**Intan Ephys Analysis Optimization**

A Documentation presented

by

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to

Olavarria Lab

Department of Psychology

in partial fulfillment of the data analysis task

in the subject of

Computational Neuroscience

University of Washington

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**Abstract:**

The thesis is given birth due to the need to analyze a set of data and the curiosity of finding the best way to generate and present the result, and to simplify the entire Ephys analysis in a simple protocol.

**Comment:**

This documentation is mainly for the purpose of recording my thoughts and attempts in optimizing the data analysis task, therefore not in a standard of submission in any kind.

**Keyword:**

Matlab, Mac Terminal, Ephys Experiments

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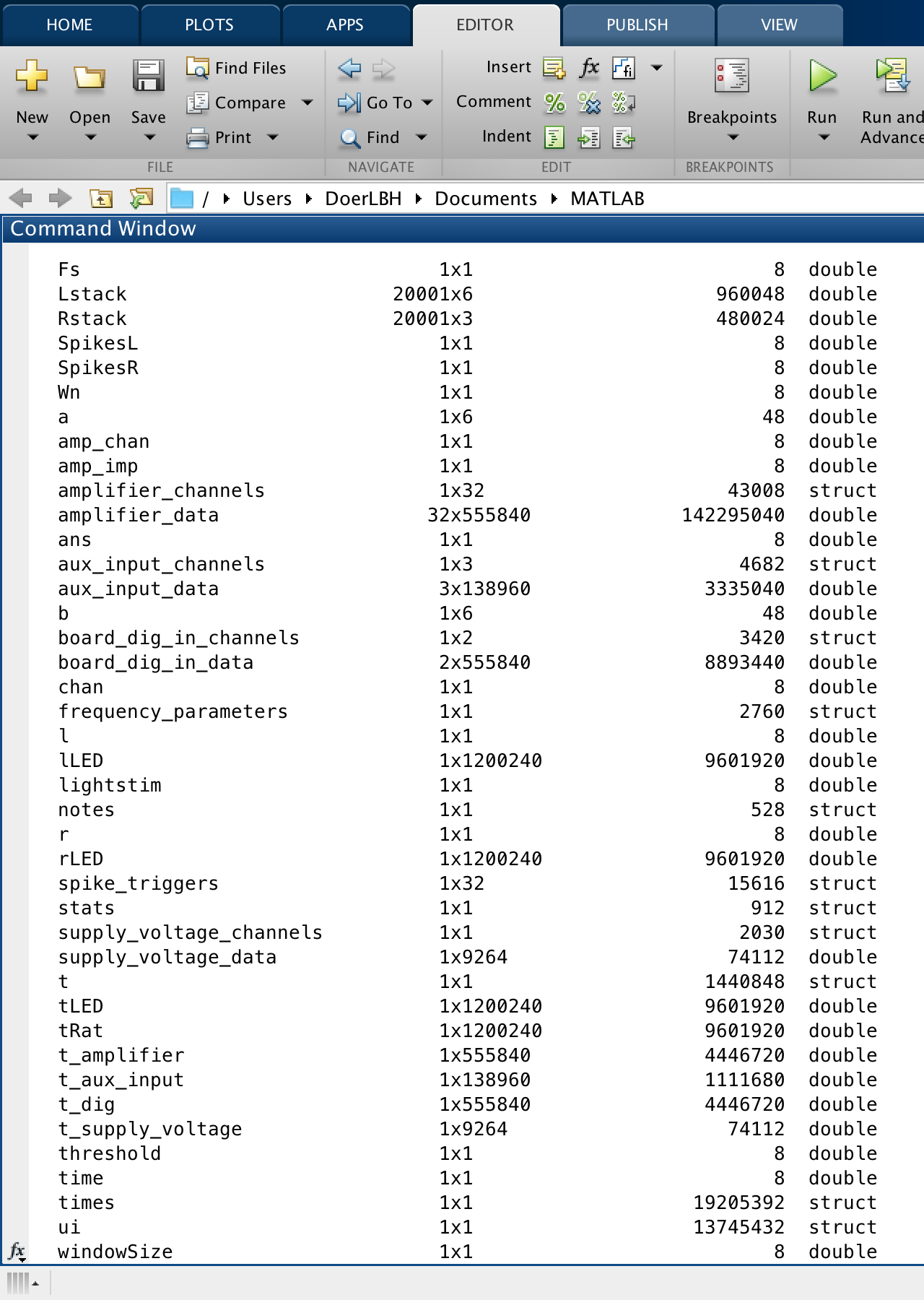
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**Traditional Solution:**

