Practice Final Exam Fall 2019

Question 1

#The director of admissions at a state university wished to determine how accurately students' grade-point averages at the end of their freshman year (Y);

#X1= the high school class rank as percentile where 99 indicates student is at or near the top of his or her class and 1 indicates student is at or near the bottom of the class #X2= ACT score #X3= Academic Year

#a-) Create a development sample (70% of the data) and hold-out sample (%30) of the data, build your regression model on the development data, check the regression for the followings: normality, outliers and influential points, and multi collinearity document all your work and attach relevant r graphs._

#b-) Test the performance of the model on the hold out sample, and investigate the model stability on the hold out sample?_

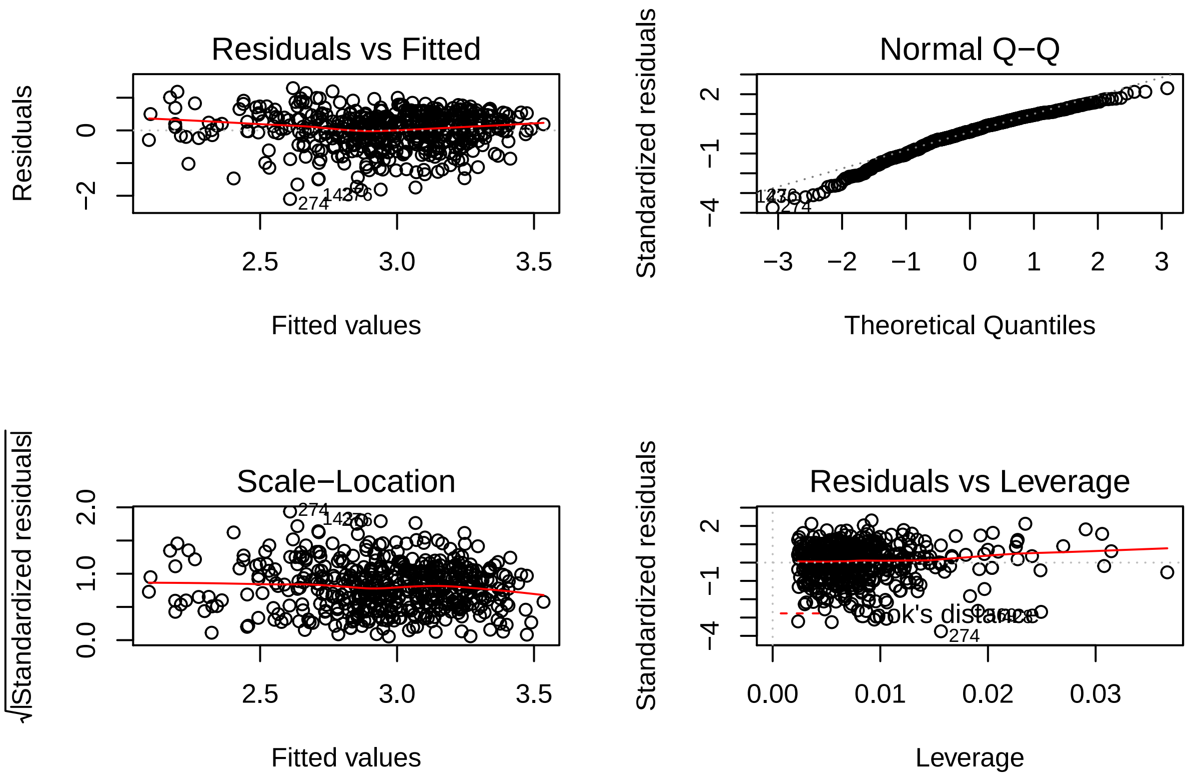
#c-) Divide the cases into two groups, placing 247 cases with the smallest fitted values (Y_i) into group 1 and the reamining cases into group 2. Conduct the Brown-Forsythe test for constancy of the error variance, using = .01. State the decision rule and conclusion._

