CSE 251A Winter 2021 - Take Home Exam 1

1 hour **Name:** **PID:**

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(1) This is an open book, open notes exam. You are free to consult any text book or notes. **You are not allowed to consult with any other person.**
(2) If you need any clarification, please post a private message to the instructors on Piazza.
(3) Remember that your work is graded on the *clarity* of your writing and explanation as well as the validity of what you write.
(4) This is a one-hour exam.

(1) (10 points) Draw the decision boundary for the 1-nearest neighbor classifier on the following labeled data points in 2 dimensions.

$$((1,2),1),((-3,4),2),((-2,-1),3)$$

For full credit, write down the equations for each segment of the decision boundary. Clearly label all the decision regions with the label assigned by the 1-nearest neighbor classifier.

(2) Suppose we have instances X drawn from an instance space $\mathcal{X}$ and labels Y drawn from $\{0, 1\}$. In class and the homework, we talked about how the data distribution D is a joint distribution over $X \times Y$ and can be factorized into the marginal over X times the conditional distribution of Y given X as: $D(X = x, Y = y) = \mu(X = x) \cdot \eta(Y = y|X = x)$. It turns out that D can also be factorized in a different manner:

$$D(X = x, Y = y) = \pi(Y = y) \cdot f(X = x|Y = y)$$

where $\pi(Y = y)$ is the marginal over Y and $f(X = x|Y = y)$ is the conditional likelihood of X given a specific value of Y.

(a) (5 points) Write down expressions for $\pi(Y = y)$ and $f(X = x|Y = y)$ as functions of $\mu(X = x)$ and $\eta(Y = y|X = x)$.

(b) (5 points) Suppose now that we change $f(X = x|Y = y)$ while keeping $\pi(Y = y)$ fixed. Does the Bayes Optimal classifier for D change? If yes, give an example where it happens. If no, give a brief justification.