HW3

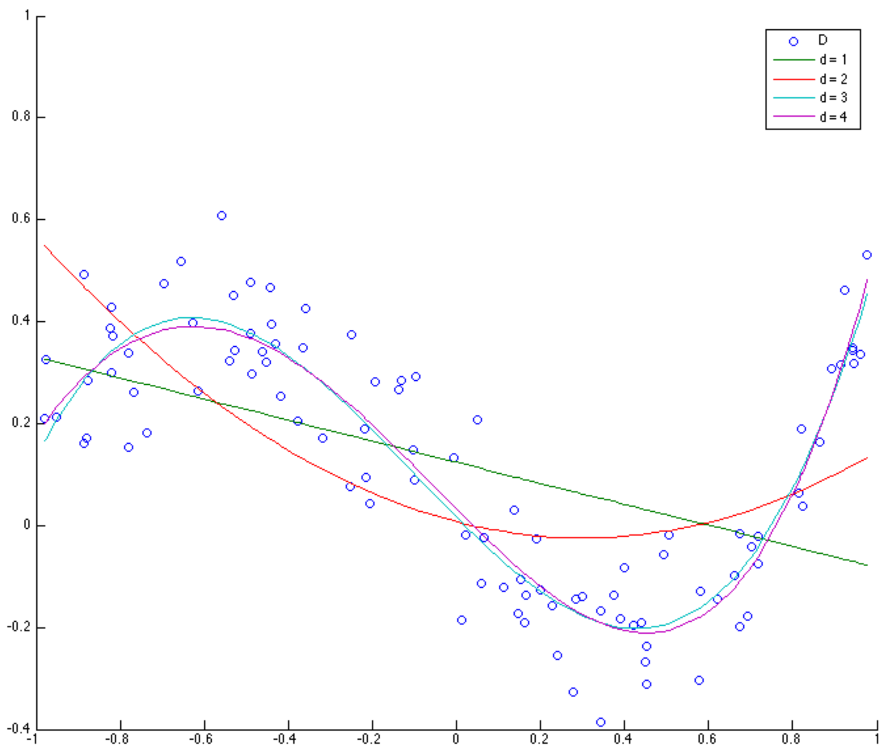
Question 1

(A)

Errors =

[4.5427, 3.4368, 0.9714, 0.9537, 0.9393, 0.9348, 0.9347, 0.9331, 0.9301, 0.9092]

d = 10 has the smallest error rate. However, in practice using d = 10 will probably over fit. d = 3 is most likely the best choice.



(B)

