CSI 747 – Final Exam Submission

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Introduction:

The final exam required implementing Support Vector Machine with primal soft-margin method, dual-soft margin method and a dual soft-margin method with a radial basis kernel using Non-linear Augmented Lagrangian Method. The implementation details are as follows:

1. Primal method for SVM using NRL
2. Dual method with scalar and radial kernel using NRAL
3. Results

The data set used were formed normalizing the vectors same as in the midterm.

Primal Method for SVM using NRL:

The MATLAB code in implementing the SVM is as follows:

```
function [ output_args ] = fx( unknowns,lambda )
    global vecLen;
    global dataPts;
    global epsilon;
    global k;
    global C;
    global data;
    global r;

    w = unknowns(1:vecLen,1);
    eta = unknowns(vecLen+1:vecLen+dataPts,1);
    b = unknowns(end,1);

    output_args= 0.5* (w'*w)+ C * sum(eta);
 end

function  [output_args] = PHI( unknown,lambda)
    global k;
    global r;

    f = fx(unknown,lambda);
    psikc = psik(unknown);

    output_args = f - 1.0/k*((lambda'*psikc(:,1)));

end
```

```
function [ psik] = psik( unknown )
%Return the function value, first differential
%second differential of glued transformation function
    global k;
    a = -2;
    c = log(0.5)+0.5;

    const = constraint(unknown);
    psik = zeros(length(const),3);

    for i = 1:length(const)
        t = k*const(i);
        if t > -0.5
            psik(i,1) = log(1+t);
            psik(i,2) = 1.0/(1+t);
            psik(i,3) = -1.0/(1+t)^2;
        else
            psik(i,1) = a*(t^2)+c;
            psik(i,2) = 2*a*t;
            psik(i,3) = 2*a;
        end
    end

end

function [ output_args ] = constraint( unknowns )
%Returns the constraints
    global vecLen;
    global dataPts;
    global data;
    global r;

    w = unknowns(1:vecLen,1);
    eta = unknowns(vecLen+1:dataPts+vecLen,1);
    b = unknowns(end,1);

    output_args = [r.*((data*w)-b)+eta-1;eta];

end

 function [ output_args ] = Grad_PHI( unknown,lambda)
    global vecLen;
    global dataPts;
    global epsilon;
    global k;
    global C;
    global data;
    global r;
    global gradc;

    w = unknown(1:vecLen,1);
    eta = unknown(vecLen+1:vecLen+dataPts,1);
    b = unknown(end,1);

    gradf = [w;C*ones(length(eta),1);0];
```

```
    psikc = psik(unknown);
    PSI_Prime = diag(psikc(:,2));

    output_args = gradf -  gradc' * PSI_Prime * lambda;
end


function [ Hessian ] = Hessian_PHI( unknown,lambda)
    global vecLen;
    global dataPts;
    global gradc;
    global k;

    hessf = zeros(vecLen+dataPts+1,vecLen+dataPts+1);
    hessf(1:vecLen,1:vecLen) = eye(vecLen);
    Y = diag(lambda);
    psikc = psik(unknown);
    Hessian = hessf - k*gradc'*Y*diag(psikc(:,3))*gradc;
end

function [ Hessian ] = Hessian_PHI( unknown,lambda)
    global vecLen;
    global dataPts;
    global gradc;
    global k;

    hessf = zeros(vecLen+dataPts+1,vecLen+dataPts+1);
    hessf(1:vecLen,1:vecLen) = eye(vecLen);
    Y = diag(lambda);
    psikc = psik(unknown);
    Hessian = hessf - k*gradc'*Y*diag(psikc(:,3))*gradc;
end



%Nonlinear Rescaling Method for Primal SVM Implementation
clear all; clc;

global vecLen;
global dataPts;
global epsilon;
global k;
global C;
global data;
global r;
global gradc;

epsilon = 1e-7;
k = 100;
data = dlmread('trainData36.dat');
vecLen = length(data(1,:));
dataPts = length(data(:,1));
C = 100;
r = [ones(500,1);-1*ones(500,1)];              %vector with 1 for 3 and -1 for
6
```

```
unknowns = ones(vecLen+dataPts+1,1);          %x
gradc = [data .* repmat(r,1,vecLen),eye(dataPts), -r;zeros(length(r),vecLen),
eye(dataPts),zeros(length(r),1)];
lambda = ones(length(gradc),1);                %y

tsteps = 0;
Grad = Grad_PHI(unknowns,lambda);
psikc = psik(unknowns);

while max([norm(Grad),norm(lambda.*constraint(unknowns)),max(-
constraint(unknowns))]) > 10^-5
    %Implementing Newton's Method
    eta = 0.1;
    n_steps = 0;
    while norm(Grad,2) > max([10^-5,(1.0/k)*norm(lambda-
psikc(:,2).*lambda,2)])

        %Regularization of Hessian
        PHI_Val = PHI(unknowns,lambda);
        Hessian = Hessian_PHI(unknowns,lambda);
        lambdah=0.0001;
         while min(eig(Hessian+(lambdah)*eye(length(Hessian)))) <= 0
             lambdah = 10*lambdah;
         end


        %Finding Direction

        delta_xs = linsolve(Hessian+(lambdah)*eye(length(Hessian)),-Grad);

        %Finding unknowns: Armijio Rule
        fprintf('\nGoing thru Armijo\n');
         alpha = 1;
         while PHI(unknowns+alpha*delta_xs,lambda)-PHI(unknowns,lambda) >=
eta * alpha * Grad'*delta_xs
              alpha = alpha/2;
         end

        unknowns = unknowns+alpha*delta_xs;

        %Updating grad_PHI, psi_values
        n_steps = n_steps+1;
        psikc = psik(unknowns);
        psi_values = diag(psikc(:,2));
        Grad = Grad_PHI(unknowns,lambda);
        fprintf('\t\t\t\tNewton Step - Gradient_PHI(norm) =
%f\n',norm(Grad));
    end

    %Updating lambda
    Grad = Grad_PHI(unknowns,lambda);
    psikc = psik(unknowns);
    lambda = lambda.*psikc(:,2);
    tsteps=tsteps+1;
```

```
    cond = max([norm(Grad),norm(lambda.*constraint(unknowns)),max(-
constraint(unknowns))]);
    fprintf('NRAL: %d\t\t Condition: %f\n',tsteps,cond);
%     c = constraint(unknowns);
%     Grad = Grad_PHI(unknowns,lambda);
 fprintf('\nNRAL = % d;max(-c(x),0): %f; \nComplementarity: %f; Newton Steps=
%d; ; \n\n\n',tsteps,,max([0,-constraint(unknowns)']),max(-
constraint(unknowns).*lambda), n_steps);
end
```

Dual Method for SVM with Scalar and Radial Kernels

The Dual Method was implemented using Matlab for two different Kernels:

1. Scalar Kernel:

```
function [ Ker ] = Kernel( data )
%Scalar Kernel
    n = length(data);
    Ker = zeros(n,n);
    for i = 1:n
        for j = 1:n
            Ker(i,j) = data(i,:)*data(j,:)';
        end
    end

end
```

2. Radial Kernel:

```
function [ Rad ] = Radial( data )
%Scalar Kernel
    n = length(data);
    Rad = zeros(n,n);
    for i = 1:n
        for j = 1:n
            Rad(i,j) = exp(-0.05*norm(data(i,:)-data(j,:))^2);
        end
    end

end
```

