Summer Research Project Report Part 1 - Time intervals

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Contents

1 Testing the intervals between flashes

1.1 Individual channels, for a particular culture

If we have assume that there are no patterns and just random noise, then we expect that for each channel in every culture and plating, the time between spikes is distributed exponentially, as we expect that the system has no memory of previous spikes, or surrounding spikes. Let X be the length of the interval before the next spike

So under the null, we expect that $X \sim \text{Exp}(\lambda)$, so $\mathbb{E}[X] = \frac{1}{\lambda}$ and $\text{Var}(X) = \frac{1}{\lambda^2}$, and so $C_v = \frac{\sigma}{\mu} = 1$

By observation, we can see that in some cultures, this is certainly not true, and the value of C_v seems to deviate significantly from 1, often getting larger than 1 as time goes on. This indicates that the spikes are getting more dispersive.

The boxplots are each for a particular culture, across every div for which data is available. For a given div, the boxplot data is from the recordings of the 60 channels. Many channels only spike a few times - for example, over a quarter did not spike more than 500 times over all divs for Culture $1-3$. Therefore these data are omitted.

1.2 Finding λ

In order to find λ, we need to take the reciprocal of the sample expectation.

In the rest of the document, I focus on the culture 1-3. I look at an individual channel, 49, and also the collection of all channels. These are both arbitrarily chosen.

Table 1: Expected interval lengths between flashes in culture 1-3, and estimation of lambda (channel 49)

Div	Sample Expectation	Estimate for λ
4	7.278349	0.137394
5	2.380654	0.420053
6	6.209933	0.161032
7	4.463837	0.224022
8	3.93533	0.254108
9	1.090983	0.916604
10	0.210622	4.747841
11	0.241741	4.13666
12	0.198811	5.02991
13	0.135562	7.376717
14	0.095558	10.46481
16	0.085162	11.74236
17	0.153134	6.530233
18	0.135885	7.359139
19	0.145544	6.870797
24	0.20867	4.792261
25	0.176588	5.662894

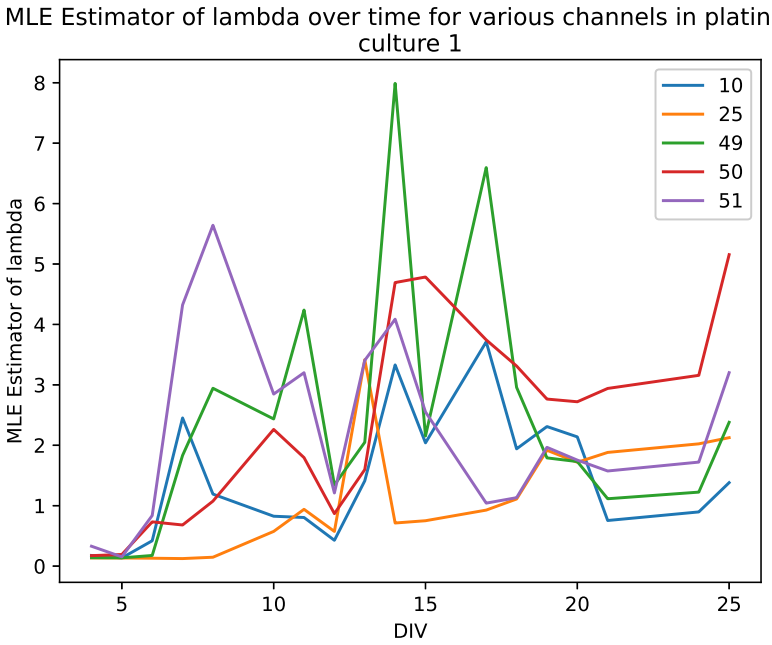
Similarly, we can look at all of the channels in the culture 1-3:

