Homework 2 - AMATH 342

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1 Part 1

1.1

Figure 1 shows images of the average preferred stimulus for different lengths of delay from 0 to 1 second. From these plots the clearest image can be seen at delay time 0.1 and 0.2 seconds. The average image shown at these times suggests that the neuron prefers an image with a bar of white pixels across the middle. It prefers the rest of the image to be dark. The result of the average stimuli would suggest that this is a simple cell because it is reacting to a bar of light in horizontal orientation. The cell would react to objects in the center of it's field in a natural image.

1.2

If the cell was in fact a complex cell then this average would be misleading since complex cells react to bars of light or dark wherever they are in the receptive field rather than in a specific location like the simple cells. Complex cells are said to be invariant since they are spatial phase selective for a particular image regardless of it's position in the field. This means that although the bar of light appears in the middle of the image the cell would reach spike wherever the bar is, leading us to misinterpret the results.

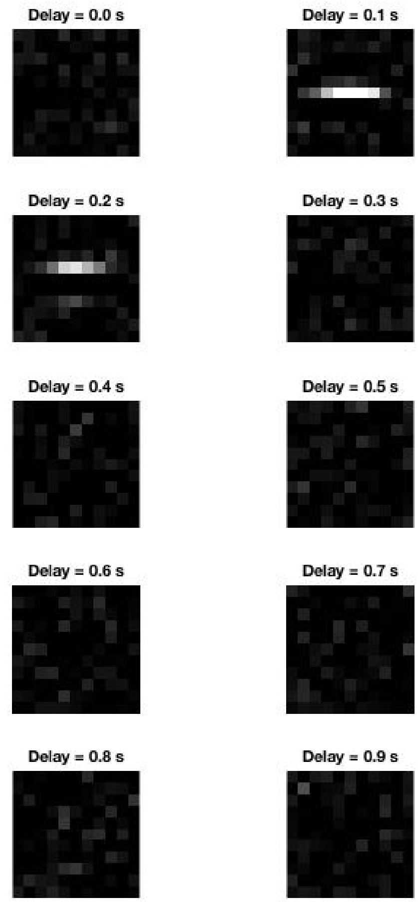

Figure 1: Average preferred stimuli image for delay between 0 and 1 second.

2 Part 2

2.1

a

The resulting error probability between an input direction of 50 and 54 for cell 1 is 0.0225.

b

When the angle changes from 52 to 53 the error goes from 18% to 8%.
Output:
ang2 = 52
error = 0.1835
ang2 = 53
error = 0.0860

