Neurophysiological Data

The following report and code has been written by Charles Burns for the Computational Neuroscience course. (10/01/2024).

Guidelines and exercises provided by Ben Willmore.

Part I: Plotting single-trial data

```
load 'spiketimes.mat'; %matlab daata file
% whos; %check what vairables are included and their sizes
```

Q1: What kind of variable is single_trial?

```
class('single_trial')
```

```
ans = 
'char'
```

A: it's a double array. Sometimes referred to as a 'vector'

Q2: How big is it?

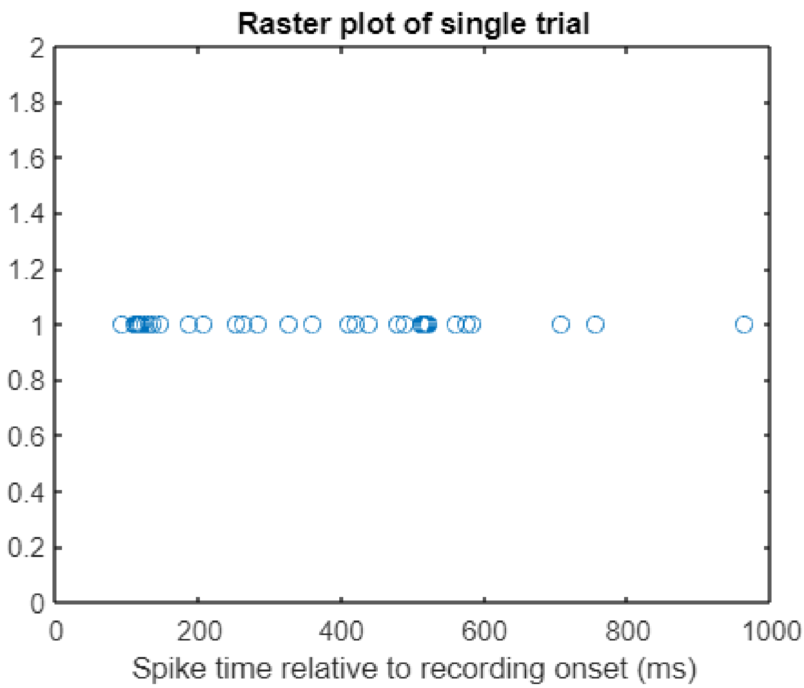
```
sz = size(single_trial) %storing the size
```

```
sz = 1×2
     1    41
```

A: It's size is 1x41, meaning it's one row with 41 columns, containing 41 different numbers.

Q3: Cut and paste the labelled raster plot into your Word document.

```
%following instructions to make a raster plot
plot(single_trial,ones(sz),'o');
xlabel('Spike time relative to recording onset (ms)')
title('Raster plot of single trial')
```



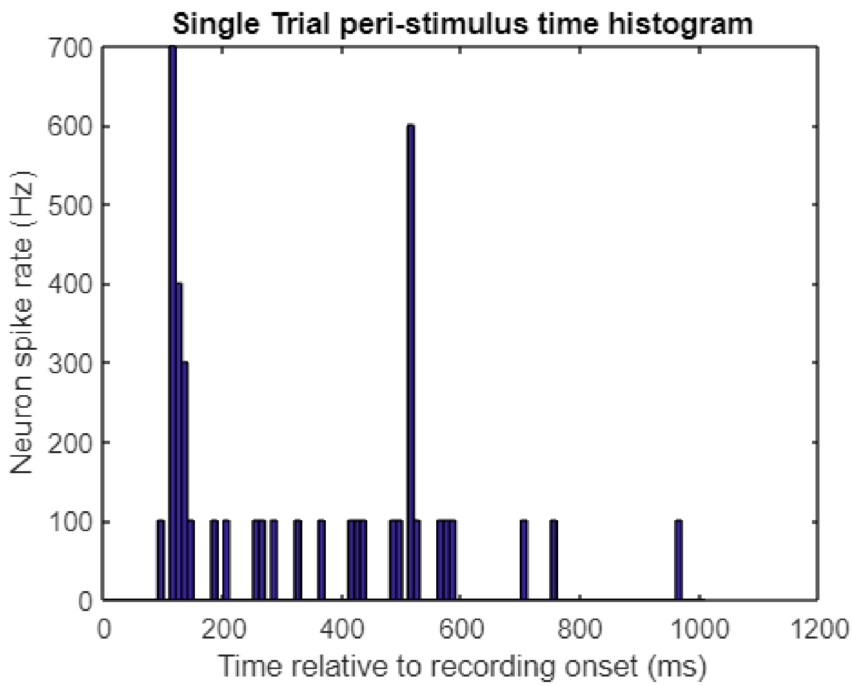
Q4: Cut and paste the labelled histogram into your Word document.

```
%following instructions to make a per-stimulus time histogram (PSTH)
edges = 0:10:1000;
response=histc(single_trial,edges) %count trials in each bin
```

```
response = 1×101
     0     0     0     0     0     0     0     0     0     1     0     7     4···
```

```
response=response/0.01; %spikes by second by scaling to length of the bin.

bar(edges,response, 'histc');
xlabel('Time relative to recording onset (ms)')
ylabel('Neuron spike rate (Hz)')
title('Single Trial peri-stimulus time histogram')
```