Solutions: #Part a: #Y= -14.691 + 0.009X1+0.037X2+0.008X3. R square is 19%. X1 and X2 are significant. while X3 is not significant. QQ looks normal with constant variance. The cooks distance graph does not indicate that there are influential or outliers. No outliers in Y or Xs.VIFs <10, no multi collinearity exists.

```
set.seed(1234)
Admission.Data <- read.csv("/cloud/project/Admission Data.csv")
n<-dim(Admission.Data)[1]
sample.ind <- sample(1:n, size = round(n*0.7))
dev.sample <- Admission.Data[sample.ind,]
holdout.sample <- Admission.Data[-sample.ind,]
f.q1<-lm(Y~X1+X2+X3,data=dev.sample)
summary(f.q1)
```

```
##
## Call:
## lm(formula = Y ~ X1 + X2 + X3, data = dev.sample)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -2.09925 -0.30183  0.06202  0.39737  1.29302
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -14.691487  36.190018  -0.406    0.685
## X1            0.009429   0.001506   6.263 8.30e-10 ***
## X2            0.036876   0.007032   5.244 2.34e-07 ***
## X3            0.008024   0.018110   0.443    0.658
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.5642 on 489 degrees of freedom
## Multiple R-squared:  0.1903, Adjusted R-squared:  0.1853
## F-statistic: 38.31 on 3 and 489 DF,  p-value: < 2.2e-16
```

```r
par(mfrow=c(2,2))
plot(f.q1)
library(faraway)
```




```r
vif(f.q1)
```

```
##       X1       X2       X3
## 1.219068 1.216963 1.001939
```

```r
library(olsrr)
```

```
## Registered S3 methods overwritten by 'car':
##   method                          from
##   influence.merMod                lme4
##   cooks.distance.influence.merMod lme4
##   dfbeta.influence.merMod         lme4
##   dfbetas.influence.merMod        lme4

##
## Attaching package: 'olsrr'

## The following object is masked from 'package:faraway':
##
##     hsb

## The following object is masked from 'package:datasets':
##
##     rivers
```

```r
influence.measures(f.q1)
```

```
## Influence measures of
```

```
##   lm(formula = Y ~ X1 + X2 + X3, data = dev.sample) :
##
##        dfb.1_    dfb.X1    dfb.X2    dfb.X3     dffit cov.r   cook.d
## 284 -2.98e-03  3.91e-02  7.42e-03  2.81e-03 -0.049914 1.027 6.24e-04
## 101  5.12e-02  9.19e-03 -1.63e-02 -5.12e-02  0.064278 1.010 1.03e-03
## 623  1.87e-02  6.07e-03 -7.53e-03 -1.87e-02 -0.024742 1.014 1.53e-04
## 645  2.61e-02 -1.69e-02 -7.81e-03 -2.61e-02 -0.039084 1.016 3.83e-04
## 400  3.67e-03 -2.15e-02  1.56e-02 -3.63e-03  0.060511 0.998 9.14e-04
## 98   1.18e-02  7.63e-03 -5.08e-04 -1.19e-02  0.016902 1.017 7.16e-05
## 103  1.66e-02 -6.90e-03  1.94e-02 -1.67e-02  0.027980 1.020 1.96e-04
## 602  9.94e-02 -3.19e-02 -9.14e-02 -9.89e-02 -0.168976 1.001 7.12e-03
## 326  1.42e-04 -7.45e-05 -1.62e-03 -1.33e-04  0.002774 1.012 1.93e-06
## 79  -1.08e-02 -5.64e-03 -1.82e-03  1.09e-02 -0.015358 1.016 5.91e-05
## 270  3.58e-02  3.61e-02  3.60e-02 -3.60e-02  0.092173 1.005 2.12e-03
## 382  1.02e-03 -1.97e-03  1.41e-02 -1.06e-03  0.027626 1.009 1.91e-04
## 184 -2.12e-02 -3.30e-02  2.41e-02  2.11e-02 -0.050774 1.011 6.45e-04
## 574  1.67e-01 -5.34e-02 -7.42e-02 -1.66e-01 -0.234054 0.961 1.35e-02
## 4   -2.03e-01 -1.64e-01  1.20e-01  2.03e-01 -0.306544 0.940 2.31e-02
## 661 -3.99e-02 -2.02e-02  1.25e-02  3.99e-02  0.054453 1.012 7.42e-04
## 552 -1.07e-02  2.93e-03  3.15e-02  1.06e-02  0.040490 1.022 4.11e-04
## 212  2.08e-02 -1.78e-03 -2.65e-02 -2.06e-02  0.044862 1.011 5.04e-04
## 195 -1.09e-02 -6.98e-03  1.35e-03  1.09e-02 -0.019843 1.011 9.86e-05
## 511  5.30e-03  3.63e-03 -1.50e-02 -5.25e-03 -0.018007 1.019 8.12e-05
## 479  5.88e-03 -1.56e-03  1.56e-03 -5.89e-03 -0.010752 1.011 2.90e-05
## 605 -2.11e-02 -1.52e-02 -2.48e-02  2.13e-02  0.046828 1.024 5.49e-04
## 634  9.38e-03 -6.88e-03  5.04e-03 -9.39e-03 -0.013441 1.016 4.53e-05
## 578  1.36e-01 -1.16e-01  1.02e-01 -1.36e-01 -0.208755 0.981 1.08e-02
## 510 -1.87e-02 -2.31e-02  6.69e-03  1.88e-02  0.042773 1.009 4.58e-04
## 424  2.36e-03 -2.67e-02  9.17e-02 -2.68e-03  0.107392 1.004 2.88e-03
## 379  7.92e-04  4.69e-03  5.72e-03 -8.19e-04  0.024403 1.009 1.49e-04
## 108  2.07e-02  5.24e-04  1.42e-02 -2.08e-02  0.029994 1.017 2.25e-04
## 131  5.83e-02 -2.88e-02  7.00e-02 -5.85e-02  0.099244 1.015 2.46e-03
## 343 -2.40e-04 -8.74e-03 -5.13e-03  2.82e-04 -0.020229 1.011 1.02e-04
## 41  -5.04e-03  4.19e-03 -6.04e-04  5.03e-03 -0.007313 1.018 1.34e-05
## 627  5.19e-02 -3.15e-02 -1.64e-02 -5.17e-02 -0.076767 1.012 1.47e-03
## 298 -4.60e-03  7.38e-02 -6.29e-02  4.63e-03 -0.090813 1.013 2.06e-03
## 258  2.59e-02  1.52e-02  3.83e-02 -2.61e-02  0.068645 1.010 1.18e-03
## 629 -2.74e-03 -1.76e-03  1.02e-03  2.74e-03  0.003914 1.016 3.84e-06
## 696 -1.22e-01 -6.89e-02 -4.25e-02  1.23e-01  0.188549 0.983 8.83e-03
## 182 -7.92e-03  9.88e-03 -3.00e-03  7.90e-03 -0.015850 1.013 6.29e-05
## 305  1.82e-03 -2.02e-02 -9.02e-03 -1.71e-03  0.030438 1.021 2.32e-04
## 358  9.19e-04 -1.67e-02  2.03e-02 -9.56e-04  0.023963 1.023 1.44e-04
## 307 -8.39e-04 -4.29e-03  1.87e-02  7.54e-04 -0.023477 1.014 1.38e-04
## 668 -3.96e-02  3.72e-02 -3.10e-02  3.97e-02  0.062622 1.015 9.82e-04
## 221  3.05e-02 -4.62e-02  6.67e-03 -3.03e-02  0.067128 1.009 1.13e-03
## 561 -2.35e-02  1.03e-02  5.27e-02  2.32e-02  0.075148 1.014 1.41e-03
## 313  6.34e-04 -8.56e-03  2.07e-03 -6.13e-04  0.009861 1.018 2.44e-05
## 136  7.19e-02  1.66e-02  4.34e-02 -7.22e-02  0.106315 1.007 2.82e-03
## 145 -9.26e-02  1.03e-01 -5.60e-02  9.24e-02 -0.178989 0.960 7.92e-03
## 123  1.96e-02  6.24e-03  1.75e-02 -1.96e-02  0.033572 1.020 2.82e-04
## 234  1.71e-02  4.00e-02 -3.63e-02 -1.71e-02  0.054690 1.016 7.49e-04
## 608  4.69e-02 -1.11e-03 -1.18e-02 -4.69e-02 -0.059366 1.010 8.82e-04
## 495 -1.46e-02  1.29e-02 -3.28e-02  1.48e-02  0.042224 1.014 4.46e-04
## 534 -1.26e-02  9.70e-03  1.45e-02  1.25e-02  0.031217 1.013 2.44e-04
```

```
## 297 -4.66e-03  7.93e-02 -1.52e-01  5.08e-03 -0.168017 1.001 7.04e-03
## 208  3.53e-02 -4.56e-02 -3.40e-02 -3.50e-02  0.091461 1.011 2.09e-03
## 677 -4.44e-02  2.89e-02 -7.97e-03  4.44e-02  0.060848 1.012 9.27e-04
## 569  1.51e-01  2.90e-01 -2.89e-02 -1.52e-01 -0.369147 0.971 3.37e-02
## 522 -2.88e-02  2.77e-02 -5.53e-02  2.90e-02  0.075776 1.007 1.44e-03
## 248  1.52e-02  1.45e-03  2.99e-02 -1.53e-02  0.042650 1.015 4.55e-04
## 365  6.85e-04  7.15e-03 -5.07e-03 -6.71e-04  0.020093 1.009 1.01e-04
## 643 -6.81e-02 -6.47e-02 -4.97e-02  6.86e-02  0.139504 1.011 4.86e-03
## 595  5.42e-03  9.22e-03 -2.53e-03 -5.44e-03 -0.011816 1.024 3.50e-05
## 434  5.18e-02 -4.08e-02  6.01e-02 -5.20e-02 -0.111539 0.989 3.10e-03
## 218  2.71e-02 -3.74e-02  4.30e-03 -2.70e-02  0.057345 1.010 8.23e-04
## 508 -1.34e-02 -1.89e-02  1.55e-02  1.34e-02  0.032825 1.011 2.70e-04
## 276 -9.58e-03  5.62e-02 -4.08e-02  9.49e-03 -0.157985 0.928 6.12e-03
## 169 -1.80e-03  2.80e-03  1.50e-03  1.78e-03 -0.004869 1.019 5.94e-06
## 71  -2.56e-02  5.54e-03 -2.80e-02  2.57e-02 -0.042582 1.019 4.54e-04
## 573  1.32e-01  2.90e-03  7.77e-03 -1.32e-01 -0.164309 0.977 6.70e-03
## 697 -7.63e-02  6.52e-02 -3.25e-02  7.63e-02  0.112227 1.006 3.15e-03
## 485 -2.36e-03 -5.74e-03  4.68e-03  2.36e-03  0.007805 1.016 1.53e-05
## 460  1.46e-02 -8.97e-03  1.59e-02 -1.46e-02 -0.030752 1.010 2.37e-04
## 60   1.86e-02  1.54e-02 -2.85e-02 -1.85e-02  0.036637 1.025 3.36e-04
## 449  4.89e-02 -4.81e-03 -7.22e-02 -4.86e-02 -0.118741 0.993 3.51e-03
## 548 -2.23e-02 -1.62e-03  4.19e-02  2.21e-02  0.059945 1.011 8.99e-04
## 19  -6.30e-02 -1.35e-02  4.98e-02  6.28e-02 -0.091103 1.010 2.08e-03
## 319  1.25e-03 -1.17e-02 -5.85e-03 -1.18e-03  0.019726 1.015 9.75e-05
## 116  1.15e-01 -2.40e-01  1.57e-01 -1.15e-01  0.278872 1.019 1.94e-02
## 660 -3.66e-02 -2.34e-02  1.97e-02  3.66e-02  0.053094 1.013 7.06e-04
## 102  8.97e-02 -3.03e-02 -4.86e-02 -8.94e-02  0.128943 1.004 4.15e-03
## 214 -3.59e-03 -5.32e-03  2.84e-03  3.59e-03 -0.008254 1.014 1.71e-05
## 390  1.04e-04  2.61e-02 -8.06e-03 -1.32e-04  0.036346 1.010 3.31e-04
## 597  4.82e-02 -1.33e-02  1.68e-02 -4.82e-02 -0.061937 1.010 9.60e-04
## 625  4.64e-02 -1.68e-02 -1.98e-02 -4.63e-02 -0.065530 1.012 1.07e-03
## 160 -3.37e-02  8.42e-02 -3.98e-02  3.36e-02 -0.097908 1.015 2.40e-03
## 77   3.58e-02 -1.07e-02 -3.97e-03 -3.57e-02  0.044850 1.013 5.04e-04
## 529 -1.91e-02  2.88e-02 -8.76e-03  1.91e-02  0.043465 1.011 4.73e-04
## 126  5.82e-02  5.21e-02 -2.72e-02 -5.82e-02  0.089829 1.011 2.02e-03
## 262  2.54e-02  1.72e-02  4.51e-02 -2.56e-02  0.075109 1.012 1.41e-03
## 442  2.05e-02  3.86e-02  2.73e-03 -2.07e-02 -0.060070 1.010 9.03e-04
## 181 -3.72e-02 -4.55e-04 -6.26e-02  3.75e-02 -0.093894 1.005 2.20e-03
## 163 -3.60e-02 -7.59e-02  1.06e-01  3.57e-02 -0.127472 1.012 4.06e-03
## 474  3.32e-03  3.76e-03 -1.05e-03 -3.33e-03 -0.007392 1.012 1.37e-05
## 228  4.78e-02 -1.13e-02 -9.69e-02 -4.72e-02  0.135210 1.005 4.56e-03
## 628 -5.48e-03 -2.79e-03  7.96e-04  5.49e-03  0.007503 1.015 1.41e-05
## 265  3.93e-02  5.23e-02 -3.59e-03 -3.94e-02  0.089064 1.001 1.98e-03
## 427  3.24e-05  1.75e-02  6.79e-02 -3.81e-04  0.095713 1.010 2.29e-03
## 632  3.05e-02 -1.85e-02  4.61e-05 -3.04e-02 -0.041874 1.014 4.39e-04
## 249  3.01e-02  1.70e-02  6.53e-03 -3.02e-02  0.056208 1.005 7.90e-04
## 655 -5.95e-02 -1.75e-02 -3.73e-02  5.98e-02  0.092069 1.009 2.12e-03
## 40   5.28e-03 -5.35e-03  2.80e-04 -5.26e-03  0.008374 1.021 1.76e-05
## 541 -3.23e-02  6.20e-02 -5.16e-02  3.24e-02  0.087308 1.007 1.91e-03
## 497  3.80e-03 -4.52e-03  1.22e-03 -3.79e-03 -0.007967 1.013 1.59e-05
## 701 -7.06e-02  3.43e-02  3.74e-02  7.04e-02  0.107580 1.008 2.89e-03
## 450  3.14e-02  3.38e-05  4.84e-03 -3.14e-02 -0.057383 1.002 8.23e-04
## 600  4.23e-02  4.61e-03  9.45e-04 -4.24e-02 -0.053049 1.010 7.04e-04
## 363  3.56e-03 -2.66e-02 -1.07e-02 -3.40e-03  0.052903 1.006 7.00e-04
```

```
## 478  8.38e-03 -1.08e-02  1.13e-02 -8.41e-03 -0.019653 1.013 9.67e-05
## 403  1.48e-04  4.82e-02 -2.49e-02 -1.56e-04  0.063961 1.006 1.02e-03
## 375  4.90e-04  1.12e-02 -2.41e-03 -5.00e-04  0.023010 1.009 1.33e-04
## 335 -3.22e-04 -7.18e-03 -1.86e-03  3.44e-04 -0.016811 1.010 7.08e-05
## 142  6.09e-02  9.44e-03  7.79e-02 -6.12e-02  0.118416 1.017 3.51e-03
## 444  3.56e-02 -4.02e-02  5.82e-02 -3.58e-02 -0.087475 1.003 1.91e-03
## 599  3.67e-02 -5.46e-03  1.70e-02 -3.68e-02 -0.048674 1.012 5.93e-04
## 640 -1.48e-02 -1.97e-02  1.75e-02  1.48e-02  0.029313 1.022 2.15e-04
## 457  2.28e-03  6.79e-04  4.21e-03 -2.30e-03 -0.006632 1.015 1.10e-05
## 188  9.85e-03 -4.48e-03 -1.35e-02 -9.76e-03  0.023390 1.015 1.37e-04
## 432  5.73e-02  1.38e-01 -1.34e-01 -5.72e-02 -0.196530 0.982 9.59e-03
## 488  9.30e-05 -1.12e-04  1.23e-04 -9.33e-05 -0.000214 1.013 1.15e-08
## 538 -1.96e-02  1.02e-02  1.86e-02  1.95e-02  0.043532 1.010 4.74e-04
## 657  1.10e-03 -2.99e-05 -8.15e-04 -1.10e-03 -0.001627 1.017 6.63e-07
## 215 -1.37e-03 -2.21e-04 -5.21e-04  1.38e-03 -0.002409 1.012 1.45e-06
## 540 -2.15e-02  9.42e-03  2.12e-02  2.14e-02  0.047497 1.009 5.65e-04
## 590  4.91e-02 -1.36e-02  3.34e-02 -4.92e-02 -0.069329 1.011 1.20e-03
## 296 -2.13e-03 -1.26e-02 -1.54e-02  2.20e-03 -0.065570 0.996 1.07e-03
## 328  6.29e-05  1.01e-03 -1.95e-03 -5.58e-05  0.002468 1.014 1.53e-06
## 147 -5.73e-02  1.83e-01 -1.14e-01  5.72e-02 -0.204776 1.011 1.05e-02
## 84   1.02e-03  6.56e-04 -2.06e-04 -1.02e-03  0.001434 1.017 5.15e-07
## 83   2.59e-02 -6.69e-03  4.55e-03 -2.58e-02  0.031718 1.014 2.52e-04
## 250  1.72e-02  1.01e-02  2.55e-02 -1.73e-02  0.045596 1.013 5.21e-04
## 621  1.39e-02  5.80e-03 -3.83e-03 -1.39e-02 -0.018538 1.014 8.61e-05
## 281 -5.29e-03  2.70e-02 -7.03e-02  5.47e-03 -0.124815 0.969 3.86e-03
## 431  6.61e-02 -2.91e-02  2.23e-02 -6.62e-02 -0.122121 0.973 3.70e-03
## 30  -8.43e-02  1.40e-03 -4.58e-02  8.45e-02 -0.114353 1.003 3.26e-03
## 10  -1.35e-01  2.97e-02 -9.54e-04  1.35e-01 -0.165117 0.982 6.77e-03
## 587  7.38e-02 -4.21e-02  4.68e-02 -7.39e-02 -0.104278 1.005 2.72e-03
## 441  3.86e-02 -9.06e-02  1.19e-01 -3.89e-02 -0.143001 1.010 5.11e-03
## 663 -3.84e-02  2.19e-02 -2.44e-02  3.85e-02  0.054315 1.013 7.38e-04
## 345  1.29e-04  3.66e-03 -3.22e-03 -1.22e-04  0.006444 1.012 1.04e-05
## 12  -1.08e-01  2.39e-02  4.81e-02  1.08e-01 -0.144999 0.996 5.24e-03
## 293  9.57e-05 -1.23e-03 -1.87e-04 -9.04e-05  0.001560 1.024 6.10e-07
## 303 -1.72e-03 -1.18e-02 -2.69e-02  1.85e-03 -0.067026 0.999 1.12e-03
## 338  6.08e-04 -3.73e-03  6.50e-04 -5.93e-04  0.009243 1.010 2.14e-05
## 350 -4.12e-04  1.75e-03 -1.65e-02  4.76e-04 -0.021537 1.014 1.16e-04
## 581  8.75e-02 -5.36e-03  5.22e-02 -8.78e-02 -0.122517 0.999 3.74e-03
## 107  5.14e-02 -1.93e-02  1.94e-02 -5.14e-02  0.065580 1.011 1.08e-03
## 543 -3.32e-02  6.12e-02 -5.21e-02  3.33e-02  0.088160 1.006 1.94e-03
## 518 -1.22e-02  1.12e-03  5.94e-03  1.21e-02  0.022919 1.010 1.32e-04
## 691 -4.79e-02  1.73e-02  2.04e-02  4.78e-02  0.067597 1.012 1.14e-03
## 43  -7.11e-03  1.02e-03  3.41e-03  7.09e-03 -0.009512 1.016 2.27e-05
## 189 -1.84e-02 -2.09e-02  1.18e-02  1.84e-02 -0.038101 1.010 3.63e-04
## 171 -3.68e-02 -3.90e-02  1.10e-02  3.68e-02 -0.074868 1.002 1.40e-03
## 39  -2.44e-02 -3.31e-03  1.47e-02  2.43e-02 -0.033023 1.015 2.73e-04
## 216  1.53e-02  4.00e-02 -5.82e-02 -1.51e-02  0.066261 1.027 1.10e-03
## 291 -3.77e-03  3.10e-02 -1.89e-02  3.73e-03 -0.059094 1.001 8.73e-04
## 58  -6.78e-03  1.22e-03  6.62e-05  6.78e-03 -0.008240 1.015 1.70e-05
## 395  7.44e-04 -3.16e-03  2.98e-02 -8.60e-04  0.038950 1.012 3.80e-04
## 693 -6.59e-02  2.66e-02  5.77e-03  6.58e-02  0.086188 1.006 1.86e-03
## 456  4.43e-02 -3.40e-02 -6.47e-02 -4.39e-02 -0.119924 1.000 3.59e-03
## 22  -1.07e-01 -2.91e-02 -4.60e-02  1.08e-01 -0.150225 0.994 5.62e-03
## 170 -4.30e-03  7.29e-03  2.17e-03  4.27e-03 -0.011303 1.018 3.20e-05
```

```
## 63  -9.83e-03 -3.82e-03  9.36e-04  9.83e-03 -0.012708 1.015 4.05e-05
## 547 -3.28e-02 -2.79e-03  1.86e-02  3.27e-02  0.062242 1.002 9.68e-04
## 417  1.13e-03 -5.49e-03  6.16e-02 -1.38e-03  0.076878 1.009 1.48e-03
## 70   1.34e-02  6.77e-03 -8.21e-03 -1.33e-02  0.018689 1.016 8.75e-05
## 59  -4.55e-02 -1.42e-02 -1.87e-02  4.56e-02 -0.064164 1.013 1.03e-03
## 484  1.77e-02 -1.94e-02 -6.36e-03 -1.76e-02 -0.039247 1.011 3.86e-04
## 203 -7.00e-03  6.36e-03 -9.81e-03  7.02e-03 -0.015182 1.014 5.77e-05
## 227  1.50e-02 -5.72e-03  8.95e-03 -1.50e-02  0.026149 1.010 1.71e-04
## 243  5.51e-02  1.59e-02 -1.11e-01 -5.46e-02  0.146358 0.997 5.34e-03
## 413  4.46e-03  1.84e-03 -4.21e-02 -4.22e-03  0.086170 0.990 1.85e-03
## 476  7.92e-03 -3.49e-03  5.39e-03 -7.94e-03 -0.015296 1.011 5.86e-05
## 650 -2.89e-02 -9.51e-03  2.02e-03  2.89e-02  0.037594 1.013 3.54e-04
## 405  1.30e-03  2.42e-02 -4.59e-03 -1.32e-03  0.054040 1.002 7.30e-04
## 397  3.31e-05  5.61e-03  1.59e-02 -1.18e-04  0.024273 1.016 1.48e-04
## 501 -2.07e-02  9.16e-03 -4.34e-02  2.09e-02  0.058752 1.011 8.64e-04
## 429  4.50e-02  1.69e-01  6.99e-02 -4.59e-02 -0.250530 0.999 1.56e-02
## 205  2.82e-02 -5.73e-02  5.09e-03 -2.80e-02  0.073945 1.014 1.37e-03
## 475  4.75e-03  2.72e-02 -2.62e-02 -4.72e-03 -0.033297 1.040 2.78e-04
## 104 -3.46e-03 -1.10e-03 -3.09e-03  3.48e-03 -0.005944 1.021 8.85e-06
## 210  3.96e-03  4.43e-03 -4.95e-03 -3.95e-03  0.008755 1.014 1.92e-05
## 471 -2.55e-03 -7.51e-03  2.72e-03  2.56e-03  0.009167 1.017 2.11e-05
## 66  -7.18e-03  3.55e-03 -6.38e-03  7.20e-03 -0.010762 1.018 2.90e-05
## 88   2.63e-02  1.55e-02 -1.71e-02 -2.62e-02  0.037699 1.016 3.56e-04
## 667 -2.90e-02  1.53e-02 -3.69e-03  2.90e-02  0.038380 1.014 3.69e-04
## 309 -4.02e-04 -6.90e-03  1.58e-02  3.43e-04 -0.018077 1.017 8.19e-05
## 596  3.83e-02  4.24e-03  7.25e-03 -3.84e-02 -0.049095 1.011 6.03e-04
## 294 -7.67e-04 -5.57e-02  1.59e-02  8.25e-04 -0.085961 0.995 1.84e-03
## 421  1.59e-04  9.43e-02 -7.82e-02 -4.34e-05  0.123710 0.996 3.82e-03
## 703 -7.57e-02  3.67e-02  4.01e-02  7.54e-02  0.115280 1.006 3.32e-03
## 430  4.70e-02  1.05e-01  3.69e-02 -4.75e-02 -0.168794 0.991 7.09e-03
## 512 -1.36e-02  1.75e-02 -1.84e-02  1.37e-02  0.031899 1.012 2.55e-04
## 361  1.84e-02 -2.89e-01  3.71e-02 -1.76e-02  0.314731 1.011 2.46e-02
## 630 -7.30e-03  2.33e-03 -5.10e-03  7.32e-03  0.010357 1.016 2.69e-05
## 480 -2.91e-02 -1.51e-01 -1.90e-02  2.97e-02  0.189047 1.019 8.92e-03
## 15  -7.69e-02  7.50e-02  8.38e-03  7.66e-02 -0.123891 1.011 3.84e-03
## 486 -1.76e-02 -4.12e-02 -6.21e-03  1.78e-02  0.060592 1.013 9.19e-04
## 254  3.38e-02  3.58e-02 -1.01e-02 -3.38e-02  0.068719 1.004 1.18e-03
## 213  6.86e-03 -6.68e-03  5.74e-03 -6.86e-03  0.013216 1.013 4.38e-05
## 458  1.56e-02 -2.29e-02  3.28e-02 -1.57e-02 -0.043871 1.014 4.82e-04
## 290 -3.54e-03  2.93e-02  9.51e-04  3.41e-03 -0.051303 1.005 6.58e-04
## 491 -1.45e-02  1.53e-02 -3.86e-02  1.46e-02  0.046692 1.016 5.46e-04
## 576  2.90e-02  8.89e-02 -7.58e-03 -2.92e-02 -0.103450 1.044 2.68e-03
## 178 -2.13e-02  1.64e-03 -3.72e-03  2.13e-02 -0.035306 1.008 3.12e-04
## 428  8.65e-02 -2.47e-01  3.98e-01 -8.77e-02 -0.433153 0.974 4.63e-02
## 562 -3.69e-02  5.53e-02 -5.08e-03  3.68e-02  0.085560 1.003 1.83e-03
## 115  5.93e-02  2.77e-02 -2.62e-02 -5.92e-02  0.079524 1.009 1.58e-03
## 165 -4.50e-02 -2.54e-02 -9.74e-03  4.51e-02 -0.083849 0.997 1.75e-03
## 377  9.95e-04  2.40e-02 -2.86e-02 -9.13e-04  0.045413 1.008 5.16e-04
## 194 -4.49e-03  3.54e-04  5.47e-04  4.48e-03 -0.007404 1.011 1.37e-05
## 230  6.69e-03  2.72e-03  3.95e-03 -6.71e-03  0.012993 1.012 4.23e-05
## 603 -2.45e-02 -3.05e-02 -1.96e-02  2.47e-02  0.057376 1.025 8.24e-04
## 389  6.50e-04  3.26e-02 -2.57e-02 -6.07e-04  0.050021 1.007 6.26e-04
## 694 -8.40e-02 -1.62e-02  2.91e-02  8.40e-02  0.108483 0.999 2.94e-03
## 87   8.88e-02 -8.33e-02 -2.40e-02 -8.84e-02  0.146732 1.009 5.38e-03
```

```
## 648 -1.45e-02  1.01e-02 -9.91e-03  1.45e-02  0.021168 1.016 1.12e-04
## 378  7.56e-04  1.46e-02 -9.02e-03 -7.42e-04  0.029975 1.008 2.25e-04
## 436  4.22e-02 -5.16e-02  9.97e-02 -4.26e-02 -0.125386 1.000 3.92e-03
## 519 -4.71e-02  4.68e-02 -2.13e-01  4.81e-02  0.235157 1.007 1.38e-02
## 592  5.25e-02  6.72e-02 -6.09e-02 -5.24e-02 -0.102007 1.015 2.60e-03
## 311 -1.91e-03  1.50e-02 -6.56e-02  2.14e-03 -0.082084 1.005 1.68e-03
## 155 -3.73e-02 -4.92e-02  1.06e-01  3.69e-02 -0.122653 1.011 3.76e-03
## 166 -2.88e-02  2.78e-02 -7.45e-03  2.87e-02 -0.053417 1.007 7.14e-04
## 207 -8.27e-03 -4.67e-03 -1.79e-03  8.29e-03 -0.015419 1.012 5.96e-05
## 674 -5.54e-02  3.61e-02 -2.79e-02  5.54e-02  0.077357 1.010 1.50e-03
## 468  2.00e-02 -3.04e-02  2.22e-02 -2.00e-02 -0.046955 1.010 5.52e-04
## 105  1.52e-01 -1.14e-01 -1.85e-01 -1.51e-01  0.329846 0.995 2.70e-02
## 75   2.44e-03  2.48e-03 -2.04e-03 -2.43e-03  0.004081 1.020 4.17e-06
## 280 -9.29e-03  1.16e-01 -4.03e-02  9.05e-03 -0.141637 0.989 4.99e-03
## 636 -5.78e-03 -1.64e-03  1.26e-03  5.78e-03  0.007446 1.014 1.39e-05
## 440  3.17e-02  5.48e-02 -2.96e-02 -3.18e-02 -0.082729 1.003 1.71e-03
## 656 -5.15e-02 -2.42e-02 -1.10e-02  5.16e-02  0.073661 1.010 1.36e-03
## 251  3.63e-02  2.91e-02 -1.81e-02 -3.63e-02  0.068602 1.002 1.18e-03
## 231  1.43e-02  1.63e-02 -9.22e-03 -1.43e-02  0.029728 1.011 2.21e-04
## 52  -5.49e-02 -1.49e-02 -2.35e-02  5.51e-02 -0.076863 1.011 1.48e-03
## 520  6.68e-03 -1.26e-03 -1.79e-02 -6.60e-03 -0.023375 1.020 1.37e-04
## 704 -7.57e-02  3.67e-02  4.01e-02  7.54e-02  0.115280 1.006 3.32e-03
## 463  2.50e-02 -2.36e-02  5.42e-03 -2.50e-02 -0.049635 1.007 6.16e-04
## 100  5.51e-02  8.13e-02 -1.01e-01 -5.48e-02  0.129762 1.025 4.21e-03
## 407  8.61e-03 -9.25e-02  1.21e-02 -8.31e-03  0.125886 0.988 3.94e-03
## 591  4.75e-02 -1.11e-02  3.16e-02 -4.76e-02 -0.066855 1.011 1.12e-03
## 141  9.02e-02  2.44e-02  3.86e-02 -9.04e-02  0.126223 1.001 3.98e-03
## 412 -5.88e-05  3.01e-02  1.51e-02 -8.58e-05  0.055406 1.008 7.68e-04
## 672 -3.72e-02  1.50e-02 -2.76e-03  3.72e-02  0.047772 1.012 5.71e-04
## 679 -6.49e-02 -5.30e-02  5.10e-02  6.48e-02  0.103021 1.008 2.65e-03
## 470 -1.21e-02 -3.69e-02 -6.06e-03  1.23e-02  0.050914 1.018 6.49e-04
## 36  -3.91e-02  8.66e-04  9.01e-03  3.91e-02 -0.048175 1.012 5.81e-04
## 114  1.26e-02  2.95e-03  1.16e-02 -1.26e-02  0.021317 1.020 1.14e-04
## 642 -1.40e-03  1.26e-03 -1.07e-03  1.40e-03  0.002181 1.018 1.19e-06
## 362  2.23e-03  7.13e-02 -1.66e-01 -1.63e-03  0.173712 1.021 7.54e-03
## 386  2.49e-05  3.02e-02 -1.55e-02 -3.11e-05  0.039328 1.011 3.87e-04
## 273  4.29e-02  1.78e-02  5.23e-02 -4.32e-02  0.100719 1.000 2.53e-03
## 196 -8.10e-03 -3.22e-03  1.83e-04  8.10e-03 -0.014061 1.011 4.95e-05
## 86  -1.70e-02 -6.77e-03 -9.13e-03  1.70e-02 -0.025851 1.017 1.67e-04
## 138  7.12e-02  4.03e-02  2.21e-02 -7.14e-02  0.106866 1.008 2.85e-03
## 344 -1.34e-04 -8.04e-03 -3.33e-04  1.54e-04 -0.014100 1.011 4.98e-05
## 211 -1.01e-02 -8.32e-03 -4.34e-03  1.02e-02 -0.021254 1.012 1.13e-04
## 517 -1.66e-02  4.41e-03 -4.40e-03  1.66e-02  0.030339 1.009 2.30e-04
## 641  1.83e-02  1.14e-02 -2.49e-02 -1.82e-02 -0.033739 1.021 2.85e-04
## 686 -1.04e-01 -6.85e-02 -3.25e-02  1.05e-01  0.165499 0.992 6.82e-03
## 586  7.51e-02 -2.40e-02  2.75e-02 -7.52e-02 -0.097228 1.003 2.36e-03
## 670 -6.05e-03  2.19e-03  4.50e-03  6.03e-03  0.009657 1.019 2.34e-05
## 692 -3.65e-02  1.62e-02  2.58e-02  3.64e-02  0.058783 1.016 8.65e-04
## 443  3.57e-02  2.29e-02 -1.66e-02 -3.58e-02 -0.070735 0.999 1.25e-03
## 339  5.35e-03 -1.03e-01  7.29e-02 -5.34e-03  0.112016 1.038 3.14e-03
## 122  2.98e-02 -2.82e-03  3.12e-02 -2.99e-02  0.049418 1.019 6.12e-04
## 202 -1.02e-02 -5.31e-05 -7.63e-03  1.02e-02 -0.019063 1.012 9.10e-05
## 530 -8.32e-03  2.26e-03  1.68e-02  8.24e-03  0.024391 1.016 1.49e-04
## 544 -2.07e-02  1.76e-02  1.64e-02  2.06e-02  0.047447 1.010 5.63e-04
```

