**CS584 Homework 1**

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Single linear

200 data:

k1, k2 = [ 0.26120329] [ 1.98610257]

RSS = 846.51412315]

RSS/200

[ 4.23257062]

estimate

[ 0.26120329 1.98610257]

[ 1.98610257 0.26120329]

[ -7.53790595e-04 2.01625419e+00 -1.49340702e-02]

[ 1.71047675e-03 -1.03382396e-01 3.96516971e+00 -1.16256162e+01]

p4: [ 3.39354872e-04 -2.55789317e-02 6.90034342e-01 -5.88591398e+00

3.23233781e+01]

p5: [ -2.24603110e-05 2.58508604e-03 -1.12861468e-01 2.33420652e+00

-2.08642499e+01 8.50317734e+01]

180(train), 20(test)

train: [[ 0.42373779] [ 1.97734961]]; MSE = 4.23343919

test: MSE = 4.2521169

rsq\_train: [ 0.96933161]

rsq\_train: [ 0.96624939]

estimate:

svar-set1

[ 1.97734961 0.42373779]

rsq\_train: [ 0.96933161]

rsq\_test: [ 0.96624939]

MSE\_train: [ 4.23343919]

rsq\_train: [ 0.96933161]

MSE\_test: [ 4.2521169]

rsq\_test: [ 0.96624939]

p2: [ -5.98921974e-04 2.00142640e+00 2.02278668e-01]

rsq\_train: [ 0.96933398]

rsq\_test: [ 0.96627139]

MSE\_train: [ 4.2331114]

rsq\_train: [ 0.96933398]

MSE\_test: [ 4.24934548]

rsq\_test: [ 0.96627139]

p3: [ 1.59486974e-03 -9.63774686e-02 3.82148170e+00 -1.06573387e+01]

rsq\_train: [ 0.96977428]

rsq\_test: [ 0.96730378]

MSE\_train: [ 4.17233278]

rsq\_train: [ 0.96977428]

MSE\_test: [ 4.11927854]

rsq\_test: [ 0.96730378]

p4: [ 3.39354872e-04 -2.55789317e-02 6.90034342e-01 -5.88591398e+00

3.23233781e+01]

MSE\_train: [ 4.10154024]

rsq\_train: [ 0.97028713]

MSE\_test: [ 4.53085946]

rsq\_test: [ 0.96403691]

p5: [ -2.24603110e-05 2.58508604e-03 -1.12861468e-01 2.33420652e+00

-2.08642499e+01 8.50317734e+01]

MSE\_train: [ 4.09383144]

rsq\_train: [ 0.97034297]

MSE\_test: [ 4.54046111]

rsq\_test: [ 0.9639607]

data 2:

x\_train.size: 180

x\_test.size: 20

p1 my method:

rsq\_train: [ 0.24570355]

rsq\_train: [ 0.31513608]

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p1: [-0.07891878 0.33283915]

MSE\_train: [ 0.06196014]

rsq\_train: [ 0.24570355]

MSE\_test: [ 0.03825547]

rsq\_test: [ 0.31513608]

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p2: [ 0.04913353 -0.38292438 0.6437814 ]

MSE\_train: [ 0.041162]

rsq\_train: [ 0.49889806]

MSE\_test: [ 0.01675475]

rsq\_test: [ 0.70005007]

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p3: [-0.02968398 0.32673071 -1.07305468 0.99734198]

MSE\_train: [ 0.02126954]

rsq\_train: [ 0.74106683]

MSE\_test: [ 0.01268473]

rsq\_test: [ 0.7729132]

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p4: [ 0.01257437 -0.18676403 0.9554036 -1.93700821 1.25914457]

MSE\_train: [ 0.0120708]

rsq\_train: [ 0.85305128]

MSE\_test: [ 0.00662936]

rsq\_test: [ 0.88131871]

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p5: [ -1.76539786e-03 4.01214228e-02 -3.39104103e-01 1.30881291e+00

-2.24544312e+00 1.31933529e+00]

MSE\_train: [ 0.01162945]

rsq\_train: [ 0.85842427]

MSE\_test: [ 0.00647401]

rsq\_test: [ 0.88409983]

data3: x\_train.size: 180

x\_test.size: 20

p1 my method:

rsq\_train: [ 0.00024172]

rsq\_train: [-0.11937502]

