



**Maynooth  
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National University  
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**OLLSCOIL NA hÉIREANN MÁ NUAD**  
**THE NATIONAL UNIVERSITY OF IRELAND MAYNOOTH**

**JANUARY 2018 EXAMINATION**

**CS401**

**Machine Learning & Neural Networks**

Dr. D. Charles, Prof. 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

Q1: An experimental protocol developed by NuGenCanPharm Inc to test if a cancer drug is effective is correct 99% of the time, on both effective and ineffective drugs. NuGenCanPharm Inc synthesizes 10,000 candidate drugs, expecting about 20 of them to actually be effective. The seventh drug they test passes the test as effective. What is the probability that, on their seventh try, NuGenCanPharm has actually found an effective cancer drug?

Q2: Explain how both the k-means algorithm and the classical NMF (non-negative matrix factorization) algorithm can be regarded as decomposing the data matrix into a product of matrices. Discuss two commonalities and two differences between the two algorithms in this framework. Give an example of data for which k-mean would be more suitable than NMF, and an example of the reverse.

Q3: Describe the tradeoff between the margin and the softness of the margin in a support vector machine being trained on noisy data. How would you decide how to set the softness parameter?

Q4: Show that given two equally-probable classes A and B, each Gaussian in n-dimensional space with identical covariance matrices but different means, the posterior probability of A being more likely than B given a data point  $x$  is a linear classifier on  $x$ .

Q5: Sketch a design for a system that uses reinforcement learning to make a better traffic light (i.e., to set the policy of a RED/YELLOW/GREEN traffic signal device.) If your solution requires non-standard hardware, be sure to explain what and why.