```
## 638 -5.23e-03 -5.22e-03  5.41e-03  5.22e-03  0.009183 1.019 2.11e-05
## 467  6.61e-03 -1.24e-02  1.93e-02 -6.67e-03 -0.023007 1.020 1.33e-04
## 342 -2.14e-05 -1.46e-02  4.60e-03  3.71e-05 -0.019826 1.012 9.85e-05
## 99   1.54e-02 -6.99e-03  1.82e-02 -1.54e-02  0.026025 1.021 1.70e-04
## 371  1.10e-03  3.15e-02 -4.86e-02 -9.46e-04  0.060901 1.010 9.28e-04
## 380  2.84e-04  1.01e-03  1.04e-02 -3.30e-04  0.015939 1.012 6.36e-05
## 97   1.38e-02  1.00e-02 -3.26e-03 -1.38e-02  0.019932 1.017 9.95e-05
## 49  -1.57e-02 -8.90e-04  6.55e-03  1.57e-02 -0.020088 1.015 1.01e-04
## 242  1.83e-02 -1.31e-03  1.98e-02 -1.83e-02  0.037304 1.011 3.48e-04
## 175 -2.72e-02 -2.61e-02  2.38e-02  2.72e-02 -0.055043 1.007 7.58e-04
## 566 -3.13e-02  2.90e-02  4.32e-02  3.10e-02  0.085741 1.008 1.84e-03
## 260  3.95e-02  6.55e-02 -3.42e-02 -3.95e-02  0.095875 1.002 2.30e-03
## 437  4.99e-02 -7.67e-02  8.91e-02 -5.02e-02 -0.131611 0.994 4.32e-03
## 521 -7.80e-04  4.06e-04  1.23e-03  7.73e-04  0.002086 1.015 1.09e-06
## 174 -4.11e-02  9.35e-03 -5.98e-02  4.14e-02 -0.092963 1.002 2.16e-03
## 671 -1.98e-02  1.13e-02  3.49e-03  1.98e-02  0.027829 1.016 1.94e-04
## 42  -3.49e-02  4.23e-02 -4.08e-02  3.50e-02 -0.063875 1.022 1.02e-03
## 183 -2.10e-02 -4.92e-02  4.46e-02  2.10e-02 -0.067196 1.015 1.13e-03
## 347  8.24e-03 -3.13e-02 -1.63e-01 -7.32e-03  0.208181 1.010 1.08e-02
## 374  2.99e-03 -1.56e-02 -6.98e-03 -2.88e-03  0.045578 1.004 5.20e-04
## 74   6.70e-02 -4.80e-02 -2.48e-02 -6.67e-02  0.103777 1.012 2.69e-03
## 549 -3.17e-02 -2.26e-02  4.86e-02  3.16e-02  0.075654 1.004 1.43e-03
## 425  6.80e-03 -9.13e-03 -7.23e-02 -6.36e-03  0.128097 0.975 4.07e-03
## 483  2.00e-02 -2.68e-02 -5.02e-03 -1.99e-02 -0.046629 1.011 5.44e-04
## 118  5.37e-02  2.98e-02 -1.73e-02 -5.37e-02  0.072960 1.010 1.33e-03
## 271  4.74e-02  4.26e-02  3.90e-03 -4.76e-02  0.095510 0.995 2.28e-03
## 555 -2.85e-02  4.03e-02  6.12e-03  2.84e-02  0.067509 1.008 1.14e-03
## 535 -1.19e-02  1.10e-02  1.27e-02  1.18e-02  0.029823 1.014 2.23e-04
## 357  1.67e-03 -2.47e-02  2.40e-02 -1.69e-03  0.033560 1.015 2.82e-04
## 252  2.70e-02  4.27e-02 -1.39e-02 -2.70e-02  0.064194 1.008 1.03e-03
## 448  3.87e-02 -6.52e-02  5.83e-02 -3.88e-02 -0.098966 1.002 2.45e-03
## 411 -4.14e-05  5.05e-02 -1.62e-02 -1.35e-05  0.067032 1.005 1.12e-03
## 637  2.90e-02 -1.05e-02 -1.24e-02 -2.89e-02 -0.040876 1.015 4.18e-04
## 533 -2.30e-02 -3.16e-02  5.05e-02  2.29e-02  0.067318 1.010 1.13e-03
## 61   6.03e-02 -6.76e-02 -2.68e-03 -6.01e-02  0.102350 1.017 2.62e-03
## 54  -9.70e-03 -3.29e-03  6.74e-03  9.68e-03 -0.013576 1.017 4.62e-05
## 308 -1.76e-03  5.99e-03 -3.62e-02  1.88e-03 -0.056447 1.005 7.97e-04
## 582  1.36e-01 -1.11e-01  1.21e-02 -1.36e-01 -0.199895 0.981 9.92e-03
## 240  4.51e-02 -5.30e-02  3.06e-03 -4.50e-02  0.090406 1.001 2.04e-03
## 179 -2.76e-02  1.47e-02 -3.47e-02  2.77e-02 -0.057105 1.008 8.16e-04
## 370  6.47e-04  2.18e-02 -2.37e-02 -5.87e-04  0.037215 1.010 3.47e-04
## 272  5.70e-02  1.43e-01 -1.43e-01 -5.68e-02  0.197884 0.994 9.75e-03
## 76   2.78e-02 -8.29e-03  1.12e-03 -2.78e-02  0.034242 1.014 2.94e-04
## 493  8.22e-03 -1.04e-02  2.93e-03 -8.21e-03 -0.017577 1.012 7.74e-05
## 224  3.09e-03  3.31e-03  4.19e-05 -3.10e-03  0.006512 1.013 1.06e-05
## 624  3.63e-02  6.09e-04 -2.16e-02 -3.62e-02 -0.050338 1.013 6.34e-04
## 164 -3.54e-02  4.20e-02 -3.26e-02  3.54e-02 -0.071753 1.006 1.29e-03
## 13  -1.24e-01 -2.21e-03  3.06e-02  1.24e-01 -0.152595 0.987 5.79e-03
## 125  7.19e-02  1.02e-02  5.97e-04 -7.20e-02  0.088389 1.005 1.95e-03
## 14  -1.49e-01 -2.77e-02 -4.51e-02  1.49e-01 -0.194992 0.974 9.43e-03
## 675 -6.67e-02  1.28e-02 -2.09e-02  6.68e-02  0.085012 1.005 1.81e-03
## 563 -3.90e-02  6.78e-02 -2.18e-02  3.89e-02  0.094486 1.002 2.23e-03
## 64  -2.51e-02  6.44e-03 -2.39e-02  2.52e-02 -0.038943 1.018 3.80e-04
## 33  -3.35e-02 -3.15e-03  2.47e-02  3.34e-02 -0.047806 1.015 5.72e-04
```

```
## 611  2.62e-02  1.72e-03  1.06e-03 -2.62e-02 -0.032724 1.013 2.68e-04
## 334 -1.22e-04 -2.43e-03  2.35e-03  1.16e-04 -0.004852 1.011 5.90e-06
## 95   2.26e-04 -5.80e-05  2.51e-04 -2.27e-04  0.000377 1.020 3.56e-08
## 639 -1.18e-02  4.78e-03 -6.70e-03  1.19e-02  0.016139 1.015 6.52e-05
## 376  4.22e-04  1.19e-02 -2.79e-03 -4.34e-04  0.022716 1.010 1.29e-04
## 269  3.41e-02  3.44e-02  3.42e-02 -3.43e-02  0.087743 1.006 1.92e-03
## 333  1.62e-04  1.35e-03 -2.57e-03 -1.52e-04  0.004395 1.011 4.84e-06
## 219  1.59e-02  2.67e-02 -3.84e-02 -1.57e-02  0.048434 1.017 5.87e-04
## 658 -7.64e-02 -8.65e-02 -2.29e-02  7.68e-02  0.148014 1.007 5.47e-03
## 588  7.25e-02 -7.84e-03 -3.74e-03 -7.25e-02 -0.089903 1.003 2.02e-03
## 53   1.36e-02  2.87e-03 -1.49e-02 -1.36e-02  0.022373 1.020 1.25e-04
## 367  2.68e-03 -7.94e-03 -1.78e-02 -2.54e-03  0.044945 1.005 5.05e-04
## 601  6.34e-02 -5.68e-02  3.83e-02 -6.35e-02 -0.096117 1.010 2.31e-03
## 499 -8.91e-03  1.15e-02 -1.51e-02  8.95e-03  0.022465 1.014 1.26e-04
## 594  1.83e-02 -1.67e-02  3.53e-02 -1.84e-02 -0.041938 1.028 4.41e-04
## 659 -3.40e-02 -3.71e-03 -7.60e-04  3.41e-02  0.042650 1.012 4.55e-04
## 177  3.77e-02 -1.17e-01 -2.07e-02 -3.72e-02  0.149656 1.029 5.60e-03
## 695 -5.37e-02  2.39e-02  2.94e-02  5.35e-02  0.081258 1.012 1.65e-03
## 416  2.15e-03  2.78e-02 -1.87e-02 -2.10e-03  0.069139 0.995 1.19e-03
## 631  1.83e-03 -8.94e-04  1.10e-03 -1.84e-03 -0.002543 1.016 1.62e-06
## 274 -8.49e-03 -1.76e-01  4.47e-01  6.81e-03 -0.479012 0.911 5.58e-02
## 256  2.92e-02  3.40e-02  8.63e-03 -2.93e-02  0.066539 1.007 1.11e-03
## 415  4.36e-03 -4.27e-02  5.40e-02 -4.44e-03  0.085885 0.996 1.84e-03
## 168 -2.72e-02 -2.77e-02  4.91e-02  2.71e-02 -0.067490 1.010 1.14e-03
## 466  8.14e-03  7.64e-03 -1.91e-03 -8.17e-03 -0.017284 1.011 7.48e-05
## 459  2.93e-02  4.90e-03 -3.73e-02 -2.91e-02 -0.065375 1.005 1.07e-03
## 494  3.46e-03  5.42e-03 -7.91e-03 -3.44e-03 -0.010495 1.016 2.76e-05
## 191  2.70e-04  1.43e-04 -4.23e-04 -2.68e-04  0.000614 1.014 9.46e-08
## 331 -5.98e-05 -1.94e-02  1.00e-02  6.27e-05 -0.025762 1.012 1.66e-04
## 259  3.46e-02  3.14e-02  1.37e-02 -3.47e-02  0.074097 1.004 1.37e-03
## 669 -3.96e-03  1.59e-03  2.87e-03  3.94e-03  0.006338 1.019 1.01e-05
## 31  -6.29e-02  3.78e-03 -5.85e-03  6.29e-02 -0.076213 1.007 1.45e-03
## 418  6.22e-04  1.71e-02  3.76e-02 -8.26e-04  0.068178 1.006 1.16e-03
## 545 -1.51e-02  1.40e-02  2.08e-02  1.49e-02  0.041247 1.014 4.26e-04
## 18  -5.67e-02 -9.79e-03  5.24e-02  5.65e-02 -0.086871 1.013 1.89e-03
## 154 -5.40e-02 -3.84e-02  4.13e-02  5.39e-02 -0.102589 0.991 2.62e-03
## 67   2.74e-02 -7.10e-03 -3.50e-03 -2.73e-02  0.034124 1.014 2.92e-04
## 384  4.08e-04  8.84e-03  7.54e-03 -4.58e-04  0.024935 1.010 1.56e-04
## 277 -1.52e-02  2.17e-01 -1.06e-01  1.50e-02 -0.248802 0.960 1.53e-02
## 354  5.14e-04 -2.43e-03  4.20e-03 -5.20e-04  0.010151 1.010 2.58e-05
## 34  -8.48e-02  1.31e-03 -5.94e-02  8.51e-02 -0.122467 1.004 3.74e-03
## 143 -1.12e-01 -8.69e-02  1.56e-01  1.11e-01 -0.243988 0.929 1.46e-02
## 50  -3.31e-02  6.61e-04 -2.52e-03  3.31e-02 -0.040166 1.013 4.04e-04
## 482  1.08e-02  1.68e-02 -2.84e-02 -1.07e-02 -0.035214 1.016 3.11e-04
## 406  1.01e-03  8.17e-03  2.72e-02 -1.14e-03  0.051750 1.006 6.70e-04
## 481 -2.25e-03 -1.26e-03 -6.29e-04  2.26e-03  0.004603 1.012 5.31e-06
## 610  2.93e-02  3.06e-02 -3.10e-02 -2.93e-02 -0.052365 1.018 6.87e-04
## 152 -1.76e-02  6.06e-02 -1.01e-02  1.74e-02 -0.067481 1.032 1.14e-03
## 94   1.75e-02  1.11e-03  6.19e-03 -1.75e-02  0.022637 1.015 1.28e-04
## 127  1.07e-01 -1.13e-01  7.04e-02 -1.07e-01  0.169494 1.001 7.16e-03
## 332  1.22e-04  2.56e-03 -3.84e-03 -1.09e-04  0.005292 1.013 7.02e-06
## 323 -3.78e-04 -5.80e-03  9.92e-03  3.43e-04 -0.013806 1.012 4.77e-05
## 368  1.48e-03  9.87e-03 -2.15e-02 -1.39e-03  0.037544 1.007 3.53e-04
## 353 -1.80e-04 -3.76e-03 -6.10e-03  2.15e-04 -0.013364 1.012 4.47e-05
```

```
## 35  -3.02e-02  2.85e-02 -1.40e-02  3.01e-02 -0.045248 1.018 5.13e-04
## 688 -6.37e-02  1.24e-02  1.14e-02  6.37e-02  0.080947 1.006 1.64e-03
## 402  1.78e-03 -3.21e-02  7.10e-02 -2.00e-03  0.077030 1.019 1.49e-03
## 699 -6.88e-02  4.18e-02  1.09e-02  6.86e-02  0.097515 1.007 2.38e-03
## 68   7.88e-03  3.36e-03 -3.34e-03 -7.88e-03  0.010447 1.016 2.73e-05
## 360 -8.77e-06 -8.14e-03 -4.64e-03  5.00e-05 -0.015747 1.013 6.21e-05
## 653 -5.14e-03  3.97e-03 -2.01e-03  5.14e-03  0.007340 1.017 1.35e-05
## 575  1.10e-01  4.63e-02  6.73e-03 -1.10e-01 -0.149531 0.988 5.56e-03
## 11  -1.59e-01  2.82e-03 -6.13e-02  1.59e-01 -0.204214 0.969 1.03e-02
## 149 -7.19e-02 -5.40e-04 -7.59e-02  7.22e-02 -0.147268 0.976 5.38e-03
## 446 -4.28e-03 -2.22e-02 -2.79e-03  4.37e-03  0.027759 1.031 1.93e-04
## 527 -2.44e-02  2.93e-02 -2.40e-02  2.44e-02  0.053133 1.008 7.06e-04
## 199  2.19e-02 -5.46e-02  2.00e-02 -2.18e-02  0.063499 1.018 1.01e-03
## 498 -3.27e-03 -3.29e-03  4.33e-03  3.26e-03  0.007641 1.013 1.46e-05
## 310 -1.02e-03 -1.48e-03  1.05e-02  9.66e-04 -0.020668 1.010 1.07e-04
## 565 -6.06e-02 -1.80e-01  4.15e-02  6.11e-02  0.222694 0.974 1.23e-02
## 644  1.86e-02  3.44e-03 -1.85e-02 -1.85e-02 -0.029736 1.018 2.21e-04
## 646 -2.06e-02 -1.50e-02  1.19e-02  2.06e-02  0.030799 1.015 2.38e-04
## 295 -3.66e-03  3.37e-02 -3.13e-02  3.66e-03 -0.062859 1.002 9.87e-04
## 572  1.31e-01  1.37e-01 -1.16e-01 -1.31e-01 -0.226071 0.980 1.27e-02
## 346 -7.27e-05 -1.23e-02 -3.49e-02  2.59e-04 -0.053331 1.013 7.12e-04
## 235  9.65e-03  6.31e-03  4.77e-03 -9.68e-03  0.019565 1.012 9.59e-05
## 618  3.82e-03 -3.14e-03  5.32e-03 -3.84e-03 -0.007143 1.022 1.28e-05
## 505  3.86e-03  1.64e-03 -7.94e-03 -3.83e-03 -0.010668 1.015 2.85e-05
## 157 -6.23e-02 -4.60e-02 -2.88e-02  6.26e-02 -0.128565 0.984 4.11e-03
## 120  5.39e-02 -3.14e-03  2.17e-02 -5.40e-02  0.069370 1.010 1.20e-03
## 372  2.54e-03 -2.67e-02  2.20e-02 -2.54e-03  0.042768 1.008 4.58e-04
## 318 -1.20e-03  6.62e-03 -9.01e-04  1.17e-03 -0.018525 1.009 8.59e-05
## 550 -5.13e-02  2.27e-02 -1.08e-01  5.18e-02  0.145628 0.990 5.28e-03
## 500  9.67e-03 -1.37e-02 -2.08e-03 -9.63e-03 -0.022922 1.013 1.32e-04
## 198  8.74e-03 -7.18e-03 -7.69e-04 -8.71e-03  0.016102 1.012 6.49e-05
## 613  1.68e-02  7.05e-03 -1.81e-03 -1.69e-02 -0.022434 1.014 1.26e-04
## 391  9.63e-03 -1.45e-01  6.93e-02 -9.44e-03  0.160826 1.000 6.45e-03
## 337  4.58e-03 -8.11e-02  4.97e-02 -4.54e-03  0.087224 1.027 1.90e-03
## 106  1.81e-02  4.92e-03  7.77e-03 -1.82e-02  0.025398 1.016 1.62e-04
## 285 -2.47e-03  3.31e-02  5.33e-03  2.33e-03 -0.041468 1.028 4.31e-04
## 23  -7.12e-02  1.00e-02  1.89e-03  7.11e-02 -0.086212 1.006 1.86e-03
## 654 -2.12e-02  2.50e-02 -2.55e-02  2.12e-02  0.039145 1.022 3.84e-04
## 1   -2.04e-01  6.89e-02  1.11e-01  2.03e-01 -0.293106 0.947 2.11e-02
## 584  4.73e-02  2.03e-02  2.72e-02 -4.76e-02 -0.075108 1.012 1.41e-03
## 241  3.75e-02 -1.16e-02 -1.18e-02 -3.74e-02  0.064328 1.002 1.03e-03
## 51   4.63e-03 -1.56e-03 -1.82e-03 -4.62e-03  0.006308 1.017 9.97e-06
## 255  2.42e-02  2.42e-02  1.65e-02 -2.44e-02  0.057144 1.009 8.17e-04
## 300 -3.02e-04  4.38e-03 -8.18e-04  2.91e-04 -0.004876 1.023 5.96e-06
## 45  -6.13e-02  9.50e-04 -4.29e-02  6.15e-02 -0.088527 1.010 1.96e-03
## 121  4.44e-02  1.19e-02  1.20e-02 -4.45e-02  0.059104 1.012 8.74e-04
## 506 -4.04e-03 -4.76e-03  8.47e-03  4.02e-03  0.011379 1.015 3.24e-05
## 201  2.78e-04  2.19e-04 -3.06e-04 -2.77e-04  0.000567 1.013 8.06e-08
## 393  1.18e-03 -2.49e-03  2.51e-02 -1.27e-03  0.040173 1.008 4.04e-04
## 589 -1.98e-02 -3.77e-02 -1.11e-02  2.00e-02  0.055233 1.032 7.64e-04
## 223  1.96e-02  1.06e-02 -1.93e-02 -1.95e-02  0.037939 1.010 3.60e-04
## 146 -5.49e-02 -4.96e-02  1.59e-01  5.43e-02 -0.183685 1.002 8.41e-03
## 25  -7.66e-02  3.48e-02 -4.32e-02  7.67e-02 -0.102818 1.006 2.64e-03
## 312 -7.09e-05 -3.36e-04  1.72e-03  6.31e-05 -0.002069 1.016 1.07e-06
```

```
## 150 -5.01e-02  1.92e-02  2.85e-02  4.99e-02 -0.091715 0.996 2.10e-03
## 423  2.20e-04  1.67e-02  5.53e-02 -5.07e-04  0.082288 1.009 1.69e-03
## 620 -2.96e-02 -2.37e-02 -1.79e-02  2.97e-02  0.054766 1.018 7.51e-04
## 2   -2.04e-01 -1.19e-01  1.96e-01  2.04e-01 -0.319978 0.943 2.52e-02
## 161 -1.02e-02  2.10e-02  8.57e-03  1.01e-02 -0.032126 1.023 2.59e-04
## 513 -4.12e-02  1.83e-02 -1.64e-01  4.20e-02  0.190678 1.008 9.07e-03
## 689 -6.71e-02  5.74e-02 -3.94e-02  6.72e-02  0.100276 1.008 2.51e-03
## 186 -2.88e-02 -3.36e-02 -8.51e-03  2.89e-02 -0.065686 1.007 1.08e-03
## 135  9.13e-02  7.32e-02 -6.80e-02 -9.12e-02  0.140997 1.002 4.96e-03
## 472  1.15e-02 -2.68e-02  3.15e-02 -1.16e-02 -0.039938 1.020 3.99e-04
## 585  8.15e-02 -5.33e-03 -5.69e-03 -8.15e-02 -0.101046 1.000 2.55e-03
## 560 -3.29e-02  4.40e-02  8.25e-03  3.28e-02  0.076711 1.005 1.47e-03
## 394  4.34e-06  9.09e-04  5.88e-03 -3.30e-05  0.007687 1.020 1.48e-05
## 263  5.74e-02  6.84e-02 -9.10e-02 -5.71e-02  0.137420 0.991 4.70e-03
## 462  8.89e-03 -2.34e-03  1.17e-02 -8.95e-03 -0.020297 1.012 1.03e-04
## 206 -1.89e-02 -1.26e-02 -2.14e-02  1.91e-02 -0.045972 1.012 5.29e-04
## 192 -1.52e-02 -2.44e-03 -5.77e-03  1.52e-02 -0.026645 1.010 1.78e-04
## 268  4.67e-02  8.94e-02 -6.05e-02 -4.66e-02  0.124274 0.998 3.85e-03
## 622  2.18e-03 -2.06e-03  3.13e-03 -2.19e-03 -0.004178 1.023 4.37e-06
## 593  7.72e-02 -6.59e-02  3.29e-02 -7.72e-02 -0.113497 1.005 3.22e-03
## 237  3.26e-02 -2.93e-02  1.68e-02 -3.26e-02  0.059810 1.006 8.95e-04
## 65   2.94e-02 -5.34e-03 -9.20e-03 -2.94e-02  0.037616 1.014 3.54e-04
## 626  3.35e-02  3.44e-03 -2.13e-02 -3.34e-02 -0.046773 1.013 5.48e-04
## 635 -4.02e-02 -8.40e-02  3.97e-02  4.03e-02  0.100015 1.025 2.50e-03
## 445  3.37e-02  2.16e-02 -1.57e-02 -3.38e-02 -0.066737 1.000 1.11e-03
## 330 -2.68e-04 -4.47e-03  4.58e-03  2.55e-04 -0.009618 1.011 2.32e-05
## 676 -9.27e-02 -1.34e-01  4.99e-02  9.29e-02  0.181601 1.001 8.22e-03
## 246  2.47e-02  2.01e-02  2.87e-03 -2.47e-02  0.048640 1.008 5.92e-04
## 351  1.25e-03 -2.93e-03 -5.34e-03 -1.20e-03  0.021000 1.009 1.10e-04
## 315 -1.09e-03 -1.18e-02 -7.40e-03  1.14e-03 -0.040249 1.006 4.05e-04
## 666 -8.61e-03  4.88e-03  2.89e-03  8.59e-03  0.012632 1.017 4.00e-05
## 156 -5.16e-02  5.39e-02 -4.47e-02  5.16e-02 -0.101081 0.996 2.55e-03
## 410  5.68e-05  1.56e-02  2.77e-02 -2.20e-04  0.049196 1.012 6.06e-04
## 487 -4.42e-03  7.73e-04 -4.09e-03  4.44e-03  0.009138 1.012 2.09e-05
## 304 -8.64e-04  9.30e-03  1.58e-03  8.22e-04 -0.013109 1.015 4.30e-05
## 524  5.32e-04 -4.93e-04 -7.34e-04 -5.27e-04 -0.001457 1.016 5.32e-07
## 113  3.94e-02  1.71e-02  1.74e-03 -3.94e-02  0.052567 1.013 6.92e-04
## 515 -1.47e-02 -1.29e-03  3.34e-03  1.47e-02  0.026828 1.009 1.80e-04
## 682 -2.54e-02  1.02e-02  1.84e-02  2.53e-02  0.040647 1.018 4.14e-04
## 349  1.08e-03  2.78e-03 -1.21e-02 -1.02e-03  0.023005 1.010 1.33e-04
## 144 -7.42e-02  1.22e-02  1.53e-01  7.33e-02 -0.210240 0.985 1.10e-02
## 583  6.60e-02  1.93e-02  3.01e-02 -6.63e-02 -0.095761 1.006 2.29e-03
## 162 -7.60e-03  1.71e-02  5.67e-03  7.51e-03 -0.024727 1.025 1.53e-04
## 288 -1.06e-03 -4.09e-02 -7.57e-02  1.49e-03 -0.142875 0.981 5.07e-03
## 366  3.85e-03 -2.88e-02 -1.16e-02 -3.68e-03  0.057282 1.005 8.21e-04
## 396 -5.36e-05  2.29e-02  3.68e-03 -2.14e-05  0.035908 1.011 3.23e-04
## 532 -2.01e-02  2.05e-02  1.49e-03  2.00e-02  0.041691 1.009 4.35e-04
## 606  8.15e-02 -5.82e-03 -8.45e-02 -8.11e-02 -0.137599 1.006 4.73e-03
## 28  -8.05e-02 -3.80e-02  1.05e-02  8.05e-02 -0.106603 1.003 2.84e-03
## 433  6.48e-02  1.11e-02 -6.11e-02 -6.46e-02 -0.132569 0.974 4.36e-03
## 327  5.57e-04  6.69e-04 -8.70e-03 -5.12e-04  0.012440 1.013 3.88e-05
## 364  2.07e-03 -8.02e-03 -6.67e-03 -1.99e-03  0.032806 1.007 2.69e-04
## 546 -2.91e-02 -5.69e-02  8.22e-02  2.89e-02  0.102012 1.010 2.60e-03
## 261  3.57e-02  5.37e-02 -5.80e-03 -3.58e-02  0.085067 1.004 1.81e-03
```

```
## 128  6.79e-02  7.20e-02 -5.82e-02 -6.78e-02  0.115692 1.011 3.35e-03
## 598  6.74e-02  1.28e-02 -4.54e-02 -6.73e-02 -0.095067 1.006 2.26e-03
## 702 -8.75e-02  6.75e-02 -6.27e-03  8.74e-02  0.126583 1.002 4.00e-03
## 690 -6.01e-02  2.17e-02  6.35e-03  6.00e-02  0.077960 1.008 1.52e-03
## 289 -2.05e-03 -2.42e-02  5.46e-02  1.84e-03 -0.069871 1.006 1.22e-03
## 111 -4.44e-04 -6.88e-05 -5.68e-04  4.47e-04 -0.000863 1.024 1.87e-07
## 684 -3.58e-02  1.15e-02  2.16e-02  3.57e-02  0.053310 1.015 7.11e-04
## 465  4.67e-03 -2.48e-03  8.25e-03 -4.70e-03 -0.011923 1.014 3.56e-05
## 96   2.05e-02  9.67e-03 -2.67e-03 -2.05e-02  0.027111 1.015 1.84e-04
## 665 -4.30e-02  2.77e-03 -4.09e-03  4.31e-02  0.053396 1.010 7.14e-04
##         hat inf
## 284 0.01919   *
## 101 0.00689
## 623 0.00657
## 645 0.00923
## 400 0.00237
## 98  0.00842
## 103 0.01249
## 602 0.01182
## 326 0.00359
## 79  0.00832
## 270 0.00681
## 382 0.00286
## 184 0.00606
## 574 0.00791   *
## 4   0.00944   *
## 661 0.00684
## 552 0.01464
## 212 0.00583
## 195 0.00369
## 511 0.01063
## 479 0.00300
## 605 0.01665
## 634 0.00828
## 578 0.00957
## 510 0.00415
## 424 0.00794
## 379 0.00242
## 108 0.00896
## 131 0.01281
## 343 0.00349
## 41  0.01006
## 627 0.00902
## 298 0.01063
## 258 0.00740
## 629 0.00739
## 696 0.00847
## 182 0.00531
## 305 0.01326
## 358 0.01443
## 307 0.00608
## 668 0.01018
## 221 0.00666
## 561 0.01039
```

```
## 313 0.00940
## 136 0.00918
## 145 0.00484   *
## 123 0.01215
## 234 0.01033
## 608 0.00618
## 495 0.00739
## 534 0.00616
## 297 0.01189
## 208 0.00945
## 677 0.00761
## 569 0.01907   *
## 522 0.00628
## 248 0.00857
## 365 0.00236
## 643 0.01414
## 595 0.01561
## 434 0.00425
## 218 0.00609
## 508 0.00482
## 276 0.00237   *
## 169 0.01060
## 71  0.01193
## 573 0.00588
## 697 0.00887
## 485 0.00817
## 460 0.00402
## 60  0.01666   *
## 449 0.00557
## 548 0.00686
## 19  0.00930
## 319 0.00707
## 116 0.03061   *
## 660 0.00766
## 102 0.00963
## 214 0.00554
## 390 0.00425
## 597 0.00641
## 625 0.00803
## 160 0.01246
## 77  0.00716
## 529 0.00527
## 126 0.00976
## 262 0.00904
## 442 0.00627
## 181 0.00704
## 163 0.01338
## 474 0.00397
## 228 0.01051
## 628 0.00682
## 265 0.00532
## 427 0.00956
## 632 0.00768
## 249 0.00384
```

```
## 655 0.00865
## 40  0.01231
## 541 0.00742
## 497 0.00435
## 701 0.00951
## 450 0.00294
## 600 0.00592
## 363 0.00378
## 478 0.00527
## 403 0.00477
## 375 0.00271
## 335 0.00285
## 142 0.01563
## 444 0.00562
## 599 0.00668
## 640 0.01365
## 457 0.00677
## 188 0.00737
## 432 0.00894
## 488 0.00506
## 538 0.00479
## 657 0.00855
## 215 0.00352
## 540 0.00471
## 590 0.00763
## 296 0.00242
## 328 0.00552
## 147 0.01968
## 84  0.00817
## 83  0.00676
## 250 0.00740
## 621 0.00654
## 281 0.00298   *
## 431 0.00312   *
## 30  0.00795
## 10  0.00670
## 587 0.00788
## 441 0.01373
## 663 0.00788
## 345 0.00342
## 12  0.00828
## 293 0.01544
## 303 0.00293
## 338 0.00247
## 350 0.00595
## 581 0.00735
## 107 0.00734
## 543 0.00711
## 518 0.00323
## 691 0.00803
## 43  0.00815
## 189 0.00463
## 171 0.00444
## 39  0.00814
```

```
## 216 0.01966   *
## 291 0.00285
## 58  0.00662
## 395 0.00595
## 693 0.00683
## 456 0.00745
## 22  0.00826
## 170 0.00997
## 63  0.00711
## 547 0.00323
## 417 0.00749
## 70  0.00837
## 59  0.00836
## 484 0.00496
## 203 0.00576
## 227 0.00366
## 243 0.00874
## 413 0.00282
## 476 0.00336
## 650 0.00628
## 405 0.00258
## 397 0.00787
## 501 0.00687
## 429 0.01833
## 205 0.01004
## 475 0.03079   *
## 104 0.01215
## 210 0.00540
## 471 0.00893
## 66  0.01005
## 88  0.00876
## 667 0.00702
## 309 0.00866
## 596 0.00615
## 294 0.00357
## 421 0.00673
## 703 0.00951
## 430 0.00893
## 512 0.00527
## 361 0.02908   *
## 630 0.00773
## 480 0.02276
## 15  0.01273
## 486 0.00823
## 254 0.00444
## 213 0.00468
## 458 0.00747
## 290 0.00344
## 491 0.00922
## 576 0.03666   *
## 178 0.00324
## 428 0.02494   *
## 562 0.00554
## 115 0.00768
```

```
## 165 0.00384
## 377 0.00392
## 194 0.00325
## 230 0.00417
## 603 0.01794   *
## 389 0.00402
## 694 0.00632
## 87  0.01342
## 648 0.00852
## 378 0.00270
## 436 0.00807
## 519 0.02046
## 592 0.01324
## 311 0.00612
## 155 0.01244
## 166 0.00445
## 207 0.00384
## 674 0.00781
## 468 0.00548
## 105 0.02347   *
## 75  0.01152
## 280 0.00634
## 636 0.00620
## 440 0.00526
## 656 0.00739
## 251 0.00395
## 231 0.00463
## 52  0.00826
## 520 0.01229
## 704 0.00951
## 463 0.00382
## 100 0.02260   *
## 407 0.00504
## 591 0.00755
## 141 0.00826
## 412 0.00513
## 672 0.00654
## 679 0.00913
## 470 0.01148
## 36  0.00675
## 114 0.01196
## 642 0.00987
## 362 0.02269
## 386 0.00505
## 273 0.00595
## 196 0.00342
## 86  0.00961
## 138 0.00926
## 344 0.00345
## 211 0.00471
## 517 0.00300
## 641 0.01286
## 686 0.00886
## 586 0.00650
```

```
## 670 0.01038
## 692 0.01065
## 443 0.00330
## 339 0.03146   *
## 122 0.01177
## 202 0.00399
## 530 0.00847
## 544 0.00525
## 638 0.01107
## 467 0.01161
## 342 0.00451
## 99  0.01264
## 371 0.00628
## 380 0.00465
## 97  0.00864
## 49  0.00729
## 242 0.00476
## 175 0.00452
## 566 0.00774
## 260 0.00609
## 437 0.00671
## 521 0.00712
## 174 0.00582
## 671 0.00802
## 42  0.01597
## 183 0.01033
## 347 0.01931
## 374 0.00262
## 74  0.01157
## 549 0.00497
## 425 0.00360   *
## 483 0.00559
## 118 0.00777
## 271 0.00435
## 555 0.00582
## 535 0.00644
## 357 0.00785
## 252 0.00581
## 448 0.00651
## 411 0.00478
## 637 0.00803
## 533 0.00714
## 61  0.01430
## 54  0.00856
## 308 0.00365
## 582 0.00890
## 240 0.00534
## 179 0.00509
## 370 0.00430
## 272 0.01217
## 76  0.00688
## 493 0.00456
## 224 0.00470
## 624 0.00750
```