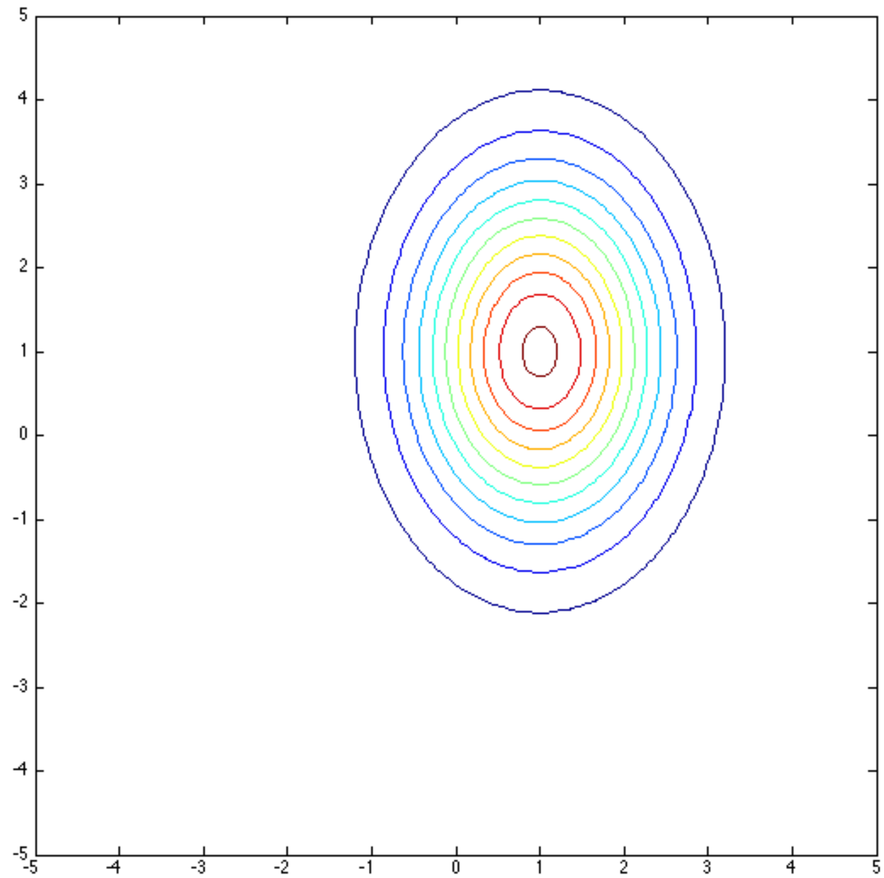
Test error (d=3) = 5.1577

Test error (d=10) = 5.7307

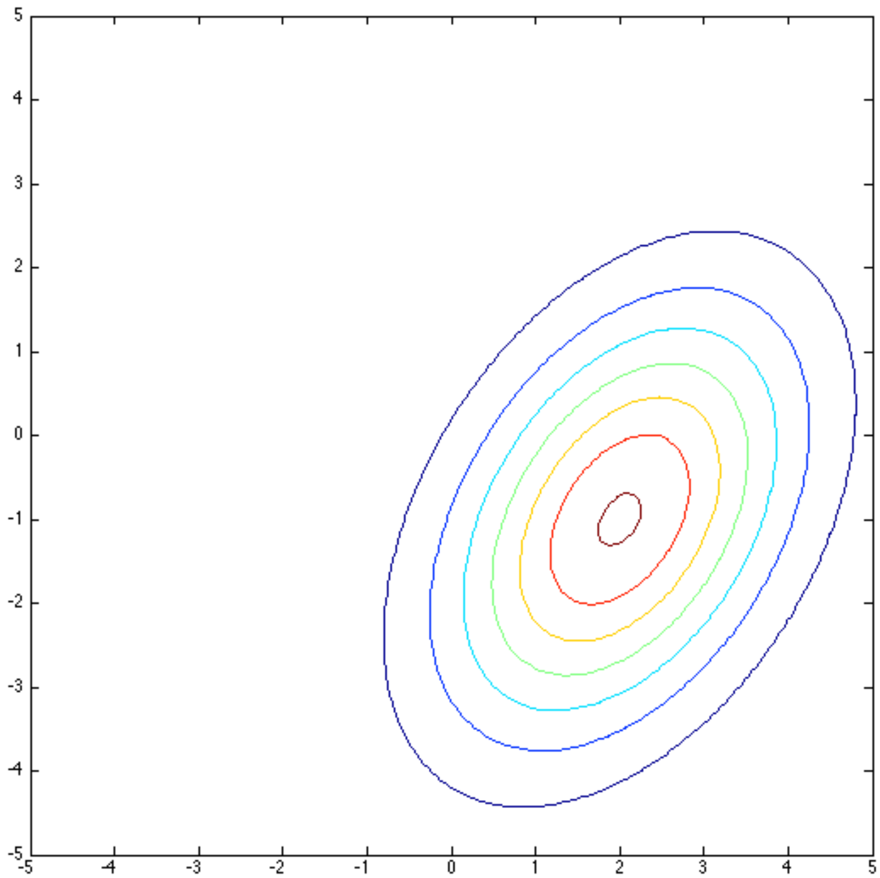
A degree 10 polynomial is overfitted to the training data and a degree 3 polynomial generalizes better to the test data.

