

Systems Neuroscience

CISC 3250

The Big Picture

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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



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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