Q5: Knowing that the stimulus onset was at 100ms, what was the response latency of the neuron, i.e., the time that the first peak in spiking occurred?

A: The first peak happens between 110 and 120ms, indicated by the height of the bin in the above figure. This would suggest that the response latency of the neuron is ~15ms.

This is a noisy estimate and may be influenced by our choice of bin edges.

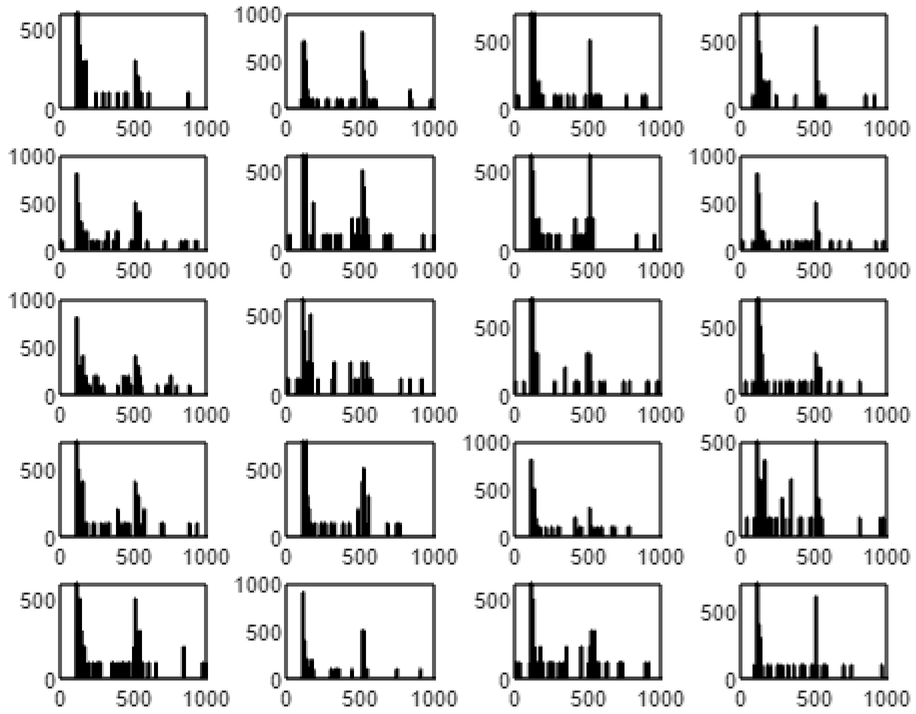
Q6: What was the maximum response rate of the neuron, in spikes/second?

A: 700.

Part II: Multiple-trial data and 'for' loops.

Q7: Paste the figure into your Word document.