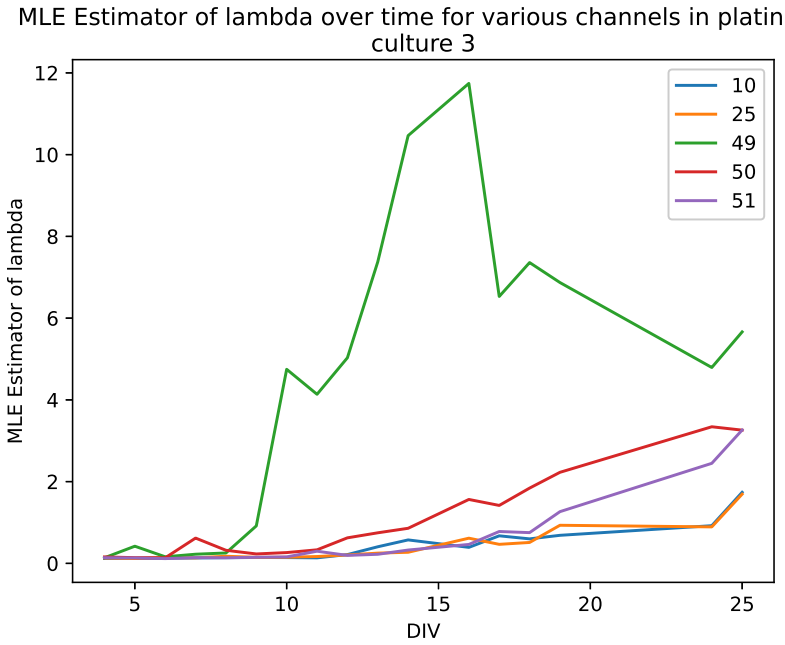
Table 2: Expected interval lengths between flashes in culture 1-3, and estimation of lambda (over all channels)

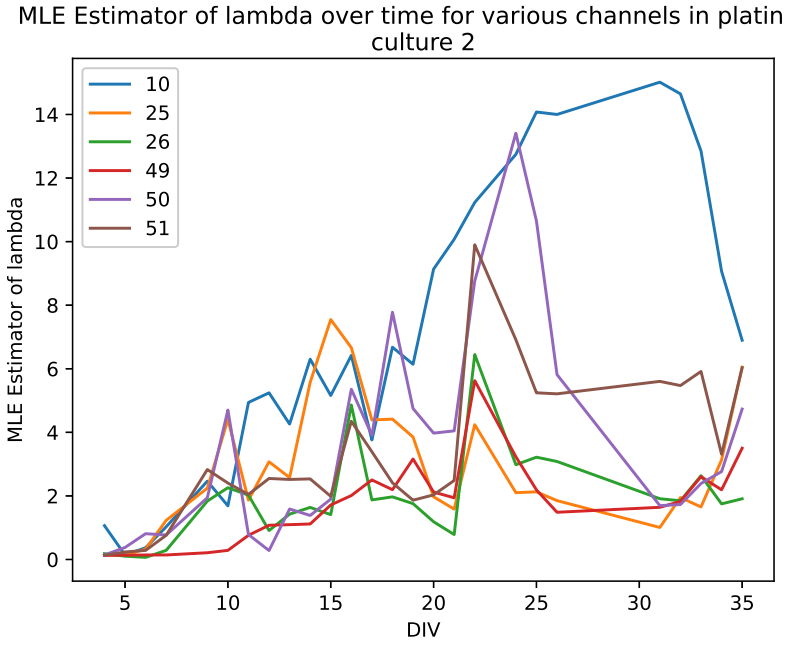
Div	Sample Expectation	Estimate for λ
4	0.081648	12.24766
5	0.054219	18.44384
6	0.068725	14.55073
7	0.033982	29.42738
8	0.024016	41.63885
9	0.022305	44.83354
10	0.017574	56.90181
11	0.020831	48.00558
12	0.023867	41.89802
13	0.015685	63.75628
14	0.017571	56.91138
16	0.014759	67.7562
17	0.014465	69.1305
18	0.0145	68.96681
19	0.012917	77.42008
24	0.010573	94.57647
25	0.007715	129.6119

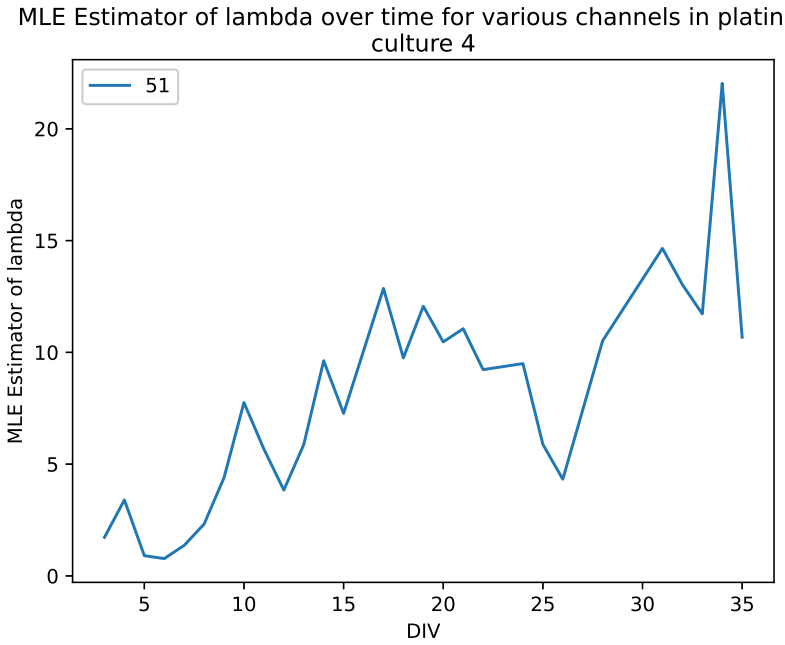
1.3 Line plots for estimates of Lambda for selected channels across various platings and cultures