Question 2

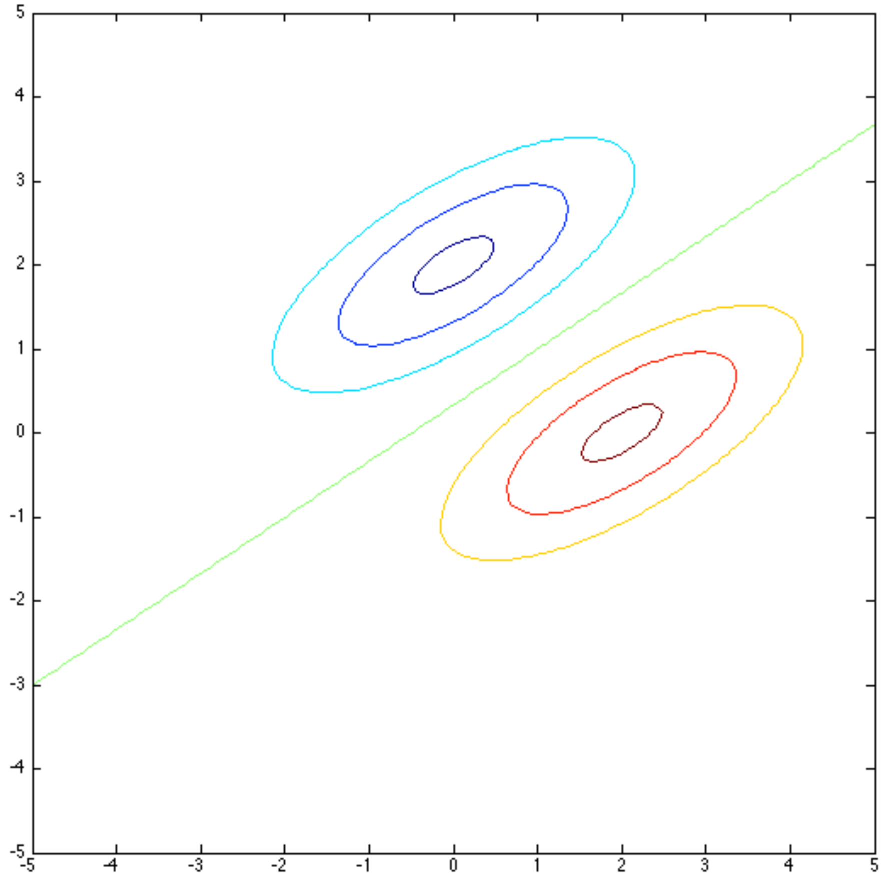
(i)



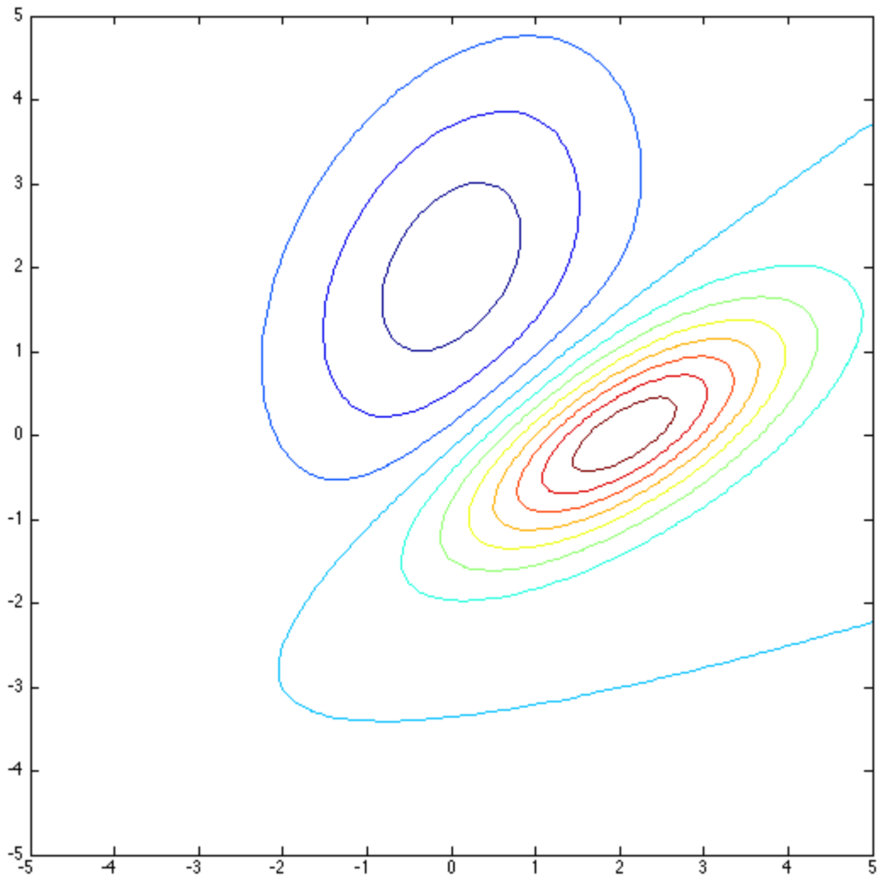
(ii)



