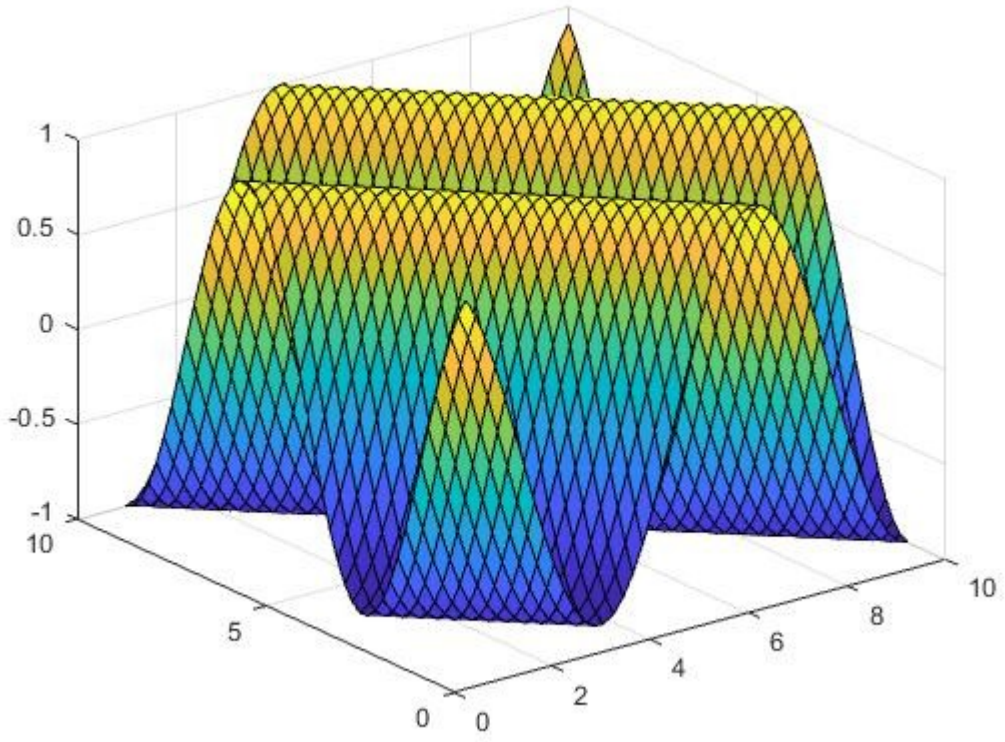
CS5486 Intelligent Systems - Assignment 2

Support Vector Regression under Radial basis function kernel

```
clear
x(:,1) = randi([-5 5],1,100)';
x(:,2) = randi([-5 5],1,100)';
test(:,1) = randi([-5 5],1,100)';
test(:,2) = randi([-5 5],1,100)';
testtarget = sin(test(:,1) + test(:,2));
z = sin(x(:,1) + x(:,2));
x1 = 1:0.2:10;
x2 = 1:0.2:10;
[X1, X2] = meshgrid(x1,x2);
Z = sin(X1 + X2);
surf(X1,X2,Z);
error = svrerror(x,test,testtarget, 'rbf', 1, 0, 'quadratic', 0.05);
output = svroutput(x,test,'rbf', 1, 0);
svr(x,z,'rbf',Inf,'quadratic',0.05);
```



```
Support Vector Regressing ....
_____________________________
Constructing ...
Optimising ...
The interior-point-convex algorithm does not accept an initial point.
Ignoring X0.

 Iter            Fval  Primal Infeas    Dual Infeas  Complementarity
    0    0.000000e+00   0.000000e+00   0.000000e+00     1.000000e+28
    1    0.000000e+00   0.000000e+00   0.000000e+00     5.000000e+24

Solver stalled, constraints satisfied.

Optimization completed because the size of the current step is less than
the default value of the step size tolerance and constraints are
satisfied to within the default value of the constraint tolerance.

<stopping criteria details>

Execution time :  0.0 seconds
Status :
|w0|^2    : 0.000000
Sum beta : 0.000000
Support Vectors : 0 (0.0%)
```

Support Vector Regressing ....

____

Constructing ...

Optimising ...