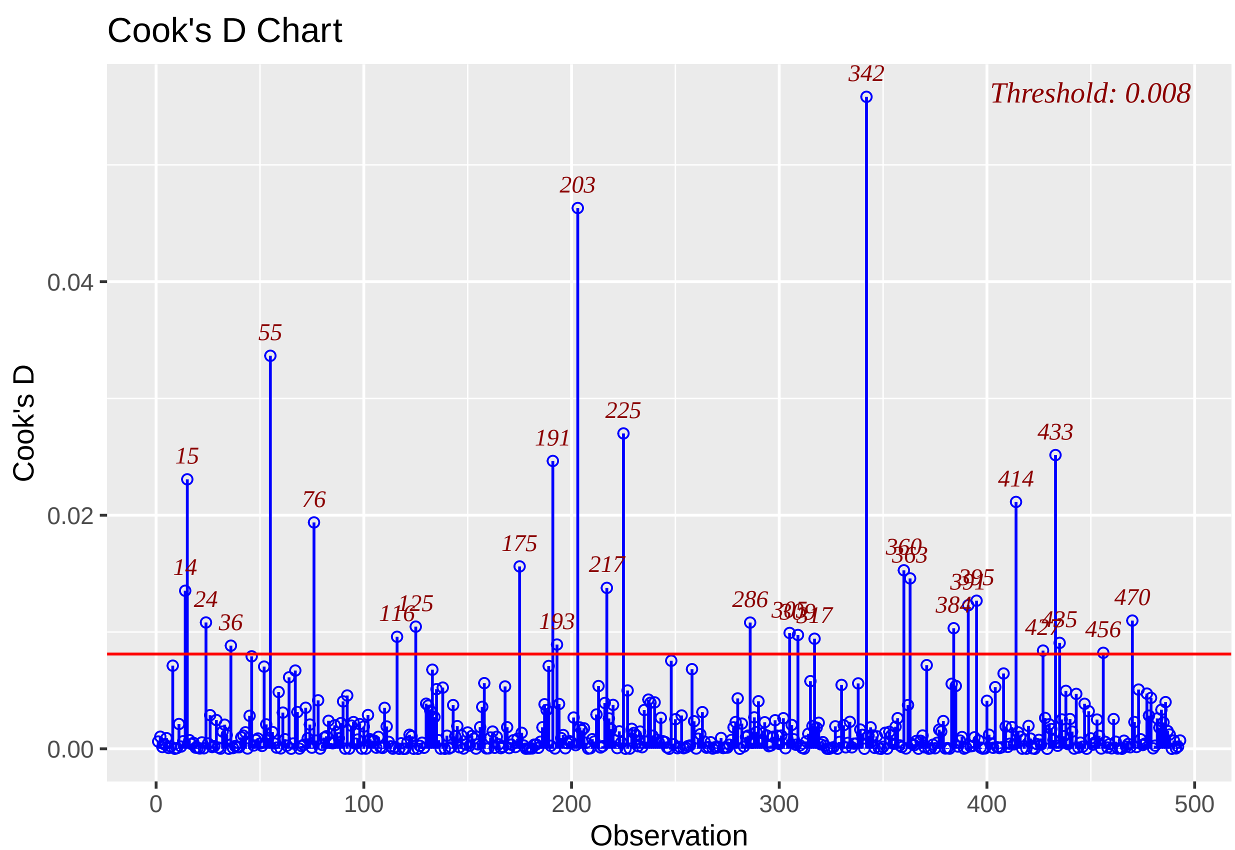
```
## 164 0.00530
## 13  0.00675
## 125 0.00655
## 14  0.00735   *
## 675 0.00625
## 563 0.00610
## 64  0.01050
## 33  0.00913
## 611 0.00589
## 334 0.00309
## 95  0.01202
## 639 0.00723
## 376 0.00285
## 269 0.00681
## 333 0.00312
## 219 0.01019
## 658 0.01265
## 588 0.00594
## 53  0.01213
## 367 0.00291
## 601 0.00939
## 499 0.00601
## 594 0.02037   *
## 659 0.00592
## 177 0.02699   *
## 695 0.00935
## 416 0.00246
## 631 0.00753
## 274 0.01563   *
## 256 0.00540
## 415 0.00377
## 168 0.00700
## 466 0.00366
## 459 0.00455
## 494 0.00759
## 191 0.00616
## 331 0.00477
## 259 0.00486
## 669 0.01051
## 31  0.00648
## 418 0.00495
## 545 0.00774
## 18  0.01052
## 154 0.00407
## 67  0.00706
## 384 0.00325
## 277 0.00869   *
## 354 0.00247
## 34  0.00895
## 143 0.00549   *
## 50  0.00646
## 482 0.00887
## 406 0.00370
## 481 0.00344
```

```
## 610 0.01140
## 152 0.02488   *
## 94  0.00722
## 127 0.01207
## 332 0.00468
## 323 0.00435
## 368 0.00303
## 353 0.00392
## 35  0.01074
## 688 0.00632
## 402 0.01366
## 699 0.00822
## 68  0.00753
## 360 0.00493
## 653 0.00831
## 575 0.00676
## 11  0.00720   *
## 149 0.00475
## 446 0.02276   *
## 527 0.00457
## 199 0.01248
## 498 0.00460
## 310 0.00284
## 565 0.00919   *
## 644 0.00998
## 646 0.00810
## 295 0.00326
## 572 0.01062
## 346 0.00787
## 235 0.00445
## 618 0.01376
## 505 0.00702
## 157 0.00458
## 120 0.00721
## 372 0.00381
## 318 0.00237
## 550 0.00687
## 500 0.00582
## 198 0.00437
## 613 0.00652
## 391 0.01103
## 337 0.02095   *
## 106 0.00826
## 285 0.02038   *
## 23  0.00657
## 654 0.01407
## 1   0.00963   *
## 584 0.00900
## 241 0.00362
## 51  0.00859
## 255 0.00579
## 300 0.01454
## 45  0.00895
## 121 0.00750
```

