LabAssignment3

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Problem1

a) The purpose of doing Markov Chain Monte Carlo is to obtain sample points from complex distributions. By constructing a Markov chain whose equilibrium probability distribution is the target distribution, we use MCMC to generate random samples from the target distribution.

b) Metropolis algorithm is a special case of Metropolis-Hastings algorithm. In Metropolis algorithm, the proposal distribution has to be symmetric, i.e., $q(\theta_1|\theta_2) = q(\theta_2|\theta_1)$. However, in Metropolis-Hastings algorithm, q(|) does not have to be symmetric.

c) The purpose of Ridge and Lasso regression is to avoid multicollinearity, too many predictors, overfitting and illconditioned $X^T X$ matrix. Both regressions have shrinkage penalty and shrink coefficients toward zero, while Lasso regression also performs variable selection.

d) IIA assumption for Multinomial Logit discrete choice model is independence of irrelevant alternatives: the ratio of probabilities of choosing two alternatives is independent of the presence or attributes of any other alternative. The model can be estimated and applied in cases where different members of the population face different sets of alternatives.

Problem2

```
library(quantreg)
```

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

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

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

```
gas <- read.csv("gas_mileage.csv",header=T)
```

a)

```
fit <- 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
```

```
summary(fit)
```

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

```
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## nonunique
##
## 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
```

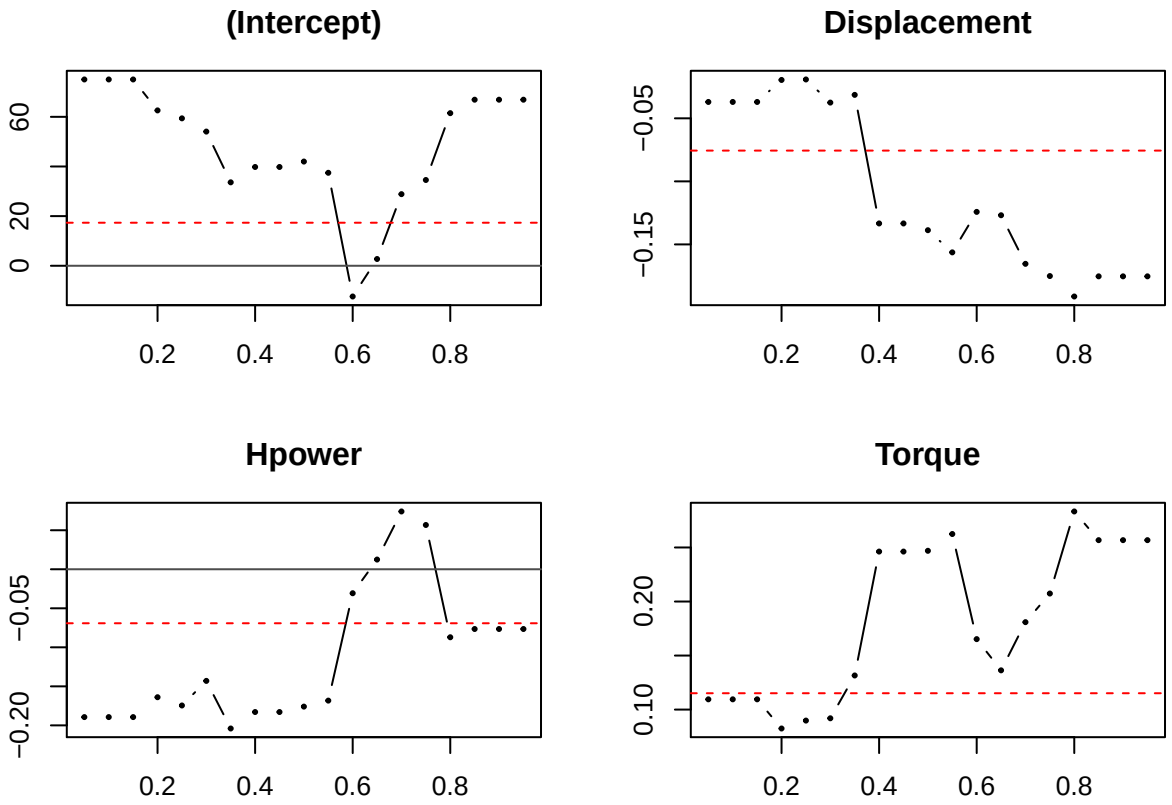
```
## Length            1.373000e-02  -1.543800e-01   7.594600e-01
## Width            -4.669700e-01  -1.331300e+00   1.108440e+00
## Weight            9.900000e-04  -3.790000e-02   3.420000e-03
## Trans._type      -9.478690e+00 -1.797693e+308   7.201720e+00
##
## Call: rq(formula = Mpg ~ ., tau = seq(0.05, 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
```

