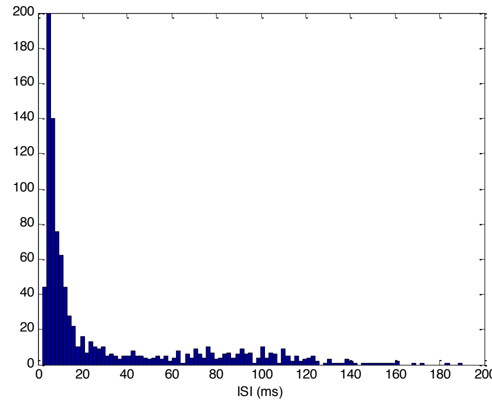
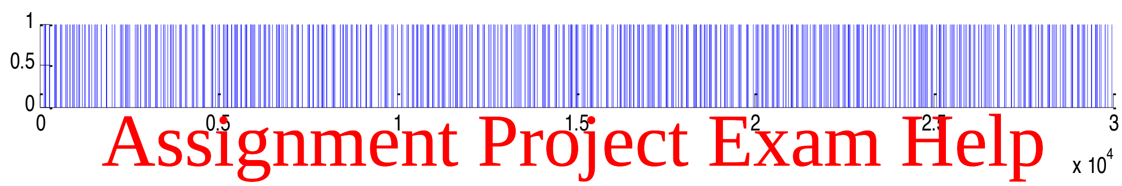
**MA 568 – Statistical Analysis of Point Process Data**

**Solutions to Problem Set #1**

```
% Question 1
load Retinal_ISIs.mat;
hist(ISIs,50);

spiketimes = cumsum(ISIs);
N = length(spiketimes);
for i = 1:N,
    line([spiketimes(i)
spiketimes(i)],[0 1]);
end;
```



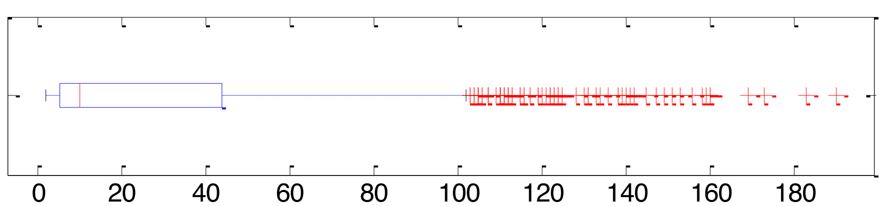






The histogram and spike train time series suggest that this neuron fires most of its spikes with an ISI between 5-40 ms. Features to note include an initial refractory period under 5 ms., a large number of spikes with ISIs around 4-8 ms., a large tail that includes ISIs out to 190 ms., and a small second mode around 90-100 ms. This suggests that a simple Poisson model will not be able to fully capture the structure observed in this data.

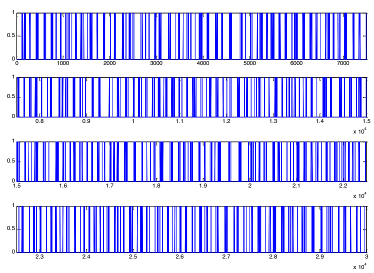


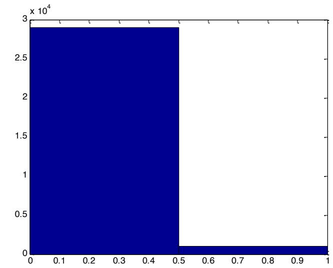
```
% Question 2
Qs = sort(ISIs);
[Qs(1) Qs(end/4) Qs(end/2) Qs(3*end/4) Qs(end)]

% ans =  2     5    10    44   190

boxplot(ISIs);
```



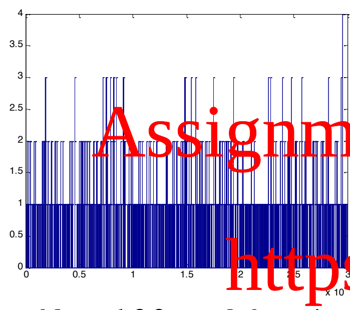
The 5-number summary and boxplot confirm our earlier observations about the distribution of ISIs. Most spikes occur at small ISIs between 5-40 ms., but there are a large number of long ISIs over 100 ms.

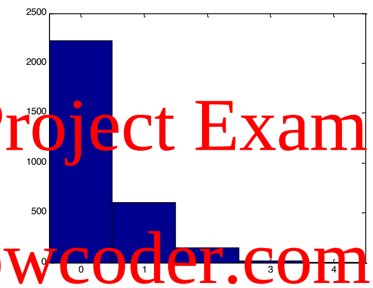
```
% Question 3
spikes1 = hist(spiketimes,0:30000);
plot(spikes1);
hist(spikes1,2);
```





```
spikes10 = hist(spiketimes,0:10:30000);
plot(spikes10);
hist(spikes10,4);
```

