CS 188, fall/1998
Midterm Exam

Problem #1

1. This problem is intended to test your understanding of how the information in the optical flow field can be used to control the movement of a robot. Assume that there is no rotation.

(a) How can you determine the Focus of Expansion (FOE) and the time to collision (tau) from the flow field?
(b) How would you use the FOE and tau variables for (a) lateral control (heading in a desired direction) (b) controlling braking behavior -- coming to a smooth stop at a desired location in front of you.
(c) If you were asked to come to a stop at a fixed distance (say 100 feet) in front of your current position, could you do that using the information in the optical flow field?

Problem #2

2. Caltrans has set up roadside cameras which can detect individual vehicles and measure their lengths. You have been hired to design a classifier for labeling each vehicle as a car or a truck (ignore other possible vehicle types such as motorcycles, buses etc) using length as a feature. You can assume that the probability distribution of length for each class is a Gaussian, with mean length being 6 feet for cars and 10 feet for trucks. The standard deviation sigma is 2 feet in each case. Only 20% of the vehicles on the road are trucks.

(a) If you have to use a classifier of type-Declare vehicles to be cars if the length is less than l_o, trucks otherwise - what should l_o be?
(b) Design (not train!) a single layer perceptron for classifying vehicles as cars or trucks using the length feature. Use neurons with logistic (sigmoid) activation functions.
(c) Suppose you now get an example of an 8ft long truck. If your error criterion is the sum of squared differences between desired and actual output, what should be the update on each weight in response to this example? Leave your answer in terms of alpha, the earning rate parameter.

Problem #3

3. In this exercise you are asked to construct a 4 node belief network corresponding to the binary random variables, Smoker, Lung-cancer, Poor-stamina, X-ray. Smokers are more likely to have lun-cancer as well as have Poor-stamina. The X-ray variable is true if there is a black spot found in the X-ray. This tends to happen whebn the person has lung cancer, though like all tests this is not perfect. Examine the nodes in the order S,P,L,X and construct the network. Specify what probabilties you would need, and state (briefly) how you might go about obtaining those numbers.

Problem #4

4. In the belief network shown, the prior probability of A is 0.1, the conditional probability of B given A is true is 0.9 and the conditional probability of B given A is false is 0.4.

Figure 1: A Bayes net.

Express the joint probability distribution of these two random variables in a belief network with the arrow reversed (see below). Specify associated prior and conditional probabilities. The important condition the new network must satisy is that it should correspond to exactly the same joint distribution as before.