Homework 1

CS 591Q/791V - Pattern Recognition

Instructor: Dr. Arun Ross

Due Date: Feb 12, 2009

Total Points: 60

Note: You are permitted to discuss the following questions with others in the class. However, you *must* write up your *own* solutions to these questions. Any indication to the contrary will be considered an act of academic dishonesty.

1. [15 points] The paper Veggie Vision by Bolle et al. discusses a pattern recognition system that automatically classifies produce items at the checkout counter of a grocery store. Briefly describe this system based on the pattern recognition terminology developed in class: (i) sensors deployed; (ii) segmentation algorithm; (iii) features used; (iv) classification scheme; and (v) post-processing methodology. How is classifier *training* accomplished by *Veggie Vision*?

2. [15 points] Consider a set of n i.i.d. samples (one-dimensional training patterns), $D = \{x_1, x_2, \ldots x_n\}$, that are drawn from the following distribution:

$$p(x|\lambda) = \frac{e^{-\lambda}\lambda^x}{x!}$$

   (a) Derive the maximum likelihood estimate of λ, i.e., $\widehat{\lambda}_{mle}$.

   (b) Assume that $D = \{12, 17, 20, 25, 30\}$. Plot the distribution after computing $\widehat{\lambda}_{mle}$ using D.

3. [15 points] Consider a set of n i.i.d. samples (one-dimensional training patterns), $D = \{x_1, x_2, \ldots x_n\}$, that are drawn from the following distribution:

$$p(x|\theta) = \begin{cases} 2\theta x e^{-\theta x^2}, & x \geq 0, \\ 0, & \text{otherwise.} \end{cases}$$

   (a) Derive the maximum likelihood estimate of θ, i.e., $\widehat{\theta}_{mle}$.

   (b) Assume that $D = \{12, 17, 20, 25, 30\}$. Plot the distribution after computing $\widehat{\theta}_{mle}$ using D.

4. [15 points] Discuss *overfitting* and *generalization* in the context of a pattern recognition system for the following three cases: (a) modeling a regression function; (b) modeling class-conditional densities; and (c) modeling decision boundaries.
