STAR: Spike Train Analysis with R

Christophe Pouzat[1,*] , Antoine Chaffiol[2] , Chong Gu[3]

1. Cerebral Physiology Laboratory, CNRS UMR 8118, Paris-Descartes University, Paris, France
2. Insect Physiology laboratory, INRA UMR 1272, Versailles, France
3. Department of Statistics, Purdue University, West Lafayette, USA

* Contact author: christophe.pouzat@gmail.com

Keywords: Point process; smoothing spline

A central working hypothesis of systems neuroscience is that action potential or spike occurrence times, as opposed to spike waveforms, are the sole information carrier between brain regions. This hypothesis legitimates and leads to the study of spike trains per se. It also encourages the development of models whose goal is to predict the probability of occurrence of a spike at a given time, without necessarily considering the biophysical spike generation mechanisms.

We have adopted the point process / counting process framework to model our spike trains recorded from the first olfactory relay of an insect: the cockroach, *Periplaneta americana*. The key element of this framework is the *conditional intensity* (CI): the instantaneous firing rate of the neuron at time, t, conditioned on potentially every event observed up to t. Despite our growing knowledge of cellular biophysics CI models with a manageable number of parameters are still lacking. We have therefore been lead to nonparametric approaches combining smoothing splines with binomial or Poisson regression models. These efforts have resulted in the STAR (Spike Train Analysis with R; Pouzat, 2009) package which is built "on top" of C. Gu's gss (General Smoothing Spline) package. Both packages are available on CRAN. In addition to nonparametric CI estimation functions, STAR provides numerous goodness of fit tests for CI based spike trains models: the full range of tests developed by Y. Ogata (1988) for earthquakes sequences is implemented together with an original one based on a direct application of Donsker's theorem (Pouzat, Chaffiol, Gu, 2008).

The insight provided by the CI based approach into the function of a "small" neuronal network will be demonstrated by results obtained from spontaneous and odor evoked neuronal activity recordings.

References

Y. Ogata (1988) Statistical Models for Earthquake Occurrences and Residual Analysis for Point Processes. *JASA*, 83, 9-27.

Christophe Pouzat (2009). STAR: Spike Train Analysis with R, `http://cran.at.r-project.org/web/packages/STAR/index.html`.

Christophe Pouzat, Antoine Chaffiol and Chong Gu (2008) Static and dynamic models for spike train analysis: Models, model diagnostics and open-source software. Manuscript available at: `http://sites.google.com/site/spiketrainanalysiswithr/` .