Systems Neuroscience
CISC 3250

The Big Picture

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JMH 332

The questions of systems and computational neuroscience

- How groups of neurons work together to achieve intelligence

- How the nervous system performs computations

- How to visual and analyze neural/cortical data

Computational neuroscience as "theory of the brain"

David Marr's three levels of analysis (1982):

- **Computational theory:** What is the computational goal and the strategy to achieve it?
- **Representation and algorithm:** What are the input and output for the computation, and how do you mathematically convert input to output?
- **Hardware implementation:** How do the physical components perform the computation?

Theory -> Algorithms

Big Picture	Computations
Memory by Association	Hebbian weight updates
Slow approach to target	Motion by fraction
~~Ignoring irrelevant sensations~~	~~Zero attention weights~~
Competing perceptions	Lateral inhibition
Energy preservation	Sparse coding

Neuroscience -> Engineering

Model	Programs
Memory by Association	Data storage – hash tables
Motion error correction	Robotic control
Distributed representation	Robust data coding
HMAX vision	Computer vision
Hebbian updates	AI: Neural net learning

Programming for neuroscience

Visualizing 3D data
Automate analysis across locations/times: for loop
Searching through data: indices and find