Homework 4

86-595 Neural Data Analysis
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Problem 1

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a. Since we have no prior on signal probabilities and the utilities of reporting signal and noise are uniform, we report a signal whenever the likelihood ratio ℓ_{sn} of signal to noise is greater than 1. Thus, since the spike rate r is distributed Poisson, we report a signal whenever

$$1 < \ell_{sn}(r) = \frac{\mathsf{P}(r \mid s)}{\mathsf{P}(r \mid n)} = \frac{\frac{30^r}{r!}e^{-30}}{\frac{20^r}{r!}e^{-20}} = \left(\frac{3}{2}\right)^r e^{-10},$$

which is the case precisely when $\boxed{r > \log_{3/2}(e^{10}) \approx 24.7.}$

b. Since we now have a prior on signal probabilities and the utilities of reporting signal and noise are uniform, we report a signal whenever the likelihood ratio ℓ_{sn} of signal to noise is greater than the ratio $\frac{\mathsf{P}(n)}{\mathsf{P}(s)} = 4$ of the priors. Thus, following the derivation in part (a),

$$4 < \left(\frac{3}{2}\right)^r e^{-10},$$

which is the case precisely when $\boxed{r > \log_{3/2}(4e^{10}) \approx 28.1.}$

c. Since we now have a prior on signal probabilities as well as nonuniform utilities of reporting signal and noise, we report a signal whenever the likelihood ratio ℓ_{sn} of signal to noise is greater than the ratio $\frac{-U_{Sn}\mathsf{P}(n)}{U_{Ss}\mathsf{P}(s)} = 20$ of the priors and utilities, where $U_{Ss} = 1$ is the utility of a true positive and $U_{Sn} = -5$ is the utility of a false positive (we leave out the utilities of a true negative and of a false negative, since they are 0). Thus, following the derivation in part (a),

$$20 < \left(\frac{3}{2}\right)^r e^{-10},$$

which is the case precisely when $\boxed{r > \log_{3/2}(20e^{10}) \approx 32.1.}$

Problem 2

a. See Figure 1, which was generated by the following code:

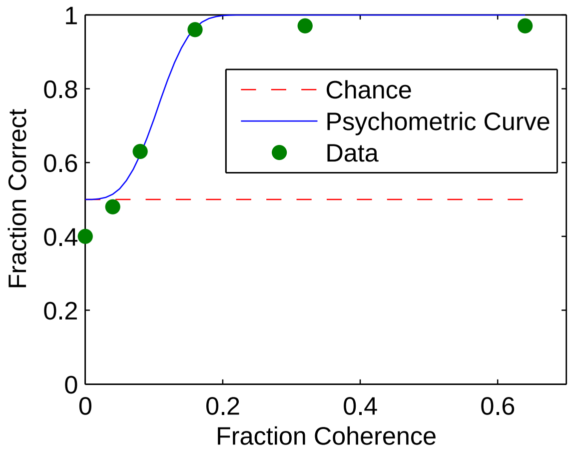

Figure 1: Choice accuracy over stimulus coherence. α, β were estimated as $0.1, 1$, respectively.

```
>> guesses = squeeze(MTdata(:,3,:));
>> correct = mean(guesses,1);
>> params = nlinfit(coherence, correct, @psychometric_curve, [0.1, 1]);
>> chance(1:65) = 0.5;
>> plot(0:0.01:0.64, chance, '--', 'Color','red');
>> plot(0:0.01:0.64, psychometric_curve(params, 0:0.01:0.64));
>> scatter(coherence, correct, 'filled');
```

b. See Figure 2, which was generated by the following code:

```
>> neurons = MTdata(:,1:2,:);
>> for i=1:100, roc(i,1:2,1:6) = mean(neurons > criterion(i)); end
>> for i=1:6, plot(squeeze(roc(:,1,i)), squeeze(roc(:,2,i)), 'Linewidth',2); hold all; en
>> plot(0:0.01:1,0:0.01:1,'color','black');
```

c. Didn't have time to do this.

d. Didn't have time to do this.

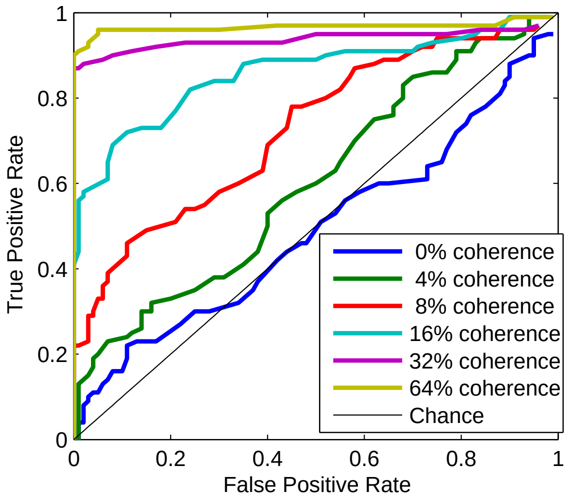

Figure 2: ROC curves for neurons at each stimulus coherence.