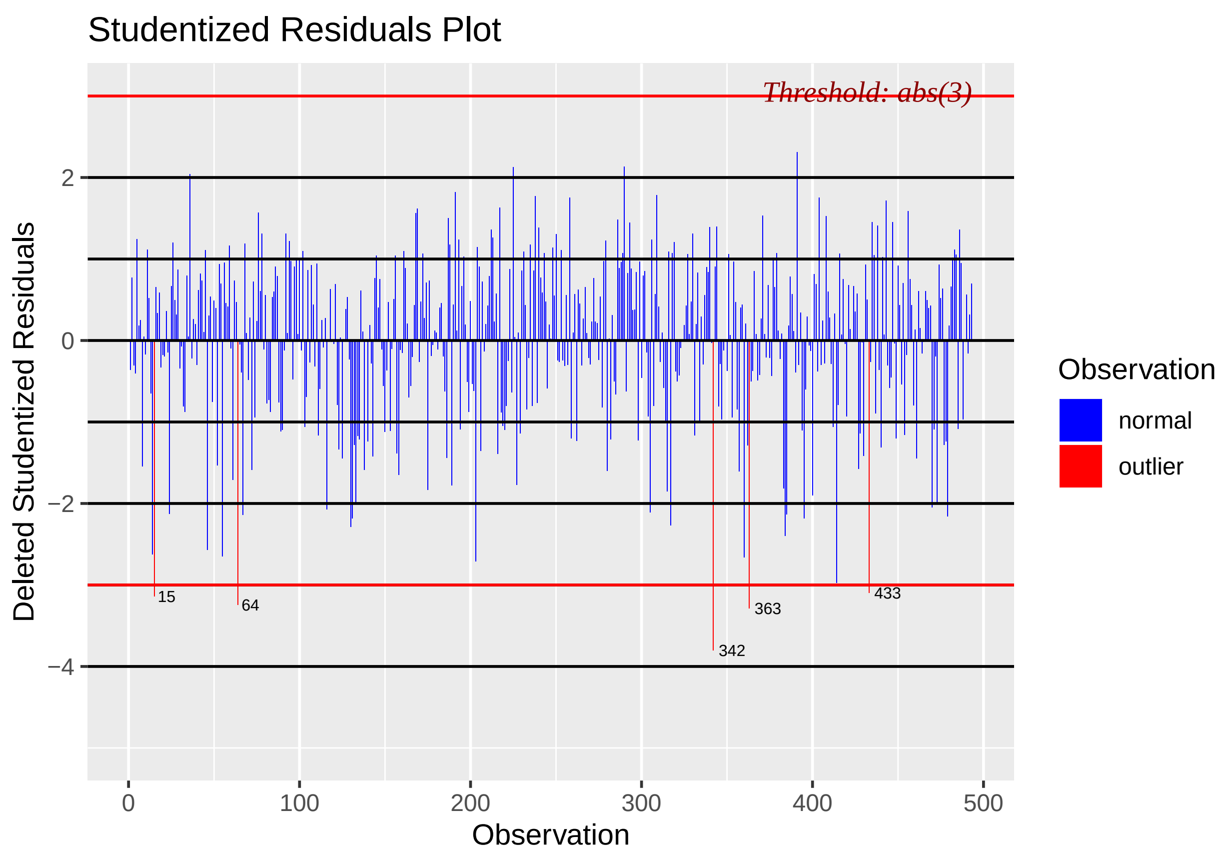
```
## 506 0.00674
## 201 0.00472
## 393 0.00362
## 589 0.02409   *
## 223 0.00436
## 146 0.01346
## 25  0.00813
## 312 0.00760
## 150 0.00420
## 423 0.00777
## 620 0.01181
## 2   0.01056   *
## 161 0.01513
## 513 0.01701
## 689 0.00909
## 186 0.00540
## 135 0.00996
## 472 0.01222
## 585 0.00592
## 560 0.00559
## 394 0.01145
## 263 0.00637
## 462 0.00449
## 206 0.00624
## 192 0.00352
## 268 0.00725
## 622 0.01465
## 593 0.00887
## 237 0.00426
## 65  0.00743
## 626 0.00754
## 635 0.01999   *
## 445 0.00330
## 330 0.00295
## 676 0.01295
## 246 0.00420
## 351 0.00236
## 315 0.00255
## 666 0.00882
## 156 0.00487
## 410 0.00658
## 487 0.00371
## 304 0.00722
## 524 0.00774
## 113 0.00749
## 515 0.00296
## 682 0.01051
## 349 0.00286
## 144 0.01047
## 583 0.00765
## 162 0.01649   *
## 288 0.00505
## 366 0.00378
## 396 0.00480
```

```
## 532 0.00426
## 606 0.01142
## 28  0.00741
## 433 0.00377   *
## 327 0.00462
## 364 0.00246
## 546 0.00994
## 261 0.00580
## 128 0.01188
## 598 0.00764
## 702 0.00863
## 690 0.00670
## 289 0.00523
## 111 0.01563
## 684 0.00896
## 465 0.00569
## 96  0.00741
## 665 0.00589
```

```
ols_plot_cooksd_chart(f.q1)
```




```
ols_plot_resid_stud(f.q1)
```




```r
#large data set, 2p/n is small
#outliers in Xs
hii <- hatvalues(f.q1)
hii
```

```
##         284         101         623         645         400          98
## 0.019191804 0.006890599 0.006572749 0.009234775 0.002367064 0.008420847
##         103         602         326          79         270         382
## 0.012489524 0.011820605 0.003586949 0.008321407 0.006812617 0.002855285
##         184         574           4         661         552         212
## 0.006061339 0.007912326 0.009442609 0.006837389 0.014640649 0.005828954
##         195         511         479         605         634         578
## 0.003693511 0.010628387 0.003004981 0.016646112 0.008279874 0.009569211
##         510         424         379         108         131         343
## 0.004147021 0.007943388 0.002415701 0.008956361 0.012812038 0.003492896
##          41         627         298         258         629         696
## 0.010057762 0.009019624 0.010631535 0.007400848 0.007391902 0.008468048
##         182         305         358         307         668         221
## 0.005305651 0.013263576 0.014433701 0.006077732 0.010179729 0.006659067
##         561         313         136         145         123         234
## 0.010391116 0.009400968 0.009178473 0.004837217 0.012150343 0.010332647
##         608         495         534         297         208         677
## 0.006179672 0.007394039 0.006155298 0.011890469 0.009451734 0.007614523
##         569         522         248         365         643         595
## 0.019072674 0.006282670 0.008572390 0.002363011 0.014144371 0.015613786
##         434         218         508         276         169          71
## 0.004248418 0.006088009 0.004815938 0.002367064 0.010600412 0.011932462
##         573         697         485         460          60         449
```

```
## 0.005877875 0.008866249 0.008171500 0.004022538 0.016663812 0.005570603
##         548          19         319         116         660         102
## 0.006856429 0.009299134 0.007073680 0.030606327 0.007664363 0.009626101
##         214         390         597         625         160          77
## 0.005544665 0.004251219 0.006405736 0.008027788 0.012460980 0.007156092
##         529         126         262         442         181         163
## 0.005266220 0.009762817 0.009039047 0.006269954 0.007036751 0.013382374
##         474         228         628         265         427         632
## 0.003968833 0.010507139 0.006819016 0.005317536 0.009562975 0.007684957
##         249         655          40         541         497         701
## 0.003838798 0.008649099 0.012307706 0.007424611 0.004353815 0.009508701
##         450         600         363         478         403         375
## 0.002941407 0.005920819 0.003775997 0.005267851 0.004766797 0.002711720
##         335         142         444         599         640         457
## 0.002845888 0.015628288 0.005618298 0.006679790 0.013651936 0.006774934
##         188         432         488         538         657         215
## 0.007372869 0.008940605 0.005062342 0.004792090 0.008547425 0.003515724
##         540         590         296         328         147          84
## 0.004712292 0.007630821 0.002415701 0.005522186 0.019676316 0.008174833
##          83         250         621         281         431          30
## 0.006763665 0.007400848 0.006538920 0.002980460 0.003118571 0.007949254
##          10         587         441         663         345          12
## 0.006696193 0.007881002 0.013731630 0.007881002 0.003419861 0.008281860
##         293         303         338         350         581         107
## 0.015444697 0.002931488 0.002465938 0.005954660 0.007352696 0.007341044
##         543         518         691          43         189         171
## 0.007105171 0.003231299 0.008027788 0.008150523 0.004634384 0.004441775
##          39         216         291          58         395         693
## 0.008139444 0.019659340 0.002850555 0.006624633 0.005954660 0.006826925
##         456          22         170          63         547         417
## 0.007448985 0.008257341 0.009967788 0.007106384 0.003230000 0.007489261
##          70          59         484         203         227         243
## 0.008374086 0.008358319 0.004964740 0.005760022 0.003661559 0.008743279
##         413         476         650         405         397         501
## 0.002823450 0.003358438 0.006277404 0.002583369 0.007871692 0.006871094
##         429         205         475         104         210         471
## 0.018331448 0.010041461 0.030793493 0.012150343 0.005400806 0.008934849
##          66          88         667         309         596         294
## 0.010045108 0.008756258 0.007015485 0.008664484 0.006154074 0.003567097
##         421         703         430         512         361         630
## 0.006729883 0.009508701 0.008927246 0.005267851 0.029080248 0.007729170
##         480          15         486         254         213         458
## 0.022760490 0.012728336 0.008232181 0.004441775 0.004682709 0.007468078
##         290         491         576         178         428         562
## 0.003435894 0.009216497 0.036655462 0.003243842 0.024936194 0.005542322
##         115         165         377         194         230         603
## 0.007682779 0.003838798 0.003921659 0.003250227 0.004173558 0.017942840
##         389         694          87         648         378         436
## 0.004016074 0.006318535 0.013417705 0.008519072 0.002704111 0.008068739
##         519         592         311         155         166         207
## 0.020455139 0.013240467 0.006118867 0.012437677 0.004450002 0.003838798
##         674         468         105          75         280         636
## 0.007810949 0.005479971 0.023472501 0.011521599 0.006343518 0.006198027
##         440         656         251         231          52         520
```

```
## 0.005257599 0.007390642 0.003951966 0.004634384 0.008257341 0.012289023
##         704         463         100         407         591         141
## 0.009508701 0.003819045 0.022596838 0.005035416 0.007546713 0.008257341
##         412         672         679         470          36         114
## 0.005127991 0.006544620 0.009127592 0.011482008 0.006751997 0.011960168
##         642         362         386         273         196          86
## 0.009867350 0.022694809 0.005051393 0.005952943 0.003415449 0.009612508
##         138         344         211         517         641         686
## 0.009263254 0.003446381 0.004712303 0.003004981 0.012856453 0.008855246
##         586         670         692         443         339         122
## 0.006504906 0.010378808 0.010654096 0.003302045 0.031455722 0.011769122
##         202         530         544         638         467         342
## 0.003990848 0.008469100 0.005253693 0.011070721 0.011611214 0.004507743
##          99         371         380          97          49         242
## 0.012643660 0.006283733 0.004654172 0.008644914 0.007290399 0.004756602
##         175         566         260         437         521         174
## 0.004521064 0.007738392 0.006085253 0.006714998 0.007121684 0.005824940
##         671          42         183         347         374          74
## 0.008024132 0.015965728 0.010332647 0.019309972 0.002620288 0.011568613
##         549         425         483         118         271         555
## 0.004970890 0.003602652 0.005587418 0.007771844 0.004353601 0.005823460
##         535         357         252         448         411         637
## 0.006443885 0.007850093 0.005809656 0.006509015 0.004778508 0.008027788
##         533          61          54         308         582         240
## 0.007135556 0.014301216 0.008558772 0.003651413 0.008899024 0.005338232
##         179         370         272          76         493         224
## 0.005090302 0.004304073 0.012170548 0.006882035 0.004560554 0.004696451
##         624         164          13         125          14         675
## 0.007501325 0.005300622 0.006751235 0.006550623 0.007345970 0.006250122
##         563          64          33         611         334          95
## 0.006100058 0.010501807 0.009134215 0.005892226 0.003093592 0.012015392
##         639         376         269         333         219         658
## 0.007229621 0.002854313 0.006812617 0.003116210 0.010193501 0.012653951
##         588          53         367         601         499         594
## 0.005944383 0.012134455 0.002913104 0.009388619 0.006014254 0.020367394
##         659         177         695         416         631         274
## 0.005920819 0.026991422 0.009350106 0.002462470 0.007526828 0.015631662
##         256         415         168         466         459         494
## 0.005399643 0.003770982 0.006998178 0.003655182 0.004552469 0.007587520
##         191         331         259         669          31         418
## 0.006155289 0.004766797 0.004862776 0.010509331 0.006479127 0.004948097
##         545          18         154          67         384         277
## 0.007738392 0.010520331 0.004074567 0.007055640 0.003248795 0.008685935
##         354          34         143          50         482         406
## 0.002467954 0.008954662 0.005489498 0.006464943 0.008870543 0.003702593
##         481         610         152          94         127         332
## 0.003443154 0.011396742 0.024875318 0.007215163 0.012074994 0.004678775
##         323         368         353          35         688         402
## 0.004354147 0.003031813 0.003920442 0.010735963 0.006324926 0.013661610
##         699          68         360         653         575          11
## 0.008224631 0.007526886 0.004927203 0.008311056 0.006755853 0.007199165
##         149         446         527         199         498         310
## 0.004750830 0.022760490 0.004570847 0.012481720 0.004597513 0.002836640
##         565         644         646         295         572         346
```

```
## 0.009188660 0.009977974 0.008104425 0.003261347 0.010617334 0.007871692
##         235         618         505         157         120         372
## 0.004454081 0.013756707 0.007018165 0.004576071 0.007212528 0.003814993
##         318         550         500         198         613         391
## 0.002366017 0.006871094 0.005823460 0.004373431 0.006519727 0.011034865
##         337         106         285          23         654           1
## 0.020949821 0.008257341 0.020379221 0.006567316 0.014070752 0.009626101
##         584         241          51         255         300          45
## 0.008996144 0.003620846 0.008585677 0.005792394 0.014544477 0.008954662
##         121         506         201         393         589         223
## 0.007504381 0.006740558 0.004721669 0.003624340 0.024091138 0.004361850
##         146          25         312         150         423         620
## 0.013464596 0.008129435 0.007603676 0.004204297 0.007769363 0.011808899
##           2         161         513         689         186         135
## 0.010562921 0.015131547 0.017006590 0.009090071 0.005399643 0.009960911
##         472         585         560         394         263         462
## 0.012224602 0.005915600 0.005587418 0.011448330 0.006371973 0.004492999
##         206         192         268         622         593         237
## 0.006235926 0.003515724 0.007254806 0.014646200 0.008866249 0.004260797
##          65         626         635         445         330         676
## 0.007425606 0.007540988 0.019986508 0.003302045 0.002951820 0.012945005
##         246         351         315         666         156         410
## 0.004203538 0.002361378 0.002545052 0.008818715 0.004874438 0.006579552
##         487         304         524         113         515         682
## 0.003707062 0.007222169 0.007738392 0.007492818 0.002961690 0.010509331
##         349         144         583         162         288         366
## 0.002864071 0.010468373 0.007648247 0.016485613 0.005049606 0.003775997
##         396         532         606          28         433         327
## 0.004795855 0.004256702 0.011419524 0.007405568 0.003773931 0.004615214
##         364         546         261         128         598         702
## 0.002462350 0.009943726 0.005802799 0.011876461 0.007637617 0.008627728
##         690         289         111         684         465          96
## 0.006698042 0.005226861 0.015628288 0.008959767 0.005686468 0.007405568
##         665
## 0.005891896
```

```r
sum(hii>(0.5))
```

```
## [1] 0
```

```r
sum(hii>(0.2))
```

```
## [1] 0
```

