Homework 5 UG

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FISHER LDA)

$$
\begin{aligned}
X_0 &= \begin{Bmatrix} 4 & 2.9 \\ 3 & 6.4 \end{Bmatrix} \\
X_1 &= \begin{Bmatrix} 2 & 5.10 \\ 2 & 2.15 \end{Bmatrix} \\
\mu_0 &= \begin{Bmatrix} 3.5 & 4.65 \end{Bmatrix} \\
\mu_1 &= \begin{Bmatrix} 2 & 3.625 \end{Bmatrix} \\
X_0^C &= \begin{Bmatrix} 0.5 & -1.75 \\ 0.5 & 1.75 \end{Bmatrix} \\
X_1^C &= \begin{Bmatrix} 0 & 1.475 \\ 0 & -1.475 \end{Bmatrix}
\end{aligned} \tag{1}
$$

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\begin{aligned}
SC_0 &= X_0^{CT} * X_0^C \\
&= \begin{Bmatrix} 0.5 & -1.75 \\ -1.75 & 6.125 \end{Bmatrix} \\
SC_1 &= X_1^{CT} * X_1^C \\
&= \begin{Bmatrix} 0 & 0 \\ 0 & 4.35125 \end{Bmatrix} \\
S_W &= SC_0 + SC_1 \\
&= \begin{Bmatrix} 0.5 & -1.75 \\ -1.75 & 10.47625 \end{Bmatrix} \\
S_B &= \{\mu_0 - \mu_1\}^T * \{\mu_0 - \mu_1\} \\
\{\mu_0 - \mu_1\} &= \begin{Bmatrix} 3.5 & 4.65 \end{Bmatrix} - \begin{Bmatrix} 2 & 3.625 \end{Bmatrix} \\
&= \begin{Bmatrix} 1 & 1.025 \end{Bmatrix} \\
S_B &= \begin{Bmatrix} 1 & 1.025 \\ 1.025 & 1.050625 \end{Bmatrix}
\end{aligned} \tag{2}
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\begin{aligned}
S_M^T * S_B * \vec{w} &= \lambda * \vec{w} \\
S_M^T * S_B &= \begin{Bmatrix} 5.6398 & 5.7808 \\ 1.0399 & 1.0654 \end{Bmatrix} \\
\begin{Bmatrix} 5.6398 & 5.7808 \\ 1.0399 & 1.0654 \end{Bmatrix} * \vec{w} &= \lambda * \vec{w} \\
\lambda_0 &= 6.70564 \\
\lambda_1 &= 4.65e7 \\
\vec{\lambda_0} &= \begin{Bmatrix} 0.983422 & 0.181330 \end{Bmatrix} \\
\vec{w} &= \vec{\lambda_0} \\
\mu_{\vec{w}}^0 &= \vec{w} * \mu_0 \\
&= 4.2852 \\
\mu_{\vec{w}}^1 &= \vec{w} * \mu_1 \\
&= 4.2852 \\
sep &= \frac{\mu_{\vec{w}}^1 + \mu_{\vec{w}}^2}{2} sep = 3.4547
\end{aligned} \tag{3}
$$

To classify point (3.8,5) we multiply it by $\vec{w}$ and see if it is less than or greater than the seperator. If it is less than the seperator then we can conclude that its Class 1 otherwise it is class 0.

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\begin{aligned}
val &= \{3.8, 5\} * \vec{w} \\
val &= 3.87243
\end{aligned} \tag{4}
$$

the value is greater than the seperator so we classify the value as Class 0

PERCEPTRON
The data is as presented

	X_1	X_2	X_3	Y
a	4	3	6	-1
b	2	-2	3	1
c	1	0	-3	1
d	4	2	3	-1

(5)

We start with a $\vec{w} = \{0, 0, 0\}$ and $\eta = 1$. We iterate until $\vec{w}$ can classified them all correctly. To solve for the right weight vector we iterate wtih the following equation until it can classified each data point accurately.

$$\vec{w}_{n+1} = \vec{w}_n + \eta * y_a * \vec{a}$$

So we iterate until All 4 data points can be classified correctly
Step 1)

$$
\begin{aligned}
\vec{w}_1 &= \{0, 0, 0\} + (1) * (-1) * \{4, 3, 6\} \\
&= \{-4, -3, -6\}
\end{aligned} \tag{1}
$$

Step 2)

$$
\begin{aligned}
v &= \vec{w}_1 * 2, \vec{-2}, 3 \\
&= -20 \\
&\quad 2
\end{aligned}
$$

Since the value is not the same sign as 1 we iterate to the equation.

$$\begin{aligned} \vec{w}_2 &= \{-4,-3,-6\} + (1) * (1) * \{2,-2,3\} \\ &= \{-2,-5,-3\} \end{aligned} \tag{2}$$

Step 3)

$$\begin{aligned} v &= \vec{w}_2 * 1, 0, \vec{-3} \\ &= 7 \end{aligned}$$

Since the value is the same sign as 1 we don't iterate we continue to next step

Step 4)

$$\begin{aligned} v &= \vec{w}_2 * 4, \vec{2}, 3 \\ &= -27 \end{aligned}$$

Since the value is the same sign as -1 we don't iterate we continue to next step. Since we reach at the end of the data, we iterate to the top again and see if it works for all.

Step 5)

$$\begin{aligned} v &= \vec{w}_2 * 4, \vec{3}, 6 \\ &= -27 \end{aligned}$$

Since the value is the same sign as 1 we don't iterate we continue to next step

Step 6)

$$\begin{aligned} v &= \vec{w}_2 * 2, \vec{-2}, 3 \\ &= -3 \end{aligned}$$

Since the value is not the same sign as 1 we iterate to the equation.

$$\begin{aligned} \vec{w}_3 &= \{-2,-5,-3\} + (1) * (1) * \{2,-2,3\} \\ &= \{0,-7,0\} \end{aligned} \tag{2}$$