Designing Incentives for Neuron Clusters:
distributed optimization with equilibrium constraints

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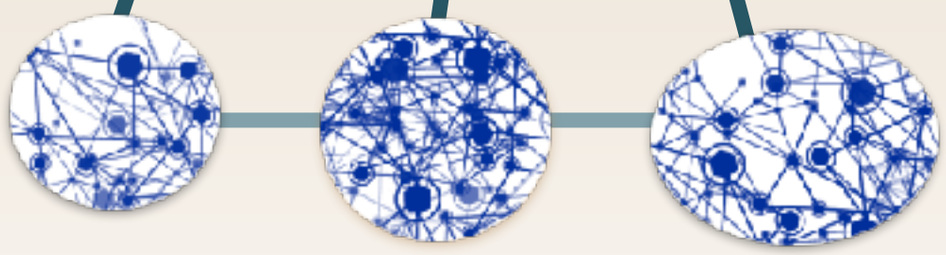
- **Problem**
  - Limitations of "global" optimization models of neuronal dynamics
- **Novel computational model**
  - Not local *minima*, but local *equilibria*
  - Provably convergent methods
  - Markets and mechanism design

Incentive design: $\min_{\mathbf{x}} f(\mathbf{x}, \theta_1, \cdots)$.



- **Example (metabolic energy)**
  - *Clusters*: minimizer of metabolic energy
    - subject to functional constraints
  - *Incentives*: distribute information
    - high level task objective

Parameters & cost functions

$$\mathbf{x}, \theta_1, \theta_2, \cdots \qquad \mathbf{f}, f_1, f_2, \cdots$$

Incentive designer

$$\min_{\mathbf{x}} \ \mathbf{f}(\mathbf{x}, \theta_1, \theta_2, \cdots)$$

Clusters of neurons

$$\min_{\theta_1} \left\{ f_1(\theta_1, \theta_2, \cdots) \mid g(\theta_1) \leq \mathbf{x} \right\}$$

$$\min_{\theta_2} \left\{ f_2(\theta_1, \theta_2, \cdots) \mid g(\theta_2) \leq \mathbf{x} \right\}$$

$$\vdots$$

Simultaneous gradient descent

$$\theta_1^+ = \theta_1 - \eta_1 \nabla_1 f_1(\theta)$$

$$\theta_2^+ = \theta_2 - \eta_2 \nabla_2 f_2(\theta)$$

$$\vdots$$

for example, (Chasnov *et al*., AAAI workshop 2019).