

Wine Project Writeup

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12/16/2017

Read in data

```
setwd("/Users/mnarayan/Documents/STATS_101A")
training <- read.csv("Wine 2017 Training Complete.csv", stringsAsFactors = F, header = T)
testing <- read.csv("Wine 2017 Testing.csv", stringsAsFactors = F, header = T)
```

Splitting the data into 70 training-30 testing data sets

```
## 70% of the sample size
smp_size <- floor(0.70*nrow(training))
## set the seed to make partition reproducible (make sure odd and >10000)
set.seed(13457)
train_ind <- sample(seq_len(nrow(training)), size = smp_size)
train <- training[train_ind,]
test <- training[-train_ind,]
```

VIF of independent values before interaction is added

```
library(car)
nointeraction <- lm(Quality ~ alcohol + volatile.acidity + sulphates + residual.sugar + free.sulfur.dioxide)
vif(nointeraction)

##           alcohol      volatile.acidity          sulphates
## 1.453190          1.793901          1.342239
##   residual.sugar  free.sulfur.dioxide total.sulfur.dioxide
## 1.561506            2.186208          2.977306
##           pH      fixed.acidity       citric.acid
## 1.433192            1.895318          1.691297
##   chlorides
## 1.603889
```

Added all interactions

```
newest <- lm(Quality ~
    volatile.acidity + residual.sugar + alcohol + pH + sulphates + free.sulfur.dioxide + fixed.acidity +
    density:Wine.Color + volatile.acidity:Wine.Color + residual.sugar:Wine.Color + alcohol:Wine.Color +
    citric.acid:total.sulfur.dioxide + citric.acid:fixed.acidity + citric.acid:free.sulfur.dioxide +
    total.sulfur.dioxide:fixed.acidity + total.sulfur.dioxide:free.sulfur.dioxide + total.sulfur.dioxide:residual.sugar)
```

```

fixed.acidity:free.sulfur.dioxide + fixed.acidity:sulphates + fixed.acidity:pH + fixed.acidity:residual.sugar + fixed.acidity:alcohol + fixed.acidity:pH:residual.sugar + fixed.acidity:alcohol:residual.sugar + fixed.acidity:pH:alcohol + fixed.acidity:pH:alcohol:residual.sugar + fixed.acidity:pH:alcohol:volatile.acidity + fixed.acidity:pH:residual.sugar + fixed.acidity:pH:volatile.acidity + fixed.acidity:pH:density + fixed.acidity:alcohol:residual.sugar + fixed.acidity:alcohol:volatile.acidity + fixed.acidity:alcohol:density + fixed.acidity:residual.sugar:volatile.acidity + fixed.acidity:residual.sugar:density + fixed.acidity:volatile.acidity:density, data = train)
summary(newest)

## 
## Call:
## lm(formula = Quality ~ volatile.acidity + residual.sugar + alcohol +
##     pH + sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##     citric.acid + density:Wine.Color + volatile.acidity:Wine.Color +
##     residual.sugar:Wine.Color + alcohol:Wine.Color + pH:Wine.Color +
##     sulphates:Wine.Color + free.sulfur.dioxide:Wine.Color + fixed.acidity:Wine.Color +
##     total.sulfur.dioxide:Wine.Color + citric.acid:Wine.Color +
##     citric.acid:total.sulfur.dioxide + citric.acid:fixed.acidity +
##     citric.acid:free.sulfur.dioxide + citric.acid:sulphates +
##     citric.acid:pH + citric.acid:alcohol + citric.acid:residual.sugar +
##     citric.acid:volatile.acidity + citric.acid:density + total.sulfur.dioxide:fixed.acidity +
##     total.sulfur.dioxide:free.sulfur.dioxide + total.sulfur.dioxide:sulphates +
##     total.sulfur.dioxide:density + total.sulfur.dioxide:pH +
##     total.sulfur.dioxide:alcohol + total.sulfur.dioxide:residual.sugar +
##     total.sulfur.dioxide:volatile.acidity + total.sulfur.dioxide:Wine.Color +
##     fixed.acidity:free.sulfur.dioxide + fixed.acidity:sulphates +
##     fixed.acidity:pH + fixed.acidity:alcohol + fixed.acidity:residual.sugar +
##     fixed.acidity:volatile.acidity + fixed.acidity:density +
##     free.sulfur.dioxide:sulphates + free.sulfur.dioxide:pH +
##     free.sulfur.dioxide:alcohol + free.sulfur.dioxide:residual.sugar +
##     free.sulfur.dioxide:volatile.acidity + free.sulfur.dioxide:density +
##     sulphates:pH + sulphates:alcohol + sulphates:residual.sugar +
##     sulphates:volatile.acidity + sulphates:density + pH:alcohol +
##     pH:residual.sugar + pH:volatile.acidity + pH:density + alcohol:residual.sugar +
##     alcohol:volatile.acidity + alcohol:density + residual.sugar:volatile.acidity +
##     residual.sugar:density + volatile.acidity:density, data = train)
## 

## Residuals:
##      Min      1Q Median      3Q      Max
## -3.7782 -0.8154 -0.0137  0.8081  4.2029
## 

## Coefficients:
##             Estimate Std. Error t value
## (Intercept) 8.203e+02  5.375e+02   1.526
## volatile.acidity -5.305e+02  1.786e+02  -2.971
## residual.sugar 1.948e+00  1.443e+00   1.350
## alcohol       2.298e+01  1.149e+01   2.000
## pH            -1.145e+02  1.458e+02  -0.785

