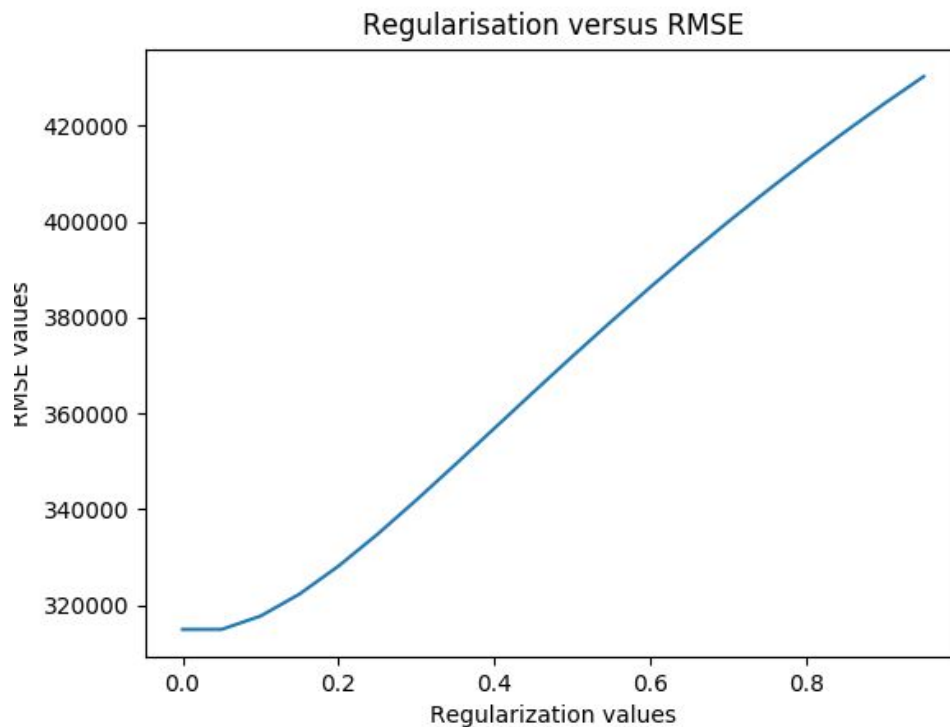


a) **Implementing Linear Regression - Comparison with various regularisation Values:**



Reg : value [weights]

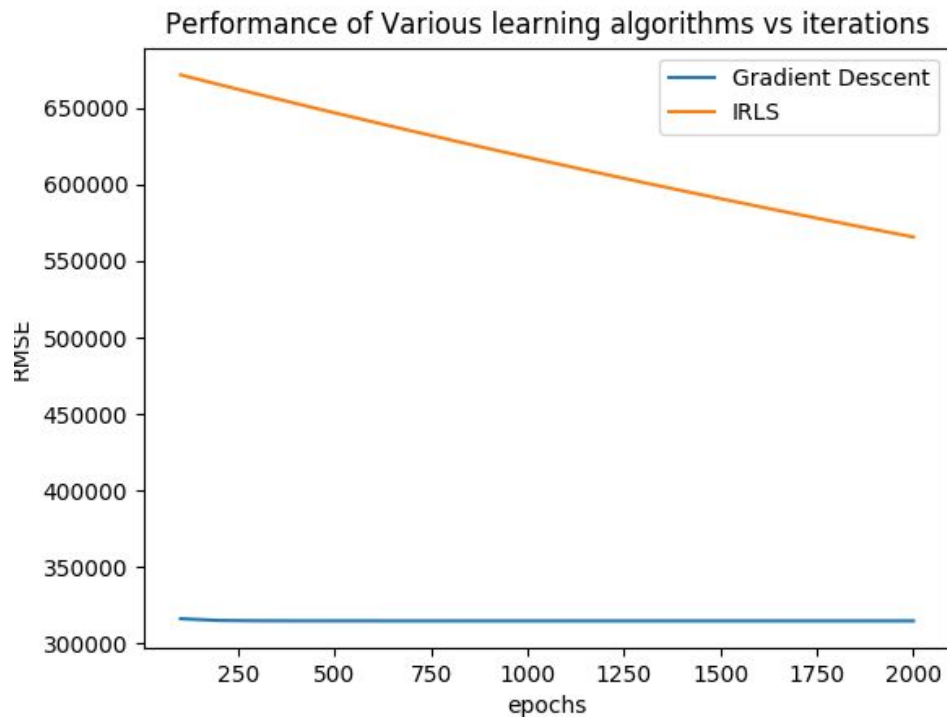
```

Reg : 0.000000 [ 533343.83233083  15751.22966211  17573.05273171
28727.47997384 279574.65204854]
Reg : 0.050000 [ 507946.50698174  17141.76064282  33688.8852681
43908.19529599 235178.49150521]
Reg : 0.100000 [ 484858.02939166  17789.42108241  40989.95265722
50116.65620645 206435.94528748]
Reg : 0.150000 [ 463777.24550507  18063.60128488  44356.96438964
52496.66249881 185616.64366849]
Reg : 0.200000 [ 444453.19360902  18123.74088232  45729.81345999
53025.63524345 169497.68628275]
Reg : 0.250000 [ 426675.06586466  18051.9422102    46014.81069953
52597.76035771 156466.12574571]
Reg : 0.300000 [ 410264.48640833  17895.45876912  45681.43362332
51661.3910745 145609.59620061]
Reg : 0.350000 [ 395069.50543024  17683.57915318  44990.66966646
50457.53181692 136364.60099114]
Reg : 0.400000 [ 380959.8802363   17435.40609646  44095.00700272
49121.986283
128359.49003895]

