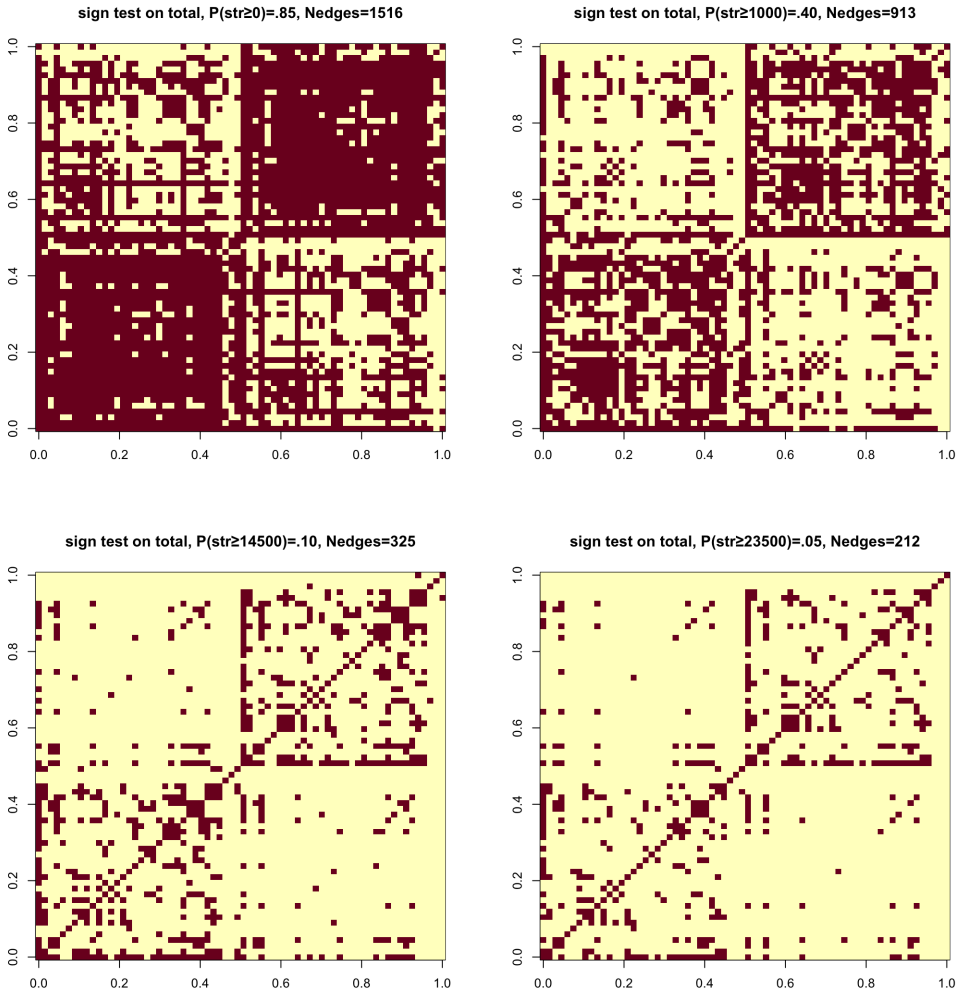


2.3 Sign test

Test on sum of raw connectomic data matrices

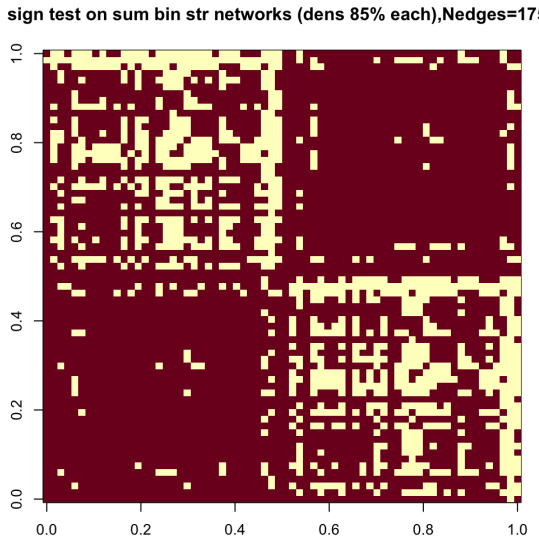
Among 957 subjects, if binarize each subject's structural connectivity at threshold= 0, the mean and median network density is approximately 0.85. Following this idea, the table summarizes different thresholds and corresponding mean and median network density among all subjects.

