CMPT 310, Spring 2019, Written Assignment 11

Due date: April 08, 2019

Problem 1. Count the number of parameters (i.e. weights) in the following neural networks: The input is a 100x100 image of black/white pixels, each represented by a real number. The output is 10 labels 0/1 labels representing what animal is depicted in the picture. (Don't forget about the bias weights!)

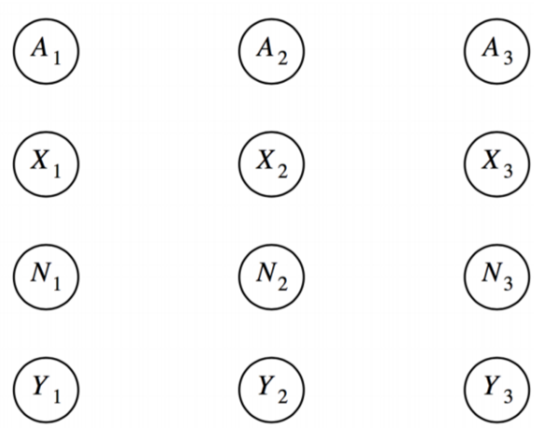
(a) Separate multi-layer perceptrons for each label, each with two hidden layers, with 20 and 10 hidden units respectively.

(b) Same as (a), but just one multi-task network instead of 10 separate networks.

(c) A multi-task convolutional neural network with the following layers: (1) a convolutional layer with 100 filters on a 5x5 grid, (2) a max-pooling layer, and (3) a fully-connected layer.

Problem 2. An agent lives on a 3×3 grid world surrounded by walls. $(1, 1)$ is at the bottom left and $(3, 1)$ is at the bottom right. An agent's actions can be *left, right, up* or *down*. The agent's percept is an integer N indicating the number of adjacent walls. The agent's state is its (X, Y) position and the prior over (X, Y) is uniform. At each time step, the agent receives its percept and performs an action.

(a) Here are the first three time slices of a dynamic Bayes net. Add links to make the best possible representation of the problem. (You need not add parents for A because the agent chooses its value.)



(b) Suppose the wall sensor is accurate and the agent's movement is deterministic. Given $N_1 = 1$, $A_1 = right$, $N_2 = 2$, where could the agent be at time 2?

Problem 3 (Optional). Suppose an agent lives in a world with two states S and $\neg S$, and can perform exactly one of two actions a and $\neg a$. Action a flips from one state to the other, and action $\neg a$ does nothing. Let S^t be the proposition that the agent is in state S at time t and let a^t be the proposition that the agent does action a at time t.

(a) Write a successor-state axiom for S^{t+1}.

(b) Convert the sentence in (a) into CNF.

(c) Show a resolution-refutation proof that if the agent is in $\neg S$ at time t and does $\neg a$ it will still be in $\neg S$ at time $t + 1$.

Problem 4 (Optional). n vehicles occupy squares $(1, 1)$ through $(n, 1)$ (i.e. the bottom row) of an $n \times n$ grid. The vehicles must be moved to the top row but in reverse order, so vehicle i that starts in $(i,1)$ is moved to $(n - i + 1, n)$. On each time step, every one of the n vehicles can move one square up, down, right, left or stay put. But, if a vehicle stays put, one other adjacent vehicle (but not more than one) can hop over it. Two vehicles cannot occupy the same square.

1. Calculate the size of the state space.

2. Calculate the branching factor.

Problem 5 (Optional). Considering Problem 4 description:

(a) Suppose that vehicle i is in square (x_i, y_i). Write a nontrivial admissible heuristic h_i for the number of moves it will require to get to its goal location $(n - i + 1, n)$, in the case where there are no other vehicles on the board.

(b) Describe one heuristics admissible for the problem of moving all n vehicles to their destinations. Explain your answer.