#Part b: #R Square is increased in the hold out sample (23% vs. 19%). X1 and X2 are significant, X3 is not signficant in both models. The coefficents have the same signs, the signficant variables' coefficents are close to each other. The model is stable. # (Intercept) X1 X2 X3 #[1,] -14.691 0.009 0.037 0.008 #[2,] -38.209 0.012 0.036 0.020

```r
pred<-predict(f.q1,holdout.sample)
sse<-sum((holdout.sample$Y-pred)^2)
sst=var(holdout.sample$Y)*(dim(holdout.sample)[1]-1)
R2.hold=1 - sse/sst
R2.hold
```

```
## [1] 0.2308834
```

```r
R2.dev=0.1903
cbind(R2.dev,R2.hold)
```

```
##      R2.dev   R2.hold
## [1,] 0.1903 0.2308834
```

```r
f.q12<-lm(Y~X1+X2+X3,data=holdout.sample)
summary(f.q12)
```

```
##
## Call:
## lm(formula = Y ~ X1 + X2 + X3, data = holdout.sample)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.60455 -0.30209  0.09393  0.38938  1.19226
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) -38.208862  57.463252  -0.665  0.50683
## X1            0.011677   0.002464   4.740 3.97e-06 ***
## X2            0.036151   0.011276   3.206  0.00156 **
## X3            0.019730   0.028773   0.686  0.49365
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.5784 on 208 degrees of freedom
## Multiple R-squared:  0.2367, Adjusted R-squared:  0.2257
## F-statistic:  21.5 on 3 and 208 DF,  p-value: 3.6e-12
```

```r
round(rbind(f.q1$coefficients,f.q12$coefficients),3)
```

```
##      (Intercept)    X1    X2    X3
## [1,]     -14.691 0.009 0.037 0.008
## [2,]     -38.209 0.012 0.036 0.020
```