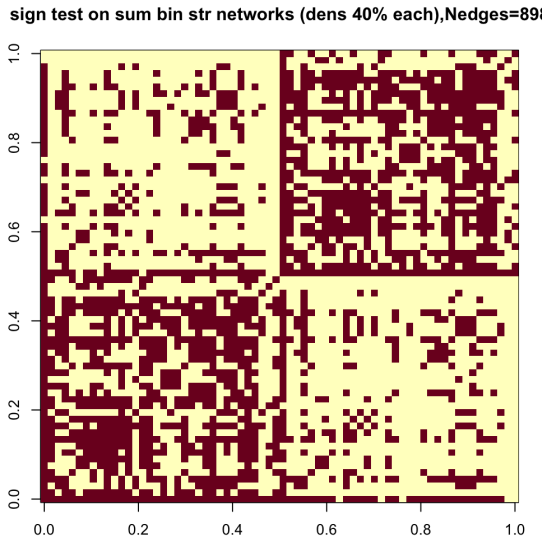
Threshold for binarized network	Mean density	Median density
0	0.8494	0.8462
1000	0.4034	0.4027
14500	0.1005	0.1013
23500	0.0496	0.0517

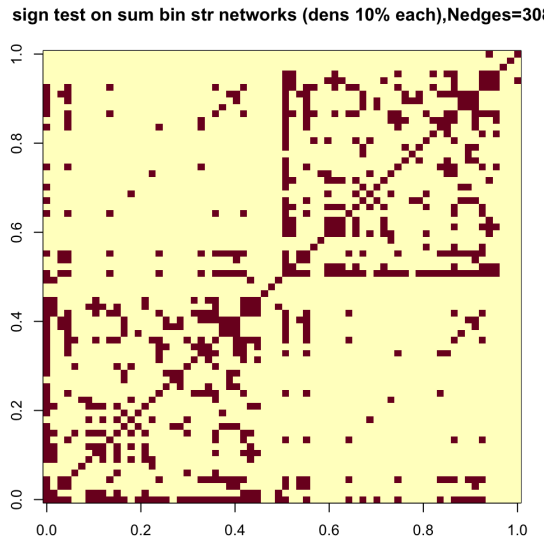


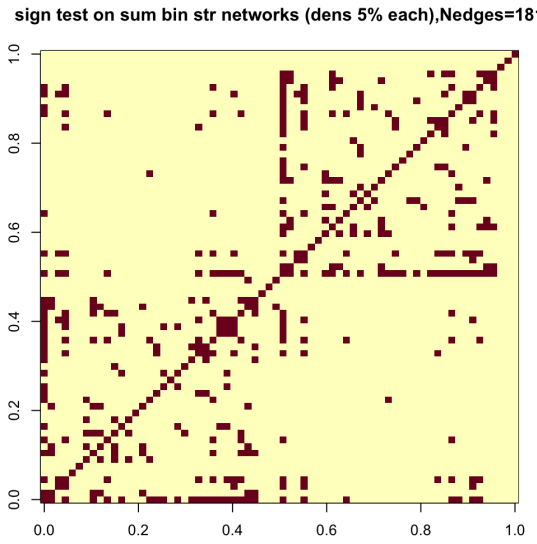
Test on sum of binarized networks

Fix a network density for every subject first. Then sum over the 957 binarized networks and perform a sign test, with the probability being the network density.