```

## sulphates	-3.575e+02	1.965e+02	-1.820
## free.sulfur.dioxide	-4.212e+00	2.622e+00	-1.606
## fixed.acidity	-3.284e-01	1.369e+01	-0.024
## total.sulfur.dioxide	8.432e-01	7.745e-01	1.089
## citric.acid	-4.295e+02	2.154e+02	-1.994
## density:Wine.ColorR	-7.974e+02	5.367e+02	-1.486
## density:Wine.ColorW	-8.109e+02	5.389e+02	-1.505
## volatile.acidity:Wine.ColorW	-1.292e-01	7.537e-01	-0.171
## residual.sugar:Wine.ColorW	-3.731e-02	3.211e-02	-1.162
## alcohol:Wine.ColorW	7.903e-03	9.039e-02	0.087
## pH:Wine.ColorW	3.635e+00	9.143e-01	3.975
## sulphates:Wine.ColorW	1.608e+00	8.781e-01	1.831
## free.sulfur.dioxide:Wine.ColorW	2.847e-02	9.534e-03	2.987
## fixed.acidity:Wine.ColorW	-5.594e-02	1.224e-01	-0.457
## total.sulfur.dioxide:Wine.ColorW	2.562e-03	2.748e-03	0.932
## citric.acid:Wine.ColorW	5.646e-01	8.963e-01	0.630
## total.sulfur.dioxide:citric.acid	2.170e-03	5.461e-03	0.397
## fixed.acidity:citric.acid	-6.496e-01	2.357e-01	-2.756
## free.sulfur.dioxide:citric.acid	1.025e-02	1.286e-02	0.797
## sulphates:citric.acid	-1.951e+00	1.257e+00	-1.552
## pH:citric.acid	-3.140e+00	1.490e+00	-2.107
## alcohol:citric.acid	6.872e-01	2.844e-01	2.416
## residual.sugar:citric.acid	-2.686e-01	8.250e-02	-3.256
## volatile.acidity:citric.acid	9.315e-01	1.180e+00	0.789
## citric.acid:density	4.406e+02	2.179e+02	2.022
## fixed.acidity:total.sulfur.dioxide	1.191e-03	1.038e-03	1.147
## free.sulfur.dioxide:total.sulfur.dioxide	-1.849e-04	3.185e-05	-5.806
## sulphates:total.sulfur.dioxide	-2.075e-02	5.408e-03	-3.837
## total.sulfur.dioxide:density	-8.435e-01	7.864e-01	-1.073
## pH:total.sulfur.dioxide	3.086e-03	6.039e-03	0.511
## alcohol:total.sulfur.dioxide	-1.656e-03	1.126e-03	-1.471
## residual.sugar:total.sulfur.dioxide	9.729e-04	3.282e-04	2.964
## volatile.acidity:total.sulfur.dioxide	6.855e-04	5.266e-03	0.130
## free.sulfur.dioxide:fixed.acidity	-9.719e-04	2.932e-03	-0.331
## sulphates:fixed.acidity	-2.539e-01	2.010e-01	-1.264
## pH:fixed.acidity	1.564e-01	1.384e-01	1.130
## alcohol:fixed.acidity	7.093e-03	2.504e-02	0.283
## residual.sugar:fixed.acidity	4.836e-03	7.962e-03	0.607
## volatile.acidity:fixed.acidity	-4.778e-01	2.410e-01	-1.983
## fixed.acidity:density	3.566e-01	1.355e+01	0.026
## sulphates:free.sulfur.dioxide	1.809e-02	1.332e-02	1.358
## pH:free.sulfur.dioxide	-8.756e-03	1.572e-02	-0.557
## alcohol:free.sulfur.dioxide	6.086e-03	3.637e-03	1.674
## residual.sugar:free.sulfur.dioxide	-2.130e-03	1.038e-03	-2.051
## volatile.acidity:free.sulfur.dioxide	1.822e-02	1.451e-02	1.256
## free.sulfur.dioxide:density	4.210e+00	2.656e+00	1.585
## pH:sulphates	-1.202e+00	1.255e+00	-0.958
## alcohol:sulphates	3.386e-01	2.399e-01	1.412
## residual.sugar:sulphates	-1.455e-01	8.632e-02	-1.685
## volatile.acidity:sulphates	-1.688e+00	1.118e+00	-1.510
## sulphates:density	3.649e+02	1.986e+02	1.837
## alcohol:pH	4.346e-01	2.190e-01	1.984
## residual.sugar:pH	-1.430e-01	6.020e-02	-2.375
## volatile.acidity:pH	1.321e+00	1.553e+00	0.851

```

## pH:density           1.095e+02  1.452e+02  0.754
## residual.sugar:alcohol 2.110e-02  7.497e-03  2.815
## volatile.acidity:alcohol 1.226e+00  2.350e-01  5.216
## alcohol:density      -2.539e+01  1.170e+01  -2.171
## volatile.acidity:residual.sugar -2.052e-01  8.517e-02  -2.409
## residual.sugar:density     -1.448e+00  1.412e+00  -1.026
## volatile.acidity:density    5.195e+02  1.817e+02  2.859
##
Pr(>|t|)

## (Intercept)          0.127044
## volatile.acidity     0.002981 ** 
## residual.sugar       0.177083
## alcohol              0.045574 *  
## pH                   0.432323
## sulphates            0.068884 .
## free.sulfur.dioxide 0.108276
## fixed.acidity         0.980864
## total.sulfur.dioxide 0.276378
## citric.acid          0.046250 *
## density:Wine.ColorR 0.137436
## density:Wine.ColorW 0.132433
## volatile.acidity:Wine.ColorW 0.863904
## residual.sugar:Wine.ColorW 0.245262
## alcohol:Wine.ColorW 0.930329
## pH:Wine.ColorW       7.13e-05 ***
## sulphates:Wine.ColorW 0.067179 .
## free.sulfur.dioxide:Wine.ColorW 0.002836 **
## fixed.acidity:Wine.ColorW 0.647739
## total.sulfur.dioxide:Wine.ColorW 0.351300
## citric.acid:Wine.ColorW 0.528765
## total.sulfur.dioxide:citric.acid 0.691081
## fixed.acidity:citric.acid        0.005871 ** 
## free.sulfur.dioxide:citric.acid 0.425619
## sulphates:citric.acid          0.120767
## pH:citric.acid               0.035202 *
## alcohol:citric.acid          0.015728 *
## residual.sugar:citric.acid   0.001139 ** 
## volatile.acidity:citric.acid 0.430021
## citric.acid:density          0.043200 *
## fixed.acidity:total.sulfur.dioxide 0.251475
## free.sulfur.dioxide:total.sulfur.dioxide 6.82e-09 ***
## sulphates:total.sulfur.dioxide 0.000126 ***
## total.sulfur.dioxide:density 0.283452
## pH:total.sulfur.dioxide     0.609385
## alcohol:total.sulfur.dioxide 0.141245
## residual.sugar:total.sulfur.dioxide 0.003049 ** 
## volatile.acidity:total.sulfur.dioxide 0.896424
## free.sulfur.dioxide:fixed.acidity 0.740334
## sulphates:fixed.acidity       0.206461
## pH:fixed.acidity             0.258481
## alcohol:fixed.acidity        0.776976
## residual.sugar:fixed.acidity 0.543615
## volatile.acidity:fixed.acidity 0.047472 *
## fixed.acidity:density        0.979012
## sulphates:free.sulfur.dioxide 0.174661

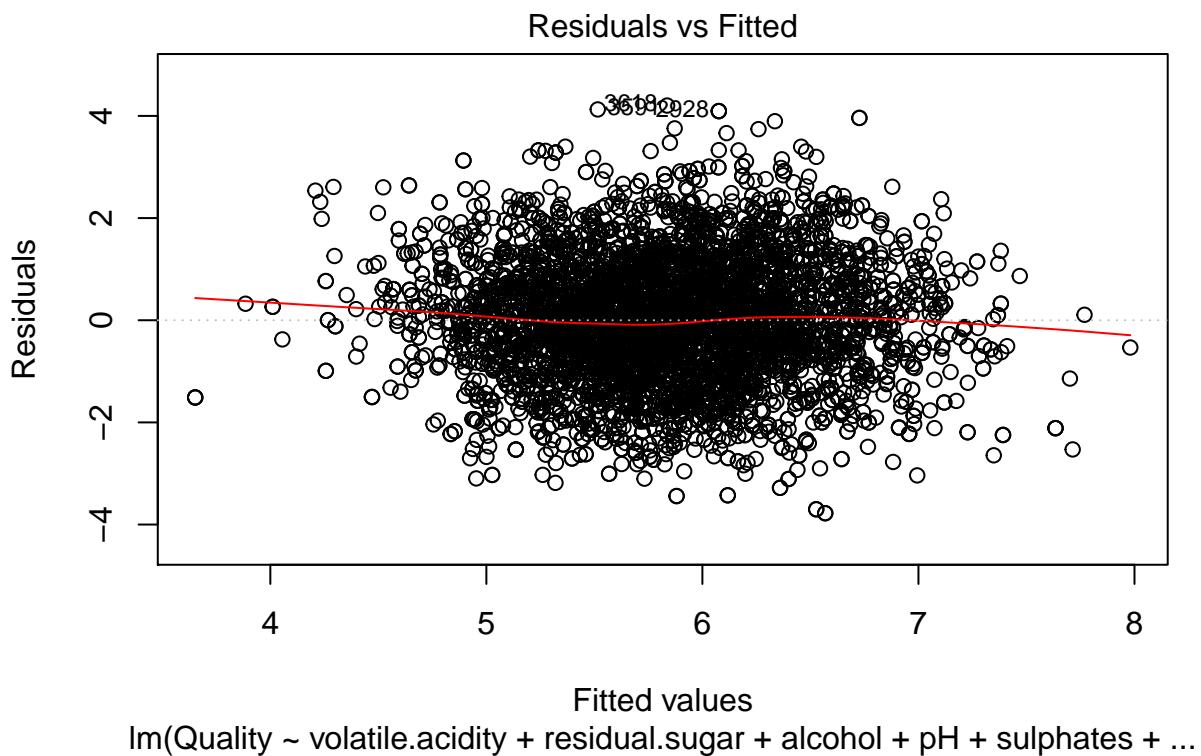
```

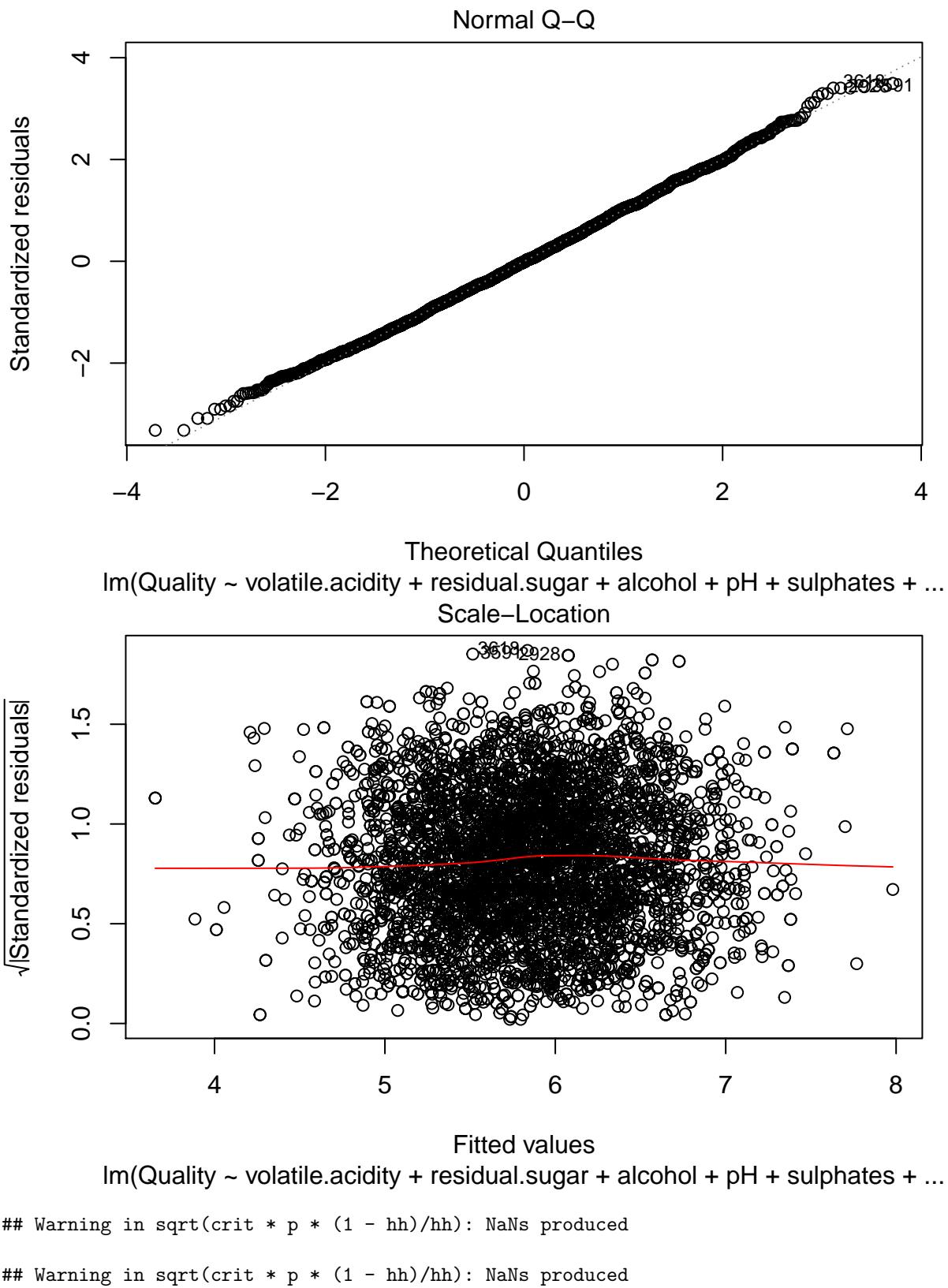
```

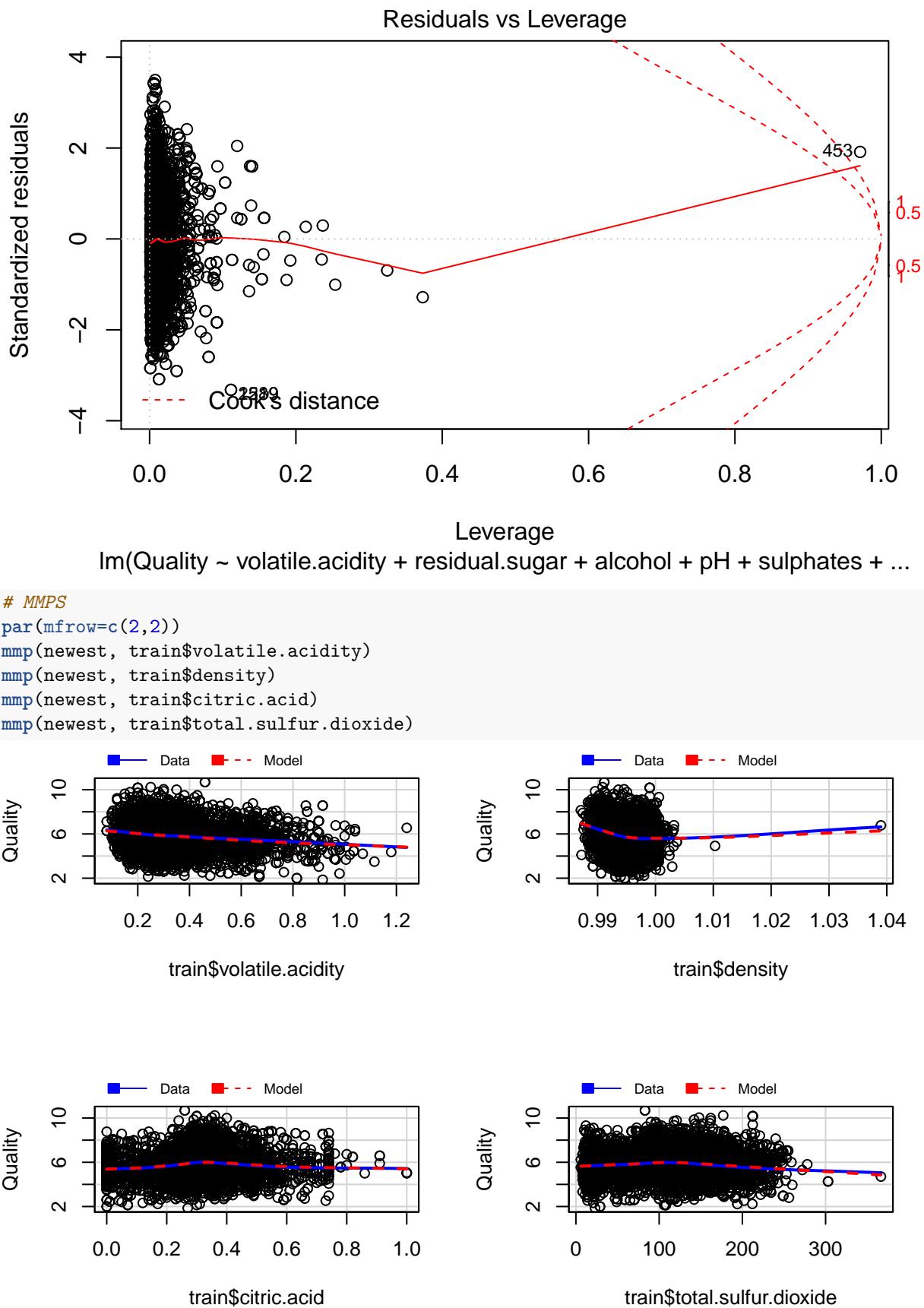
## pH:free.sulfur.dioxide          0.577512
## alcohol:free.sulfur.dioxide    0.094292 .
## residual.sugar:free.sulfur.dioxide 0.040343 *
## volatile.acidity:free.sulfur.dioxide 0.209163
## free.sulfur.dioxide:density     0.112968
## pH:sulphates                  0.338310
## alcohol:sulphates              0.158086
## residual.sugar:sulphates       0.092038 .
## volatile.acidity:sulphates     0.131209
## sulphates:density              0.066285 .
## alcohol:pH                     0.047284 *
## residual.sugar:pH              0.017580 *
## volatile.acidity:pH            0.394941
## pH:density                     0.451067
## residual.sugar:alcohol          0.004897 **
## volatile.acidity:alcohol        1.90e-07 ***
## alcohol:density                 0.030002 *
## volatile.acidity:residual.sugar 0.016040 *
## residual.sugar:density          0.305144
## volatile.acidity:density        0.004269 **

## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 
## Residual standard error: 1.207 on 4834 degrees of freedom
## Multiple R-squared:  0.1786, Adjusted R-squared:  0.1676
## F-statistic: 16.17 on 65 and 4834 DF,  p-value: < 2.2e-16
plot(newest)

