Machine Learning Exercise 3

Florian Schneider

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1 Gaussian Discriminant Analysis

1.1 Features

After some feature engineering I had the best scores with the following features.

- Mean of the image of all RGB channels
- Mean of the image of R channel
- Mean of the image of B channel
- Min of the image of all RGB channels
- Max of the image of all RGB channels
- Number of purple pixels in the RGB image. See 1.1.1

1.1.1 Number of purple pixels feature

This was the key feature which also classified the difficult image (see figure 1.1.1) correctly. The feature was computed by calculating the 'maximum' purple color $p_{max} = \begin{pmatrix}157 & 80 & 139\end{pmatrix}$ and the 'minimum' purple color $p_{min} = \begin{pmatrix}116 & 20 & 130\end{pmatrix}$. The number of purple pixel is the number of pixels which lay in between p_{max} and p_{min}.

1.2 Problems with non-scalar features and the singular matrix

I also wanted to try histograms, threshold or binary image or K-means cluster features. The problem here was, that those features are not single numbers but vectors (of different sizes). With those vector features it is not possible to compute the covariance matrix Σ. When I tried the trick to use the elements of the vectors as single feature values, the problem was that there was no inverse Σ^{-1} for the covariance matrix Σ since it became a singular matrix. Without the inverse Σ^{-1} it's not possible to compute the multivariate Gaussian distribution $\mathcal{N}_y(\mu_y, \Sigma)$

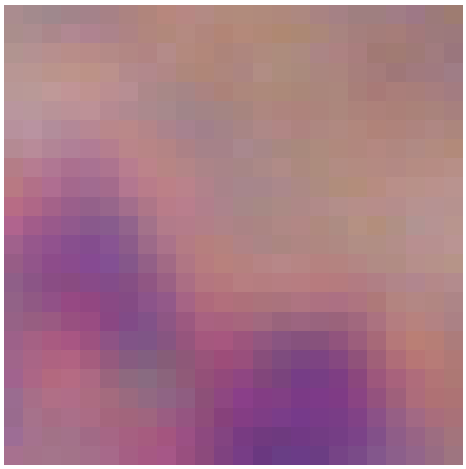

Figure 1: This sample was hard to detect and required some trail and error feature engineering to classify correctly. The name of the image in the samples is 'n06.png'.

1.3 Model Parameters

The maximum likelihood on 80% of the images as training set lead to the following model parameters:

$\phi = 0.5$

$\mu_p = \begin{pmatrix} 151.78 & 208.08 & 48.08 & 174.99 & 142.09 & 1.75 \end{pmatrix}$

$\mu_n = \begin{pmatrix} 139.58 & 188.42 & 99.00 & 163.87 & 127.87 & 1.00 \end{pmatrix}$

$$\Sigma = \begin{pmatrix} 231.90 & 169.82 & -23.26 & 223.36 & 207.97 & 4.65 \\ 169.82 & 221.68 & -208.56 & 169.35 & 168.68 & 9.29 \\ -23.26 & -208.56 & 858.76 & -25.88 & -72.53 & -32.22 \\ 223.36 & 169.35 & -25.88 & 225.53 & 196.45 & 6.05 \\ 207.97 & 168.68 & -72.53 & 196.45 & 196.97 & 16.83 \end{pmatrix}$$

1.4 Evaluation

The evaluation on all 60 images after MLE training on 80% of the images lead to the following results:

Accuracy	1.0
Precision	1.0
Recall	1.0
F1	1.0

Table 1: Results of the evaluation of all 60 images after training on 80% of the images