lab_assignment_3

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1.

(a)

sample points from a distribution that is hard to sample from directly

(b)

q(.|.) does not have to be symmetric for MH but has to be for Metropolis Algorithm. Thus their accepting probability are different as well.

(c)

Ridge regression add a l2 regularization term to the regression thus pushing predictors that are less important to have coefficients closer to zero thus performing variable selections.

Lasso add a l1 regularization term to the regression. Different from ridge, Lasso pushes coefficient to zero for some insignificant variables.

(d)

The IIA assumptiton states the ration of probability of choosing between two alternatives is independent of the presence or any other alternative's attributes.

2.

(a)

```
library(quantreg)
```

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

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

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

```
gas_mileage <- read.csv('../gas_mileage.csv')
str(gas_mileage)
```

```
## 'data.frame':	32 obs. of  12 variables:
##  $ Mpg            : num  18.9 17 20 18.2 20.1 ...
##  $ Displacement   : num  350 350 250 351 225 440 231 262 89.7 96.9 ...
##  $ Hpower         : int  165 170 105 143 95 215 110 110 70 75 ...
##  $ Torque         : int  260 275 185 255 170 330 175 200 81 83 ...
##  $ Comp_ratio     : num  8 8.5 8.25 8 8.4 8.2 8 8.5 8.2 9 ...
##  $ Rear_axle_ratio: num  2.56 2.56 2.73 3 2.76 2.88 2.56 2.56 3.9 4.3 ...
##  $ Carb_barrels   : int  4 4 1 2 1 4 2 2 2 2 ...
##  $ No._speeds     : int  3 3 3 3 3 3 3 3 4 5 ...
##  $ Length         : num  200 200 197 200 194 ...
##  $ Width          : num  69.9 72.9 72.2 74 71.8 69 65.4 65.4 64 65 ...
##  $ Weight         : int  3910 3860 3510 3890 3365 4215 3020 3180 1905 2320 ...
##  $ Trans._type    : int  1 1 1 1 0 1 1 1 0 0 ...
```

```r
fit2 <- rq(Mpg~.,data = gas_mileage,tau=seq(0.05,0.95,0.05))
```

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

```r
summary(fit2)
```

```
## 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, 0.05), data = gas_mileage)
##
## 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, 0.05), data = gas_mileage)
##
## 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, 0.05), data = gas_mileage)
##
## 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, 0.05), data = gas_mileage)
##
## 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, 0.05), data = gas_mileage)
##
## 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, 0.05), data = gas_mileage)
##
## 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, 0.05), data = gas_mileage)
##
```

```
## 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, 0.05), data = gas_mileage)
##
## 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, 0.05), data = gas_mileage)
##
## 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, 0.05), data = gas_mileage)
##
## 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, 0.05), data = gas_mileage)
##
## 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, 0.05), data = gas_mileage)
##
## 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
```

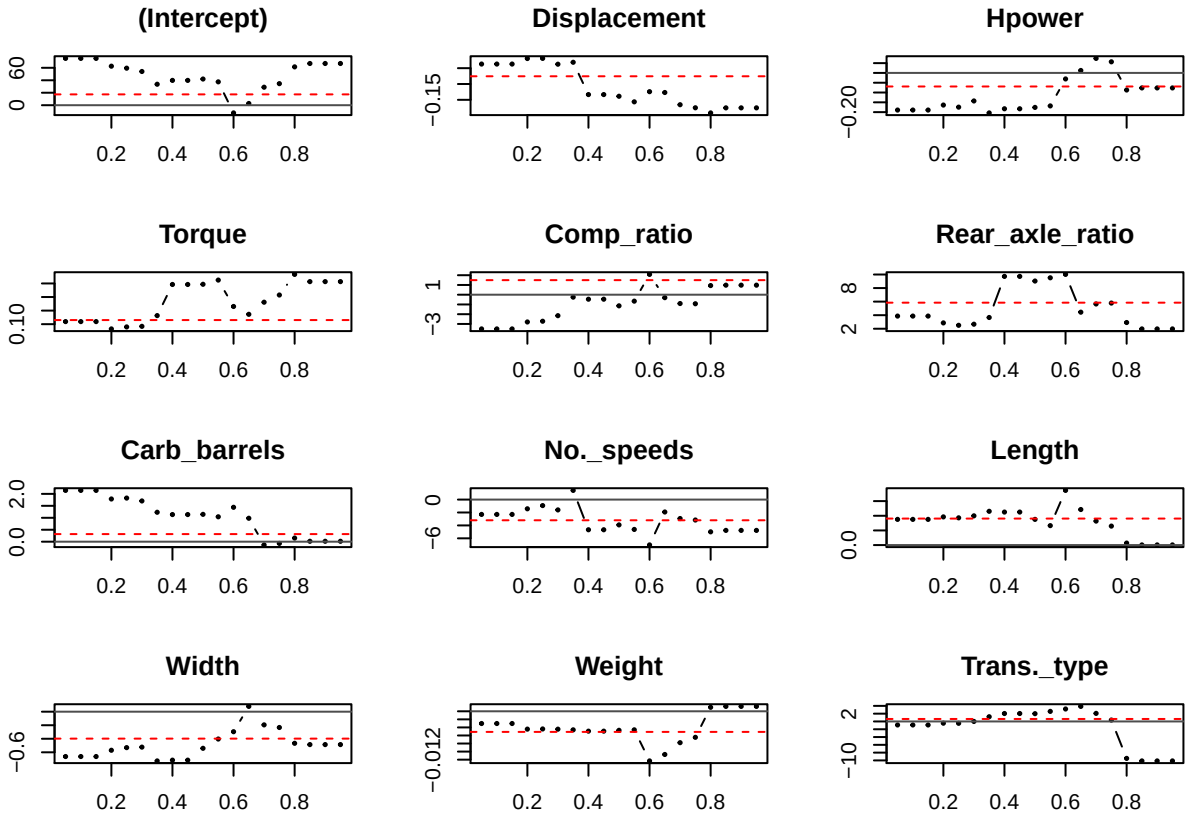
```
## Width            -0.29559     -1.54439   0.35325
## Weight           -0.01231     -0.02441   0.00933
## Trans._type       3.20547    -17.37450  10.84163
##
## Call: rq(formula = Mpg ~ ., tau = seq(0.05, 0.95, 0.05), data = gas_mileage)
##
## tau: [1] 0.65
##
## Coefficients:
##                 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, 0.05), data = gas_mileage)
##
## 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, 0.05), data = gas_mileage)
##
## 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, 0.05), data = gas_mileage)
##
## 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, 0.05), data = gas_mileage)
##
## 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, 0.05), data = gas_mileage)
##
## 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, 0.05), data = gas_mileage)
##
## 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(fit2)
```