```

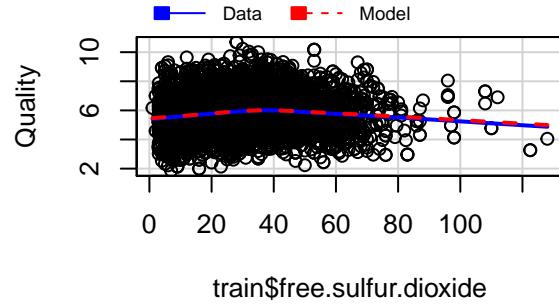
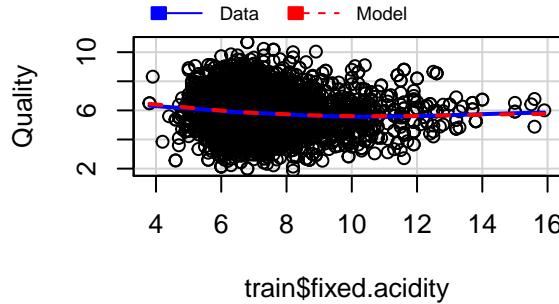






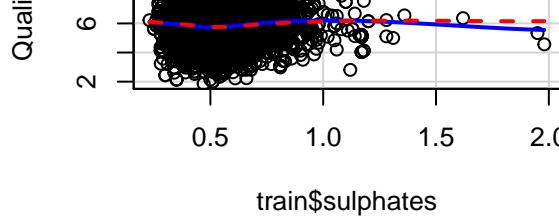
```
par(mfrow=c(2,2))
```

```
mmp(newest, train$fixed.acidity)
mmp(newest, train$free.sulfur.dioxide)
mmp(newest, train$sulphates)
mmp(newest, train$pH)
```

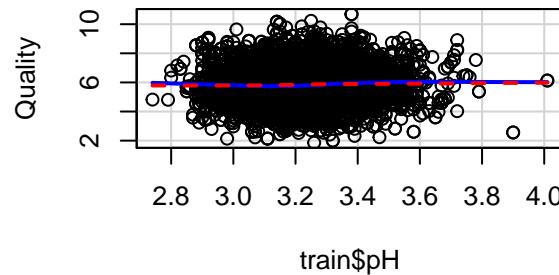


```
par(mfrow=c(2,2))
```

```
mmp(newest, train$sulphates)
```



```
mmp(newest, train$pH)
```



```
par(mfrow=c(2,2))
```

```
mmp(newest, train$alcohol)
mmp(newest, train$residual.sugar)
```

```
## backward AIC
```

```
backAIC <- step(newest, direction = "backward", data=train)
```

```
## Start: AIC=1907.53
```

```
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
```

```
##     sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
```

```
##     citric.acid + density:Wine.Color + volatile.acidity:Wine.Color +
```

Forward/Backward AIC/BIC

```
# backward AIC
```

```
backAIC <- step(newest, direction = "backward", data=train)
```

```
## Start: AIC=1907.53
```

```
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
```

```
##     sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
```

```
##     citric.acid + density:Wine.Color + volatile.acidity:Wine.Color +
```

```

## residual.sugar:Wine.Color + alcohol:Wine.Color + pH:Wine.Color +
## sulphates:Wine.Color + free.sulfur.dioxide:Wine.Color + fixed.acidity:Wine.Color +
## total.sulfur.dioxide:Wine.Color + citric.acid:Wine.Color +
## citric.acid:total.sulfur.dioxide + citric.acid:fixed.acidity +
## citric.acid:free.sulfur.dioxide + citric.acid:sulphates +
## citric.acid:pH + citric.acid:alcohol + citric.acid:residual.sugar +
## citric.acid:volatile.acidity + citric.acid:density + total.sulfur.dioxide:fixed.acidity +
## total.sulfur.dioxide:free.sulfur.dioxide + total.sulfur.dioxide:sulphates +
## total.sulfur.dioxide:density + total.sulfur.dioxide:pH +
## total.sulfur.dioxide:alcohol + total.sulfur.dioxide:residual.sugar +
## total.sulfur.dioxide:volatile.acidity + total.sulfur.dioxide:Wine.Color +
## fixed.acidity:free.sulfur.dioxide + fixed.acidity:sulphates +
## fixed.acidity:pH + fixed.acidity:alcohol + fixed.acidity:residual.sugar +
## fixed.acidity:volatile.acidity + fixed.acidity:density +
## free.sulfur.dioxide:sulphates + free.sulfur.dioxide:pH +
## free.sulfur.dioxide:alcohol + free.sulfur.dioxide:residual.sugar +
## free.sulfur.dioxide:volatile.acidity + free.sulfur.dioxide:density +
## sulphates:pH + sulphates:alcohol + sulphates:residual.sugar +
## sulphates:volatile.acidity + sulphates:density + pH:alcohol +
## pH:residual.sugar + pH:volatile.acidity + pH:density + alcohol:residual.sugar +
## alcohol:volatile.acidity + alcohol:density + residual.sugar:volatile.acidity +
## residual.sugar:density + volatile.acidity:density
##
##                                     Df Sum of Sq    RSS     AIC
## - fixed.acidity:density          1   0.001 7039.9 1905.5
## - alcohol:Wine.Color            1   0.011 7039.9 1905.5
## - volatile.acidity:total.sulfur.dioxide 1   0.025 7039.9 1905.5
## - volatile.acidity:Wine.Color      1   0.043 7039.9 1905.6
## - alcohol:fixed.acidity          1   0.117 7040.0 1905.6
## - free.sulfur.dioxide:fixed.acidity 1   0.160 7040.0 1905.6
## - total.sulfur.dioxide:citric.acid 1   0.230 7040.1 1905.7
## - fixed.acidity:Wine.Color        1   0.304 7040.2 1905.7
## - pH:total.sulfur.dioxide        1   0.380 7040.2 1905.8
## - pH:free.sulfur.dioxide         1   0.452 7040.3 1905.8
## - residual.sugar:fixed.acidity    1   0.537 7040.4 1905.9
## - citric.acid:Wine.Color          1   0.578 7040.4 1905.9
## - pH:density                      1   0.827 7040.7 1906.1
## - volatile.acidity:citric.acid    1   0.907 7040.8 1906.2
## - free.sulfur.dioxide:citric.acid 1   0.925 7040.8 1906.2
## - volatile.acidity:pH             1   1.054 7040.9 1906.3
## - total.sulfur.dioxide:Wine.Color 1   1.265 7041.1 1906.4
## - pH:sulphates                   1   1.335 7041.2 1906.5
## - residual.sugar:density          1   1.532 7041.4 1906.6
## - total.sulfur.dioxide:density     1   1.676 7041.5 1906.7
## - pH:fixed.acidity                1   1.860 7041.7 1906.8
## - fixed.acidity:total.sulfur.dioxide 1   1.916 7041.8 1906.9
## - residual.sugar:Wine.Color        1   1.967 7041.8 1906.9
## - volatile.acidity:free.sulfur.dioxide 1   2.298 7042.2 1907.1
## - sulphates:fixed.acidity          1   2.325 7042.2 1907.2
## - sulphates:free.sulfur.dioxide    1   2.684 7042.5 1907.4
## <none>                           7039.9 1907.5
## - alcohol:sulphates               1   2.903 7042.8 1907.5
## - alcohol:total.sulfur.dioxide     1   3.153 7043.0 1907.7
## - volatile.acidity:sulphates       1   3.319 7043.2 1907.8

