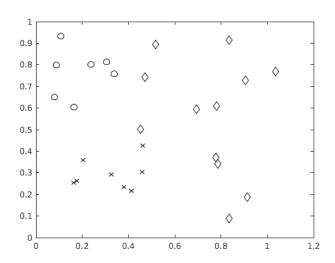
# Machine Learning – January 18, 2019 - B

Time limit: 2 hours.

Last Name	First Name	Matricola
	exam for ML 2018/19, write below na the course). Please specify also if yo	me of exam, CFU, and academic year ou are an Erasmus student.
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## **EXERCISE 1**

Consider the data shown in the figure below:



Considering classification based on support vector machines (SVMs):

- 1. Explain if the data are separable and motivate your answer (only 'yes' or 'no' are not acceptable answers).
- 2. Explain what type of kernel function you would use in this case.
- 3. Describe what are the possible solutions for applying SVMs for classification of multiple classes.

# **EXERCISE 2**

- 1. Describe the perceptron model for classification and its training rule.
- 2. Draw a graphical representation of a 2D data set for binary classification and provide a qualitative graphical example of a possible evolution of perceptron training (4 images showing a possible temporal evolution of the solution of the algorithm on the sketched data set).

#### **EXERCISE 3**

Consider a regression problem for the target function  $f: \Re^6 \to \Re^6$ . Design a solution based on Artificial Neural Network for this problem: draw a layout of a suitable ANN for this problem and discuss the choices.

- 1. Determine the size of the ANN model (i.e., the number of unknown parameters).
- 2. Is Backpropagation algorithm affected by local minima? If so, how can we avoid or attenuate it?
- 3. Is Backpropagation algorithm affected by overfitting? If so, how can we avoid or attenuate it?

#### **EXERCISE 4**

- 1. Briefly describe the goal of linear regression and define the corresponding model.
- 2. Given a dataset  $\mathcal{D} = \{(\mathbf{x}_1, t_1), \dots, (\mathbf{x}_N, t_N)\}$  with  $\mathbf{x}_n$  the input values and  $t_n$  the corresponding target values, explain how the parameters of the model can be estimated either in a batch or in a sequential mode.

## **EXERCISE 5**

In Bayesian Learning, given a data set D and a hypothesis h, we can express the following relationship between the probability distributions (Bayes theorem):

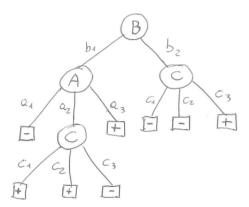
$$P(h|D) = \frac{P(D|h)P(h)}{P(D)}$$

In this context:

- 1. define Maximum a posteriori (MAP) hypotheses and Maximum likelihood (ML) hypotheses.
- 2. define the concept of Naive Bayes Classifier
- 3. discuss about practical applicability of the Naive Bayes Classifier

#### EXERCISE 6

Given a classification problem for the function  $f: A \times B \times C \to \{+, -\}$ , with  $A = \{a_1, a_2, a_3\}, B = \{b_1, b_2\}, C = \{c_1, c_2, c_3\}$  and the following decision tree T that is the result of a learning algorithm on a given data set:



- 1. Provide a rule based representation of the tree T.
- 2. Determine if the tree T is consistent with the following set of samples  $S \equiv \{s_1 = \langle a_1, b_1, c_1, \rangle, s_2 = \langle a_2, b_1, c_2, + \rangle, s_3 = \langle a_1, b_2, c_3, + \rangle, s_4 = \langle a_2, b_2, c_2, + \rangle\}$ . Show all the passages needed to get to the answer.