Lab Assignment 3

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```
setwd("~/Desktop/Everything Starts With Data/Lab Assignment 3")
library(quantreg)
```

```
## Loading required package: SparseM
```

```
##
## Attaching package: 'SparseM'
```

```
## The following object is masked from 'package:base':
##
##     backsolve
```

```
library(e1071)
library(boot)
```

Problem 1

a)

The purpose of MCMC is to sample points from distribution $p(\cdot)$ that is difficult to sample from directly.

b)

Metropolis Algorithm starts with an initial value θ_0 and $q(\cdot|\cdot)$ need to be symmetric.

Metropolis Hastings Algorithm generalizes from the Metropolis Algorithm and $q(\cdot|\cdot)$ does not to have symmetric.

c)

The purpose of Ridge Regression is to minimize SSE subject to $\lambda \sum \beta_j^2 \leq s$

The purpose of Lasso Regression is to minimize SSE subject to $\lambda \sum |\beta_j| \leq s$

d)

IIA is the ratio of the probabilities of choosing two alternatives is independent of the presence or attributes of any other alternative.

Problem 2

```
gas = read.csv("gas_mileage.csv")
```

a)

```r
qrfit1 = rq(Mpg ~ ., tau = seq(0.05, 0.95, by=0.05), data = gas)
```

```
## Warning in rq.fit.br(x, y, tau = tau, ...): Solution may be nonunique
```

```r
sumqr = summary(qrfit1)
```

```
## Warning in rq.fit.br(x, y, tau = tau, ci = TRUE, ...): Solution may be
## nonunique

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## nonunique
```

```r
sumqr
```

```
##
## Call: rq(formula = Mpg ~ ., tau = seq(0.05, 0.95, by = 0.05), data = gas)
##
## tau: [1] 0.05
##
## Coefficients:
##                  coefficients   lower bd       upper bd
## (Intercept)       7.505845e+01 -1.797693e+308  1.797693e+308
## Displacement     -3.701000e-02 -1.797693e+308  1.797693e+308
## Hpower           -1.893800e-01 -1.797693e+308  1.797693e+308
## Torque            1.094900e-01 -1.797693e+308  1.797693e+308
## Comp_ratio       -3.509360e+00 -1.797693e+308  1.797693e+308
## Rear_axle_ratio   3.866260e+00 -1.797693e+308  1.797693e+308
## Carb_barrels      2.145330e+00 -1.797693e+308  1.797693e+308
## No._speeds       -2.299040e+00 -1.797693e+308  1.797693e+308
## Length            1.753600e-01 -1.797693e+308  1.797693e+308
## Width            -6.623400e-01 -1.797693e+308  1.797693e+308
## Weight           -3.030000e-03 -1.797693e+308  1.797693e+308
## Trans._type      -9.004500e-01  -1.792682e+01  1.797693e+308
```

