ComS 474
Homework 4

Sean Gordon

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1) $\begin{pmatrix} w1 \\ w2 \\ w3 \end{pmatrix} = \lambda_1 * \begin{pmatrix} a_1 \\ b_1 \\ c_1 \end{pmatrix} - \lambda_3 * \begin{pmatrix} a_3 \\ b_3 \\ c_3 \end{pmatrix} = 4.5 * (1) * \begin{pmatrix} .5 \\ .25 \\ .125 \end{pmatrix} + 1.5 * (-1) * \begin{pmatrix} .3 \\ .75 \\ .325 \end{pmatrix} = \begin{pmatrix} 1.8 \\ 0 \\ .075 \end{pmatrix}$

Prediction $= (1, 1, 0) * \begin{pmatrix} 1.8 \\ 0 \\ .075 \end{pmatrix} + 1 = 2.8 > 0$, thus the predicted class is 1.

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2) As the gutters span from $wx + w_b - 1$ to $wx + w_b + 1$, the size of the margin is $\frac{2}{||w||}$, and the size of each gutter is 1/2 that $\Rightarrow \frac{1}{||w||} = \frac{1}{\sqrt{w_1^2 + w_2^2}} = \frac{1}{\sqrt{1.8^2 + .075^2}} = \frac{1}{1.802} = 0.555$.

However, the professor has specified that d_1 and d_2 are both 1, so the equations for both gutters are: $wx + w_b \pm 1 = 0 \Rightarrow$

$$\begin{pmatrix} 1.8 \\ 0 \\ .075 \end{pmatrix} * x + 1 = -1$$

and

$$\begin{pmatrix} 1.8 \\ 0 \\ .075 \end{pmatrix} * x + 1 = 1$$

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3) A point is inside the margin when $|wx + w_b| < 2d = |wx + 1| < 1.11$

(1) $|(0.5, 0.25, 0.125) * \begin{pmatrix} 1.8 \\ 0 \\ .075 \end{pmatrix} + 1| = 1.909 > 1.11$, so this sample is outside the margin.

(2) $|(0.4, 0.15, 0.225) * \begin{pmatrix} 1.8 \\ 0 \\ .075 \end{pmatrix} + 1| = 1.737 > 1.11$, so this sample is outside the margin.

(3) $|(0.3, 0.75, 0.325) * \begin{pmatrix} 1.8 \\ 0 \\ .075 \end{pmatrix} + 1| = 1.564 > 1.11$, so this sample is outside the margin.

(4) $|(0.2, 0.65, 0.425) * \begin{pmatrix} 1.8 \\ 0 \\ .075 \end{pmatrix} + 1| = 1.392 > 1.11$, so this sample is outside the margin.

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4)

(1) If $y_i = 1$ and $w^T x_i + w_b \leq -1$, $y_i(w^T x_i + w_b) \leq -1$, disproving the condition.

(2) This condition holds for $y_i = 1$ and $w^T x_i + w_b \leq -1$ and for $y_i = -1$ and $w^T x_i + w_b \leq 1$. Both of these sets of values when input into $y_i(w^T x_i + w_b) \leq -1$

(3) If $y_i = 1$ and $w^T x_i + w_b \leq -1$, $y_i(w^T x_i + w_b) \leq -1$, disproving the condition.

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(5) If $y_i = 1$ and $w^T x_i + w_b \leq -1$, $y_i(w^T x_i + w_b) \leq -1$, disproving the condition.

(6) This condition holds for $y_i = 1$ and $w^T x_i + w_b \leq -1$ and for $y_i = -1$ and $w^T x_i + w_b \leq 1$. Both of these sets of values when input into $y_i(w^T x_i + w_b) \leq 0$