Introduction to Machine Learning (67577)

Exercise III – Classification

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**Theoretical Questions**

**Bayes Optimal and LDA**

1. Show that :

We know from bayes theorem that , therefore it is sufficient to show that .

Suppose in the first case that . If so, thus the corresponding would be (as ). For the other case, , which in turn means , so would be . We can write those in compart form as followed

1. Show that where :

From Q.1 we have , and we know that for calculating , taking will provide the same result. If so, let us concentrate on the following:

Substituting we have

Since the first is not a function of , it will not affect the result of . Let us simplify the second component

Since is the same for both , :

Yet again, is not a function of , therefore is not relevant for the calculation of . In conclusion we have

And consequently

1. Write your formula for estimating , and based on :

We can calculate the mean by summing the ratio of occurrences:

The probability would be the sum of occurrences divided by the total size

Similar to what we have seen in lecture 1, we can write

And

**Type I errors**

1. Let us write the possible cases, given that indicates spam and is non-spam:
2. If the current mail is non-spam (:
3. (true negative): I have correctly identified the mail as non spam
4. (false positive): I have declared the mail is spam (which is wrong)
5. If the current mail is spam (:
6. (true positive): I have correctly identified the mail as spam
7. (false negative): I have declared the mail is non-spam (which is wrong)

1.b is denoted a Type-I error – we would wish to avoid declaring regular mail as spam

2.b is not as bad, though still an error.

**SVM – Formulation**

1. Write the Hard-SVM problem as a QP problem:

We can set , so the QP takes the form of

Since , , so for we have the QP set. (as )

Simplifying the conditions:

Or in matrix form

Therefore, in matrix form for every :

This finishes the transition to QP

()

