

Software Supplement to ‘A Statistical Description of Neural Ensemble Dynamics’

JOHN D. LONG II AND JOSE M. CARMENA

The software in this package complements the paper ‘A Statistical Description of Neural Ensemble Dynamics’ accepted for publication in *Frontiers in Computational Neuroscience*. It contains all the functions necessary to use the techniques and recreate the figures detailed in the paper. In addition, a data visualization tool has been provided to further the goal of helping experimentalists more completely explore neural ensemble data. All functions contain inline commentary and documentation.

Paper. You can download the paper at

<http://www.eecs.berkeley.edu/~carmena/publications.html>

This version will be the most up-to-date. If you use any function in this toolbox in your research, please cite this paper.

Getting started. Run the m-file ‘setPath.m’ to add the relevant subdirectories to your MATLAB[®] search path. All functions were written on a Windows machine running MATLAB[®] 7.3.0 R2006b and also tested on MATLAB[®] 7.10 R2010a. These functions require the MATLAB[®] Statistics toolbox because of our use of the functions ‘randsample’ and ‘ksdensity.’ Open source functions can be used to replace these dependencies, if needed. I anticipate the only problem for Mac and linux users will be setting the paths correctly.

Demo. To acquaint yourself with the main functions described in this paper, we recommend you go through the demo provided (demo_kdq_Bayes_KL.m). It takes you through the main functions while reproducing some of the figures in the paper. As you move through the demo, text will be displayed at the command line detailing what’s going on.

Data Formatting. The main data object for all the functions is an NxM matrix of N samples from M simultaneously recorded binary variables. Given the variety of recording systems used in neuroscience, it is left to the user to format the data appropriately. All functions are compatible with the compact uint8 data format, to allow the user to input large ensembles recorded over long periods of time.

Main functions. Here are brief descriptions of the functions contained in this package. For more details, consult the comments within the associated m-files.

- `stat_ensemble_dynamics`: calculates both the Bayes's estimator for the KL-divergence, according to a user specified null hypothesis, and the population firing rate of the ensemble.
- `stat_ensemble_dynamics_visualization`: provides a basic visualization tool for observing changes in the KL-divergence or population firing rate over time, or as they relate to the ensemble data and/or behavioral events.
- `kdq_bayes_KL`: calculates the KL-divergence according to a range of available null hypotheses, which may be specified by the user. It employs the kdq-tree to adaptively quantize the domain of ensemble states based upon the observed data.
- `bayes_est_KL_priors`: calculates the Bayesian estimator for the KL-divergence between Dirichlet distributions with a Dirichlet prior.
- `Bern_tree`: implements a variant of the kdq-tree.
- `Bern_tree_update`: takes in a previously constructed Bern-tree and data to generate multinomial samples.
- `population_fr`: calculates the population, or ensemble, firing rate for a neural ensemble.
- `bin_spikes`: bins ensemble data according to a user specified number of samples.
- `word_hist`: counts and sorts ensemble patterns.

Recommendation. For the interested user we highly recommend the paper, ‘Generating Spikes Trains with Specified Correlation-Coefficients’ by Jakob Macke, Phillipp Berens, Alexander Ecker, Andreas Tolias, and Mathias Bethge, published in Neural Computation 2009. The software supplement they provide was used to generate all the correlated datasets used to test our functions. It is a great tool for evaluating the performance of these functions. Their package also provided the template for this supplement.

Disclaimer. While we hope and did our best to ensure that all the provided functions are error-free, we cannot guarantee this (who could?). Therefore, we do not take responsibility for any mistakes you might make as a consequence of using these functions.

Contact. You can reach us via email

jlong29@berkeley.edu or jlong29@gmail.com
carmena@eecs.berkeley.edu

If you have any questions, or might be interested in contributing to an expansion of this package, you can also post on the wiki associated with this package posted on Google code at:

<http://code.google.com/p/kdq-bayes-kl>

Software license. All functions are freely available for download under GPL Version 3 (<http://www.gnu.org/licenses/gpl.html>). This means you are free to use, copy, modify, and redistribute code and any part of it. This explicitly excludes all proprietary code used in the functions, which might be needed for proper functionality (MATLAB[®] toolboxes by The Mathworks).