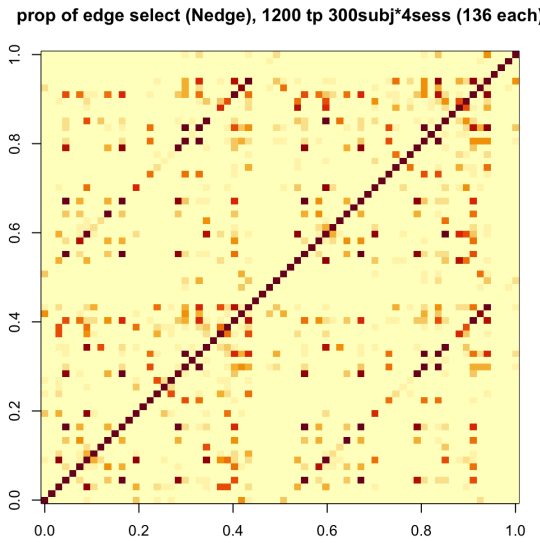


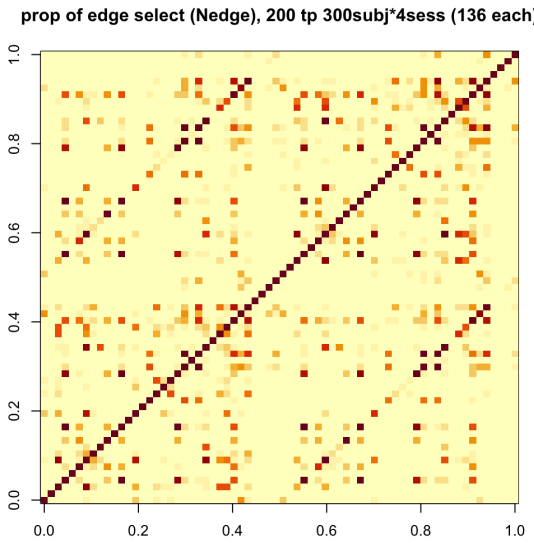
3 Functional connectivity

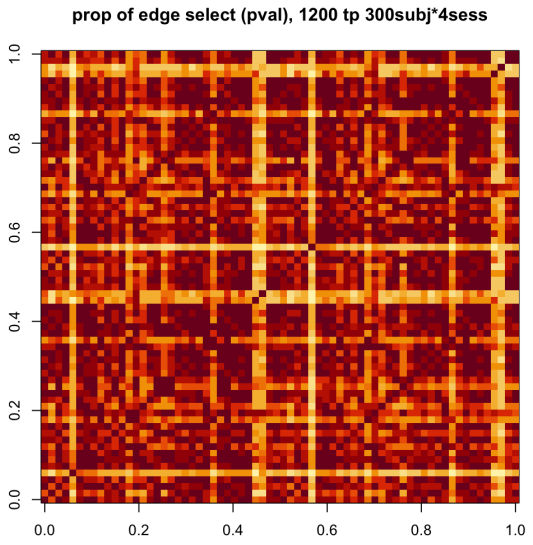
3.1 Marginal correlation-based network

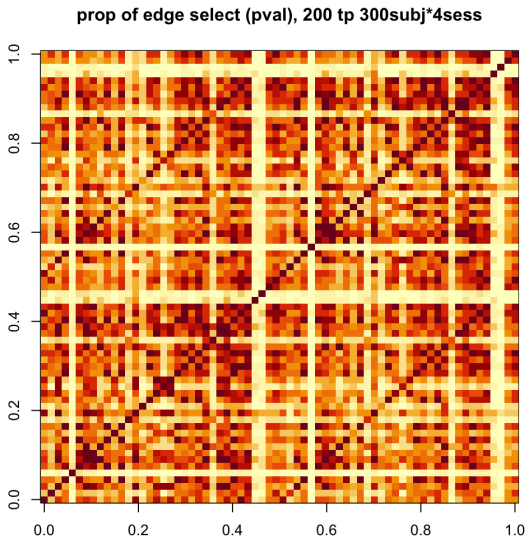
Network construction based on density (number of edges): for every subject and every fMRI session, select region pairs corresponding to 136 correlations largest in magnitude.

