EN.580.694: Statistical Connectomics
Final Project Proposal

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Including non-neuronal cell types in a neural network graph: a model comparison

Opportunity It has been argued that other cell types in the central nervous system, apart from neurons and their different subtypes, are also organized in networks, communicate with each other with biochemicals just as neurons interact via neurotransmitters and should therefore be included in the models of biological neural networks [1].

Challenge However, it remains unclear what is the best way to include them in models of neuron graphs: a) as new nodes with different node and/or edge attributes, or b) as a network of their own that interacts with the main neuron graph (two interdependent networks).

Action A set of complex networks is said to be interdependent if there exist dependency links between them; that is, if one of the edges connecting one network to the other fails, the node depending on this edge will fail even if it remains connected and undisturbed within it's own network. One main difference between an independent network and a set of interdependent networks is their robustness against targeted attack, where certain nodes are removed from the network and the degree of failure is measured. Stochastic blockmodeling (SBM) is a network model that define nodes to be structurally equivalent if and only if their connectivity with similar nodes is similar. It is useful for gaining insight into the structure of a complex network and possibly identifying hubs and communities [3]. Here, propose constructing the two topologies described above (models a and b) using the data of neurons and glial cells connections in C. elegans, available at the WormAtlas.[2]. We will apply a SBM to each of models and compare their fit. Additionally, we propose carrying out random attack on both models and compare their robustness to failure, in order to determine whether the model corresponds to that of an independent network or to a set of interdependent networks.

Resolution We will have a comparison of the modeling options for including new cell types in a neural network graph, and thus provide a guide for choosing the model that best approaches the interaction of these cell types with neurons.

Future Work One likely difficulty of this project will carrying out the targeted attack experiments.

Statistical Decision Theoretic

Two models are going to be constructed:

Model A a single multivariate graph/network with both the neurons and glial cells as nodes. It will allow node attributes and varying edge weights to account for the difference between neuron-neuron, neuron-glia and glia-glia connections

Model B two separate networks. A neuron network comprising 302 nodes and a glial network of 50 nodes. The model will allow for dependency links between networks.

References

[1] Giaume, Christian; Koulakoff, Annette; Roux, Lisa; Holcman, David; Rouach, Nathalie: Astroglial networks: a step further in neuroglial and gliovascular interactions. Nature reviews. Neuroscience (2010).

[2] Altun, Z.F. and Hall, D.H. 2015. Handbook of C. elegans Anatomy. In WormAtlas. http://www.wormatlas.org/hermaphrodite/hermaphroditehomepage.htm

[3] Goldenberg, Anna; Zheng, Alice; Fienberg, Stephen E; Airoldi, Edoardo M. A Survey of Statistical Network Models; arXiv : 0912 . 5410v1 [stat . ME] 29 Dec 2009

[4] Danziger, Michael M.; Bashan, Amir; Berezin, Yehiel;Shekhtman, Louis M.;Havlin, Shlomo: An Introduction to Interdependent Networks; Nonlinear Dynamics of Electronic Systems (2014)