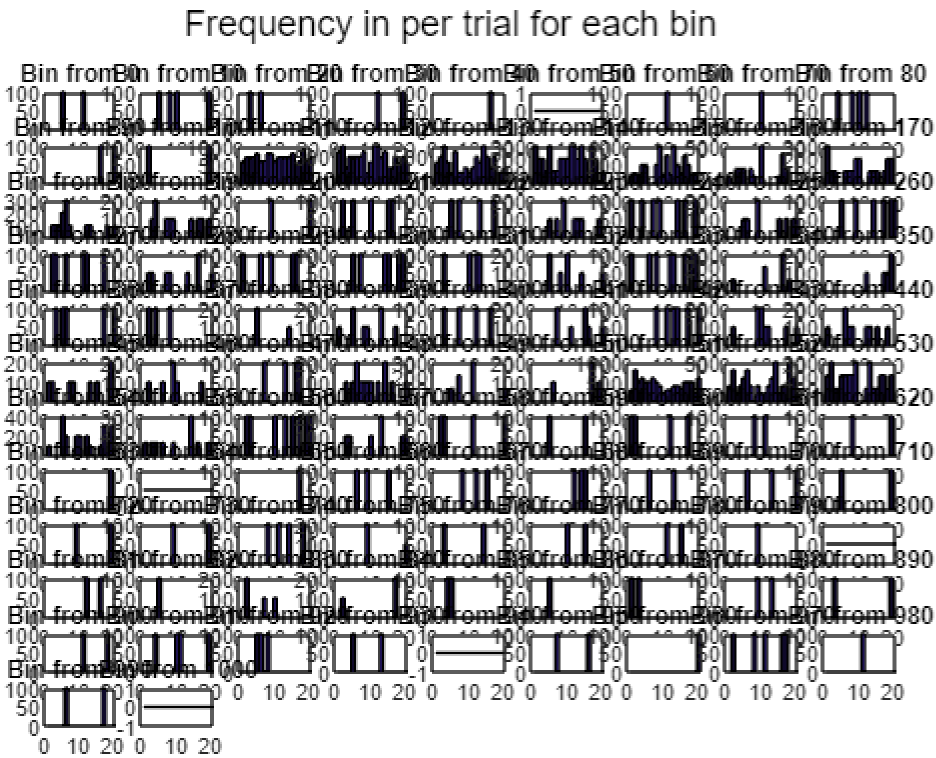
```
%again, following instructions (see plotpsthes.m)
plotpsthes
```



```
sgtitle('PSTHs for multiple trials')
```

Q8: Paste the figure into your Word document. What does each graph represent now?

```
plotpsthes2
sgtitle('Spike frequency per trial for each bin')
```



A: Each graph, for a given time bin (e.g. 0-10ms), now represents the spike frequency per trial (1-20).

To some, it might indicate how much variability there is across trials (whether there is consistency in when neurons spikes across trials).

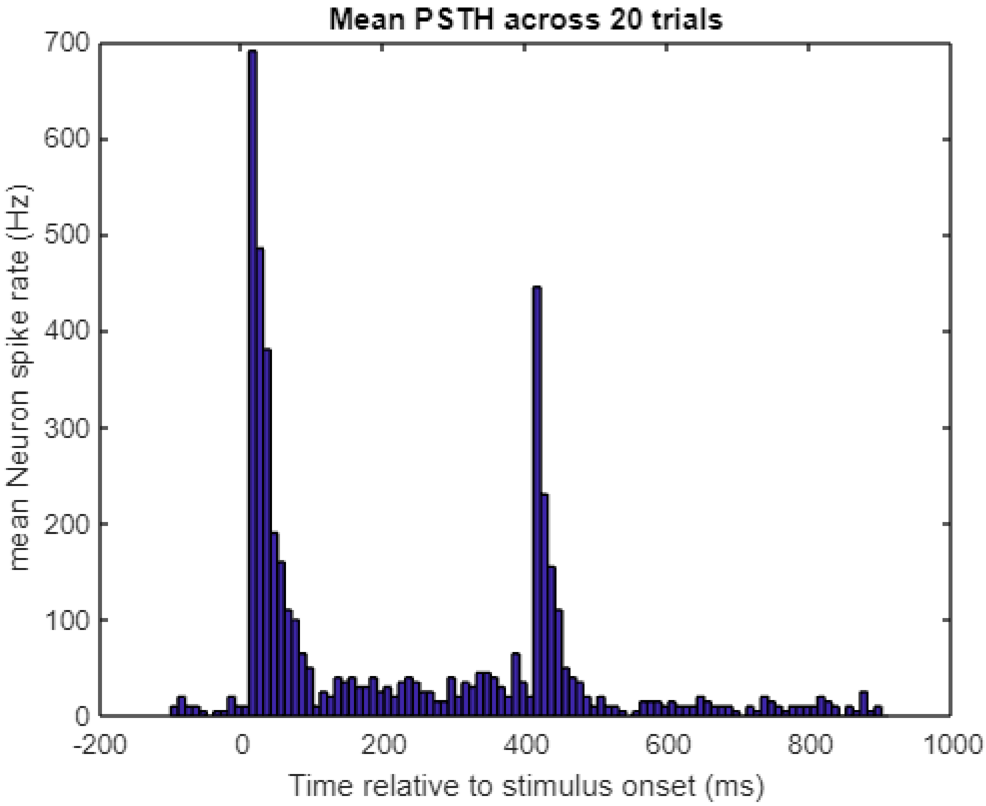
But 101 plots is a lot. We shouldn't really be doing this.