#Part c: #Ho:Error variance is constant #Ha:Error variance is Not Constant. P value is greater than 0.01. Accept Ho. Error variance is constant.

```r
ei<-f.q1$residuals
DM<-data.frame(cbind(f.q1$fitted.values,ei))
DM.S<-DM[order(DM[,1]),]
DM1<-DM.S[1:247,]
DM2<-DM.S[248:493,]
M1<-median(DM1[,2])
M2<-median(DM2[,2])
N1<-length(DM1[,2])
N2<-length(DM2[,2])
d1<-abs(DM1[,2]-M1)
d2<-abs(DM2[,2]-M2)
s2<-sqrt((var(d1)*(N1-1)+var(d2)*(N2-1))/(N1+N2-2))
Den<- s2*sqrt(1/N1+1/N2)
Num<- mean(d1)-mean(d2)
T= Num/Den
T
```

```
## [1] 1.134514
```

```r
2*(1-pt(T,N1+N2-2))
```

```
## [1] 0.2571326
```

Question 2

#We are interested in predicting the number of customers who complained about the service, use the attached data sets to answer the questions below:

#a) Build a model to predict the number of complaints, perform the statistical tests that shows that model is significant #b) Find the predicted number complaints given the independent variables below #X1 X2 X3 X4 X5 #606 41393 3 3.04 6.32

#Solutions: *a-) The model is signficant. Based on the Deviance and LRT tests.*

```r
Complaints <- read.csv("/cloud/project/Complaints.csv")
f.q2<-glm(Y~.,data=Complaints,family="poisson")
summary(f.q2)
```

```
##
## Call:
## glm(formula = Y ~ ., family = "poisson", data = Complaints)
##
## Deviance Residuals:
##      Min        1Q    Median        3Q       Max
## -2.93195  -0.58868  -0.00009   0.59269   2.23441
##
## Coefficients:
##               Estimate Std. Error z value Pr(>|z|)
## (Intercept)  2.942e+00  2.072e-01  14.198  < 2e-16 ***
## X1           6.058e-04  1.421e-04   4.262 2.02e-05 ***
## X2          -1.169e-05  2.112e-06  -5.534 3.13e-08 ***
## X3          -3.726e-03  1.782e-03  -2.091   0.0365 *
## X4           1.684e-01  2.577e-02   6.534 6.39e-11 ***
## X5          -1.288e-01  1.620e-02  -7.948 1.89e-15 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for poisson family taken to be 1)
##
##     Null deviance: 422.22  on 109  degrees of freedom
## Residual deviance: 114.99  on 104  degrees of freedom
## AIC: 571.02
##
## Number of Fisher Scoring iterations: 4
```

```r
1-pchisq(422.22-114.99,5)
```

```
## [1] 0
```

```r
beta <- coef(f.q2)
beta
```

```
##   (Intercept)            X1            X2            X3            X4
##  2.942438e+00  6.057667e-04 -1.168607e-05 -3.726472e-03  1.683830e-01
##            X5
```

```
## -1.287738e-01
```

```r
anova(f.q2,test="Chisq")
```

```
## Analysis of Deviance Table
##
## Model: poisson, link: log
##
## Response: Y
##
## Terms added sequentially (first to last)
##
##
##      Df Deviance Resid. Df Resid. Dev  Pr(>Chi)
## NULL                   109     422.22
## X1    1   42.662       108     379.56 6.507e-11 ***
## X2    1    0.807       107     378.75    0.3691
## X3    1    0.316       106     378.43    0.5741
## X4    1  195.949       105     182.49 < 2.2e-16 ***
## X5    1   67.500       104     114.99 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
nothing <- glm(Y ~ 1,family="poisson",Complaints)
anova(nothing,f.q2,test="Chi")
```

```
## Analysis of Deviance Table
##
## Model 1: Y ~ 1
## Model 2: Y ~ X1 + X2 + X3 + X4 + X5
##   Resid. Df Resid. Dev Df Deviance  Pr(>Chi)
## 1       109     422.22
## 2       104     114.99  5   307.23 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

b-) The predicted count is 12.3 or 12.

```r
dat=data.frame(cbind(X1=606,X2=41393,X3=3,X4=3.04,X5=6.32))
predict(f.q2,dat,type="response")
```

```
##        1
## 12.33778
```

Question 3

#For the attached data sets, build a model to predict Y based on the independent variables and test if there is an autocorrelation persists in the data. If autocorrelation persists, remediate the autocorrelation.

#Solution: R square is 77%. X3,X4 and X5 are signficant. There is no autocorrelation based on the DW test. However, unequal variances should be further tested and the observation 18 could be an influential point.

```r
library(lmtest)
```

```
## Loading required package: zoo
```

```
##
## Attaching package: 'zoo'

## The following objects are masked from 'package:base':
##
##     as.Date, as.Date.numeric
```

```r
Monthly.Sales <- read.csv("/cloud/project/Monthly Sales.csv")
f.q3<-lm(formula = Y ~ ., data = Monthly.Sales)
summary(f.q3)
```

```
##
## Call:
## lm(formula = Y ~ ., data = Monthly.Sales)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1063.26  -329.03   -77.92   239.84  1434.78
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) -1.287e+03  2.171e+03  -0.593   0.5570
## X1           9.509e+03  7.828e+03   1.215   0.2324
## X2           1.889e+01  3.119e+01   0.606   0.5484
## X3           6.129e+02  8.021e+01   7.641 4.82e-09 ***
## X4          -1.670e-01  8.161e-02  -2.046   0.0481 *
## X5           6.445e-01  2.513e-01   2.564   0.0146 *
## X6          -3.102e+01  8.881e+01  -0.349   0.7289
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 528.4 on 36 degrees of freedom
## Multiple R-squared:  0.771,  Adjusted R-squared:  0.7329
## F-statistic:  20.2 on 6 and 36 DF,  p-value: 3.491e-10
```

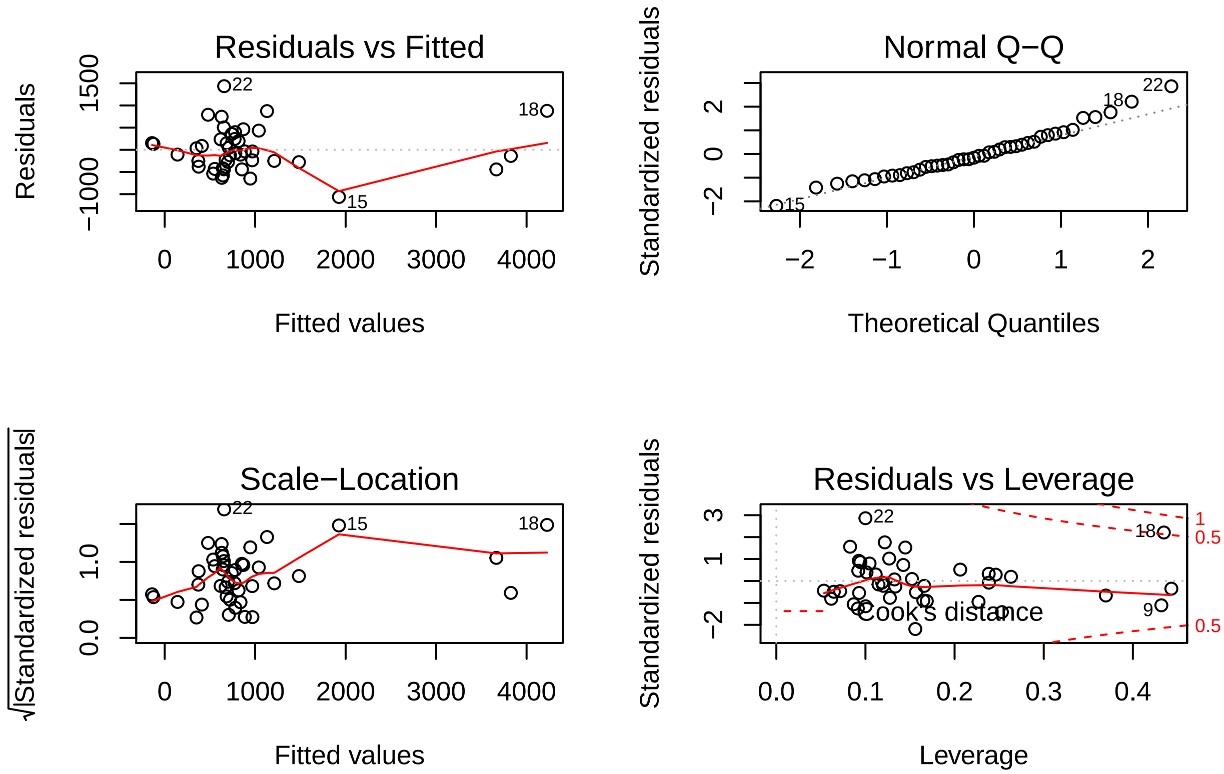
```r
dwtest(f.q3)
```

```
##
##  Durbin-Watson test
##
## data:  f.q3
## DW = 1.9618, p-value = 0.2903
## alternative hypothesis: true autocorrelation is greater than 0
```

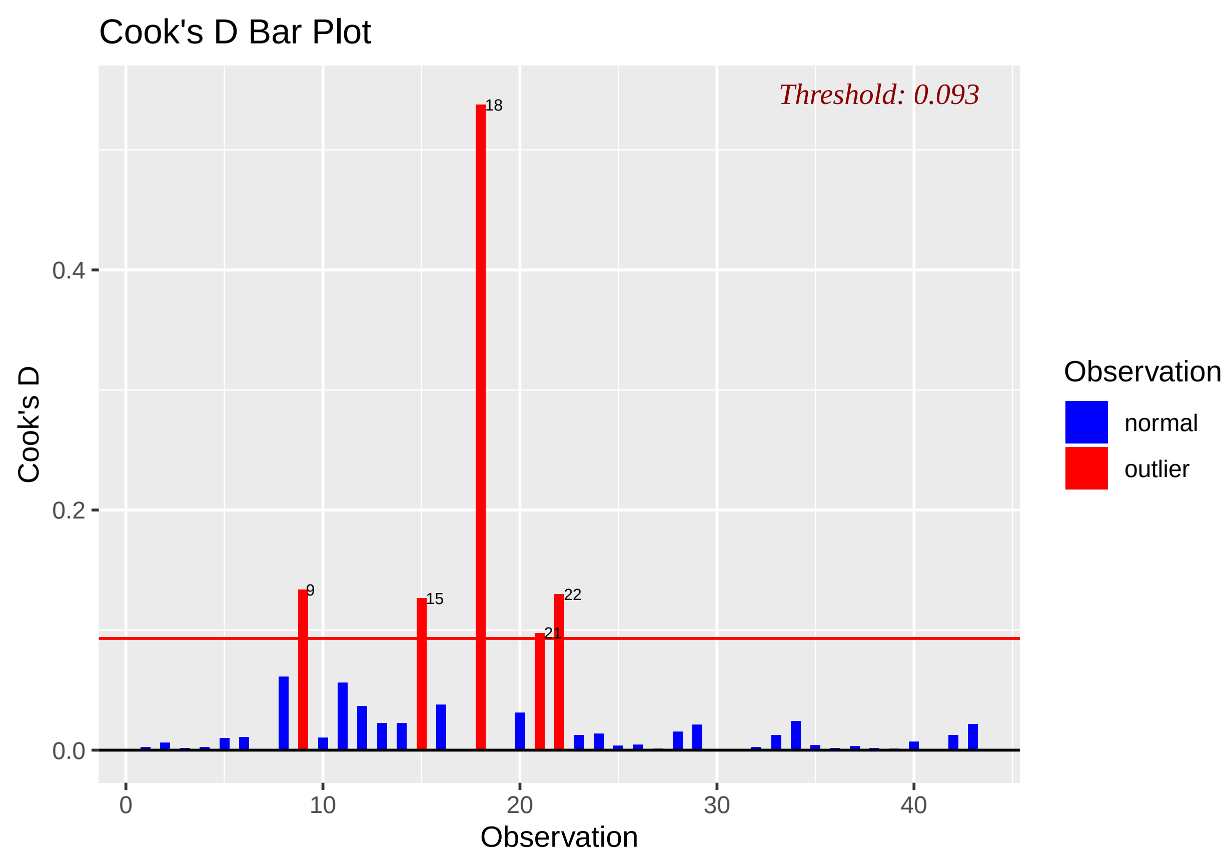
```r
round(f.q3$coefficients,2)
```

```
## (Intercept)          X1          X2          X3          X4          X5
##    -1287.33     9508.67       18.89      612.91       -0.17        0.64
##          X6
##      -31.02
```

```r
par(mfrow=c(2,2))
plot(f.q3)
```




```r
library(olsrr)
ols_plot_cooksd_bar(f.q3)
```



Question 4

#For the following hospital data, #Y= Total cost #X1=Interventions #X2=Drugs #X3=Emergency room visits #X4=Complications #X5=Comorbidities #a-) use the best subset method to find optimal linear regression model #b) Compare your model in part a against the regression tree and Neural Network Model, and calculate the SSE for each model, which method has the lowest SSE?

#Part a: The best subset model contains, X1,X2 and X3 and are all significant. The R Square is 54%.However, there is an unequal variances proble, QQ plot indicates S shape, heavy tail, transformation of Y needed.

