

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. Introduce the clustering problem in machine learning.
2. Describe K-means clustering and GMM for clustering pointing out the main differences.

[Solution: Question 1]

[Solution: Question 1]

Question 2 [6 points]

The following model

$$h(x) = \sum_{k=1}^N \alpha_k e^{-\gamma \|x - c_k\|^2} \quad x \in \mathbb{R}^d$$

is called a Radial Basis Function Network. The parameters describing the function $h(x)$ are the coefficients α_k , the “centers” $c_k \in \mathbb{R}^d$ and the real parameter $\gamma > 0$.

1. Assuming the network is used to solve a regression problem, given training data (x_i, y_i) , $i = 1, \dots, m$, and assuming c_k and γ are fixed, how would you estimate the parameters α_k ? What if $N > m$?
2. Does this model remind you of one regression model studied in class? Under which conditions? Would this relation suggest a way to fix/choose the centers c_k ?

[Solution: Question 2]

[Solution: Question 2]

Question 3 [6 points]

1. Define the notion of stability of learning algorithms (in particular “on-average-replace-one-stable” algorithms) and explain its practical relevance.
2. Discuss the link between (OAROS) stability of algorithms and overfitting. Provide a proof of your statement.

[Solution: Question 3]

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Question 4 [6 points]

1. Introduce the logistic regression model and provide an explicit expression for the resulting classification rule.
2. It is possible to extend the logistic regression model so that the classification rule is non-linear in the inputs? If so, how can this be done? (one example is sufficient)

[Solution: Question 4]

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