## Problem 1

Researchers have designed an animated face that can look happy or sad. To investigate whether people can perceive these emotions in the animated face they have designed an experiment where they show either a happy face or a sad face. Three participants identified the facial expression of 60 faces by pressing one of two buttons labeled "happy" and "sad" for every face. The researchers noted that some participants were pretty good at identifying happy faces as happy while the responses to sad face varied more. Based on this, the researchers concluded that the animation of the sad face needed more work whereas the animation of the happy face worked as expected.

The number of correct responses for each subject and experimental condition is in the table below.

| Subject 1 | | Subject 2 | | Subject 3 | |
|---|---|---|---|---|---|
| Happy | Sad | Happy | Sad | Happy | Sad |
| 41 | 19 | 39 | 18 | 32 | 28 |

Use signal detection theory to interpret the results.

A. Did the facial animation work as intended?

B. Is the researchers conclusion valid?

## Problem 2

Cats have very good hearing. In order to test a cats hearing, researchers train a cat to detect (by pressing a lever) a sound by giving it a treat every time it correctly detects a sound. In one experiment, researchers test the ability of a cat to detect a sound of 5 dB. They present the sound 60 times. The cat has been trained to know that the sound can only occur when a blue light is on. To test that the cat's strategy they also present the blue light 60 times without playing a sound. The cat pressed the lever 57 times when there was a sound and 35 times when there was no sound. Researchers are impressed with the cat's ability to detect the sound but worried about the high false alarm rate. Use signal detection theory to interpret the results.

A. What was the sensitivity and bias (or criterion) of the cat?

B. Describe the cat's strategy. What is the most likely explanation for the cat's choice of strategy?

C. Based on your analysis, what is the cat's psychometric function?

## Problem 3

In a signal detection task, the participant is allowed to rate the confidence of her response as "high", "medium" or "low". In the table below are the response counts for when a stimulus was presented (S) and for control trials where no stimulus was presented (NS).

| | No | | | Yes | | |
|---|---|---|---|---|---|---|
| | High Confidence | Medium confidence | Low Confidence | Low Confidence | Medium confidence | High Confidence |
| NS | 2 | 31 | 57 | 8 | 2 | 0 |
| S | 2 | 14 | 27 | 38 | 15 | 4 |

A. Calculate the parameters of the unequal variance model and use them to estimate whether the observer behaves according to the equal or unequal variance model. Also provide a description of how you calculate the parameters.

## Problem 4

An observer responds according to the equal variance signal detection model with a sensitivity of $d' = 1$ and a criterion, $c = 0.7$ (with respect to zero set at the mean of the no-signal distribution). Re-interpret the observer as a Bayesian observer with an optimal criterion, a maximum a posteriori decision rule and a prior probability for the occurrence of a signal. What is prior probability of the observer? Explain how you arrived at your conclusion.

## Problem 5

When we apply PCA to image patches the principal components resemble the receptive fields of the early visual system. Split the two images ("woodBW" and "Mona") that come with this assignment into image patches of 10-by-10 pixels and perform pca on the patches. Transfrom the first six principal components back to image space and display them as image patches on the same gray-scale. Hint: This is completely similar to what you have done in one of the exercises in the course. Compare the six principal components from the two images.

A. Are some (or all) of them similar?

B. If any of them differ, describe the difference.

C. From which image did you obtain principal components that most realistically resemble the receptive fields of neurons in the visual system? Why?