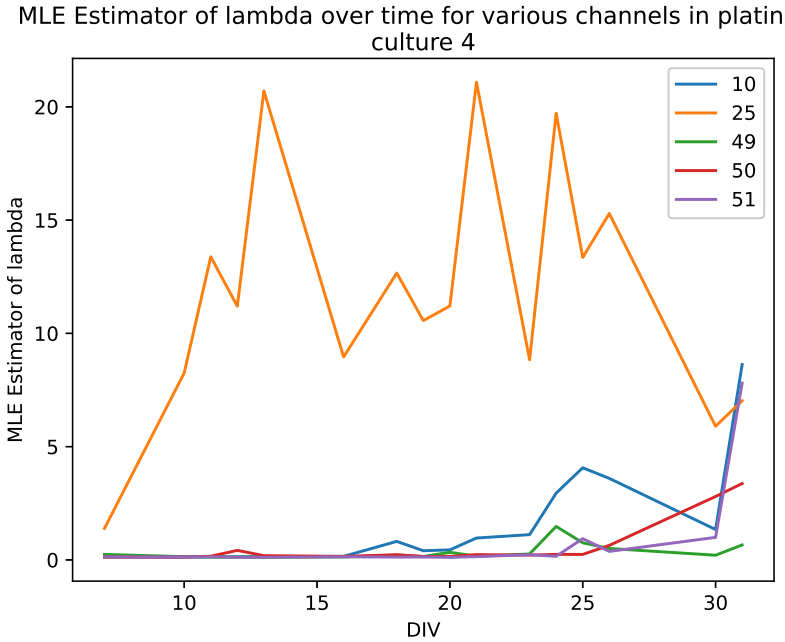
These plots are only of channels for which the MLE λ has a $C_v < 0.1$