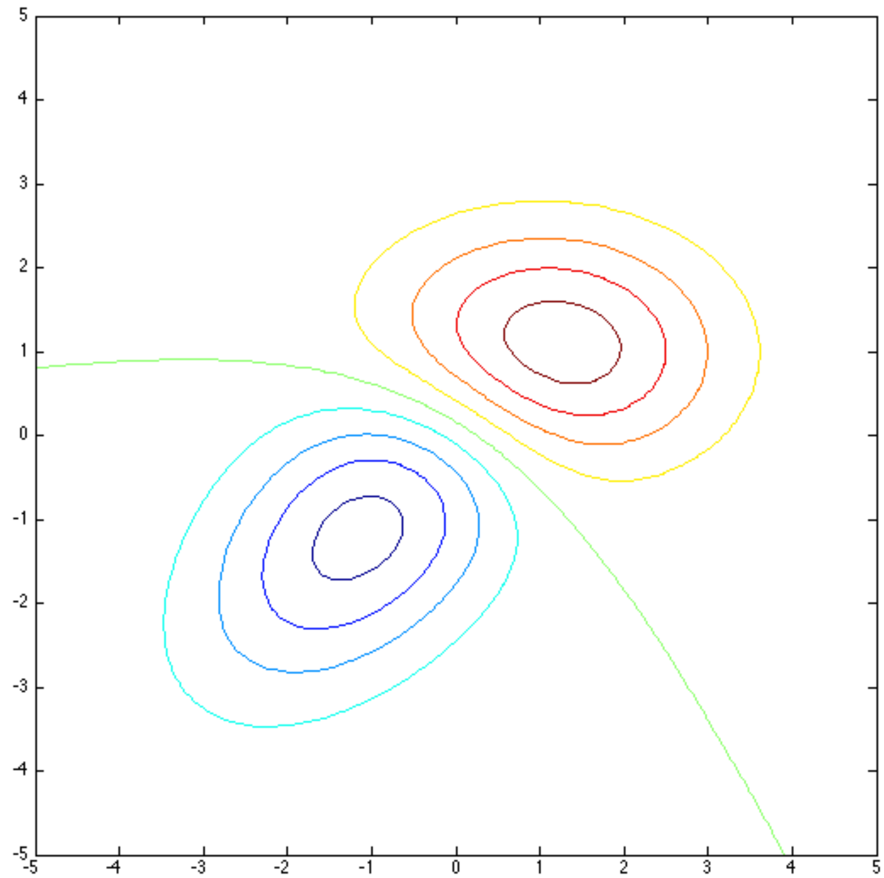
(iii)



(iv)



(v)



Question 3

(i)

The MLE estimates of the mean and covariance matrices for a multivariate gaussian are as follows

$$\overline{x} = \begin{bmatrix} \bar{x}_1 \\ \vdots \\ \bar{x}_p \end{bmatrix} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

$$\mathbf{Q} = \frac{1}{n-1}\sum_{i=1}^{n}(x_i - \overline{x})(x_i - \overline{x})^{\mathrm{T}},$$

These are unbiased estimators

(ii)

