**PGP in AI/ML**

**Answers Classification - Assignment 5**

1. For the constrained optimization problem given below, write it’s equivalent unconstrained optimization problem using Lagrange multiplier and KKT conditions **[3M]**

minimize f(x) = 4x12 − x1 − x2 − 2.5, with respect to x1, x2;

subject to: c1(x) = x22 − 1.5x12 + 2x1 − 1 ≥ 0,

c2(x) = x22 + 2x12 − 2x1 − 4.25 ≤ 0

Answer 1.

Optimisation problem with in-equality constraint can be solved using Lagrange and KKT functions, which is denoted as below,

Minimize L (X) = F(X) + Sum (i=1..p) [ Lambda(i) \* Ci (X) ], where

p : Number of constraint functions.

Above objective function can be written as,

*Minimize L(x1, x2, l1, l2) = f(x1, x2) + l1 \* c1(x1,x2) + l2 \* c2(x1,x2)*

*= 4x12 − x1 − x2 − 2.5 + l1 \* -(x22 − 1.5x12 + 2x1 − 1) + l2 \* (x22 + 2x12 − 2x1 − 4.25)*

*= 4x12 − x1 − x2 − 2.5 + l1 \* (-x22 + 1.5x12 - 2x1 + 1) + l2 \* (x22 + 2x12 − 2x1 − 4.25)*

To minimise this combined equation, we should solve following KKT conditions,

*L = 4x12 − x1 − x2 − 2.5 + l1 \* (-x22 + 1.5x12 - 2x1 + 1) + l2 \* (x22 + 2x12 − 2x1 − 4.25)*

**Equation-1** : dL(x1,x2,l1,l2) / dx1 = 0

(8x1 - 1) + l1 \* (3x1 - 2) + l2 \* (4x1 - 2) = 0

**Equation-2** : dL(x1,x2,l1,l2) / dx2 = 0

-1 + l1 \* (-2x2) + l2 \* (2x2) = 0

**Equation-3** : l1 >= 0, l2 >= 0

**Equation-4** : l1 \* (-x22 + 1.5x12 - 2x1 + 1) = 0

l2 \* (x22 + 2x12 − 2x1 − 4.25) = 0

1. For the dataset -2 (liver disease dataset), implement SVM classifier using Python. **[7M**]

Answer 2.

1. Refer to Python implementation notebook
2. Refer to Python implementation notebook
3. Compare accuracy measures (Precision/Recall/F1/CM)

Kernel is used to map a non linearly separable data from one space (which is not linearly separable) into a space where the data can be separated using a hyperplane.

There are kernel tricks (similarity or dis-similarity functions) that can be used to map the input data into a different space where hyperplanes can be used to classify the data using standard linear SVM techniques.

Using Linear Kernel (Default):

precision recall f1-score support

No 0.00 0.00 0.00 67

Yes 0.71 1.00 0.83 167

micro avg 0.71 0.71 0.71 234

macro avg 0.36 0.50 0.42 234

weighted avg **0.51** 0.71 0.59 234

Using Gaussian Kernel (RBF):

precision recall f1-score support

No 1.00 0.01 0.03 67

Yes 0.72 1.00 0.84 167

micro avg 0.72 0.72 0.72 234

macro avg 0.86 0.51 0.43 234

weighted avg **0.80** 0.72 0.60 234

Using Polynomial Kernel:

precision recall f1-score support

No 0.00 0.00 0.00 67

Yes 0.71 1.00 0.83 167

micro avg 0.71 0.71 0.71 234

macro avg 0.36 0.50 0.42 234

weighted avg **0.51** 0.71 0.59 234

As seen above in the analysis, A Gaussian kernel separates the data best with better “precision” and “recall”.