Homework 5 UG

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FISHER LDA)

$$X_0 = \begin{Bmatrix} 4 & 2.9 \\ 3 & 6.4 \end{Bmatrix}$$

$$X_1 = \begin{Bmatrix} 2 & 5.10 \\ 2 & 2.15 \end{Bmatrix}$$

$$\mu_0 = \begin{Bmatrix} 3.5 & 4.65 \end{Bmatrix}$$

$$\mu_1 = \begin{Bmatrix} 2 & 3.625 \end{Bmatrix} \tag{1}$$

$$X_0^C = \begin{Bmatrix} 0.5 & -1.75 \\ 0.5 & 1.75 \end{Bmatrix}$$

$$X_1^C = \begin{Bmatrix} 0 & 1.475 \\ 0 & -1.475 \end{Bmatrix}$$

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$$SC_0 = X_0^{CT} * X_0^C$$

$$= \begin{Bmatrix} 0.5 & -1.75 \\ -1.75 & 6.125 \end{Bmatrix}$$

$$SC_1 = X_1^{CT} * X_1^C$$

$$= \begin{Bmatrix} 0 & 0 \\ 0 & 4.35125 \end{Bmatrix}$$

$$S_W = SC_0 + SC_1$$

$$= \begin{Bmatrix} 0.5 & -1.75 \\ -1.75 & 10.47625 \end{Bmatrix} \tag{2}$$

$$S_B = \{\mu_0 - \mu_1\}^T * \{\mu_0 - \mu_1\}$$

$$\{\mu_0 - \mu_1\} = \begin{Bmatrix} 3.5 & 4.65 \end{Bmatrix} - \begin{Bmatrix} 2 & 3.625 \end{Bmatrix}$$

$$= \begin{Bmatrix} 1 & 1.025 \end{Bmatrix}$$

$$S_B = \begin{Bmatrix} 1 & 1.025 \\ 1.025 & 1.050625 \end{Bmatrix}$$

$$S_M^T * S_B * \vec{w} = \lambda * \vec{w}$$

$$S_M^T * S_B = \begin{Bmatrix} 5.6398 & 5.7808 \\ 1.0399 & 1.0654 \end{Bmatrix}$$

$$\begin{Bmatrix} 5.6398 & 5.7808 \\ 1.0399 & 1.0654 \end{Bmatrix} * \vec{w} = \lambda * \vec{w}$$

$$\lambda_0 = 6.70564$$

$$\lambda_1 = 4.65e7$$

$$\vec{\lambda_0} = \begin{Bmatrix} 0.983422 & 0.181330 \end{Bmatrix} \tag{3}$$

$$\vec{w} = \vec{\lambda_0}$$

$$\mu_{\vec{w}}^0 = \vec{w} * \mu_0$$

$$= 4.2852$$

$$\mu_{\vec{w}}^1 = \vec{w} * \mu_1$$

$$= 4.2852$$

$$sep = \frac{\mu_{\vec{w}}^1 + \mu_{\vec{w}}^2}{2} sep = 3.4547$$

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.

$$val = \{3.8, 5\} * \vec{w}$$

$$val = 3.87243 \tag{4}$$

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

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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)

$$\vec{w_1} = \{0, 0, 0\} + (1) * (-1) * \{4, 3, 6\}$$

$$= \{-4, -3, -6\} \tag{1}$$

Step 2)

$$v = \vec{w_1} * \overrightarrow{2, -2, 3}$$

$$= -20$$

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

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

(2)

Step 3)

$$v = \vec{w}_2 * \overrightarrow{1, 0, -3}$$
$$= 7$$

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

Step 4)

$$v = \vec{w}_2 * \overrightarrow{4, 2, 3}$$
$$= -27$$

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)

$$v = \vec{w}_2 * \overrightarrow{4, 3, 6}$$
$$= -27$$

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

Step 6)

$$v = \vec{w}_2 * \overrightarrow{2, -2, 3}$$
$$= -3$$

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

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

(2)

Step 7)

$$v = \vec{w}_2 * \overrightarrow{1, 0, -3}$$
$$= 0$$

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

Step 8)

$$v = \vec{w}_2 * \overrightarrow{4, 2, 3}$$
$$= -14$$

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

Step 9)

$$v = \vec{w_2} * \overrightarrow{4,3,6}$$
$$= -21$$

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

Step 10)

$$v = \vec{w_2} * \overrightarrow{2,-2,3}$$
$$= 14$$

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

Step 11)

$$v = \vec{w_2} * \overrightarrow{1,0,-3}$$
$$= 0$$

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

Step 12)

$$v = \vec{w_2} * \overrightarrow{4,2,-3}$$
$$= -14$$

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

So the final wieght vector is $\overrightarrow{0,7,0}$