```
##
## Call: rq(formula = Mpg ~ ., tau = seq(0.05, 0.95, by = 0.05), data = gas)
##
## tau: [1] 0.1
##
## Coefficients:
##                 coefficients   lower bd       upper bd
## (Intercept)       7.505845e+01  -2.640074e+02   1.965771e+02
## Displacement     -3.701000e-02  -3.574400e-01   6.540000e-02
## Hpower           -1.893800e-01  -7.592400e-01   1.053380e+00
## Torque            1.094900e-01  -3.856000e-01   8.116000e-01
## Comp_ratio       -3.509360e+00  -1.141334e+01   7.802265e+01
## Rear_axle_ratio   3.866260e+00  -1.949856e+01   3.144942e+01
## Carb_barrels      2.145330e+00  -1.083878e+01   1.214711e+01
## No._speeds       -2.299040e+00  -9.998130e+00   1.812914e+01
## Length            1.753600e-01  -2.232600e-01  1.797693e+308
## Width            -6.623400e-01 -1.797693e+308   1.918620e+00
## Weight           -3.030000e-03  -1.060100e-01   1.284000e-02
## Trans._type      -9.004500e-01  -1.561480e+00  1.797693e+308
##
## Call: rq(formula = Mpg ~ ., tau = seq(0.05, 0.95, by = 0.05), data = gas)
##
## tau: [1] 0.15
##
## Coefficients:
##                 coefficients   lower bd       upper bd
## (Intercept)       7.505845e+01  -9.002075e+01   1.453873e+02
## Displacement     -3.701000e-02  -2.327100e-01   2.910000e-02
## Hpower           -1.893800e-01  -6.259600e-01   6.757800e-01
## Torque            1.094900e-01  -2.939300e-01   5.021700e-01
## Comp_ratio       -3.509360e+00  -6.623030e+00   2.989379e+01
## Rear_axle_ratio   3.866260e+00  -1.374687e+01   1.842395e+01
## Carb_barrels      2.145330e+00  -3.081880e+00   6.189830e+00
## No._speeds       -2.299040e+00  -9.698530e+00   1.010556e+01
## Length            1.753600e-01  -8.571000e-02   2.162340e+00
## Width            -6.623400e-01  -3.833210e+00   4.010500e-01
## Weight           -3.030000e-03  -1.328000e-02   1.131000e-02
## Trans._type      -9.004500e-01  -1.446450e+00  1.797693e+308
##
## Call: rq(formula = Mpg ~ ., tau = seq(0.05, 0.95, by = 0.05), data = gas)
##
## tau: [1] 0.2
##
## Coefficients:
##                 coefficients   lower bd       upper bd
## (Intercept)       6.259344e+01  -8.228754e+01   1.409044e+02
## Displacement     -1.956000e-02  -2.040000e-01   3.166000e-02
## Hpower           -1.639200e-01  -6.078400e-01   4.992700e-01
## Torque            8.250000e-02  -3.315400e-01   4.444400e-01
## Comp_ratio       -2.796880e+00  -6.437820e+00   1.030132e+01
## Rear_axle_ratio   2.859870e+00  -4.345210e+00   1.796188e+01
## Carb_barrels      1.786780e+00  -1.398360e+00   3.303940e+00
## No._speeds       -1.428330e+00  -9.994610e+00   1.355025e+01
## Length            1.922900e-01  -1.138700e-01   1.237590e+00
```

```
## Width            -5.698600e-01  -3.078290e+00   5.256000e-02
## Weight           -4.420000e-03  -1.309000e-02   1.036000e-02
## Trans._type      -4.470000e-01  -7.606060e+00  1.797693e+308
##
## Call: rq(formula = Mpg ~ ., tau = seq(0.05, 0.95, by = 0.05), data = gas)
##
## tau: [1] 0.25
##
## Coefficients:
##                 coefficients   lower bd       upper bd
## (Intercept)       5.939339e+01  -8.167520e+01   1.244924e+02
## Displacement     -1.917000e-02  -2.322600e-01   2.464000e-02
## Hpower           -1.745200e-01  -5.456900e-01   3.766700e-01
## Torque            8.982000e-02  -3.224100e-01   4.848900e-01
## Comp_ratio       -2.721790e+00  -6.584030e+00   1.024147e+01
## Rear_axle_ratio   2.507430e+00  -6.154160e+00   1.816992e+01
## Carb_barrels      1.825000e+00  -1.590480e+00   3.191410e+00
## No._speeds       -9.305200e-01  -1.021943e+01   1.580215e+01
## Length            1.858100e-01  -1.563300e-01   4.075000e-01
## Width            -5.308900e-01  -2.755050e+00   2.577000e-02
## Weight           -4.380000e-03  -1.345000e-02   9.000000e-03
## Trans._type      -4.767800e-01  -7.956070e+00  1.797693e+308
##
## Call: rq(formula = Mpg ~ ., tau = seq(0.05, 0.95, by = 0.05), data = gas)
##
## tau: [1] 0.3
##
## Coefficients:
##                 coefficients lower bd  upper bd
## (Intercept)      54.06294    -68.83438 103.95882
## Displacement     -0.03751     -0.22369   0.02329
## Hpower           -0.14300     -0.49277   0.31943
## Torque            0.09195     -0.33155   0.43812
## Comp_ratio       -2.15210     -6.28234   9.89148
## Rear_axle_ratio   2.66851     -6.44198  18.14440
## Carb_barrels      1.70373     -3.17755   3.36442
## No._speeds       -1.60050    -10.35158  14.36612
## Length            0.19950     -0.16919   0.42062
## Width            -0.52344     -1.20202   0.04226
## Weight           -0.00444     -0.00998   0.00998
## Trans._type       0.00138     -9.84964  18.44084
##
## Call: rq(formula = Mpg ~ ., tau = seq(0.05, 0.95, by = 0.05), data = gas)
##
## tau: [1] 0.35
##
## Coefficients:
##                 coefficients lower bd  upper bd
## (Intercept)      33.61471    -64.66366 114.81804
## Displacement     -0.03139     -0.21008   0.03422
## Hpower           -0.20400     -0.44658   0.30928
## Torque            0.13156     -0.27674   0.31270
## Comp_ratio       -0.25080     -5.45183   9.81983
## Rear_axle_ratio   3.65908     -7.03406  14.90364
```