```

```

## - sulphates:citric.acid 1 3.507 7043.4 1908.0
## - free.sulfur.dioxide:density 1 3.660 7043.5 1908.1
## - alcohol:free.sulfur.dioxide 1 4.079 7043.9 1908.4
## - residual.sugar:sulphates 1 4.135 7044.0 1908.4
## - sulphates:Wine.Color 1 4.882 7044.7 1908.9
## - sulphates:density 1 4.914 7044.8 1909.0
## - volatile.acidity:fixed.acidity 1 5.724 7045.6 1909.5
## - alcohol:pH 1 5.734 7045.6 1909.5
## - citric.acid:density 1 5.956 7045.8 1909.7
## - residual.sugar:free.sulfur.dioxide 1 6.125 7046.0 1909.8
## - pH:citric.acid 1 6.463 7046.3 1910.0
## - alcohol:density 1 6.862 7046.7 1910.3
## - residual.sugar:pH 1 8.216 7048.1 1911.2
## - volatile.acidity:residual.sugar 1 8.450 7048.3 1911.4
## - alcohol:citric.acid 1 8.501 7048.4 1911.4
## - fixed.acidity:citric.acid 1 11.062 7050.9 1913.2
## - residual.sugar:alcohol 1 11.540 7051.4 1913.5
## - volatile.acidity:density 1 11.903 7051.8 1913.8
## - residual.sugar:total.sulfur.dioxide 1 12.796 7052.7 1914.4
## - free.sulfur.dioxide:Wine.Color 1 12.990 7052.8 1914.6
## - residual.sugar:citric.acid 1 15.435 7055.3 1916.3
## - density:Wine.Color 2 19.993 7059.8 1917.4
## - sulphates:total.sulfur.dioxide 1 21.442 7061.3 1920.4
## - pH:Wine.Color 1 23.016 7062.9 1921.5
## - volatile.acidity:alcohol 1 39.628 7079.5 1933.0
## - free.sulfur.dioxide:total.sulfur.dioxide 1 49.085 7088.9 1939.6
##
## Step: AIC=1905.53
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
## sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
## citric.acid + density:Wine.Color + volatile.acidity:Wine.Color +
## residual.sugar:Wine.Color + alcohol:Wine.Color + pH:Wine.Color +
## sulphates:Wine.Color + free.sulfur.dioxide:Wine.Color + fixed.acidity:Wine.Color +
## total.sulfur.dioxide:Wine.Color + citric.acid:Wine.Color +
## total.sulfur.dioxide:citric.acid + fixed.acidity:citric.acid +
## free.sulfur.dioxide:citric.acid + sulphates:citric.acid +
## pH:citric.acid + alcohol:citric.acid + residual.sugar:citric.acid +
## volatile.acidity:citric.acid + citric.acid:density + fixed.acidity:total.sulfur.dioxide +
## free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
## total.sulfur.dioxide:density + pH:total.sulfur.dioxide +
## alcohol:total.sulfur.dioxide + residual.sugar:total.sulfur.dioxide +
## volatile.acidity:total.sulfur.dioxide + free.sulfur.dioxide:fixed.acidity +
## sulphates:fixed.acidity + pH:fixed.acidity + alcohol:fixed.acidity +
## residual.sugar:fixed.acidity + volatile.acidity:fixed.acidity +
## sulphates:free.sulfur.dioxide + pH:free.sulfur.dioxide +
## alcohol:free.sulfur.dioxide + residual.sugar:free.sulfur.dioxide +
## volatile.acidity:free.sulfur.dioxide + free.sulfur.dioxide:density +
## pH:sulphates + alcohol:sulphates + residual.sugar:sulphates +
## volatile.acidity:sulphates + sulphates:density + alcohol:pH +
## residual.sugar:pH + volatile.acidity:pH + pH:density + residual.sugar:alcohol +
## volatile.acidity:alcohol + alcohol:density + volatile.acidity:residual.sugar +
## residual.sugar:density + volatile.acidity:density
##
## Df Sum of Sq      RSS      AIC

```

## - alcohol:Wine.Color	1	0.011	7039.9	1903.5
## - volatile.acidity:total.sulfur.dioxide	1	0.024	7039.9	1903.5
## - volatile.acidity:Wine.Color	1	0.042	7039.9	1903.6
## - alcohol:fixed.acidity	1	0.149	7040.0	1903.6
## - free.sulfur.dioxide:fixed.acidity	1	0.165	7040.0	1903.6
## - total.sulfur.dioxide:citric.acid	1	0.230	7040.1	1903.7
## - pH:total.sulfur.dioxide	1	0.395	7040.3	1903.8
## - pH:free.sulfur.dioxide	1	0.457	7040.3	1903.8
## - fixed.acidity:Wine.Color	1	0.544	7040.4	1903.9
## - citric.acid:Wine.Color	1	0.640	7040.5	1904.0
## - residual.sugar:fixed.acidity	1	0.891	7040.7	1904.2
## - pH:density	1	0.895	7040.8	1904.2
## - volatile.acidity:citric.acid	1	0.907	7040.8	1904.2
## - free.sulfur.dioxide:citric.acid	1	0.927	7040.8	1904.2
## - volatile.acidity:pH	1	1.054	7040.9	1904.3
## - total.sulfur.dioxide:Wine.Color	1	1.300	7041.2	1904.4
## - pH:sulphates	1	1.338	7041.2	1904.5
## - residual.sugar:density	1	1.548	7041.4	1904.6
## - total.sulfur.dioxide:density	1	1.740	7041.6	1904.7
## - pH:fixed.acidity	1	1.869	7041.7	1904.8
## - fixed.acidity:total.sulfur.dioxide	1	1.989	7041.8	1904.9
## - residual.sugar:Wine.Color	1	2.060	7041.9	1905.0
## - volatile.acidity:free.sulfur.dioxide	1	2.307	7042.2	1905.1
## - sulphates:fixed.acidity	1	2.324	7042.2	1905.2
## - sulphates:free.sulfur.dioxide	1	2.710	7042.6	1905.4
## <none>			7039.9	1905.5
## - alcohol:sulphates	1	2.958	7042.8	1905.6
## - alcohol:total.sulfur.dioxide	1	3.200	7043.1	1905.8
## - volatile.acidity:sulphates	1	3.319	7043.2	1905.8
## - sulphates:citric.acid	1	3.543	7043.4	1906.0
## - free.sulfur.dioxide:density	1	3.668	7043.5	1906.1
## - alcohol:free.sulfur.dioxide	1	4.083	7043.9	1906.4
## - residual.sugar:sulphates	1	4.327	7044.2	1906.5
## - sulphates:Wine.Color	1	5.070	7044.9	1907.1
## - sulphates:density	1	5.103	7045.0	1907.1
## - volatile.acidity:fixed.acidity	1	5.724	7045.6	1907.5
## - alcohol:pH	1	6.018	7045.9	1907.7
## - residual.sugar:free.sulfur.dioxide	1	6.145	7046.0	1907.8
## - citric.acid:density	1	6.447	7046.3	1908.0
## - pH:citric.acid	1	6.470	7046.3	1908.0
## - alcohol:density	1	6.908	7046.8	1908.3
## - volatile.acidity:residual.sugar	1	8.754	7048.6	1909.6
## - residual.sugar:pH	1	8.781	7048.6	1909.6
## - alcohol:citric.acid	1	8.850	7048.7	1909.7
## - fixed.acidity:citric.acid	1	11.112	7051.0	1911.3
## - residual.sugar:alcohol	1	11.570	7051.4	1911.6
## - volatile.acidity:density	1	12.314	7052.2	1912.1
## - free.sulfur.dioxide:Wine.Color	1	13.049	7052.9	1912.6
## - residual.sugar:total.sulfur.dioxide	1	13.324	7053.2	1912.8
## - residual.sugar:citric.acid	1	16.492	7056.3	1915.0
## - density:Wine.Color	2	23.263	7063.1	1917.7
## - sulphates:total.sulfur.dioxide	1	21.510	7061.4	1918.5
## - pH:Wine.Color	1	26.005	7065.9	1921.6
## - volatile.acidity:alcohol	1	40.448	7080.3	1931.6

```

## - free.sulfur.dioxide:total.sulfur.dioxide 1 49.198 7089.1 1937.7
##
## Step: AIC=1903.54
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
## sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
## citric.acid + density:Wine.Color + volatile.acidity:Wine.Color +
## residual.sugar:Wine.Color + pH:Wine.Color + sulphates:Wine.Color +
## free.sulfur.dioxide:Wine.Color + fixed.acidity:Wine.Color +
## total.sulfur.dioxide:Wine.Color + citric.acid:Wine.Color +
## total.sulfur.dioxide:citric.acid + fixed.acidity:citric.acid +
## free.sulfur.dioxide:citric.acid + sulphates:citric.acid +
## pH:citric.acid + alcohol:citric.acid + residual.sugar:citric.acid +
## volatile.acidity:citric.acid + citric.acid:density + fixed.acidity:total.sulfur.dioxide +
## free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
## total.sulfur.dioxide:density + pH:total.sulfur.dioxide +
## alcohol:total.sulfur.dioxide + residual.sugar:total.sulfur.dioxide +
## volatile.acidity:total.sulfur.dioxide + free.sulfur.dioxide:fixed.acidity +
## sulphates:fixed.acidity + pH:fixed.acidity + alcohol:fixed.acidity +
## residual.sugar:fixed.acidity + volatile.acidity:fixed.acidity +
## sulphates:free.sulfur.dioxide + pH:free.sulfur.dioxide +
## alcohol:free.sulfur.dioxide + residual.sugar:free.sulfur.dioxide +
## volatile.acidity:free.sulfur.dioxide + free.sulfur.dioxide:density +
## pH:sulphates + alcohol:sulphates + residual.sugar:sulphates +
## volatile.acidity:sulphates + sulphates:density + alcohol:pH +
## residual.sugar:pH + volatile.acidity:pH + pH:density + residual.sugar:alcohol +
## volatile.acidity:alcohol + alcohol:density + volatile.acidity:residual.sugar +
## residual.sugar:density + volatile.acidity:density
##
##                                     Df Sum of Sq    RSS     AIC
## - volatile.acidity:total.sulfur.dioxide 1  0.022 7039.9 1901.5
## - volatile.acidity:Wine.Color          1  0.040 7039.9 1901.6
## - alcohol:fixed.acidity              1  0.144 7040.0 1901.6
## - free.sulfur.dioxide:fixed.acidity  1  0.164 7040.0 1901.7
## - total.sulfur.dioxide:citric.acid   1  0.223 7040.1 1901.7
## - pH:total.sulfur.dioxide           1  0.390 7040.3 1901.8
## - pH:free.sulfur.dioxide            1  0.453 7040.3 1901.8
## - fixed.acidity:Wine.Color          1  0.571 7040.4 1901.9
## - citric.acid:Wine.Color            1  0.674 7040.5 1902.0
## - residual.sugar:fixed.acidity      1  0.881 7040.7 1902.2
## - pH:density                       1  0.889 7040.8 1902.2
## - free.sulfur.dioxide:citric.acid   1  0.931 7040.8 1902.2
## - volatile.acidity:citric.acid      1  0.932 7040.8 1902.2
## - volatile.acidity:pH               1  1.055 7040.9 1902.3
## - total.sulfur.dioxide:Wine.Color   1  1.291 7041.2 1902.4
## - pH:sulphates                     1  1.356 7041.2 1902.5
## - residual.sugar:density           1  1.545 7041.4 1902.6
## - total.sulfur.dioxide:density      1  1.730 7041.6 1902.7
## - pH:fixed.acidity                 1  1.877 7041.7 1902.8
## - fixed.acidity:total.sulfur.dioxide 1  1.996 7041.9 1902.9
## - residual.sugar:Wine.Color         1  2.123 7042.0 1903.0
## - volatile.acidity:free.sulfur.dioxide 1  2.325 7042.2 1903.2
## - sulphates:fixed.acidity          1  2.351 7042.2 1903.2
## - sulphates:free.sulfur.dioxide     1  2.719 7042.6 1903.4
## <none>                                7039.9 1903.5