**(Efficiency to improve)**

To analyze the patchness, the operational definition might be the patchy darkness difference appeared on V1 of ipsi and contra cortices after tracer injected and HRP reaction. Therefore using ImageJ plot profile is the most approachable choice.



Fs

Lstack

Rstack

SpikesL

SpikesR

Wn

a

amp\_chan

amp\_imp

amplifier\_channels

amplifier\_data

ans

aux\_input\_channels

aux\_input\_data

b

board\_dig\_in\_channels

board\_dig\_in\_data

chan

frequency\_parameters

l

lLED

lightstim

notes

r

rLED

spike\_triggers

stats

supply\_voltage\_channels

supply\_voltage\_data

t

tLED

tRat

t\_amplifier

t\_aux\_input

t\_dig

t\_supply\_voltage

threshold

time

times

ui

windowSize

amplifier\_channels 1x32 43008 struct

amplifier\_data 32x555840 142295040 double

aux\_input\_channels 1x3 4682 struct

aux\_input\_data 3x138960 3335040 double

board\_dig\_in\_channels 1x2 3420 struct

board\_dig\_in\_data 2x555840 8893440 double

frequency\_parameters 1x1 2760 struct

notes 1x1 528 struct

spike\_triggers 1x32 15616 struct

supply\_voltage\_channels 1x1 2030 struct

supply\_voltage\_data 1x9264 74112 double

t\_amplifier 1x555840 4446720 double

t\_aux\_input 1x138960 1111680 double

t\_dig 1x555840 4446720 double

t\_supply\_voltage 1x9264 74112 double

amplifier\_data 32x555840 142295040 double

aux\_input\_data 3x138960 3335040 double

board\_dig\_in\_data 2x555840 8893440 double

supply\_voltage\_data 1x9264 74112 double

t\_amplifier 1x555840 4446720 double

t\_aux\_input 1x138960 1111680 double

t\_dig 1x555840 4446720 double

t\_supply\_voltage 1x9264 74112 double

/Users/DoerLBH/Dropbox/git/OLab\_IntanEphys/Data/test

%% Begin with opening file to be analyzed

clear all %Starting a new analysis so we want to eliminate all old variables

close all

%

%First we import the data using:

%read\_Intan\_RHD2000\_file = Opens the Matlab file browser UI to locate the

%file of interest. Afterward it reads header info and establishes basic

%variables from the .rhd file

%

read\_Intan\_RHD2000\_file

%

%From function info: % Reads Intan Technologies RHD2000 data file generated by evaluation board

% GUI. Data are parsed and placed into variables that appear in the base

% MATLAB workspace. Therefore, it is recommended to execute a 'clear'

% command before running this program to clear all other variables from the

% base workspace.

%check what variables have been imported, especially if youre unsure

%whether accessory amplifier channels were disabled or not during recording

%% Establishing some basic variables from values pulled in by above function

amplifier\_channels(1) %Channel data is being collected on (on

%preamplifier this would be 'A-004'

%Above command gives data output about the channel on which data is being

%collected

%% Variable name changes below to simplify:

tRat = t\_amplifier; %time variable for ephys data

tLED = t\_dig; %time variable for LED data

ui.ratData = amplifier\_data(1,:);

lLED = board\_dig\_in\_data(1,:);

rLED = board\_dig\_in\_data(2,:);

% %% Check variables look right-- plot should be identical to last one

% figure % for spike detection

% hold on

% plot(tRat, ui.ratData,'blue')

% plot(tLED,lLED,'red') %max makes red lines continue across top half of vertical axis

% plot(tLED,rLED,'green')

% xlabel 'time (s)'

% ylabel 'amplitude (A.U.)'