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p1: [-0.0038674 0.52697054]

MSE\_train: [ 0.51830252]

rsq\_train: [ 0.00024172]

MSE\_test: [ 0.32597774]

rsq\_test: [-0.11937502]

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p2: [-0.06741865 0.68002448 -0.64196123]

MSE\_train: [ 0.25512431]

rsq\_train: [ 0.50788847]

MSE\_test: [ 0.24631473]

rsq\_test: [ 0.15417981]

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p3: [ -3.39807518e-04 -6.23000783e-02 6.59524725e-01 -6.24677249e-01]

MSE\_train: [ 0.25508276]

rsq\_train: [ 0.50796863]

MSE\_test: [ 0.24752208]

rsq\_test: [ 0.15003386]

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p4: [ 0.0072519 -0.14554866 0.87197609 -1.42226147 0.42355383]

MSE\_train: [ 0.12957968]

rsq\_train: [ 0.75005261]

MSE\_test: [ 0.10322223]

rsq\_test: [ 0.64554516]

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p5: [ -9.65599650e-05 9.66781206e-03 -1.67008483e-01 9.52203473e-01

-1.53608184e+00 4.60718522e-01]

MSE\_train: [ 0.12943639]

rsq\_train: [ 0.75032901]

MSE\_test: [ 0.10140347]

rsq\_test: [ 0.65179059]

data4:

x\_train.size: 180

x\_test.size: 20

p1 my method:

rsq\_train: [ 7.35638758e-05]

rsq\_train: [-0.02479049]

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p1: [-0.00315079 0.96590264]

MSE\_train: [ 1.14315024]

rsq\_train: [ 7.35638758e-05]

MSE\_test: [ 1.72445474]

rsq\_test: [-0.02479049]

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p2: [-0.06871603 0.68370458 -0.16834031]

MSE\_train: [ 0.87498088]

rsq\_train: [ 0.23464433]

MSE\_test: [ 1.41351243]

rsq\_test: [ 0.15999297]

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p3: [ 0.00362178 -0.12285142 0.89846299 -0.34322644]

MSE\_train: [ 0.87024017]

rsq\_train: [ 0.23879109]

MSE\_test: [ 1.37029609]

rsq\_test: [ 0.18567511]

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p4: [-0.00519543 0.10727868 -0.78648424 2.36056194 -1.0529637 ]

MSE\_train: [ 0.80784537]

rsq\_train: [ 0.29336852]

MSE\_test: [ 1.24375014]

rsq\_test: [ 0.26087748]

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p5: [-0.00178123 0.03911857 -0.28394218 0.66546649 0.32309149 -0.40424192]

MSE\_train: [ 0.76140198]

rsq\_train: [ 0.33399308]

MSE\_test: [ 1.20543009]

rsq\_test: [ 0.28364991]

svar-set1: MSE of train and test set data l is least data in the 3 degree polynomial model

svar-set2: MSE of train and test set data l is least data in the 5 degree polynomial model

svar-set3: MSE of train and test set data l is least data in the 5 degree polynomial model

svar-set4: MSE of train and test set data l is least data in the 5 degree polynomial model

Reduce Train data set 150 ; 50

Data1

x\_train.size: 150

x\_test.size: 50

p1 my method:

rsq\_train: [ 0.96955786]

rsq\_train: [ 0.9674571]

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p1: [ 1.97811066 0.34886358]

MSE\_train: [ 4.22038643]

rsq\_train: [ 0.96955786]

MSE\_test: [ 4.29856341]

[ 0.0325429]

rsq\_test: [ 0.9674571]

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p2: [ 0.00218342 1.89015766 1.15959099]

MSE\_train: [ 4.21587319]

rsq\_train: [ 0.96959041]

MSE\_test: [ 4.34355935]

rsq\_test: [ 0.96711645]

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p3: [ 1.21705636e-03 -7.07133691e-02 3.27010151e+00 -7.02994895e+00]

MSE\_train: [ 4.17893242]

rsq\_train: [ 0.96985687]

MSE\_test: [ 4.21425175]

rsq\_test: [ 0.96809539]

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p4: [ 2.31165595e-04 -1.72575751e-02 4.62544120e-01 -3.28833927e+00

2.18555671e+01]