##(c) Torque and Rear_axie_ratio showed constant positive linear relationship with the response. And they both reached high coefficients beteween 0.4 to 0.6 conditional quantile. trans.type is close to 0 the majority time but suddenly changed to highly negatively correlated after 0.8th conditional quantile.

(d)

```
summary(fit2,se='boot')[10]
```

```
## [[1]]
##
## Call: rq(formula = Mpg ~ ., tau = seq(0.05, 0.95, 0.05), data = gas_mileage)
##
## tau: [1] 0.5
##
## Coefficients:
##                 Value    Std. Error t value  Pr(>|t|)
## (Intercept)     41.98707 56.84858    0.73858  0.46969
## Displacement    -0.13873  0.11927   -1.16314  0.25996
## Hpower          -0.17596  0.23742   -0.74113  0.46818
## Torque           0.24692  0.18740    1.31758  0.20417
## Comp_ratio      -1.14223  5.25522   -0.21735  0.83038
## Rear_axle_ratio  9.03682  6.99297    1.29227  0.21261
## Carb_barrels     1.14349  2.81740    0.40587  0.68962
## No._speeds      -3.91968  7.90493   -0.49585  0.62600
## Length           0.17526  0.30273    0.57895  0.56980
## Width           -0.54095  0.69217   -0.78153  0.44465
## Weight          -0.00472  0.01077   -0.43813  0.66651
```

```
## Trans._type      1.99845  8.15325    0.24511  0.80914
```

3.

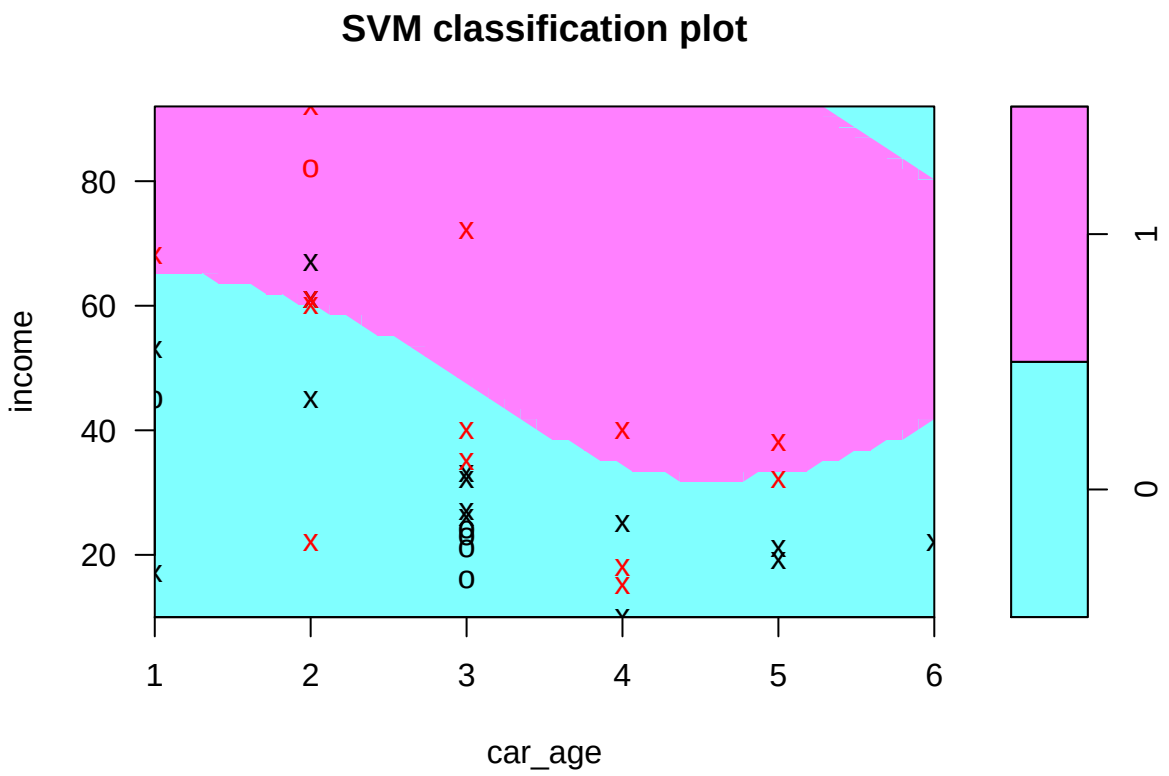
(a)

```
library(e1071)
car <- read.csv("../car.csv", header = T)
svm <- svm(as.factor(y) ~ ., data = car)
summary(svm)
```

```
##
## Call:
## svm(formula = as.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(svm,car)
```



(c)

```
predict(svm,data.frame(income=50,car_age=5),type='response')
```

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

the family will buy a car.