TÉCNICO LISBOA

MEIC 2020/2021
Aprendizagem - Machine Learning
Homework I
Deadline 05/04/2021 20:00
Submit on Fenix as pdf

I) Perceptron (6 Pts)

Consider the following linearly separable training set:

$\boldsymbol{x}^1=(1,1)^T$, $\boldsymbol{x}^2=(2,2)^T$, $\boldsymbol{x}^3=(0,-1)^T$, $\boldsymbol{x}^4=(-1,0)^T$

and the corresponding target of the two classes is indicated as

$t^1=1$, $t^2=1$, $t^3=-1$, $t^4=-1$

a) Initialize all weights to one (including the bias). Use a learning rate of one for simplicity. Apply the perceptron learning algorithm (Rosenblatt's original algorithm) until convergence. (4 pts)

b) Draw the separation hyperplane/line. (2 pts)

II) Decision Trees (6 pts)

F1	*F2*	*F3*	*F4*	*Output*
c	*a*	*b*	*x*	*n*
a	*a*	*c*	*a*	*t*
a	*b*	*b*	*a*	*t*
c	*b*	*c*	*x*	*m*
a	*b*	*b*	*c*	*f*

(a) (3 pts)
Determine the root of decision tree using the ID3 algorithm with the target "Output". Indicate the calculation.

(b) (3 pts)
Determine the decision tree using the ID3 algorithm with the target "Output". Indicate the calculation and draw your decision tree.

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III) Perceptron – Decision Trees (2 pts)

A factory process produces a product in the shape of a rectangle with length l and width w.

Assume that for a product to be considered non-defective its length and width must satisfy the following constraints $1.3\text{cm} \leq l \leq 2.2\text{cm}$, $1.3\text{cm} \leq w \leq 3.1\text{cm}$. The factory would like to have a classifier that distinguishes defective from non-defective products given their length and width. From the following options which can learn to solve this task? Justify your choice (short with one sentence)

- Only the Perceptron.
- Only the Decision Tree.
- Both.
- Neither.

IV) Gaussian Naive Bayes (6 pts)

You are given the following training set:

x_1	x_2	Class
0	10	A
0	20	A
10	10	A
5	20	A
30	30	B
40	40	B
50	30	B
50	50	B

And the query vector $x = (05,10)^T$

a) (3 pts) Compute the most probable class for the query vector, under the Naive Bayes assumption, using 1-dimensional Gaussians to model the likelihoods.

b) (3 pts) Compute the most probable class for the query vector assuming that the likelihoods are 2-dimensional Gaussians.