STUDIES OF NEURAL DYNAMICS: OPPORTUNITIES FOR THEORY, MODELING AND DATA ANALYSIS

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A. Neural Connectivity and the Function of Neural Circuits

- Detailed information about the anatomy of the brain is being collected at a number of levels.

- Data Analysis and Signal Processing

  Analyze experimental data to give realistic probabilistic characterizations of neural features

- Theory and Modeling

  Develop anatomically informed models of neural circuits and use them to characterize (predict) behavior of neural circuits and brain areas.

B. States of Neural Circuits and Functions of Neural Circuits and Brain Regions

- **How neural circuits and brain regions respond to tasks and stimuli depends critically on the dynamics of ongoing brain activity**

- **Data Analysis and Signal Processing**
  Develop statistical methods to characterize the dynamic background properties of neural system

  Use these dynamic methods to analyze experimental data

- **Theory and Modeling**
  Use dynamic models to characterize neural responses to stimuli, tasks and behaviors taking proper account of background dynamics

C. Integrating Information Across Different Spatial and Temporal Scales

- In neuroscience information is accruing across multiple different temporal and spatial scales

- Data Analysis and Signal Processing
  Develop statistical models that allow information such as multimodal recordings within the same experiment or information from different experiments to be combined

- Theory and Modeling
  Use dynamic models to predict what level of anatomic detail is required to constrain characterizations of system properties

D. Use of Computational Principles To Discover Brain Function

- Computational approaches in neuroscience provide insights into the underlying principles of brain function

- Data Analysis and Signal Processing

  Develop details statistical characterizations of natural signals

- Theory and Modeling

  Use computational principles to investigate the properties of neural systems

E. Use of Neural Principles to Inspire Computing

- Computational Opportunity

  Develop computing strategies and architectures using the fundamental functional principles behind the organization of the brain

F. Dynamics of Brain Development

- Simulate the ontogenesis of the brain and the nervous system

- Theory, Modeling and Computation

   Develop detailed simulation studies of brain and nervous system development integrating information on neural and genetic control.

G. Informatics

- Data of all types accrue currently at an unprecedented rate

- Computer Science Opportunities

    Develop standards for data sharing and management

    Develop tools to facilitate data storing

    and analysis

H. Education and Training

Develop formal programs to train quantitative scientists wishing to enter neuroscience

Incorporate mathematical, computational and statistical tools into undergraduate and graduate curricula in biology and neuroscience.