CSCI/ARTI 8950 Machine Learning

Assignment Number 2: Due 2/16/2023 **(by eLC)**

1. **[20 points][MID]** 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	-

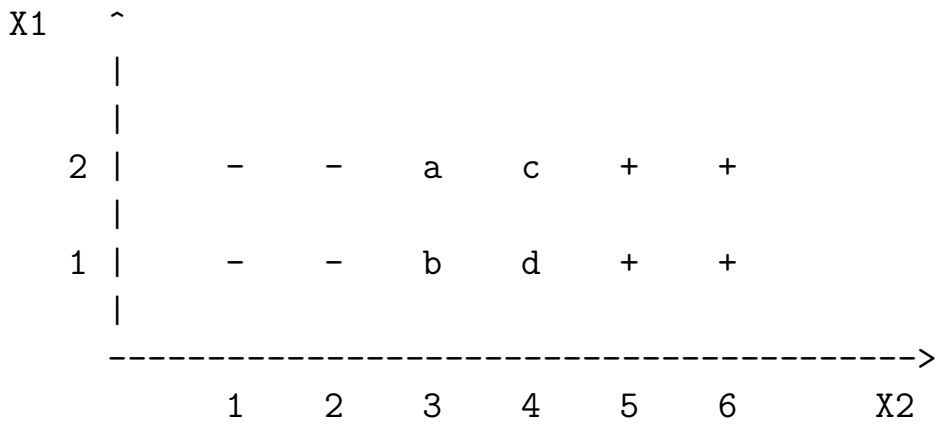
The attributes **A1** through **A4** are integers with values in the range [1,2,3] each.

   (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. **[20 points][MID]** Consider the following diagram of a set of samples for machine learning:



   (a) For the label assignment (a=-,b=+,c=+,d=-) can all the given samples (including a, b, c, and d) be correctly classified by the 3-nearest neighbor rule? This rule labels any sample with the majority label of its 3 nearest neighbors in Euclidean distance from the given samples (the sample itself is NOT considered one of the neighbors). If your answer is NO, briefly explain why.

(b) 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 $X_i \leq V$ where i is 1 or 2 and V is a variable threshold. If your answer is YES, sketch one such decision tree. If your answer is NO, briefly explain why.

3. **[20 points][MID] Short answers please**

(a) Give one advantage for using 3-nearesr neighbor over 1-nearest neighbor for classification.

(b) Give one advantage for using 1-nearesr neighbor over 3-nearest neighbor for classification.

(c) Give one advantage to using the information GainRatio measure over the information Gain measure for constructing decision trees.

(d) Give one advantage for using two-fold cross-validation over ten-fold cross-validation.

(e) Give one advantage for using ten-fold cross-validation over tow-fold cross-validation.