WRITE FIRST NAME, LAST NAME, AND ID NUMBER ("MATRICOLA") ON YOUR ASSIGNMENT. TIME: 1.5 hours.

FIRST NAME: .....

LAST NAME: .....

ID NUMBER: .....

Question 1 [6 points]

1. Describe the GMM model for clustering
2. How can you train, based on the maximul likelihood principle, GMMs? Discuss the main steps of the algorithm employed.

[Solution: Question 1]

[Solution: Question 1]

Question 2 [6 points]

1. Introduce the "general" machine learning problem, with all its main ingredients (data, model classes, loss, risk and empirical risk etc.), the main assumptins typically made.

2. Which are the desirable properties of a learning algorithm and which are the tradeoffs that need to be made. Motivate your answer.

[Solution: Question 2]

[Solution: Question 2]

Question 3 [6 points]

1. Describe the concept and use of regularization in machine learning (it is ok but not necessary to refer to a specific class of problems, e.g. linear regression) and formalize how models are trained using regularization.

2. Explain the role of regularization parameters, and draw a qualitative plot of how empirical error (or empirical risk) and generalization error (or true risk) vary as a function of regularization parameters. How do you select in practice "optimal" regularization parameters?

[Solution: Question 3]

[Solution: Question 3]

Question 4 [6 points]

1. Explain, with reference to a linear regressio problem, the relation between regularization and Bayesian estimation of unknown model parameters

2. Can you use the Bayesian formulation to estimate hyperparameters of the prior distribution and, if so, how? Comment on the relation with Question 3.

[Solution: Question 4]

[Solution: Question 4]