CSE 40171: Artificial Intelligence



Artificial Neural Networks with Anatomical Fidelity: Networks of the Brain

Homework #5 has been released. It is due **tonight** at 11:59PM.

Project Updates are Due on 11/25 at 11:59PM

(See Course Website for Instructions)

Network encoding a stimulus



Tang et al. eLife 2018

Networks of the brain

- Networks found in the brain are **non-random** in structure
- Structural modules are interlinked by hub vertices and arranged hierarchically
- Tradeoff between conserving connections and metabolic cost
- Networks promote efficiency of information flow and neural processing

How do we go from an observed network of cells to a mathematical representation?

Network Measures

Vertex Degree



Clustering Coefficient



Centrality



Path Length and Distance



Community Structure: Modules and Hubs



Network Models













Connectivity Matrices

A Human Connectome (diffusion MRI tractography)



Network Topology of a Cortical Canonical Circuit





Network Diagram of mesoscale Drosophila connectome



Network Diagram of mesoscale Drosophila connectome



Are all neurons the same?

Excitatory Cells



Inhibitory Cells



Changes in membrane potential



Micro Network Motifs

- A. Feedforward excitation
- **B.** Feedforward inhibition
- E. Feedback/Recurrent inhibition F. Feedback/Recurrent excitation
- Excitation Inhibition



D. Lateral inhibition



C. Convergence/divergence E2





Considerations Related to Scale

- Connectivity can be expressed at different levels of measurement
- Different levels can tell us different things about the brain
- Sometimes circuit reconstruction is constrained by the type of imaging performed
- High resolution imaging techniques do not currently scale to entire brains
 - Even when we can image an entire brain, the automatic reconstruction is still a problem

Subcellular Scale



Cellular Scale



Regional Scale