```
library(rpart)
```

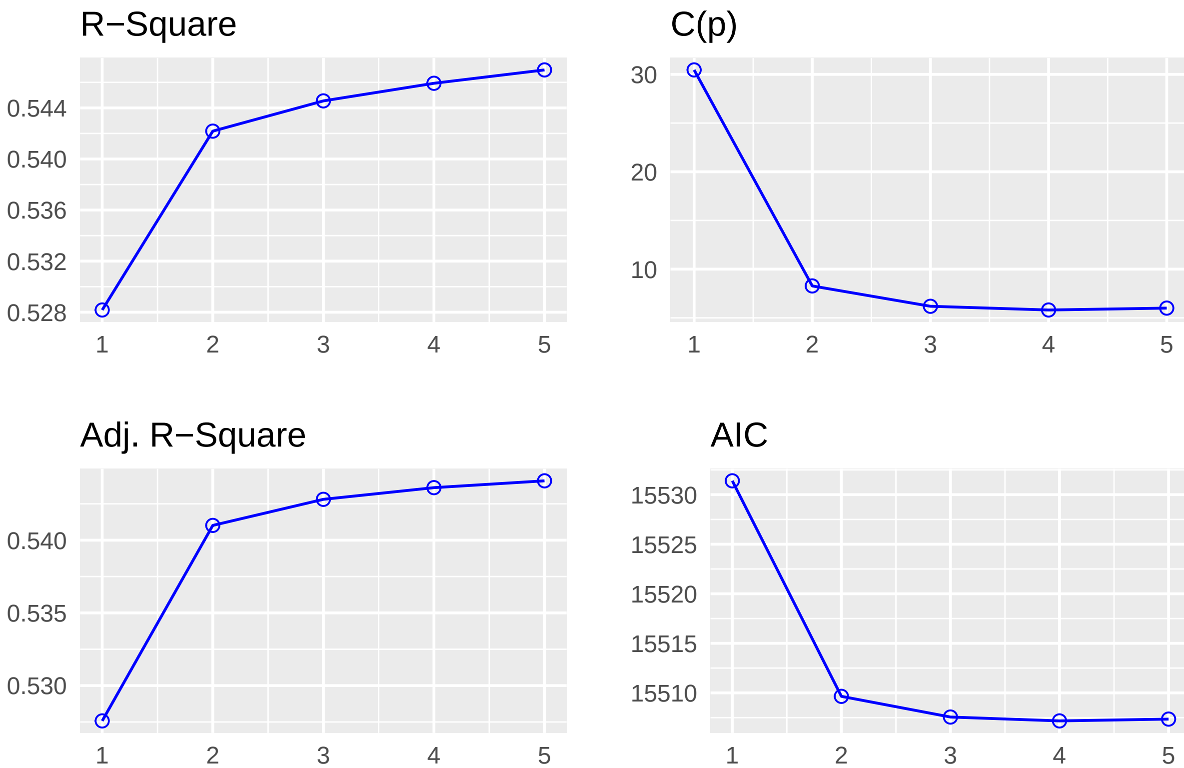
```
##
## Attaching package: 'rpart'

## The following object is masked from 'package:faraway':
##
##     solder
```

```
library(rpart.plot)
library(neuralnet)
library(olsrr)
library(leaps)
Hospital <- read.csv("/cloud/project/Hospital.csv")
f.q4.reg<-lm(Y~.,data=Hospital)
summary(f.q4.reg)
```

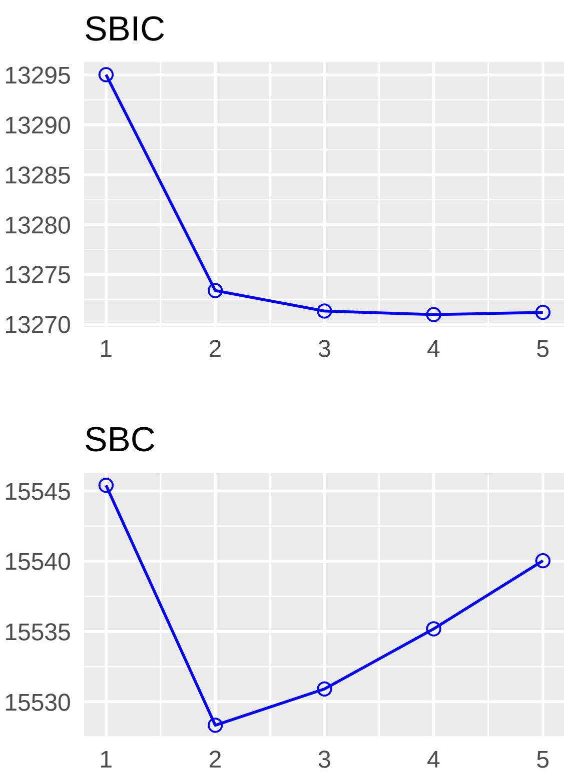
```
##
## Call:
## lm(formula = Y ~ ., data = Hospital)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -29826  -1620     51   1223  36600
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) -2364.39     288.66  -8.191 1.05e-15 ***
## X1            802.68      31.66  25.352  < 2e-16 ***
## X2           -353.78     179.51  -1.971   0.0491 *
## X3            389.78      75.39   5.170 2.97e-07 ***
## X4            896.26     666.85   1.344   0.1793
## X5             41.96      27.48   1.527   0.1272
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 4517 on 782 degrees of freedom
## Multiple R-squared:  0.547,  Adjusted R-squared:  0.5441
## F-statistic: 188.8 on 5 and 782 DF,  p-value: < 2.2e-16
```

```
#Best Subset Regression
k4<-ols_step_best_subset(f.q4.reg,prem=0.05,details=TRUE)
plot(k4)
```

page 1 of 2



page 2 of 2

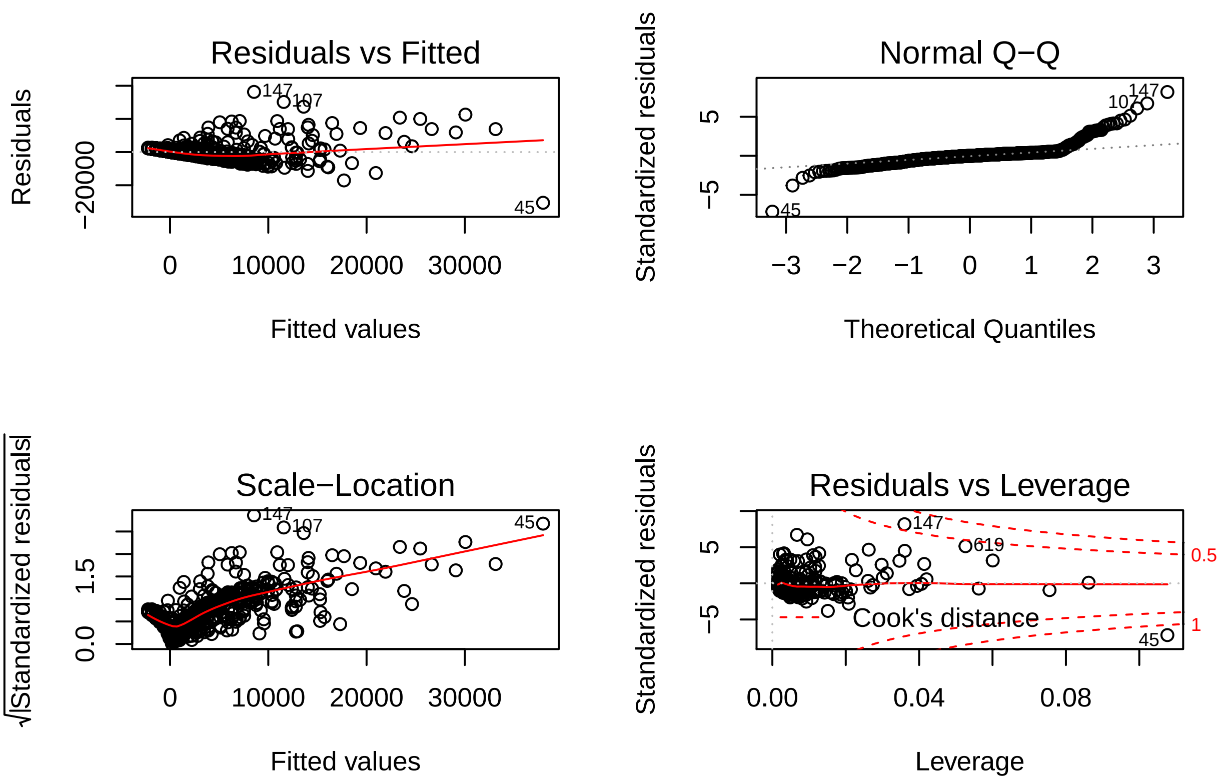



```
#based on AIC and SBIC, the best subset model is "X1 X2 X3 X5". However, X5 is not significant. Use X1 .

f.q4.bestsubset<-lm(Y~X1+X2+X3,data=Hospital)
```

```r
summary(f.q4.bestsubset)
```

```
##
## Call:
## lm(formula = Y ~ X1 + X2 + X3, data = Hospital)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -30573  -1671    -46   1200  36295
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) -2241.02     276.89  -8.094 2.21e-15 ***
## X1            816.13      31.01  26.315  < 2e-16 ***
## X2           -360.67     178.62  -2.019   0.0438 *
## X3            397.27      75.38   5.270 1.76e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 4524 on 784 degrees of freedom
## Multiple R-squared:  0.5445, Adjusted R-squared:  0.5428
## F-statistic: 312.5 on 3 and 784 DF,  p-value: < 2.2e-16
```

```r
par(mfrow=c(2,2))
plot(f.q4.bestsubset)
```




```r
#alternatively
#b <- regsubsets(Y~X1+X2+X3+X4+X5,data=Hospital)
#rs <- summary(b)
#AIC <- 788*log(rs$rss/788) + (2:6)*2
```

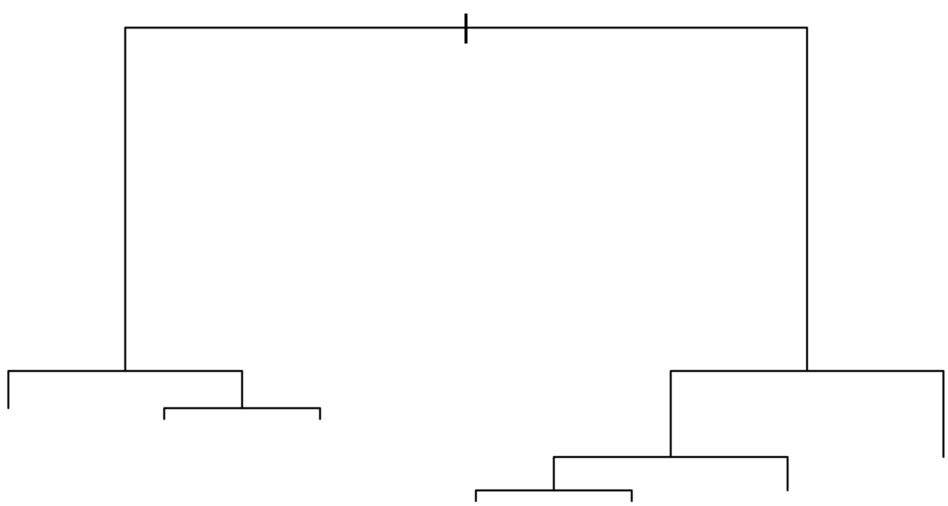
```r
#par(mfrow=c(1,3))
#plot(AIC ~ I(1:5), ylab="AIC", xlab="Number of Predictors")
#plot(1:5,rs$adjr2,xlab="No. of Parameters",ylab="Adjusted R-square")
#which.max(rs$adjr2)
#plot(1:5,rs$cp,xlab="No. of Parameters",ylab="Cp Statistic")
#abline(0,1)

anova(f.q4.bestsubset)
```

```
## Analysis of Variance Table
##
## Response: Y
##            Df     Sum Sq    Mean Sq F value    Pr(>F)
## X1          1 1.8605e+10 1.8605e+10 909.184 < 2.2e-16 ***
## X2          1 8.5133e+06 8.5133e+06   0.416    0.5191
## X3          1 5.6836e+08 5.6836e+08  27.774 1.764e-07 ***
## Residuals 784 1.6044e+10 2.0464e+07
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
an=anova(f.q4.bestsubset)
SSE.bestsubset=an$`Sum Sq`[4]
```

#Part b: Neural Network Model has the lowest SSE, perform better than other two models. However, it is less transparent than the other models.

```r
r.q4.tree<-rpart(Y~.,data=Hospital)
plot(r.q4.tree)
```



```r
pop<-Hospital
SSE.Tree<-sum((predict(r.q4.tree)-pop$Y)^2)

max = apply(pop, 2 , max)
min = apply(pop, 2 , min)
scaled = as.data.frame(scale(pop, center = min, scale = max - min))
NN = neuralnet(Y~X1+X2+X3+X4+X5, scaled , hidden = 6 , linear.output = T )

predict_testNN = compute(NN, scaled [,c(2:6)])
predict_testNN1 = (predict_testNN$net.result * (max(pop$Y) - min(pop$Y))) + min(pop$Y)
```

```r
SSE.NN<-sum((pop$Y-predict_testNN1)^2)

round(data.frame(cbind(SSE.bestsubset,SSE.Tree,SSE.NN)),0)
```

```
##   SSE.bestsubset    SSE.Tree      SSE.NN
## 1    16043593057 12731887579 11001170565
```

Question 5

#In a flu shot study, 159 clients were randomly selected and asked whether they actually received a flu shot. A client who received a flu shot was coded Y=1 and a client who did not receive a flu shot was coded Y =0. In addition. data were collected on their age (X1) and their health awareness. The latter data were combined into a health awareness index (X2), for which higher values indicate greater awareness. Also included in the data was client gender, where males were coded X3=1 and females were coded X3=0. #a) Fit a model to predict the probability of getting a flu shot and state the fitted response function. #b) Use the likelihood ratio test to determine whether X3 can be dropped from the regression model #c) What is the estimated probability that male clients aged 55 with a health awareness index of 60 will receive a flu shot? Obtain a 90% confidence interval for your prediction #d) Conduct Hosmer-Lemshow goodness of fit test for the appropriateness of the logistic regression function

#Part a: b0 = -1.17, b1 = 0.07, b2 = 0.09, b3 = 0.43 #pi=[1+exp(-1.17+ 0.07X1+0.09X2+0.43X3)]^{-1}. X1 and X2 are significant.

```r
Flue.Shot <- read.csv("/cloud/project/Flue Shot.csv")
lmod <- glm(Y ~ X1 + X2 + X3, family = binomial, Flue.Shot)
summary(lmod)
```

```
##
## Call:
## glm(formula = Y ~ X1 + X2 + X3, family = binomial, data = Flue.Shot)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -1.4037  -0.5637  -0.3352  -0.1542   2.9394
##
## Coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept) -1.17716    2.98242  -0.395  0.69307
## X1           0.07279    0.03038   2.396  0.01658 *
## X2          -0.09899    0.03348  -2.957  0.00311 **
## X3           0.43397    0.52179   0.832  0.40558
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 134.94  on 158  degrees of freedom
## Residual deviance: 105.09  on 155  degrees of freedom
## AIC: 113.09
##
## Number of Fisher Scoring iterations: 6
```

```r
beta <- coef(lmod)
cbind(beta,exp(beta))
```

```
##                      beta
## (Intercept) -1.17715922 0.3081529
## X1           0.07278802 1.0755025
## X2          -0.09898649 0.9057549
## X3           0.43397485 1.5433801
```

b-) Yes. It can be dropped from the model

```r
lmodc<-glm(Y ~ X1 + X2 , family = binomial, Flue.Shot)
anova(lmodc,lmod,test="Chi")
```

```
## Analysis of Deviance Table
##
## Model 1: Y ~ X1 + X2
## Model 2: Y ~ X1 + X2 + X3
##   Resid. Df Resid. Dev Df Deviance Pr(>Chi)
## 1       156     105.80
## 2       155     105.09  1  0.70221    0.402
```

#Part c-) The probability of receiving a flue shot is 0.0642. The 95% CI # ilogit(results) # LowerCL Prediction UpperCL # 0.0246986 0.06422395 0.1568308

```r
library(faraway)
dat<-data.frame(cbind(X1=55,X2=60,X3=1))
pre1=predict(lmod,dat,type="link",se.fit=T)
LowerCL = pre1$fit-qnorm(1-0.05/2)*pre1$se.fit; UpperCL = pre1$fit+qnorm(1-0.05/2)*pre1$se.fit
Prediction = pre1$fit
results = round(cbind(LowerCL,Prediction,UpperCL),3)
ilogit(results)
```

```
##     LowerCL Prediction   UpperCL
## 1 0.0246986 0.06422395 0.1568308
```

d-) Ho: The model is good fit; Ha: Model is not a good fit. Accept Null,P value>0.05. The model is a good fit.

```r
library(ResourceSelection)
```

```
## ResourceSelection 0.3-5   2019-07-22
```

```r
hoslem.test(lmod$y,fitted(lmod),g=5)
```

```
##
##  Hosmer and Lemeshow goodness of fit (GOF) test
##
## data:  lmod$y, fitted(lmod)
## X-squared = 5.3538, df = 3, p-value = 0.1477
```