```

Reg : 0.450000 [367823.33264193 17163.85189687 43086.71811892
 47733.63140919 121336.4554655]
 Reg : 0.500000 [355562.55488712 16877.87327175 42023.0669553
 46339.10642912 115109.27854723]
 Reg : 0.550000 [344092.79505185 16583.79116404 40940.07876904
 44966.00677544 109539.1404035]
 Reg : 0.600000 [333339.89520604 16286.12226121 39860.587089
 43630.45143048 104519.73529515]
 Reg : 0.650000 [323238.6862594 15988.11541439 38798.99818075
 42341.46098422 99967.87503379]
 Reg : 0.700000 [313731.66607322 15692.11181324 37764.23680843
 41103.60702819 95817.26688704]
 Reg : 0.750000 [304767.90418157 15399.79401521 36761.62734139
 39918.66815763 92014.23955458]
 Reg : 0.800000 [296302.12905921 15112.36066396 35794.10455607
 38786.6685978 88514.75097749]
 Reg : 0.850000 [288293.9634006 14830.65161985 34863.01115071
 37706.54397862 85282.23480524]
 Reg : 0.900000 [280707.28013742 14555.23951636 33968.63924067
 36676.58149163 82286.00494187]
 Reg : 0.950000 [273509.65755136 14286.49484612 33110.56316079
 35694.67396739 79500.11060223]

b) Experimenting with optimization algorithms:



Gradient Descent with 0 epochs: [-0.46554665 1.26099385 -1.89703274 -0.90539347 -0.33812074]

IRLS with 0 epochs: [-0.30479653 0.55642769 0.29793506 0.94446445 -1.12172037]

Gradient Descent with 100 epochs: [533329.66594307 17224.09099569 39049.3027014 51250.47643929 247640.88073279]

IRLS with 100 epochs: [6134.09536258 181.9309245 201.66825485 331.07644875 3216.20871666]

Gradient Descent with 200 epochs: [533343.83195455 16114.01085671 22899.07857295 34672.54707524 271489.55358636]

IRLS with 200 epochs: [12197.00758951 359.28630485 401.7118506 656.92535607 6393.37795782]

Gradient Descent with 300 epochs: [533343.83233082 15843.52497487 18917.86190603 30254.31316148 277515.24765102]

IRLS with 300 epochs: [18191.61779841 535.91367728 599.14382352 980.68667492 9536.8112336]

Gradient Descent with 400 epochs: [533343.83233083 15774.71092937 17914.4766711 29116.89698078 279050.55602046]

IRLS with 400 epochs: [24117.14924826 712.53839732 794.46167174 1300.04015321 12642.62349689]

Gradient Descent with 500 epochs: [533343.83233083 15757.17708488 17659.48103224
28826.17905063
279441.89658632]

IRLS with 500 epochs: [29974.08080892 884.76214008 988.0911431 1613.90930089
15711.58101734]

Gradient Descent with 600 epochs: [533343.83233083 15752.70784313 17594.53047739
28752.01520876
279541.65611388]

IRLS with 600 epochs: [35761.43428761 1057.10681723 1177.93138546 1926.37687331
18747.33590513]

Gradient Descent with 700 epochs: [533343.83233083 15751.56859246 17577.97713655
28733.1059012
279567.08640719]

IRLS with 700 epochs: [41486.32179324 1224.11555637 1367.46285609 2233.25991781
21748.2628659]

Gradient Descent with 800 epochs: [533343.83233083 15751.27816755 17573.75747174
28728.28512927
279573.56930308]

IRLS with 800 epochs: [47143.3773726 1391.25732805 1552.88321224 2538.31185386
24711.7074193]

Gradient Descent with 900 epochs: [533343.83233083 15751.20413251 17572.68181075
28727.05619923
279575.2219244]

IRLS with 900 epochs: [52734.78617192 1558.15464303 1738.48915562 2841.22367178
27644.17082929]

Gradient Descent with 1000 epochs: [533343.83233083 15751.18525936 17572.40760237
28726.74291683
279575.64321377]

IRLS with 1000 epochs: [58262.1076116 1721.20441346 1921.15952889 3137.44077788
30541.64840144]

Gradient Descent with 1100 epochs: [533343.83233083 15751.18044806 17572.33769884
28726.66305204
279575.75061255]

IRLS with 1100 epochs: [63727.43294185 1881.56581898 2100.13636769 3431.98397025
33405.14311126]

Gradient Descent with 1200 epochs: [533343.83233083 15751.17922156 17572.31987913
28726.642693
279575.77799052]

IRLS with 1200 epochs: [69127.64021466 2041.55757033 2277.38404661 3723.20021456
36237.96855634]

Gradient Descent with 1300 epochs: [533343.83233083 15751.1789089
17572.31533641 28726.63750295
279575.78496988]

IRLS with 1300 epochs: [74467.20122616 2198.53438052 2452.70325712 4010.7706983
39036.25557734]

Gradient Descent with 1400 epochs: [533343.83233083 15751.17882919 17572.31417836
28726.63617987
279575.7867491]

IRLS with 1400 epochs: [79742.80885725 2356.29663037 2627.90946156 4294.74637466
41801.35443131]

Gradient Descent with 1500 epochs: [533343.83233083 15751.17880887 17572.31388315
28726.6358426
279575.78720266]

IRLS with 1500 epochs: [84961.25245473 2509.03773008 2799.33638728 4576.752115
44536.38797203]

Gradient Descent with 1600 epochs: [533343.83233083 15751.1788037
17572.31380789 28726.63575662
279575.78731828]

IRLS with 1600 epochs: [90119.87684499 2660.25668242 2969.7198856
4852.69667984
47240.10211904]

Gradient Descent with 1700 epochs: [533343.83233083 15751.17880237 17572.31378871
28726.6357347
279575.78734775]

IRLS with 1700 epochs: [95217.44905184 2811.50761216 3136.42215153 5129.43970736
49911.74374891]

Gradient Descent with 1800 epochs: [533343.83233083 15751.17880204 17572.31378382
28726.63572911
279575.78735527]

IRLS with 1800 epochs: [100256.46181607 2960.06266642 3304.16389708
5401.70761062
52553.51591807]

Gradient Descent with 1900 epochs: [533343.83233083 15751.17880195 17572.31378257
28726.63572769
279575.78735718]

IRLS with 1900 epochs: [105237.03671001 3108.34939952 3467.5681354
5667.35691839
55165.15262044]

Gradient Descent with 2000 epochs: [533343.83233083 15751.17880193 17572.31378225
28726.63572732
279575.78735767]

IRLS with 2000 epochs: [110160.44141912 3252.83980455 3629.89028149
5933.1959866
57746.07954814]