```
## Carb_barrels      1.23102     -3.39051   3.63315
## No._speeds        1.41816    -10.18349  11.84650
## Length            0.23047     -0.16893   0.42550
## Width            -0.72708     -1.12616   0.06438
## Weight           -0.00460     -0.00969   0.01709
## Trans._type       1.21189    -13.55527  19.91186
##
## Call: rq(formula = Mpg ~ ., tau = seq(0.05, 0.95, by = 0.05), data = gas)
##
## tau: [1] 0.4
##
## Coefficients:
##                 coefficients lower bd  upper bd
## (Intercept)      39.79782    -38.02844 113.89174
## Displacement     -0.13338     -0.20434   0.03074
## Hpower           -0.18288     -0.42267   0.26439
## Torque            0.24622     -0.04369   0.30530
## Comp_ratio       -0.46214     -5.25613   8.45928
## Rear_axle_ratio   9.72169     -7.02632  13.60216
## Carb_barrels      1.13543     -2.96256   3.81884
## No._speeds       -4.67178    -10.06583  11.59511
## Length            0.22521     -0.17691   0.45815
## Width            -0.71592     -0.96215   0.04934
## Weight           -0.00493     -0.00970   0.01547
## Trans._type       2.03764    -13.21112  13.78413
##
## Call: rq(formula = Mpg ~ ., tau = seq(0.05, 0.95, by = 0.05), data = gas)
##
## tau: [1] 0.45
##
## Coefficients:
##                 coefficients lower bd  upper bd
## (Intercept)      39.79782    -56.56228 106.18042
## Displacement     -0.13338     -0.20343   0.02052
## Hpower           -0.18288     -0.41773   0.25501
## Torque            0.24622     -0.01230   0.30261
## Comp_ratio       -0.46214     -6.14907   8.28425
## Rear_axle_ratio   9.72169     -6.94519  13.35862
## Carb_barrels      1.13543     -2.98675   4.21629
## No._speeds       -4.67178    -10.00668  11.72722
## Length            0.22521     -0.18485   0.43406
## Width            -0.71592     -1.16886   0.17787
## Weight           -0.00493     -0.00847   0.01610
## Trans._type       2.03764    -15.49451   7.66150
##
## Call: rq(formula = Mpg ~ ., tau = seq(0.05, 0.95, by = 0.05), data = gas)
##
## tau: [1] 0.5
##
## Coefficients:
##                 coefficients lower bd  upper bd
## (Intercept)      41.98707    -50.15249  99.41846
## Displacement     -0.13873     -0.19219   0.01530
## Hpower           -0.17596     -0.39591   0.25625
```

