T-61.6040 Assignment-07/2011

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AIM

Implementation distance minimizing QP for kernel learning discussed in the lecture in Iris data.

$$k_{GAU} = (x_i, x_j) = exp(-\|x_i x_j\|_2^2/s^2),\ C = 1,\ and\ s = 1. \quad (1)$$

Datasets

The datasets given are Iris training and test data with 4 features Training set consisting of 90 and test set consisting of 60 samples each.

Implementation

Load and zscore normalize both the train and test data using zscore matlab command. Zscore normalization can also be done using the method described in the lecture. As the distribution is same the statistics of the training set and the test set would be same.

```
   X = zscore(dlmread('iris_train_X.txt'));
X_t = zscore(dlmread('iris_test_X.txt'));
Y = (dlmread('iris_train_y.txt'));
Y_t = (dlmread('iris_test_y.txt'));
```

Create a label list for one versus all aproach method. The true values are given -1s for one class and the rest are denoted as 1s

```
y1 = ones(90,1);
y2 = ones(90,1);
y3 = ones(90,1);
y1t = ones(60,1);
```

```
y2t = ones(60,1);
y3t = ones(60,1);
y1(1:30,1) =-1;
y2(31:60,1) =-1;
y3(61:90,1) =-1;
y1t(1:20,1) =-1;
y2t(21:40,1) =-1;
y3t(41:60,1) =-1;
```

Calculate kernel function for each feature.

```
K = exp(-bsxfun(@plus,sum(X.^2,2),...
bsxfun(@plus,sum(X.^2,2)',-2.*X*X'))./(1.^2));
KF = sum((sum(K.*K)));
X_1 = X(:,1);
K1 = exp(-bsxfun(@plus,sum(X_1.^2,2),...
bsxfun(@plus,sum(X_1.^2,2)',-2.*X_1*X_1'))./(1.^2));

X_2 = X(:,2);
K2 = exp(-bsxfun(@plus,sum(X_2.^2,2),...
bsxfun(@plus,sum(X_2.^2,2)',-2.*X_2*X_2'))./(1.^2));

X_3 = X(:,3);
K3 = exp(-bsxfun(@plus,sum(X_3.^2,2),...
bsxfun(@plus,sum(X_3.^2,2)',-2.*X_3*X_3'))./(1.^2));

X_4 = X(:,4);
K4 = exp(-bsxfun(@plus,sum(X_4.^2,2),...
bsxfun(@plus,sum(X_4.^2,2)',-2.*X_4*X_4'))./(1.^2));
```

Calculate the Fnorm and calculate the H and c for solving the optimization problem.

```
K1F = sum(sum(K1.*(K1)));
K2F = sum(sum(K2.*(K2)));
K3F = sum(sum(K3.*(K3)));
K4F = sum(sum(K4.*(K4)));

K12F = sum(sum(K1.*(K2)));
K13F = sum(sum(K1.*(K3)));
K14F = sum(sum(K1.*(K4)));
K23F = sum(sum(K2.*(K3)));
K24F = sum(sum(K2.*(K4)));
K34F = sum(sum(K3.*(K4)));

H = [K1F K12F K13F K14F; K12F K2F...
 K23F K24F; K13F K23F K3F K34F; K14F K24F K34F K4F];
KF ={K1 K2 K3 K4};
yv = {y1 y2 y3};
yvt = {y1t y2t y3t};
```

Solve SVM optimization problem in standard QP form using quadprog function in matlab and find eta values.

```
Q = (yv{i}*yv{i}');
H = [K1F K12F K13F K14F; K12F K2F K23F ...
K24F; K13F K23F K3F K34F; K14F K24F K34F K4F];
c = -[sum(sum(K1.*Q)); sum(sum(K2.*Q));...
     sum(sum(K3.*Q)); sum(sum(K4.*Q));]
A = [];
Aeq = [1 1 1 1];
l = zeros(4,1);
b = [];
beq = 1;
u = ones(4, 1);

options = optimset('Algorithm','interior-point-convex','MaxIter',1500);
% solve quadprog to find eta values
eta{i} = quadprog(H, c, A, b, Aeq, beq, l, u,[],options);
```

Calculate Keta values and solve svm problem for finding alpha values

```
    Keta = eta{i}(1)*K1 + eta{i}(2)*K2 + eta{i}(3)*K3 + eta{i}(4)*K4;
H = Q.*Keta;
A = [];
Aeq = yv{i}';
l = zeros(90,1);
c = -1*ones(90,1);
b = [];
beq = 0;
u = 1*ones(90, 1);

options = optimset('Algorithm','interior-point-convex','MaxIter',1500);
% solve quadprog to find alpha values
alpha = quadprog(H, c, A, b, Aeq, beq, l, u,[],options);
% calculate near boundary coefficients
```

Compute the near boundary coefficients and move near boundary alpha values to boundaries

```
     alpha(alpha < C(k) * 0.001) = 0;
     alpha(alpha > C(k)*0.999999999999) = C(k);
```

Compute value for bias parameter b

```
     sv = find(alpha >0 & alpha<C(k));
     sv_one = zeros(500,1);
     sv_one(sv,1) = 1;
    b = sv_one'*(yv{i}-((alpha.*yv{i})'*Keta')')/sum(sv_one)
```

Compute the decision function on training set and calculate the confusion matrix

```
   temp = bsxfun(@plus,Keta(sv,:)'*(alpha(sv,:).*yv{i}(sv,:)),b);
```

```
res =temp;
res(res>=0) = 1;
res(res<0) = -1;
conf{i} = confusionmat(yv{i},res);
```

