FIRST NAME: ....

LAST NAME: ....

ID NUMBER: ....

Question 1 [6 points]

1. Introduce the notion of OAROS of a learning algorithm

2. Prove that an OAROS algorithm does not overfit

[Solution: Question 1]

[Solution: Question 1]

Question 2 [6 points]

1. Define the regression problem in machine leraning

2. Introduce Support Vector Machine for Regression and explain how the loss function used in this framework to measure the fitting error relates the the concept of "support vectors".

[Solution: Question 2]

[Solution: Question 2]

Question 3 [6 points]

 With reference to the clustering problem:

1. Introduce a probailistic model used for clustering and, assuming the model has been learned, how the assignment of a data point $\bar{x}$ to the clusters can be performed.

2. Discuss how the model is trained by using the maximul likelihood principle and the EM algorithm.

[Solution: Question 3]

[Solution: Question 3]

Question 4 [6 points]

1. Define the cost J for an ℓ_1- regularized linear regression problem with square loss (LASSO) with parameter vactor $w \in \mathbb{R}^d$ and regularization parameter λ. Denoting with $\hat{w}_L(\lambda)$ the optimal parameter vector as a function of the regularization parameter λ draw a typical behaviour of the components of $\hat{w}_L(\lambda)$ as a function of λ.

2. Explain, by means of a "pictorial" argument (a plot/figure) why the estimate of the parameter w tends to be sparse.

[Solution: Question 4]

[Solution: Question 4]

EXTRA (Replacing Oral Exam/HW) [8 points]

Each of the following 4 questions, in order of appearence, refer to the previus Questions 1,2,3,4.

(a) Which tool can be used to guarantee that an algorithm is (OAROS) stable? Explain and motivate.

(b) Making use of the hinge loss, explain the link between Support Vector Machine for binary classification and Support Vector Machine for regression

(c) Describe annother problem in which the probabilistic model introduced in Question 3 is useful.

(d) In the context of LASSO regeression, explain how you would tune the regularization parameter λ in practice.

[Solution: EXTRA (Replacing Oral Exam/HW)]

[Solution: EXTRA (Replacing Oral Exam/HW)]

[Solution: EXTRA (Replacing Oral Exam/HW)]