02458 Cognitive Modeling test Exam

- This is a test exam. It will not count towards your final grade.
- Time of exam: The exam begins 9 am on the 26th of October 2023. The exam ends at 11:15 am.
- All aids allowed. Connection to the internet is *not* allowed.

Problem 2: Signal detection theory and the psychometric function (20 points)

Using a deep neural network researchers believe they can synthesise images that are more or less exciting. In order to test their hypothesis, they present two groups of 50 images each to an observer. One group of images contain images that they believe should not be exciting and the other group contain images that they believe should be very exciting. The observer responds on a excitement scale from 1 to 5 where 5 is maximally exciting. The results are listed in the table below.

Response category	1	2	3	4	5
Response counts for not exciting images	4	15	22	7	2
Response counts for exciting images	2	4	8	10	26

- What are the parameter values for the parameters of the unequal variance receiver operating characteristics (ROC) for this experiment?
- Rebin the data by pooling responses in response categories 2-5 into a single response category. Calculate the sensitivity d' for the rebinned data. Rebin the data by pooling responses in response categories 1-4 into a single response category. Calculate the sensitivity d' for the rebinned data. Interpret your results.

Problem 4: Linear encoding of faces (30 points)

Researchers have used Principal Component Analysis (PCA) to reduce the number of dimensions of images with 360-by-260 pixels to 20. For each face they have estimated a smile intensity index from behavioural data. The have fitted a linear regression model with the PCA scores as predictors and the smile intensity as the response variable. Their analysis is similar to the one you did in Homework 2.

All the data from their analysis are in the file that come with this exercise. Below is a description of the content of each file.

Filename	Content
image1, image2 and image3	360-by-260 matrices containing the brightness values for one image. The brightness values range from 0 to 1.
meanimage	A 360-by-260 matrix containing the brightness values for the mean image across all the images that the researchers used in their analysis. They subtracted this image from all the images before reducing the dimension of the images to 20 using PCA
PCA_Scores	A 3-by-20 matrix containing the PCA scores for the three images in the files image1-3

PCA_Components	A 93600-by-20 matrix containing the 20 PCA components (coefficients) as 20 column vectors. The first 360 elements of each PCA component corresponds to the first column in the corresponding 360-by-260 image. The next 360 elements correspond to the second column in the corresponding 360-by-260 image
RegressionParameters	The 20 parameters in the linear regression model
RegressionIntercept	The intercept in the linear regression model
SmileIndx	The smile intensity indices for each of the three images in the files image1-3

- The data set that comes with this exercise contains data from three selected images. What the model's predicted smile index of for each of the three faces? Explain how you calculated this. How do they compare to the true values?
- The model is not based on the actual images but on the PCA scores. Visualise the three faces reconstructed from the 20 principal components. Visualise the reconstructed faces and the corresponding actual images. Try to find an explanation for the discrepancies in predicted and true smile intensities from this visualisation.
- Homework 2 we created synthetic images with specific levels of smile, gender or some other attribute. In this problem we want to make synthetic face in a different way: take a specific face and change it so that it gets a smile index of 0.2 without changing other attributes of the face. Do this for each of the three faces that are included in the data that comes with this exam. Plot the images. You should still be able to identify the main features of the person from these reconstructed images but the facial expression should have changed. Explain your approach. Provide a table with the PCA scores each of the synthetic image.