Introduction to Modern AI
AI1001 - Fall 2020
Homework Assignment 3

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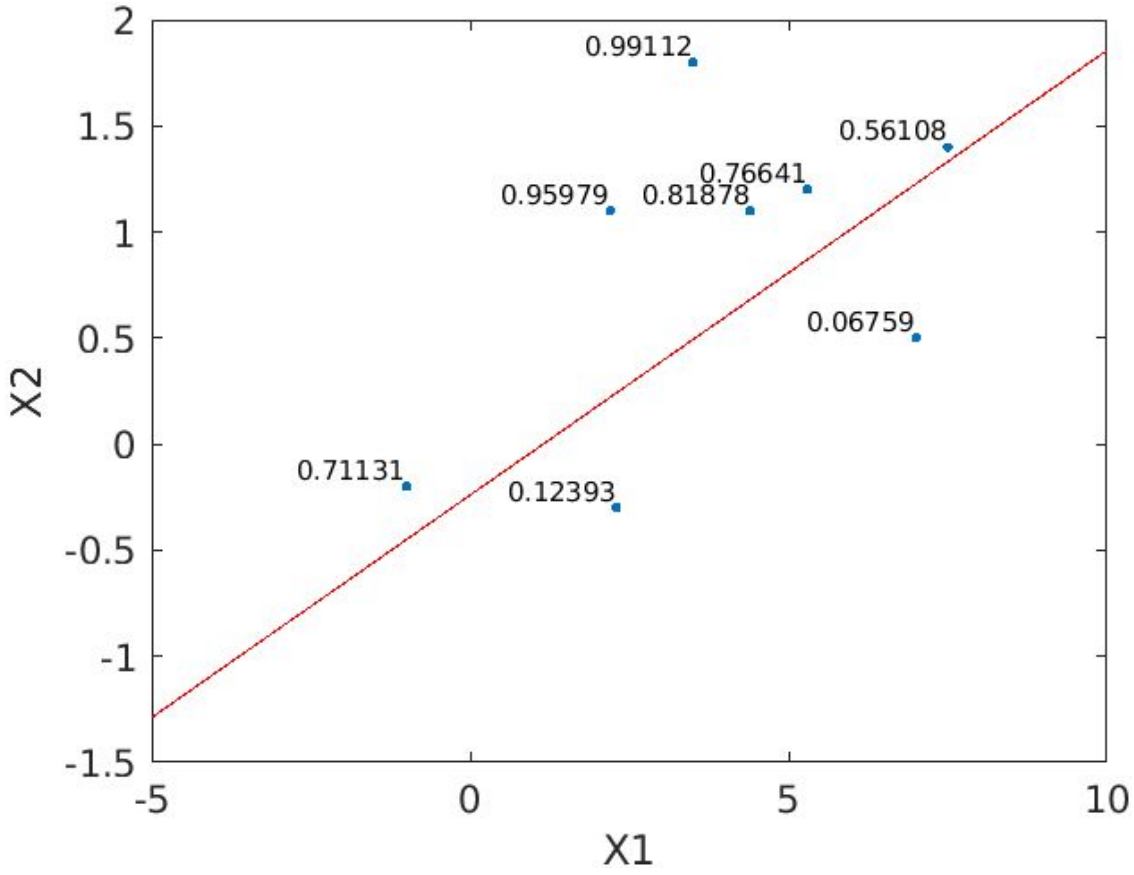
Q 1

A. Probabilities of assigning the label 1 to each training vector

$P[X] = [0.7113,\ 0.9911,\ 0.7664,\ 0.9598,\ 0.5611,\ 0.1239,\ 0.8188,\ 0.0676]$

B. Figure showing the optimal separating straight line, and probabilities assigned to each training vector.

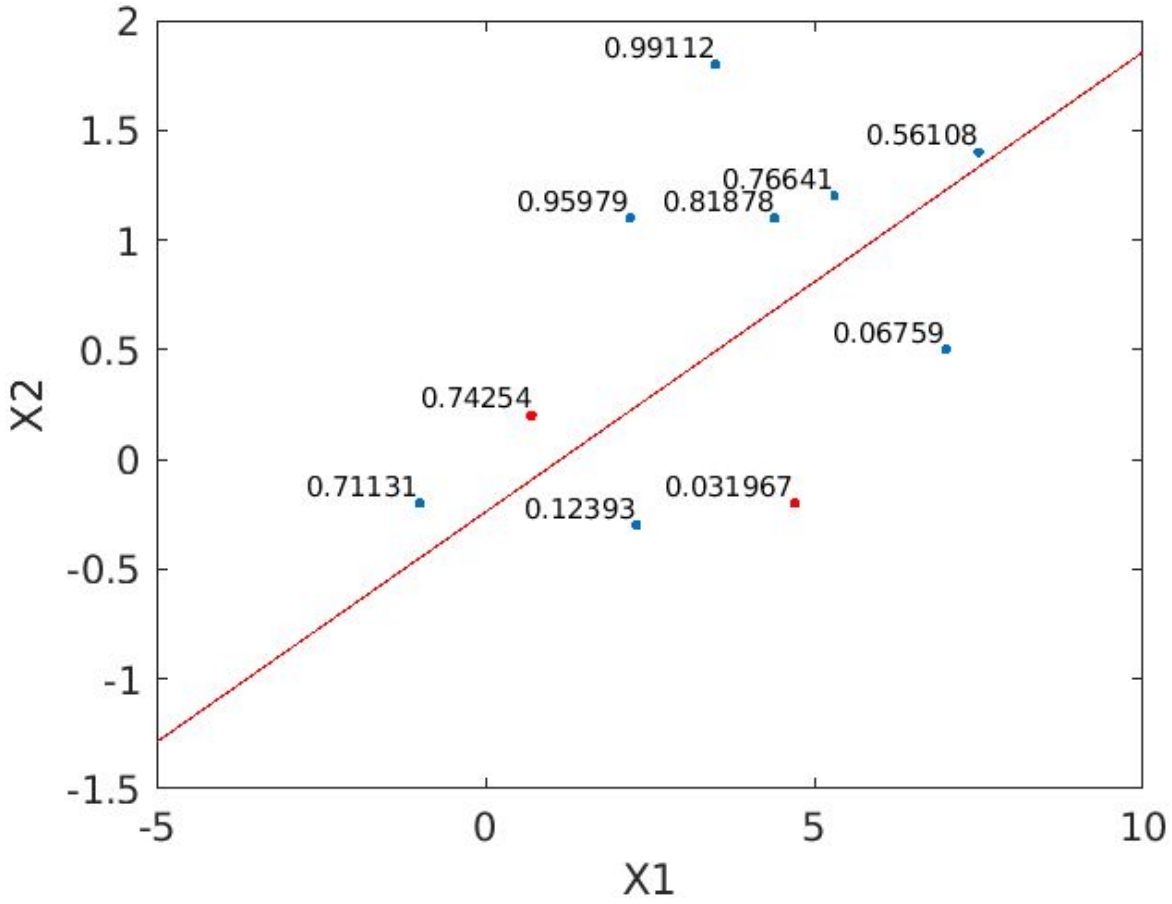
$b = [0.8670 \quad -0.7565 \quad 3.6090]$



