CSCI/ARTI 8950 Machine Learning
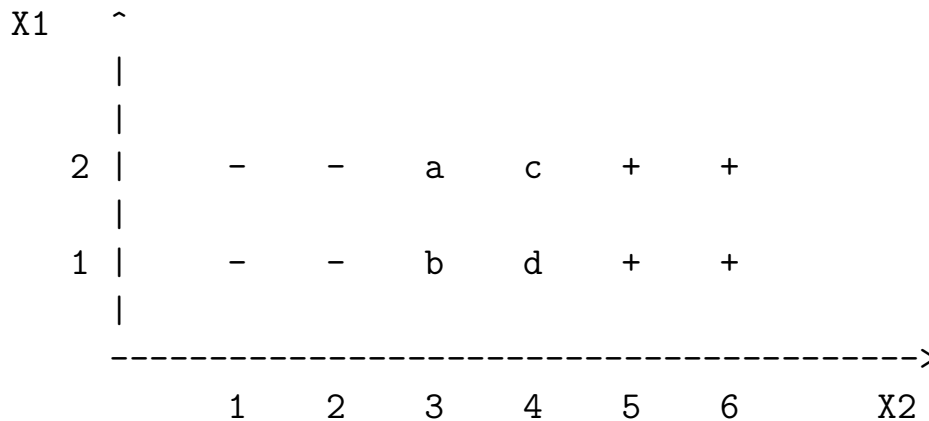
Assignment Number 3: Due 2/27/2023 **(by elc)**

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=-) how would the 1-Nearest Neighbor algorithm using Hamming Distance classify the following examples: (1,2,2,3) and (3,2,1,1)? The Hamming Distance is the number of positions that have different values in the two samples.

   (b) Propose a label assignment for a, b, c, and d that will make all samples correctly classifiable by the 3-Nearest Neighbor algorithm using Hamming Distance.

2. **[20 points][MID]** Consider the following diagram of a set of samples for machine learning:

```
X1    ^
      |
      |
   2  |     -    -    a    c    +    +
      |
   1  |     -    -    b    d    +    +
      |
      -------------------------------------->
            1    2    3    4    5    6       X2
```

   (a) 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.

(b) Propose a label assignment for a, b, c, and d that makes all the given samples (including a, b, c, and d) correctly classifiable 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).

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

A hypothesis space is complete if it contains at least one hypothesis that can correctly classify all samples in any possible training set. An algorithm searches a hypothesis space completely if it finds all hypotheses in that space that can correctly classify all samples in a given training set.

(a) Give the name of one algorithm that searches a complete space of hypotheses but searches it incompletely.

(b) Give the name of one algorithm that searches an incomplete space of hypotheses and searches it incompletely.

(c) Give one advantage to using support vector machines over perceptrons.

(d) Give one advantage for using perceptrons over support vector machines.