20402024_Neuron_Responses_assignment

March 5, 2016

```
In [210]: get_ipython().magic('matplotlib inline')
          import pandas;
          import matplotlib;
          import matplotlib.pyplot as plt
          import scipy.io;
          import numpy as np
          from matplotlib.pylab import rcParams
          import math
          from scipy import signal
          from scipy.fftpack import fft, fftshift
          import scipy.stats
          from rstyle import rstyle

          def ggaxes(fig=None):
              if fig is None: fig = plt.figure()
              ax = fig.add_subplot(111)
              rstyle(ax)
              return ax

          rcParams['figure.figsize'] = 10, 10
          rcParams['figure.dpi'] = 300;
          rcParams['lines.linewidth'] = 2.2;
          get_ipython().magic('pdb')
```

```
Automatic pdb calling has been turned ON
```

```
In [279]: def synthetic_neuron(drive):
              """
              Simulates a mock neuron with a time step of 1ms.
              Arguments:
              drive - input to the neuron (expect zero mean; SD=1)
              Returns:
              rho - response function (0=non-spike and 1=spike at each time step)
              """
              dt = .001
              T = dt*len(drive)
              time = np.arange(0, T, dt)
              lagSteps = .02/dt
              drive = np.concatenate((np.zeros(lagSteps), drive[lagSteps:]))
              system = scipy.signal.lti([1], [.03**2, 2*.03, 1])
              _, L, _ = scipy.signal.lsim(system, drive[:,np.newaxis], time)
              rate = np.divide(30, 1 + np.exp(50*(.05-L)))
              spikeProb = rate*dt
              return np.random.rand(len(spikeProb)) < spikeProb
```

```
        def gaussian(x, mu, var):
            return np.exp(-np.power(x-mu, 2.)/(2*var))

