CS 188 Midterm Exam, 1030-12 noon, Wed Mar 15, 2000

Make sure you have both pages of this exam.

1. This question tests your knowledge of vision

   (a) In an image, edges can arise due to a variety of reasons: discontinuities in depth, orientation, reflectance or illumination. Draw a diagram to illustrate each of these four cases.

   (b) Sketch the optical flow field I would observe if I was driving directly towards a wall at constant velocity. As I approach the wall (but keep my velocity constant) would I notice any change in the optical flow field?

   (c) Can it be the case that on a curved object illuminated by a distant light source, points with different surface normals have the same brightness values ? Conversely, can there be points on the surface with identical surface normals, but different brightness values?

2. Caltrans has set up roadside cameras which can detect individual vehicles and measure their lengths. You have been hired to design a Bayesian 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 σ is 2 feet in each case. Only 20% of the vehicles on the road are trucks.

   - Plot the posterior probability density $P(\text{car} \mid l)$ where l is the length of the vehicle. Calculate, and indicate clearly on the graph, the values of l for which $P(\text{car} \mid l) = 0.25$, 0.5,0.75 respectively.
   - Your optimal classification rule is to declare all vehicles longer than l_0 to be trucks. What is l_0 ?

3. The EQUAL function of 2 inputs x_1, x_2 is defined to be 1 if the inputs are the same (both 0 or both 1) and 0 otherwise. Can this function be represented by a single layer perceptron? Either prove that this is impossible or construct such a perceptron.

4. Construct the joint probability distribution corresponding to the two binary random variables, *Male, Colorblind.* It is known that the population consists of 45% males and 55% females. Only 1% of females are colorblind, while 10 % of the males are colorblind. Express the joint probability distribution in two ways

- As a table of numbers corresponding to the four possibilities.
- As a Bayes net in the graphical form shown. State the additional information needed to complete the specification of the Bayes net.

Figure 1: **A Bayes net.**