C. Probability with which the logistic regressor assigns the probability of 1 to the following test sample.

$v_1 = [0.7\ 0.2]$ *and* $v_2 = [4.7 - 0.2]$.

$P[v_1] = 0.7425$ *and* $P[v_2] = 0.0320$



Red points are the new test inputs to the model.

Q2

Only the direction vector of the optimal logistic regression classifier will be reversed. Its position in space will be unaffected.

The probability **p** associated with each training sample will become **1 - p** because

1) The labeling is reversed.
2) The optimal logistic regression classifier's position does not change.

Q3

Data Replication Method

$$\begin{array}{c} \\ \text{Class 1} \\ \text{Class 2} \\ \text{Class 3} \end{array} \begin{array}{c} \begin{array}{cc} \Delta_1 & \Delta_2 \end{array} \\ \begin{bmatrix} +1 & +1 \\ -1 & +1 \\ -1 & -1 \end{bmatrix} \end{array}$$

One vs. Rest Method

$$\begin{array}{c} \\ \text{Class 1} \\ \text{Class 2} \\ \text{Class 3} \end{array} \begin{array}{c} \begin{array}{ccc} \Delta_1 & \Delta_2 & \Delta_3 \end{array} \\ \begin{bmatrix} +1 & -1 & -1 \\ -1 & +1 & -1 \\ -1 & -1 & +1 \end{bmatrix} \end{array}$$

One vs. One Method

$$\begin{array}{c} \\ \text{Class 1} \\ \text{Class 2} \\ \text{Class 3} \end{array} \begin{array}{c} \begin{array}{ccc} \Delta_{12} & \Delta_{13} & \Delta_{23} \end{array} \\ \begin{bmatrix} +1 & +1 & 0 \\ -1 & 0 & +1 \\ 0 & -1 & -1 \end{bmatrix} \end{array}$$

Q4

1. **Surveillance and security**

   Facial recognition plays an important role in surveillance and security. In recent years, there has been a huge increase in the usage of biometric systems. Biometric-based techniques include Facial Recognition, Fingerprints, Retina, or voice-based authentication. These methods are the replacement of traditional security measures like Passwords, keys, PINs, cards, etc. It is hard to remember them, and they can be stolen, or one can forget them, and they can be easily lost. However, there is no such headache in the use of biometric-based techniques. Facial recognition techniques are also used to analyze video footage of security cameras to catch criminals.

   CNN's have been successful in this area because of their properties like high frequency, and virtuous recognition rate.

2. **Optical character recognition (OCR)**

   OCR is the conversion of images of typed, handwritten, or printed text into machine-encoded text, whether from a scanned document, a photo of a document, a scene-photo (for example the text on signs and billboards in a landscape photo), etc. With the use of CNNs and newer models and algorithms, the error in character recognition has been brought down to values as low as 0.4%.

3. **Scene graph generation**

   Scene Graph Generation (SGG) aims to extract entities, predicates, and their semantic structure from images, enabling a deep understanding of visual content, with many applications such as visual reasoning and image retrieval.

   Many variants built on top of CNN's like Graph R-CNN, Multiscale convolutional networks have shown promising results and accuracies on several Scene graph generation datasets.

Q5

1. **Fraud Detection**

   A lot of banks, credit card companies use fraud detection models built on top of DNNs. These models are capable of detecting anomalies and analyzing request patterns. These models are highly scalable and are used along with machine learning models for providing a better understanding of the systems. These models are orders of magnitude than any human, hence are able to detect frauds quickly.

2. **Natural language processing**

   DNNs have improved performance in several tasks in NLP like machine translation, speech recognition, and audio generation. DNNs are also used for creating virtual assistants that perform many of the above-mentioned tasks.

3. **Medical Science**

   DNNs are used to identify genetic configurations indicative of certain high-risk diseases like autism, cancers, and atrophy. DNNs analyze medical scans to identify possible malignant tumors that may be indicative of cancer.

Reference:

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