The interior-point-convex algorithm does not accept an initial point.

Ignoring X0.

Iter	Fval	Primal Infeas	Dual Infeas	Complementarity
0	0.000000e+00	0.000000e+00	0.000000e+00	1.000000e+28
1	0.000000e+00	0.000000e+00	0.000000e+00	5.000000e+24

Solver stalled, constraints satisfied.

Optimization completed because the size of the current step is less than the default value of the step size tolerance and constraints are satisfied to within the default value of the constraint tolerance.

<stopping criteria details>

Execution time : 0.0 seconds

Status :

|w0|^2   : 0.000000

Sum beta : 0.000000

Support Vectors : 0 (0.0%)

Results

Execution time	Mean squared error
0.0 seconds	0.552808

sample	error squared
1	0.516006
2	0.527411
3	0.535234
4	0.607383
5	0.55272
6	0.605971
7	0.581207
8	0.526002
9	0.5934
10	0.517354
11	0.544746
12	0.577626
13	0.545547
14	0.555118
15	0.52042
16	0.512983
17	0.605971
18	0.595743
19	0.563799
20	0.528726
21	0.519258
22	0.560767
23	0.577
24	0.521505
25	0.577626
26	0.575097
27	0.546171
28	0.634444
29	0.51714

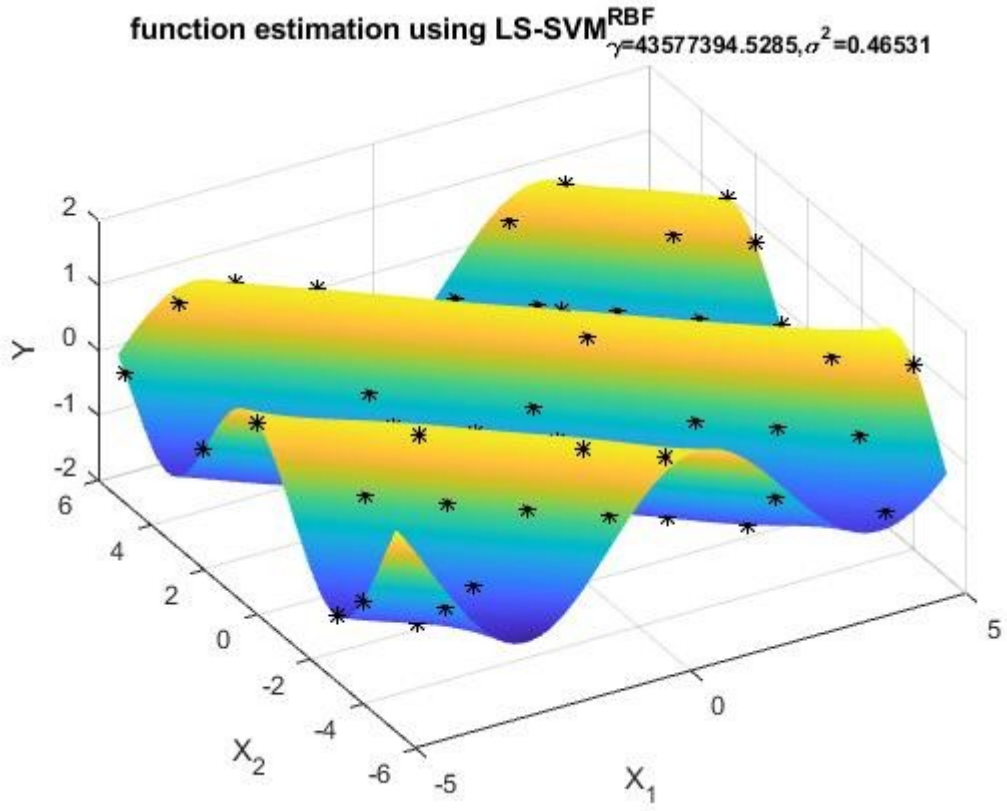
2
0.54617
30 1
0.54937
31 5
0.50141
32 2
0.52955
33 6
0.63444
34 4
0.60495
35 8
0.53342
36 3
0.60321
37 1
0.58675
38 4
0.58245
39 1
0.52612
40 8
41 0.5571
0.52635
42 4
0.56076
43 7
0.51925
44 8
0.52593
45 6
0.59574
46 3
0.57269
47 1
0.60489
48 2
0.60314
49 8
0.51600
50 6
0.52443
51 4
0.58675
52 4
53 0.53869
0.59574
54 3
0.54937
55 5
0.52593
56 6
0.52111
57 3

