CRCNS.org pvc-11 data description

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Utah array extracellular recordings of spontaneous and visually evoked activity from anesthetized macaque primary visual cortex (V1).

Summary

The data comprise two conditions: spontaneous and evoked V1 activity. The data were recorded by Matthew Smith and Adam Kohn, in the Kohn lab at the Albert Einstein College of Medicine (both data sets), and J. Anthony Movshon's lab at New York University (spontaneous data set). Tai Sing Lee (Carnegie Mellon University) provided research support and Ryan Kelly (Carnegie Mellon University) participated in the data collection and processing.

The first **spontaneous data set** comprises spiking activity from ~70 – 100 neurons (single- and multi-units) simultaneously recorded using Utah arrays placed in visual cortex of four adult *Macaca fascicularis* monkeys (a total of six arrays). Sufentanil (4-18 microg/kg/hr) was used for anesthesia. Recordings were obtained while animals viewed a uniform gray screen. Included in this data set are results from spike sorting from each of six arrays. Scripts which perform basic characterization are provided (see below).

The second **evoked data set** comprises spiking activity from 44 to 104 neurons (single- and multi-units) from 5 arrays (3 monkeys). The evoked data set was collected using the same approach as the spontaneous data set (i.e., anesthesia, V1, Macaque monkeys). Spiking activity was recorded while presenting different grayscale visual stimuli, including drifting sinusoidal gratings (each presented for 1.28 s), a movie of sinusoidal gratings with ~100 different drift directions (300 ms each, 30 s movie in total), a movie of a contiguous natural scene (a monkey wading through water, 30 s), and a movie of white noise (30 s). The data set comprises the event times of spike sorted units from each array, the visual stimuli, scripts that compute binned spike counts and mean firing rates, and the peri-stimulus time histograms (PSTHs) analyzed in Cowley et al., 2016.

For further details on how the data were obtained, see the following references:

Smith MA, Kohn A (2008) Spatial and temporal scales of neuronal correlation in primary visual cortex. J Neurosci, 28: 12591–12603.
http://dx.doi.org/10.1523/JNEUROSCI.2929-08.2008

Kelly RC, Smith MA, Kass RE, Lee TS (2010) Local field potentials indicate network state and account for neuronal response variability. J Comput Neurosci, 29: 567–579
https://dx.doi.org/10.1007/s10827-009-0208-9

Conditions for using the data

If you publish any work using the data, please cite the data set in the following recommended format:

Kohn, A., Smith, M.A. (2016) Utah array extracellular recordings of spontaneous and visually evoked activity from anesthetized macaque primary visual cortex (V1). CRCNS.org
http://dx.doi.org/10.6080/K0NC5Z4X

Methods

A description of the methods used to obtain the data can be found in the papers referenced above, e.g. Smith & Kohn (2008) and Kelly et al., (2010)

Data files organization

The files are organized with all functions and data folders located in the parent directory. The contents of the folder are described below:

- **/spikes_spontaneous**: Each data file represents neural activity from a single recording session from one Utah array. There are a total of six data files, each representing a different recording session and array.
- **/spikes_gratings**: Spike times for three arrays in response to individual drifting sinusoidal gratings (1.28 s).
- **/psths_gratings**: PSTHs of the individual gratings used in Cowley et al., 2016.
- **/spikes_movies**: Spike times for two arrays in response to three different movies (gratings, natural, and noise, each presented 30s). Also contains the sequence of orientation angles (theta).
- **/psths_movies**: PSTHs of the movie stimuli used in Cowley et al., 2016.
- **/stimuli_gratings**: Drifting sinusoidal gratings (1.28s) shown to subject.
- **/stimuli_movies**: Three different stimulus movies (30s) shown to subject.

example_spontaneous_spikes.m – The file contains an example analysis of pairwise correlations within the array recordings. The file loads data from each recording session and computes pairwise correlations within each session. The script then plots pairwise correlations across all sessions in a histogram.