```
## Torque            0.24692     -0.02048   0.29231
## Comp_ratio       -1.14223     -6.05074   8.13403
## Rear_axle_ratio   9.03682     -6.58867  12.87569
## Carb_barrels      1.14349     -2.74990   4.52378
## No._speeds       -3.91968     -9.28143   7.94056
## Length            0.17526     -0.17574   0.40710
## Width            -0.54095     -1.21406   0.19273
## Weight           -0.00472     -0.01453   0.01580
## Trans._type       1.99845    -16.08817  12.71580
##
## Call: rq(formula = Mpg ~ ., tau = seq(0.05, 0.95, by = 0.05), data = gas)
##
## tau: [1] 0.55
##
## Coefficients:
##                 coefficients lower bd  upper bd
## (Intercept)      37.45543    -44.82510  83.71515
## Displacement     -0.15632     -0.18890   0.00376
## Hpower           -0.16826     -0.39300   0.25379
## Torque            0.26247     -0.01384   0.30666
## Comp_ratio       -0.66081     -6.06884   6.68266
## Rear_axle_ratio   9.51487     -6.24103  12.86802
## Carb_barrels      1.04178     -3.13414   4.18934
## No._speeds       -4.62124     -9.61926   8.96272
## Length            0.13267     -0.10225   0.52539
## Width            -0.40408     -1.49854   0.22254
## Weight           -0.00460     -0.01807   0.01441
## Trans._type       2.58728    -17.09597  11.63718
##
## Call: rq(formula = Mpg ~ ., tau = seq(0.05, 0.95, by = 0.05), data = gas)
##
## tau: [1] 0.6
##
## Coefficients:
##                 coefficients lower bd  upper bd
## (Intercept)     -12.38280    -43.03643  95.08684
## Displacement     -0.12421     -0.41794  -0.00553
## Hpower           -0.03070     -0.35527   0.24415
## Torque            0.16519     -0.02707   0.42386
## Comp_ratio        2.08188     -5.70257   6.47639
## Rear_axle_ratio  10.01460     -6.14963  12.04353
## Carb_barrels      1.43890     -2.71410   4.09294
## No._speeds       -7.01770     -9.16567   8.71186
## Length            0.37290     -0.10354   0.51369
## Width            -0.29559     -1.54439   0.35325
## Weight           -0.01231     -0.02441   0.00933
## Trans._type       3.20547    -17.37450  10.84163
##
## Call: rq(formula = Mpg ~ ., tau = seq(0.05, 0.95, by = 0.05), data = gas)
##
## tau: [1] 0.65
##
## Coefficients:
##                 coefficients lower bd  upper bd
```

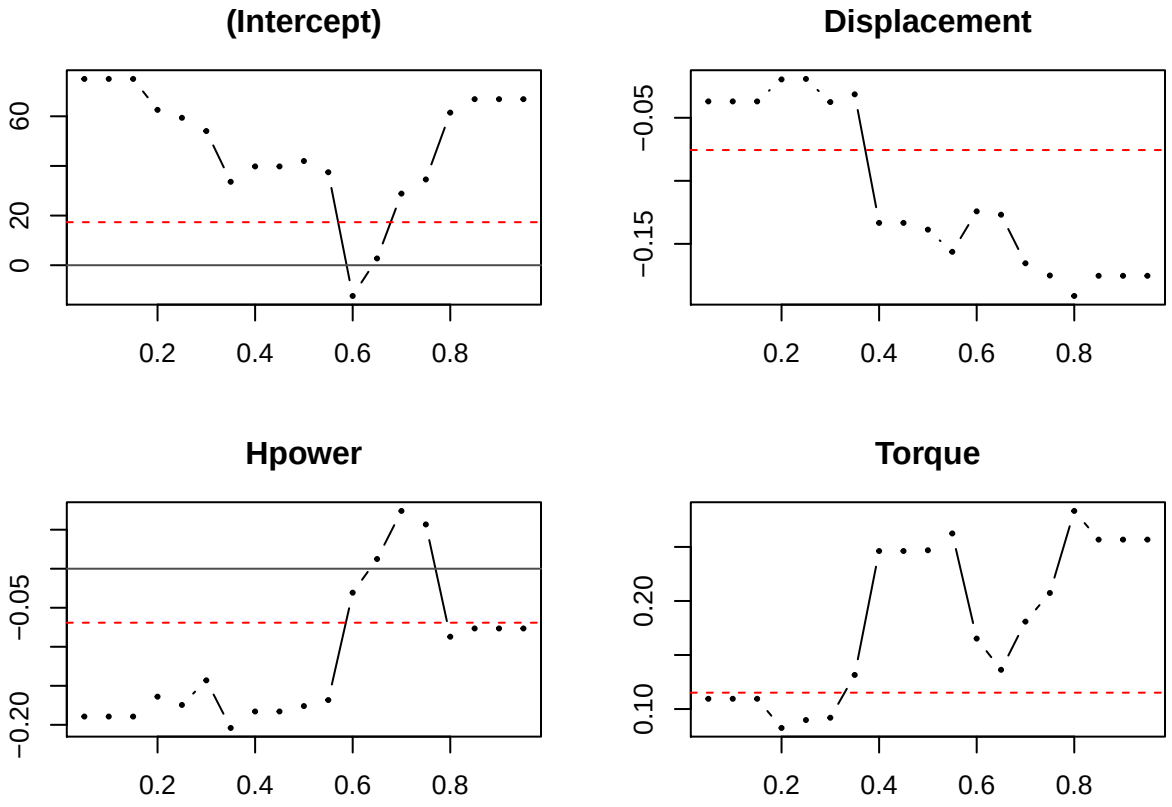
```
