First list the sessions in the database.

```
warning('off')
T = make_sessions_table
```

```
T = 35×18 table
```

...

	sess_date	rat	sessid	mat_file_name	probe_serial	days_implanted
1	27-May-2019	"K265"	699605	""X:\RATTER\PhysDat...	"17131311562"	5
2	30-May-2019	"A242"	700519	"X:\RATTER\PhysData...	"17131311621"	10
3	03-Jun-2019	"A242"	701531	"X:\RATTER\PhysData...	"17131311621"	14
4	06-Jun-2019	"A242"	702016	"X:\RATTER\PhysData...	"17131311621"	17
5	07-Jun-2019	"A242"	702361	"X:\RATTER\PhysData...	"17131311621"	18
6	10-Jun-2019	"A242"	703121	"X:\RATTER\PhysData...	"17131311621"	21
7	12-Jun-2019	"A242"	703771	"X:\RATTER\PhysData...	"17131311621"	23
8	20-Jun-2019	"A242"	706158	"X:\RATTER\PhysData...	"17131311621"	31
9	28-Jun-2019	"A242"	708534	"X:\RATTER\PhysData...	"17131311621"	39
10	15-Jul-2019	"A230"	713429	"X:\RATTER\PhysData...	"17131308571"	13
11	26-Sep-2019	"A241"	734656	"X:\RATTER\PhysData...	"18194823302"	15
12	26-Sep-2019	"A243"	734648	"X:\RATTER\PhysData...	"18194824132"	13
13	30-Sep-2019	"X046"	735284	"X:\RATTER\PhysData...	"18194823122"	15
14	09-Oct-2019	"A241"	737985	"X:\RATTER\PhysData...	"18194823631"	28
15	10-Oct-2019	"A243"	738225	"X:\RATTER\PhysData...	"18194824132"	27
16	29-Oct-2019	"A243"	743494	"X:\RATTER\PhysData...	"18194824132"	46
17	01-Nov-2019	"A243"	744398	"X:\RATTER\PhysData...	"18194824132"	49
18	11-Dec-2019	"A241"	753483	"X:\RATTER\PhysData...	"18194823631"	91
19	14-Jan-2020	"A241"	760297	"X:\RATTER\PhysData...	"18194823631"	125
20	22-Jan-2020	"A241"	762805	"X:\RATTER\PhysData...	"18194823631"	133
21	23-Jan-2020	"A241"	763087	"X:\RATTER\PhysData...	"18194823631"	134
22	11-Feb-2020	"A249"	768938	"X:\RATTER\PhysData...	"18194819132"	7
23	04-Sep-2020	"A249"	784371	"X:\RATTER\PhysData...	"18194819132"	213
24	07-Sep-2020	"A249"	784741	"X:\RATTER\PhysData...	"18194819132"	216
25	07-Sep-2020	"A256"	784742	"X:\RATTER\PhysData...	"18194819321"	6
26	09-Sep-2020	"A249"	785000	"X:\RATTER\PhysData...	"18194819132"	218
27	11-Sep-2020	"A249"	785272	"X:\RATTER\PhysData...	"18194819132"	220
28	11-Sep-2020	"A256"	785275	"X:\RATTER\PhysData...	"18194819321"	10

	sess_date	rat	sessid	mat_file_name	probe_serial	days_implanted
29	23-Sep-2020	"A249"	786975	"X:\RATTER\PhysData...	"18194819132"	232
30	23-Sep-2020	"A256"	786978	"X:\RATTER\PhysData...	"18194819321"	22
31	25-Sep-2020	"A249"	787269	"X:\RATTER\PhysData...	"18194819132"	234
32	18-Sep-2020	"A249"	786254	"X:\RATTER\PhysData...	"18194819132"	227
33	18-Sep-2020	"A256"	786258	"X:\RATTER\PhysData...	"18194819321"	17
34	21-Sep-2020	"A256"	786682	"X:\RATTER\PhysData...	"18194819321"	20
35	28-Sep-2020	"A256"	787674	"X:\RATTER\PhysData...	"18194819321"	27

Load one of them (the last one, just for examples).

```
Cells = load(T.mat_file_name{end})
```