Q9: Label your axes, give your figure a title and paste it into your Word document.

```
close all;

%obsolete code:
% mn = zeros(1,101);
% nTrials = size(condition1,1)
% for ii = 1:nTrials;
%
%  mn = mn + condition1(ii,:)/0.01; %rescaling to hrz
% end
% mn = mn/nTrials; %mean per trial

bar((edges-100),mean(condition1)*100,'histc');
title('Mean PSTH across 20 trials')
xlabel('Time relative to stimulus onset (ms)')
ylabel('Mean neuron spike rate (Hz)')
```



Part III: Comparing conditions

Q10: Label your axes, give your figure a title and paste it into your Word document.

```
mean1 = mean(condition1)/0.01 %rescaling to Hz
```

```
mean1 = 1×101
   10.0000   20.0000   10.0000   10.0000    5.0000         0    5.0000    5.0000 ···
```

```
sd1 = std(condition1)/0.01
```

```
sd1 = 1×101
   30.7794   41.0391   30.7794   30.7794   22.3607         0   22.3607   22.3607 ···
```

```
mean2 = mean(condition2)/0.01
```

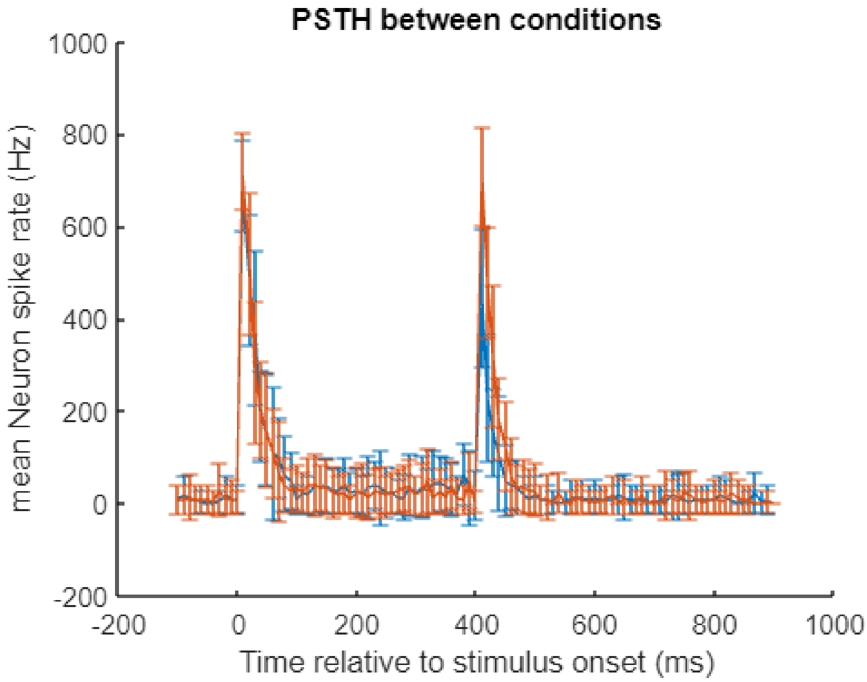
```
mean2 = 1×101
   10.0000   10.0000   15.0000   10.0000   10.0000   10.0000    5.0000   30.0000 ···
```

```
sd2 = std(condition2)/0.01
```

```
sd2 = 1×101
   30.7794   30.7794   48.9360   30.7794   30.7794   30.7794   22.3607   57.1241 ···
```

```
figure; hold on;
errorbar((edges-100),mean1,sd1);
```

```
errorbar((edges-100),mean2,sd2);
title('PSTH between conditions');
xlabel('Time relative to stimulus onset (ms)')
ylabel('Mean neuron spike rate (Hz)')
```



Q11. Are the responses of the neuron different in the two conditions? At what time are the responses most different?