## (Intercept)       2.72420    -62.53270  90.21213
## Displacement     -0.12688     -0.45468   0.03413
## Hpower            0.01245     -0.33805   0.20142
## Torque            0.13632     -0.01474   0.71181
## Comp_ratio       -0.30299     -6.43194   7.23641
## Rear_axle_ratio   4.44313     -6.87306  12.41785
## Carb_barrels      0.97970     -3.14994   4.08618
## No._speeds       -1.92379     -9.72640  11.20294
## Length            0.24256     -0.02695   0.54294
## Width             0.07790     -1.54193   0.34287
## Weight           -0.01072     -0.02450   0.00551
## Trans._type       3.86325    -17.61289   6.83024
##
## Call: rq(formula = Mpg ~ ., tau = seq(0.05, 0.95, by = 0.05), data = gas)
##
## tau: [1] 0.7
##
## Coefficients:
##                 coefficients lower bd  upper bd
## (Intercept)      28.85096    -75.12977 102.50991
## Displacement     -0.16541     -0.47664   0.05931
## Hpower            0.07405     -0.33272   0.20573
## Torque            0.18091      0.03334   0.66419
## Comp_ratio       -0.90495     -6.34058   7.71359
## Rear_axle_ratio   5.65233     -7.01015  14.03433
## Carb_barrels     -0.13504     -2.96208   4.04653
## No._speeds       -2.93528    -10.54811  11.40447
## Length            0.16370     -0.07872   0.53613
## Width            -0.19469     -1.21537   0.36292
## Weight           -0.00779     -0.02598   0.00638
## Trans._type       2.07428    -23.65402   5.03042
##
## Call: rq(formula = Mpg ~ ., tau = seq(0.05, 0.95, by = 0.05), data = gas)
##
## tau: [1] 0.75
##
## Coefficients:
##                 coefficients   lower bd       upper bd
## (Intercept)       3.455691e+01  -8.684394e+01   1.032997e+02
## Displacement     -1.751100e-01  -4.660100e-01   6.019000e-02
## Hpower            5.674000e-02  -3.025600e-01   8.576000e-02
## Torque            2.073900e-01  -1.951000e-01   5.179700e-01
## Comp_ratio       -9.275300e-01  -7.579510e+00   9.662210e+00
## Rear_axle_ratio   5.785450e+00  -6.660930e+00   1.305027e+01
## Carb_barrels     -7.231000e-02  -3.181530e+00   4.833050e+00
## No._speeds       -3.165050e+00  -1.308105e+01   1.568430e+01
## Length            1.295500e-01  -1.320200e-01   6.347100e-01
## Width            -2.334800e-01  -1.300490e+00   3.444300e-01
## Weight           -6.460000e-03  -2.710000e-02   9.380000e-03
## Trans._type       3.597200e-01 -1.797693e+308   5.314290e+00
##
## Call: rq(formula = Mpg ~ ., tau = seq(0.05, 0.95, by = 0.05), data = gas)
##
## tau: [1] 0.8
```

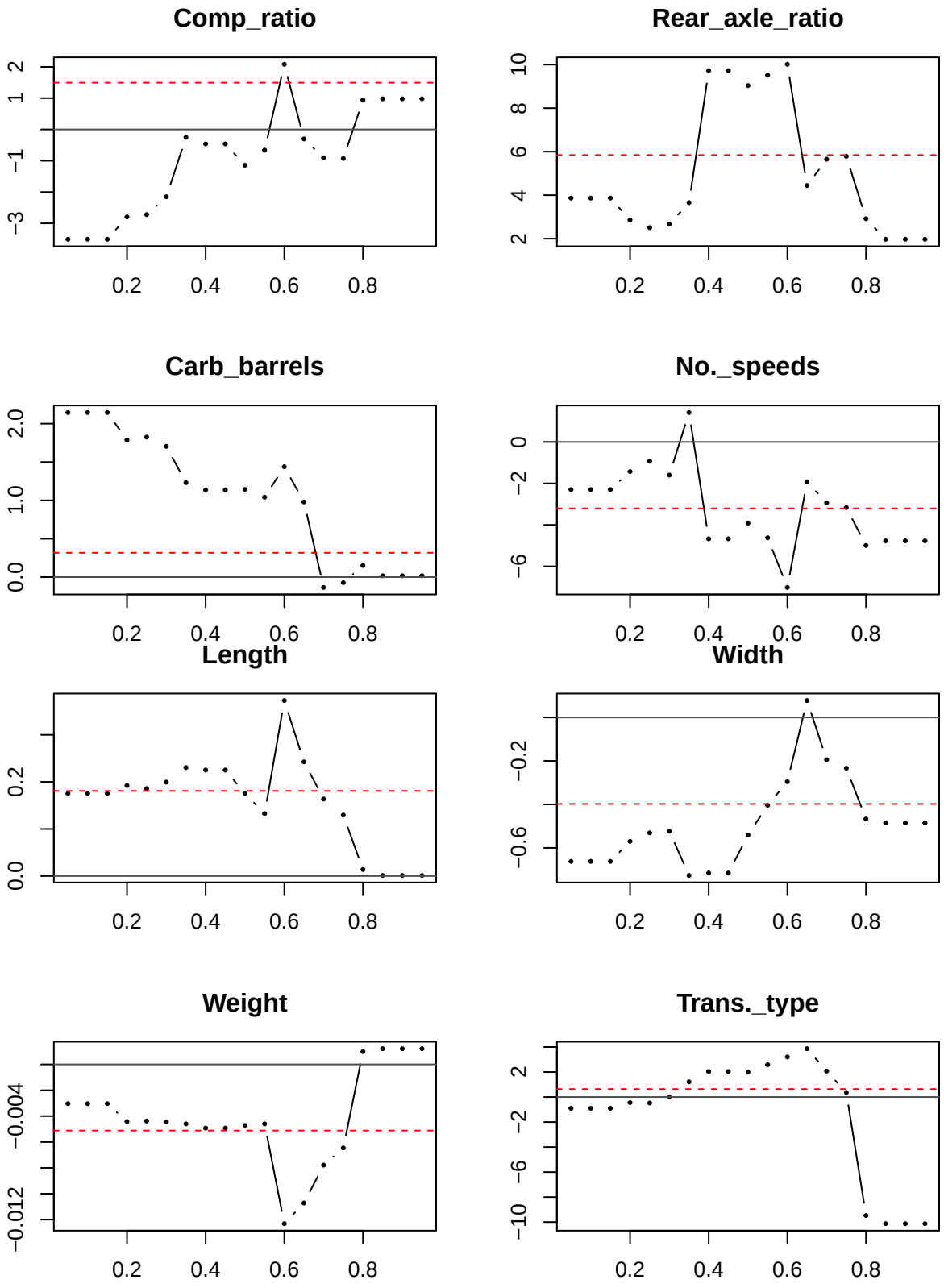
```