```

```

## - alcohol:sulphates 1 2.950 7042.8 1903.6
## - volatile.acidity:sulphates 1 3.315 7043.2 1903.8
## - alcohol:total.sulfur.dioxide 1 3.440 7043.3 1903.9
## - sulphates:citric.acid 1 3.532 7043.4 1904.0
## - free.sulfur.dioxide:density 1 3.658 7043.5 1904.1
## - alcohol:free.sulfur.dioxide 1 4.078 7043.9 1904.4
## - residual.sugar:sulphates 1 4.405 7044.3 1904.6
## - sulphates:density 1 5.137 7045.0 1905.1
## - sulphates:Wine.Color 1 5.223 7045.1 1905.2
## - volatile.acidity:fixed.acidity 1 5.831 7045.7 1905.6
## - alcohol:pH 1 6.093 7046.0 1905.8
## - residual.sugar:free.sulfur.dioxide 1 6.138 7046.0 1905.8
## - pH:citric.acid 1 6.460 7046.3 1906.0
## - citric.acid:density 1 6.495 7046.4 1906.0
## - residual.sugar:pH 1 8.842 7048.7 1907.7
## - volatile.acidity:residual.sugar 1 8.884 7048.8 1907.7
## - alcohol:citric.acid 1 8.885 7048.8 1907.7
## - alcohol:density 1 9.346 7049.2 1908.0
## - fixed.acidity:citric.acid 1 11.202 7051.1 1909.3
## - volatile.acidity:density 1 12.385 7052.3 1910.2
## - free.sulfur.dioxide:Wine.Color 1 13.039 7052.9 1910.6
## - residual.sugar:total.sulfur.dioxide 1 13.375 7053.2 1910.8
## - residual.sugar:alcohol 1 13.851 7053.7 1911.2
## - residual.sugar:citric.acid 1 16.577 7056.4 1913.1
## - sulphates:total.sulfur.dioxide 1 21.656 7061.5 1916.6
## - density:Wine.Color 2 24.784 7064.7 1916.8
## - pH:Wine.Color 1 26.042 7065.9 1919.6
## - volatile.acidity:alcohol 1 41.280 7081.1 1930.2
## - free.sulfur.dioxide:total.sulfur.dioxide 1 49.308 7089.2 1935.7
##
## Step: AIC=1901.55
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##       sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##       citric.acid + density:Wine.Color + volatile.acidity:Wine.Color +
##       residual.sugar:Wine.Color + pH:Wine.Color + sulphates:Wine.Color +
##       free.sulfur.dioxide:Wine.Color + fixed.acidity:Wine.Color +
##       total.sulfur.dioxide:Wine.Color + citric.acid:Wine.Color +
##       total.sulfur.dioxide:citric.acid + fixed.acidity:citric.acid +
##       free.sulfur.dioxide:citric.acid + sulphates:citric.acid +
##       pH:citric.acid + alcohol:citric.acid + residual.sugar:citric.acid +
##       volatile.acidity:citric.acid + citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##       free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##       total.sulfur.dioxide:density + pH:total.sulfur.dioxide +
##       alcohol:total.sulfur.dioxide + residual.sugar:total.sulfur.dioxide +
##       free.sulfur.dioxide:fixed.acidity + sulphates:fixed.acidity +
##       pH:fixed.acidity + alcohol:fixed.acidity + residual.sugar:fixed.acidity +
##       volatile.acidity:fixed.acidity + sulphates:free.sulfur.dioxide +
##       pH:free.sulfur.dioxide + alcohol:free.sulfur.dioxide + residual.sugar:free.sulfur.dioxide +
##       volatile.acidity:free.sulfur.dioxide + free.sulfur.dioxide:density +
##       pH:sulphates + alcohol:sulphates + residual.sugar:sulphates +
##       volatile.acidity:sulphates + sulphates:density + alcohol:pH +
##       residual.sugar:pH + volatile.acidity:pH + pH:density + residual.sugar:alcohol +
##       volatile.acidity:alcohol + alcohol:density + volatile.acidity:residual.sugar +
##       residual.sugar:density + volatile.acidity:density