The SVM Code implementation was as follows:

```
function  [output_args] = PHI(alpha,y,z)
    global r;
```

```
    global K;
    global C;
    global k;
    global psikc;

    fx = -sum(alpha) + 0.5*sum(sum((alpha*alpha').*(r*r').*K));
    eq_g1 = alpha'*r;
    output_args = fx - 1.0/k *(sum(y .* psikc(:,1)))- z*eq_g1 + k/2.0 *
norm(eq_g1)^2;

end


function [ output_args ] = Grad_PHI( alpha,y,z)
    global r;
    global K;
    global C;
    global k;
    global gradc;

    gradf = -1*ones(length(alpha),1)+((r*r').*K)*alpha;
    gradg = r';
    eq_g1 = alpha'*r;

    psikc = psik([alpha;C-alpha]);


    output_args = gradf - gradc'*(psikc(:,2).*y) - gradg'*z+k*gradg' * eq_g1;

end

function [ output_args ] = Hessian_PHI(alpha,y)
    global K;
    global r;
    global k;
    global C;
    global gradc;

    hessf = (r*r').*K;
%     Y = diag(y);
%     PSI_Dprime = diag(psikc(:,3));
    gradg = r';
    psikc = psik([alpha;C-alpha]);
    output_args = hessf - k*gradc'*(diag(y.*psikc(:,3)))*gradc + k* (gradg' *
gradg);

end

function [ psik] = psik( const )
%Return the function value, first differential
%second differential of glued transformation function
    global k;
    a = -2;
    c = log(0.5)+0.5;
```

```
    psik = zeros(length(const),3);

    for i = 1:length(const)
        t = k*const(i);
        if t >= -0.5
            psik(i,1) = log(1+t);
            psik(i,2) = 1.0/(1+t);
            psik(i,3) = -1.0/((1+t)^2);
        else
            psik(i,1) = a*(t^2)+c;
            psik(i,2) = 2*a*t;
            psik(i,3) = 2*a;
        end
    end

end


% Nonlinear Rescaling Method for Problem 2(a)
clear all; clc;
global vecLen; global dataPts; global epsilon; global k; global C; global
data; global r; global K; global gradc;

epsilon = 1e-5;
k = 100;
data = dlmread('Train_36.txt');
vecLen = length(data(1,:));
dataPts = length(data(:,1));
C = 100;
r = [ones(500,1);-1*ones(500,1)];              %vector with 1 for 3 and -1 for
6
alpha = ones(dataPts,1);          %x

K = Kernel(data);
psikc = psik([alpha;C-alpha]);
gradc = [eye(length(alpha));-1*eye(length(alpha))];
tsteps = 0;

y = ones(length(alpha)*2,1);
z = 0;
Grad = Grad_PHI(alpha,y,z);
constraint = @(x)[x;C-x];
g = @(x)x'*r;

while max([norm(Grad,2),norm(y.*constraint(alpha)),max(-
constraint(alpha)),norm(g(alpha)) ]) >epsilon

    n_steps = 0;
    psikc = psik(constraint(alpha));
    % Implementing Newton's Method
    eta = 0.08;
    while norm(Grad) > max([epsilon,(1.0/k)*norm((y-
(psikc(:,2).*y))),norm(g(alpha))])
```

```
        Hessian = Hessian_PHI(alpha,y);
        lambda = 0.0001;
        %Regularization of Hessian

        while min(eig(Hessian + lambda*eye(length(Hessian))))<=0
%p > 0 => not positive definite
            lambda = 10*lambda;
        end

        %Finding Direction

        delta_xs = linsolve(Hessian + lambda*eye(length(Hessian)),-
Grad_PHI(alpha,y,z));

       %Finding x_step: Armijio Rule
       alph = 1;
       while PHI(alpha+alph*delta_xs,y,z)-PHI(alpha,y,z) >= (eta * alph *
Grad_PHI(alpha,y,z)'*delta_xs)
            alph = alph/2;
       end
         %Updating alpha
        alpha = alpha+alph*delta_xs;

        %Updating grad_PHI, psi_values
        Grad = Grad_PHI(alpha,y,z);
        n_steps = n_steps+1;
        psikc = psik(constraint(alpha));
        fprintf('\t\tNewton Step: %d\t||Grad PHI|| =
%f\n',n_steps,norm(Grad));
    end

    % Updating y_step
    PHI_Values = PHI(alpha,y,z);
    tsteps = tsteps + 1;
    psikc = psik(constraint(alpha));
    y = y.*psikc(:,2);
    z = z-k*g(alpha);
    Grad = Grad_PHI(alpha,y,z);
    Norm_Grad_AL = @(alpha)-1*ones(length(alpha),1)+((r*r').*K)*alpha -
gradc'*y -z'*r;
    fprintf('\nNRAL = % d; ||Grad L|| = %f;\n||g(x)|| = %f;max(-c(x),0): %f;
\nComplementarity: %f; Newton Steps= %d; ;
\n\n\n',tsteps,norm(Norm_Grad_AL(alpha)),norm(g(alpha)),max([0,-
constraint(alpha)']),max(-constraint(alpha).*y), n_steps);
end
dlmwrite('alpha.txt',alpha,'\n');
```

Results:

1. Dual SVM Scalar Kernel: The following are the results and B values obtained for the support vectors:

B =

Columns 1 through 8

1.0000 0.9572 0.9695 0.9603 0.9935 0.9926 0.9736 0.9513

Columns 9 through 16

0.9854 0.9687 0.9747 0.9622 0.9869 0.9862 0.9826 1.0018

Columns 17 through 24

0.9967 0.9615 0.9736 0.9564 0.9804 0.9559 1.0033 0.9787

Columns 25 through 32

0.9482 0.9598 0.9818 0.9524 0.9604 0.9641 0.9835 0.9928

Columns 33 through 40

0.9701 1.0000 0.9771 0.9879 0.9722 0.9933 0.9637 0.9947

Columns 41 through 48

0.9804 0.9872 0.9820 0.9972 0.9796 0.9690 0.9652 0.9858

Columns 49 through 56

0.9870 0.9884 0.9772 0.9951 0.9855 0.9596 0.9892 0.9684

Columns 57 through 64

0.9570 0.9742 0.9831 0.9969 0.9751 0.9729 0.9591 0.9480

Columns 65 through 72

0.9901 0.9893 0.9693 0.9601 0.9920 0.9389 0.9499 0.9792

Columns 73 through 80

0.9843 0.9669 0.9510 0.9779 0.9427 0.9900 0.9778 0.9945

Columns 81 through 88

0.9899 0.9873 0.9744 0.9720 0.9518 0.9557 0.9867 0.9765

Columns 89 through 96

0.9124 0.9659 0.9449 0.9757 0.9628 0.9674 0.9982 0.9869

Columns 97 through 104

0.9913 0.9677 0.9561 0.9723 0.9892 0.9998 0.9888 0.9761

Columns 105 through 112

0.9689 0.9886 0.9937 0.9779 0.9949 0.9788 1.0024 0.9716

Columns 113 through 120

0.9704 0.9930 0.9825 0.9923 0.9491 0.8748 0.9694 0.9948

Columns 121 through 128

0.9886 1.0012 0.9750 0.9706 0.9727 0.9684 0.9973 0.9396

Columns 129 through 136

0.9917 0.9725 0.9598 0.9844 0.9665 0.9719 0.9662 0.9901

Columns 137 through 144

0.9942 0.9757 0.9773 0.9872 0.9936 0.9726 0.9899 0.9932

Columns 145 through 152

0.9666 0.9417 0.9945 1.0007 0.9738 0.9691 0.9809 0.9792

Columns 153 through 160

0.9691 0.9674 0.9488 0.9690 0.9467 0.9609 0.8785 0.9475

Columns 161 through 168

0.9591 0.9704 0.9713 1.0007 0.9524 0.9795 0.9355 0.9867

Columns 169 through 176

0.9868 0.9834 0.9724 0.9614 0.9632 1.0000 0.9522 0.9501

Columns 177 through 184

0.9974 0.9881 0.9751 0.9387 0.9370 0.9913 0.9464 0.9861

Columns 185 through 192

0.9792 0.9784 0.9694 0.9784 0.9766 0.9256 0.9518 0.9925

Columns 193 through 200

0.9833 0.9466 0.9826 0.9634 1.0000 0.9668 0.9584 0.9774

Columns 201 through 208

0.9544 0.9854 0.9577 0.9849 0.9675 0.9702 0.9495 0.9695

Columns 209 through 216

0.9927 0.9641 0.9716 0.9818 0.9569 0.9773 0.9814 0.9854

Columns 217 through 224

0.9789 0.9478 0.9942 0.9480 0.9724 0.9928 1.0003 0.9615

Columns 225 through 232

0.9746 0.9035 0.9852 0.9746 0.9898 1.0000 0.9685 0.9605

Columns 233 through 240

0.9701 0.9468 0.9760 0.9847 0.9957 0.9483 0.9945 0.9924

Columns 241 through 248

0.9742 0.9738 0.9817 1.0004 0.9521 0.9679 0.9864 0.9956

Columns 249 through 256

0.9509 0.9733 0.9869 0.9738 0.9874 0.9445 0.9703 0.9839

Columns 257 through 264

0.9744 0.9760 0.9787 0.9875 0.9638 0.9671 0.9528 0.9894

Columns 265 through 272

0.9615 0.9820 0.9736 0.9891 0.9749 0.9730 0.9612 0.9662

Columns 273 through 280

0.9707 0.9821 0.9431 0.9764 0.9116 0.9918 0.9858 1.0000

Columns 281 through 288

0.9803 0.9491 0.9751 0.9834 0.9676 0.9701 0.9941 0.9574

Columns 289 through 296

1.0012 0.9698 0.9684 0.9554 0.9669 0.9861 0.9489 0.9795

Columns 297 through 304

0.9654 0.9671 0.9830 0.9628 0.9864 0.9822 0.9938 0.9799

Columns 305 through 312

0.9712 1.0006 0.9591 0.9791 0.9869 0.9899 0.9915 0.9534

Columns 313 through 320

0.9519 0.9859 0.9816 0.9545 0.9793 0.9656 0.9737 0.9630

Columns 321 through 328

0.9498 0.9900 0.9530 0.9569 0.9868 0.9784 0.9519 0.9577

Columns 329 through 336

0.9484 0.9914 0.9974 0.9795 0.9663 0.9901 0.9918 0.9877

Columns 337 through 344

0.9898 0.9400 0.9936 0.9754 0.9885 0.9556 0.9802 0.9695

Columns 345 through 352

0.9786 0.9961 0.9707 0.9938 0.9727 0.9463 0.9919 0.9444

Columns 353 through 360

0.9612 0.9897 0.9774 0.9736 0.9936 0.9627 0.9672 0.9801

Columns 361 through 368

0.9926 0.9785 0.9695 0.9695 0.9450 0.9635 0.9741 0.9712

Columns 369 through 376

0.9636 0.9709 0.9815 0.9987 0.9714 0.9938 0.9653 0.9697

Columns 377 through 384

0.9272 0.9686 0.9600 0.9454 0.9569 0.9655 0.9957 0.9801

Columns 385 through 392

0.9901 0.9802 0.9886 0.9544 0.9955 0.9844 0.9974 0.9898

Columns 393 through 400

0.9790 0.9488 0.9703 0.9733 0.9731 0.9705 0.9844 0.9828

Columns 401 through 408

0.9728 0.9625 0.9736 0.9963 0.9839 0.9976 0.9655 0.9687

Columns 409 through 416

0.9966 0.9715 0.9931 0.9638 0.9886 0.9628 0.9884 0.9792

Columns 417 through 424

0.9662 0.9710 0.9810 0.9696 0.9927 0.9790 0.9764 0.9704

Columns 425 through 432

0.9825 0.9768 0.9671 0.9955 0.9859 0.9568 0.9856 0.9620

Columns 433 through 440

0.9997 0.9664 0.9962 0.9809 0.9846 0.9638 0.9459 0.9808

Columns 441 through 448

0.9723 0.9889 0.9810 0.9994 0.9632 0.9762 0.9609 0.9862

Columns 449 through 456

0.9835 0.9923 0.9828 0.9807 0.9771 0.9788 0.9674 0.9546

Columns 457 through 464

0.9906 0.9973 0.9550 0.9351 0.9593 0.9735 0.9824 0.9796

Columns 465 through 472

0.9784 0.9805 0.9860 0.9760 0.9895 0.9378 0.9730 0.9895

Columns 473 through 480

0.9295 0.9884 0.9771 0.9899 0.8893 0.9440 0.9663 0.9967

Columns 481 through 488

0.9558 0.9609 0.9951 0.9509 0.9971 0.9410 0.9833 0.9963

Columns 489 through 496

0.9831 0.9831 0.9766 0.9844 0.9739 0.9805 0.9762 0.9827

Columns 497 through 504

0.9732 0.9532 1.0024 0.9803 -0.9968 -0.9175 -0.9920 -0.9595

Columns 505 through 512

-0.9951 -0.9955 -0.9635 -0.9846 -0.9502 -0.9834 -0.9850 -0.9740

Columns 513 through 520

-0.9614 -0.9757 -0.9803 -0.9618 -0.9875 -0.9814 -0.9850 -0.9731

Columns 521 through 528

-0.9907 -1.0000 -0.9967 -0.9656 -0.9828 -0.9791 -0.9960 -0.9926