Similarly compute the Keta value for the test data

```
 X_1t = X_t(:,1);
K1t = exp(-bsxfun(@plus,sum(X_1(sv,:).^2,2),...
bsxfun(@plus,sum(X_1t.^2,2)',-2.*X_1(sv,:)*X_1t'))./(1.^2));

X_2t = X_t(:,2);
K2t = exp(-bsxfun(@plus,sum(X_2(sv,:).^2,2),...
bsxfun(@plus,sum(X_2t.^2,2)',-2.*X_2(sv,:)*X_2t'))./(1.^2));

X_3t = X_t(:,3);
K3t = exp(-bsxfun(@plus,sum(X_3(sv,:).^2,2),...
bsxfun(@plus,sum(X_3t.^2,2)',-2.*X_3(sv,:)*X_3t'))./(1.^2));

X_4t = X_t(:,4);
K4t = exp(-bsxfun(@plus,sum(X_4(sv,:).^2,2),...
bsxfun(@plus,sum(X_4t.^2,2)',-2.*X_4(sv,:)*X_4t'))./(1.^2));

Ketat = eta{i}(1)*K1t + eta{i}(2)*K2t + eta{i}(3)*K3t + eta{i}(4)*K4t;
```

Compute the decision function on test set and calculate the confusion matrix.

```
   temp = bsxfun(@plus,Ketat'*(alpha(sv,:).*yv{i}(sv,:)),b);
rest = temp;
% thresholding
rest(rest>=0) = 1;
rest(rest<0) = -1;
conft{i} = confusionmat(yvt{i},rest);
```

Threshold the decisions to get proper +1 and −1

```
res(res>=0) = 1;
res(res<0) = -1;
```

Plot the bar graphs showing the eta values.

```
    bar(eta{i});
xlabel('Kernel');
ylabel('Weight');
axis([1 4 0.0 1.0])
title([num2str((i)), ' versus others' ]);
  %---print figure---
  fnout = [num2str((i)), ' versus others', '.jpg'];
  print('-djpeg','-r150',fnout);
```

Running of code for this implementation in matlab: MLK

Results

Tables below show the confusion matrices computed.

Table 1: Confusion matrix for 1 vs rest for training set

30	0
0	60

Table 2: Confusion matrix for 2 vs rest for training set

28	2
2	58

Table 3: Confusion matrix for 3 vs rest for training set

28	2
2	58

Table 4: Confusion matrix for 1 vs rest for test set

20	0
0	40

Table 5: Confusion matrix for 2 vs rest for test set

20	0
2	38

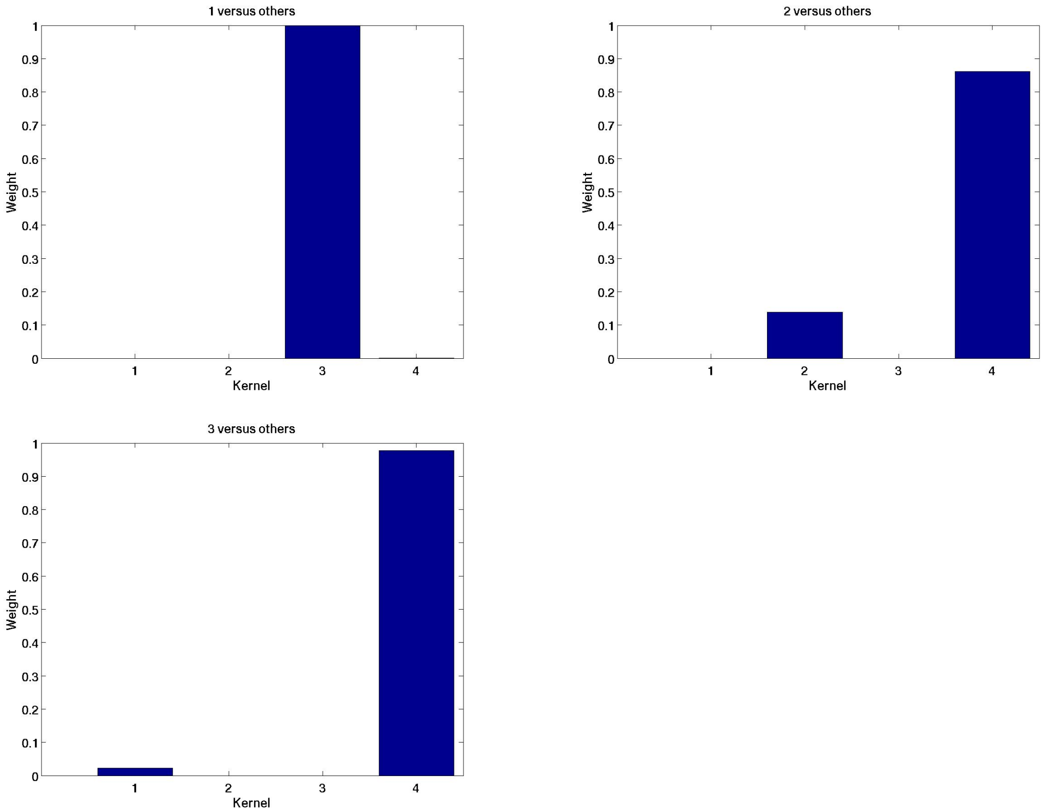
Table 6: Confusion matrix for 3 vs rest for test set

18	2
0	40

Figure 1 shows the bar plot of eta values generated.

References

Figure 1: Bar plot of eta values utilized in implementing kernel.



[1] Scholkopf and Smola (2002)
[2] http://en.wikipedia.org/wiki/Support_vector_machine
[3] http://www.mathworks.se/help/toolbox/optim/ug/quadprog.html

Attachments

Matlab code MLK.m and datasets have been archived along with this report.