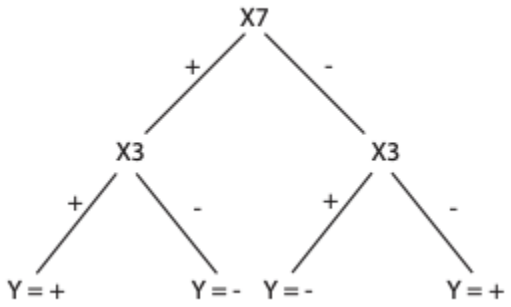
PART-A [5 questions = 40 points]

Question1 [6 points]
Explain overfitting [2 points] and VC dimension [2 points]. Explain the relationship between VC dimension and overfitting. [2 points]

Question2 [4 points]
Can a hypothesis class with a high VC dimension always fit any set of training data perfectly? [2 points] Why or why not? [2 points]

Question3 [10 points]
What is the VC Dimension of a 2D classifier with a rectangle shape? [2 points] Explain with examples (similar to the procedure performed in class). [8 points]

Question4 [10 points]
For the following problem consider a decision tree with boolean inputs ($X_1, \ldots, X_n$) and boolean outputs ($Y \in \{+, -\}$). Consider a regular depth-2 decision tree (4 leaf nodes in total) in which the left and right child of the root are required to test the same attribute. For example:



Consider the training data to be noise-free for target concept (c) which is described by a regular, depth-2 decision tree. How many training examples must you provide the learning algorithm in order to assure that with probability 0.99 the learner will output a tree whose true accuracy is at least 0.97? Assume you have data with 20 features in total (although you believe only two of these twenty will be needed to describe the correct tree).

Question5 [10 points]
Consider the same setup as Question 5 and you modify the algorithm to handle instances that have real-valued attributes instead of boolean attributes (So you allow each decision tree node to perform a Boolean threshold test of the form $X_i > a$ where a is allowed to take on any real value). The tree is similarly constrained such that the two second-level nodes, must both test the same attribute and use the same threshold.
For this modification, How many training examples must you provide the learning algorithm in order to assure that with probability 0.99 the learner will output a tree whose true accuracy is at least 0.97? In this case, assume that each example has only two attributes, so the tree will end up using both. You can still assume that the target concept (c) is in the new hypothesis space.

PART-B [3 questions = 10 points]

Question1 [6 points]
How does the value iteration algorithm work [3 points], and what are its basic steps [3 points]?

Question2 [2 points]
How do you choose the initial values for the state value function in the value iteration algorithm?

Question3 [2 points]
What are some limitations of value iteration in reinforcement learning?

PART-C [9 questions = 30 points]

Refer to the Jupyter Notebook (IPYNB file) for further instructions on Deep-Q-learning.

You are expected to work through it and understand the code first (more like a code play-around notebook). This assignment requires no code parts to be filled.
