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Assignment 3

Introduction to Machine Learning

Prof. B. Ravindran

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1. Which of the following is true about a logistic regression based classifier?

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(d) The decision boundary is non-linear in the weights

Sol. (a), (c)

2. For a binary classification problem, the decision boundary resulting from the use of logistic regression is

(a) linear

(b) sigmoid

(c) parabolic

(d) exponential

Sol. (a)

Refer to the videos

3. (2 marks) Consider the case where two classes follow Gaussian distribution which are centered at $(-1, 2)$ and $(1, 4)$ and have identity covariance matrix. Which of the following is the

separating decision boundary using LDA?

(a) $y - x = 3$

(b) $x + y = 3$

(c) $x + y = 6$

(d) (b) and (c) are possible

(e) None of these

(f) Can not be found from the given information

Sol. (b)

As the distribution is Gaussian and have identity covariance (which are equal), the separating boundary will be linear. The decision boundary will be orthogonal to the line joining the centers and will pass from the midpoint of centers.

4. Consider the following relation between a dependent variable and an independent variable identified by doing simple linear regression. Which among the following relations between the two variables does the graph indicate?

1

(a) as the independent variable increases, so does the dependent variable

(b) as the independent variable increases, the dependent variable decreases



(c) if an increase in the value of the dependent variable is observed, then the independent

variable will show a corresponding increase

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(f) none of the above

Sol. (e)

5. Given the following distribution of data points:

2

What method would you choose to perform Dimensionality Reduction?

- (a) Linear Discriminant Analysis
- (b) Principal Component Analysis

Sol. (a)

PCA does not use class labels and will treat all the points as instances of the same pool. Thus the principal component will be the vertical axis, as the most variance is along that direction. However, projecting all the points into the vertical axis will mean that critical information is lost and both classes are mixed completely. LDA, on the other hand models each class with a gaussian. This will lead to a principal component along the horizontal axis which retains class information (the classes are still linearly separable)

6. In general, which of the following classification methods is the most resistant to gross outliers?

3

- (a) Quadratic Discriminant Analysis (QDA)
- (b) Linear Regression
- (c) Logistic regression
- (d) Linear Discriminant Analysis (LDA)

Sol. (c)

In general, a good way to tell if a method is sensitive to outliers is to look at the loss it incurs upon ignoring outliers.

Linear Regression uses a square loss and thus, outliers that are far away from the hyperplane contribute significantly to the loss.

LDA and QDA both use the L2-Norm and, for the same reason, sensitive to outliers.

Logistic Regression weights the points close to the boundary higher than points far away. This is an implication of the Logistic loss function (beyond the boundary, roughly linear instead of quadratic).

7. Suppose that we have two variables, X and Y (the dependent variable). We wish to find the relation between them. An expert tells us that relation between the two has the form $Y = mX^2 + c$. Available to us are samples of the variables X and Y. Is it possible to apply linear regression to this data to estimate the values of m and c?

- (a) no
- (b) yes
- (c) insufficient information

Sol. (b)

Instead of considering the dependent variable directly, we can transform the independent variable by considering the square of each value. Thus, on the X-axis, we can plot values of X^2 and on the Y-axis, we can plot values of Y. The relation between the dependent and the transformed independent variable is linear and the value of slope and intercept can be estimated using linear regression.

8. In a binary classification scenario where x is the independent variable and y is the dependent

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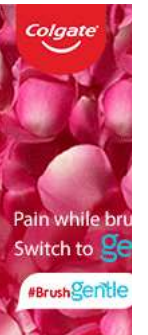
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(d) exponential distribution

Sol. (a)

The dependent variable is binary, so a Bernoulli distribution is assumed.

9. Consider the following data:

4

Feature 1 Feature 2 Class

1 1 A

2 3 A

2 4 A

5 3 A

8 6 B

8 8 B

9 9 B

11 7 B

Assuming that you apply LDA to this data, what is the estimated covariance matrix?

(a)

1.875 0.3125

0.3125 0.9375

(b)

2.5 0.4167

0.4167 1.25

(c)

1.875 0.3125

0.3125 1.2188

(d)

2.5 0.4167

0.4167 1.625

(e) None of these

Sol. (d)

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