##
## Coefficients:
##                 coefficients   lower bd       upper bd
## (Intercept)       6.148552e+01  -1.049836e+02   8.566354e+01
## Displacement     -1.913300e-01  -4.137200e-01   6.737000e-02
## Hpower           -8.712000e-02  -2.164400e-01   7.954000e-02
## Torque            2.833300e-01  -2.153400e-01   4.907800e-01
## Comp_ratio        9.368600e-01  -7.735370e+00   9.631920e+00
## Rear_axle_ratio   2.917710e+00  -4.611710e+00   1.369960e+01
## Carb_barrels      1.512300e-01  -4.358200e+00   4.657640e+00
## No._speeds       -4.994060e+00  -1.314589e+01   1.682156e+01
## Length            1.373000e-02  -1.543800e-01   7.594600e-01
## Width            -4.669700e-01  -1.331300e+00   1.108440e+00
## Weight            9.900000e-04  -3.790000e-02   3.420000e-03
## Trans._type      -9.478690e+00 -1.797693e+308   7.201720e+00
##
## Call: rq(formula = Mpg ~ ., tau = seq(0.05, 0.95, by = 0.05), data = gas)
##
## tau: [1] 0.85
##
## Coefficients:
##                 coefficients   lower bd       upper bd
## (Intercept)       6.690518e+01  -1.017219e+02   8.340677e+01
## Displacement     -1.753400e-01  -4.133800e-01   8.903000e-02
## Hpower           -7.653000e-02  -2.252300e-01   2.891000e-02
## Torque            2.567900e-01  -2.193400e-01   5.192900e-01
## Comp_ratio        9.785700e-01  -1.052048e+01   1.013836e+01
## Rear_axle_ratio   1.973560e+00  -4.461560e+00   1.404317e+01
## Carb_barrels      1.741000e-02  -5.369720e+00   4.663750e+00
## No._speeds       -4.769530e+00  -1.477001e+01   1.962953e+01
## Length            1.180000e-03  -2.910870e+00   7.777500e-01
## Width            -4.858100e-01  -1.369200e+00   4.014110e+00
## Weight            1.210000e-03  -4.319000e-02   3.710000e-03
## Trans._type      -1.012671e+01 -1.797693e+308   7.245470e+00
##
## Call: rq(formula = Mpg ~ ., tau = seq(0.05, 0.95, by = 0.05), data = gas)
##
## tau: [1] 0.9
##
## Coefficients:
##                 coefficients   lower bd       upper bd
## (Intercept)       6.690518e+01  -9.810508e+01   8.661455e+01
## Displacement     -1.753400e-01  -4.236900e-01   1.289300e-01
## Hpower           -7.653000e-02  -2.656700e-01   4.391000e-02
## Torque            2.567900e-01  -3.484200e-01   5.416000e-01
## Comp_ratio        9.785700e-01  -3.524620e+01   2.352705e+01
## Rear_axle_ratio   1.973560e+00  -6.904900e+00   1.521520e+01
## Carb_barrels      1.741000e-02  -9.354370e+00   4.553580e+00
## No._speeds       -4.769530e+00  -2.477762e+01   2.793282e+01
## Length            1.180000e-03 -1.797693e+308   9.343800e-01
## Width            -4.858100e-01  -5.684390e+00  1.797693e+308
## Weight            1.210000e-03  -4.721000e-02   5.040000e-03
## Trans._type      -1.012671e+01 -1.797693e+308   7.331570e+00
##
```