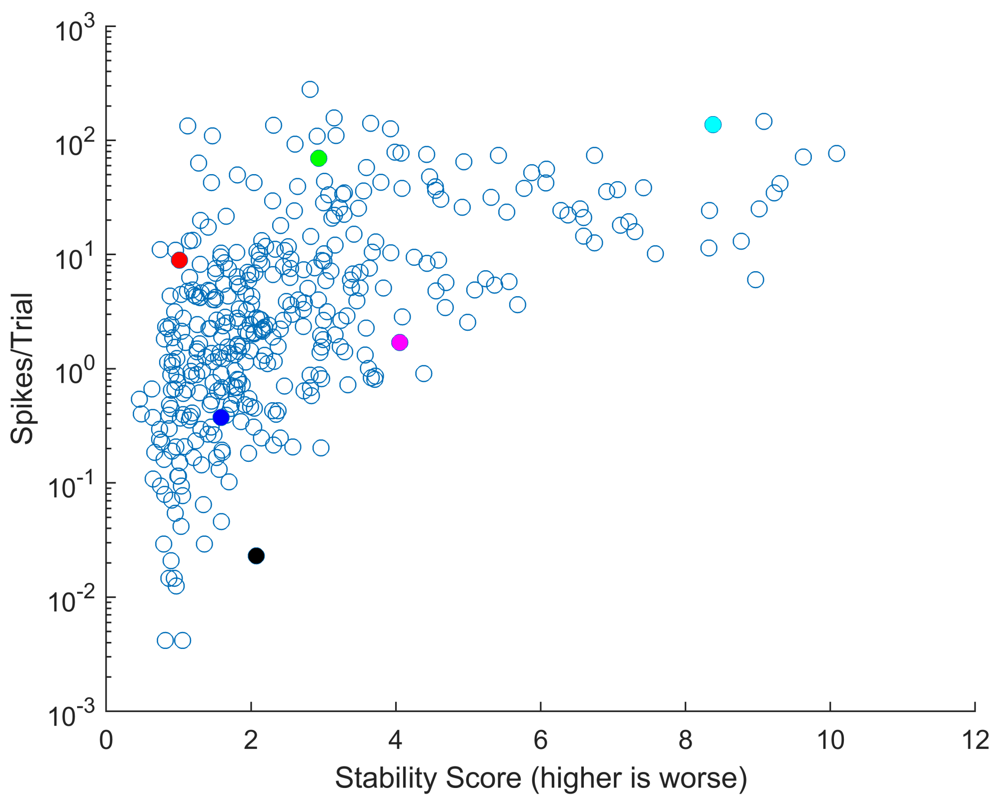
```
Cells = struct with fields:
                  rec: [1×1 struct]
             jrc_file: 'E:\Adrian\A256\A256_2020_09_28\A256_2020_09_28_g0\spikesort_2020_11_23_09_09_42_ks2jrc\A256
        mat_file_name: 'E:\Adrian\A256\A256_2020_09_28\A256_2020_09_28_g0\spikesort_2020_11_23_09_09_42_ks2jrc\A256
              made_by: 'make_Cells_from_JRC'
               params: 'time_s_from_last_ts_to_include_spike'
               Trials: [1×1 struct]
              nTrials: 479
               sessid: 787674
        last_modified: 25-Nov-2020 14:47:22
                  rat: 'A256'
            sess_date: '2020-09-28'
                 bank: [368×1 double]
            electrode: [368×1 double]
            unitCount: [368×1 double]
         unitISIRatio: [1×368 double]
           unitLRatio: [1×368 double]
          unitIsoDist: [1×368 double]
           unitVppRaw: [368×1 single]
      meanWfGlobalRaw: [61×306×368 single]
         clusterNotes: {368×1 cell}
          waveformSim: [368×368 double]
     raw_spike_time_s: {368×1 cell}
          firing_rate: [1×368 double]
         spike_time_s: [1×1 struct]
        kSpikeWindowS: [1×1 struct]
              ks_good: [1×368 logical]
   frac_isi_violation: [368×1 double]
             waveform: [1×368 struct]
             recorded: {368×1 cell}
    distance_from_tip: [368×1 double]
          penetration: [1×1 struct]
           hemisphere: 'right'
         probe_serial: '18194819321'
                   DV: [368×1 double]
                   ML: [368×1 double]
                   AP: [368×1 double]
              regions: [1×368 double]
```

