

BITS F464 - Machine Learning

Assignment-1A: Fisher's Linear Discriminant

Made by -

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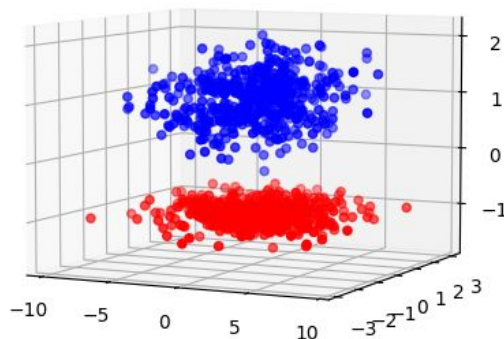
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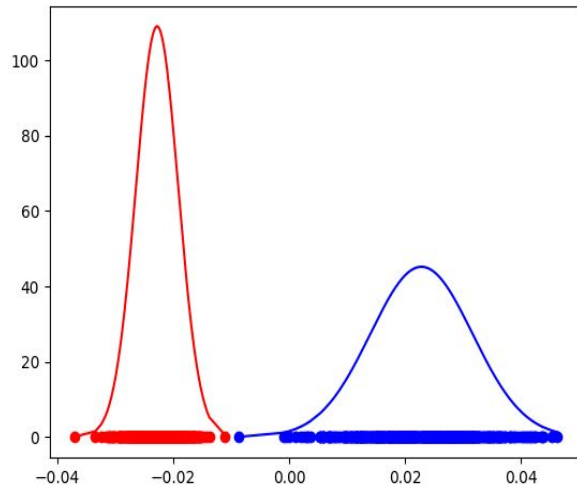
Model Description

- The main idea is to maximize the difference between the means of the classes and minimize sum of variances.
- The expression boils down to maximize $w^T S_b w / w^T S_w w$ where S_b is the between class covariance matrix and S_w is the within class covariance matrix.
- W comes proportional to the expression $S_w(M_1 - M_2)$
- This algorithm works only if points are linearly separable else there will be a large number of misclassifications.
- When the points are projected onto w , we get a 1D plot of the points. Now we need a threshold to discriminate between the points in 1D.
- This is done by fitting normal distributions in the 1D classes.
- The intersection of these distributions gives us the threshold.
- If threshold is b and let w be $[w_1, w_2, w_3]$ then $\Rightarrow w_1 \cdot x + w_2 \cdot y + w_3 \cdot z \geq b$ is a negative point and $w_1 \cdot x + w_2 \cdot y + w_3 \cdot z < b$ is a positive point or vice versa.
- Thus $w^T x = b$ gives us the discriminating boundary in original space.

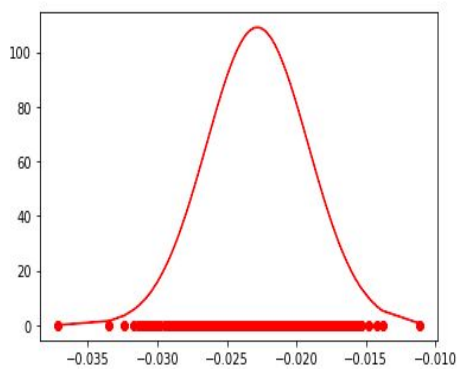
Plots



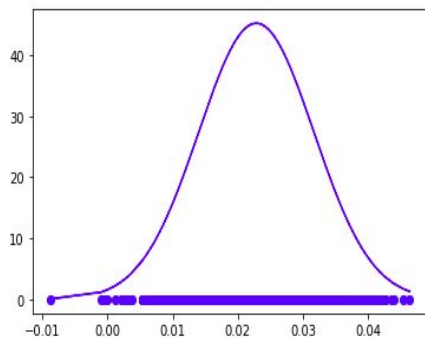
Plot visualizing the points in 3D space. Red represents 0 and blue represents 1.



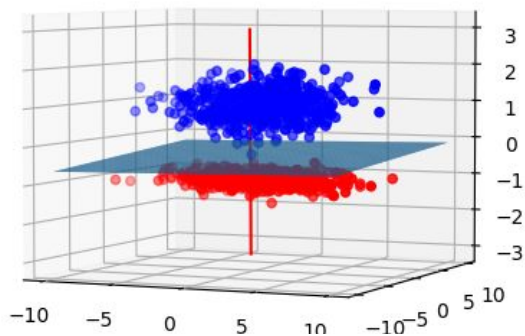
Plot visualizing the clusters in 1D and their respective normal curves.



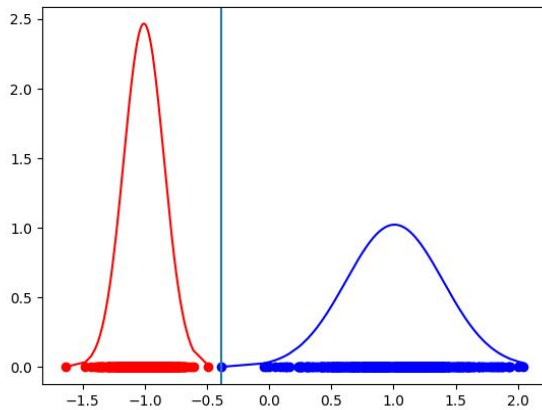
Scatter plot and normal curve for class 0 in 1D



Scatter plot and normal curve for class 1 in 1D



3D plane separating the classes in original space



Line separating the classes in 1D
 $x = -0.3893028$

Results

- The unit vector w $[-0.00655686 \ -0.01823739 \ 0.99981218]$
- The intersection point of normal distributions in 1D -0.3893028 , 0
- The line separating the classes in 1D is $x = -0.3893028$.
- The discriminant function $-0.00655686x - 0.01823739y + 0.99981218z = -0.3893028$.
- Accuracy is 100%