

Final Report to the Office of Naval Research

Computational Neuroscience Workshop

AD-A243 462



Marine Biological Laboratory

August 24 to August 30, 1991



Summary

The Computational Neuroscience Workshop was held in Woods Hole at the Marine Biological Laboratory on August 24 to August 30, 1991, concurrently with the last week of the Computational Neuroscience Summer Course. Nineteen participants met for in-depth discussions on topics ranging from computational models of visual processing to models of learning in the oculomotor system. There were many interactions between the students in summer course and the participants in the workshop through lectures given by workshop participants and through personal discussions about individual research projects. The format of the workshop has now been fine-tuned over the last six years to enhance scientific exchange; the workshop this year was perhaps the most successful in achieving high-level discussions in an informal setting. We were also fortunate this year to begin the workshop one day after power was restored to Woods Hole after Hurricane Bob, which swept through the Cape just a few days before the meeting.

Background

The primary purpose of the workshop was to bring together the leading investigators interested in applying computational modeling techniques to problems in brain function. This was the seventh year in which this workshop was held at Woods Hole. There was a general feeling that the field of computational neuroscience had over this time started to live up to its early promise and the workshop has contributed significantly to this

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development. The impact of the workshop were apparent in the research papers that the participants circulated, many of which grew out of discussions between participants at earlier workshops. The existence of the summer course was an encouraging indication of the hopes for the future of the field.

Overview

One of the central theme of this year's workshop was learning and memory in populations of neurons. This topic was introduced in talks by Terry Sejnowski on adaptation of the vestibulo-ocular reflex, by Eric Knudsen on neural and behavioral plasticity during the development of sound localization in the barn owl, by Bob Desimone on habituation of neurons in the inferior temporal cortex to complex stimuli, and by Dana Ballard on reinforcement learning in the setting of planning. Jim Bower summarized his detailed structural models of olfactory cortex, concluding that it may be taking advantage of two types of unsupervised learning.

Another major theme was neural mechanisms for computation, ranging from the dendritic to the network levels. Bart Mel reported on his studies of the capacities of neurons to store complex patterns in their dendritic trees using NMDA receptors. Rodney Douglas demonstrated a VLSI chip that he has designed for reproducing the properties of channels in neurons in real time. Christof Koch showed how dendrites, by virtue of their nonlinear conductance mechanisms, may have their responses to synaptic inputs altered by background spontaneous activity.

Several talks focussed on eye movements. Charles Bruce presented evidence for an area in frontal cortex dedicated to smooth pursuit eye movements. Terry Sejnowski presented a model of smooth pursuit coupled with the vestibulo-ocular reflex. Richard Andersen has developed new models of spatial transformations in parietal cortex that use reinforcement learning. James Buchanan showed how connectionist models of swimming oscillators could be used to understand swimming rhythms in the lamprey spinal cord.

The visual representation of shape was an important topic and Steve Zucker presented a new theory for how the shape of bounding contours can be described by competing reaction and diffusion processes. This new representation may allow a more systematic way to study the complex response properties of neurons in visual cortex. Jun Zhang showed how there may be an underlying metric that can be used to represent moving shapes. Jan Koenderink and Ted Adelson presented interesting new approaches to the general problem of representing visual images with differential operators and geometric invariants. Ken Miller summarized the extensive literature on the critical period in the development of visual cortex and presented his model of how ocular dominance columns and orientation columns arise. John Allman showed some exciting new video from an NMR microscope that could greatly improve the resolution of current imaging techniques.

Administrative Support

The Marine Biological Laboratory has been supporting computational neuroscience for over seven years. The encouragement and enthusiasm among the administration and the scientists at MBL is an important element in the success of the workshops and the summer course. The environment in Woods Hole is ideal for bringing researchers together in a relaxed but intellectually stimulating atmosphere. Perhaps the most important exchanges at the workshop occurred outside the formal sessions. Unlike most meetings which are highly scheduled, the afternoons were left free for participants to break up into smaller groups for in depth discussions.

Another indication of support at MBL for computational neuroscience was the attendance at some workshop sessions of several neuroscientists who have summer laboratories at MBL. These included Rodolfo Llinas and John Moore.



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**Woods Hole Workshop in
Computational Neuroscience - 1991
Marine Biological Laboratory**

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**7th Annual
Woods Hole Workshop
on
Computational Neuroscience**

Marine Biological Laboratory

August 24 - August 30, 1991

Saturday, August 24

8:00 p.m. Reception, Room 103 Lillie

Sunday, August 25

Eye Movements

9:00 a.m. Charles Bruce, Yale University
10:15 a.m. Break
10:45 a.m. Terrence Sejnowski, The Salk Institute
12:00 p.m. Lunch

Visual and Spatial Maps

7:00 p.m. Richard Andersen, MIT
8:15 p.m. Break
8:30 p.m. Steven Zucker, McGill University

Monday, August 26

Dendrites

9:00 a.m. Rodney Douglas, MRC Neuroanatomical Unit, Oxford
10:15 a.m. Break
10:45 a.m. Bartlett Mel, Caltech
12:00 p.m. Lunch

Sensory and Motor Coordination

7:00 p.m. Eric Knudsen, Stanford University
8:15 p.m. Break
8:30 p.m. James Buchanan, Marquette University

Tuesday, August 27

Development of Visual Cortex

9:00 a.m. Michael Stryker, UC San Francisco
10:15 a.m. Break
10:45 a.m. Kenneth Miller, Caltech
12:00 p.m. Lunch

Learning and Memory

7:00 p.m. Robert Desimone, NIMH
8:15 p.m. Break
8:30 p.m. Dana Ballard, Rochester University

Wednesday, August 28

Visual Attention and Motion Processing

9:00 a.m. David Van Essen, Caltech
10:15 a.m. Break
10:45 a.m. Jun Zhang, The Salk Institute
12:00 p.m. Lunch

Vision and Imaging

7:00 p.m. Jan Koenderink, University of Utrecht
8:15 p.m. Break
8:30 p.m. John Allman, Caltech

Thursday, August 29

Neurons and Circuits

9:00 a.m. Christof Koch, Caltech
10:15 a.m. Break
10:45 a.m. James Bower, Caltech
12:00 p.m. Lunch

Visual Representations of Shape

7:00 p.m. Alexander Pentland, MIT
8:15 p.m. Break
8:30 p.m. Edward Adelson, MIT

Friday, August 30

2:00 p.m. Demonstrations of Student Projects

Day Trip to Martha's Vinyard

6:00 p.m. Course Dinner/Awards