MSE\_train: [ 4.14667685]

rsq\_train: [ 0.97008953]

MSE\_test: [ 4.17825535]

rsq\_test: [ 0.96836791]

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p5: [ -2.29654894e-05 2.52926283e-03 -1.06658333e-01 2.14819274e+00

-1.86553410e+01 7.59333959e+01]

MSE\_train: [ 4.1386093]

rsq\_train: [ 0.96836791]

MSE\_test: [ 4.17958162]

rsq\_test: [ 0.96835787]

data2:

x\_train.size: 150

x\_test.size: 50

p1 my method:

rsq\_train: [ 0.23862031]

rsq\_train: [ 0.28915716]

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p1: [-0.07842592 0.32615745]

MSE\_train: [ 0.06182678]

rsq\_train: [ 0.23862031]

MSE\_test: [ 0.05311341]

[ 0.71084284]

rsq\_test: [ 0.28915716]

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p2: [ 0.04969803 -0.38300871 0.63592303]

MSE\_train: [ 0.04134559]

rsq\_train: [ 0.49084057]

MSE\_test: [ 0.03135766]

rsq\_test: [ 0.58032505]

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p3: [-0.03094549 0.33645499 -1.08954483 0.99827642]

MSE\_train: [ 0.0211801]

rsq\_train: [ 0.73917294]

MSE\_test: [ 0.01896487]

rsq\_test: [ 0.74618384]

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p4: [ 0.01307751 -0.19313003 0.98176783 -1.97527633 1.27138661]

MSE\_train: [ 0.01179757]

rsq\_train: [ 0.85471625]

MSE\_test: [ 0.0108183]

rsq\_test: [ 0.85521336]

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p5: [ -1.41303552e-03 3.49816235e-02 -3.13494352e-01 1.25948766e+00

-2.21738525e+00 1.31975053e+00]

MSE\_train: [ 0.01153065]

rsq\_train: [ 0.85521336]

MSE\_test: [ 0.00994813]

rsq\_test: [ 0.86685934]

data3

x\_train.size: 150

x\_test.size: 50

p1 my method:

rsq\_train: [ 0.00100113]

rsq\_train: [-0.01924129]

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p1: [-0.00736864 0.50327443]

MSE\_train: [ 0.47699844]

rsq\_train: [ 0.00100113]

MSE\_test: [ 0.56679837]

[ 1.01924129]

rsq\_test: [-0.01924129]

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p2: [-0.06401002 0.63915705 -0.56573053]

MSE\_train: [ 0.23802506]

rsq\_train: [ 0.50149362]

MSE\_test: [ 0.29984929]

rsq\_test: [ 0.46079807]

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p3: [ 0.00147527 -0.08630231 0.72867838 -0.63971555]

MSE\_train: [ 0.23721062]

rsq\_train: [ 0.50319933]

MSE\_test: [ 0.30493155]

rsq\_test: [ 0.45165893]

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p4: [ 0.00679476 -0.13521427 0.79642571 -1.23590505 0.33814275]

MSE\_train: [ 0.12312189]

rsq\_train: [ 0.74214041]

MSE\_test: [ 0.14093139]

rsq\_test: [ 0.74657109]

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

p5: [ -3.20409305e-04 1.48175283e-02 -2.06450679e-01 1.06198374e+00

-1.60962156e+00 4.59002450e-01]

MSE\_train: [ 0.12145707]

rsq\_train: [ 0.74657109]

MSE\_test: [ 0.14646803]

rsq\_test: [ 0.73661486]

Data4

x\_train.size: 150

x\_test.size: 50

p1 my method:

rsq\_train: [ 5.69537491e-07]

rsq\_train: [-0.03178113]

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p1: [ -2.73460966e-04 9.17238994e-01]

MSE\_train: [ 1.0816912]

rsq\_train: [ 5.69537491e-07]

MSE\_test: [ 1.57115126]

[ 1.03178113]

rsq\_test: [-0.03178113]

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p2: [-0.06276063 0.62924447 -0.14418968]

MSE\_train: [ 0.85272863]

rsq\_train: [ 0.21167137]

MSE\_test: [ 1.18469433]

rsq\_test: [ 0.22200664]

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p3: [ 0.00315998 -0.11026817 0.81898689 -0.2987934 ]