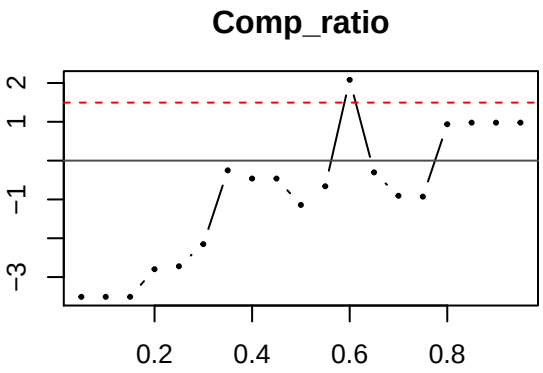
```
## Rear_axle_ratio   1.973560e+00 -1.797693e+308  1.797693e+308
## Carb_barrels      1.741000e-02 -1.797693e+308  1.797693e+308
## No._speeds       -4.769530e+00 -1.797693e+308  1.797693e+308
## Length            1.180000e-03 -1.797693e+308  1.797693e+308
## Width            -4.858100e-01 -1.797693e+308  1.797693e+308
## Weight            1.210000e-03 -1.797693e+308  1.797693e+308
## Trans._type      -1.012671e+01 -1.797693e+308   7.544440e+00
```

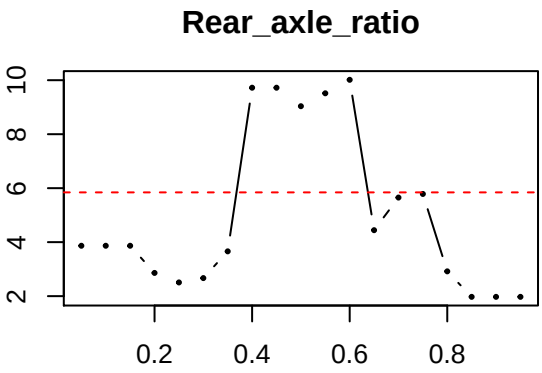
The regression models for the 0.05, 0.10,..., 0.90, 0.95th conditional quantile for Mpg regressed on all predictors is shown above.

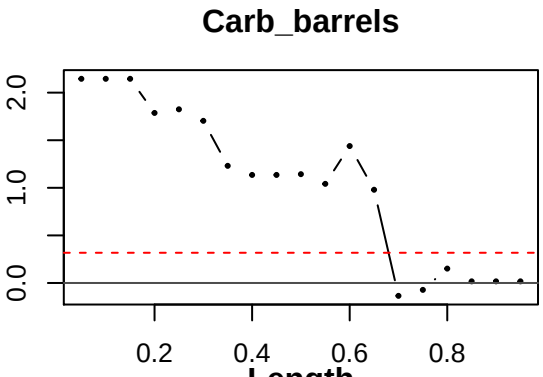
b)