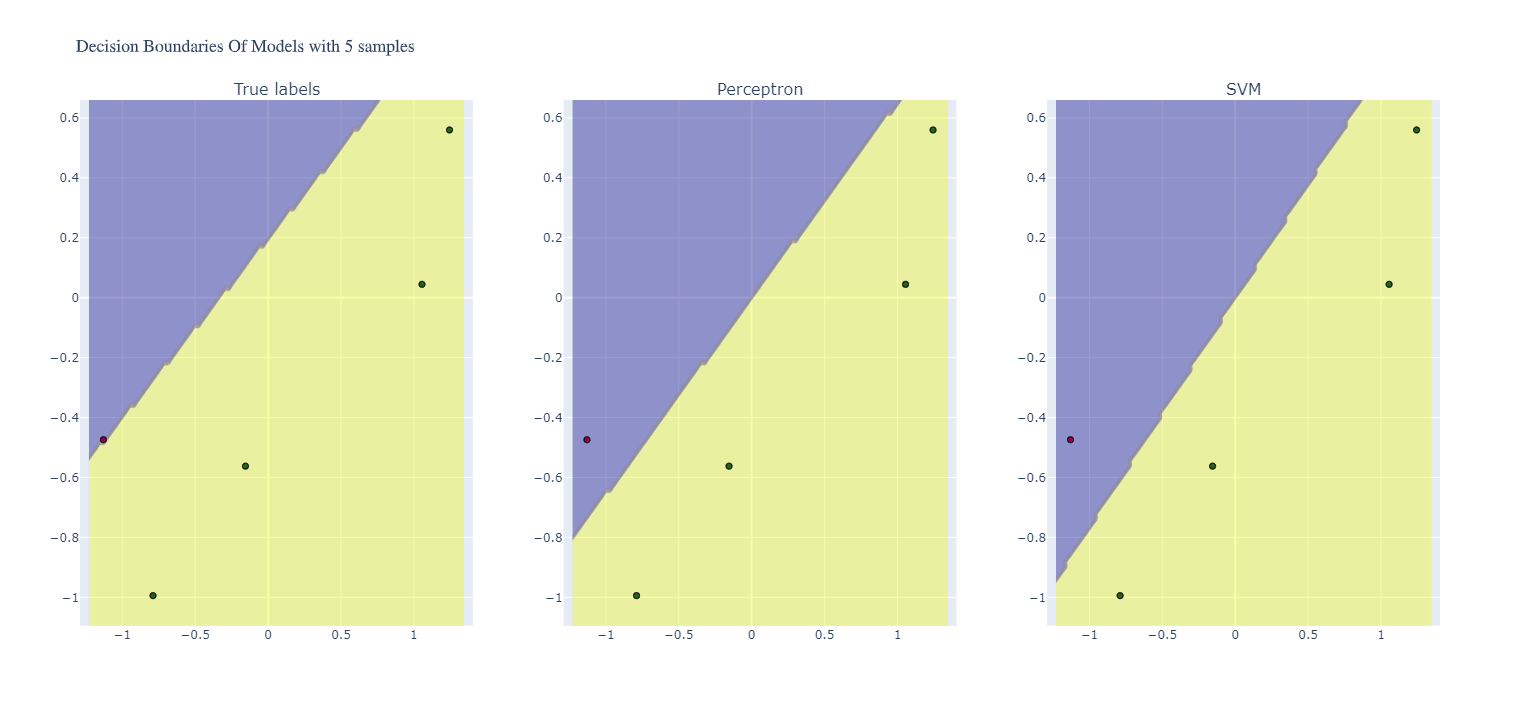
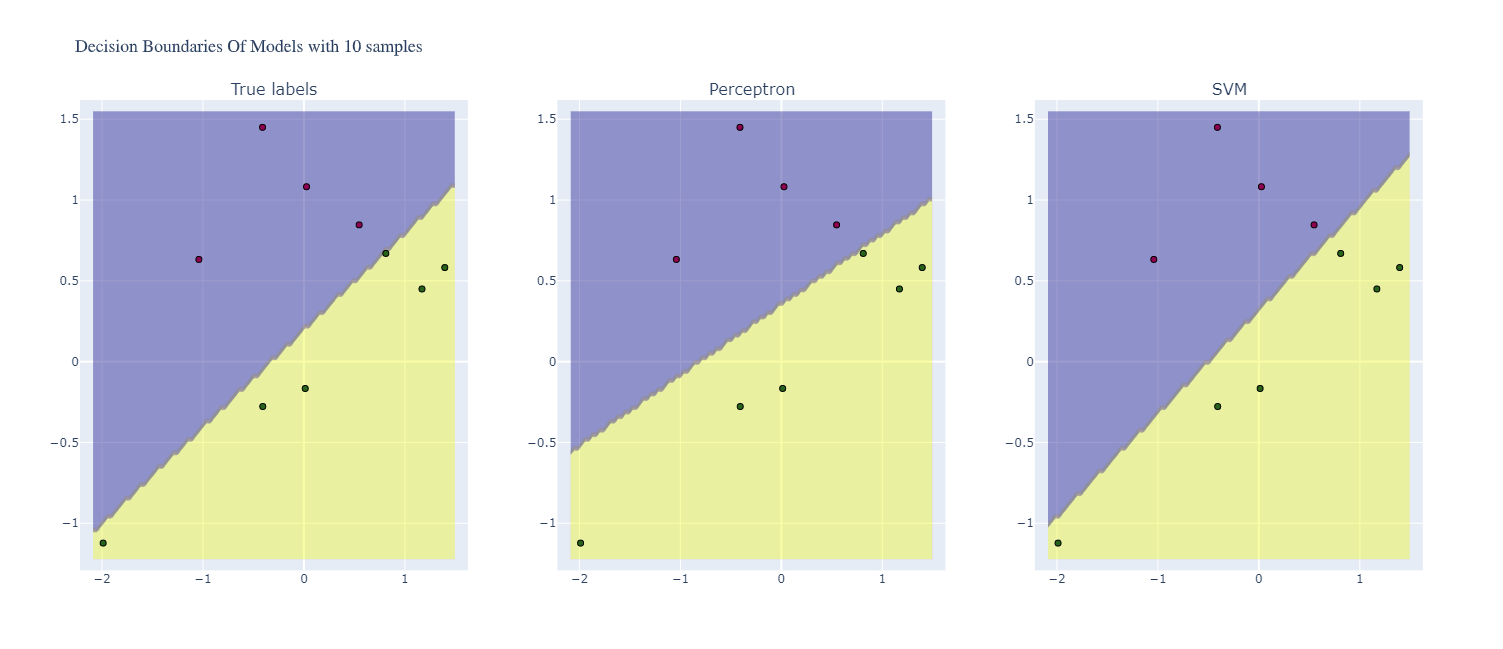
1. Showing problem equivalence

Minimizing separately

Explicitly writing the condition for

**Practical Questions**

**Implemention and simulation-comparison of different classifiers**

1. Code
2. Code
3. Here are the plots decision boundaries of models with samples:

