Organization of Behavior: What are the principles?

Question

- Nervous systems are robust and versatile in (ethologically appropriate) uncertain environments.

- What are the problem solving strategies ("computational algorithms", "engineering/design principles")?

- Are there common principles that apply across scales of organization (e.g. homeostatic regulation using feedback control)? How did they evolve?

Approach (1):

- Identify key organisms that represent major transitions in nervous system evolution. (eg: synapses appear in jellyfish; a basal vertebrate, etc). Thoroughly quantify at multiple levels - Genomes, Circuits, Behavior.

- Characterize commonalities and differences in nervous system strategies in performing major behavioral tasks.

Approach 2:

- Identify a key problem that animals need to solve (e.g. oriented locomotion, sensing in different modalities) as part of their behavior.

- Study the range of solutions employed by the corresponding nervous systems.

Common suite of experiments and theory for both approaches:

- Genomes.

- Meso- and/or micro-scale neural circuitry.

- Quantify behavior with "controlled" ethological and ecological realism and continuous monitoring.

- Informatics tools for data integration.

- Theoretical analysis of strategies/principles used to solve the major behavioral tasks.

- Synthetic biology/robotics to test/implement solution strategies.

Outcome/Impact

- Comprehensive, comparative data set across animals.

- Deeper theoretical understanding of nervous system architecture.

- Discovery of new engineering principles for robustness to uncertainty, and evolvability.

- Guide the design of robots that can deal with complex tasks.

Discussion Group

Ted Carnevale
Sharon Crook
Ralph Greenspan
John Hildebrand
David Kleinfeld
Partha Mitra
Olaf Sporns
Emo Todorov
Tim Tully