Use the new utility function "calculate_unit_stability" to get the stability metric and number of spikes per trial for each cell. The stability metric is the ratio of sd's of two distributions of trial-averaged firing rates A and B. A is the distribution obtained by repeatedly sampling groups of contiguous trials. B is the distribution obtained by repeatedly sampling random groups of trials. If the ratio is large, it means sampling groups of trials that are contiguous in time gives a broader distribution of rates than you'd expect -- i.e. the variability in firing rate across time is systematic. For a neuron whose firing rate statistics do not change across the session, the stability metric would be exactly 1.

```
[stability,presence,nspks] = calculate_unit_stability(Cells)
```

```
stability = 1×368
    8.7693    2.5784    4.2533    4.0718    3.2662    1.8006    1.6544    2.4046 ···
presence = 1×368
    0.9875    0.1065    0.9958    1.0000    1.0000    0.8706    0.1795    0.5699 ···
nspks = 1×368
   13.1127    0.2067    9.4593   77.3779   33.7244   10.4280    0.3925    2.2296 ···
```

```
cla;scatter(stability,nspks);hold on
examples = [156 267 234 246 361 37];
colors ={'r','g','c','m','k','b'};
for i=1:6
    scatter(stability(examples(i)),nspks(examples(i)),colors{i},'filled');hold on;
end
xlabel('Stability Score (higher is worse)')
ylabel('Spikes/Trial')
set(gca,'yscale','log')
```