Columns 529 through 536

-0.9777 -0.9868 -0.9613 -0.9838 -0.9849 -0.9523 -0.9606 -0.9974

Columns 537 through 544

-0.9827 -0.9884 -0.9961 -0.9944 -0.9831 -0.9857 -0.9181 -0.9801

Columns 545 through 552

-0.9971 -0.9657 -0.9584 -0.9923 -0.9704 -0.9726 -0.9853 -0.9593

Columns 553 through 560

-0.9633 -0.9940 -0.9629 -0.9626 -0.9764 -0.9617 -0.9918 -0.9848

Columns 561 through 568

-0.9693 -0.9677 -0.9833 -0.9876 -0.9927 -0.9586 -0.9606 -0.9802

Columns 569 through 576

-0.9648 -0.9891 -0.9730 -0.9697 -0.9871 -0.9801 -0.9735 -0.9789

Columns 577 through 584

-0.9877 -0.9913 -0.9923 -0.9707 -0.9607 -0.9705 -0.9889 -1.0001

Columns 585 through 592

-0.9903 -0.9535 -0.9830 -0.9952 -0.9976 -0.9862 -0.9858 -0.9918

Columns 593 through 600

-0.9703 -0.9824 -0.9872 -0.9607 -0.9882 -0.9627 -0.9844 -0.9715

Columns 601 through 608

-0.9952 -0.9909 -0.9912 -0.9779 -0.9850 -1.0000 -0.9794 -0.9710

Columns 609 through 616

-0.9915 -0.9746 -0.9910 -0.9738 -0.9729 -0.9948 -0.9849 -0.9964

Columns 617 through 624

-0.9621 -1.0000 -0.9677 -0.9940 -0.9668 -0.9776 -0.9780 -0.9988

Columns 625 through 632

-0.9911 -0.9719 -0.9950 -0.9808 -0.9534 -0.9770 -0.9804 -0.9896

Columns 633 through 640

-0.9698 -0.9970 -0.9644 -0.9615 -0.9805 -0.9866 -0.9757 -0.9652

Columns 641 through 648

-0.9952 -0.9905 -0.9603 -0.9642 -0.9894 -0.9483 -0.9617 -0.9885

Columns 649 through 656

-0.9705 -0.9938 -0.9683 -0.9939 -0.9637 -0.9932 -0.9899 -0.9692

Columns 657 through 664

-0.9662 -0.9922 -0.9961 -0.9574 -0.9917 -0.9789 -0.9589 -0.9630

Columns 665 through 672

-0.9802 -0.9656 -0.9915 -0.9609 -0.9575 -0.9722 -0.9901 -0.9746

Columns 673 through 680

-0.9490 -0.9881 -0.9823 -0.9489 -0.9735 -0.9761 -0.9550 -0.9721

Columns 681 through 688

-0.9881 -0.9596 -0.9887 -0.9931 -0.9650 -0.9910 -0.9794 -0.9627

Columns 689 through 696

-0.9625 -0.9828 -0.9872 -0.9814 -0.9962 -0.9953 -0.9921 -0.9753

Columns 697 through 704

-0.9767 -0.9685 -0.9969 -0.9895 -0.9878 -0.9717 -0.9995 -0.9837

Columns 705 through 712

-0.9707 -0.9919 -0.9814 -0.9861 -0.9962 -0.9899 -0.9795 -0.9711

Columns 713 through 720

-0.9681 -0.9706 -0.9959 -0.9490 -0.9977 -0.9481 -0.9737 -0.9830

Columns 721 through 728

-0.9725 -0.9610 -0.9651 -0.9614 -0.9633 -0.9795 -0.9799 -0.9946

Columns 729 through 736

-0.9984 -0.9736 -0.9681 -0.9791 -0.9969 -0.9835 -0.9765 -0.9826

Columns 737 through 744

-0.9268 -0.9589 -0.9633 -0.9947 -0.9997 -0.9816 -0.9934 -0.9937

Columns 745 through 752

-0.9687 -0.9532 -0.9942 -0.9889 -0.9927 -0.9876 -0.9574 -0.9666

Columns 753 through 760

-0.9833 -0.9746 -0.9944 -0.9714 -0.9806 -0.9968 -0.9910 -0.9980

Columns 761 through 768

-0.9565 -0.9557 -0.9808 -0.9834 -0.9819 -0.9843 -0.9706 -0.9636

Columns 769 through 776

-0.9910 -0.9890 -0.9837 -0.9885 -0.9672 -0.9690 -0.9881 -0.9954

Columns 777 through 784

-0.9963 -0.9710 -0.9797 -0.9939 -0.9762 -0.9948 -0.9673 -0.9616

Columns 785 through 792

-0.9759 -0.9910 -0.9582 -0.9677 -0.9939 -0.9423 -0.9517 -0.9834

Columns 793 through 800

-0.9803 -0.9956 -0.9740 -0.9584 -0.9537 -0.9905 -0.9926 -0.9643

Columns 801 through 808

-0.9892 -0.9802 -0.9999 -0.9928 -0.9642 -0.9800 -0.9736 -0.9911

Columns 809 through 816

-0.9604 -0.9498 -0.9847 -0.9622 -0.9576 -0.9786 -0.9644 -0.9797

Columns 817 through 824

-0.9605 -0.9516 -0.9685 -0.9734 -0.9726 -0.9950 -0.9665 -0.9770

Columns 825 through 832

-0.9538 -0.9716 -0.9973 -0.9936 -0.9387 -0.9966 -0.9921 -0.9891

Columns 833 through 840

-0.9838 -0.9799 -0.9533 -0.9750 -0.9664 -0.9871 -0.9660 -0.9892

Columns 841 through 848

-0.9946 -0.9555 -0.9810 -0.9918 -0.9935 -0.9833 -0.9846 -0.9720

Columns 849 through 856

-0.9802 -0.9821 -0.9927 -0.9600 -0.9857 -0.9961 -0.9984 -0.9941

Columns 857 through 864

-0.9822 -0.9815 -0.9956 -0.9893 -0.9901 -0.9951 -0.9972 -1.0001

Columns 865 through 872

-0.9730 -0.9942 -0.9609 -0.9843 -0.9599 -0.9741 -0.9777 -0.9922

Columns 873 through 880

-0.9829 -0.9937 -0.9610 -0.9623 -0.9379 -0.9609 -0.9764 -0.9862

Columns 881 through 888

-0.9692 -0.9618 -0.9566 -0.9937 -0.9920 -0.9972 -0.9890 -0.9734

Columns 889 through 896

-0.9710 -0.9942 -0.9845 -0.9789 -0.9916 -0.9614 -0.9930 -0.9912

Columns 897 through 904

-0.9641 -0.9668 -0.9807 -0.9659 -0.9651 -0.9518 -0.9808 -0.9718

Columns 905 through 912

-0.9934 -0.9721 -0.9778 -0.9850 -0.9928 -0.9902 -0.9788 -0.9892

Columns 913 through 920

-0.9906 -0.9778 -0.9779 -0.9641 -0.9876 -0.9638 -0.9937 -1.0000

Columns 921 through 928

-0.9728 -0.9628 -0.9985 -0.9695 -0.9807 -0.9759 -0.9646 -0.9660

Columns 929 through 936

-0.9929 -0.9777 -1.0000 -0.9890 -0.9865 -0.9516 -0.9772 -0.9934

Columns 937 through 944

-0.9410 -0.9876 -0.9749 -0.9872 -0.9681 -0.8980 -0.9844 -0.9639

Columns 945 through 952

-0.9570 -0.9780 -0.9999 -0.9963 -0.9718 -0.9990 -0.9722 -0.9793

Columns 953 through 960

-0.9973 -0.9845 -0.9744 -0.9682 -0.9502 -0.9869 -0.9654 -0.9907

Columns 961 through 968

-0.9855 -0.9653 -0.9837 -0.9630 -0.9819 -0.9805 -0.9105 -0.9900

Columns 969 through 976

-0.9852 -0.9797 -0.9942 -0.9770 -0.9848 -0.9915 -0.9703 -1.0000

Columns 977 through 984

-0.9867 -0.9948 -0.9818 -0.9776 -0.9389 -0.9732 -0.9707 -0.9869

Columns 985 through 992

-0.9768 -0.9751 -0.9759 -0.9778 -0.9892 -0.9562 -0.9511 -0.9626

Columns 993 through 1000

-0.9741 -0.9652 -0.9517 -0.9735 -0.9488 -0.9721 -0.9553 -0.9692

Checking the Obtained values of Y from Test data to verify accuracy and errors

hits =

979

misses =

21

Accuracy_Percent =

97.9000

Error_Percent =

2.1000

2. Radial Basis Kernel:

The Value of b for various support vectors:

B =

Columns 1 through 8

0.0389 0.1582 0.2468 0.0390 0.0390 0.0390 0.2006 0.3685

Columns 9 through 16

0.0390 0.1331 0.1662 0.2195 0.0390 0.0390 0.0390 0.0390

Columns 17 through 24

0.0390 0.2315 0.0843 0.2264 0.0390 0.2370 0.0389 0.0995

Columns 25 through 32

0.0942 0.2051 0.0390 0.1736 0.0390 0.0390 0.0390 0.0390

Columns 33 through 40

0.0390 0.0390 0.0390 0.0390 0.0390 0.0390 0.0508 0.0390

Columns 41 through 48

0.0390 0.0390 0.0390 0.0390 0.0390 0.1858 0.0390 0.0390

Columns 49 through 56

0.0390 0.0390 0.1022 0.0390 0.0390 0.0390 0.0390 0.4921

Columns 57 through 64

0.0479 0.1531 0.0822 0.0389 0.0461 0.0390 0.2278 0.0390

Columns 65 through 72

0.0390 0.0390 0.1245 0.4576 0.0389 0.3261 0.3641 0.0390

Columns 73 through 80

0.0390 0.0658 0.1683 0.1911 0.2013 0.0390 0.0390 0.0390

Columns 81 through 88

0.0390 0.0390 0.0390 0.2340 0.4266 0.3432 0.0390 0.0811

Columns 89 through 96

0.0390 0.4516 0.1304 0.0390 0.0390 0.0390 0.0390 0.0390

Columns 97 through 104

0.0390 0.0802 0.1170 0.0390 0.0390 0.0390 0.0390 0.0390

Columns 105 through 112

0.3165 0.0390 0.0390 0.0404 0.0390 0.1809 0.0390 0.1203

Columns 113 through 120

0.1827 0.0390 0.0390 0.0390 0.3980 0.2598 0.0390 0.0390

Columns 121 through 128

0.0390 0.0390 0.1502 0.1624 0.0390 0.1297 0.0390 0.4762

Columns 129 through 136

0.0390 0.1633 0.2228 0.0390 0.3772 0.0390 0.2433 0.0390

Columns 137 through 144

0.0390 0.0916 0.0390 0.0390 0.0390 0.1815 0.0390 0.0390

Columns 145 through 152

0.3206 0.3341 0.0390 0.0390 0.0390 0.4384 0.1099 0.0658

Columns 153 through 160

0.0390 0.0484 0.3368 0.3186 0.2600 0.3419 0.5477 0.4262

Columns 161 through 168

0.4216 0.0390 0.1216 0.0390 0.4770 0.0427 0.3663 0.0390

Columns 169 through 176

0.0390 0.0390 0.0390 0.1378 0.1332 0.0390 0.2492 0.1385

Columns 177 through 184

0.0390 0.0390 0.0390 0.4429 0.3805 0.0390 0.3815 0.0390

Columns 185 through 192

0.0390 0.0390 0.2564 0.0390 0.1380 0.2383 0.0791 0.0390

Columns 193 through 200

0.0390 0.3902 0.0390 0.0390 0.0390 0.1582 0.0390 0.1038

Columns 201 through 208

0.0390 0.0390 0.3083 0.0390 0.0808 0.0390 0.5548 0.2585

Columns 209 through 216

0.0390 0.0390 0.0390 0.0390 0.2236 0.0390 0.2185 0.0390

Columns 217 through 224

0.0390 0.6141 0.0390 0.5771 0.2146 0.0390 0.0390 0.3345

Columns 225 through 232

0.1902 0.0390 0.0390 0.0390 0.0390 0.0390 0.1123 0.2045

Columns 233 through 240

0.0390 0.3302 0.0390 0.0390 0.0390 0.3643 0.0389 0.0390

Columns 241 through 248

0.0390 0.0390 0.0685 0.0390 0.3931 0.0390 0.0390 0.0390

Columns 249 through 256

0.0885 0.2109 0.0390 0.2734 0.0390 0.3874 0.0726 0.0390

Columns 257 through 264

0.0390 0.1868 0.0390 0.0389 0.4396 0.0390 0.3011 0.0390

Columns 265 through 272

0.4641 0.2475 0.1080 0.0390 0.1242 0.0390 0.0816 0.4412

Columns 273 through 280

0.1089 0.0390 0.4981 0.0390 0.3927 0.0390 0.0390 0.0390

Columns 281 through 288

0.3101 0.4246 0.0596 0.0390 0.0390 0.0390 0.0390 0.3607

Columns 289 through 296

0.0390 0.3518 0.0869 0.0390 0.0390 0.0390 0.3383 0.0816

Columns 297 through 304

0.3214 0.0390 0.0390 0.0390 0.0427 0.0390 0.0390 0.0390

Columns 305 through 312

0.2668 0.0390 0.3742 0.0390 0.0390 0.0390 0.0390 0.4433

Columns 313 through 320

0.2690 0.0390 0.0390 0.1516 0.1079 0.2050 0.2004 0.1065

Columns 321 through 328

0.4612 0.0390 0.2889 0.0946 0.0390 0.0390 0.0791 0.3340

Columns 329 through 336

0.0390 0.0390 0.0390 0.0390 0.1501 0.0390 0.0390 0.0390

Columns 337 through 344

0.0390 0.5705 0.0390 0.1331 0.0390 0.1778 0.0390 0.1780

Columns 345 through 352

0.0390 0.0390 0.1150 0.0390 0.0390 0.4337 0.0390 0.3863

Columns 353 through 360

0.4094 0.0390 0.0390 0.0390 0.0389 0.2732 0.0390 0.0390

Columns 361 through 368

0.0390 0.1053 0.1548 0.1286 0.2544 0.1727 0.0390 0.1781

Columns 369 through 376

0.1165 0.1664 0.0390 0.0390 0.1294 0.0389 0.1187 0.2518

Columns 377 through 384

0.0875 0.0390 0.2245 0.3392 0.4028 0.2582 0.0390 0.0390

Columns 385 through 392

0.0390 0.0390 0.0390 0.0390 0.0390 0.0390 0.0390 0.0390

Columns 393 through 400

0.1089 0.2262 0.0390 0.0390 0.2590 0.1723 0.0390 0.0390

Columns 401 through 408

0.3267 0.3276 0.0390 0.0390 0.0718 0.0390 0.0390 0.0390

Columns 409 through 416

0.0390 0.3497 0.0389 0.1432 0.0390 0.0643 0.0390 0.1171

Columns 417 through 424

0.2670 0.1823 0.0390 0.0480 0.0390 0.1626 0.3317 0.0390

Columns 425 through 432

0.0390 0.0929 0.0390 0.0390 0.0390 0.0390 0.0882 0.1642

Columns 433 through 440

0.0390 0.1291 0.0390 0.1155 0.0390 0.1447 0.4365 0.0390

Columns 441 through 448

0.0390 0.0390 0.0727 0.0390 0.0390 0.0390 0.3250 0.0438

Columns 449 through 456

0.0390 0.0390 0.0890 0.0390 0.1533 0.0390 0.1928 0.3805

Columns 457 through 464

0.0390 0.0389 0.4088 0.4918 0.2741 0.0390 0.0390 0.0390

Columns 465 through 472

0.0390 0.0390 0.0390 0.1128 0.0390 0.2473 0.0390 0.0390

Columns 473 through 480

0.3912 0.0656 0.0390 0.0390 0.1400 0.5776 0.0390 0.0390

Columns 481 through 488

0.2599 0.1694 0.0390 0.3796 0.0390 0.3640 0.0390 0.0389

Columns 489 through 496

0.1586 0.0390 0.0390 0.0390 0.0390 0.2351 0.1452 0.0390

Columns 497 through 504

0.2666 0.2917 0.0390 0.2734 0.0390 -0.0061 0.0390 -0.1117

Columns 505 through 512

0.0389 0.0390 -0.0642 -0.0512 -0.3279 0.0390 0.0390 0.0390

Columns 513 through 520

-0.1237 0.0390 -0.0653 -0.0068 0.0390 0.0390 0.0390 0.0112

Columns 521 through 528

0.0367 0.0390 0.0390 -0.1151 -0.1380 0.0390 0.0390 0.0390

Columns 529 through 536

-0.1209 0.0390 -0.1655 -0.0175 0.0389 -0.3092 0.0390 0.0390

Columns 537 through 544

0.0390 0.0390 0.0390 0.0390 -0.1916 -0.1617 0.0390 0.0390

Columns 545 through 552

0.0390 -0.1224 -0.1407 0.0390 0.0389 0.0328 0.0390 -0.0091

Columns 553 through 560

-0.2310 0.0390 0.0018 -0.0895 0.0390 -0.0891 0.0390 0.0390

Columns 561 through 568

0.0390 -0.0539 0.0390 -0.0346 0.0390 -0.1443 -0.2736 0.0390

Columns 569 through 576

-0.1724 0.0390 0.0248 0.0390 0.0390 0.0390 0.0390 0.0390

Columns 577 through 584

0.0390 0.0390 0.0390 0.0390 -0.0740 0.0390 0.0390 0.0390

Columns 585 through 592

-0.0249 -0.2836 0.0390 0.0390 0.0390 0.0390 0.0389 0.0390

Columns 593 through 600

0.0154 0.0389 0.0390 0.0390 0.0390 0.0390 0.0390 0.0390

Columns 601 through 608

0.0390 0.0390 0.0390 0.0213 0.0390 0.0390 0.0390 0.0390

Columns 609 through 616

0.0390 0.0390 0.0390 0.0390 -0.1339 0.0390 0.0390 0.0390

Columns 617 through 624

-0.1543 0.0389 -0.0333 0.0390 -0.0923 -0.0125 0.0390 0.0390

Columns 625 through 632

0.0390 0.0180 0.0390 0.0390 -0.2635 0.0390 -0.0757 0.0390

Columns 633 through 640

0.0390 0.0390 -0.2099 -0.1055 0.0390 0.0390 0.0389 -0.0371

Columns 641 through 648

0.0390 0.0390 -0.1908 -0.0420 0.0390 -0.2317 -0.0855 0.0390

Columns 649 through 656

0.0389 0.0390 -0.1363 0.0390 0.0390 0.0390 0.0390 -0.0801

Columns 657 through 664

0.0390 0.0390 0.0390 -0.2342 0.0390 -0.0187 -0.0631 -0.0232

Columns 665 through 672

0.0390 -0.1037 0.0390 -0.1587 -0.0775 -0.0877 0.0390 -0.0008

Columns 673 through 680

-0.2625 0.0390 0.0390 0.0390 0.0389 0.0390 -0.2445 -0.0495

Columns 681 through 688

0.0390 -0.1533 0.0390 0.0390 0.0389 -0.0729 0.0390 -0.1866

Columns 689 through 696

0.0390 -0.0092 0.0390 0.0390 0.0390 0.0390 0.0390 0.0390

Columns 697 through 704

0.0390 0.0390 0.0390 0.0390 0.0390 -0.1020 0.0390 0.0125

Columns 705 through 712

-0.1236 0.0390 0.0230 0.0390 0.0390 0.0390 -0.0950 0.0174

Columns 713 through 720

-0.0309 0.0333 0.0390 -0.2741 0.0390 -0.2861 -0.0650 0.0390

Columns 721 through 728

-0.0138 0.0059 -0.2515 -0.1026 -0.1285 0.0390 0.0389 0.0390

Columns 729 through 736

0.0390 0.0390 0.0010 0.0390 0.0390 0.0390 0.0390 -0.0633

Columns 737 through 744

0.0390 -0.0003 -0.1193 0.0390 0.0390 0.0390 0.0390 0.0390

Columns 745 through 752

0.0389 -0.0459 0.0390 0.0390 0.0389 0.0390 -0.2359 0.0390

Columns 753 through 760

0.0390 0.0390 0.0390 -0.0127 0.0390 0.0390 0.0390 0.0389

Columns 761 through 768

-0.0009 -0.2757 0.0390 0.0390 0.0390 0.0390 0.0390 -0.1835

Columns 769 through 776

0.0390 0.0390 0.0390 0.0390 0.0390 -0.1922 0.0390 0.0390

Columns 777 through 784

0.0390 0.0214 -0.0636 0.0390 0.0389 0.0390 0.0390 -0.1182

Columns 785 through 792

0.0390 0.0390 -0.1276 -0.0050 0.0390 -0.3397 -0.2607 0.0390

Columns 793 through 800

0.0390 0.0389 0.0390 -0.1024 -0.1667 0.0390 0.0390 0.0390

Columns 801 through 808

0.0390 -0.0205 0.0389 0.0390 0.0132 0.0390 0.0390 -0.0411

Columns 809 through 816

-0.0079 0.0390 0.0390 -0.0458 -0.1297 0.0390 -0.1755 0.0390

Columns 817 through 824

-0.1967 -0.3661 0.0390 0.0390 0.0390 0.0390 -0.1665 0.0390

Columns 825 through 832

