



**Maynooth
University**
National University
of Ireland Maynooth

OLLSCOIL NA hÉIREANN MÁ NUAD
THE NATIONAL UNIVERSITY OF IRELAND
MAYNOOTH

JANUARY 2019 EXAMINATION

CS401

Machine Learning & Neural Networks

Dr. C. Hayes, Dr. J. Timoney, Prof. B. Pearlmutter

Time allowed: 2 hours

Answer at least four questions

Your mark will be based on your best **four** answers

All questions carry equal marks

- 1 Using electronic surveillance devices, the proctors of an exam being given to 2000 people learn that one person is cheating. They retain a human lie detector: a person skilled in interviewing people who can tell with 99% certainty whether someone is lying. The people who took the test are interviewed one by one and asked whether they were cheating. At some point the interviewer jumps up and yells: AH HA! YOU ARE LYING! What is the probability that the person they just caught was actually cheating? [25 marks]
- 2 What is batch gradient descent? What is the limitation on its speed? What assumptions does it make about the machine being optimized? [25 marks]
- 3 What is the maximum number of support vectors you can have (in general position) on a hard-margin linear SVM with input points in 3D space. (Draw a diagram.) How would this change if instead of a linear SVM, a nonlinear SVM (using the kernel trick) were used? [25 marks]
- 4 You are given a set of predictors $x_1(t), \dots, x_n(t)$ of a binary variable, $z(t)$, along with the guarantee that there is some subset of three of the predictors, $\{x_i, x_j, x_k\}$, of which at least two are always right at any time t . Exhibit a good online adaptive algorithm for making your own prediction $\hat{z}(t)$ based on the $x(t)$, where you can also use information about z , \hat{z} , and x for times $0, 1, \dots, t-1$. The criterion for being a "good" algorithm is good worst-case performance: a good bound on the number of errors made. Exhibit this bound. [25 marks]
- 5 Describe a situation in which the Perceptron Learning Rule will fail to converge. Explain. [25 marks]