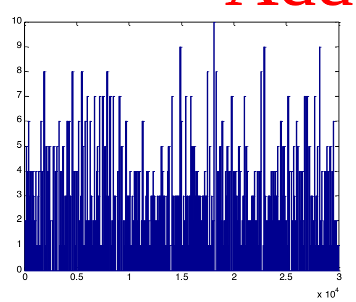


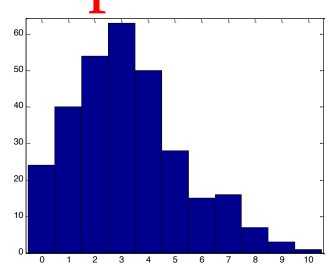




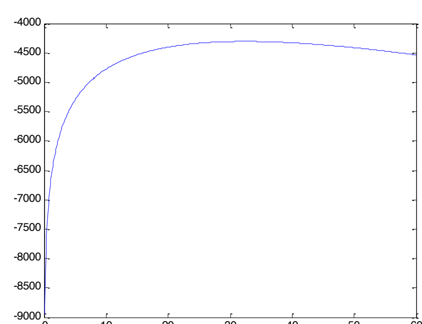
```
spikes100 = hist(spiketimes,0:100:30000);
plot(spikes100);
hist(spikes100,10);
```

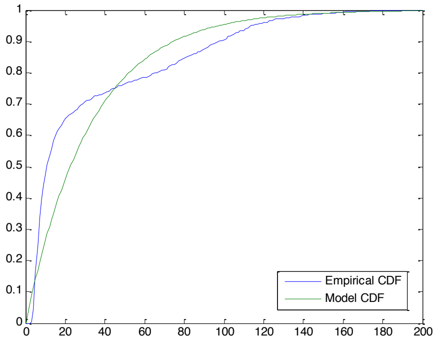






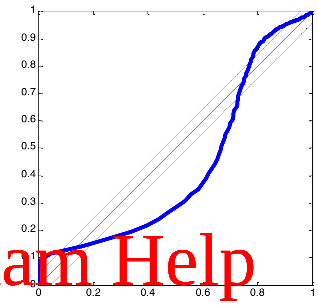
```
% Question 4
lams = [0:1e-1:60];
L = N*log(lams*1e-3)-lams*30;
plot(lams,L);

lam = N/30
SE = sqrt(N)/30;
CI = [lam-1.96*SE lam+1.96*SE]

% lam = 32.4000
% CI = 30.3631   34.4369
```



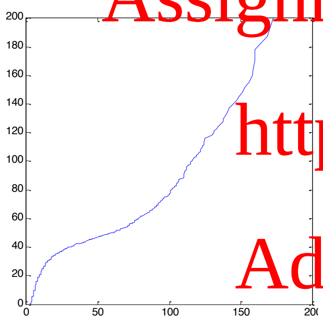



```
% Question 5
w = [0:200];
for i = 1:length(w),
    Femp(i) = sum(Qs<=w(i))/N;
end;
plot(w,Femp,w,1-exp(-w/lam))
```

```
KSStat = max(abs(1-exp(-w/lam)-Femp))

% KSStat = 0.2314

plot(Femp,1-exp(-w/lam));
axis([0 1 0 1]);
```





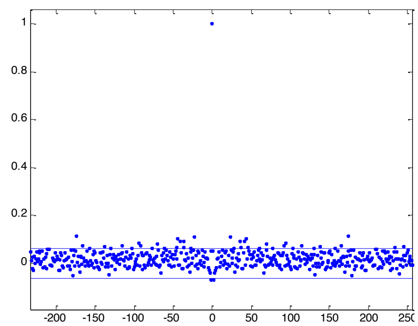


```
% Question 6
Qmodel = expinv(1/N:1/N:1,lam);
plot(Qs,Qmodel)
axis([0 200 0 200])
```



```
% Question 7
FF1 = var(spikes1)/mean(spikes1)
CI1 = gaminv([.025 .975], length(spikes1)/2, 2/length(spikes1))

% FF1 = 0.9676
% CI1 = 0.9841    1.0161

FF10 = var(spikes10)/mean(spikes10)
CI10 = gaminv([.025 .975], length(spikes10)/2, 2/length(spikes10))

% FF10 = 1.1271
% CI10 = 0.9500    1.0512

FF100 = var(spikes100)/mean(spikes100)
CI100 = gaminv([.025 .975], length(spikes100)/2, 2/length(spikes100))

% FF100 = 1.3411
% CI100 = 0.8464    1.1662
```

```
% Question 8
Z = ISIs-mean(ISIs);
plot(-(N-1):(N-1),xcorr(Z,Z,'coef'),'.')
line([-N N],[1.96/sqrt(N) 1.96/sqrt(N)]);
line([-N N],[-1.96/sqrt(N) -1.96/sqrt(N)]);
```




At small lags, the autocorrelation function falls outside the 95% confidence bounds more often than expected by chance alone for small lags, suggesting that nearby spikes have ISIs that are not independent.



9. From the above analysis, we can conclude that under a simple Poisson model the firing rate of this neuron is likely somewhere between 30-34 Hz. However, this Poisson model fails to account for many aspects of the spiking activity including its refractoriness, bursting, and long ISIs. Our analysis of the Fano Factor suggests that there is less variability in the 1 ms. increments and more in the 10 ms and 100 ms increments than would be expected from a Poisson process. The autocorrelation analysis suggests a dependence structure on past spiking activity. Therefore, describing the structure of this data will require history dependent point process models.