CS533 — Written Homework 3 — Due Friday, November 17, 2000

1. Consider the following training examples. Compute the mutual information between each of the features f1, f2, f3, and f4, and the class. What feature will C4.5 choose for the root of the decision tree using the mutual information heuristic?

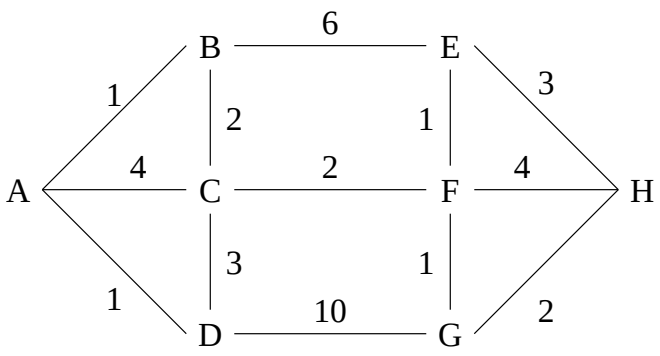
class	f1	f2	f3	f4
c1	0	0	1	0
c1	0	0	0	1
c1	0	1	0	0
c2	0	0	0	1
c2	0	1	0	0
c2	0	1	0	1
c2	1	0	0	1

2. A learning problem that is very hard for learning algorithms is the parity problem. In parity, the class is c2 if an odd number of the features are 1, else the class is c1. For example, here are all 8 possible examples for 3-bit parity:

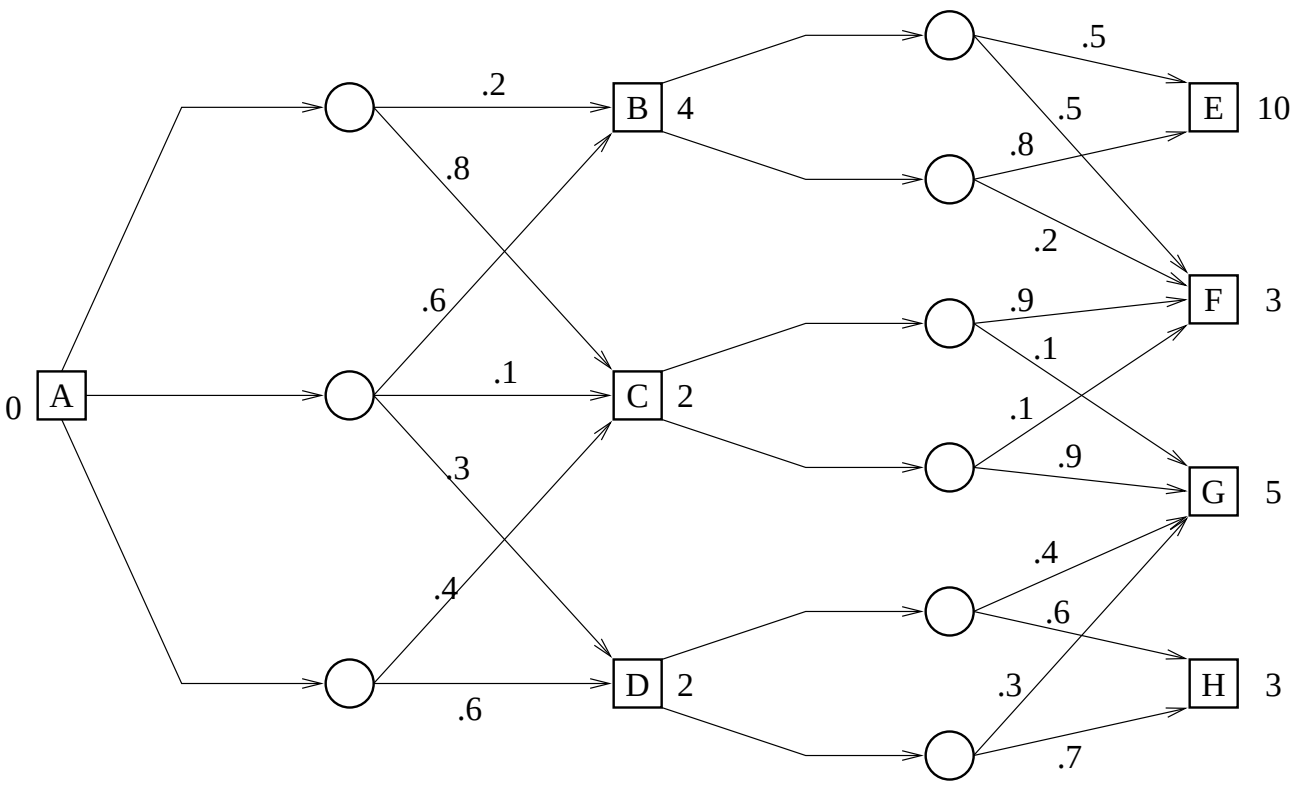
class	f1	f2	f3
c1	0	0	0
c2	0	0	1
c2	0	1	0
c1	0	1	1
c2	1	0	0
c1	1	0	1
c1	1	1	0
c2	1	1	1

If C4.5 were given these examples, what would it compute as the mutual information for each feature? Show an example of a decision tree that correctly classifies all examples of 3-parity.

3. Compute the optimal value function and the optimal policy for the following graph problem like the one on the slides in class. The start state is A and the goal state is H. Each path connecting two states is labeled with its cost. Assume that the initial value function is Infinite at every node. What is the minimum number of "backups" required to compute this value function? List the states in order of when they should be backed up. What would happen if the value function was initialized to 0 at every node?



4. Consider the following stochastic reinforcement learning problem. The square nodes are the states (where our policy must choose which action to perform). These are also sometimes called the choice nodes. The circular nodes are random nodes, where a random choice is made (according to the indicated probabilities) to determine the next state. The numbers next to each state specify the reward we get when we enter that state. Compute the optimal value function for this problem. When you perform a backup, you must compute an expected value according to the formula:

$$f(s) = \max_a \sum_{s'} p(s'|s,a)[r(s') + f(s')]$$

where s' is the resulting state after choosing action a. $p(s'|s,a)$ is the probability that if we start in state s and apply operator a we will move to state s'.