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CSCI 567 – HW3

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**[Problem 1]**

**(*1.1*)**

**No.** Because it is **non-linear**.

**(*1.2*)**

A picture containing chart

Description automatically generated

**Yes**, because the points are obviously **linearly separable**.

**(*1.3*)**

***K*** =

For each row = , and column = .

**(*1.4*)**

Let *N* denote the size of the training set. Then the primal formulation of this SVM is:

, for ∈ ξ

s.t. for *w* = and all *n*, 1 - ≤ and ≥ 0

and dual formulation of this SVM is:

s.t. and 0 ≤ ≤ *C*, ∀*n*

Because the data is separable, thus we set *C* to be +∞, which makes ξ = 0. Therefore, the primal formulation of this SVM becomes:

s.t. for *w* = and all *n*, 1 - ≤ 0

and dual formulation of this SVM becomes:

s.t. and ≥ 0, ∀*n*

Let *k* (*x, x’*) denote , then the dual formulation of this SVM becomes:

s.t. and ≥ 0, ∀*n*

**(*1.5*)**

Since and ≥ 0 for ∀*n*, thus we have:

Therefore:

Then we observe the following:

, if set it to 0 = , then we have .

, if set it to 0 = , then we have .

And .

Since , and , thus . Also, because , thus .

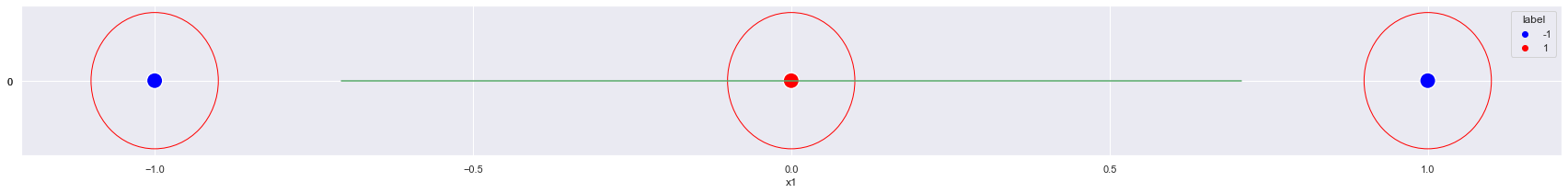
**(*1.6*)**

All of these () are support vectors, since they all have that is greater than 0.

A picture containing chart

Description automatically generated

*2-demensional graph*



*1-demensional graph (original)*

**[Problem 2]**

**(*2.1*)**

(weighted) Corresponding classification error:

Entropy (base *e*):

Gini impurity:

**(*2.2*)**

They have same classification error rate, and their weighted Gini impurities are:

,

Their conditional Entropy (base *e*) are:

has both lower Gini impurity (which means it is purer) and lower conditional Entropy, thus I would choose it.

**[Problem 3]**

**(*3.1*)**

We have:

We find the minimizer by taking the derivative of it and set it to 0:

And we observe that:

**(*3.2*)**

Since:

Thus:

Because:

Therefore:

And we can get:

Solve by Quadratic formula, get:

But earlier we got:

Thus , in other words, , which is the hardest.