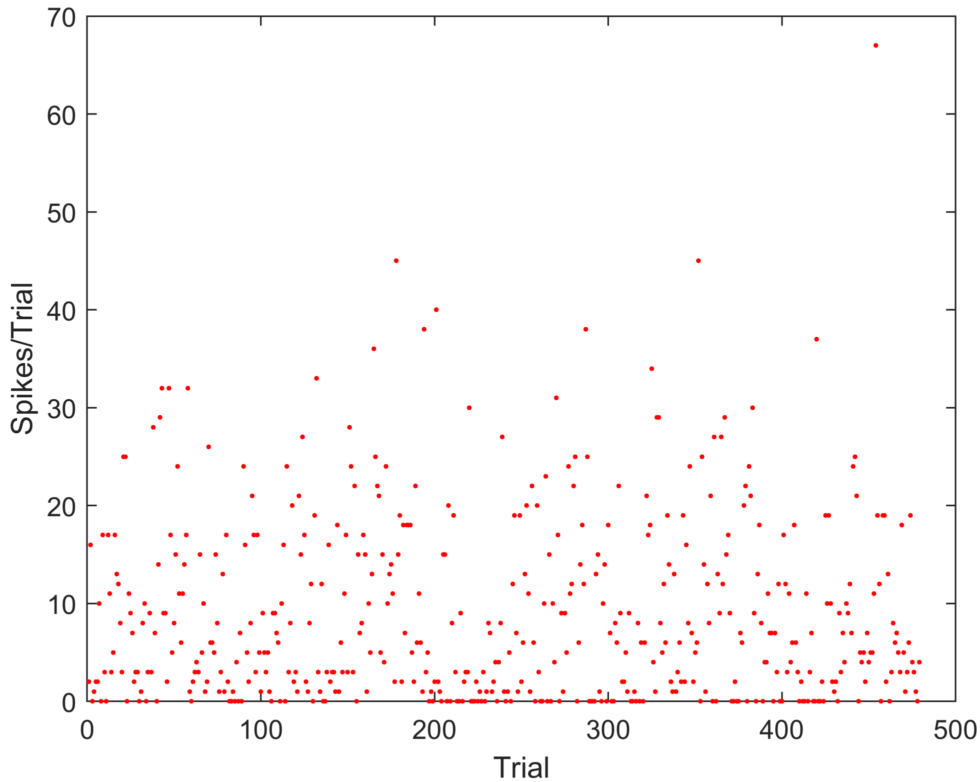


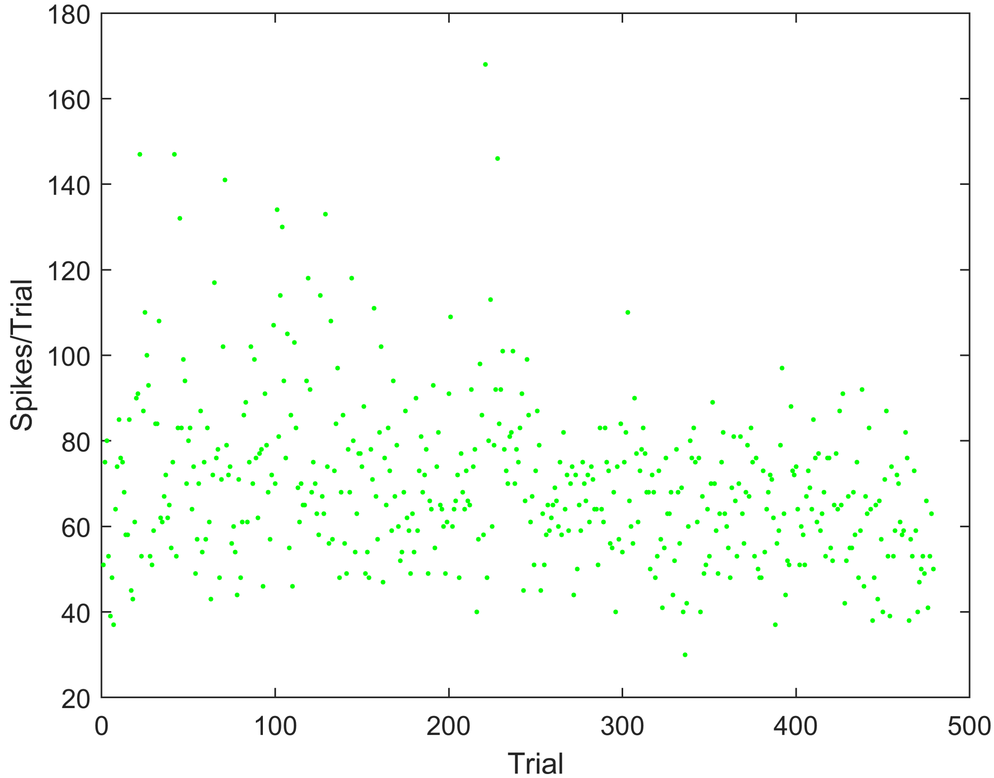
What you can see is that the majority of cells form a cluster with stability slightly above 1 (i.e. some excess variability across time but not much). Then there is a long tail of cells with stability values much greater than 1.

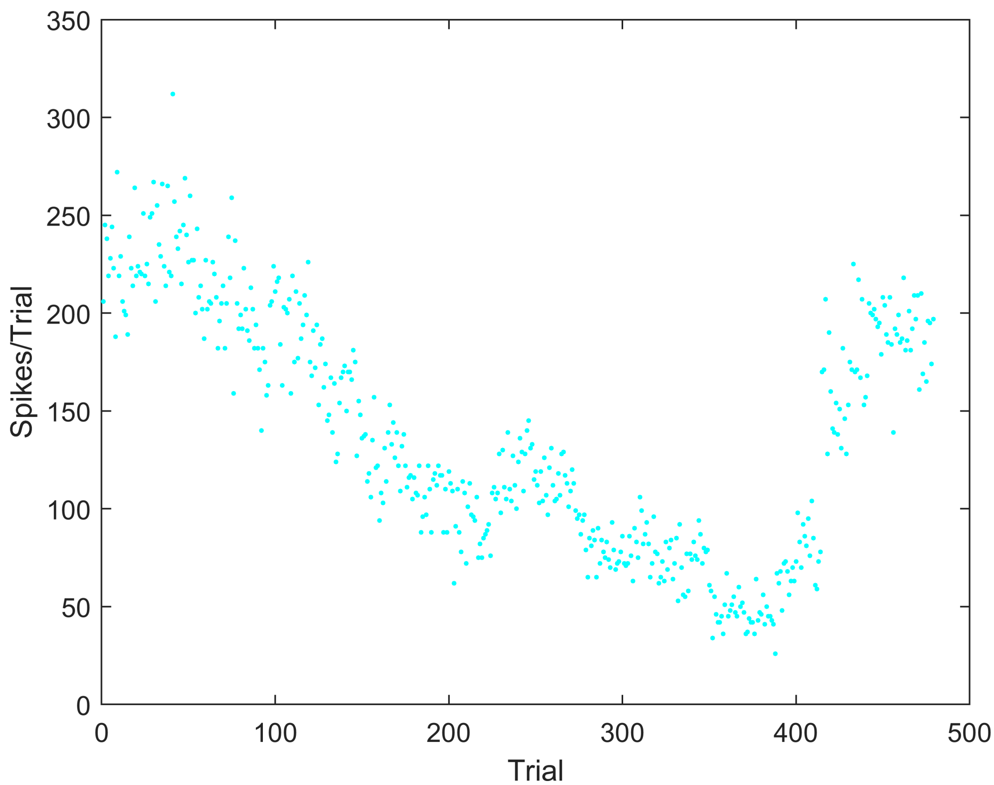
Cells with very low firing rates do not show large stability scores because Poisson variability (which shows up in both the A and B distribution) swamps variability across time. You probably want to exclude these cells anyway.