        def plot_spike_raster(trial, spikeTimes, ax):
            rep_trials = np.repeat(trial, np.size(spikeTimes))
            sizes = np.ones(len(spikeTimes))*40;
            ax.axhline(y=trial, linewidth=0.3);
            ax.scatter(spikeTimes, np.array([rep_trials]), marker='|', alpha=0.9,
                       color='black', s=sizes);

        def plot_psth(spikeTimes, num_bins, ax2):
            counts = ax2.hist(spikeTimes, bins = num_bins, histtype='step');
            return counts;
```

```
In [3]: tuning_data = scipy.io.loadmat('MT direction tuning.mat');
```

```
In [83]: sptimes = 1000*tuning_data['spikeTimes'][0];
         directions = tuning_data['direction'];
```

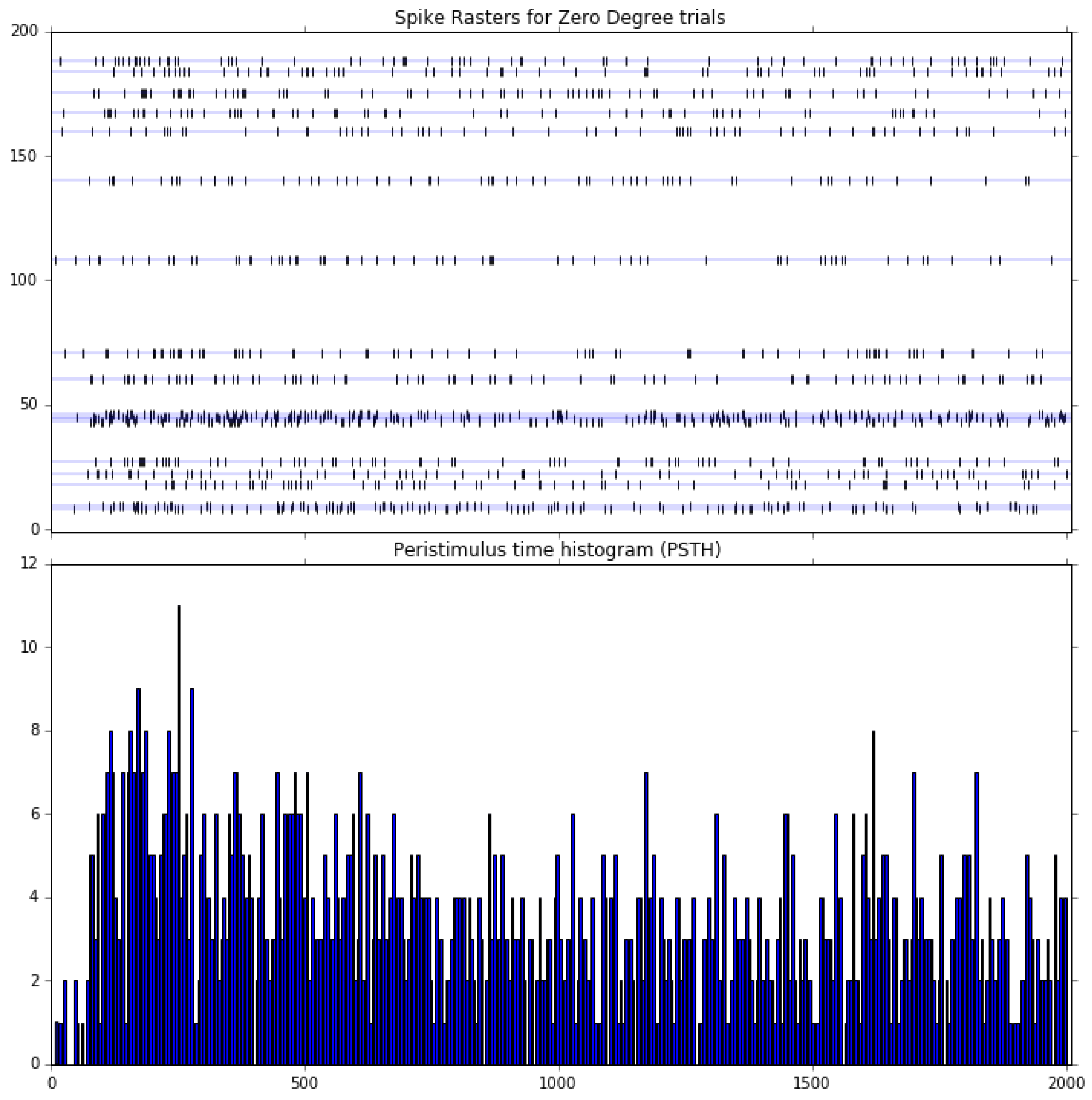
```
In [282]: zero_deg_trial_indices = np.where(directions==0)[1];
          zer_deg_trial_spike_times = sptimes[zero_deg_trial_indices];
          fig, (ax, ax2) = plt.subplots(2, 1, sharex=True)
          fig.tight_layout();
          # ax.grid('on');

          for trial, spikeTimes in zip(zero_deg_trial_indices, zer_deg_trial_spike_times):
              plot_spike_raster(trial, spikeTimes, ax);

          ax.set_xlim([-0.05,2010])
          ax.set_ylim([-1, 200])
          ax.set_title("Spike Rasters for Zero Degree trials")

          all_spikes = np.array(zer_deg_trial_spike_times[0])
          for i in range(1, len(zer_deg_trial_spike_times)):
              all_spikes = np.concatenate((all_spikes, zer_deg_trial_spike_times[i]), axis=1);
          num_bins = 2/0.005;
          ax2.hist(all_spikes[0], bins=num_bins)
          ax2.set_title('Peristimulus time histogram (PSTH) ')
          # ax2.set_xlabel
```

```
Out[282]: <matplotlib.text.Text at 0x1439d4eb8>
```



Use Gaussian window functions to generate single trial rate estimates

```
In [265]: std_dev1 = 0.5;
