Homework #7: Chapters 18 - 20

The following exercises are due at the beginning of class on Friday, April 25. 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. 53), identifying each of the components of the model as appropriate. Is this supervised learning or reinforcement learning?

2. *[25 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	2	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. *[8 pts.]* 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. *[8 pts.]* Which of these examples is the candidate definition $Beds(x,2) \wedge Baths(x,1.5)$ consistent with? Which examples result in false positives and which ones in false negatives?

   c. *[5 pts.]* Give all the immediate specializations of $Type(x,TownHouse) \wedge Garage(x,Yes)$ 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 ($\wedge$) symbols). Thus, the immediate specialization of a sentence should differ by only a single conjunct.

   d. *[4 pts.]* Give all the immediate generalizations of $Type(x,Condo) \wedge Beds(x,3) \wedge Garage(x,No)$ 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.

3. *[30 pts.]* Use current best-hypothesis search learning on the training set from problem #1 above. As was demonstrated in class, assume the algorithm is implemented as a depth-first search. The initial hypothesis should either be "True" or "False", and each node in your search tree should show the current hypothesis and how it classifies the current example (i.e., true positive, true negative, false positive or false negative). When a node is expanded, its children are determined by the consistency of its hypothesis. If it is consistent, then it has a

single child with the same hypothesis considering the next example. If it is inconsistent, then the children's hypotheses are the immediate specializations (or generalizations) that are consistent with all examples to that point. 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. When there is a choice of otherwise equivalent nodes to expand, always choose the one that adds the leftmost remaining condition from the attributes in the table.

4. *[15 pts.]* Construct by hand a feed-forward neural network of threshold units that computes the exclusive or (XOR) function of two inputs. Assume that 1 = true and 0 = false for all inputs and outputs. Be sure to say which activation function you are using.

5. *[20 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, a_7, a_8, and a_9) of all other nodes in the network. Show you work for each activation level.