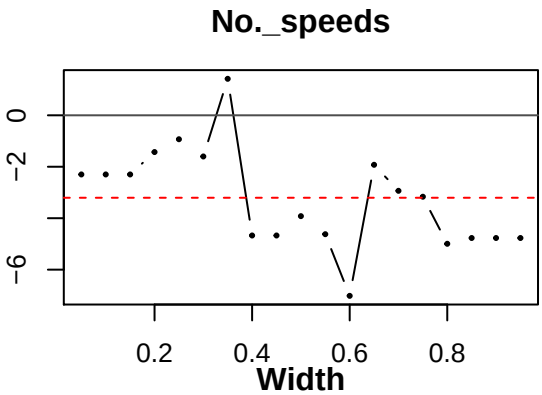
```
plot.rqs(fit,mfrow=c(2,2))
```

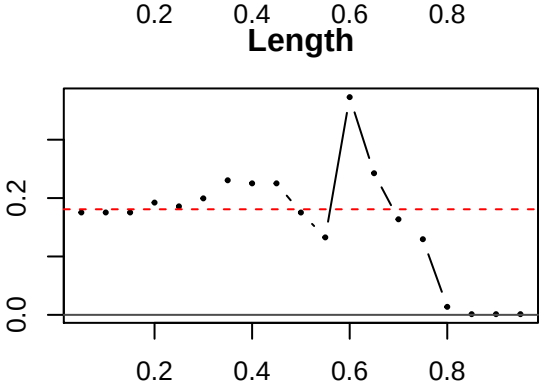


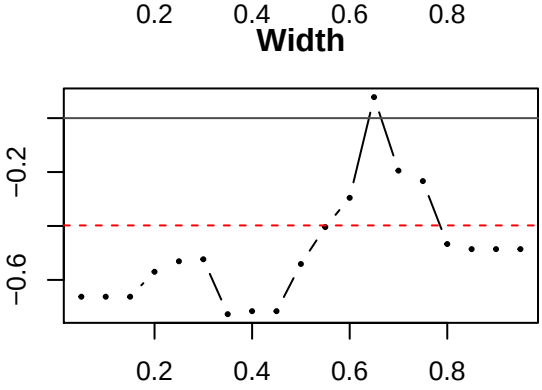


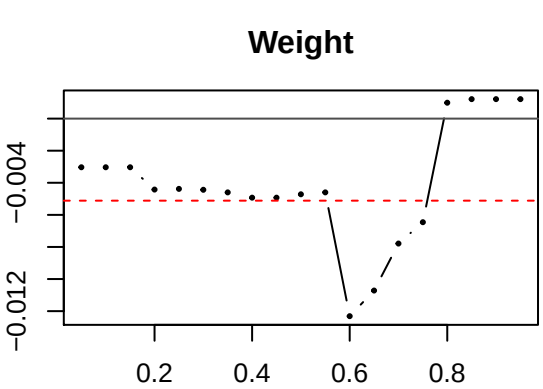


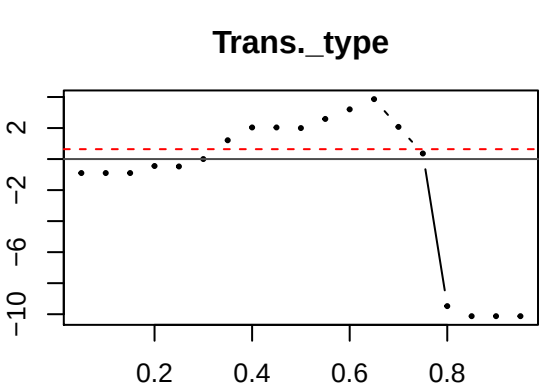












The plotted results are shown above.

c)

When $\tau = 0.9$:

The coefficient of displacement is -0.17534, meaning that when displacement is increased by one unit then 0.9th quantile of Mpg will decrease by 0.17534 on average keeping others fixed.

The coefficient of carb_barrels is 0.01741, meaning that when carb_barrels is increased by one unit then 0.9th quantile of Mpg will increase by 0.01741 on average keeping others fixed.

The coefficient of width is -0.48581, meaning that when width is increased by one unit then 0.9th quantile of Mpg will decrease by 0.48581 on average keeping others fixed.

From the plots:

Displacement: in lower quantiles, a unit increase in displacement will lead to a much smaller decrease in Mpg compared to upper quantiles, and the decreased amount tends to be larger in higher quantiles (0.8th quantile).

Carb_barrels: in lower quantiles (below 0.68th), a unit increase in carb_barrels will lead to an increase in Mpg, and the increased amount tends to be larger in lower quantiles; while in upper quantiles, a unit increase in carb_barrels will lead to no change or a slightly decrease or increase in Mpg.

Width: in lower and upper quantiles (below 0.5th and above 0.8th), a unit increase in width will lead to a greater decrease in Mpg (around a decrease of 0.6); while in between 0.5th and 0.8th quantiles, a unit increase in width will lead to a smaller decrease in Mpg (or even a slightly increase in Mpg in 0.63th quantile).

