CSCE 478/878: Machine Learning **Fall Semester, 2003**

Prerequisite Test

August 23, 2004 *Due Date: September 3*

No collaboration is allowed, but you may use any resources you wish, so long as you cite them. Show all work and state all assumptions. submit your solutions to all 5 parts (in a single pdf file) via the web-based handin program. If you do not know the definitions to some terms, consult the instructor, TA, or the Mathworld link on the course home page.

1. **(10 pts)** Give the equation for a hyperplane (i.e., a 4-dimensional plane in this case) that separates the set of points $A = \{(0,0,0),(1,1,0),(0,2,1)\}$ from $B = \{(0,0,4),(3,3,1),(4,2,0),(1,6,0)\}$. Describe how you derived the equation and verify that your hyperplane actually does separate the two sets of points.

2. **(5 pts)** Given the set of numbers $A = \{2,3,4,5,7,9\}$, what is its mean? What is its variance?

3. **(5 pts)** What is the power set of the set $A = \{a,b,c\}$? In general, if a set has n elements, what is the size of its power set?

4. **(10 pts)** Let $\vec{a} = [a_1,\ldots,a_n]$ be a vector and

$$B = \left\{\vec{b}_1,\ldots\vec{b}_m\right\} = \{[b_{11},b_{21},\ldots,b_{n1}],[b_{12},\ldots,b_{n2}],\ldots,[b_{1m},\ldots,b_{nm}]\}$$

be a set of vectors. Solve

$$\frac{\partial}{\partial a_i}\sum_{\vec{b}_j\in B}\left(c-\vec{a}\cdot\vec{b}_j\right)^2,$$

where c is a constant and $\vec{a}\cdot\vec{b}_j$ is the dot product of $\vec{a}$ and $\vec{b}_j$. Carefully explain each step of your derivation.

5. **(20 pts)** Write a brief (2–3 pages) essay on any advanced computer science-related topic that you are familiar with, e.g. virtual memory, Ethernet, NP-completeness or any other topic covered in a 4XX/8XX computer science or applied math class. Assume that the reader of this essay has a basic computer science and math background, but is unfamiliar with the topic that you are writing about. Thus you want to convey the fundamental ideas and applications of this topic, *but do not overwhelm the reader with enormous amounts of detail!* Cite all references you use in a style such as that found in any ACM or IEEE journal. Do *not* simply copy the material from these sources, but instead *write this in your own words.* Only your presentation and writing style will be graded, so have someone proofread this for you before handing it in.