Gradient Descent with 2100 epochs: [533343.83233083 15751.17880192 17572.31378217
28726.63572723

279575.78735779]
IRLS with 2100 epochs: [115027.30523099 3396.41581408 3789.23250387
6194.4169504
60296.96040177]
Gradient Descent with 2200 epochs: [533343.83233083 15751.17880192 17572.31378215
28726.63572721
279575.78735783]
IRLS with 2200 epochs: [119840.2852429 3539.12140146 3947.96659678
6455.49297666
62818.75458919]
Gradient Descent with 2300 epochs: [533343.83233083 15751.17880192 17572.31378215
28726.6357272
279575.78735783]
IRLS with 2300 epochs: [124594.01478876 3681.05611033 4105.54679062
6710.15099667
65311.39622748]
Gradient Descent with 2400 epochs: [533343.83233083 15751.17880192 17572.31378215
28726.6357272
279575.78735784]
IRLS with 2400 epochs: [129296.39236624 3817.6301093 4259.53438802
6964.18667243
67775.74538621]
Gradient Descent with 2500 epochs: [533343.83233083 15751.17880192 17572.31378215
28726.6357272
279575.78735784]
IRLS with 2500 epochs: [133943.68799399 3956.73132307 4412.58502082
7213.9817922
70212.6510437]
Gradient Descent with 2600 epochs: [533343.83233083 15751.17880192 17572.31378215
28726.6357272
279575.78735784]
IRLS with 2600 epochs: [138536.62802452 4091.09596386 4564.47917364
7461.97584497
72619.80035568]
Gradient Descent with 2700 epochs: [533343.83233083 15751.17880192 17572.31378215
28726.6357272
279575.78735784]
IRLS with 2700 epochs: [143077.69932428 4226.0067546 4713.35303366
7706.18271066
75001.29309146]
Gradient Descent with 2800 epochs: [533343.83233083 15751.17880192 17572.31378215
28726.6357272
279575.78735784]

IRLS with 2800 epochs: [147566.59408527 4357.89601357 4863.13258123
7947.7335184
77353.37256398]

Gradient Descent with 2900 epochs: [533343.83233083 15751.17880192 17572.31378215
28726.6357272
279575.78735784]

IRLS with 2900 epochs: [152002.73598616 4488.9075345 5006.91252326
8186.98854392
79678.91917383]

Gradient Descent with 3000 epochs: [533343.83233083 15751.17880192 17572.31378215
28726.6357272
279575.78735784]

IRLS with 3000 epochs: [156389.16011372 4619.11298332 5152.0918922
8424.02753056
81978.0297827]

Gradient Descent with 3100 epochs: [533343.83233083 15751.17880192 17572.31378215
28726.6357272
279575.78735784]

IRLS with 3100 epochs: [160724.865657 4746.98501349 5295.22837028
8656.18288954
84251.45026181]

Gradient Descent with 3200 epochs: [533343.83233083 15751.17880192 17572.31378215
28726.6357272
279575.78735784]

IRLS with 3200 epochs: [165010.90314194 4872.08129227 5437.37476318
8887.66208229
86497.81738121]

Gradient Descent with 3300 epochs: [533343.83233083 15751.17880192 17572.31378215
28726.6357272
279575.78735784]

IRLS with 3300 epochs: [169246.56448339 4998.8202689 5574.95399113
9116.26689786
88718.54078257]

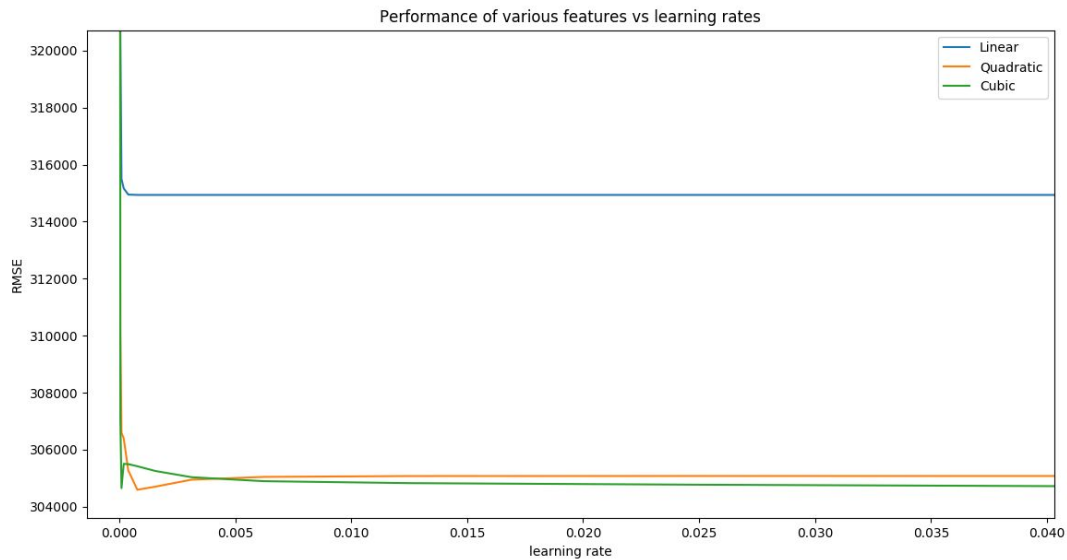
Gradient Descent with 3400 epochs: [533343.83233083 15751.17880192 17572.31378215
28726.6357272
279575.78735784]

IRLS with 3400 epochs: [173434.51594076 5123.18592943 5713.20590368
9341.16102845
90913.89688004]

Gradient Descent with 3500 epochs: [533343.83233083 15751.17880192 17572.31378215
28726.6357272
279575.78735784]

