Quiz 4

November 7, 2013

Name: ____________________ **NetID:** __________

Question 1. (1 point) Which of the following classifiers is **not** guaranteed to always make the same prediction as the **Bayes Optimal** classifier,

$$h(x) = argmax_{y \in Y}\{P(Y = y|X = x)\} \ ?$$

(a) $h(x) = argmax_{y \in Y}\{P(Y = y, X = x)\}$

(b) $h(x) = argmax_{y \in Y}\{P(Y = y|X = x) \cdot P(X = x)\}$

(c) $h(x) = argmax_{y \in Y}\{P(X = x|Y = y) \cdot P(Y = y)\}$

(d) $h(x) = argmax_{y \in Y}\{P(Y = y|X = x) \cdot P(Y = y)\}$

Question 2. (1 point) Suppose we have a binary classification problem where instances have 3 boolean attributes. We want to use a **Naïve Bayes** model with **Maximum Likelihood Estimation** to classify new points. Given the following training data and a test point $\mathbf{x} = (1, 1, 1)$, what is the value that our model assigns to the conditional probability $P(X = (1, 1, 1)|Y = +)$?

x_1	x_2	x_3	Label
1	0	1	+
1	1	0	+
0	0	1	-
0	1	1	-

(a) 1 (b) $\frac{1}{2}$ (c) $\frac{1}{4}$ (d) $\frac{1}{8}$

Question 3. (1 point) Our Naïve Bayes model from the previous question will estimate the conditional probability $P(X_1 = 1|Y = -) = \mathbf{0}$ and thus $P(X = (1, 1, 1)|Y = -) = \mathbf{0}$. We suspect that this is unrealistically harsh! Therefore, we decide to try smoothing with **Laplace Estimation** instead. What is the value that our model assigns to $P(X = (1, 1, 1)|Y = -)$ if Laplace estimates are used?

Recall: Laplace estimate of $P(X_i = x_i|Y = y) = \frac{\#(X_i = x_i, Y = y) + 1}{\#(Y = y) + |X_i|}$

(a) $\frac{3}{16}$ (b) $\frac{3}{32}$ (c) $\frac{3}{64}$ (d) 0

Question 4. (1 point) Which of the following statements about first-order Markov models is **false**?

(a) The next state depends *only* on the current state.

(b) The probability of a sequence s_a, s_b, s_c is equal to $P(S_1 = s_a) \cdot P(S_2 = s_b|S_1 = s_a) \cdot P(S_3 = s_c|S_2 = s_b)$.

(c) All states are equally likely to be the start state.

(d) $P(S_i = s|S_{i-1} = s')$ is the same for all i.