Pattern Recognition and Machine Learning

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ENSIMAG 3 Final Exam - Feb 2019

Conditions: You have the right to use any notes or written material. You may answer questions in English or in French. When appropriate, illustrate your answer with mathematics. Your written answers must be clear and legible. Illegible text will not be graded. Duration: 3 hours.

1) (2 points) Provide a definition and an explanation for Precision and Recall. How are they calculated? How and when are they used? What do they tell about a classifier?

2) (4 points) You are provided with a Viola-Jones style face detector composed of a committee of weak classifiers trained with Ada boost. The committee has been trained to accept 10% false positives and 1% false negatives. Is it possible to determine a Probability of Error for this face detector? If yes, give the formula and explain how to use it. If no, explain why.

3) (4 Points) You are asked to use a linear Support Vector machine to construct a pattern detector using 3 dimensional feature vectors $\vec{X}$. You have used an on-line SVM learning algorithm to discover the S support $\{\vec{X}_s\}$ and bias b for your detector.

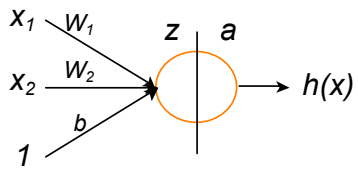
a) How many support vectors should the learning algorithm provide?

b) How are $\vec{w}$ and b computed from the support vectors $\{\vec{X}_s\}$?

c) Write the equation for the discriminant function $g(\vec{X})$.

d) What happens if the data are not separable?

4) (10 points) You are presented with a single neuron with two inputs (x_1, x_2) and a single output, $h(\vec{X}) = a$ computed using a sigmoid, $\sigma(z)$. Your network has been initialized with weights w_1=+0.1 and w_2= –0.1 and b=0. Assume a learning rate of η=0.1.



Your network should be trained to recognize the following training data:

m	x_1	x_2	y_m
1	0	0	0
2	0	1	1
3	1	0	1
4	1	1	1

a) Compute z and $h(\vec{X}_m)$ for m=1.

b) Compute $\delta_{out} = h(\vec{X}_m) - y_m$ for m=1

c) Compute $\delta_m^{(1)}$ for m=1

d) Compute Δw_1, Δw_2, and Δb for m=1

e) Update w_1, w_2, and b for m=1.

f) Will your neuron converge for this training data?