
Coherency - Measuring Representational Quality
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Aaron D. Redish
University of Minnesota Twin Cities

Recent advances in technology have made simultaneous recording of neuronal ensembles possible. From these ensembles, it is possible to *reconstruct* behavioral variables, by which one attempts to predict a behavioral or stimulus variable from neural firing patterns. While reconstruction is a powerful tool, it only provides a value and gives no indication of the quality of the representation itself. Because neuronal representations are highly distributed, cells could be firing in a manner that is generally consistent or generally inconsistent with the reconstructed value. We proposed to develop new methods for the measurement of this internal consistency and to use those new measures to detect the dynamics of learning and memory.

We developed two methods capable of accurately measuring the internal consistency of representations from neuronal ensembles. Using simulations, we were able to show that these measures could, in principle, be used to detect dynamic events. We then used these measures on recordings taken from three experiments: post-subicular ensembles (head-direction cells), hippocampal ensembles (place cells), and dorsal striatal cell ensembles. From the head-direction ensembles, we found that the new measures could be used to predict reconstruction accuracy from internal sources (thus when the consistency was low, the reconstruction was poor), which means it could be used by the head-direction system to detect the believability of its current representation. From the hippocampal and striatal cell ensembles, we found that the new measures could detect changes associated with learning. These changes paralleled behavioral learning changes in interesting ways.

PI Website

http://ccgb.umn.edu/~redish/

Publications

(Primary papers - meets primary aims)

- J.C. Jackson, A.D. Redish (2003) "Detecting dynamical changes within a simulated neural ensemble using a measure of representational quality" Network: Computation in Neural Systems, 14:629-645.

- J. C. Jackson, A.D. Redish (2004) "Measuring ensemble consistency without measuring tuning curves", Neurocomputing 58-60C: 91-99.

- A. Johnson, K. D. Seeland, A. D. Redish (2005) "Reconstruction of the postsubiculum head direction signal from neural ensembles" Hippocampus 15:86-96.

(Secondary papers - within the general rubric of the aims of the proposal)
- B Masimore, J Kakalios, AD Redish (2004) "Measuring fundamental frequencies in local field potentials" Journal of Neuroscience Methods 138(1-2):97-105.

- B. Masimore, J. Kakalios and A. D. Redish (2003) "Measuring neural coupling from non-Gaussian power spectra of voltage traces taken from awake, behaving animals", Proceedings of SPIE vol. 5110, Fluctuations and Noise in Biological, Biophysical, and Biomedical Systems, edited by Sergey M. Bezrukov, Hans Frauenfelder and Frank Moss. (SPIE, Bellingham, WA), pages 224-234.

- N. C. Schmitzer-Torbert, J. C. Jackson, D. Henze, K. D. Harris, A. D. Redish (2005) "Quantitative measures of cluster quality for use in extracellular recordings" Neuroscience 131:1-11.