CMSC 671 Homework 5 — Fall 2010

Due Date: Wednesday, December 8th, 2010

1 Problem 1: Decision Tree (25 pts.)

Adapted from a problem in book Vipin Kumar et al. "Introduction to Data Mining".
Consider the training examples shown in Table 1 for a binary classification problem.

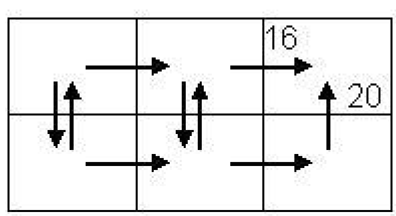
$Instance$	a_1	a_2	a_3	$TargetClass$
1	T	T	1.0	+
2	T	T	6.0	+
3	T	F	5.0	-
4	F	F	4.0	+
5	F	T	7.0	-
6	F	T	3.0	-
7	F	F	8.0	-
8	T	F	7.0	+
9	F	T	5.0	-

Table 1: Data set for Problem 1.

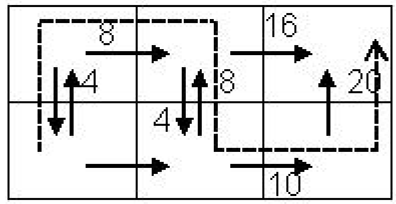
1. What is the entropy of this collection of training examples?
2. What are the information gains of a_1 and a_2 relative to these training examples?
3. For a_3, which is a continuous attribute, compute the information gain for every possible split.
4. What is the best split (among a_1, a_2, and a_3) according to the information gain?
5. What is the best split (between a_1 and a_2) according to the classification error rate?

2 Problem 2: Reinforcement Learning (25 pts.)

Consider the following deterministic grid world. Allowable moves are shown by arrows; the numbers indicate the reward for performing an action. (Unmarked arrows mean that the action yields zero reward/penalty.)



(a) Given current values for Q shown below, show all of the changes in the Q estimates when the agent takes the path shown by the dotted line. (Note that the path starts in the lower left cell, and ends in the upper right cell.) Use gamma=.5.



(b) Show all of the final optimal Q values for gamma=0.5 and for gamma=0.9. (Mark these values on two copies of the grid.)

(c) Given your Q values above, show all of the V* values for each state, and mark one optimal policy (action to take in each cell), for gamma=0.5 and for gamma=0.9.

3 Problem 3: Learning Bayes Nets (15 pts.)

Consider an arbitrary Bayesian network, a complete data set for that network, and the likelihood for the data set according to the network. Give a simple proof (i.e., in words) that the likelihood of the data cannot decrease if we add a new link to the network and recompute the meaximum-likelihood parameter values.

4 Problem 4: Nash Equilibria (10 pts.)

(R&N Exercise 17.16) Show that a dominant strategy equilibrium is always a Nash equilibrium, but not (necessarily) vice versa.

5 Problem 5: (15 pts.)

R&N Exercise 17.18

6 Problem 6: (10 pts.)

(R&N Exercise 17.20) Imagine an auction mechanism that is just like an ascending-bid auction, except that at the end, the winning bidder, the one who bid b_{max}, pays only $b_{max}/2$ rather than b_{max}. Assuming all agents are rational, what is the expected revenue to the auctioneer for this mechanism, compared with a standard ascending-bid auction?