% legend('Raw Data', 'Left Eye LED','Right Eye LED')

%% filter data

Wn = 300/10000; % Normalized cutoff frequency

[b,a] = butter(5,Wn,'high');

ui.ratData = filtfilt(b,a,ui.ratData);

%% invert signal data for thresholding

ui.ratData = ui.ratData.\*(-1);

%% Setting threshold for spikes and finding light ON times

threshold = 20;

Fs = 20000; %amplifier\_sample\_rate

windowSize = Fs \* 0.05; %creates our time interval by taking the 20k

% sampling rate at which the data was collected and converts it to

% timestamps collected every millisecond, in other words the value of

% windowSize is 1 ms.

% Finding all spikes in recording:

ui.spikes = diff(ui.ratData > threshold) > 0.1;

%% Plot Again with spikes showing & correct time axis now:

t=length(tRat)-1

figure % for spike detection

hold on

plot(tRat(1:t), ui.ratData(1:t),'blue')

plot(tRat(1:t), ui.spikes\*max(ui.ratData),'black')

plot(tLED(1:t),lLED(1:t)\*80,'green') %max makes red lines continue across top half of vertical axis

plot(tLED(1:t),rLED(1:t)\*80,'red')

xlabel 'time (s)'

ylabel 'amplitude (A.U.)'

legend('Raw Data', 'Spikes', 'Left Eye LED','Right Eye LED')

%% Count spikes during each LED stimulation

SpikesL = sum(ui.spikes.\*lLED(1:end-1))

SpikesR = sum(ui.spikes.\*rLED(1:end-1))

%% This creates a whole lot of extra light related variables, but unsure if they are actually useful

lightstim = 199; %change?

ui.leftLEDon = diff(lLED < -lightstim)>0.1;

ui.rightLEDon = diff(rLED < -lightstim)>0.1;

% times.leftLED = find(leftLED == 500);

% times.rightLED = find(rightLED == 500);

%rewrite:

times.lLEDon = find(lLED == 1);

% Gives all time points that left LED is on

%result is a vector 1 x 80299

times.lLEDoff = find(lLED == 0);

% Gives all time points that left LED is off

%result is a vector 1 x 1119941

times.rLEDon = find(rLED == 1);

times.rLEDoff = find(rLED == 0);

% the above code will break out the time points when the LED is on for each

% side and when it is off. Next step:

% Need to ask it to count how many times ui.spikes takes place

% during each LEDon segment

%% gets light "on" times into one array

times.lLEDstart = times.lLEDon(diff(times.lLEDon)>Fs\*0.05);

%results in three specific time points for this LED

times.rLEDstart = times.rLEDon(diff(times.rLEDon)>Fs\*0.05);

% this turns the times.xLEDon into a list of the points when the LED turned

% on \*\*\*Use this for making a raster plot\*\*\*\*

%results in two specific time points for this LED

%% create raster plots-Left Stim

% Error: Subscript indices must either be real ve integers or

% logicals.

for l = 1:length(times.lLEDstart)

% collects window of data each time the light stimulus initiated

windowSize = round(Fs\*0.5); % window size in samples

ui.Lrastercell{l} = ui.spikes(times.lLEDstart(l) - windowSize:times.lLEDstart(l) + windowSize);

end

%In original script, variable that's equivalent to 'times.lLEDon' is e.g.

% a 23x1 double that includes only the start times for light turning

% on. Maybe be better to use times.lLEDstart?