58	0.5571
59	0.54554
60	0.53079
61	0.56751
62	0.56482
63	0.58577
64	0.59612
65	0.52042
66	0.52111
67	0.58017
68	0.52806
69	0.59640
70	0.49712
71	0.52259
72	0.52299
73	0.56199
74	0.5571
75	0.59236
76	0.53370
77	0.51714
78	0.55780
79	0.53993
80	0.53605
81	0.57762
82	0.60403
83	0.49907
84	0.52746
85	0.58475
86	0.56076
87	0.52612

```
           8
      0.52741
  88        1
      0.52462
  89        4
      0.52111
  90        3
      0.49583
  91        1
      0.56482
  92        4
      0.54122
  93        6
      0.56076
  94        7
      0.60302
  95        3
      0.55666
  96        9
      0.51974
  97        2
      0.49907
  98        4
      0.56199
  99        2
      0.52777
 100        3
```

Least Squares Support Vector Machines (LS-SVM)

```
clear
x(:,1) = randi([-5 5],1,100)';
x(:,2) = randi([-5 5],1,100)';
z = sin(x(:,1) + x(:,2));
output = lssvm(x, z, 'f');
```


function estimation using LS-SVM$^{RBF}_{\gamma=43577394.5285,\sigma^2=0.46531}$
Y
2
1
0
-1
-2
6
4
2
0
-2
-4
-6
X_2
-5
0
5
X_1

```
>> LSSVM

   Determine initial tuning parameters for simplex...: # cooling cycle(s) 1
  |-                                                  -|
  ************************************************** done

 1. Coupled Simulated Annealing results:  [gam]          2046.6412
                                          [sig2]         0.18348
                                          F(X)=          0.0094033

 TUNELSSVM: chosen specifications:
 2. optimization routine:           simplex
    cost function:                  leaveoneoutlssvm
    kernel function                 RBF_kernel


 3. starting values:                   2046.6412     0.18347693

 Iteration   Func-count     min f(x)     log(gamma)     log(sig2)     Procedure

     1            3     9.263367e-03      8.8240         -1.6957      initial
     2            7     5.034341e-03      8.2240         -1.0957      shrink
     3            9     4.370522e-03      9.1240         -0.7957      expand
     4           11     4.370522e-03      9.1240         -0.7957      contract inside
     5           13     4.370522e-03      9.1240         -0.7957      contract outside
     6           15     3.791092e-03      10.3052         -0.7019      expand
     7           17     3.791092e-03      10.3052         -0.7019      contract inside
     8           18     3.791092e-03      10.3052         -0.7019      reflect
     9           20     3.122940e-03      12.1216         -0.6339      expand
    10           21     3.122940e-03      12.1216         -0.6339      reflect
    11           22     3.122940e-03      12.1216         -0.6339      reflect
    12           24     2.635292e-03      15.3923         -0.4125      expand
    13           26     2.635292e-03      15.3923         -0.4125      contract inside
optimisation terminated sucessfully (MaxFunEvals criterion)

Simplex results:
X=4839464.726555   0.662018, F(X)=2.635292e-03

Obtained hyper-parameters: [gamma sig2]: 4839464.7266     0.66201753293
Start Plotting...finished
```

```
>> LSSVM

  Determine initial tuning parameters for simplex...: # cooling cycle(s) 1

 |-                                                  -|

 ************************************************** done


1. Coupled Simulated Annealing results:  [gam]       122304.3452

                                         [sig2]      0.4378

                                         F(X)=       0.0070214
```

TUNELSSVM: chosen specifications:

2. optimization routine: simplex

cost function: leaveoneoutlssvm

kernel function RBF_kernel

3. starting values: 122304.3452 0.4378040684

Iteration	Func-count	min f(x)	log(gamma)	log(sig2)	Procedure
1	3	6.474794e-03	12.9143	-0.8260	initial
2	5	6.474794e-03	12.9143	-0.8260	contract outside
3	7	6.474794e-03	12.9143	-0.8260	contract inside
4	9	6.474794e-03	12.9143	-0.8260	contract outside
5	10	6.474794e-03	12.9143	-0.8260	reflect
6	12	6.075005e-03	14.9768	-0.7510	expand
7	14	6.075005e-03	14.9768	-0.7510	contract inside
8	15	6.075005e-03	14.9768	-0.7510	reflect
9	16	6.075005e-03	14.9768	-0.7510	reflect
10	18	5.991515e-03	15.8299	-0.8072	reflect
11	22	5.971754e-03	16.4346	-0.7416	shrink
12	24	5.934219e-03	17.5900	-0.7650	expand
13	26	5.934219e-03	17.5900	-0.7650	contract inside

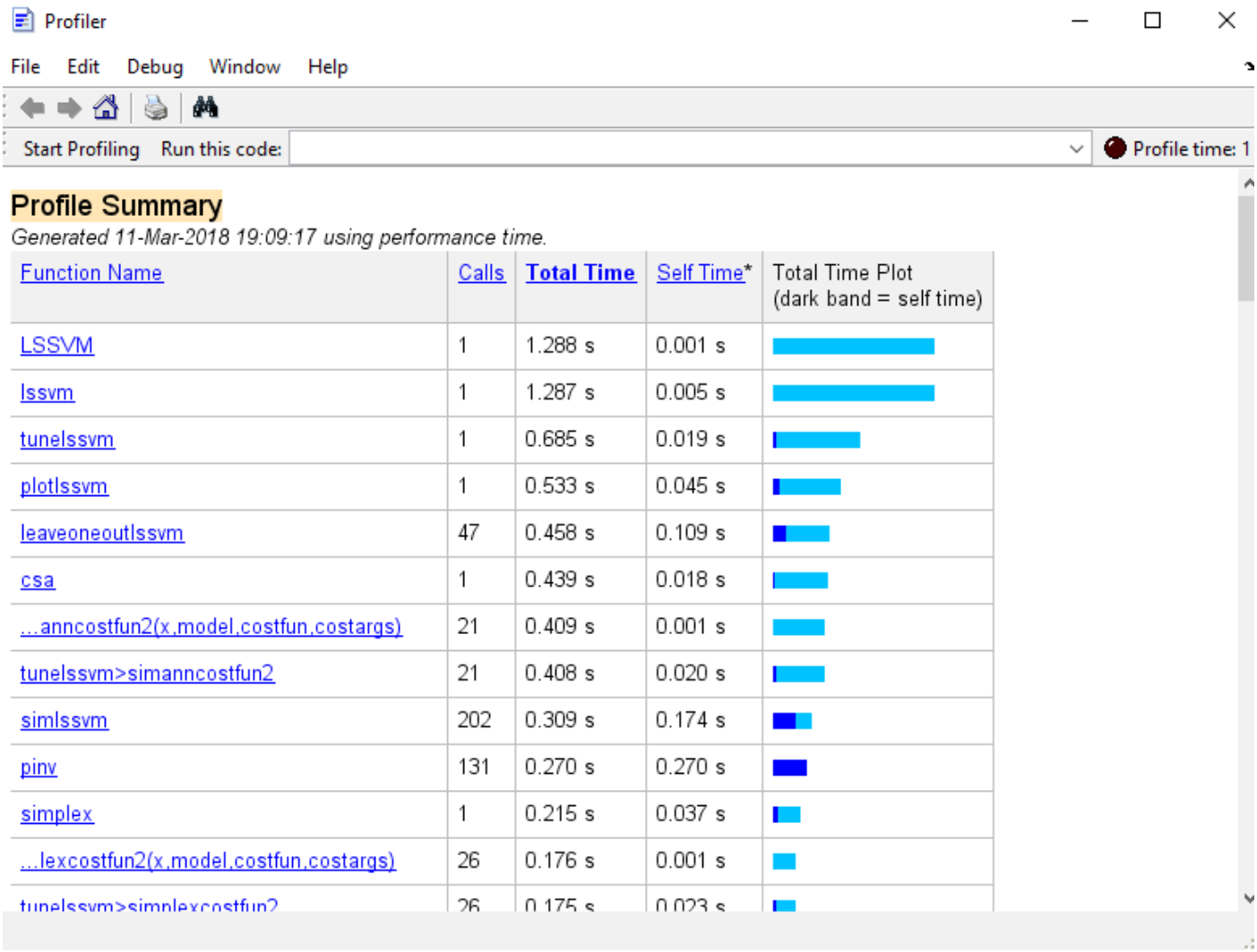
optimisation terminated sucessfully (MaxFunEvals criterion)