MSE\_train: [ 0.84918374]

rsq\_train: [ 0.21494854]

MSE\_test: [ 1.16235166]

rsq\_test: [ 0.23667916]

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p4: [-0.00526901 0.10819554 -0.78266016 2.30441957 -1.01786185]

MSE\_train: [ 0.78452564]

rsq\_train: [ 0.27472352]

MSE\_test: [ 1.07263819]

rsq\_test: [ 0.29559434]

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p5: [-0.0015168 0.0325314 -0.22619454 0.46056915 0.56258634 -0.47249007]

MSE\_train: [ 0.75065473]

rsq\_train: [ 0.29559434]

MSE\_test: [ 0.99141371]

rsq\_test: [ 0.34893477]

Multivariate regression:

Total data:

Mdata1:

const 0.9959

x1 0.9975

x2 0.9905

MSE: 0.258702892151

Mdata2:

const 0.0009

x1 0.0646

x2 -0.0006

MSE: 0.0199118768693

Mdata3:

const 0.9989

x1 0.9979

x2 1.0008

x3 0.9988

x4 -0.0012

x5 1.9998

MSE: 0.250743148719

Mdata4:

const 0.0101

x1 4.668e-05

x2 0.0001

x3 3.952e-05

x4 0.0002

x5 -1.837e-06

MSE: 0.00418917439966

Higher level:

Data1:

A0+a1\*x+a2\*y+a3\*x^2+a4\*x\*y+a5\*y^2

coef std err t P>|t| [95.0% Conf. Int.]

const 1.0223 0.019 53.676 0.000 0.985 1.060

x1 0.9975 0.009 115.479 0.000 0.981 1.014

x2 0.9905 0.009 114.664 0.000 0.974 1.007

x3 -0.0126 0.008 -1.537 0.124 -0.029 0.003

x4 -0.0085 0.007 -1.156 0.248 -0.023 0.006

x5 -0.0064 0.008 -0.784 0.433 -0.023 0.010

data2:

coef std err t P>|t| [95.0% Conf. Int.]

------------------------------------------------------------------------------

const 0.0004 0.005 0.081 0.936 -0.010 0.011

x1 0.0646 0.002 26.927 0.000 0.060 0.069

x2 -0.0006 0.002 -0.253 0.800 -0.005 0.004

x3 2.058e-05 0.002 0.009 0.993 -0.004 0.004

x4 -0.0011 0.002 -0.527 0.598 -0.005 0.003

x5 0.0003 0.002 0.138 0.890 -0.004 0.005

data3:

a0+a1\*x1+a2\*x2+a3\*x3+a4\*x4+a5\*x5+a6\*x1^2+a7\*x2^2+a8\*x3^2+a9\*x4^2+a10\*x5^2

const 0.9965 0.004 261.147 0.000 0.989 1.004

x1 0.9980 0.001 813.860 0.000 0.996 1.000

x2 1.0008 0.001 816.581 0.000 0.998 1.003

x3 0.9988 0.001 815.442 0.000 0.996 1.001

x4 -0.0011 0.001 -0.880 0.379 -0.003 0.001

x5 1.9998 0.001 1630.942 0.000 1.997 2.002

x6 0.0014 0.001 1.329 0.184 -0.001 0.003

x7 -0.0013 0.001 -1.323 0.186 -0.003 0.001

x8 -0.0005 0.001 -0.508 0.611 -0.003 0.002

x9 -0.0003 0.001 -0.308 0.758 -0.002 0.002

x10 0.0009 0.001 0.878 0.380 -0.001 0.003

data4:

coef std err t P>|t| [95.0% Conf. Int.]

------------------------------------------------------------------------------

const 0.0440 0.000 91.799 0.000 0.043 0.045

x1 5.909e-05 0.000 0.384 0.701 -0.000 0.000

x2 0.0001 0.000 0.654 0.513 -0.000 0.000

x3 3.349e-05 0.000 0.218 0.828 -0.000 0.000

x4 0.0002 0.000 1.460 0.144 -7.69e-05 0.001

x5 -1.463e-05 0.000 -0.095 0.924 -0.000 0.000

x6 -0.0052 0.000 -40.108 0.000 -0.005 -0.005

x7 -0.0001 0.000 -1.115 0.265 -0.000 0.000

x8 -0.0050 0.000 -38.195 0.000 -0.005 -0.005

x9 -0.0049 0.000 -37.960 0.000 -0.005 -0.005

x10 -0.0051 0.000 -39.180 0.000 -0.005 -0.005

MSE:

Data1:

Train:

Row: 2450

MSE: 0.25800120516

Test:

Row: 50

MSE: 0.281907095552

Data2:

Train:

Row: 2450

MSE: 0.0200158719878

Test:

Row: 50

MSE: 0.0147231540775

Data3:

Train:

Row: 99900

MSE: 14.4838115942

Test:

Row: 100

MSE: 12.3854983595

Data4:

Train:

Row: 99900

MSE: 0.00395142847316

Test:

Row: 100

MSE: 0.00319633351941

Explicit solution

Data1:

[[ 0.99752589]

[ 0.99048461]]

mse: [[ 1.2504733]]

data2:

[[ 0.06458313]

[-0.00060792]]

mse: [[ 0.01991267]]

data3:

[[ 9.98888180e-01]

[ 1.00066063e+00]

[ 9.98744225e-01]

[ -1.59114109e-03]

[ 1.99987699e+00]]

mse: [[ 1.24861541]]

data4:

[[ 5.29559018e-05]

[ 1.10912497e-04]

[ 3.81903871e-05]

[ 2.38354477e-04]

[ -3.53383038e-06]]

mse: [[ 0.00429159]]

iterative solution:

a0+ a1\*x0+ a2\*x1 = y

Data1:

num\_iterations: 1000 learning\_rate: 0.001

[ 0.86136909] [ 0.93560181] [ 0.92899764]

mse [ 0.28736327]

learing rate = 0.0001

[0][0][0]

mse [ 3.99284066]

[ 0.18053813] [ 0.24179257] [ 0.24008582]

mse [ 2.49751499]

num\_iterations: 1000 learning\_rate: 1e-05

[ 0.01971988] [ 0.02730612] [ 0.02711337]

mse [ 3.80586907]

num\_iterations: 10000 learning\_rate: 1e-05

[ 0.18052345] [ 0.24176637] [ 0.2400598]

mse [ 2.49764809]

learning\_rate = 0.000001

mse [ 3.99284066]

[ 0.00198976] [ 0.00276481] [ 0.00274529]

mse [ 3.97370071]

data2:

learing rate = 0.0001

mse [ 0.02570149]

[ 0.18053813] [ 0.24179257] [ 0.24008582]

mse [ 0.17616175]

learning\_rate = 0.000001

mse [ 0.02570149]

[ 0.00198976] [ 0.00276481] [ 0.00274529]

mse [ 0.025232]

data3:

mse [ 12.93707986]

num\_iterations: 100 learning\_rate: 0.001

[ 0.1814961] [ 0.2842524] [ 0.28497466] [ 0.28405728] [-0.00059824] [ 0.00608746]

mse [ 10.12079213]

num\_iterations: 100 learning\_rate: 0.01

[ 0.86681712] [ 0.96624045] [ 0.96818929] [ 0.96485117] [-0.00147617] [ 0.06533818]

mse [ 6.52063721]

num\_iterations: 100 learning\_rate: 0.1

[ 0.99909956] [ 0.99955968] [ 1.00165288] [ 0.99814789] [-0.00136831] [ 0.66673759]

mse [ 3.21724785]

mse [ 12.93707986]

num\_iterations: 200 learning\_rate: 0.1

[ 0.99909956] [ 0.99955968] [ 1.00165288] [ 0.99814789] [-0.00136831] [ 0.66673759]

mse [ 3.21724785]

data4:

mse [ 0.00429172]

num\_iterations: 100 learning\_rate: 0.01

[ 0.00877825] [ 4.67960439e-05] [ 0.00010606] [ 3.78883215e-05] [ 0.00023086] [ 0.00022281]

mse [ 0.00419106]

d kernel

data1:

train MSE:

MES: -0.000592494783072

test MSE:

MES: 0.114285660424

Data2

train MSE:

MES: 0.000329163130249

test MSE:

MES: -0.0163264909216

Data3:

train MSE:

MES: -1.19652527498e-05

test MSE:

MES: -0.654729722302

Data4

train MSE:

MES: -2.46044821317e-05

test MSE:

MES: 0.22851579077