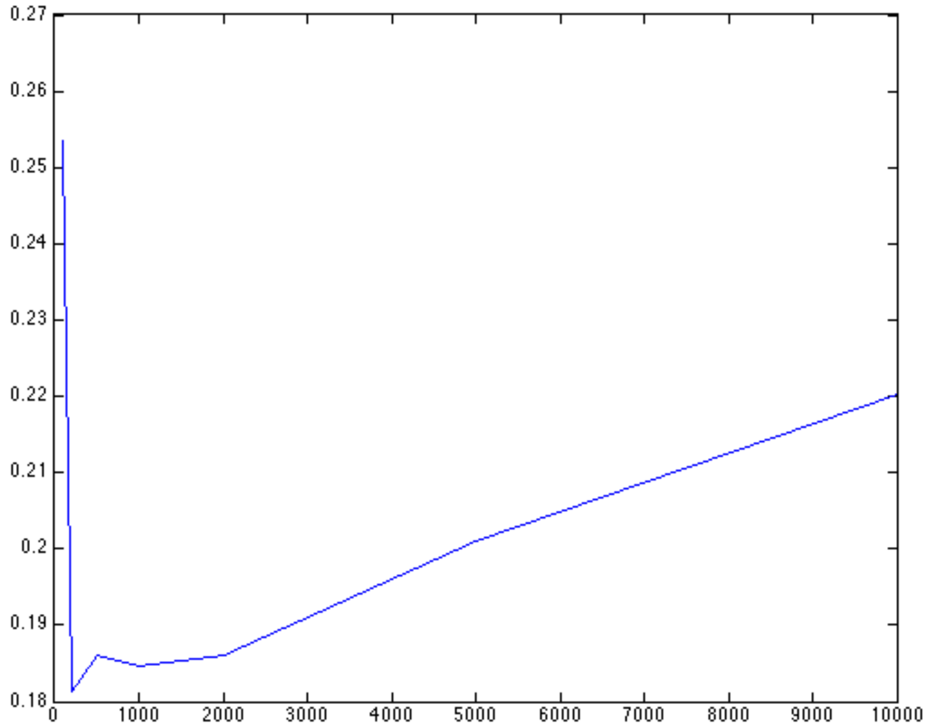
I modeled the prior distribution of the classes by using their rate of occurrence in the training set.

(iii)

This is the covariate matrix of class "1" displayed as a heat map. The image shows that the matrix is symmetric and semidefinite.

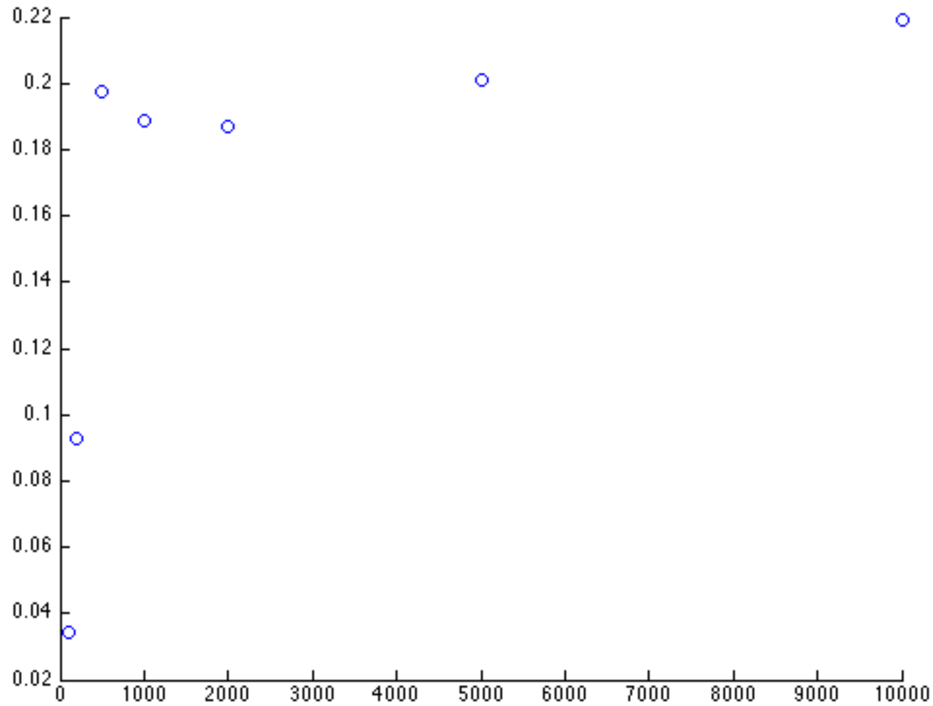
(iv)

A



This is a linear decision boundary since we are essentially calculating a linear combination in 784 space.

B



This is a quadratic decision boundary.