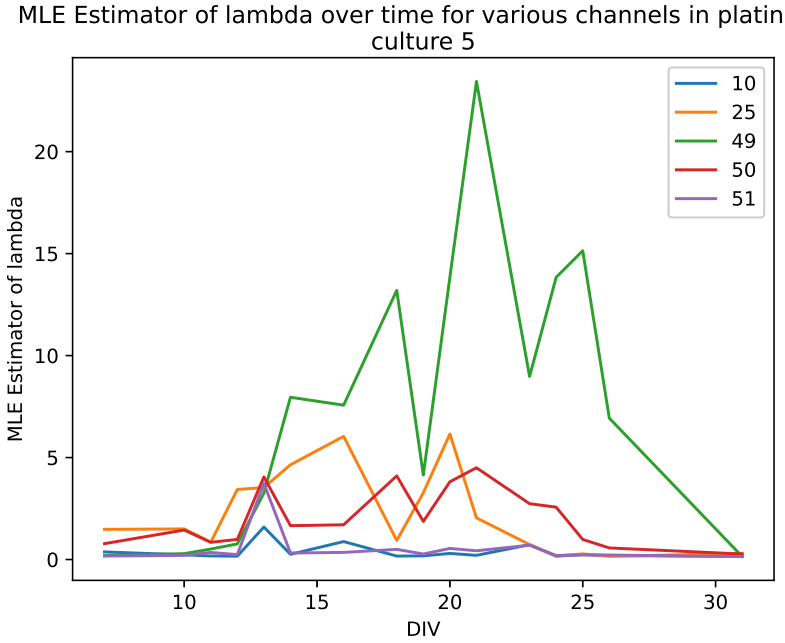


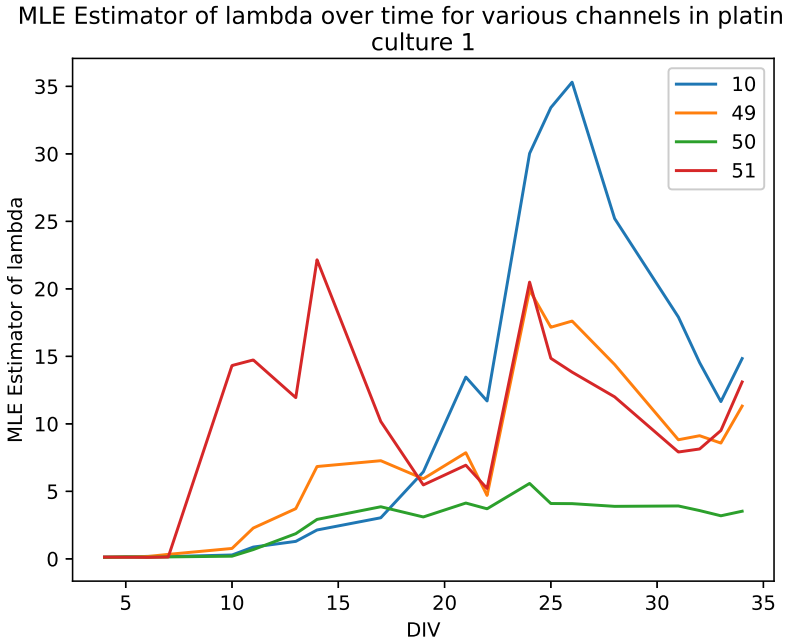

MLE Estimator of lambda over time for various channels in plating 1, culture 3
MLE Estimator of lambda
DIV
10
25
49
50
51

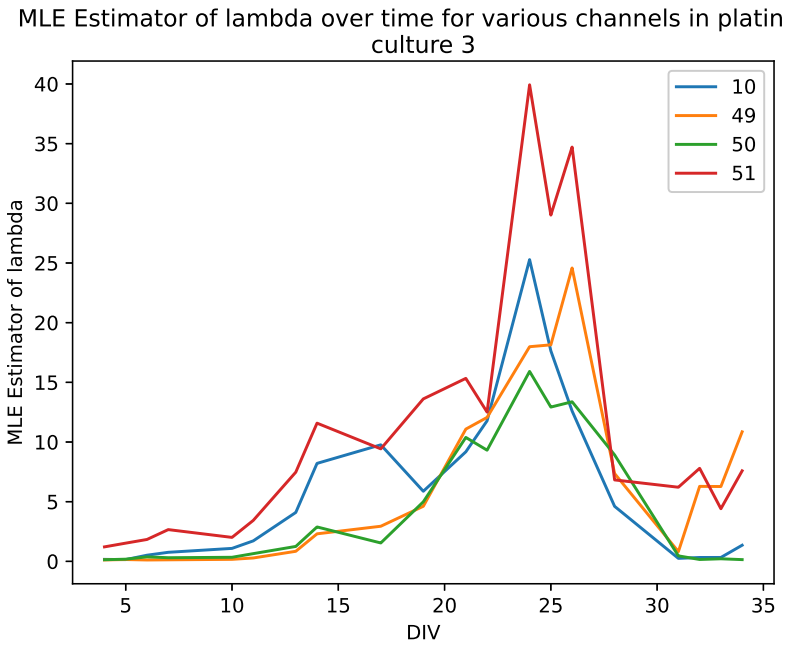

MLE Estimator of lambda over time for various channels in plating 2, culture 2
MLE Estimator of lambda
DIV
10
25
26
49
50
51


MLE Estimator of lambda over time for various channels in plating 2, culture 4
51
MLE Estimator of lambda
DIV
0
5
10
15
20
5
10
15
20
25
30
35


MLE Estimator of lambda over time for various channels in plating 3, culture 4
10
25
49
50
51
MLE Estimator of lambda
DIV
0
5
10
15
20
10
15
20
25
30


MLE Estimator of lambda over time for various channels in plating 3, culture 5
MLE Estimator of lambda
DIV
10
25
49
50
51
0
5
10
15
20
10
15
20
25
30


MLE Estimator of lambda over time for various channels in plating 6, culture 1
MLE Estimator of lambda
DIV
10
49
50
51
0
5
10
15
20
25
30
35
5
10
15
20
25
30
35


MLE Estimator of lambda over time for various channels in plating 6, culture 3
MLE Estimator of lambda
DIV
10
49
50
51
0
5
10
15
20
25
30
35
40