-0.0236 -0.1599 0.0390 0.0390 -0.2266 0.0390 0.0390 -0.0078

Columns 833 through 840

0.0018 0.0390 -0.1773 0.0390 -0.1099 0.0389 0.0390 -0.0020

Columns 841 through 848

0.0390 0.0390 0.0390 0.0001 0.0390 0.0390 0.0390 0.0390

Columns 849 through 856

0.0390 0.0174 0.0390 -0.0734 0.0390 0.0390 0.0390 0.0390

Columns 857 through 864

0.0389 0.0390 0.0390 0.0390 0.0131 0.0389 0.0390 0.0390

Columns 865 through 872

-0.0229 0.0390 -0.2033 0.0390 -0.0134 0.0390 0.0390 0.0390

Columns 873 through 880

0.0390 0.0390 -0.0927 -0.1856 -0.1607 0.0390 0.0063 0.0390

Columns 881 through 888

0.0062 0.0390 0.0390 0.0390 0.0390 0.0390 0.0390 0.0221

Columns 889 through 896

-0.1666 0.0390 0.0390 0.0390 0.0390 -0.1349 0.0390 0.0390

Columns 897 through 904

-0.2295 0.0356 0.0390 -0.0703 0.0101 -0.2971 0.0125 -0.1164

Columns 905 through 912

0.0390 0.0233 0.0390 0.0390 0.0390 -0.0248 -0.2041 0.0389

Columns 913 through 920

0.0390 0.0390 -0.0038 -0.0630 0.0390 -0.0926 0.0390 0.0390

Columns 921 through 928

0.0390 -0.0713 0.0390 -0.0704 0.0390 0.0390 -0.0872 0.0390

Columns 929 through 936

0.0390 0.0389 0.0390 0.0390 0.0390 -0.3312 0.0390 0.0390

Columns 937 through 944

-0.1163 0.0390 0.0390 0.0390 -0.1492 0.0390 -0.0136 0.0264

Columns 945 through 952

-0.1170 0.0390 0.0390 0.0390 0.0390 0.0390 -0.0688 0.0390

Columns 953 through 960

0.0389 0.0390 -0.1411 -0.0733 -0.2810 0.0390 -0.1198 0.0390

Columns 961 through 968

0.0390 0.0390 0.0390 -0.0315 0.0390 0.0390 -0.1687 0.0389

Columns 969 through 976

0.0389 -0.0701 0.0390 -0.1783 0.0390 0.0390 -0.1615 0.0390

Columns 977 through 984

0.0390 0.0390 -0.0860 0.0390 0.0390 0.0268 0.0240 0.0390

Columns 985 through 992

0.0390 -0.2585 0.0390 -0.0713 0.0390 -0.2554 -0.0978 -0.0146

Columns 993 through 1000

0.0390 -0.0171 -0.1907 0.0390 -0.1529 0.0388 -0.0343 0.0221

Checking the Obtained values of Y from Test data to verify accuracy and errors

hits =

966

misses =

34

Accuracy_Percent =

96.6000

Error_Percent =

3.4000

3. Radial Even & Odd classification:

The Value of b for various support vectors:

B =

Columns 1 through 8

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 9 through 16

-0.2068 -0.2068 -0.2068 -0.2068 -0.1876 -0.2068 -0.2068 -0.2068

Columns 17 through 24

-0.1766 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 25 through 32

-0.2068 -0.2068 -0.2069 -0.2068 -0.2068 -0.2068 -0.2069 -0.2068

Columns 33 through 40

-0.2068 -0.2068 -0.1375 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 41 through 48

-0.1826 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 49 through 56

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 57 through 64

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.1542 -0.2068 -0.2068

Columns 65 through 72

-0.2068 -0.2068 -0.2068 -0.0882 -0.2068 -0.2068 -0.2068 -0.2068

Columns 73 through 80

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 81 through 88

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 89 through 96

-0.1477 -0.2069 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 97 through 104

-0.1259 -0.2068 -0.2068 -0.2068 -0.0570 -0.2068 -0.2069 -0.1729

Columns 105 through 112

-0.0559 -0.2069 -0.1620 -0.1115 -0.2069 -0.2068 -0.1014 -0.2034

Columns 113 through 120

-0.2068 -0.2068 -0.1126 -0.2068 -0.2068 -0.1501 -0.2068 -0.2069

Columns 121 through 128

-0.1772 -0.2068 0.0815 -0.1190 -0.2068 0.0707 -0.2068 -0.2068

Columns 129 through 136

-0.2036 -0.1823 -0.1255 -0.2069 -0.2069 -0.2068 -0.2069 0.0069

Columns 137 through 144

-0.2069 0.0423 0.0554 -0.0628 0.0030 0.1638 -0.0151 -0.2035

Columns 145 through 152

-0.1042 -0.2068 -0.2069 -0.2069 -0.2068 -0.2068 0.0673 -0.0283

Columns 153 through 160

-0.1598 -0.1005 -0.2068 -0.0973 0.0074 -0.0410 -0.2069 0.0103

Columns 161 through 168

-0.2069 -0.2068 -0.1709 -0.1390 -0.2068 -0.2068 -0.2068 -0.2068

Columns 169 through 176

-0.2068 -0.2068 -0.2068 -0.1667 -0.2069 -0.1790 -0.2068 0.0146

Columns 177 through 184

-0.0608 -0.2068 -0.1435 -0.2069 -0.1932 -0.2068 -0.2068 0.1287

Columns 185 through 192

-0.1860 -0.2068 0.1006 -0.2069 -0.2068 -0.0626 0.0371 -0.2068

Columns 193 through 200

-0.2069 -0.0753 -0.2068 -0.1277 -0.0699 -0.2068 -0.1190 -0.2068

Columns 201 through 208

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 209 through 216

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2069

Columns 217 through 224

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 225 through 232

-0.2068 -0.2068 -0.2069 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 233 through 240

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 241 through 248

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 249 through 256

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 257 through 264

-0.2068 -0.2069 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 265 through 272

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 273 through 280

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 281 through 288

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 289 through 296

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 297 through 304

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 305 through 312

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 313 through 320

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 321 through 328

-0.2068 -0.2068 -0.2068 -0.0706 -0.2069 -0.1805 -0.2068 -0.2068

Columns 329 through 336

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 337 through 344

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 345 through 352

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 353 through 360

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2069 -0.2068 -0.2068

Columns 361 through 368

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.1379 -0.0874

Columns 369 through 376

-0.0167 -0.2068 -0.2068 -0.2068 -0.2068 -0.2069 -0.2068 -0.2068

Columns 377 through 384

-0.2068 -0.2069 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2069

Columns 385 through 392

-0.2068 -0.2068 -0.2068 -0.2068 -0.2069 -0.2068 -0.2068 -0.2068

Columns 393 through 400

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 401 through 408

-0.2068 -0.2068 -0.2068 -0.2068 -0.2069 -0.2068 -0.2068 -0.2068

Columns 409 through 416

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2069

Columns 417 through 424

-0.2068 -0.2068 -0.2068 -0.2069 -0.2068 -0.2068 -0.2068 -0.2068

Columns 425 through 432

0.0341 -0.2069 -0.2069 -0.1192 0.0377 -0.2068 -0.2068 0.0638

Columns 433 through 440

-0.2068 -0.1639 -0.2068 -0.2068 -0.2068 -0.2069 -0.2068 -0.2068

Columns 441 through 448

-0.2068 0.0016 -0.2068 -0.2068 -0.2068 -0.2069 -0.2069 -0.2068

Columns 449 through 456

-0.2068 -0.2069 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 457 through 464

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 465 through 472

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2069

Columns 473 through 480

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2069 -0.2069 -0.2069

Columns 481 through 488

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 489 through 496

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 497 through 504

-0.2068 -0.2068 -0.2068 -0.2069 -0.2068 -0.2068 -0.2068 -0.2068

Columns 505 through 512

-0.2068 -0.2068 -0.2069 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 513 through 520

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 521 through 528

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 529 through 536

-0.2068 -0.2068 -0.2068 -0.2068 -0.2162 -0.2068 -0.2068 -0.2068

Columns 537 through 544

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2606 -0.2068

Columns 545 through 552

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 553 through 560

-0.2068 -0.2068 -0.2068 -0.2068 -0.2069 -0.3443 -0.2068 -0.2068

Columns 561 through 568

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 569 through 576

-0.2068 -0.2068 -0.2069 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 577 through 584

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2744 -0.2068

Columns 585 through 592

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2478

Columns 593 through 600

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 601 through 608

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 609 through 616

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2115 -0.3448 -0.2569

Columns 617 through 624

-0.4077 -0.3084 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 625 through 632

