EN.580.694: Statistical Connectomics
Final Project Proposal

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Effects of Spatial Resolution on Accurate Determination of Graph Connectivitiy

Opportunity The ability to measure individual connectomes holds great promise in advancing our knowledge of the brain and consciousness. Despite these promises, current technology and state of knowledge prevents us from rescaling this measurement process into a computational problem that can be solved within a reasonable time with finite resources. The complexity of the problem inevitably poses a challenge both in validation of data and establishment of a consensus dataset. This proposal posits that one factor that may contribute to these challenges is the spatial resolution at which the data is obtained.

Challenge There are no obvious technological or experimental challenges that have prevented a study of the form proposed here from being pursued in the past.

Action In this study, a true neuron connectivity network will be generated using a stochastic block model. The neurons will be assumed to be in a 2-dimensional grid where each pixel will represent a neuron. In one limiting case, contiguous pixels will be assigned one block, while in another limiting case, each pixel will be assigned randomly to a block. These limiting cases will represent the extremes of what would assumed to be observed physiologically. The former case represents the homogeneous case where all neighboring neurons belong to the same block while the latter represents the heterogeneous case where no two neighboring neurons belong to the same block. Once the true network is generated, the network will be coarsened by combining the connectivity of neighboring neurons to form one aggregate neuron. Analysis will be performed on this coarsened data to determine the parameters of the model and their deviations from the true value.

Resolution It is predicted that the homogeneous case will experience minimal detriment from coarsening while the heterogeneous case will experience significant detriment. Since physiological conditions fall somewhere between these two limting cases, it is expected that deviations from the true connectome will depend both on the spatial resolution of the measurement and the brain region of interest.

Future Work Future work will include further development of the model onto a 3-dimensional grid which would be more experimentally and clinically relevant.

Statistical Decision Theoretic

Sample Space $\mathscr{G} = (V, E, B)^{N\times N}$ where V is the presence of a vertex, E is the presence of an edge, and B is the block to which it belongs.

Model The model is given by the stochastic block model:
$\{\mathrm{SBM}_N^k(\rho, \beta) : \rho \in \Delta_k,\ \beta \in (0,1)^{k\times k}\}$

Action Action space will consist of the possible parameters of the stochastic block model.

Decision Rule Class k-means clustering will be used to identify the identity of a neuron to a particular block.

Loss Function Likelihood or sum of squares will be used as loss function.

Risk The risk will be defined as the expectation of the loss.