IRLS with 3500 epochs: [177573.83586455 5244.43179847 5850.26393779
9564.6807427
93082.54005843]
Gradient Descent with 3600 epochs: [533343.83233083 15751.17880192 17572.31378215
28726.6357272
279575.78735784]
IRLS with 3600 epochs: [181666.26183551 5363.79406335 5985.19027982
9784.96946607
95228.01275145]
Gradient Descent with 3700 epochs: [533343.83233083 15751.17880192 17572.31378215
28726.6357272
279575.78735784]
IRLS with 3700 epochs: [185709.86082162 5484.28918091 6118.80447604
10002.22294703
97346.75894189]
Gradient Descent with 3800 epochs: [533343.83233083 15751.17880192 17572.31378215
28726.6357272
279575.78735784]
IRLS with 3800 epochs: [189708.47206421 5602.39483774 6250.99349217
10218.23170864
99444.78445712]
Gradient Descent with 3900 epochs: [533343.83233083 15751.17880192 17572.31378215
28726.6357272
279575.78735784]
IRLS with 3900 epochs: [193662.43977657 5718.7048826 6381.40936927
10431.00498579
101515.44416778]

c) Experimenting with combination of features:



Linear with 0.050000 lr: [533343.83233083 15704.72684696 10273.9276614
16360.32829634
176366.00921185]

Quadratic with 0.050000 lr: [533343.83233083 19487.45067816 81738.790259
28922.47153083
-156226.29887069 -9293.46034034 -62638.96737521 -10575.91475782
337718.26119724]

Cubic with 0.050000 lr: [533343.83233083 34940.72734417 137030.21708477
89393.03390017
-169447.78154248 -56540.3490019 -170145.76334447 -123705.42923143
352088.8222581 37461.2679994 54202.3844379 76212.05986554
-1280.33871879]

Linear with 0.025000 lr: [533343.83233082 15704.74733153 10274.04880317
16360.45539186
176365.80465205]

Quadratic with 0.025000 lr: [533343.83233083 19487.51164161 81733.11052267
28922.63326721
-156226.05247832 -9293.50330237 -62633.34735009 -10575.98149284
337718.06906357]

Cubic with 0.025000 lr: [533343.83233083 34950.61354813 90467.53009127
86913.93786051
-157733.83477618 -56486.68911321 -85560.0451302 -119131.29986805
330765.81005495 37433.23894988 15136.96531162 73202.20830609
9032.97959276]

Linear with 0.012500 lr: [533343.83233082 15704.77467019 10274.21047876
16360.62501326
176365.53164695]

Quadratic with 0.012500 lr: [533343.83233082 19489.94558897 81506.34905278
28929.09042325
-156216.21430089 -9295.21854531 -62408.96988593 -10578.64579409
337710.39720826]

Cubic with 0.012500 lr: [533343.83233082 35097.98448108 66026.60620766
77596.28308944
-123543.40027629 -56764.67061009 -40080.19926916 -102511.08229279
270403.37074525 37677.54074615 -6295.68081492 62345.82947081
37814.97655505]

Linear with 0.006250 lr: [533343.83233079 15704.81312297 10274.43788109
16360.86359161
176365.14765583]

Quadratic with 0.006250 lr: [533343.83233082 19535.29123897 77285.7438222
29047.54220439
-156016.89066991 -9327.1261712 -58233.61240005 -10627.14116629
337552.3631977]

Cubic with 0.006250 lr: [533343.83233082 35138.81389131 53814.30195484
61681.3497259
-81386.45852702 -56707.00044849 -16199.26049294 -74024.04871653
197014.47183874 37675.14190344 -18043.70527387 43710.20880257
72326.66554481]

Linear with 0.003125 lr: [533343.83233073 15704.86709407 10274.75705591
16361.19845263
176364.60869798]

Quadratic with 0.003125 lr: [533343.83233082 19696.75360494 62743.74511977
29248.67190397
-153393.09756726 -9434.98526618 -43952.11423457 -10663.50171153
335186.60796483]

Cubic with 0.003125 lr: [533343.83233082 33395.46072692 47889.72173052
45179.56455994
-48169.83512749 -51784.79149173 -3875.76916716 -44309.75864625
140039.2192581 34044.85026959 -24493.63904602 24232.88508363
98720.69748479]

Linear with 0.001563 lr: [533343.83233057 15704.94314519 10275.20680779
16361.67030784
176363.84924818]

Quadratic with 0.001563 lr: [533343.83233081 19966.88749476 42686.1316543
27646.93099137
-132188.08663561 -9564.88180844 -25203.45794524 -9526.87429596
315388.58731926]

Cubic with 0.001563 lr: [533343.83233081 28878.14765422 43878.33807627
32864.42149033

-27139.75886661 -39284.36566585 2268.77090069 -21899.79700464
104775.92862357 24761.58201021 -26813.37528234 9495.11901581
114786.35356893]

Linear with 0.000781 lr: [533343.83233014 15705.05115736 10275.84557144
16362.34046345
176362.77063403]

Quadratic with 0.000781 lr: [533343.83233079 20276.95411205 26014.05409151
22588.209745

-79304.36842965 -9625.1021572 -11522.51356134 -6237.77128724
265771.65800415]

Cubic with 0.000781 lr: [5.33343832e+05 2.37358118e+04 3.65912212e+04
2.52964717e+04

-1.41867438e+04 -2.49568172e+04 4.89949621e+03 -7.88460712e+03
8.53440297e+04 1.40755295e+04 -2.26502997e+04 2.39547195e+02
1.22756155e+05]

Linear with 0.000391 lr: [533343.74553397 15732.8453924 10440.23711334
16534.78117363
176085.20462482]

Quadratic with 0.000391 lr: [533343.74553412 20254.00415295 15390.22287256
17061.89966382

-17320.8368162 -9331.09782124 -4323.30862035 -2863.22551017
207394.71801235]

Cubic with 0.000391 lr: [5.33343746e+05 1.97678534e+04 2.61382846e+04
2.04363274e+04

-1.70588944e+03 -1.39697321e+04 5.43748681e+03 -3.62670046e+02
7.57275655e+04 5.90916752e+03 -1.41448686e+04 -4.37020478e+03
1.21971632e+05]

Linear with 0.000195 lr: [533128.34683047 16206.76711568 13274.07483011
19492.92518865
171313.0208711]

Quadratic with 0.000195 lr: [533128.34600607 19008.248739449518.25487824
14842.83237856

30607.62233899 -7855.63401641 -977.74278068 -2004.04728327
161649.61185857]

Cubic with 0.000195 lr: [533128.3467759 17059.40110975 16936.33632834
16615.65620075