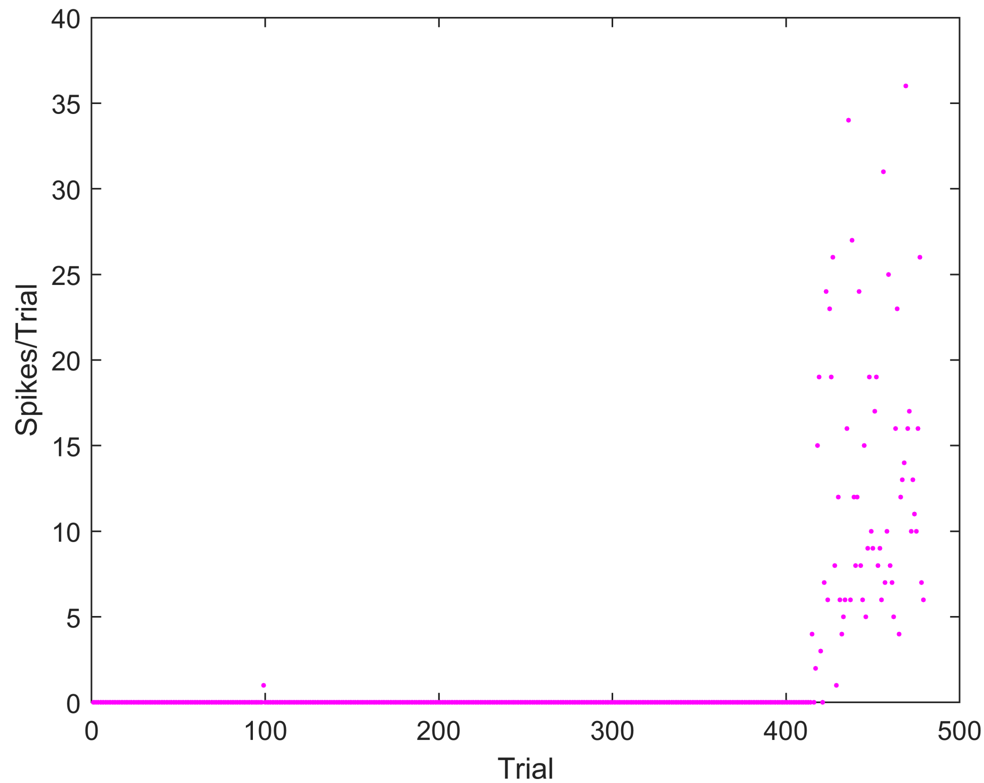
To get a sense of what the firing rate of cells in the above distribution look like, I've flagged 6 example cells. I've plotted spikes/trial across the session for each cell. A threshold of about 4 or 5 for the stability score seems reasonable to exclude cells which are truly anomalously unstable. This would exclude 10-15% of cells for this session.

```
for i=1:6
    figure;plot(cellfun(@numel,Cells.spike_time_s.cpoke_in{examples(i)}),sprintf('.%s',colors{i
end
```