          std_dev2 = 0.005;
          len_gauss = 3;
          window1 = scipy.signal.gaussian(M=len_gauss, std=std_dev1)
          window1 /= window1.sum()

          window2 = scipy.signal.gaussian(M=len_gauss, std=std_dev2)
          window2 /= window2.sum()

          num_bins = 20;
          trial_nine = zer_deg_trial_spike_times[zero_deg_trial_indices[1]].tolist()[0]

          # import pdb; pdb.set_trace();
          smoothed = np.convolve(trial_nine, window1, 'full');
          smoothed2 = np.convolve(trial_nine, window2, 'full');

          print(scipy.stats.describe(trial_nine).mean, scipy.stats.describe(trial_nine).minmax)
          print(scipy.stats.describe(smoothed).mean, scipy.stats.describe(smoothed).minmax)
          print(scipy.stats.describe(smoothed2).mean, scipy.stats.describe(smoothed2).minmax)
```

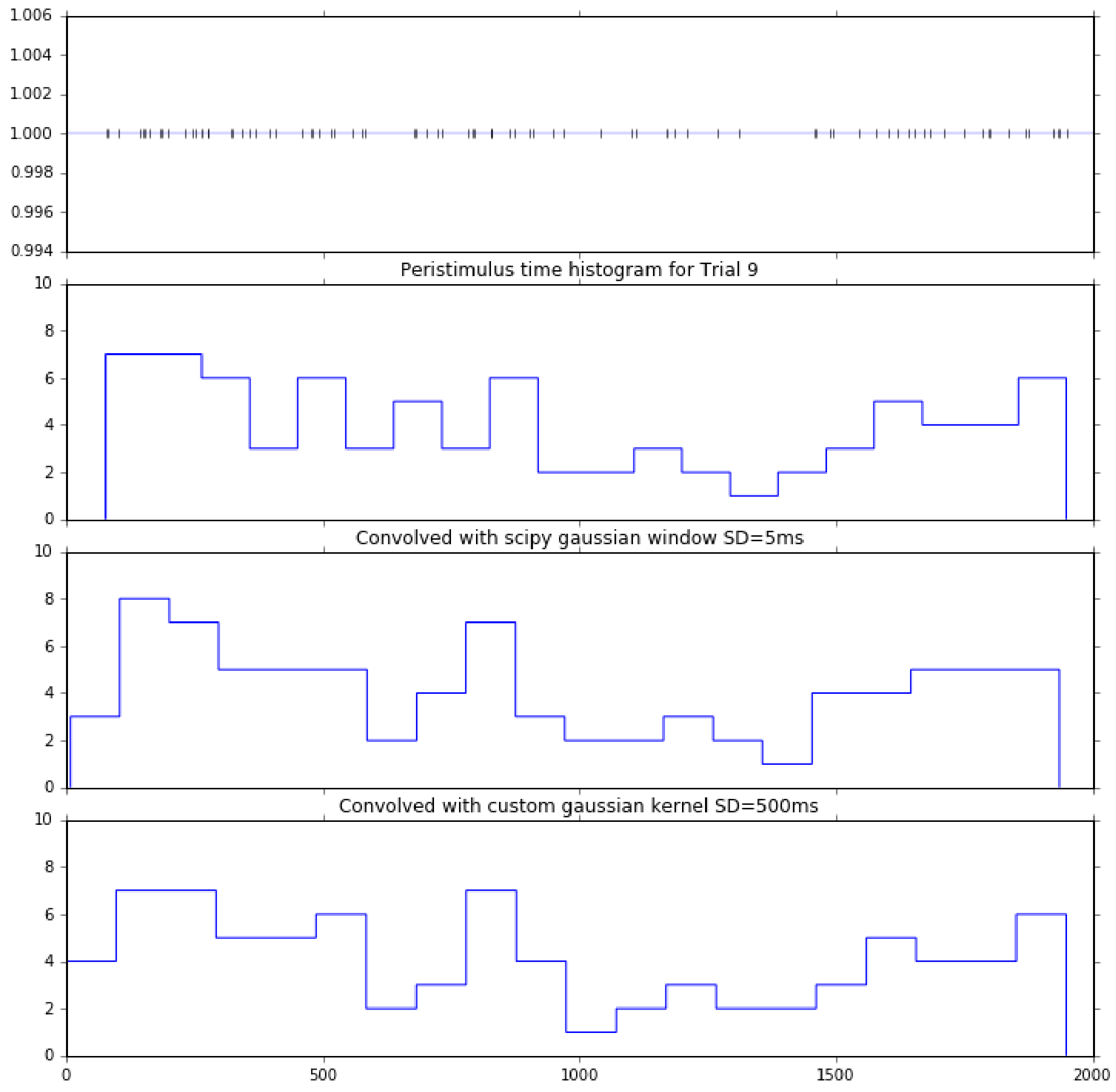
```
920.225 (77.0, 1949.0)
897.780487805 (8.2010373767784568, 1935.2780837470302)
897.780487805 (0.0, 1949.0)
```

```
In [272]: f, (ax2,ax3,ax4,ax5) = plt.subplots(4,1, sharex=True);
          f.tight_layout()

          plot_spike_raster(1, trial_nine, ax2);
          ax2.set_xlim([0,2000])

          plot_psth(trial_nine, num_bins, ax3);
          ax3.set_title('Peristimulus time histogram for Trial 9');
          ax3.set_ylim([0,10])
          plot_psth(smoothed, num_bins, ax4)
          ax4.set_title('Convolved with scipy gaussian window SD=5ms');
          ax4.set_ylim([0,10])
          plot_psth(smoothed2, num_bins, ax5)
          ax5.set_title('Convolved with custom gaussian kernel SD=500ms')
          ax5.set_ylim([0,10])
```

```
Out[272]: (0, 10)
```



```
In [156]: lll = {'x': nine_edges[1:], 'y':nine_hist}
          ll = pandas.DataFrame(lll)
          ?ll.hist()

In [249]: len(((np.random.randn(10) * 8) ** 2))

Out[249]: 10
```