Network construction based on significance of p-value: for every subject and every fMRI session, select all region pairs corresponding to p-value lower than 0.05/2278.





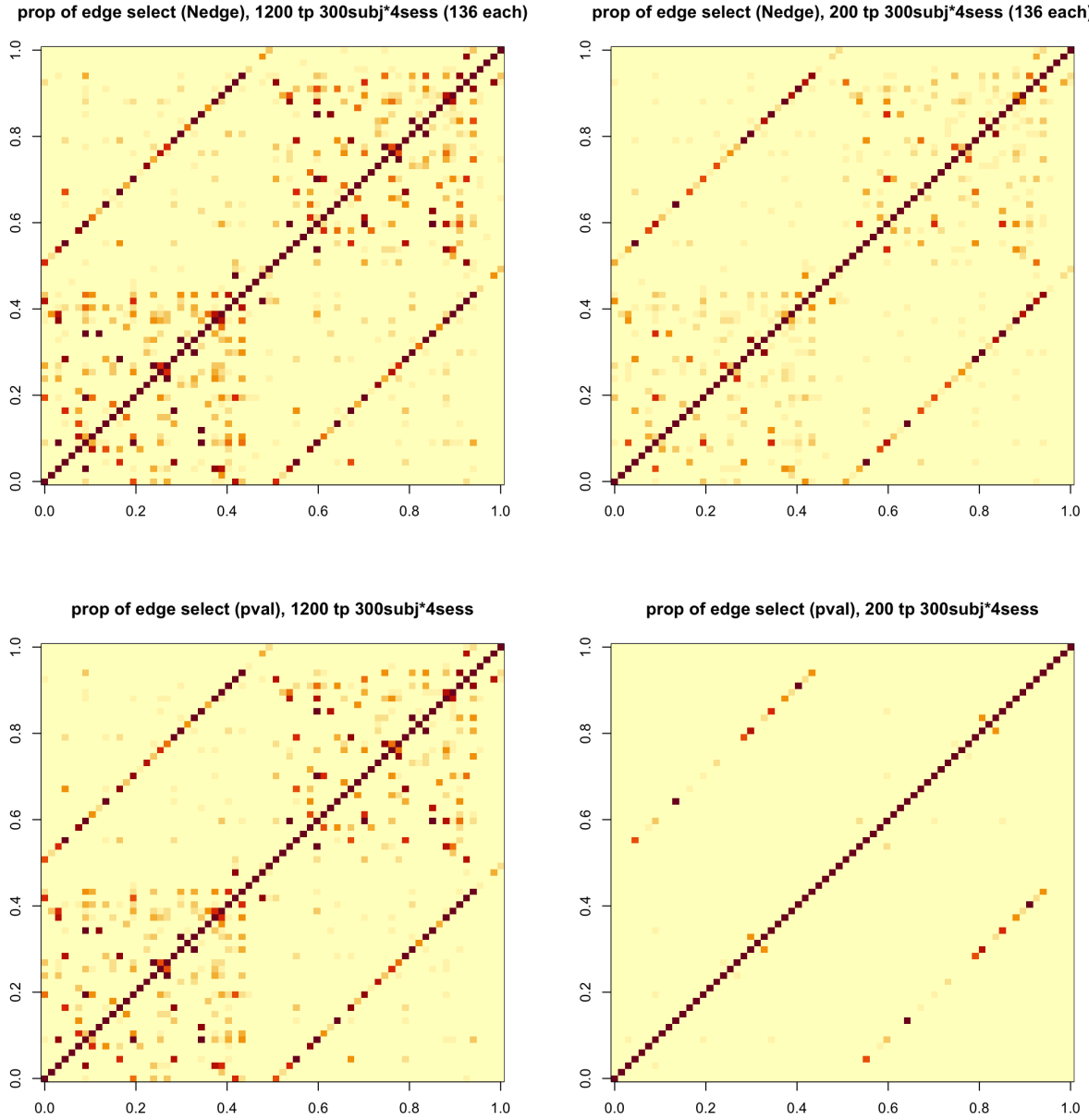




3.2 Partial correlation-based network

Network construction based on density (number of edges): for every subject and every fMRI session, select region pairs corresponding to 136 correlations largest in magnitude.