15448.0383066 -7118.06716114 4875.28596845 2734.0175784
71858.71225475 1033.23257639 -7041.2837401 -5593.21206705
111674.88715578]

Linear with 0.000098 lr: [522619.27515004 17638.33801275 23092.46992076
29472.71104913

154887.16267232]
Quadratic with 0.000098 lr: [522619.27250299 16762.537892027646.15110867
16343.04590334
58798.23562143 -5114.50545307 1717.68396594 -1839.32310437
130812.28869441]
Cubic with 0.000098 lr: [522619.28138915 14910.52035222 11044.69349135
15515.98679028
32753.20089792 -3184.65695733 4166.57021731 3702.72680355
70288.10985879 -1158.26466405 -2966.87760337 -6510.16392416
97544.32849442]
Linear with 0.000049 lr: [457706.68007206 18305.76976109 35442.37648757
41212.65253033
129958.03868155]
Quadratic with 0.000049 lr: [457706.84037443 14569.74152943 11370.67441742
20966.40413481
67998.73432334 -1606.58155828 7764.80406561 2746.43814906
106214.15006213]
Cubic with 0.000049 lr: [4.57706699e+05 1.28419074e+04 9.06136711e+03
1.78860624e+04
4.41580602e+04 -7.52007162e+02 4.92586163e+03 5.05511364e+03
6.76398654e+04 -1.37435028e+03 3.02834805e+02 -7.34756131e+03
8.36231183e+04]
Linear with 0.000024 lr: [332489.87457204 15848.32953739 38486.07453613
42784.26645351
99003.97033696]
Quadratic with 0.000024 lr: [332489.23337397 12296.8476269 17979.59027566
25309.44660313
63435.56788359 1291.17587279 15664.87875383 9894.25112225
83022.14757059]
Cubic with 0.000024 lr: [332489.48467125 10734.91610072 11639.41791242
20852.39601283
46746.4720033 1032.08490649 9045.90693985 8337.70598071
60720.00571155 -398.3886872 5789.01905903 -4928.59959811
68769.01836748]
Linear with 0.000012 lr: [206042.30388582 11163.81546697 30364.73748705
33089.40754088
65841.08547376]
Quadratic with 0.000012 lr: [206042.88834504 9282.5762498 19711.43909486
23929.58680507
49951.41272607 2335.21554276 18234.29214214 12703.55542478
59681.14515824]
Cubic with 0.000012 lr: [206043.87538482 8293.56887669 14483.02913038
20501.48024226

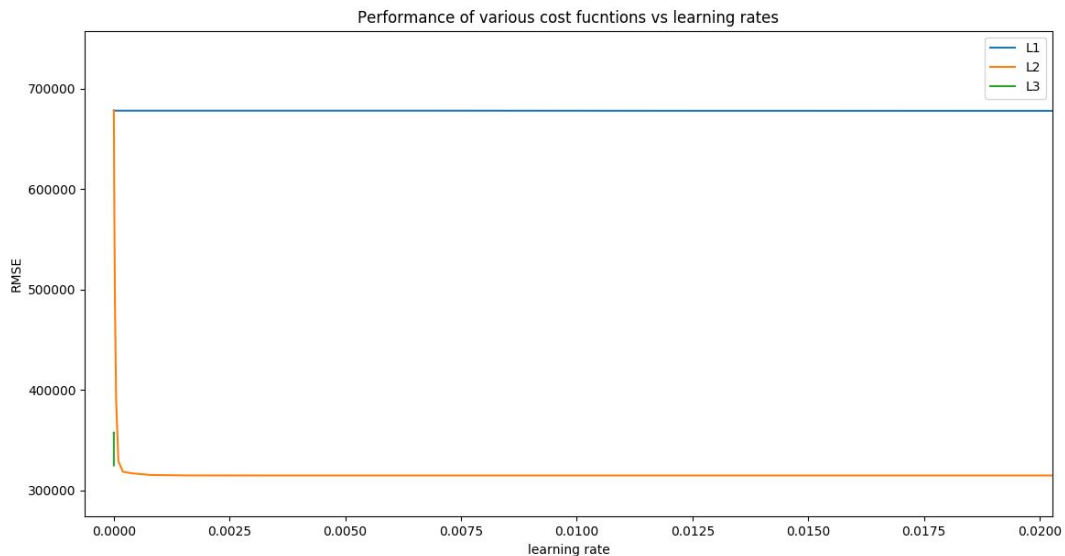
40917.44832821 1904.04459285 12892.45236846 10556.14423627
 48776.74151124 522.4313254 10577.8440597 -1155.95072611
 52083.69672785]
 Linear with 0.000006 lr: [115534.305666056759.53610433 19420.89383197
 20973.62689745
 38891.4589449]
 Quadratic with 0.000006 lr: [115534.65245066 6054.983535 15449.9011534
 17544.76184186
 33308.79257271 1992.1612945 14563.36067786 10406.72886822
 38073.25244144]
 Cubic with 0.000006 lr: [115535.73884547 5626.12256725 12973.97110941
 15931.07111628
 29644.61532133 1766.4688122 12057.29558288 9269.64594101
 33854.99583752 756.62641709 10540.22429527 781.32323886
 34941.18466896]
 Linear with 0.000003 lr: [61289.13376129 3738.12091095 11034.33365968
 11864.96529327
 21275.77046401]
 Quadratic with 0.000003 lr: [61288.74924751 3522.22623296 9811.11206004
 10806.95148215
 19599.16879437 1291.70719375 9314.87774712 6713.9481776
 21936.70873733]
 Cubic with 0.000003 lr: [61288.35494624 3377.61767346 8950.52803942 10243.9323241
 18401.90336885 1210.98924602 8444.95916511 6301.56283957
 20587.67060691 588.96239607 7546.06407081 1038.68916817
 20875.57996492]
 Linear with 0.000002 lr: [31580.24771061 1968.69802757 5888.60654573 6319.21497863
 11146.45609217]
 Quadratic with 0.000002 lr: [31578.57607208 1908.01304613 5546.71653202
 6023.44568924
 10686.69541613 734.00276689 5285.79329606 3821.96481357
 11840.04241929]
 Cubic with 0.000002 lr: [31579.09800366 1866.57208427 5292.43319675 5857.57444494
 10339.32214677 709.28314959 5028.33955658 3698.07790386
 11454.1848432 363.6063556 4533.33720079 743.8406149
 11514.63389884]
 Linear with 0.000001 lr: [16030.64089686 1011.52288667 3042.6951808
 3261.13736756
 5705.66316803]
 Quadratic with 0.000001 lr: [16031.75672642 993.9155204 2952.14286564
 3183.92379794
 5584.85124678 392.41771996 2815.51172929 2039.95680723
 6159.57267304]

