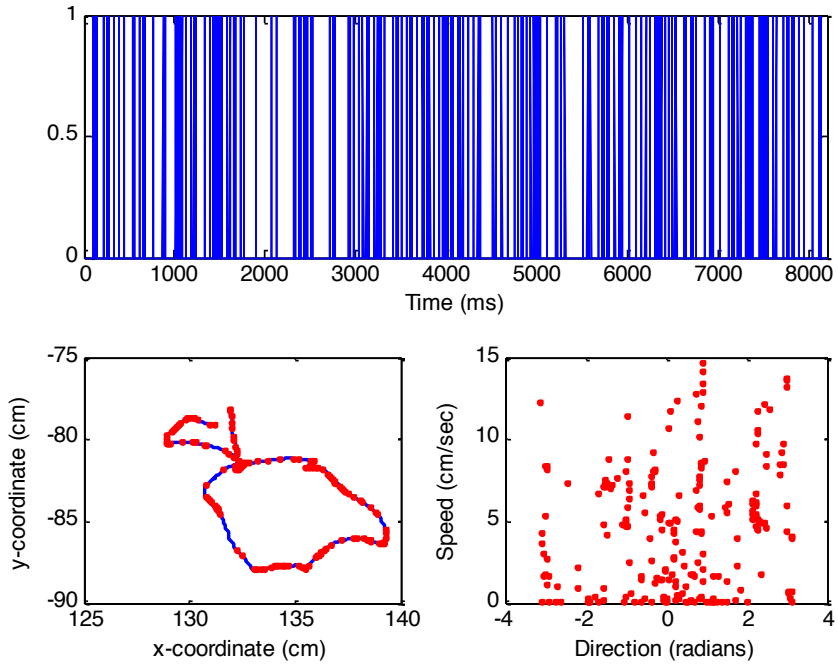
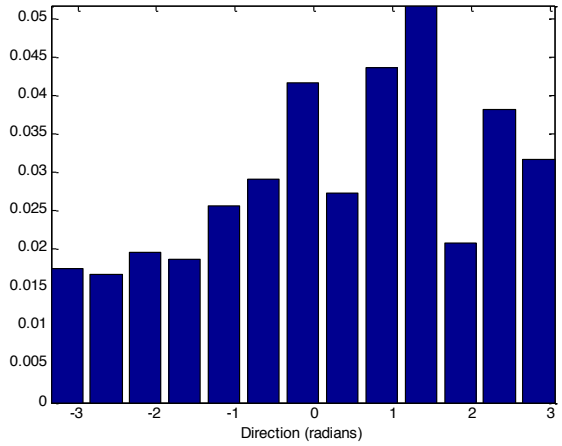
MA 568 – Statistical Analysis of Point Process Data

Solutions to Problem Set 2

```
% Question 1
load M1_spikes
plot(T,spikes);
plot(X,Y,X(spiketimes),Y(spiketimes),'r.');
plot(phi(spiketimes),V(spiketimes),'r.');
```

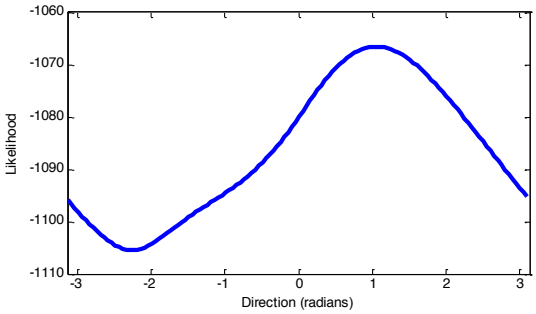



```
% Question 2
dirs = -pi:.5:pi;
onh = hist(phi(spiketimes),dirs)./hist(phi,dirs);
bar(dirs,onh);
```



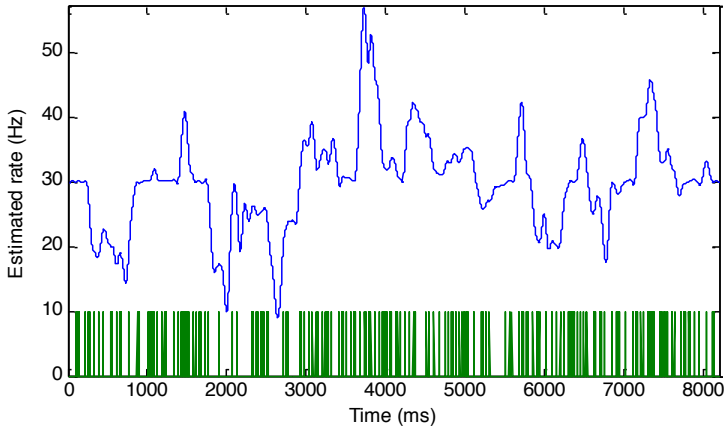
This occupancy normalized histogram suggests that the neuron fires most when the animal is moving approximately 1-1.5 radians relative to movement to the right, at a rate of approximately 55 Hz.

```
% Question 3
phis = -pi:.05:pi;
lambda = 30+30*V*ones(size(phis))/16.1.*cos(phi*ones(size(phis))-
ones(size(phi))*phis);
L=spikes'*log(lambda*1e-3)-
ones(size(spikes'))*lambda*1e-3;
plot(phis,L);

MLind = find(L==max(L));
phi_ML = phis(MLind)

>> phi_ML = 1.0584
```