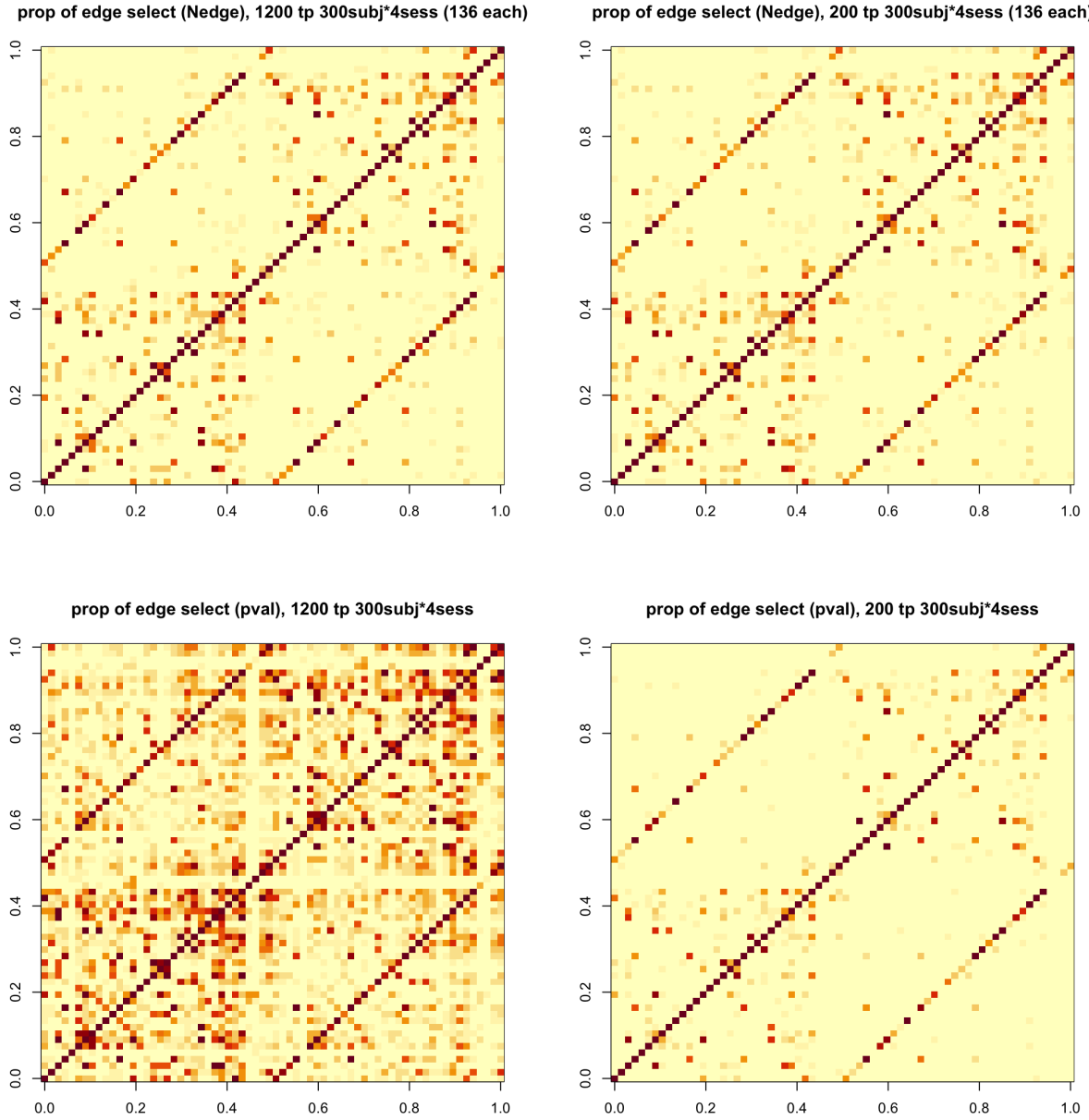
Network construction based on significance of p-value: for every subject and every fMRI session, select all region pairs corresponding to p-value lower than 0.05/2278.