Simplex results:

X=43577394.528494 0.465312, F(X)=5.934219e-03

Obtained hyper-parameters: [gamma sig2]: 43577394.5285 0.465312385999

Start Plotting...finished



Profile Summary

Generated 11-Mar-2018 19:09:17 using performance time.

Function Name	Calls	Total Time	Self Time*	Total Time Plot (dark band = self time)
LSSVM	1	1.288 s	0.001 s	
lssvm	1	1.287 s	0.005 s	
tunelssvm	1	0.685 s	0.019 s	
plotlssvm	1	0.533 s	0.045 s	
leaveoneoutlssvm	47	0.458 s	0.109 s	
csa	1	0.439 s	0.018 s	
...anncostfun2(x,model,costfun,costargs)	21	0.409 s	0.001 s	
tunelssvm>simanncostfun2	21	0.408 s	0.020 s	
simlssvm	202	0.309 s	0.174 s	
pinv	131	0.270 s	0.270 s	
simplex	1	0.215 s	0.037 s	
...lexcostfun2(x,model,costfun,costargs)	26	0.176 s	0.001 s	
tunelssvm>simplexcostfun2	26	0.175 s	0.023 s	

Execution time of the LSSVM function: 1.287 s

Results

Execution time	Mean Squared Error
1.287 seconds	0.479818

sample	error sqaured
1	0.020704
2	0.819865
3	0.566983
4	5.51E-07
5	0.827976
6	0.078643
7	0.921773
8	0.573050
9	0.574481

10	0.828016
11	0.695638
12	0.712262
13	5.61E-06
14	0.432186
15	0.704434
16	2.28E-06
17	0.574481
18	0.019874
19	2.28E-06
20	3.11E-07
21	0.977242
22	0.709416
23	2.28E-06
24	0.705617
25	0.699575
26	0.019874
27	0.571672
28	0.170534
29	0.706553
30	0.020809
31	0.711928
32	0.569684
33	0.019021
34	0.709416
35	0.709416
36	0.827976
37	0.019768
38	3.95E-08
39	0.020099
40	0.01976

8
0.07831
41 3
0.70655
42 3
0.82797
43 6
44 0.07869
0.97724
45 2
0.81986
46 5
0.57626
47 7
0.56859
48 2
0.70659
49 6
0.92527
50 3
0.82797
51 6
52 3.95E-08
0.55761
53 4
0.70625
54 7
0.82801
55 6
0.57174
56 9
0.82801
57 6
58 1.5E-05
59 0.82635
0.97840
60 9
61 0.01967
0.81921
62 1
0.02043
63 9
0.17070
64 6
0.91515
65 2
0.01893
66 3
0.82527
67 4
0.01987
68 4
69 0.4351
70 5.51E-07
71 0.02043

	9
	0.82232
72	1
	0.70561
73	7
74	0.82635
75	0.83063
	0.42859
76	1
	0.29672
77	4
	0.70625
78	7
	0.71226
79	2
	0.82797
80	6
81	0.296
	0.91218
82	8
	0.57448
83	1
84	3.95E-08
	0.08110
85	9
	0.02027
86	7
	0.70659
87	6
88	0.83063
	0.43160
89	1
	0.71226
90	2
91	1.14E-05
	0.01893
92	3
93	0.70949
94	3.11E-07
	0.71211
95	3
	0.92416
96	6
	0.57174
97	9
	0.97980
98	4
	0.17053
99	4
	0.97980
100	4

Comparsion

The execution time of the SVR under RBF is zero and it is lower than the execution time of ISSVM. The mean squared error of SVR is higher than ISSVM by about 0.1.