EN.580.694: Statistical Connectomics
Final Project Proposal

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Testing the properties of converging excitatory neurons in mouse visual cortex

Opportunity Bock et al. 2011 *Nature* serially reconstructed electron microscopy data combined with two photon data gives us a partial wiring diagram of neurons in V1 and their corresponding preferred stimulus orientation. We would like to know what factors govern the probability that two excitatory neurons will converge onto an inhibitory neuron

Challenge Models like the SBM cannot characterize relationships between three nodes. Thus, were we to construct a graph as Bock et al. did where the nodes are neurons and the edges are synapses, we have a poor model for understanding the properties of convergent input.

Action I will redefine the graph such that nodes are excitatory neurons and an edge between neurons exists when the excitatory neurons converge onto the same inhibitory neuron.

Resolution By redefining the graph as described above, I can use SBM to divide the nodes (excitatory neurons) according to 1) orientation selectivity and 2) geometry. These will be two different SBMs. The blocks of the SBM represent the probability of an edge (convergence) between neurons of different orientation selectivities and locations in space.

Future Work Test the above on a larger sample.

Statistical Decision Theoretic

The proposed statistical decision theoretic addresses the question of how excitatory neurons in mouse V1 selectively converge onto inhibitory neurons. It does this by evaluating two SBMs, one where ρ is based on preferred stimulus orientation and one where ρ is based on location in space.

Sample Space The sample space is given as $\Omega = \mathcal{X} \times \mathcal{Y}$ where $\mathcal{X} = (0,1)^{n \times n}$ is the adjacency matrix describing the presence or absence of convergent input between two excitatory neurons and $\mathcal{Y}$ describes the properties of the excitatory neuron including preferred stimulus orientation and location in space. $\Omega \subseteq \mathcal{G}_n$

Model $\{SBM_N^k(\rho, \beta) : \rho \in \Delta_k \ \beta \in (0,1)^{k \times k}\}$ such that ρ is the probability of an excitatory neuron (node) having a given preferred orientation and β is the probability of an edge between nodes from different blocks of preferred orientation (convergent input).

Similarly, we'll define another SBM where this time ρ is the probability of an excitatory neuron (node) occupying a particular region of space.

Action Space $\mathcal{A} = \{0, 1\}$: fail or reject the null hypothesis, where the null hypothesis is that the probability of an edge between nodes in different blocks is the same between blocks? Need help formulating the null hypothesis.

Decision Rule Class $\mathbb{T}\{t(D) \subset CR\}$ for t test statistic, D data, CR critical region, $\mathbb{T}$ truth function.

Loss Function $l : \mathcal{A} \times \mathcal{A} \to \mathbb{R}_+$

Risk Function $E(l)$

I apologize that this is such a rough draft and this project may change as I work on it more. Thank you.