```
## Call: rq(formula = Mpg ~ ., tau = seq(0.05, 0.95, by = 0.05), data = gas)
##
## tau: [1] 0.95
##
## Coefficients:
##                 coefficients   lower bd       upper bd
## (Intercept)       6.690518e+01 -1.797693e+308  1.797693e+308
## Displacement     -1.753400e-01 -1.797693e+308  1.797693e+308
## Hpower           -7.653000e-02 -1.797693e+308  1.797693e+308
## Torque            2.567900e-01 -1.797693e+308  1.797693e+308
## Comp_ratio        9.785700e-01 -1.797693e+308  1.797693e+308
## Rear_axle_ratio   1.973560e+00 -1.797693e+308  1.797693e+308
## Carb_barrels      1.741000e-02 -1.797693e+308  1.797693e+308
## No._speeds       -4.769530e+00 -1.797693e+308  1.797693e+308
## Length            1.180000e-03 -1.797693e+308  1.797693e+308
## Width            -4.858100e-01 -1.797693e+308  1.797693e+308
## Weight            1.210000e-03 -1.797693e+308  1.797693e+308
## Trans._type      -1.012671e+01 -1.797693e+308   7.544440e+00
```

b)

```
plot(qrfit1, mfrow =  c(2,2))
```




Comp_ratio
Rear_axle_ratio
Carb_barrels
No._speeds
Length
Width
Weight
Trans._type

c)

Length: Before 0.55th, with one unit increase th length, there will be on average 0.18 increase in mpg. From about 0.55th to 0.7th, the length has a drastic positive impact on mpg. After that the length has lesser positive impact on mpg. After 0.8th quantile the length has almost no influence on mpg.

Weight: Before 0.6th quantile, onw unit increase in weight will lead to about 0.18 increase in mpg. At 0.6th quantile, 0.1 unit increase in weight will lead to about 0.25 increase in mpg. After 0.8th quantile, weight has no influence on quantile.

comp_ratio: for most part, with the increase in comp_ratio, there will be a lesser negative impact in mpg But for comp_ratio at 0.6th quantile or after 0.8th quantile, it has a positive effect on mpg.

d)