computeSpontCounts.m – Takes as input the 'EVENT' field from a given data set (see 'Data Format' section), a spike counts bin length, and a time (in seconds) between bins and outputs a matrix spike counts for each unit. See the computeSpontCounts.m header text for a more detailed description of the function.

script_mean_firing_rates_gratings.m -- Script that computes the mean firing rates for the individual gratings data sets. Users can utilize sections of the script to obtain spikes in 1ms bins and spike counts in 20ms bins (or choose any bin size).

script_mean_firing_rates_movies.m -- Script that computes the mean firing rates for the three movie data sets. Users can utilize sections of the script to obtain spikes in 1ms bins and spike counts in 20ms bins (or choose any bin size).

Data formats

Data format for recorded neural activity:

data = struct containing information about neural spiking activities from one array, which has the following fields:

EVENTS: {For evoked data: num_units x num_stim x num_trials, cell. For spontaneous data: 1 x num_units}. Each element of this cell array contains a [num_events x 1] matrix of

spiking events (sorted action potentials) for a given unit. The elements of the spiking event matrix represent time (in seconds) when the spiking event occurred.

CHANNELS: [num_units x 2, double]. Each row corresponds to a unit in the .EVENTS cell array. The first column indicates the channel number of the sorted unit and the second column indicates the index of the unit on the channel. For example, a '90' in the first column indicates that the unit came from channel 90. A '2' in the second column indicates that this is the second unit on channel 90. (See 'MAP' to map channel number to location on the electrode array)

MAP: [10x10, double]. Each element in the array indicates a channel number. The index of the channel number within the array indicates the location of the channel on the Utah array. The distance on the array between adjacent channels (corresponding to adjacent elements in the matrix) was 400 μm.

SNR: [num_units x 1, double]: Signal to noise ratio for each unit. Computed as the ratio of the average waveform amplitude to the standard deviation of the waveform noise.

Data format for visual stimuli:
M [num_pixels x num_pixels x num_images, uint8]: Images of the visual stimuli (in grayscale)

Data format for gratings PSTHs:
psths [1 x num_stimuli]: cell array of PSTH matrices,
where psths{istim} [num_neurons x num_timepoints]

Data format for movie PSTHs:
psths [num_neurons x num_timepoints]: PSTH matrix

How to get started

For spontaneous data set:
The example.m file demonstrates a spike count correlation analysis script. The script demonstrates how to load the data, convert spiking events into spike counts, and compute the distribution of correlations across all neuron pairs from the same array.

For evoked data set, individual gratings:
Run script_mean_firing_rates_gratings.m. This returns S(igrat).mean_FRs (num_neurons x num_timebins), which contains the mean firing rates. You can plot the mean firing rate versus time for each neuron by indexing S(igrat).mean_FRs(ineuron,:).

For evoked data set, movie stimuli:
Run script_mean_firing_rates_movies.m. This saves mean_FRs files in /spikes_movies. Similar to the individual gratings data set, you can plot the mean firing rates versus time for each neuron by indexing mean_FRs(ineuron,:).

How to get help

To get help with the data set post any questions on the forum at CRCNS.org, or e-mail Matthew Smith (matt@smithlab.net) or Adam Kohn (adam.kohn@einstein.yu.edu) directly.

Authors of this write-up:
Benjamin R. Cowley and Ryan C. Williamson, Oct. 2016

References

1. Williamson RC, Cowley BR, Litwin-Kumar A, Doiron B, Kohn A, Smith MA*, Yu BM* (2016) Scaling properties of dimensionality reduction for neural populations and network models. PLoS Comput Biol, in press.
2. Cowley BR, Smith MA, Kohn A, Yu BM (2016). “Stimulus-driven population activity patterns in macaque primary visual cortex. PLoS Comput Biol, in press.
3. Kelly RC, Smith MA, Kass RE, Lee TS (2010) Local field potentials indicate network state and account for neuronal response variability. J Comput Neurosci, 29: 567–579.
4. Smith MA, Kohn A (2008) Spatial and temporal scales of neuronal correlation in primary visual cortex. J Neurosci, 28: 12591–12603.