3.3 Low-order correlation-based network

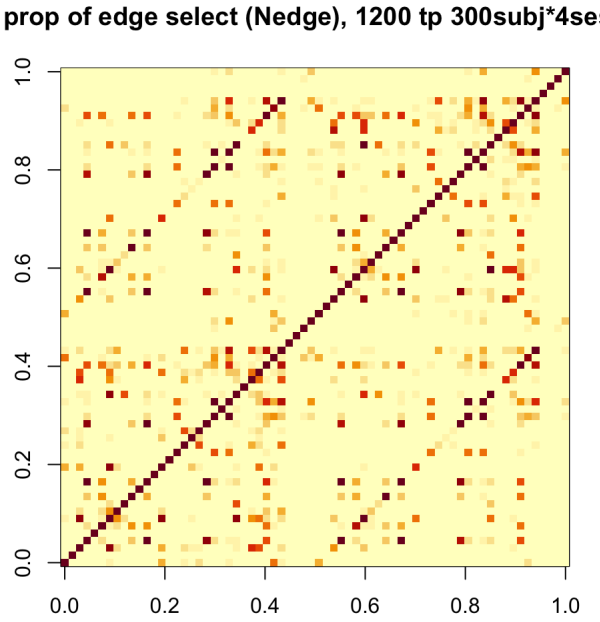
Network construction based on density (number of edges): for every subject and every fMRI session, select region pairs corresponding to 136 correlations largest in magnitude.

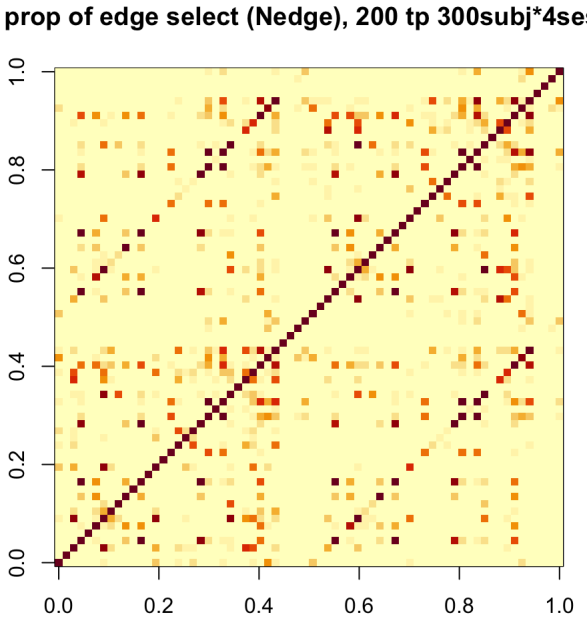
Network construction based on significance of p-value: for every subject and every fMRI session, select all region pairs corresponding to p-value lower than 0.05/2278.