```
median = rq(Mpg ~ ., tau = .5, data = gas)
summary(median, se = "boot")
```

```
##
## Call: rq(formula = Mpg ~ ., tau = 0.5, data = gas)
##
## tau: [1] 0.5
##
## Coefficients:
##                 Value    Std. Error t value  Pr(>|t|)
## (Intercept)     41.98707 52.58797    0.79842  0.43504
## Displacement    -0.13873  0.10416   -1.33194  0.19950
## Hpower          -0.17596  0.21068   -0.83516  0.41458
## Torque           0.24692  0.17208    1.43494  0.16845
## Comp_ratio      -1.14223  5.19150   -0.22002  0.82833
## Rear_axle_ratio  9.03682  6.86134    1.31706  0.20434
## Carb_barrels     1.14349  2.53075    0.45184  0.65678
## No._speeds      -3.91968  7.96215   -0.49229  0.62847
## Length           0.17526  0.29047    0.60338  0.55379
## Width           -0.54095  0.62739   -0.86223  0.39990
## Weight          -0.00472  0.01004   -0.46975  0.64418
## Trans._type      1.99845  8.52550    0.23441  0.81731
```

Problem 3

```
car = read.csv("car.csv")
```

a)

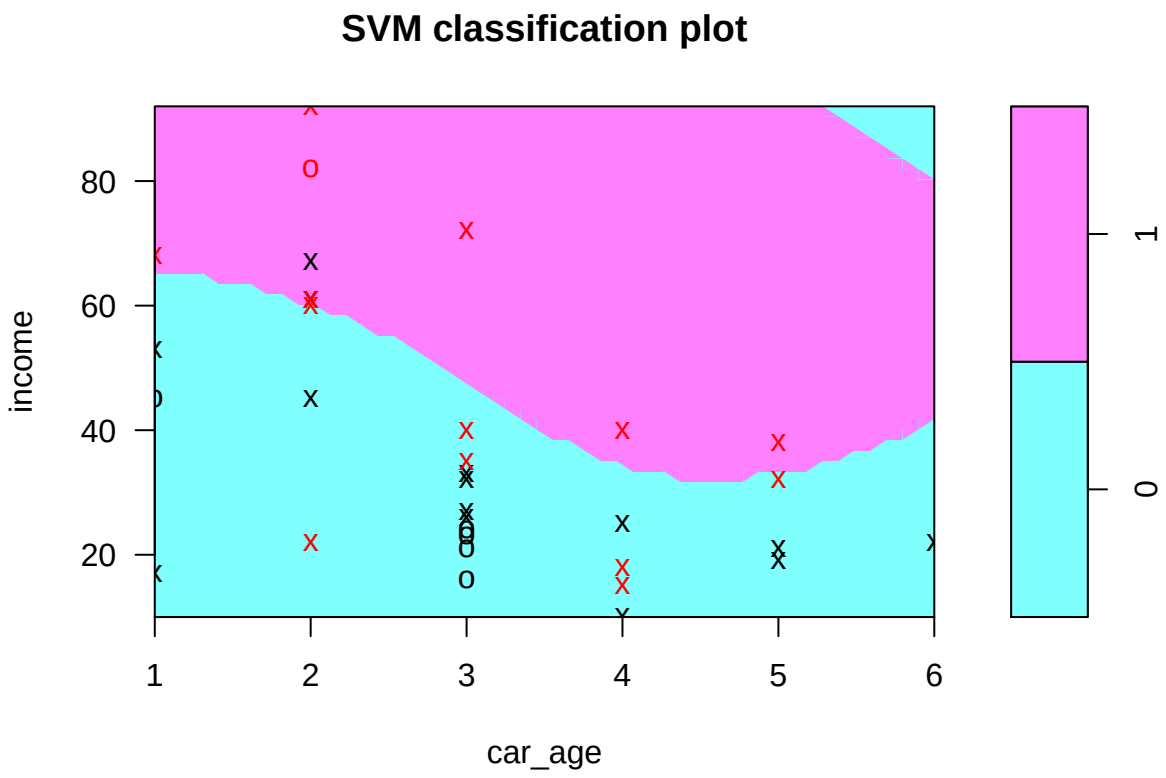
```
carsvm = svm(factor(y) ~ ., data = car)
summary(carsvm)
```

```
##
## Call:
## svm(formula = factor(y) ~ ., data = car)
```

```
##
##
## Parameters:
##    SVM-Type:  C-classification
##  SVM-Kernel:  radial
##        cost:  1
##       gamma:  0.5
##
## Number of Support Vectors:  27
##
##  ( 14 13 )
##
##
## Number of Classes:  2
##
## Levels:
##  0 1
```

b)

```
plot(carsvm, data = car, income ~ car_age)
```



c)

```
predict(carsvm, newdata = data.frame(income = 50, car_age = 5))
```

```
## 1
```

```
## 1
## Levels: 0 1
```

This family will purchase a new car.