Homework #7: Chapters 18 and 19

The following exercises are due at the beginning of class on Friday, April 28. Note, this homework is continued on the reverse side of the paper.

1. *[30 pts.]* In this problem we'll consider the following training set:

Example	Type	Garage	Bedrooms	Bathrooms	Goal Predicate
X_1	TownHouse	Yes	2	1.5	Yes
X_2	Condo	No	2	1.5	No
X_3	Apartment	Yes	2	1	No
X_4	TownHouse	Yes	4	1	No
X_5	TownHouse	Yes	3	1.5	Yes
X_6	Condo	Yes	1	1	No
X_7	TownHouse	No	3	1.5	No
X_8	Apartment	Yes	2	1.5	No

   a. Convert the training set into a set of first-order logic description and classification sentences. Use the predicates *Type(x,t)*, *Beds(x,b)*, *Baths(x,b)* and *Garage(x,g)* in your description sentences and *Q(x)* for your goal predicate.

   b. Which of these examples is the candidate definition *Beds(x,2) ∧ Baths(x,1.5)* consistent with? Which examples result in false positives and which ones in false negatives?

   c. Give all the immediate specializations of *Type(x,TownHouse) ∧ Garage(x,Yes)* that are consistent with examples X_3, X_4, and X_5. Do not consider any other examples. Assume that the hypothesis space only contains hypotheses whose candidate definitions are positive conjunctive sentences (i.e., a set of unnegated atoms separated by and (∧) symbols). Thus, the immediate specialization of a sentence should differ by only a single conjunct.

   d. Give all the immediate generalizations of *Type(x,Condo) ∧ Beds(x,3) ∧ Garage(x,No)* that are consistent with example X_2. Do not consider any other examples. As above, assume that the hypothesis space only contains hypotheses whose candidate definitions are positive conjunctive sentences.

2. *[25 pts.]* Use version space learning on the training set from problem #1 above. Assume that the examples are received in the order given and that the hypothesis space only contains hypotheses whose candidate definitions are positive conjunctive sentences. Classify each example with respect to all hypotheses in the G-set and S-set, and be sure to show the G-set and S-set after each step.

3. *[20 pts.]* Construct by hand a perceptron that can calculate the logic function implies (=>). Assume that 1 = true and 0 = false for all inputs and outputs. Be sure to say which activation function you are using.

4. *[25 pts.]* Consider the following neural network in which the hidden units and output units use a **threshold activation function**. 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, and a_7) of the remaining nodes in the network. Show you work for each activation level.