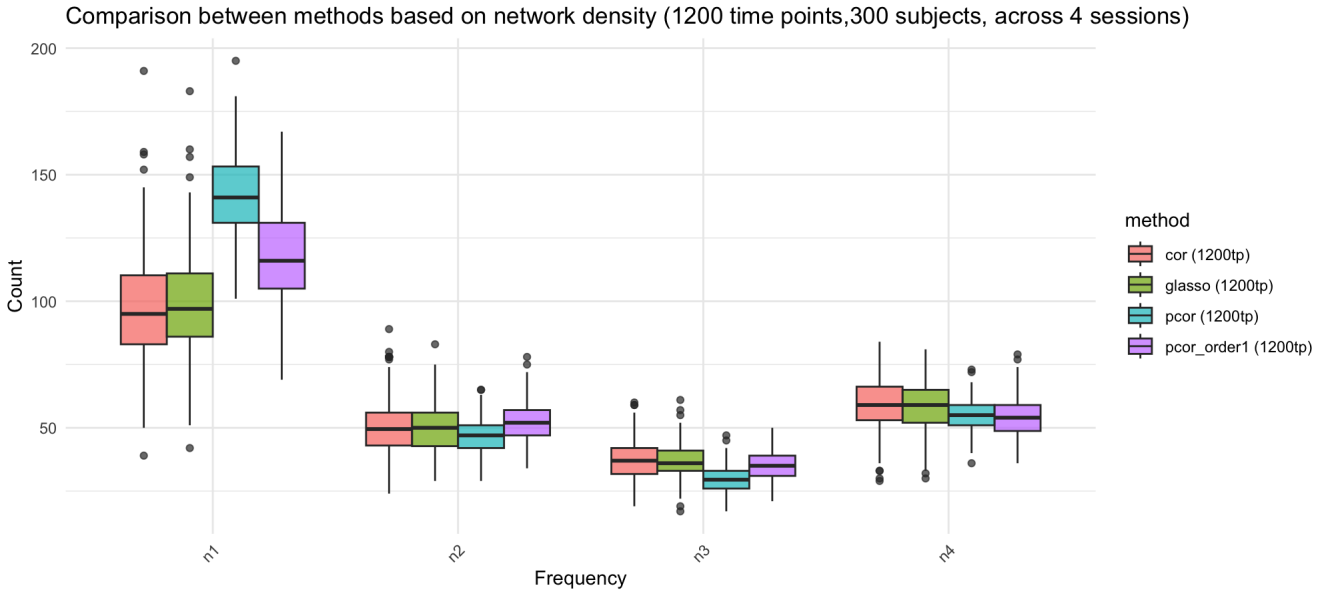
3.4 Glasso-based network

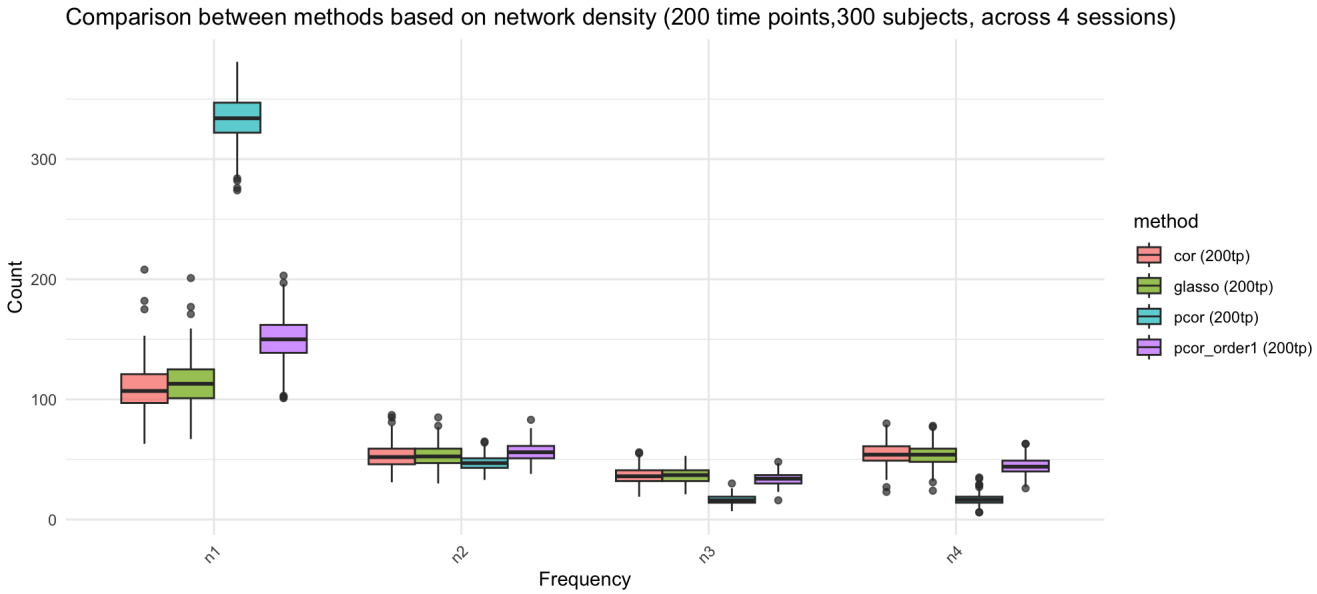
Network construction based on density (number of edges): for every subject and every fMRI session, fit glasso and leave exactly 136 entries corresponding to nonzero entries in the inverse of correlation matrix.

