# CSCI/ARTI 8950 Machine Learning

## Assignment Number 4: Due 2/26/2009 **(in class)**

1. [**15 points**] Consider the following training set of samples for machine learning:

| Example | A1 | A2 | A3 | A4 | label |
|---|---|---|---|---|---|
| 1 | 1 | 2 | 2 | 2 | - |
| 2 | 1 | 1 | 1 | 1 | a |
| 3 | 2 | 3 | 2 | 1 | b |
| 4 | 1 | 3 | 3 | 3 | c |
| 5 | 3 | 1 | 2 | 1 | d |
| 6 | 1 | 1 | 1 | 2 | - |

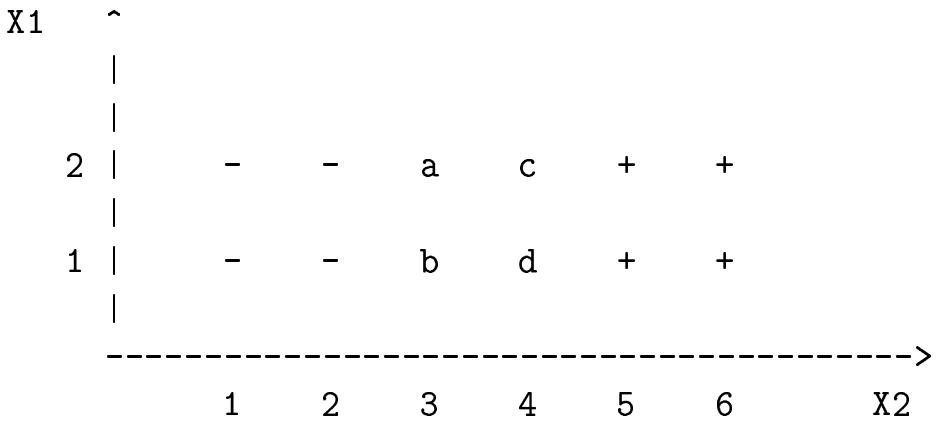
The attributes **A1** through **A4** are integers with values in the range [1,2,3] each.

   (a) For the label assignment (a=-,b=+,c=-,d=+) give a minimal size (measured by the total number of nodes) decision tree that can correctly classify all the training examples.

   (b) How would the tree given in Part (a) above classify the following examples: (1,2,2,3) and (3,2,1,1)?

   (c) Propose a label assignment for a, b, c, and d that will make attribute **A4** better than attribute **A3** according to the ID3 information gain measure.

2. [**15 points**] Consider the following diagram of a set of samples for machine learning:




- For the label assignment (a=+,b=+,c=-,d=-) can all the given samples (including a, b, c, and d) be correctly classified by a properly trained (or computed in any possible way) Perceptron, whose inputs are X1,X2 and has 2 variable weights and a variable threshold? If your answer is YES, sketch one such Perceptron. If your answer is NO, briefly explain why.

- For the label assignment (a=+,b=-,c=+,d=-) can all the given samples (including a, b, c, and d) be correctly classified by a properly trained (or computed in any possible way) binary decision tree with at most 2 levels (2 decisions along each path)? The decision at each level will be of the form $X_i \leq V_i$ where $i$ is 1 or 2 and $V_i$ is a variable threshold. If your answer is YES, sketch one such decision tree. If your answer is NO, briefly explain why.

3. [**10 points**] Solve problem 4.9 on page 125 of the text book.

4. [**10 points**] Solve problem 5.2 on page 152 of the text book.