Learning the Neural Code for Prosthetic Control
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Current technology allows simultaneous recording from hundreds of cells in the brains of awake, behaving animals. Using this information to understand how the brain represents and processes complex information will enable neural prosthetic technologies that promise a new generation of therapies for the severely disabled. To that end we are developing new mathematical and computational methods for modeling and decoding neural activity. The project has goals: 1) We are developing new probabilistic models of the neural code that exploit machine learning methods and high performance computing resources. These models represent the probabilistic relationship between multiple behavioral variables and the firing activity of a large population of neurons. 2) Neural decoding methods are being developed that model the uncertainty in neural recordings to make sound inferences that can drive neural prostheses. 3) Adaptation and learning of cells in the brain is being studied using the mathematical models developed here and an understanding of this adaptation will be used to design new algorithms for prosthetic applications. To learn high dimensional probabilistic models from vast amounts of neural data, a new class of mathematical and computational tools is required. In particular we are developing "maximum entropy" methods to learn non-parametric statistical models of high-dimensional, correlated neural data. We have also developed mathematical models to determine the efficacy of neural activity patterns in inducing learning. These new methods address fundamental problems in neural coding that will enable new prosthetic devices through a tight cycle of hypothesis, development, testing, and validation.

Project Website

http://www.cs.brown.edu/~black/Projects/CRCNS/

Publications

Mehta, M. R., "Role of rhythms in facilitating short-term memory," *Neuron* 45, 7:9 (2005).

Roth, S. and Black, M. J., "Fields of experts: A framework for learning image priors with applications," to appear: *Proc. IEEE Conf. on Computer Vision and Pattern Recognition*, June 2005.