1. One of the main approaches for the multimodal analysis of social signals, is the use of a Multiple Classifier System, i.e., a "combination of several classifiers that deal separately with the various modalities" (quoted from A.Vinciarelli and A.Esposito, "Multimodal Analysis of Social Signals", in "The Handbook of Multimodal-Multisensor Interfaces", Oviatt et al., eds., 203-226, ACM, 2018).

(a) Explain the difference between the two main approaches for the combination of classifiers, namely "early fusion" and "late fusion".

[15 marks]

(b) Explain the most important aspects of the combination of classifiers.

[15 marks]

2. A "judgment study" is an experiment in which "*behaviours, persons, objects or concepts are evaluated by one or more judges, raters, coders or evaluators, referred to collectively as judges*" (quoted from R.Rosenthal, Conducting Judgment Studies: Some Methodological Issues", in "The New Handbook of Methods in Nonverbal Behavior Research", J.A.Harrigan, R.Rosenthal and K.R.Scherer, eds.).

(a) Explain the most important aspects of judgment studies, including the issues of reliability;

[15 marks]

(b) Define 'encoders' and 'decoders' in judgement studies and explain in detail the difference between them.

[15 marks]

3. Explain the most important aspects of <u>one</u> of the four experimental studies that have been presented during the course:

1. Synthetic impressions;
2. Speech and Personality;
3. Facial Expressions;
4. Nonverbal Behaviour in Phone Calls.

[15 marks]

1. Address the following questions about two major methodological instruments introduced during the course, namely Basic Signal Processing (question a) and Bayesian Decision Theory (question b).

(a) A digital signal is a sequence of physical measurements collected at regular time steps. Explain how signals are processed in the time-domain, including at least one of the most important short-term properties (the answer must not contain more than 1000 words. Any text after the 1000th word will not be considered).

[15 marks]

(b) Explain what the "Expected Loss" or "Conditional Risk" is in Bayesian Decision Theory. In particular, provide its definition and show how it is used to develop the Bayes Decision Rule (the answer must not contain more than 1000 words. Any text after the 1000th word will not be considered).

[15 marks]

2. Address the following questions about two psychological aspects of Computational Social Intelligence, namely facial expressions (question a) and multimodal communication (question b):

(a) Explain how facial expressions are analysed from a psychological point of view (the answer mist not contain more than 1000 words. Any text after the 1000th word will not be taken into account).

[15 marks]

(b) Describe the concept of multimodality in Communication and Life Sciences and, in particular, explain how the combination of multiple signals can lead to different responses (the answer must not contain more than 1000 words. Any text after the 1000th word will not be taken into account).

[15 marks]

3. Explain the most important aspects of <u>one</u> of the four experimental studies that have been presented during the course (the answer mist not contain more than 1000 words. Any text after the 1000th word will not be taken into account).:

1. Synthetic impressions;
2. Speech and Personality;
3. Facial Expressions;
4. Nonverbal Behaviour in Phone Calls.

[15 marks]

1. The following table shows the result of a study about the amount of time spent on social media every week:

	Age < 30	Age ≥ 30
T > 12 hours	125	32
T ≤ 12 hours	79	77

The study participants have been split into two categories:

- People that are less than 30 years old (column "Age < 30")
- People that are at least 30 years old (column "Age ≥ 30").

These two categories have been further been split into two subgroups:

- People that spend more than 12 hours per week on social media (row "T > 12 hours")
- People that spend at most 12 hours per week on social media (row "T ≤ 12 hours").

(a) Use the data above to build a contingency table.

[5 marks]

(b) Write the formula of a χ^2 variable that can test the following research hypothesis: "*People younger than 30 and people at least 30 years old tend to spend a different amount of time per week on social media*".

[5 marks]

(c) Provide the null hypothesis corresponding to the research hypothesis stated at point (b) of this question.

[5 marks]

(d) Write the formula of the expectation values for the relevant cells of the contingency table.

[5 marks]

(e) Calculate the number of degrees of freedom for the χ^2 variable you have defined at point **(b)** of this question (write the formula you use it to calculate it).

[3 marks]

(f) Calculate the value of the χ^2 variable defined at point **(b)** of this question. Compare the value of the χ^2 variable with the critical value 3.841 (corresponding to confidence level $\alpha = 0.95$).

[2 marks]

(g) Explain whether the null hypothesis can be rejected and whether this means that the research hypothesis is true.

[5 marks]

2. Consider a classification problem where there are two classes C_1 and C_2 with a-priori probabilities $p(C_1) = 0.67$ and $p(C_2) = 0.33$, respectively. Consider 5 different feature vectors ($\bar{x}_1, \bar{x}_2, \bar{x}_3, \bar{x}_4$ *and* $\bar{x}_5$) such that the likelihoods are as follows:

$p(\bar{x}_1\|C_1) = 0.50$	$p(\bar{x}_1\|C_2) = 0.10$
$p(\bar{x}_2\|C_1) = 0.30$	$p(\bar{x}_2\|C_2) = 0.20$
$p(\bar{x}_3\|C_1) = 0.10$	$p(\bar{x}_3\|C_2) = 0.30$
$p(\bar{x}_4\|C_1) = 0.07$	$p(\bar{x}_4\|C_2) = 0.35$
$p(\bar{x}_5\|C_1) = 0.03$	$p(\bar{x}_5\|C_2) = 0.05$

(a) Explain how the prior rule works.

[4 marks]

(b) Find the class of the five vectors $\bar{x}_1, \bar{x}_2, \bar{x}_3, \bar{x}_4$ *and* $\bar{x}_5$ according to the prior rule.

[6 marks]

(c) Explain how the posterior rule works.

[8 marks]

(d) Find the class of the five vectors $\bar{x}_1, \bar{x}_2, \bar{x}_3, \bar{x}_4$ *and* $\bar{x}_5$ according to the posterior rule.

[12 marks]

3. Explain the most important aspects of <u>one</u> of the four experimental studies that have been presented during the course:

1. Synthetic impressions;
2. Speech and Personality;
3. Facial Expressions;
4. Nonverbal Behaviour in Phone Calls.

The answer must include no more than 1,000 words. The text beyond the first 1,000 words will not be considered.

[15 marks]

Example of Question

- The following data shows number of years spent in education and yearly income (in thousands of Pounds) for 10 persons:

$$(3.2,21)\ (4.1,22)\ (3.7,25)\ (5.0,23)$$
$$(6.0,30)\ (5.7,31)\ (6.2,35)\ (6.5,33)$$
$$(7.0,21)\ (7.2,35)$$

Example of Question

- Calculate the correlation between number of years spent in education and yearly income;
- Calculate covariance between number of years spent in education and yearly income;
- Is there a statistically significant relationship between number of years spent in education and yearly income?
- Consider those who spent at most 5 years in education and the others. Is there a statistically significant difference between the two groups in terms of yearly income?