-0.2068 -0.3536 -0.2068 -0.2068 -0.2068 -0.3406 -0.2068 -0.2068

Columns 633 through 640

-0.2068 -0.2068 -0.2069 -0.2068 -0.2068 -0.4865 -0.2068 -0.3665

Columns 641 through 648

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2069 -0.2068 -0.2069

Columns 649 through 656

-0.2068 -0.2068 -0.2068 -0.2069 -0.2068 -0.2068 -0.2068 -0.2068

Columns 657 through 664

-0.2068 -0.4049 -0.2068 -0.2598 -0.2068 -0.3015 -0.2068 -0.2068

Columns 665 through 672

-0.2068 -0.3035 -0.2068 -0.2068 -0.2068 -0.2069 -0.2069 -0.2068

Columns 673 through 680

-0.2068 -0.2068 -0.2068 -0.3313 -0.3957 -0.2068 -0.2068 -0.2068

Columns 681 through 688

-0.2996 -0.2068 -0.3646 -0.2069 -0.2068 -0.2068 -0.2068 -0.2068

Columns 689 through 696

-0.2068 -0.3622 -0.2068 -0.2068 -0.2068 -0.2068 -0.4021 -0.2068

Columns 697 through 704

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 705 through 712

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.4561 -0.2068 -0.3169

Columns 713 through 720

-0.2068 -0.2068 -0.2068 -0.2068 -0.2069 -0.2068 -0.2068 -0.2068

Columns 721 through 728

-0.2068 -0.2068 -0.2068 -0.2068 -0.3857 -0.2170 -0.2125 -0.2068

Columns 729 through 736

-0.3356 -0.3624 -0.2068 -0.4473 -0.2068 -0.2068 -0.2068 -0.2068

Columns 737 through 744

-0.3104 -0.2069 -0.2068 -0.2068 -0.2068 -0.2952 -0.2068 -0.2069

Columns 745 through 752

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 753 through 760

-0.3103 -0.2068 -0.2069 -0.2068 -0.2302 -0.2068 -0.2068 -0.2525

Columns 761 through 768

-0.2068 -0.2696 -0.2068 -0.2069 -0.2068 -0.2068 -0.2068 -0.2069

Columns 769 through 776

-0.2398 -0.2068 -0.2069 -0.2068 -0.2733 -0.2068 -0.2068 -0.2187

Columns 777 through 784

-0.2068 -0.2068 -0.3488 -0.2068 -0.2068 -0.2068 -0.3669 -0.3062

Columns 785 through 792

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.4805

Columns 793 through 800

-0.2068 -0.3366 -0.2068 -0.2069 -0.2068 -0.2068 -0.2068 -0.2068

Columns 801 through 808

-0.3126 -0.2068 -0.2366 -0.2068 -0.2068 -0.2068 -0.2972 -0.3338

Columns 809 through 816

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2968 -0.2068

Columns 817 through 824

-0.2069 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 825 through 832

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 833 through 840

-0.2068 -0.2068 -0.2835 -0.2068 -0.2068 -0.2068 -0.2123 -0.2068

Columns 841 through 848

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2953 -0.2068

Columns 849 through 856

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 857 through 864

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 865 through 872

-0.2068 -0.3446 -0.2068 -0.2068 -0.2068 -0.2068 -0.3484 -0.2068

Columns 873 through 880

-0.2068 -0.2068 -0.4208 -0.2068 -0.2069 -0.2068 -0.2068 -0.2068

Columns 881 through 888

-0.2068 -0.3356 -0.2068 -0.2068 -0.2068 -0.2068 -0.3803 -0.2068

Columns 889 through 896

-0.2068 -0.2068 -0.2068 -0.3807 -0.2068 -0.2068 -0.2068 -0.2068

Columns 897 through 904

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2231

Columns 905 through 912

-0.4463 -0.2068 -0.2069 -0.2069 -0.2068 -0.2068 -0.2068 -0.2068

Columns 913 through 920

-0.2068 -0.2069 -0.2069 -0.2069 -0.2068 -0.2068 -0.3195 -0.2069

Columns 921 through 928

-0.2068 -0.2068 -0.2125 -0.2068 -0.2504 -0.2069 -0.2068 -0.2068

Columns 929 through 936

-0.2068 -0.2068 -0.2453 -0.2068 -0.2099 -0.3099 -0.2068 -0.2068

Columns 937 through 944

-0.2068 -0.2068 -0.4198 -0.2068 -0.2068 -0.2068 -0.2068 -0.3783

Columns 945 through 952

-0.2650 -0.2068 -0.4518 -0.2068 -0.2068 -0.2068 -0.5706 -0.2068

Columns 953 through 960

-0.2526 -0.2068 -0.3197 -0.2068 -0.2068 -0.2068 -0.2068 -0.3655

Columns 961 through 968

-0.2068 -0.2068 -0.3571 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 969 through 976

-0.2068 -0.2068 -0.2068 -0.2068 -0.2069 -0.4050 -0.2388 -0.2068

Columns 977 through 984

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068

Columns 985 through 992

-0.2068 -0.2530 -0.2068 -0.2918 -0.2069 -0.2068 -0.2069 -0.2068

Columns 993 through 1000

-0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.2068 -0.3165

Checking the Obtained values of Y from Test data to verify accuracy and errors

hits =

701

misses =

299

Accuracy_Percent =

70.1000

Error_Percent =

29.9000

4. Primal SVM Results:

Newton: ||Grad_PHI|| = 159739953.049329

Newton: ||Grad_PHI|| = 3283468.107358

Newton: ||Grad_PHI|| = 105450.140272

Newton: ||Grad_PHI|| = 29602.967759

Newton: ||Grad_PHI|| = 167831.009098

Newton: ||Grad_PHI|| = 3850.697458

Newton: ||Grad_PHI|| = 1630.237527

Newton: ||Grad_PHI|| = 646.465358

Newton: ||Grad_PHI|| = 253.742488

Newton: ||Grad_PHI|| = 145.364362

Newton: ||Grad_PHI|| = 68.618282

Newton: ||Grad_PHI|| = 37.783899

Newton: ||Grad_PHI|| = 20.301214

NRAL = 1;max(-c(x),0): 0.250478;

Complementarity: 25.095619; Newton Steps= 13; ;

NRAL = 2;max(-c(x),0): 0.250478;

Complementarity: 2514.356587; Newton Steps= 0; ;

Newton: ||Grad_PHI|| = 31304840.722354

Newton: ||Grad_PHI|| = 313847.433833

Newton: ||Grad_PHI|| = 156136.724406

Newton: ||Grad_PHI|| = 77285.725852

Newton: ||Grad_PHI|| = 37868.154890

Newton: ||Grad_PHI|| = 18175.205197

Newton: ||Grad_PHI|| = 8360.310647

Newton: ||Grad_PHI|| = 3515.322810

Newton: ||Grad_PHI|| = 1212.357021

NRAL = 3;max(-c(x),0): 0.048901;

Complementarity: 0.000537; Newton Steps= 9; ;

Newton: ||Grad_PHI|| = 3101.698410

Newton: ||Grad_PHI|| = 2859.127936

Newton: ||Grad_PHI|| = 2423.022978

Newton: ||Grad_PHI|| = 964.776563

Newton: ||Grad_PHI|| = 185.221708

Newton: ||Grad_PHI|| = 10.006304

NRAL = 4;max(-c(x),0): 0.020748;

Complementarity: 0.001116; Newton Steps= 6; ;

Newton: ||Grad_PHI|| = 862.206305

Newton: ||Grad_PHI|| = 517.467451

Newton: ||Grad_PHI|| = 63.811984

Newton: ||Grad_PHI|| = 1.239022

Newton: ||Grad_PHI|| = 0.000488

NRAL = 5;max(-c(x),0): 0.002079;

Complementarity: 0.000021; Newton Steps= 5; ;

NRAL = 6;max(-c(x),0): 0.002079;

Complementarity: 0.000023; Newton Steps= 0; ;

Newton: ||Grad_PHI|| = 9.894025

Newton: ||Grad_PHI|| = 0.045318

NRAL = 7;max(-c(x),0): 0.000597;

Complementarity: 0.018824; Newton Steps= 2; ;

NRAL = 8;max(-c(x),0): 0.000597;

Complementarity: 0.019186; Newton Steps= 0; ;

Newton: ||Grad_PHI|| = 10.118353

Newton: ||Grad_PHI|| = 0.049752

NRAL = 9;max(-c(x),0): 0.000556;

Complementarity: 0.000018; Newton Steps= 2; ;

NRAL = 10;max(-c(x),0): 0.000556;

Complementarity: 0.000018; Newton Steps= 0; ;

Newton: ||Grad_PHI|| = 9.928024

Newton: ||Grad_PHI|| = 0.046101

NRAL = 11;max(-c(x),0): 0.000264;

Complementarity: 0.018729; Newton Steps= 2; ;