```

	Df	Sum of Sq	RSS	AIC
##				
## - volatile.acidity:Wine.Color	1	0.020	7039.9	1899.6
## - alcohol:fixed.acidity	1	0.143	7040.0	1899.7
## - free.sulfur.dioxide:fixed.acidity	1	0.165	7040.1	1899.7
## - total.sulfur.dioxide:citric.acid	1	0.201	7040.1	1899.7
## - pH:total.sulfur.dioxide	1	0.376	7040.3	1899.8
## - pH:free.sulfur.dioxide	1	0.445	7040.3	1899.9
## - fixed.acidity:Wine.Color	1	0.591	7040.5	1900.0
## - citric.acid:Wine.Color	1	0.719	7040.6	1900.0
## - pH:density	1	0.881	7040.8	1900.2
## - residual.sugar:fixed.acidity	1	0.893	7040.8	1900.2
## - volatile.acidity:citric.acid	1	0.948	7040.8	1900.2
## - free.sulfur.dioxide:citric.acid	1	0.980	7040.9	1900.2
## - volatile.acidity:pH	1	1.040	7040.9	1900.3
## - total.sulfur.dioxide:Wine.Color	1	1.335	7041.2	1900.5
## - pH:sulphates	1	1.347	7041.2	1900.5
## - residual.sugar:density	1	1.684	7041.6	1900.7
## - total.sulfur.dioxide:density	1	1.725	7041.6	1900.8
## - pH:fixed.acidity	1	1.862	7041.8	1900.8
## - fixed.acidity:total.sulfur.dioxide	1	1.980	7041.9	1900.9
## - residual.sugar:Wine.Color	1	2.101	7042.0	1901.0
## - sulphates:fixed.acidity	1	2.352	7042.2	1901.2
## - sulphates:free.sulfur.dioxide	1	2.732	7042.6	1901.5
## <none>		7039.9	1901.5	
## - alcohol:sulphates	1	2.952	7042.8	1901.6
## - volatile.acidity:sulphates	1	3.294	7043.2	1901.8
## - alcohol:total.sulfur.dioxide	1	3.429	7043.3	1901.9
## - sulphates:citric.acid	1	3.518	7043.4	1902.0
## - free.sulfur.dioxide:density	1	3.645	7043.5	1902.1
## - volatile.acidity:free.sulfur.dioxide	1	3.833	7043.7	1902.2
## - alcohol:free.sulfur.dioxide	1	4.070	7044.0	1902.4
## - residual.sugar:sulphates	1	4.402	7044.3	1902.6
## - sulphates:density	1	5.134	7045.0	1903.1
## - sulphates:Wine.Color	1	5.261	7045.2	1903.2
## - volatile.acidity:fixed.acidity	1	5.980	7045.9	1903.7
## - alcohol:pH	1	6.079	7046.0	1903.8
## - residual.sugar:free.sulfur.dioxide	1	6.116	7046.0	1903.8
## - pH:citric.acid	1	6.452	7046.3	1904.0
## - citric.acid:density	1	6.538	7046.4	1904.1
## - residual.sugar:pH	1	8.820	7048.7	1905.7
## - alcohol:citric.acid	1	8.896	7048.8	1905.7
## - volatile.acidity:residual.sugar	1	9.042	7048.9	1905.8
## - alcohol:density	1	9.357	7049.2	1906.1
## - fixed.acidity:citric.acid	1	11.251	7051.1	1907.4
## - volatile.acidity:density	1	13.171	7053.1	1908.7
## - residual.sugar:total.sulfur.dioxide	1	13.657	7053.5	1909.0
## - residual.sugar:alcohol	1	13.960	7053.8	1909.3
## - free.sulfur.dioxide:Wine.Color	1	14.165	7054.1	1909.4
## - residual.sugar:citric.acid	1	16.600	7056.5	1911.1
## - sulphates:total.sulfur.dioxide	1	21.805	7061.7	1914.7
## - density:Wine.Color	2	24.771	7064.7	1914.8
## - pH:Wine.Color	1	26.049	7065.9	1917.7
## - volatile.acidity:alcohol	1	41.305	7081.2	1928.2

```

## - free.sulfur.dioxide:total.sulfur.dioxide 1 50.143 7090.0 1934.3
##
## Step: AIC=1899.56
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
## sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
## citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
## pH:Wine.Color + sulphates:Wine.Color + free.sulfur.dioxide:Wine.Color +
## fixed.acidity:Wine.Color + total.sulfur.dioxide:Wine.Color +
## citric.acid:Wine.Color + total.sulfur.dioxide:citric.acid +
## fixed.acidity:citric.acid + free.sulfur.dioxide:citric.acid +
## sulphates:citric.acid + pH:citric.acid + alcohol:citric.acid +
## residual.sugar:citric.acid + volatile.acidity:citric.acid +
## citric.acid:density + fixed.acidity:total.sulfur.dioxide +
## free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
## total.sulfur.dioxide:density + pH:total.sulfur.dioxide +
## alcohol:total.sulfur.dioxide + residual.sugar:total.sulfur.dioxide +
## free.sulfur.dioxide:fixed.acidity + sulphates:fixed.acidity +
## pH:fixed.acidity + alcohol:fixed.acidity + residual.sugar:fixed.acidity +
## volatile.acidity:fixed.acidity + sulphates:free.sulfur.dioxide +
## pH:free.sulfur.dioxide + alcohol:free.sulfur.dioxide + residual.sugar:free.sulfur.dioxide +
## volatile.acidity:free.sulfur.dioxide + free.sulfur.dioxide:density +
## pH:sulphates + alcohol:sulphates + residual.sugar:sulphates +
## volatile.acidity:sulphates + sulphates:density + alcohol:pH +
## residual.sugar:pH + volatile.acidity:pH + pH:density + residual.sugar:alcohol +
## volatile.acidity:alcohol + alcohol:density + volatile.acidity:residual.sugar +
## residual.sugar:density + volatile.acidity:density
##
##                                     Df Sum of Sq    RSS    AIC
## - alcohol:fixed.acidity           1  0.142 7040.1 1897.7
## - free.sulfur.dioxide:fixed.acidity 1  0.176 7040.1 1897.7
## - total.sulfur.dioxide:citric.acid 1  0.198 7040.1 1897.7
## - pH:total.sulfur.dioxide         1  0.378 7040.3 1897.8
## - pH:free.sulfur.dioxide          1  0.460 7040.4 1897.9
## - fixed.acidity:Wine.Color        1  0.572 7040.5 1898.0
## - citric.acid:Wine.Color          1  0.856 7040.8 1898.2
## - pH:density                      1  0.877 7040.8 1898.2
## - residual.sugar:fixed.acidity     1  0.903 7040.8 1898.2
## - volatile.acidity:citric.acid     1  0.930 7040.8 1898.2
## - free.sulfur.dioxide:citric.acid 1  0.965 7040.9 1898.2
## - volatile.acidity:pH              1  1.064 7041.0 1898.3
## - total.sulfur.dioxide:Wine.Color   1  1.316 7041.2 1898.5
## - pH:sulphates                    1  1.334 7041.2 1898.5
## - total.sulfur.dioxide:density      1  1.745 7041.7 1898.8
## - residual.sugar:density           1  1.787 7041.7 1898.8
## - pH:fixed.acidity                 1  1.878 7041.8 1898.9
## - fixed.acidity:total.sulfur.dioxide 1  1.973 7041.9 1898.9
## - residual.sugar:Wine.Color         1  2.153 7042.1 1899.1
## - sulphates:fixed.acidity          1  2.333 7042.2 1899.2
## - sulphates:free.sulfur.dioxide     1  2.717 7042.6 1899.5
## <none>                                7039.9 1899.6
## - alcohol:sulphates                1  2.946 7042.9 1899.6
## - volatile.acidity:sulphates        1  3.287 7043.2 1899.8
## - alcohol:total.sulfur.dioxide       1  3.459 7043.4 1900.0
## - sulphates:citric.acid             1  3.502 7043.4 1900.0

```

```

## - volatile.acidity:free.sulfur.dioxide      1    3.878 7043.8 1900.3
## - free.sulfur.dioxide:density              1    3.902 7043.8 1900.3
## - alcohol:free.sulfur.dioxide             1    4.236 7044.1 1900.5
## - residual.sugar:sulphates                1    4.383 7044.3 1900.6
## - sulphates:density                      1    5.140 7045.0 1901.1
## - sulphates:Wine.Color                  1    5.252 7045.2 1901.2
## - volatile.acidity:fixed.acidity          1    6.004 7045.9 1901.7
## - alcohol:pH                            1    6.068 7046.0 1901.8
## - pH:citric.acid                      1    6.456 7046.4 1902.1
## - residual.sugar:free.sulfur.dioxide     1    6.476 7046.4 1902.1
## - citric.acid:density                  1    6.889 7046.8 1902.4
## - residual.sugar:pH                    1    8.850 7048.8 1903.7
## - alcohol:citric.acid                 1    9.080 7049.0 1903.9
## - alcohol:density                      1    9.337 7049.2 1904.1
## - fixed.acidity:citric.acid           1    11.316 7051.2 1905.4
## - volatile.acidity:residual.sugar       1    12.494 7052.4 1906.2
## - residual.sugar:total.sulfur.dioxide   1    13.741 7053.7 1907.1
## - residual.sugar:alcohol                1    13.943 7053.9 1907.3
## - free.sulfur.dioxide:Wine.Color        1    14.689 7054.6 1907.8
## - residual.sugar:citric.acid          1    17.443 7057.4 1909.7
## - volatile.acidity:density            1    17.810 7057.7 1910.0
## - sulphates:total.sulfur.dioxide       1    21.797 7061.7 1912.7
## - density:Wine.Color                  2    26.380 7066.3 1913.9
## - pH:Wine.Color                      1    26.506 7066.4 1916.0
## - volatile.acidity:alcohol            1    45.837 7085.7 1929.4
## - free.sulfur.dioxide:total.sulfur.dioxide 1    50.324 7090.2 1932.5
##
## Step: AIC=1897.66
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##          sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##          citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
##          pH:Wine.Color + sulphates:Wine.Color + free.sulfur.dioxide:Wine.Color +
##          fixed.acidity:Wine.Color + total.sulfur.dioxide:Wine.Color +
##          citric.acid:Wine.Color + total.sulfur.dioxide:citric.acid +
##          fixed.acidity:citric.acid + free.sulfur.dioxide:citric.acid +
##          sulphates:citric.acid + pH:citric.acid + alcohol:citric.acid +
##          residual.sugar:citric.acid + volatile.acidity:citric.acid +
##          citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##          total.sulfur.dioxide:density + pH:total.sulfur.dioxide +
##          alcohol:total.sulfur.dioxide + residual.sugar:total.sulfur.dioxide +
##          free.sulfur.dioxide:fixed.acidity + sulphates:fixed.acidity +
##          pH:fixed.acidity + residual.sugar:fixed.acidity + volatile.acidity:fixed.acidity +
##          sulphates:free.sulfur.dioxide + pH:free.sulfur.dioxide +
##          alcohol:free.sulfur.dioxide + residual.sugar:free.sulfur.dioxide +
##          volatile.acidity:free.sulfur.dioxide + free.sulfur.dioxide:density +
##          pH:sulphates + alcohol:sulphates + residual.sugar:sulphates +
##          volatile.acidity:sulphates + sulphates:density + alcohol:pH +
##          residual.sugar:pH + volatile.acidity:pH + pH:density + residual.sugar:alcohol +
##          volatile.acidity:alcohol + alcohol:density + volatile.acidity:residual.sugar +
##          residual.sugar:density + volatile.acidity:density
##
##                                     Df Sum of Sq    RSS    AIC
## - free.sulfur.dioxide:fixed.acidity      1    0.166 7040.2 1895.8