Cubic with 0.000001 lr: [16029.64456965 983.7570844 2884.29213255 3138.82156253
 5492.31647049 384.72395844 2747.33284076 2007.92401945
 6056.66816489 201.51225503 2486.90326125 436.9014136
 6063.51419756]
 Linear with 0.000000 lr: [8075.73651284 511.17515146 1545.90396298 1656.15821567
 2887.92695104]
 Quadratic with 0.000000 lr: [8077.45990169 507.56154838 1524.00592535 1638.54477297
 2858.21574286
 202.88469238 1453.64555819 1053.08468409 3142.25566378]
 Cubic with 0.000000 lr: [8076.05728149 504.78711943 1505.19088422 1624.87265572
 2832.16649772
 202.37493957 1435.45067105 1043.97566392 3115.97406295 105.05173106
 1303.39801556 235.7365542 3110.66952051]
 Linear with 0.000000 lr: [4053.17367746 257.86590704 778.22462803 834.16513202
 1452.38246605]
 Quadratic with 0.000000 lr: [4055.16936413 254.63751951 774.9954628 829.54639478
 1445.69886408
 102.78120773 739.53583524 536.17076198 1585.97234505]
 Cubic with 0.000000 lr: [4053.52725246 254.94388636 767.68860395 827.80688423
 1439.09059461
 101.57349294 735.45720668 533.98113762 1579.00696428 54.30720298
 667.76867168 121.69472113 1576.19129389]
 Linear with 0.000000 lr: [2031.03143363 130.0184235 391.74094143 420.05908968
 729.03516098]
 Quadratic with 0.000000 lr: [2029.90315844 129.21069045 389.97285277 420.21776591
 727.91533849
 51.45129575 372.98664568 270.14143942 797.10466948]
 Cubic with 0.000000 lr: [2030.41169279 128.43402601 389.35548368 419.83525048
 724.50491139
 51.60014453 371.28922022 270.34582349 798.13247696 28.20077894
 337.6433782 63.70596459 793.03827638]
 Linear with 0.000000 lr: [1016.25843993 65.6621027 196.81823174 209.85172434
 364.89537785]
 Quadratic with 0.000000 lr: [1015.83355826 64.52580508 196.74633257
 209.72867746 366.64550009
 25.1859764 187.51095714 134.39827084 400.72758567]
 Cubic with 0.000000 lr: [1015.41357452 66.48772744 194.90216333 209.29134225
 362.40515122
 26.3390658 188.30253081 133.66743881 399.22150137 13.60439885
 168.96929904 31.46722335 395.17441047]
 Linear with 0.000000 lr: [508.89583227 32.13937788 97.06466055 106.33166345
 181.31811564]

Quadratic with 0.000000 lr: [507.08151135 30.99499306 97.92536424 105.15063694
 181.81069027
 13.00677607 93.09414857 68.61050114 199.94841387]
 Cubic with 0.000000 lr: [507.70518317 30.66437222 98.21103834 104.97489795
 182.10914666
 12.04987888 95.30976092 67.75941468 200.74596588 5.96578182
 87.14649177 17.31642768 199.71911782]
 Linear with 0.000000 lr: [254.8309238 17.60886358 50.17237891 51.09471558
 92.71208943]
 Quadratic with 0.000000 lr: [253.75572673 13.93721636 50.13379826 53.17311301
 90.57770199
 4.36207902 48.08173461 34.58322248 100.4915664]
 Cubic with 0.000000 lr: [256.2950996 13.3409949 49.63711987 54.60672314
 91.21584141
 7.76667772 47.00856787 33.62895818 99.87962012 3.3279987
 42.59060975 9.15733697 99.82682286]
 Linear with 0.000000 lr: [126.92017925 6.77911445 24.14574305 27.20967846
 46.76681753]
 Quadratic with 0.000000 lr: [126.96162912 8.43337884 25.07093967 25.80822065
 47.2332349
 5.50968534 25.42489852 17.85791523 48.82497941]
 Cubic with 0.000000 lr: [127.8469649 8.50770963 23.88261133 28.01756808
 43.75229427
 2.29588141 22.20121827 16.05297933 51.04585763 2.08885033
 21.49921863 4.923308 48.4677674]
 Linear with 0.000000 lr: [64.56115728 3.6131919 13.48781282 13.32440621
 21.91472889]
 Quadratic with 0.000000 lr: [63.09648863 2.58418246 12.43853381 14.25400477
 23.11881588
 1.47600841 11.60814702 8.86216495 24.71711073]
 Cubic with 0.000000 lr: [65.218422 4.07687057 11.5307805 12.92814437 21.36701838
 2.51073876 11.11552656 7.11578519 24.24172052 0.21979805
 11.30431612 2.95694735 25.32155979]
 Linear with 0.000000 lr: [29.94321103 0.42689506 6.58141826 7.51868112 12.23440489]
 Quadratic with 0.000000 lr: [31.76080889 3.24069707 6.89429904 6.07083785
 10.41075664
 0.53620008 6.29973745 5.49548274 13.61824222]
 Cubic with 0.000000 lr: [30.93433979 2.53173064 7.22861957 8.6424399 12.35001378
 0.12654896 4.43124061 4.68897246 12.07892419 2.29793023
 5.57963239 1.03903322 12.8215893]
 Linear with 0.000000 lr: [14.96478662 1.62331117 3.31211734 2.80616957 6.23675465]
 Quadratic with 0.000000 lr: [17.64653591 0.14942878 4.51156249 3.79083407
 6.27262705