NRAL = 12;max(-c(x),0): 0.000264;

Complementarity: 0.019087; Newton Steps= 0; ;

Newton: ||Grad_PHI|| = 10.114884

Newton: ||Grad_PHI|| = 0.049421

NRAL = 13;max(-c(x),0): 0.000392;

Complementarity: 0.000017; Newton Steps= 2; ;

NRAL = 14;max(-c(x),0): 0.000392;

Complementarity: 0.000017; Newton Steps= 0; ;

Newton: ||Grad_PHI|| = 9.925505

Newton: ||Grad_PHI|| = 0.045873

NRAL = 15;max(-c(x),0): 0.000187;

Complementarity: 0.018648; Newton Steps= 2; ;

NRAL = 16;max(-c(x),0): 0.000187;

Complementarity: 0.019003; Newton Steps= 0; ;

Newton: ||Grad_PHI|| = 10.111939

Newton: ||Grad_PHI|| = 0.049154

NRAL = 17;max(-c(x),0): 0.000288;

Complementarity: 0.000016; Newton Steps= 2; ;

NRAL = 18;max(-c(x),0): 0.000288;

Complementarity: 0.000016; Newton Steps= 0; ;

Newton: ||Grad_PHI|| = 9.923017

Newton: ||Grad_PHI|| = 0.045658

NRAL = 19;max(-c(x),0): 0.000186;

Complementarity: 0.018568; Newton Steps= 2; ;

NRAL = 20;max(-c(x),0): 0.000186;

Complementarity: 0.018920; Newton Steps= 0; ;

Newton: ||Grad_PHI|| = 10.109025

Newton: ||Grad_PHI|| = 0.048895

NRAL = 21;max(-c(x),0): 0.000223;

Complementarity: 0.000015; Newton Steps= 2; ;

NRAL = 22;max(-c(x),0): 0.000223;

Complementarity: 0.000015; Newton Steps= 0; ;

Newton: ||Grad_PHI|| = 9.920550

Newton: ||Grad_PHI|| = 0.045449

NRAL = 23;max(-c(x),0): 0.000185;

Complementarity: 0.018490; Newton Steps= 2; ;

NRAL = 24;max(-c(x),0): 0.000185;

Complementarity: 0.018839; Newton Steps= 0; ;

Newton: ||Grad_PHI|| = 10.106142

Newton: ||Grad_PHI|| = 0.048642

NRAL = 25;max(-c(x),0): 0.000196;

Complementarity: 0.000013; Newton Steps= 2; ;

NRAL = 26;max(-c(x),0): 0.000196;

Complementarity: 0.000014; Newton Steps= 0; ;

Newton: ||Grad_PHI|| = 9.918104

Newton: ||Grad_PHI|| = 0.045244

NRAL = 27;max(-c(x),0): 0.000184;

Complementarity: 0.018412; Newton Steps= 2; ;

NRAL = 28;max(-c(x),0): 0.000184;

Complementarity: 0.018758; Newton Steps= 0; ;

Newton: ||Grad_PHI|| = 10.103288

Newton: ||Grad_PHI|| = 0.048395

NRAL = 29;max(-c(x),0): 0.000189;

Complementarity: 0.000012; Newton Steps= 2; ;

NRAL = 30;max(-c(x),0): 0.000189;

Complementarity: 0.000013; Newton Steps= 0; ;

Newton: ||Grad_PHI|| = 9.915679

Newton: ||Grad_PHI|| = 0.045044

NRAL = 31;max(-c(x),0): 0.000184;

Complementarity: 0.018336; Newton Steps= 2; ;

NRAL = 32;max(-c(x),0): 0.000184;

Complementarity: 0.018679; Newton Steps= 0; ;

Newton: ||Grad_PHI|| = 10.100463

Newton: ||Grad_PHI|| = 0.048153

NRAL = 33;max(-c(x),0): 0.000183;

Complementarity: 0.000011; Newton Steps= 2; ;

NRAL = 34;max(-c(x),0): 0.000183;

Complementarity: 0.000012; Newton Steps= 0; ;

Newton: ||Grad_PHI|| = 9.913273

Newton: ||Grad_PHI|| = 0.044848

NRAL = 35;max(-c(x),0): 0.000183;

Complementarity: 0.018260; Newton Steps= 2; ;

NRAL = 36;max(-c(x),0): 0.000183;

Complementarity: 0.018600; Newton Steps= 0; ;

Newton: ||Grad_PHI|| = 10.097665

Newton: ||Grad_PHI|| = 0.047915

NRAL = 37;max(-c(x),0): 0.000176;

Complementarity: 0.000011; Newton Steps= 2; ;

NRAL = 38;max(-c(x),0): 0.000176;

Complementarity: 0.000011; Newton Steps= 0; ;

Newton: ||Grad_PHI|| = 9.910887

Newton: ||Grad_PHI|| = 0.044656

NRAL = 39;max(-c(x),0): 0.000182;

Complementarity: 0.018186; Newton Steps= 2; ;

NRAL = 40;max(-c(x),0): 0.000182;

Complementarity: 0.018523; Newton Steps= 0; ;

Newton: ||Grad_PHI|| = 10.094894

Newton: ||Grad_PHI|| = 0.047683

NRAL = 41;max(-c(x),0): 0.000170;

Complementarity: 0.000010; Newton Steps= 2; ;

NRAL = 42;max(-c(x),0): 0.000170;

Complementarity: 0.000010; Newton Steps= 0; ;

Newton: ||Grad_PHI|| = 9.908520

Newton: ||Grad_PHI|| = 0.044468

NRAL = 43;max(-c(x),0): 0.000181;

Complementarity: 0.018112; Newton Steps= 2; ;

NRAL = 44;max(-c(x),0): 0.000181;

Complementarity: 0.018447; Newton Steps= 0; ;

Newton: ||Grad_PHI|| = 10.092150

Newton: ||Grad_PHI|| = 0.047455

NRAL = 45;max(-c(x),0): 0.000164;

Complementarity: 0.000009; Newton Steps= 2; ;

NRAL = 46;max(-c(x),0): 0.000164;

Complementarity: 0.000009; Newton Steps= 0; ;

Newton: ||Grad_PHI|| = 9.906171

Newton: ||Grad_PHI|| = 0.044283

NRAL = 47;max(-c(x),0): 0.000181;

Complementarity: 0.018039; Newton Steps= 2; ;

NRAL = 48;max(-c(x),0): 0.000181;

Complementarity: 0.018371; Newton Steps= 0; ;

Newton: ||Grad_PHI|| = 10.089432

Newton: ||Grad_PHI|| = 0.047233

NRAL = 49;max(-c(x),0): 0.000157;

Complementarity: 0.000008; Newton Steps= 2; ;

NRAL = 50;max(-c(x),0): 0.000157;

Complementarity: 0.000008; Newton Steps= 0; ;

Newton: ||Grad_PHI|| = 9.903841

Newton: ||Grad_PHI|| = 0.044102

NRAL = 51;max(-c(x),0): 0.000180;

Complementarity: 0.017968; Newton Steps= 2; ;

NRAL = 52;max(-c(x),0): 0.000180;

Complementarity: 0.018297; Newton Steps= 0; ;

Newton: ||Grad_PHI|| = 10.086738

Newton: ||Grad_PHI|| = 0.047014

NRAL = 53;max(-c(x),0): 0.000152;

Complementarity: 0.000008; Newton Steps= 2; ;

NRAL = 54;max(-c(x),0): 0.000152;

Complementarity: 0.000008; Newton Steps= 0; ;

Newton: ||Grad_PHI|| = 9.901529

Newton: ||Grad_PHI|| = 0.043925

NRAL = 55;max(-c(x),0): 0.000179;

Complementarity: 0.017897; Newton Steps= 2; ;

NRAL = 56;max(-c(x),0): 0.000179;

Complementarity: 0.018223; Newton Steps= 0; ;

Newton: ||Grad_PHI|| = 10.084069

Newton: ||Grad_PHI|| = 0.046800

NRAL = 57;max(-c(x),0): 0.000146;

Complementarity: 0.000007; Newton Steps= 2; ;

NRAL = 58;max(-c(x),0): 0.000146;

Complementarity: 0.000007; Newton Steps= 0; ;

Newton: ||Grad_PHI|| = 9.899234

Newton: ||Grad_PHI|| = 0.043751

NRAL = 59;max(-c(x),0): 0.000178;

Complementarity: 0.017827; Newton Steps= 2; ;

NRAL = 60;max(-c(x),0): 0.000178;

Complementarity: 0.018151; Newton Steps= 0; ;