Maynooth University
National University of Ireland Maynooth

OLLSCOIL NA hÉIREANN MÁ NUAD

THE NATIONAL UNIVERSITY OF IRELAND MAYNOOTH

JANUARY 2016 EXAMINATION

CS401

Machine Learning & Neural Networks

Dr. D. Charles, Dr. A. Winstanley, 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

[25 marks]

1 The manufacturer of the CPU in your computer announces that there was a manufacturing fault in the model you have which affected one out of one million shipped units. The fault causes the output of an important simulation to be wrong. Fortunately it is wrong in a fashion which looks suspicious 99% of the time, and a correct simulation is very unlikely to look similarly suspicious, which happens only once in three hundred thousand simulations. You run a simulation and the output looks suspicious. What is the probability that your CPU has this fault?

[25 marks]

2 Pat McLearner speculates that a machine learning system trained on a binary (i.e., two class) classification task cannot in general be expected to achieve a lower error rate than the rate of labeling errors in the training set. Do you agree or disagree? If you agree, give a simple proof sketch; if you disagree, give a simple counterexample.

[25 marks]

3 Give an example of a kernel function K and the corresponding nonlinear phi function such that K(x,y) = phi(x) . phi(y), where the "." denotes dot product. (Note: the example can be low dimensional rather than something practical, if you'd like.) Then explain briefly how the kernel trick is used to "kernelize" an algorithm.

[25 marks]

4 Describe (e.g., with an equation and a brief description of terms) how a Q-learning system does an update after it starts in state s1, performs action a, ends up in state s2, and receives a reward of r.

[25 marks]

5 You implement a simple batch gradient descent optimization routine. You have tested the gradient calculation against numeric differences, and are positive that you're getting the right gradient. But when you run the optimizer, after a while you notice that the training set error (which you print every iteration) has stopped going down and started to go up! What will you do, and (briefly) why?