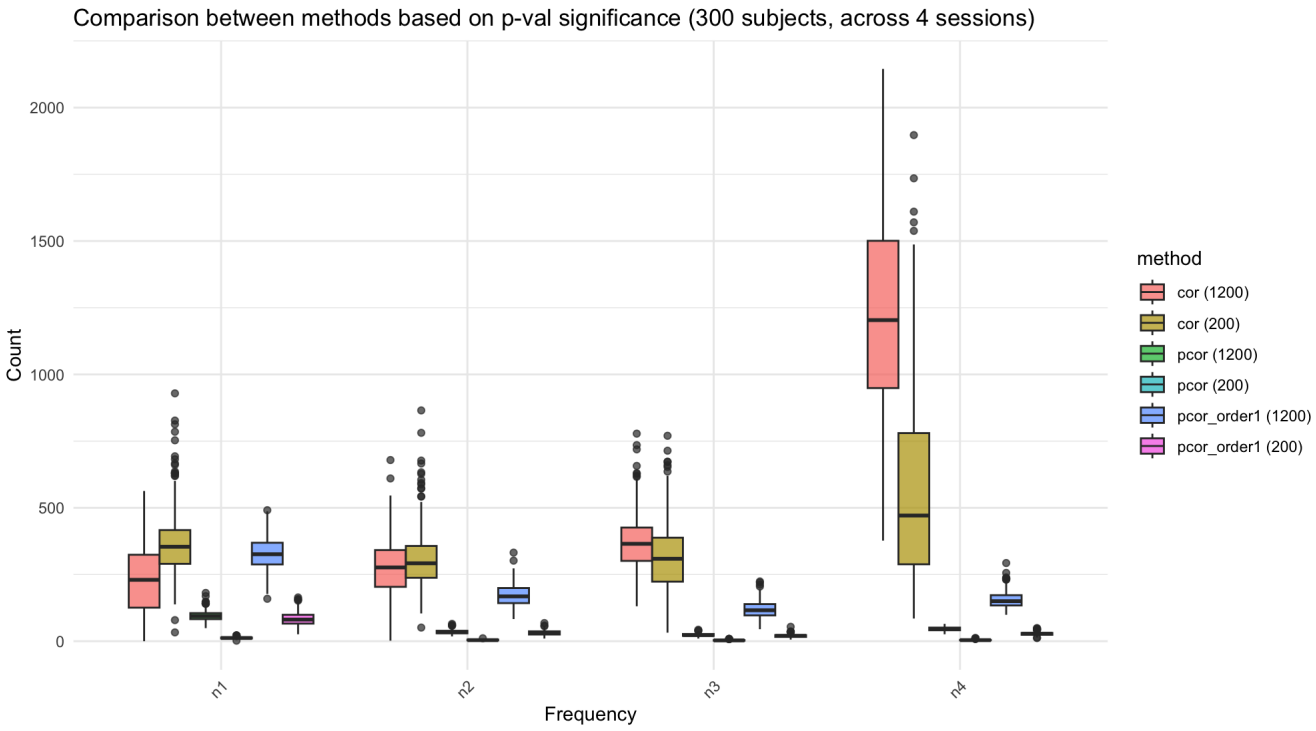




3.5 Comparison






Comparison between methods based on p-val significance (300 subjects, across 4 sessions)
Count
2000
1500
1000
500
0
n1
n2
n3
n4
Frequency
method
cor (1200)
cor (200)
pcor (1200)
pcor (200)
pcor_order1 (1200)
pcor_order1 (200)