d)

```
fit2 <- rq(Mpg~.,tau=0.5, data=gas)
summary.rq(fit2,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 47.47494    0.88440  0.38814
## Displacement    -0.13873  0.09810   -1.41421  0.17436
## Hpower          -0.17596  0.22933   -0.76726  0.45287
## Torque           0.24692  0.17062    1.44719  0.16504
## Comp_ratio      -1.14223  5.06178   -0.22566  0.82401
## Rear_axle_ratio  9.03682  7.00910    1.28930  0.21362
## Carb_barrels     1.14349  2.45340    0.46609  0.64675
## No._speeds      -3.91968  8.19806   -0.47812  0.63832
## Length           0.17526  0.29090    0.60249  0.55437
## Width           -0.54095  0.63658   -0.84977  0.40661
## Weight          -0.00472  0.00974   -0.48450  0.63387
## Trans._type      1.99845  8.30979    0.24049  0.81267
```

Problem3

```
library(e1071)
```

```
car <- read.csv("car.csv",header=T)
```

a)

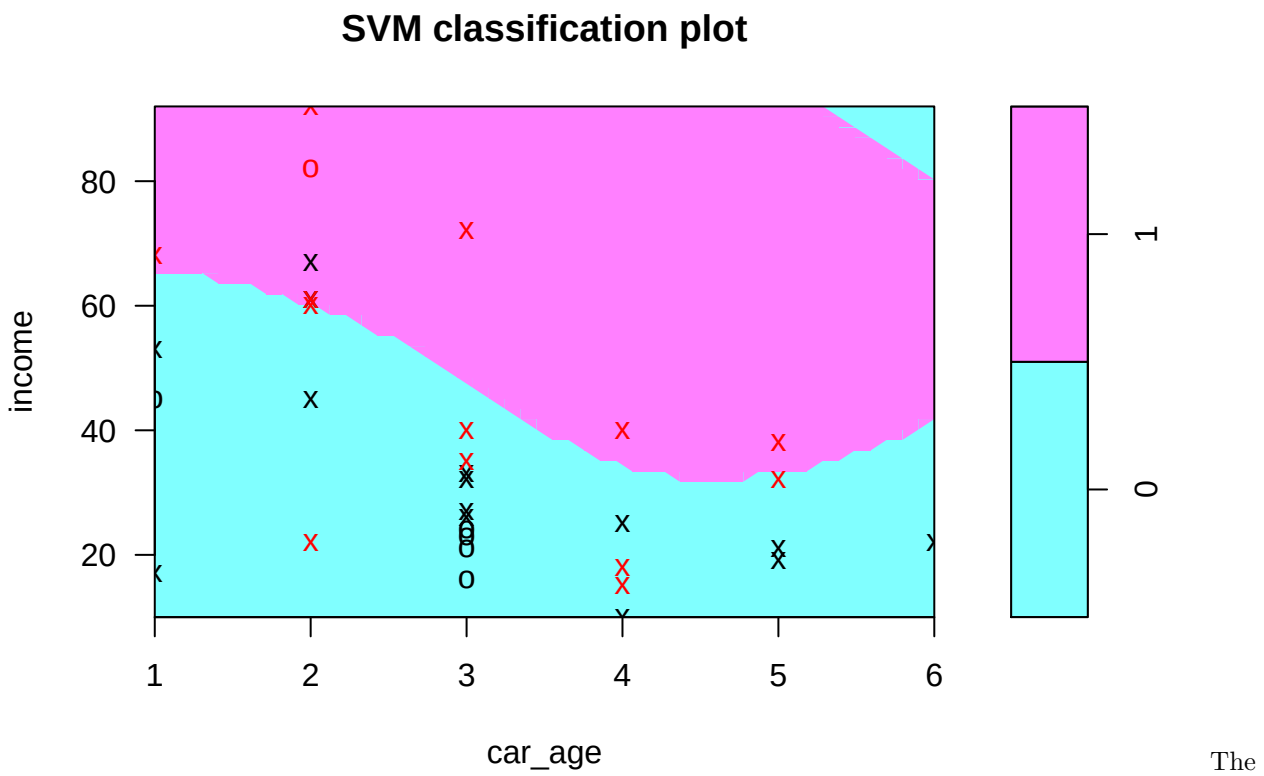
```
svm <- svm(factor(y)~., data=car)
summary(svm)
```

```
##
## 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
```

The fitted support vector machine is shown above.

b)

```
plot(svm, car, income~car_age)
```



The plot is shown above

c)

```
newdata <- with(car, data.frame(income=50,car_age=5))

predict(svm, newdata = newdata, type = "response")
```

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

From above, the response for a family with income = 50 and car age = 5 is 1. So the person will buy the car.