Machine Learning – October 15, 2019

Time limit: **2 hours**.

Last Name ..... First Name ..... Matricola .....

Note: if you are not doing the exam for ML 2018/19, write below name of exam, CFU, and academic year (when you were supposed to attend the course). Please specify also if you are an Erasmus student.

.....

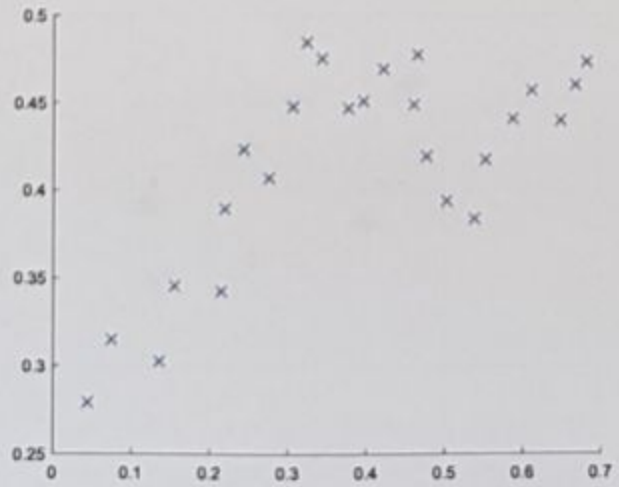
EXERCISE 1

1. Provide the definition of *Confusion matrix* for a multi-class classification problem.
2. Provide a numerical example of a confusion matrix for a 3-classes classification problem with a balanced data set including 100 samples for each class (300 samples in total). Show the confusion matrix in two formats: with absolute values and with the corresponding percentage values.
3. Compute the accuracy of the classifier for the numerical example provided above.

Hint: use simple numerical values, so that you do not need to make complex calculations.

EXERCISE 2

Consider the learning problem of estimating the function $f : \Re \mapsto \Re$ with dataset $D = \{(x_i, y_i)\}$ plotted in the figure below:



1. Describe how to perform regression based on these data using a method of your choice. Specifically, provide a mathematical formulation of the model, highlighting the model parameters.
2. Considering the method you have chosen describe a way to reduce overfitting.
3. Draw a plausible plot of the learned model based on your choices.

EXERCISE 3

1. Describe the perceptron model for classification.
2. Describe the perceptron training algorithm.
3. Discuss convergence properties of perceptón training algorithm.

EXERCISE 4

1. Qualitatively explain the maximum margin principle on which Linear SVM classification is based.
2. Draw an example of a 2-D binary classification problem showing: i) a generic margin separating points belonging to two different classes, and ii) the margin identified by Linear SVM.

EXERCISE 5

1. Describe the K-nearest neighbors (K-NN) algorithm for classification.
2. Given the dataset below for the two classes $\{star, plus\}$, determine the answer of K-NN for the query point indicated with symbol o for K=1, K=3, and K=5. Motivate your answer, showing (with a graphical drawing) which instances contribute to the solution.

EXERCISE 6

1. Describe the general approach of boosting.
2. Assume you have an image classifier with low classification accuracy. Provide the main steps for achieving higher classification accuracy by combining multiple instances of the classifier.