Neural Information Processing Systems in real-live neural circuits

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Questions
What network dynamics predict behavior?
What dynamics are predictive of new learning?
What governs plasticity in the network?

Methods
Optical imaging
High density electrophysiology
Behavioral manipulation
Circuit manipulation
Neural decoding analysis
Two directions of inference

**Top-down:**
Use behavior to parse neural dynamics

**Bottom up:**
Use neural dynamics to parse behavior
Meet the data

• Electrophysiology
  • Multiple-individual neurons
    • Millisecond precision
    • 10’s – 100’s of isolated neurons
  • What can be decoded?
    • Behavioral state of the animal (position / head direction / goal)
    • Animal day dreams
Meet the data

• Electrophysiology
  • Local field potentials
    • Multiple distinct spectral bands (i.e., like radio channels)
    • Each represents distinct scale of system interaction
      • Examples:
        -> 250 Hz – 100’s of local cells (among the fastest)
        -> 2 Hz – Millions of cells throughout brain (among the slowest)

• What can be decoded?
  • Varies with each spectral band
  • Functional coupling between brain areas
Meet the data

• Optical imaging
  • Unit activity
    • Sub-second resolution (~100 ms)
    • 100’s - 1000’s of neurons

• Diffuse signaling by specific project pathways
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