```

```

## - total.sulfur.dioxide:citric.acid      1  0.214 7040.3 1895.8
## - pH:total.sulfur.dioxide               1  0.336 7040.4 1895.9
## - pH:free.sulfur.dioxide                1  0.443 7040.5 1896.0
## - fixed.acidity:Wine.Color              1  0.485 7040.5 1896.0
## - citric.acid:Wine.Color                1  0.832 7040.9 1896.2
## - pH:density                           1  0.870 7040.9 1896.3
## - residual.sugar:fixed.acidity          1  0.888 7040.9 1896.3
## - volatile.acidity:citric.acid         1  0.922 7041.0 1896.3
## - free.sulfur.dioxide:citric.acid       1  1.020 7041.1 1896.4
## - volatile.acidity:pH                  1  1.074 7041.1 1896.4
## - total.sulfur.dioxide:Wine.Color        1  1.291 7041.3 1896.6
## - pH:sulphates                         1  1.328 7041.4 1896.6
## - total.sulfur.dioxide:density          1  1.721 7041.8 1896.9
## - residual.sugar:density                1  1.798 7041.8 1896.9
## - fixed.acidity:total.sulfur.dioxide    1  1.859 7041.9 1897.0
## - pH:fixed.acidity                      1  2.017 7042.1 1897.1
## - residual.sugar:Wine.Color              1  2.127 7042.2 1897.1
## - sulphates:fixed.acidity               1  2.273 7042.3 1897.2
## - sulphates:free.sulfur.dioxide         1  2.686 7042.7 1897.5
## <none>                                1  7040.1 1897.7
## - alcohol:sulphates                    1  3.088 7043.1 1897.8
## - volatile.acidity:sulphates            1  3.232 7043.3 1897.9
## - sulphates:citric.acid                1  3.518 7043.6 1898.1
## - alcohol:total.sulfur.dioxide          1  3.589 7043.6 1898.2
## - free.sulfur.dioxide:density           1  3.894 7043.9 1898.4
## - volatile.acidity:free.sulfur.dioxide  1  3.980 7044.0 1898.4
## - alcohol:free.sulfur.dioxide           1  4.235 7044.3 1898.6
## - residual.sugar:sulphates              1  4.348 7044.4 1898.7
## - sulphates:density                     1  5.158 7045.2 1899.2
## - sulphates:Wine.Color                 1  5.253 7045.3 1899.3
## - volatile.acidity:fixed.acidity        1  5.889 7045.9 1899.8
## - alcohol:pH                            1  6.174 7046.2 1900.0
## - residual.sugar:free.sulfur.dioxide    1  6.471 7046.5 1900.2
## - pH:citric.acid                      1  6.759 7046.8 1900.4
## - citric.acid:density                  1  6.934 7047.0 1900.5
## - residual.sugar:pH                   1  8.976 7049.0 1901.9
## - alcohol:citric.acid                 1  10.153 7050.2 1902.7
## - fixed.acidity:citric.acid            1  11.295 7051.3 1903.5
## - volatile.acidity:residual.sugar       1  12.419 7052.5 1904.3
## - alcohol:density                      1  12.503 7052.6 1904.4
## - residual.sugar:total.sulfur.dioxide   1  13.625 7053.7 1905.1
## - free.sulfur.dioxide:Wine.Color        1  14.827 7054.9 1906.0
## - residual.sugar:alcohol                1  15.196 7055.2 1906.2
## - residual.sugar:citric.acid            1  17.473 7057.5 1907.8
## - volatile.acidity:density              1  17.685 7057.7 1908.0
## - sulphates:total.sulfur.dioxide        1  21.771 7061.8 1910.8
## - density:Wine.Color                   2  27.134 7067.2 1912.5
## - pH:Wine.Color                        1  27.052 7067.1 1914.5
## - volatile.acidity:alcohol              1  45.911 7086.0 1927.5
## - free.sulfur.dioxide:total.sulfur.dioxide 1  50.834 7090.9 1930.9
##
## Step: AIC=1895.78
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##      sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +

```

```

## citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
## pH:Wine.Color + sulphates:Wine.Color + free.sulfur.dioxide:Wine.Color +
## fixed.acidity:Wine.Color + total.sulfur.dioxide:Wine.Color +
## citric.acid:Wine.Color + total.sulfur.dioxide:citric.acid +
## fixed.acidity:citric.acid + free.sulfur.dioxide:citric.acid +
## sulphates:citric.acid + pH:citric.acid + alcohol:citric.acid +
## residual.sugar:citric.acid + volatile.acidity:citric.acid +
## citric.acid:density + fixed.acidity:total.sulfur.dioxide +
## free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
## total.sulfur.dioxide:density + pH:total.sulfur.dioxide +
## alcohol:total.sulfur.dioxide + residual.sugar:total.sulfur.dioxide +
## sulphates:fixed.acidity + pH:fixed.acidity + residual.sugar:fixed.acidity +
## volatile.acidity:fixed.acidity + sulphates:free.sulfur.dioxide +
## pH:free.sulfur.dioxide + alcohol:free.sulfur.dioxide + residual.sugar:free.sulfur.dioxide +
## volatile.acidity:free.sulfur.dioxide + free.sulfur.dioxide:density +
## pH:sulphates + alcohol:sulphates + residual.sugar:sulphates +
## volatile.acidity:sulphates + sulphates:density + alcohol:pH +
## residual.sugar:pH + volatile.acidity:pH + pH:density + residual.sugar:alcohol +
## volatile.acidity:alcohol + alcohol:density + volatile.acidity:residual.sugar +
## residual.sugar:density + volatile.acidity:density
##
##                                     Df Sum of Sq    RSS     AIC
## - pH:total.sulfur.dioxide          1   0.209 7040.4 1893.9
## - total.sulfur.dioxide:citric.acid 1   0.265 7040.5 1894.0
## - pH:free.sulfur.dioxide          1   0.281 7040.5 1894.0
## - fixed.acidity:Wine.Color        1   0.423 7040.6 1894.1
## - citric.acid:Wine.Color         1   0.778 7041.0 1894.3
## - pH:density                     1   0.839 7041.1 1894.4
## - volatile.acidity:citric.acid   1   0.863 7041.1 1894.4
## - residual.sugar:fixed.acidity   1   0.882 7041.1 1894.4
## - free.sulfur.dioxide:citric.acid 1   0.930 7041.1 1894.4
## - volatile.acidity:pH             1   1.116 7041.3 1894.6
## - pH:sulphates                   1   1.353 7041.6 1894.7
## - total.sulfur.dioxide:Wine.Color 1   1.381 7041.6 1894.7
## - total.sulfur.dioxide:density    1   1.666 7041.9 1894.9
## - pH:fixed.acidity               1   2.057 7042.3 1895.2
## - fixed.acidity:total.sulfur.dioxide 1   2.108 7042.3 1895.2
## - residual.sugar:Wine.Color       1   2.118 7042.3 1895.2
## - residual.sugar:density         1   2.122 7042.3 1895.3
## - sulphates:fixed.acidity        1   2.234 7042.5 1895.3
## <none>                           7040.2 1895.8
## - alcohol:sulphates              1   3.036 7043.3 1895.9
## - sulphates:free.sulfur.dioxide   1   3.052 7043.3 1895.9
## - volatile.acidity:sulphates      1   3.203 7043.4 1896.0
## - sulphates:citric.acid          1   3.488 7043.7 1896.2
## - alcohol:total.sulfur.dioxide    1   3.676 7043.9 1896.3
## - volatile.acidity:free.sulfur.dioxide 1   4.182 7044.4 1896.7
## - residual.sugar:sulphates        1   4.297 7044.5 1896.8
## - sulphates:density              1   5.102 7045.3 1897.3
## - sulphates:Wine.Color            1   5.238 7045.5 1897.4
## - alcohol:free.sulfur.dioxide     1   5.541 7045.8 1897.6
## - volatile.acidity:fixed.acidity   1   5.727 7045.9 1897.8
## - alcohol:pH                      1   6.116 7046.3 1898.0
## - free.sulfur.dioxide:density     1   6.236 7046.5 1898.1

```

```

## - pH:citric.acid
## - citric.acid:density
## - residual.sugar:pH
## - residual.sugar:free.sulfur.dioxide
## - alcohol:citric.acid
## - fixed.acidity:citric.acid
## - volatile.acidity:residual.sugar
## - alcohol:density
## - free.sulfur.dioxide:Wine.Color
## - residual.sugar:alcohol
## - residual.sugar:total.sulfur.dioxide
## - residual.sugar:citric.acid
## - volatile.acidity:density
## - sulphates:total.sulfur.dioxide
## - density:Wine.Color
## - pH:Wine.Color
## - volatile.acidity:alcohol
## - free.sulfur.dioxide:total.sulfur.dioxide 1   6.726 7046.9 1898.5
1   6.778 7047.0 1898.5
1   8.948 7049.2 1900.0
1   9.927 7050.1 1900.7
1   10.007 7050.2 1900.7
1   11.130 7051.3 1901.5
1   12.288 7052.5 1902.3
1   12.553 7052.8 1902.5
1   14.692 7054.9 1904.0
1   15.077 7055.3 1904.3
1   15.407 7055.6 1904.5
1   17.311 7057.5 1905.8
1   17.521 7057.7 1906.0
1   22.490 7062.7 1909.4
2   27.235 7067.5 1910.7
1   27.040 7067.3 1912.6
1   45.765 7086.0 1925.5
1   50.833 7091.1 1929.0
##
## Step: AIC=1893.92
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##      sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##      citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
##      pH:Wine.Color + sulphates:Wine.Color + free.sulfur.dioxide:Wine.Color +
##      fixed.acidity:Wine.Color + total.sulfur.dioxide:Wine.Color +
##      citric.acid:Wine.Color + total.sulfur.dioxide:citric.acid +
##      fixed.acidity:citric.acid + free.sulfur.dioxide:citric.acid +
##      sulphates:citric.acid + pH:citric.acid + alcohol:citric.acid +
##      residual.sugar:citric.acid + volatile.acidity:citric.acid +
##      citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##      free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##      total.sulfur.dioxide:density + alcohol:total.sulfur.dioxide +
##      residual.sugar:total.sulfur.dioxide + sulphates:fixed.acidity +
##      pH:fixed.acidity + residual.sugar:fixed.acidity + volatile.acidity:fixed.acidity +
##      sulphates:free.sulfur.dioxide + pH:free.sulfur.dioxide +
##      alcohol:free.sulfur.dioxide + residual.sugar:free.sulfur.dioxide +
##      volatile.acidity:free.sulfur.dioxide + free.sulfur.dioxide:density +
##      pH:sulphates + alcohol:sulphates + residual.sugar:sulphates +
##      volatile.acidity:sulphates + sulphates:density + alcohol:pH +
##      residual.sugar:pH + volatile.acidity:pH + pH:density + residual.sugar:alcohol +
##      volatile.acidity:alcohol + alcohol:density + volatile.acidity:residual.sugar +
##      residual.sugar:density + volatile.acidity:density
##
##                                     Df Sum of Sq    RSS     AIC
## - pH:free.sulfur.dioxide           1   0.127 7040.6 1892.0
## - total.sulfur.dioxide:citric.acid 1   0.178 7040.6 1892.0
## - fixed.acidity:Wine.Color         1   0.332 7040.8 1892.2
## - citric.acid:Wine.Color          1   0.880 7041.3 1892.5
## - volatile.acidity:citric.acid    1   0.883 7041.3 1892.5
## - residual.sugar:fixed.acidity     1   0.941 7041.4 1892.6
## - pH:density                      1   1.096 7041.5 1892.7
## - free.sulfur.dioxide:citric.acid 1   1.096 7041.5 1892.7
## - volatile.acidity:pH              1   1.307 7041.7 1892.8
## - pH:sulphates                    1   1.310 7041.7 1892.8