A: The above figure would suggest that the neuron's responses are not different between conditions.

```
whichMaxDiff = find(abs(mean2-mean1)==max(abs(mean2-mean1)))
```

```
whichMaxDiff = 52
```

Thelargest difference in spike rate is observed between 510 and 520 milliseconds

```
diffTrials1 = condition1(:,whichMaxDiff);

diffTrials2 = condition2(:,whichMaxDiff);

[h, p] = ttest2(diffTrials1,diffTrials2); %checking whether they come from
distributions with equal means.

p
```

```
P = 1.5146e-07
```

Q12. Are the responses significantly different at P<0.01? What about P<0.001?

```
p < 0.01
```

```
ans = logical
   1
```

```
p < 0.001
```

```
ans = logical
   1
```

A: Yes to both. (we have $p < 10^{-6}$).

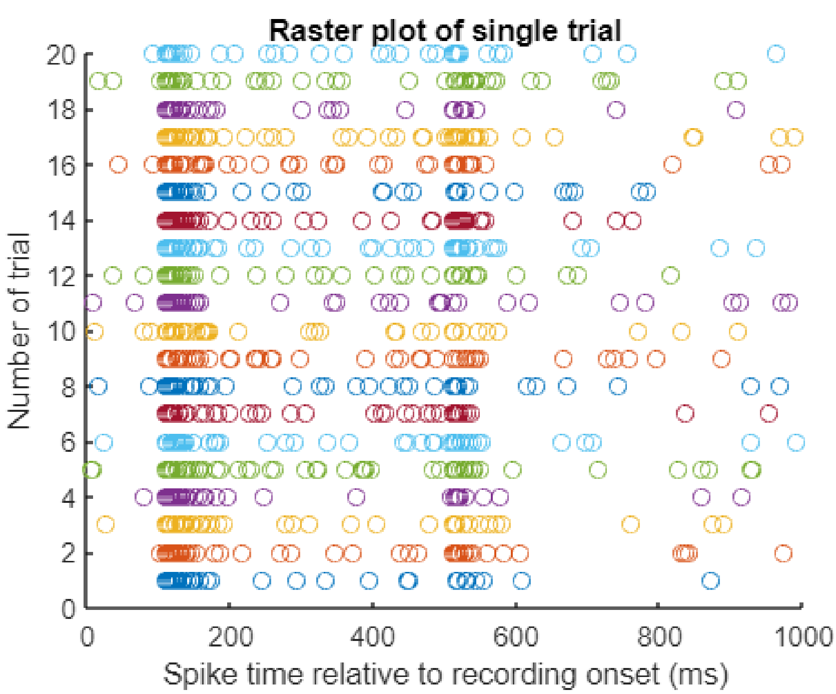
Part IV: Cell arrays

Q13. Label your axes, give your figure a title and paste it into your Word document.

```
nTrials = size(spiketimes1,2)
```

```
nTrials = 20
```

```
figure; hold on;
for i= 1:nTrials
sz= size(spiketimes1{i});
%following instructions to make a raster plot
plot(spiketimes1{i},ones(sz)*i,'o');
xlabel('Spike time relative to recording onset (ms)')
ylabel('Number of trial')
title('Raster plot of single trial')
end
hold off;
```



Q14. Label your axes, give your figure a title and paste it into your Word document.

```
allTrialData = [spiketimes1{:}];
nTrials = size(spiketimes1,2);
edges = 0:10:1000;
response=histc(allTrialData,edges); %count trials in each bin
response=response/0.01; %spike Hz second by scaling to length of the bin.
meanResponse = response/nTrials;

bar((edges-100),meanResponse, 'histc');
xlabel('Time relative to stimulus onset (ms)')
ylabel('Mean neuron spike rate (Hz)')
title('Mean PSTH across 20 trials')
```