

Pattern Recognition and Machine Learning

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ENSIMAG 3

Final Exam - Feb 2020

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? 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.

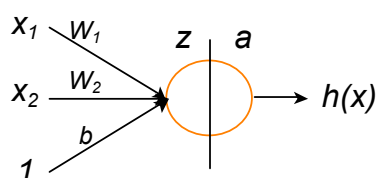
3) (4 points) You have been hired as a political analyst to work on the political campaign for a referendum. Your job is to identify the sectors of the population for which you can design targeted publicity on Facebook. For this you prepare an on-line personality quiz. Each question has a small number of possible responses. You receive M responses. The questions are as follows

- 1) What is your age? A) 18-29, B) 30-39, C) 40-49, D) 50-59, E) 60 or older
- 2) How many years of University education do you have? A) none, B) 1 to 2 years, C) 3 to 4 years, D) 5 to 6 years, E) 7 to 8 years, F) more than 8 years.
- 3) How much do you earn each year? A) < 20K B) 20K to 40K C) >40K to 60K D) >60 to 80K, E) >80 to 100K, F) > 100K.
- 4) How will you vote in the referendum? A) Yes, B) No, C) Undecided, D) I will not vote.

a) Explain how to use a ratio of histograms to predict the response to question 4 as a function of the answers to questions 1, 2 and 3. How many people must be polled before you can trust the results.

b) Explain how to use the EM algorithm to discover categories of voters who are undecided given their responses to questions 1 to 3. What assumption is necessary? How would you initialize the algorithm? How would you determine the number of categories?

4) (10 points) You are presented with a single neuron with two inputs (x_1, x_2) and a single output, computed using a sigmoid, $\sigma(z)$. Your network has been initialized with weights $W_1=0.1$ and $W_2=-0.2$ and $b=+0.2$. Assume a learning rate of $\eta=0.1$. Your network should be trained to recognize the following training data:



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

- a) Compute z , and a for $m=1$.
- b) Compute $\delta_m^{(out)} = h(X_m) - y_m$ for $m=1$.
- c) Compute δ_m 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?