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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 is already enabling neural prosthetic technologies to assist the severely disabled. Recent neural motor prosthesis trials in humans increases the urgency for understanding the neural control of movement and for developing practical methods to enable people with high spinal cord injury to regain control of devices in the world. With this in mind, we are developing new mathematical and computational methods for modeling and decoding neural activity. The project has three primary aims: 1) Development of new probabilistic models of the neural code that exploit machine learning methods. These models represent the probabilistic relationship between multiple behavioral variables and the firing activity of large populations of neurons. 2) Development of new spike sorting and decoding methods that model the uncertainty in neural recordings. 3) Mathematical characterization of the adaptation and learning of neurons to enable the design of new algorithms for prosthetic applications.

Project (or PI) Website

http://www.cs.brown.edu/people/black/Projects/CRCNS/home.html

http://www.cs.brown.edu/people/black/

Publications

1. Roth, S., Black, M. J., On the spatial statistics of optical flow, International Conf. on Computer Vision, ICCV, pp. 42-49, 2005.
http://www.cs.brown.edu/people/black/Papers/iccv05roth.pdf

2. Wood, F., Roth, S., and Black, M. J., Modeling neural population spiking activity with Gibbs distributions. To appear: Advances in Neural Information Processing Systems, 2005. http://www.cs.brown.edu/people/black/Papers/nips2005draft.pdf

3. Wood, F., Prabhat, Donoghue, J. P., Black, M. J., Inferring attentional state and kinematics from motor cortical firing rates, Proc. IEEE Engineering in Medicine and Biology Society, pp 1544-1547, Sept. 2005. http://www.cs.brown.edu/people/black/Papers/fwoodEMBS05.pdf

4. Fisher, J and Black, M. J., Motor cortical decoding using an autoregressive moving average model, Proc. IEEE Engineering in Medicine and Biology Society, pp. 1469-1472, Sept. 2005. http://www.cs.brown.edu/people/black/Papers/embs05ARMAfinal.pdf

5. Kim, S.-P., Wood, F., Fellows, M., Donoghue, J. P., Black, M. J., Statistical analysis of the non-stationarity of neural population codes. BioRob 2006, The first IEEE / RAS-EMBS International Conference on Biomedical Robotics and Biomechatronics, pp. 295-299, Pisa, Italy, Feb. 2006. http://www.cs.brown.edu/people/black/Papers/biorob2006.pdf

6. Yeung, Y., Ahmed O., Pujala, A., Shaikouni, A., Mehta, M., Spike pattern potency as a measure of the efficacy of natural spike trains in inducing synaptic plasticity. Society for Neuroscience, Program No. 503.18. 2005 Abstract.

7. Wood, F. and Black, M. J., Energy based models of motor cortical population activity, Program No. 689.20. 2005 Abstract Viewer and Itinerary Planner. Washington, DC:Society for Neuroscience, 2005. Online. http://www.cs.brown.edu/people/black/Papers/SFN05.html

8. Black, M. J. and Roth, S., On the receptive fields of Markov random fields: Predictions from a probabilistic model of scene statistics, Abstract, Cosyne, Salt Lake City, March 2005. http://www.cs.brown.edu/people/black/Papers/Cosyne05.html

Publications (previous year)

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

1. Roth, S. and Black, M. J., “Fields of experts: A framework for learning image priors with applications,” *Proc. IEEE Conf. on Computer Vision and Pattern Recognition*, vol. II, pp. 860-867, June 2005. http://www.cs.brown.edu/people/black/Papers/cvpr2005.pdf