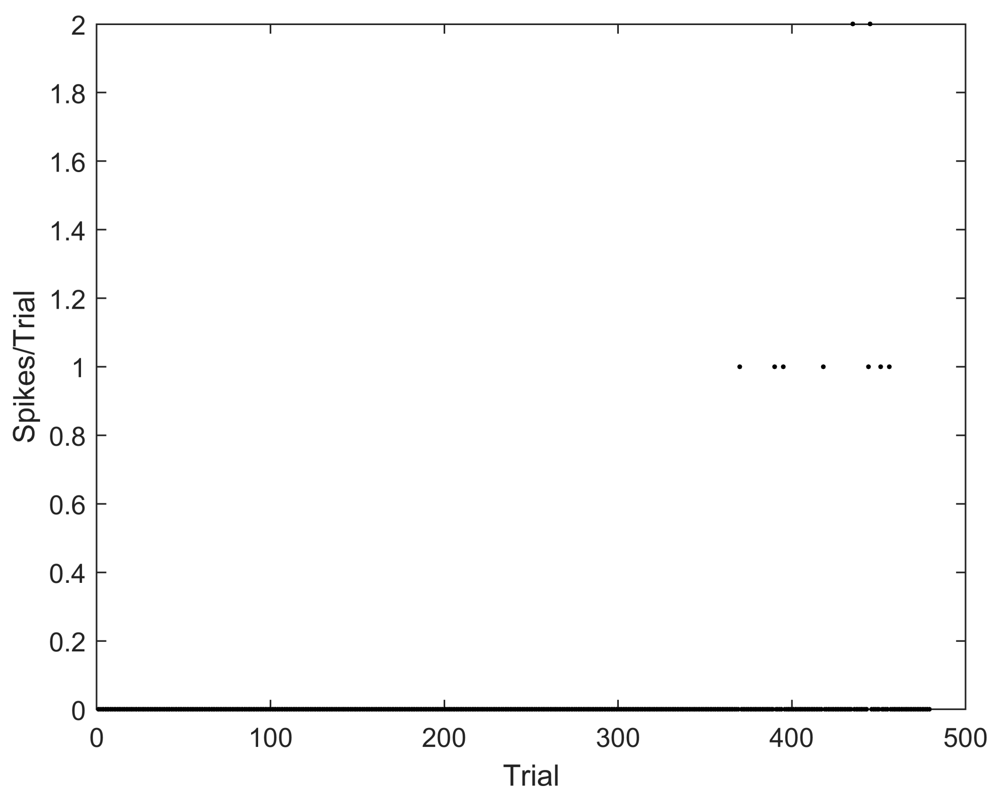



Spikes/Trial
Trial
180
160
140
120
100
80
60
40
20
0
100
200
300
400
500

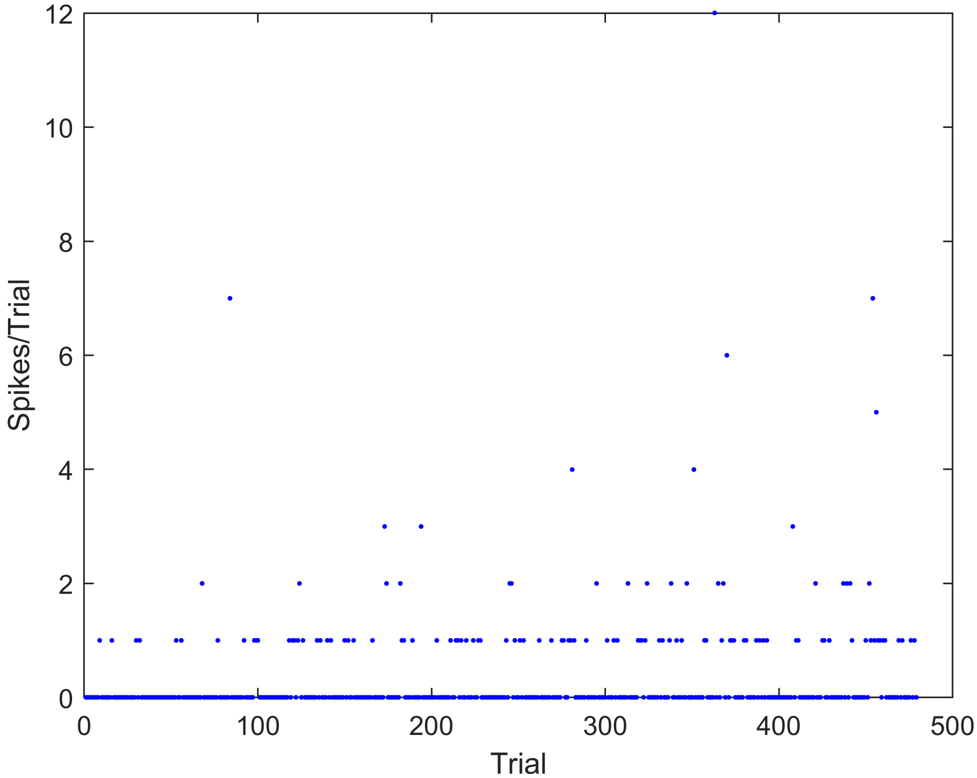

Spikes/Trial
Trial
350
300
250
200
150
100
50
0
100
200
300
400
500



Spikes/Trial
Trial
0
5
10
15
20
25
30
35
40
0
100
200
300
400
500

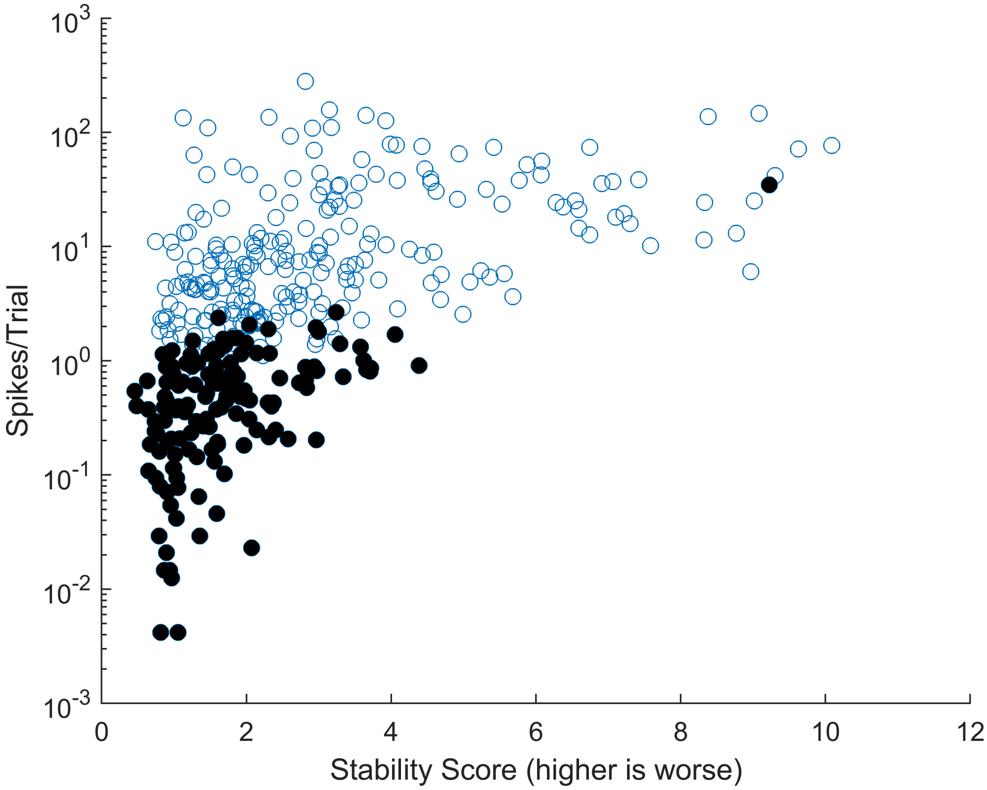


Spikes/Trial
Trial
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
0
100
200
300
400
500



The function "calculate_unit_stability" also returns a value called "presence." This is the fraction of trials for which a unit spiked. Excluding cells for which that value is less than 0.5 (i.e. fired on less than half of trials) seems also reasonable and excludes the low firing rate cells (about 1/3 of cells).

```
figure
scatter(stability,nspks)
hold on
scatter(stability(presence<0.5),nspks(presence<0.5),'k','filled')
set(gca,'yscale','log')
xlabel('Stability Score (higher is worse)')
ylabel('Spikes/Trial')
```



10^3
10^2
10^1
10^0
10^{-1}
10^{-2}
10^{-3}
Spikes/Trial
0
2
4
6
8
10
12
Stability Score (higher is worse)