CS 156 Problem Set 5

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Oct 31, 2016

$$\begin{aligned}
\text{Variants} &= 1500\ (\frac{e^{-\lambda}\lambda^{x}}{x!}) && (1)\\
&= 1500\ (\frac{e^{-1} * 1^{1}}{1!}) && (2)\\
&= \frac{1500}{e} && (3)\\
&= 551.8 && (4)
\end{aligned}$$

$$\begin{aligned}
[\mathrm{E}] &= [\mathrm{E}]_{\mathrm{T}} - [\mathrm{ES}] && (5)\\
[\mathrm{ES}] &= \frac{[\mathrm{E}]_{\mathrm{T}} - [\mathrm{ES}]}{K_{\mathrm{M}}} && (6)\\
[\mathrm{ES}] &= \frac{[\mathrm{E}]_{\mathrm{T}}[\mathrm{S}]/K_{\mathrm{M}}}{1 + [\mathrm{S}]/K_{\mathrm{M}}} && (7)\\
[\mathrm{ES}] &= [\mathrm{E}]_{\mathrm{T}}\frac{[\mathrm{S}]}{[\mathrm{S}] + K_{\mathrm{M}}} && (8)
\end{aligned}$$

$$V_0 = k_2[\mathrm{ES}] \qquad (9)$$

$$\begin{aligned}
V_0 &= k_2[\mathrm{E}]_{\mathrm{T}}\frac{[\mathrm{S}]}{[\mathrm{S}] + K_{\mathrm{M}}} && (10)\\
V_0 &= V_{\max}\frac{[\mathrm{S}]}{[\mathrm{S}] + K_{\mathrm{M}}} && (11)\\
& && (12)
\end{aligned}$$

Problem 1

(C) - We can solve for the smallest possible possible value of N by solving the following equation:

$$\begin{aligned} \mathbb{E}_{\mathcal{D}}[E_{\text{in}}(\boldsymbol{w}_{\text{ln}})] &= \sigma^2(1 - \frac{d+1}{N}) \\ 0.008 &= (0.1)^2(1 - \frac{(8)+1}{N}) \\ N &= 45 \end{aligned}$$

So the lowest answer choice that satisfies the desired expected in-sample error is $N = 100$.

Problem 2

(D) - To achieve the desired boundary, we can use the following formula of a hyperbola:

$$\begin{aligned} ax_1^2 - bx_2^2 &= 1 \\ ax_1^2 - bx_2^2 - 1 &= 0 \end{aligned}$$

However, because this equation gives the opposite dichotomy as the one desired, we need to multiply everything by -1 to get:

$$-ax_1^2 + bx_2^2 + 1 = 0$$

Which matches with answer choice D.

Problem 3

(C) - Since we know that $d_{\text{vc}} \leq \tilde{d} + 1$, we know that $d_{\text{vc}} < 15$.

Problem 4

(E) - Using the chain rule and other differentiation rules, we find the derivative to match E.

Problem 5

(D) - The code outputs 10 which matches answer choice D.

Problem 6

(E) - The code outputs $(u, v) = [0.0447, 0.0239]$ which is closest to answer choice E.

Problem 7

(A) - The code outputs 0.133 which is closest to A. This also makes sense because doing it this way should be slower than using gradient descent.

Problem 8

(E) - The code outputs 0.189 which is closest to answer choice E.

Problem 9

(A) - The code outputs 264.2 which is closest to answer choice A.

Problem 10

(E) - Since the step we want to take in PLA is $y_n \boldsymbol{x}_n$, our error function has to be of the form of $-y_n \boldsymbol{w}^{\mathrm{T}} \boldsymbol{x}_n$. However, since PLA only cares about misclassified points, if a point is classified correctly, the error function should be 0, so we obtain the error function in answer choice E.