1.5845356 2.58827964 0.14346751 4.87063669]
Cubic with 0.000000 lr: [14.70445616 0.99044581 2.37039098 3.32686956 6.85404818
-1.54040741 0.68695234 2.21002325 7.80434217 0.14791398
2.49118418 -0.79111453 8.01492769]
Linear with 0.000000 lr: [6.2504058 0.57411761 0.31830447 1.10783469 2.12267413]
Quadratic with 0.000000 lr: [9.00929277 1.23615113 2.15318681 1.70268363 2.68470756
1.43949578
1.75320565 0.54814545 2.63372131]
Cubic with 0.000000 lr: [6.96794577 -0.85030084 2.68488659 2.14495323 4.15839027
0.93189484
0.59204183 2.76397948 5.21367881 -0.93203226 2.08761539 -0.62139412
2.76393664]
Linear with 0.000000 lr: [2.02055644 -1.73090227 1.7612244 -0.1536332 0.91679824]
Quadratic with 0.000000 lr: [3.96424511 0.56877524 0.64585627 1.57167063 0.0200805
0.27749529
-0.55394439 0.5727657 0.56764618]
Cubic with 0.000000 lr: [5.11396101 -0.19537295 0.06253896 0.2034846 1.29130821
1.53085041
-0.61730127 1.45869543 0.88887689 -0.28013683 0.88305722 1.11505378
-0.10925229]
Linear with 0.000000 lr: [1.59179057 0.58097857 -0.54031567 -1.04797192 0.61094392]
Quadratic with 0.000000 lr: [2.07697724 0.12727752 0.14603998 0.09040222 0.56934426
-1.16157401
0.66426661 -0.05075745 1.189646]
Cubic with 0.000000 lr: [1.75193862 -0.78439947 1.79203898 0.91719477 0.47611905
1.02328042
0.70772452 0.24350624 1.50520345 -0.45478551 1.50785723 1.01758081
-0.57337909]

d) Experimenting with cost functions:



L1 with 0.050000000 lr: [5.00772894e+02 -3.76153830e-02 -4.02464424e-01
-9.42894672e-01
7.76900715e-01]

L2 with 0.050000000 lr: [533343.83233083 15751.22966197 17573.05272968
28727.47997152
279574.65205166]

L3 with 0.050000000 lr: [nan nan nan nan nan]

L1 with 0.025000000 lr: [2.50367262e+02 -9.23164139e-02 -6.42929713e-02
4.03475700e-01
1.02901465e+00]

L2 with 0.025000000 lr: [533343.83233083 15751.25168289 17573.37267348
28727.84550297
279574.16049763]

L3 with 0.025000000 lr: [nan nan nan nan nan]

L1 with 0.012500000 lr: [126.08802707 -0.48338273 1.03010757 0.20685654
0.1525337]

L2 with 0.012500000 lr: [533343.83233082 15751.28281665 17573.82501981
28728.36229986
279573.46552535]

L3 with 0.012500000 lr: [nan nan nan nan nan]

L1 with 0.006250000 lr: [-0.48834305 -1.18363339 1.93643362 1.30143181 0.47390788]

L2 with 0.006250000 lr: [533343.83233082 15751.3267469 17574.46328991
28729.09150584
279572.48490864]

L3 with 0.006250000 lr: [nan nan nan nan nan]

L1 with 0.003125000 lr: [1.0928313 0.23837084 -0.70373092 -0.27858486 0.61323499]
 L2 with 0.003125000 lr: [533343.83233082 15752.32616313 17588.98458589
 28745.6801726
 279550.17593932]
 L3 with 0.003125000 lr: [nan nan nan nan nan]
 L1 with 0.001562500 lr: [-0.51321861 -0.70914156 -1.09020365 0.48028282 -0.76052439]
 L2 with 0.001562500 lr: [533343.83233081 15831.2424347 18738.62675887
 30051.4892815
 277789.25265229]
 L3 with 0.001562500 lr: [nan nan nan nan nan]
 L1 with 0.000781250 lr: [1.4375568 0.78482904 0.66960131 -0.69529598 -0.40209637]
 L2 with 0.000781250 lr: [533343.74606309 16422.87617662 27498.5966145
 39591.07132659
 264648.22266691]
 L3 with 0.000781250 lr: [nan nan nan nan nan]
 L1 with 0.000390625 lr: [1.94755364 -0.14309883 -1.48801722 -1.26533048 1.38213995]
 L2 with 0.000390625 lr: [533128.67520301 17903.60937443 46725.85222584
 58397.55839253
 235510.66670813]
 L3 with 0.000390625 lr: [nan nan nan nan nan]
 L1 with 0.000195313 lr: [-0.29356833 1.04319775 0.89497276 0.79062402 0.12828333]
 L2 with 0.000195313 lr: [522623.37751451 20832.37539532 61668.85075417
 70164.16770181
 194522.61634655]
 L3 with 0.000195313 lr: [nan nan nan nan nan]
 L1 with 0.000097656 lr: [-0.62999465 0.58027484 -1.51696621 1.23743373 -0.46147205]
 L2 with 0.000097656 lr: [457714.15566945 22275.30869997 57175.77555801
 62099.60455488
 141698.35750086]
 L3 with 0.000097656 lr: [nan nan nan nan nan]
 L1 with 0.000048828 lr: [0.52071163 -2.08753887 0.16366927 -0.62569395 -0.61093408]
 L2 with 0.000048828 lr: [332494.93619054 18430.22387039 40453.49201127
 43014.94597295
 89692.3546379]
 L3 with 0.000048828 lr: [nan nan nan nan nan]
 L1 with 0.000024414 lr: [-0.30987407 -1.8050194 0.83050996 0.81251851 0.39299442]
 L2 with 0.000024414 lr: [206045.2259525 12232.60113122 24306.78039495
 25590.52840166
 51180.77477986]
 L3 with 0.000024414 lr: [nan nan nan nan nan]
 L1 with 0.000012207 lr: [-1.02545895 1.93543363 -0.30177718 -1.6068641 -0.35043697]
 L2 with 0.000012207 lr: [115534.939106117097.88997879 13356.54528964
 13996.12700801