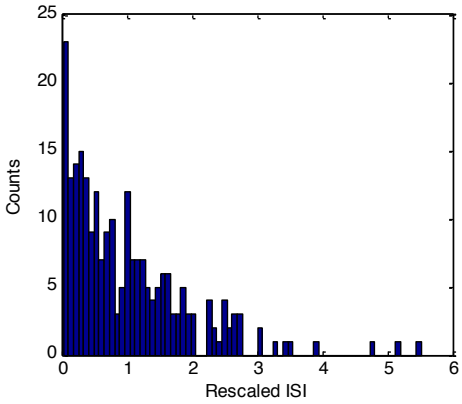



```
se = 1/sqrt(-(L(MLind+1)-2*L(MLind)+L(MLind -1))/5e-2/5e-2);
CI = [phi_ML-1.96*se phi_ML+1.96*se]

>> CI = 0.6784    1.4384
```

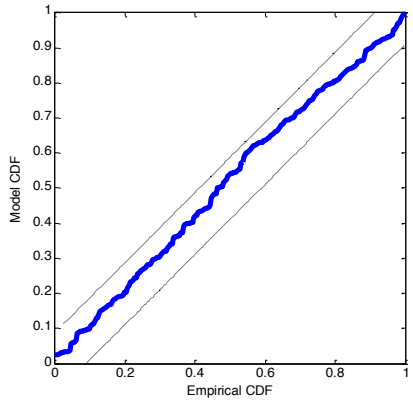
```
% Question 4
lambda_ML = 30+30*V/16.1.*cos(phi-phi_ML);
plot(T,lambda_ML,T,spikes)
```

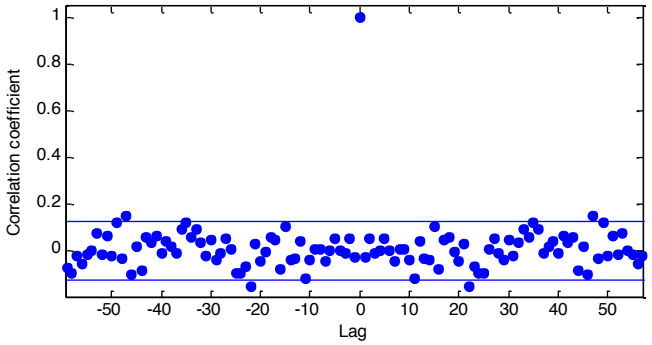



```
% Question 5
spikeInd = find(spikes);
ISIs = diff([0; spikeInd]);
hist(ISIs,50);
lambdaInt = cumsum(lambda_ML)*1e-3;
Z = diff([0; lambdaInt(spikeInd)]);
hist(Z,50);

[Femp xs] = ecdf(Z);
Fm = expcdf(xs, 1);
n = length(Z);
```



```
plot(Femp,Fm,Fm,Fm+1.36/sqrt(n),'k:',Fm,Fm-1.36/sqrt(n),'k:');
axis([0 1 0 1]);
```






```
% Question 6
plot(-236:236,xcorr(Z-mean(Z),'coef'),'.');
line([-236 236],[1.96/sqrt(n) 1.96/sqrt(n)]);
line([-236 236],[-1.96/sqrt(n) -1.96/sqrt(n)]);

% Question 7
rescaledTimes = cumsum(Z);
spikes = hist(rescaledTimes,0:rescaledTimes(end));
FF = var(spikes)/mean(spikes)

>> FF = 0.8936

FF_CI = gaminv([.025 .975],length(spikes)/2,2/length(spikes))

>> FF_CI = 0.8298    1.1859
```

The sample Fano factor lies within the 95% confidence interval, so we cannot preclude an inhomogeneous Poisson model based on this binning of the data.

% Question 8

The model passes the KS test and the correlation structure in the rescaled ISIs does not appear to be significant. This suggests that this inhomogeneous Poisson model is able to describe well the statistical structure of this brief segment of data.

The model fit suggests that this neuron is cosine tuned, with a preferred direction about 1.05 radians from the horizontal, and modulated by movement speed.