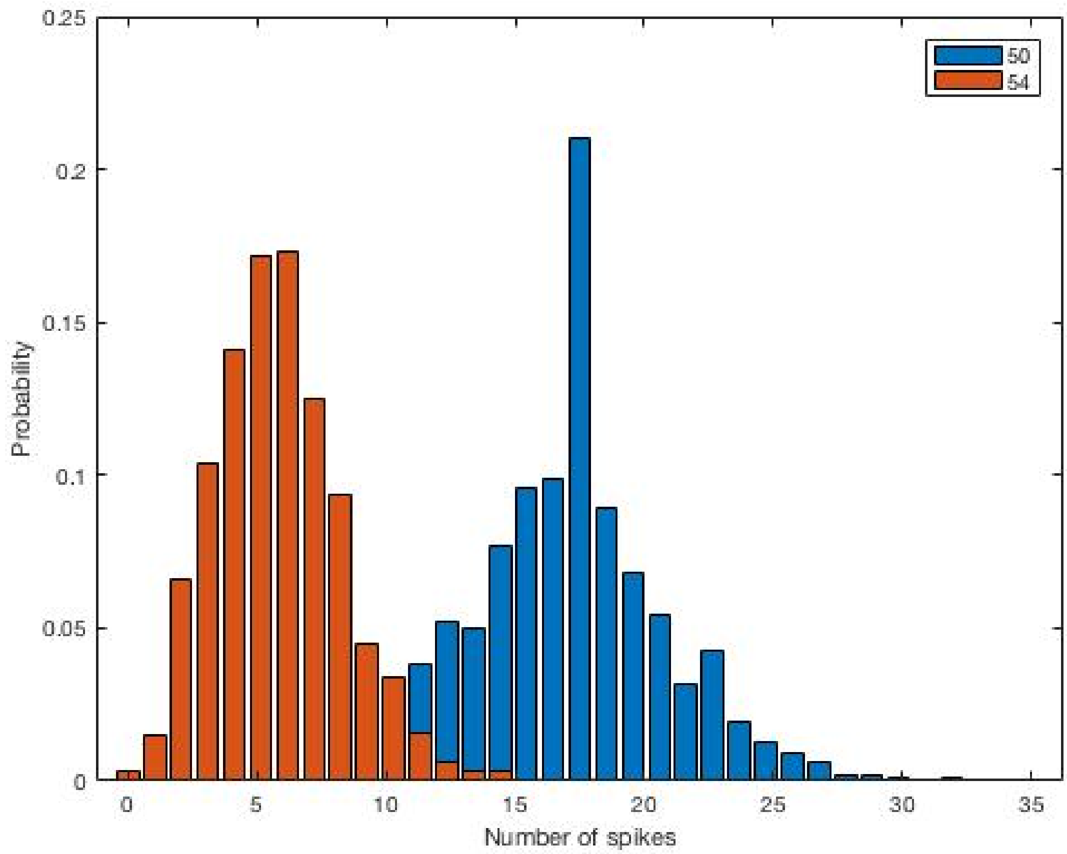

Figure 2: Histogram number of spikes vs probability for starting directions 50 and 54.

```
clear all; close all;

ang1 = 50;

spiketrain1 = generate_noisy_data_cockroach(ang1,1,1000);


bins = 35;

[counts1,center1] = hist(sum(spiketrain1,2),linspace(0,bins,bins));
ave1 = counts1/sum(counts1);

for ang2 = 51:56
    ang2
    spiketrain2 = generate_noisy_data_cockroach(ang2,1,1000);
    [counts2, center2] = hist(sum(spiketrain2,2),linspace(0,bins,bins));
    ave2 = counts2/sum(counts2);
    error = sum(ave1(ave1<ave2)).*0.5 + sum(ave2(ave2<ave1)).*0.5
end

%%
```

```
figure
bar(center1,ave1);
hold on


bar(center2,ave2);
legend('50','54')
xlabel('Number of spikes')
ylabel('Probability')
```

c

When the starting input is 20 there are often no spikes recorded. Running the above code with an ang2 range of 21-40 gives the following output.

Table 1: Table of error for various angles

Angle	21	22	23	24	25	26	27	28	29	30
Error	0	0	0.4995	0.4995	0.4930	0.4870	0.4825	0.4580	0.4250	0.3565
Angle	31	32	33	34	35	36	37	38	39	40
Error	0.2775	0.1905	0.1085	0.0380	0.0155	5.0000e-04	0	0	0	0

2.2

To achieve more discriminable results at firing angle of 20 degrees we can simply change the cockroach_tuning code so the mean value in the Gaussian (mu) is closer 20. This moves the tuning curve so that it is at it's maximum rate at 20 degrees. Figure 3 shows the histogram of spikes vs probability for this altered distribution.

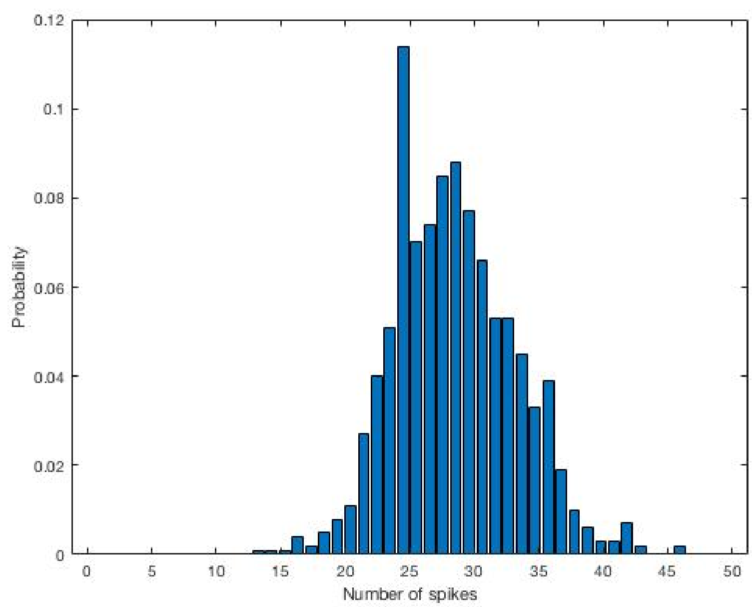

Figure 3: Histogram of spike probability for firing rate at 20 degrees, mu = 20.

```
function [ f ] = cockroach_tuning(stim_dir, cell_num)

    if cell_num == 1
        mu = 20;
        sigma = 5;
        f = gaussian(mu, sigma, stim_dir);
    elseif cell_num == 2
        mu = 45;
        sigma = 10;
        f = gaussian(mu, sigma, stim_dir);
    else
        mu = 30;
        sigma = 10;
        f1 = gaussian(mu, sigma, stim_dir);
        mu = 60;
        f2 = gaussian(mu, sigma, stim_dir);
        f = (f1 + f2);
    end
end

function [f] = gaussian(mu,sigma, x)
   maxrate = 300; % max firing rate
   f = maxrate*exp(-0.5*((x-mu)/sigma).^2);
end
```