%times.lLedon in this script gives the chunks when led was on, aka a

%1x80299 double

t.Lraster = transpose((1:length(ui.Lrastercell{1}(:)))/Fs);

t.Lraster = repmat(t.Lraster,1,length(times.lLEDstart));

% creates time vector for raster

times.Lrasterlight = 1:(length(times.lLEDstart));

t.Lrasterlight = ones(1,(length(times.lLEDstart)))\*windowSize/Fs;

% creates dashed line for indicating stim onset on raster plot

ui.Lraster = horzcat(ui.Lrastercell{:});

% concatenates cell array into a double

Lstack = repmat(1:length(times.lLEDstart),length(t.Lraster),1);

% creates transform for stacking windowed data for the raster plot

%% create raster plots-Right Stim

% Error: Subscript indices must either be real ve integers or

% logicals.

for r = 1:length(times.rLEDstart)

% collects window of data each time the light stimulus initiated

windowSize = round(Fs\*0.5); % window size in samples

ui.Rrastercell{r} = ui.spikes(times.rLEDstart(r) - windowSize:times.rLEDstart(r) + windowSize);

end

t.Rraster = transpose((1:length(ui.Rrastercell{1}(:)))/Fs);

t.Rraster = repmat(t.Rraster,1,length(times.rLEDstart));

% creates time vector for raster

times.Rrasterlight = 1:(length(times.rLEDstart));

t.Rrasterlight = ones(1,(length(times.rLEDstart)))\*windowSize/Fs;

% creates dashed line for indicating stim onset on raster plot

ui.Rraster = horzcat(ui.Rrastercell{:});

% concatenates cell array into a double

Rstack = repmat(1:length(times.rLEDstart),length(t.Rraster),1);

% creates transform for stacking windowed data for the raster plot

%% Before running next part, need to find how many times light goes on,

% do this by checking the variable "times.lLEDstart" and "times.rLEDstart".

% It will either show the exact values for the start times or will indicate

% how many different light on times there are, if trials exceeds ~5.

times

%% this number needs to be input as last value in reshape function below:

ui.LrasterStack = reshape(ui.Lraster,20001,3);

ui.RrasterStack = reshape(ui.Rraster,20001,2);

%% Check plot to verify reshape has been applied appropriately to LEFT data:

figure % creates raster plot

plot(t.Lraster,ui.LrasterStack+Lstack);

hold on

plot(t.Lrasterlight,times.Lrasterlight,'-.black');

hold off

ylabel 'trial number'

xlabel 'time (s)'

%% Check plot to verify reshape has been applied appropriately to RIGHT data:

figure % creates raster plot

plot(t.Rraster,ui.RrasterStack+Rstack);

hold on

plot(t.Rrasterlight,times.Rrasterlight,'-.black');

hold off

ylabel 'trial number'

xlabel 'time (s)'

%% Lastly, get spike averages for each eye

stats.spikes.Laveon = sum(sum(ui.LrasterStack(windowSize:end,:)))/length(times.lLEDstart);

% % calculates average number of spikes after light turned on

stats.spikes.Laveoff = sum(sum(ui.LrasterStack(1:windowSize,:)))/length(times.lLEDstart);

% % calculates average number of spikes preceding light onset

stats.spikes.Laveon

stats.spikes.Laveoff

%% Lastly, get spike avwerages for each eye

stats.spikes.Raveon = sum(sum(ui.RrasterStack(windowSize:end,:)))/length(times.rLEDstart);

% % calculates average number of spikes after light turned on

stats.spikes.Raveoff = sum(sum(ui.RrasterStack(1:windowSize,:)))/length(times.rLEDstart);

% % calculates average number of spikes preceding light onset

stats.spikes.Raveon

stats.spikes.Raveoff

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(**Note:** Some methods mentioned above is only in my plan for summer, thus not explored deep into details,and not referenced here for now)

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I will continue the voyage of exploring the infinite realm of neuroscience in my academic career fearlessly.

Baihan Lin

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