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
```

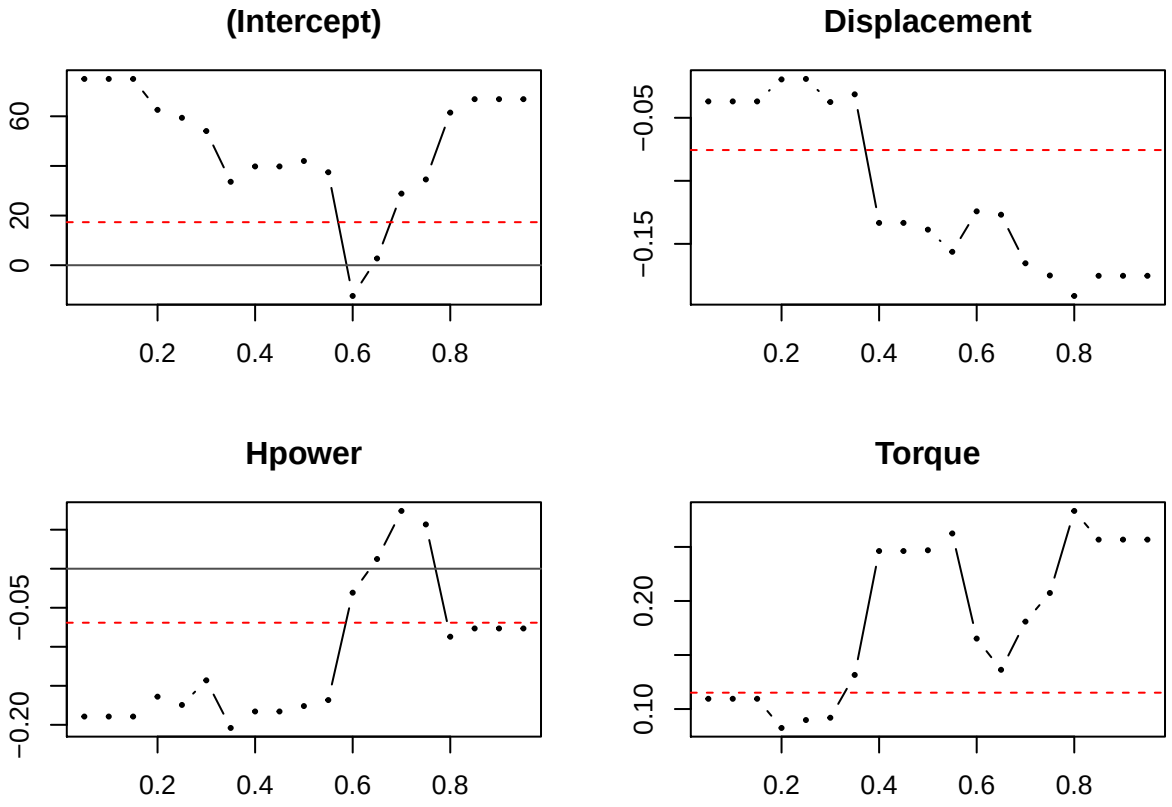
```
## (Intercept)       2.72420    -62.53270  90.21213
## Displacement     -0.12688     -0.45468   0.03413
## Hpower            0.01245     -0.33805   0.20142
## Torque            0.13632     -0.01474   0.71181
## Comp_ratio       -0.30299     -6.43194   7.23641
## Rear_axle_ratio   4.44313     -6.87306  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
```

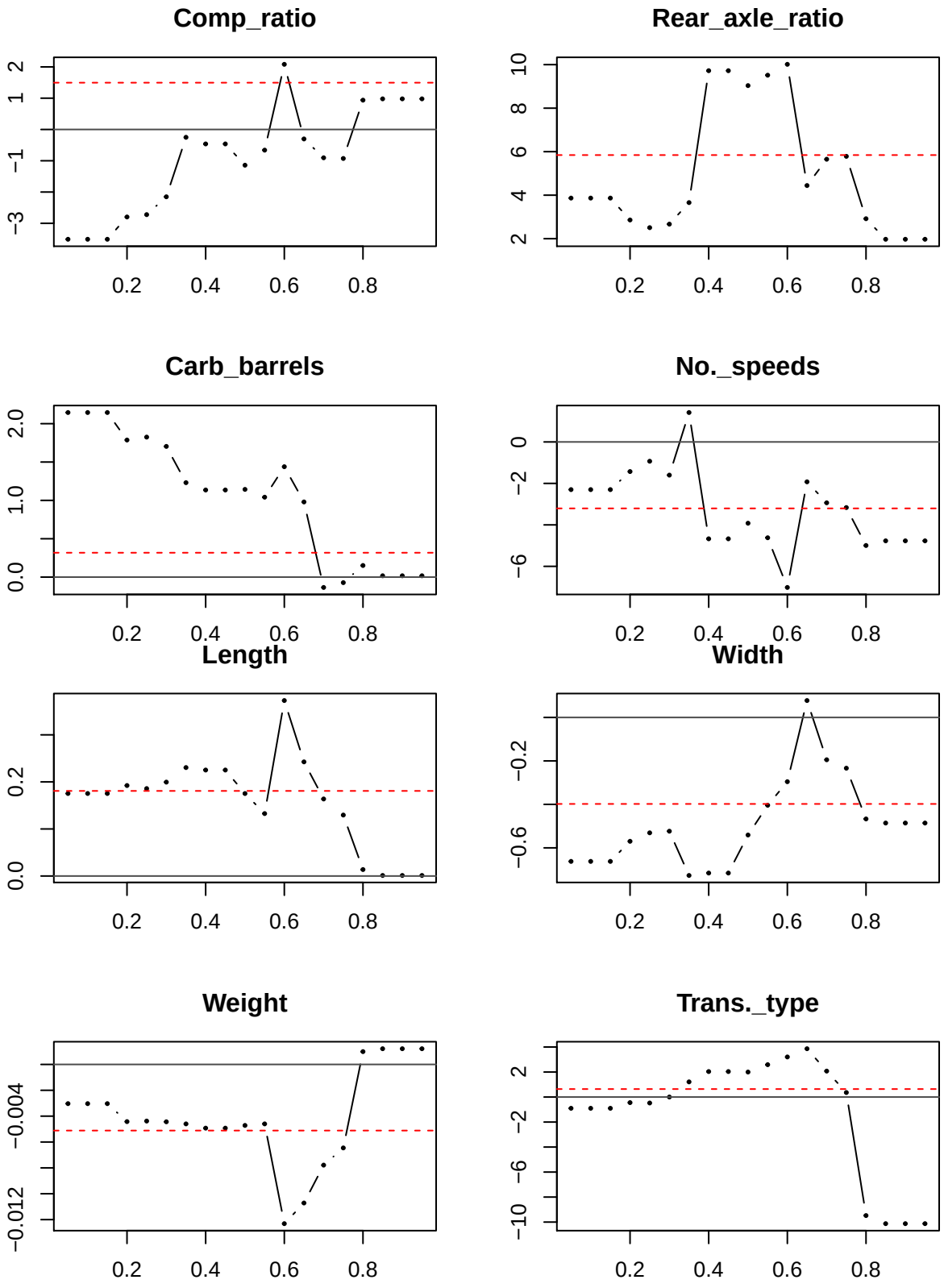
```
##
## Coefficients:
##                 coefficients   lower bd       upper bd
## (Intercept)       6.148552e+01  -1.049836e+02   8.566354e+01
## Displacement     -1.913300e-01  -4.137200e-01   6.737000e-02
## Hpower           -8.712000e-02  -2.164400e-01   7.954000e-02
## Torque            2.833300e-01  -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, basically length has no influence on mpg. From about 0.55th to 0.7th, the length has a drastic positive impact on mpg. After that the length has negative impact on mpg.

Weight: before 0.5th, the mpg increases with weight increases. From 0.6th - 0.8th, the mpg decreases with weight increases. After 0.8th, the mpg increases with weight increases with a high degree.

