Homework #7: Chapters 18

The following exercises are due at the beginning of class on Friday, April 29. Note, this homework is continued on the reverse side of the paper.

1. *[10 pts.]* Consider the case of learning to play tennis (or some other sport with which you are familiar). Explain how this process fits into the general learning model from Fig. 2.15 (p. 55), identifying each of the components of the model as appropriate. Is this supervised learning or reinforcement learning?

2. *[35 pts. total]* In this problem we'll consider the following training set:

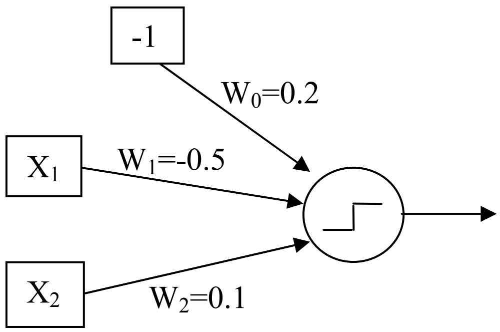
Example	**Color**	**Legs**	**Tail**	**Fur**	**Goal Predicate**
X_1	Brown	4	Yes	Yes	Yes
X_2	Brown	2	No	Yes	No
X_3	Green	4	Yes	No	No
X_4	Brown	0	Yes	No	No
X_5	Black	4	Yes	Yes	Yes
X_6	Black	2	No	Yes	No
X_7	Gold	2	Yes	No	No
X_8	Gold	4	Yes	Yes	Yes

   a) *[5 pts.]* Calculate the information requirement for the training set.

   b) *[20 pts.]* Calculate the information gain for each of the four attributes: *color*, *legs*, *tail*, and *furs*. **Hint:** If you don't have a calculator capable of doing base 2 logarithms, you can calculate them using the natural logarithm: $\log_2 x = \ln x / \ln 2$.

   c) *[10 pts.]* Based on your findings in part b), draw a partial decision tree that includes the attribute on which the first test should be performed and its immediate child nodes. You may use a question mark for the attribute of any nodes that cannot be completely classified by the first attribute test.

3. *[30 pts.]* Use the perceptron learning algorithm to teach the perceptron shown at the top of the page to recognize implications (i.e. $X_1 \Rightarrow X_2$). Assume that a **threshold activation function** is being used and that the threshold function returns 1 when its input is ≥ 0 and returns 0 otherwise. For initial weights, use $W_0 = 0.2$, $W_1 = -0.5$, and $W_2 = 0.1$. For the learning rate, use $\alpha = 0.1$. Use only the examples in the table to the right of the network in your learning process. Stop the training once the weights remain unchanged for one full pass through the examples. The examples must be used in the order given by the table below. Start again with the first example whenever you exhaust all of the examples but have not yet reached the stopping criteria. Show all of the intermediate calculations and values (not just the answer or the updated weights after each example).



Training Set		
X_1	X_2	out
0	1	1
1	0	0
0	0	1
1	1	1

4. *[25 pts.]* Consider the following neural network in which the hidden units and output units use a **threshold activation function** (as above, assume it returns 1 when its input is ≥ 0 and returns 0 otherwise). The number of each node is written in bold above it. The t=*x* notation means that a unit has threshold *x* (as opposed to 0). Recall, this is shorthand for an ordinary threshold node which has an additional bias weight of *x* on a fixed input of –1. Given the activation levels written in the boxes for the input units on the left, compute the activation levels (a_3, a_4, a_5, a_6, a_7, a_8 and a_9) of the remaining nodes in the network. Show you work for each activation level.