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%Assignment 3 MAT5OPT Q4

syms w [3 1] real
syms b real
Df = [w' 0];

%Training data and labels respectively, including new data.
td = readtable('Trainingdata.csv');
tl = readtable('Traininglabels.csv');
nd = readtable('Newdata.csv');

%Creating the matrix for Dg(w,b)
td_t =
td(:,{'Var1','Var2','Var3','Var4','Var5','Var6','Var7','Var8','Var9','Var10'});
tl_t =
tl(:,{'Var1','Var2','Var3','Var4','Var5','Var6','Var7','Var8','Var9','Var10'});
n_d =
nd(:,{'Var1','Var2','Var3','Var4','Var5','Var6','Var7','Var8','Var9','Var10'});

p = td_t{:,1:10};
l = tl_t{:,1:10};
n_d = n_d{:,1:10};

Dg = [-l'.*p' -l'];

%Creating a symbolic 10 × 1 real-valued vector
syms mu [10 1] real

%Creating a vector DL that represents DL(w,b;μ).
DL = Df + mu'*Dg;

%Creating a vector g whose i-th row is gi(w,b) and a row vector mug
%whose i-th element equals μigi(w,b).
g = 1- l'.*(w'*p + b)';

%NOTE: .* is pointwise multiplication
mug = mu'.*g';

%Creating a vector KKT by concatenating DL and mug.
KKT = [DL mug];

% Define vars = [w' b mu'] and run sol = solve(KKT, vars).
% The solution is a structure that can be easily substituted
% into an expression by typing subs(expr,sol).
% Verify that the solutions are valid by running subs(KKT, sol).
vars = [w' b mu'];
sol = solve(KKT, vars);

subs(KKT, sol);

%Run subs(mu', sol).
subs(mu', sol);

%Run subs(g', sol)
subs(g', sol);
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%what the variables r1 and r2 contain after running this code:
r1 = all(subs(g', sol) <= 0, 2);
r2 = all(subs(mu', sol) >= 0, 2);

%find and the elementwise & operator to
%determine the rows corresponding to possible solutions
%according to the KKT theorem.

find(r1 & r2)

%It takes a while to run.
%I got the only valid solution is in row 307.


%Determine the optimal separating hyperplane of the data points.
%The previous answer shows that the only valid solution is in row 307.
vals = subs([w' b], sol);
result = vals(307,:)

%
% w =
%
[997775165103809544845016335324274691522443608064/93781564599382964268437821672023
3154701282521279;
%
92922195472290276393024440938026844566872653824/9378156459938296426843782167202331
54701282521279;
%
956851609532056620709389370033245129333442347008/937815645993829642684378216720233
154701282521279]

%and,
%b = -
11219186534782669137435017652703077302535151819567/9378156459938296426843782167202
33154701282521279

% Using 3-4 significant figures we get
% w = [1.064;0.099; 1.020]
% b = -11.96;

%Now, we use it to label for the newdata.
w = result(1:3);
b = result(4);
q = n_d;
sign(w*q + b)

%The following labels are
%[-1, -1, -1, -1, -1, 1, 1, -1, 1, -1].
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