27441.90979531]
 L3 with 0.000012207 lr: [nan nan nan nan nan]
 L1 with 0.000006104 lr: [2.40333681 1.47534707 0.32072362 -0.6503373 0.08565748]
 L2 with 0.000006104 lr: [61289.28868111 3831.01269098 7005.04396452 7324.07058144
 14222.38474462]
 L3 with 0.000006104 lr: [nan nan nan nan nan]
 L1 with 0.000003052 lr: [-1.22623876 1.96103242 -0.49166565 -1.33878344 1.26476595]
 L2 with 0.000003052 lr: [31579.43668288 1993.66209989 3588.13267094 3746.20230055
 7244.26776331]
 L3 with 0.000003052 lr: [nan nan nan nan nan]
 L1 with 0.000001526 lr: [1.35074525 1.10224656 -0.78337045 0.39145831 -0.13553987]
 L2 with 0.000001526 lr: [16030.04678806 1014.82501274 1815.32063895 1894.85892385
 3655.56686574]
 L3 with 0.000001526 lr: [nan nan nan nan nan]
 L1 with 0.000000763 lr: [-1.00270038 0.98393017 1.1491227 0.25665337 -0.2027259]
 L2 with 0.000000763 lr: [8076.29252259 513.75649949 914.06488606 953.48930281
 1836.68961935]
 L3 with 0.000000763 lr: [nan nan nan nan nan]
 L1 with 0.000000381 lr: [-0.86939671 0.89669616 -0.3938091 -2.25030634 -0.10282155]
 L2 with 0.000000381 lr: [4052.61752774 258.96119453 456.83458141 477.31090325
 922.05025797]
 L3 with 0.000000381 lr: [588694.36497321 13292.58953617 -9977.90324859
 -2819.81893493
 492015.28823887]
 L1 with 0.000000191 lr: [-1.74270772 0.0908524 0.51554541 -0.3579084 -1.3808774]
 L2 with 0.000000191 lr: [2030.84105883 128.70286341 227.7353797 241.23414655
 460.09763535]
 L3 with 0.000000191 lr: [588694.36574928 13292.59036547 -9977.89368153
 -2819.80396571
 492015.27393694]
 L1 with 0.000000095 lr: [-1.0870523 -0.17052326 -0.54365578 -0.56401188 0.50206735]
 L2 with 0.000000095 lr: [1017.05238582 64.23802762 114.63794503 119.96218162
 230.05683417]
 L3 with 0.000000095 lr: [588694.36649536 13292.59116272 -9977.88448427
 -2819.78957497
 492015.26018775]
 L1 with 0.000000048 lr: [-2.48878956 -1.29487492 0.79794558 -0.26741846 -0.42138676]
 L2 with 0.000000048 lr: [509.5377812 32.27640083 56.0031056 58.21807472
 114.63918839]
 L3 with 0.000000048 lr: [588694.36719683 13292.59191229 -9977.87583697
 -2819.77604467
 492015.24726068]
 L1 with 0.000000024 lr: [-0.26725171 -1.68096529 -0.05020445 -0.09666805 0.17101973]

L2 with 0.000000024 lr: [251.74353524 15.11288478 28.09095148 29.18564154
 57.86526147]
 L3 with 0.000000024 lr: [588694.36888801 13292.59371945 -9977.8549892
 -2819.74342422
 492015.21609461]
 L1 with 0.000000012 lr: [0.56800631 0.3481616 -0.21848516 -0.8746757 -0.59163043]
 L2 with 0.000000012 lr: [128.45115764 6.91183891 13.04924675 16.08832939
 27.26069054]
 L3 with 0.000000012 lr: [588694.37096105 13292.59593464 -9977.82943455
 -2819.70343848
 492015.17789179]
 L1 with 0.000000006 lr: [0.93339122 -0.07449022 0.17224337 -1.62355111 1.37609362]
 L2 with 0.000000006 lr: [62.97414179 5.51989928 8.09295274 6.74204473 13.51898826]
 L3 with 0.000000006 lr: [588694.37628876 13292.60162761 -9977.76376037
 -2819.6006751
 492015.07971115]
 L1 with 0.000000003 lr: [-0.23103875 -2.18284297 1.26084651 1.78469667 -0.46096526]
 L2 with 0.000000003 lr: [31.39970813 2.19342217 4.47671446 4.40367704 7.2987733]
 L3 with 0.000000003 lr: [588699.36057631 13297.92286143 -9916.46156741
 -2723.43075573
 491923.28207323]
 L1 with 0.000000001 lr: [0.71861559 -1.08242132 1.62418055 -0.04813939 -0.16571228]
 L2 with 0.000000001 lr: [15.48079636 1.22200716 2.25926963 1.66021702 3.16137477]
 L3 with 0.000000001 lr: [588917.79761814 13535.01540793 -7160.47071351
 1583.26457716
 487816.95444418]
 L1 with 0.000000001 lr: [-0.83572726 -0.91448461 -0.43374861 0.39231078 2.22564681]
 L2 with 0.000000001 lr: [5.52583826 0.66740514 0.43150634 0.616347 1.93241084]
 L3 with 0.000000001 lr: [590023.07399837 14856.19675926 10406.11467299
 24269.65848012
 464527.94589066]
 L1 with 0.000000000 lr: [-0.74584501 -0.39587048 1.38367336 0.7175465 0.28912367]
 L2 with 0.000000000 lr: [3.01704458 -1.0416436 0.27071417 0.37852104 1.17141721]
 L3 with 0.000000000 lr: [589257.20211078 17273.28444279 48005.67307387
 62666.11864207
 421017.95695065]
 L1 with 0.000000000 lr: [-0.5333564 0.95614595 -0.9919923 -0.5924857 1.68499797]
 L2 with 0.000000000 lr: [3.27344837 0.0396648 0.70580655 2.2999844 2.52724385]
 L3 with 0.000000000 lr: [559987.56576122 21965.46741108 84260.4739744
 100096.69822693
 370500.25116818]
 L1 with 0.000000000 lr: [0.27011357 -0.19847167 -0.74821395 1.25502542 0.51013899]
 L2 with 0.000000000 lr: [-0.17892635 -0.26800095 0.95218528 0.94023673 0.80631037]

L3 with 0.000000000 lr: [458712.43491024 27819.24143358 89130.14476566
107024.34749215
296243.03933656]