comp_ratio: for most part, with the increase in comp_ratio, there will be a decrease in 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 52.12326    0.80553  0.43102
## Displacement    -0.13873  0.09478   -1.46374  0.16051
## Hpower          -0.17596  0.21166   -0.83132  0.41669
## Torque           0.24692  0.15968    1.54630  0.13943
## Comp_ratio      -1.14223  5.24223   -0.21789  0.82997
## Rear_axle_ratio  9.03682  6.30151    1.43407  0.16870
## Carb_barrels     1.14349  2.58037    0.44315  0.66294
## No._speeds      -3.91968  7.26813   -0.53930  0.59629
## Length           0.17526  0.29831    0.58752  0.56415
## Width           -0.54095  0.66293   -0.81600  0.42517
## Weight          -0.00472  0.00995   -0.47392  0.64126
## Trans._type      1.99845  7.11439    0.28090  0.78199
```

Problem 3

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

a)

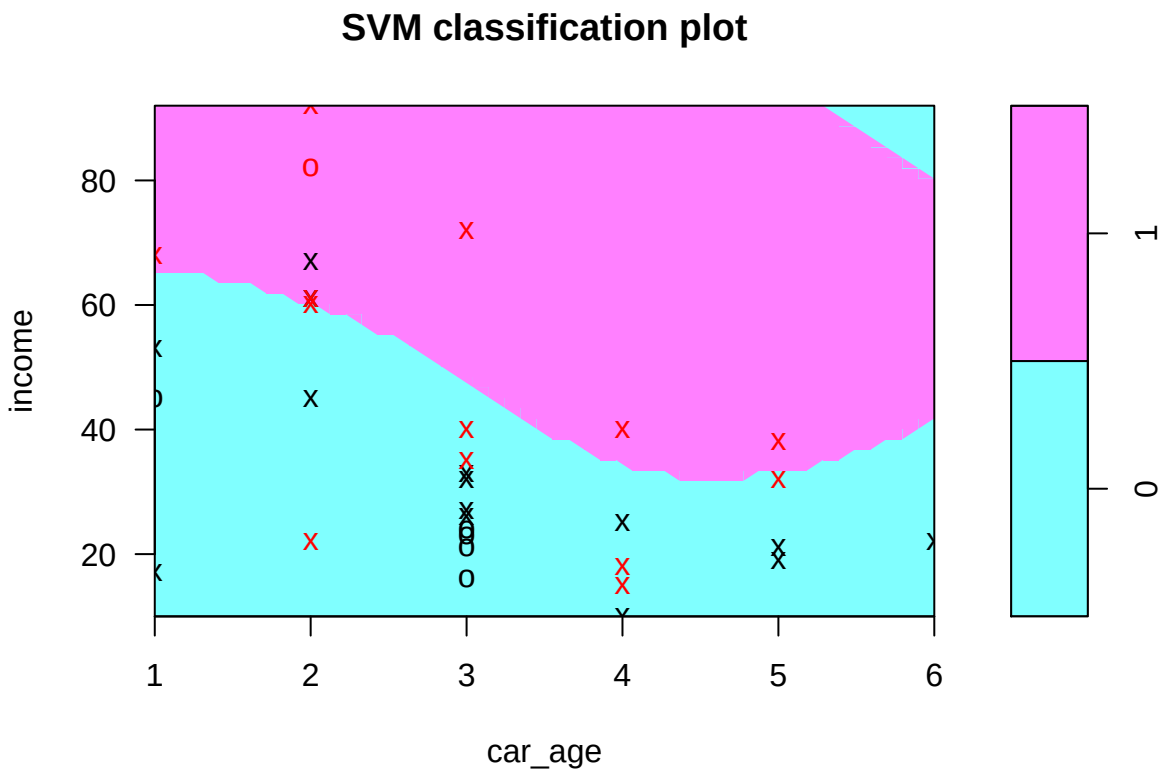
```
carsvm = svm(factor(y) ~ ., data = car)
summary(carsvm)
```

```
##
## 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.