```

```

## - total.sulfur.dioxide:Wine.Color      1    1.453 7041.9 1892.9
## - total.sulfur.dioxide:density        1    1.470 7041.9 1893.0
## - pH:fixed.acidity                   1    1.899 7042.3 1893.2
## - fixed.acidity:total.sulfur.dioxide 1    1.971 7042.4 1893.3
## - residual.sugar:Wine.Color          1    2.024 7042.5 1893.3
## - sulphates:fixed.acidity           1    2.260 7042.7 1893.5
## - residual.sugar:density            1    2.435 7042.9 1893.6
## <none>                                7040.4 1893.9
## - sulphates:free.sulfur.dioxide     1    3.068 7043.5 1894.1
## - alcohol:sulphates                 1    3.071 7043.5 1894.1
## - volatile.acidity:sulphates        1    3.232 7043.7 1894.2
## - sulphates:citric.acid            1    3.424 7043.9 1894.3
## - alcohol:total.sulfur.dioxide     1    3.514 7043.9 1894.4
## - volatile.acidity:free.sulfur.dioxide 1    4.203 7044.6 1894.8
## - residual.sugar:sulphates         1    4.267 7044.7 1894.9
## - sulphates:density                1    5.126 7045.6 1895.5
## - sulphates:Wine.Color             1    5.246 7045.7 1895.6
## - alcohol:free.sulfur.dioxide      1    5.406 7045.8 1895.7
## - volatile.acidity:fixed.acidity   1    5.609 7046.0 1895.8
## - free.sulfur.dioxide:density      1    6.068 7046.5 1896.2
## - alcohol:pH                      1    6.228 7046.7 1896.3
## - pH:citric.acid                  1    6.537 7047.0 1896.5
## - citric.acid:density              1    6.738 7047.2 1896.6
## - residual.sugar:pH                1    9.146 7049.6 1898.3
## - residual.sugar:free.sulfur.dioxide 1    9.718 7050.1 1898.7
## - alcohol:citric.acid              1    9.875 7050.3 1898.8
## - fixed.acidity:citric.acid       1    11.013 7051.4 1899.6
## - volatile.acidity:residual.sugar 1    12.153 7052.6 1900.4
## - alcohol:density                  1    12.417 7052.8 1900.6
## - free.sulfur.dioxide:Wine.Color   1    14.633 7055.1 1902.1
## - residual.sugar:alcohol           1    14.869 7055.3 1902.3
## - residual.sugar:citric.acid      1    17.194 7057.6 1903.9
## - volatile.acidity:density        1    17.407 7057.8 1904.0
## - residual.sugar:total.sulfur.dioxide 1    17.525 7058.0 1904.1
## - sulphates:total.sulfur.dioxide 1    22.682 7063.1 1907.7
## - density:Wine.Color              2    38.851 7079.3 1916.9
## - pH:Wine.Color                   1    39.219 7079.6 1919.1
## - volatile.acidity:alcohol         1    45.642 7086.1 1923.6
## - free.sulfur.dioxide:total.sulfur.dioxide 1    50.924 7091.4 1927.2
##
## Step: AIC=1892.01
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##          sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##          citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
##          pH:Wine.Color + sulphates:Wine.Color + free.sulfur.dioxide:Wine.Color +
##          fixed.acidity:Wine.Color + total.sulfur.dioxide:Wine.Color +
##          citric.acid:Wine.Color + total.sulfur.dioxide:citric.acid +
##          fixed.acidity:citric.acid + free.sulfur.dioxide:citric.acid +
##          sulphates:citric.acid + pH:citric.acid + alcohol:citric.acid +
##          residual.sugar:citric.acid + volatile.acidity:citric.acid +
##          citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##          total.sulfur.dioxide:density + alcohol:total.sulfur.dioxide +
##          residual.sugar:total.sulfur.dioxide + sulphates:fixed.acidity +

```

```

## pH:fixed.acidity + residual.sugar:fixed.acidity + volatile.acidity:fixed.acidity +
## sulphates:free.sulfur.dioxide + alcohol:free.sulfur.dioxide +
## residual.sugar:free.sulfur.dioxide + volatile.acidity:free.sulfur.dioxide +
## free.sulfur.dioxide:density + pH:sulphates + alcohol:sulphates +
## residual.sugar:sulphates + volatile.acidity:sulphates + sulphates:density +
## alcohol:pH + residual.sugar:pH + volatile.acidity:pH + pH:density +
## residual.sugar:alcohol + volatile.acidity:alcohol + alcohol:density +
## volatile.acidity:residual.sugar + residual.sugar:density +
## volatile.acidity:density
##
##                                     Df Sum of Sq    RSS     AIC
## - total.sulfur.dioxide:citric.acid   1   0.164 7040.7 1890.1
## - fixed.acidity:Wine.Color          1   0.400 7041.0 1890.3
## - citric.acid:Wine.Color           1   0.856 7041.4 1890.6
## - volatile.acidity:citric.acid      1   0.896 7041.4 1890.6
## - residual.sugar:fixed.acidity      1   0.902 7041.5 1890.6
## - pH:density                      1   1.107 7041.7 1890.8
## - pH:sulphates                    1   1.274 7041.8 1890.9
## - free.sulfur.dioxide:citric.acid   1   1.390 7041.9 1891.0
## - volatile.acidity:pH              1   1.393 7041.9 1891.0
## - total.sulfur.dioxide:density      1   1.474 7042.0 1891.0
## - total.sulfur.dioxide:Wine.Color    1   1.547 7042.1 1891.1
## - pH:fixed.acidity                 1   1.935 7042.5 1891.4
## - residual.sugar:Wine.Color         1   2.087 7042.6 1891.5
## - sulphates:fixed.acidity          1   2.247 7042.8 1891.6
## - residual.sugar:density           1   2.414 7043.0 1891.7
## - fixed.acidity:total.sulfur.dioxide 1   2.566 7043.1 1891.8
## <none>                                7040.6 1892.0
## - sulphates:free.sulfur.dioxide     1   2.998 7043.6 1892.1
## - alcohol:sulphates                1   3.019 7043.6 1892.1
## - volatile.acidity:sulphates        1   3.238 7043.8 1892.3
## - sulphates:citric.acid            1   3.440 7044.0 1892.4
## - alcohol:total.sulfur.dioxide      1   3.490 7044.0 1892.4
## - residual.sugar:sulphates          1   4.207 7044.8 1892.9
## - volatile.acidity:free.sulfur.dioxide 1   4.270 7044.8 1893.0
## - sulphates:density                1   5.067 7045.6 1893.5
## - sulphates:Wine.Color              1   5.191 7045.7 1893.6
## - alcohol:free.sulfur.dioxide       1   5.383 7045.9 1893.8
## - volatile.acidity:fixed.acidity     1   5.590 7046.1 1893.9
## - free.sulfur.dioxide:density       1   6.084 7046.6 1894.2
## - alcohol:pH                       1   6.326 7046.9 1894.4
## - pH:citric.acid                  1   6.734 7047.3 1894.7
## - citric.acid:density              1   6.772 7047.3 1894.7
## - residual.sugar:pH                1   9.653 7050.2 1896.7
## - alcohol:citric.acid              1   9.989 7050.5 1897.0
## - residual.sugar:free.sulfur.dioxide 1  10.016 7050.6 1897.0
## - fixed.acidity:citric.acid        1  11.125 7051.7 1897.8
## - volatile.acidity:residual.sugar   1  12.058 7052.6 1898.4
## - alcohol:density                  1  12.474 7053.0 1898.7
## - free.sulfur.dioxide:Wine.Color    1  14.523 7055.1 1900.1
## - residual.sugar:alcohol             1  15.130 7055.7 1900.5
## - volatile.acidity:density          1  17.312 7057.9 1902.0
## - residual.sugar:citric.acid        1  17.329 7057.9 1902.1
## - residual.sugar:total.sulfur.dioxide 1  17.473 7058.0 1902.2

```

```

## - sulphates:total.sulfur.dioxide      1  22.582 7063.1 1905.7
## - density:Wine.Color                 2  38.865 7079.4 1915.0
## - pH:Wine.Color                      1  39.127 7079.7 1917.2
## - volatile.acidity:alcohol           1  45.518 7086.1 1921.6
## - free.sulfur.dioxide:total.sulfur.dioxide 1  51.184 7091.7 1925.5
##
## Step: AIC=1890.13
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
## sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
## citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
## pH:Wine.Color + sulphates:Wine.Color + free.sulfur.dioxide:Wine.Color +
## fixed.acidity:Wine.Color + total.sulfur.dioxide:Wine.Color +
## citric.acid:Wine.Color + fixed.acidity:citric.acid + free.sulfur.dioxide:citric.acid +
## sulphates:citric.acid + pH:citric.acid + alcohol:citric.acid +
## residual.sugar:citric.acid + volatile.acidity:citric.acid +
## citric.acid:density + fixed.acidity:total.sulfur.dioxide +
## free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
## total.sulfur.dioxide:density + alcohol:total.sulfur.dioxide +
## residual.sugar:total.sulfur.dioxide + sulphates:fixed.acidity +
## pH:fixed.acidity + residual.sugar:fixed.acidity + volatile.acidity:fixed.acidity +
## sulphates:free.sulfur.dioxide + alcohol:free.sulfur.dioxide +
## residual.sugar:free.sulfur.dioxide + volatile.acidity:free.sulfur.dioxide +
## free.sulfur.dioxide:density + pH:sulphates + alcohol:sulphates +
## residual.sugar:sulphates + volatile.acidity:sulphates + sulphates:density +
## alcohol:pH + residual.sugar:pH + volatile.acidity:pH + pH:density +
## residual.sugar:alcohol + volatile.acidity:alcohol + alcohol:density +
## volatile.acidity:residual.sugar + residual.sugar:density +
## volatile.acidity:density
##
##                                         Df Sum of Sq   RSS   AIC
## - fixed.acidity:Wine.Color          1  0.480 7041.2 1888.5
## - residual.sugar:fixed.acidity     1  0.812 7041.5 1888.7
## - volatile.acidity:citric.acid    1  0.950 7041.7 1888.8
## - pH:density                      1  1.128 7041.8 1888.9
## - pH:sulphates                   1  1.261 7042.0 1889.0
## - volatile.acidity:pH              1  1.414 7042.1 1889.1
## - total.sulfur.dioxide:density    1  1.561 7042.3 1889.2
## - total.sulfur.dioxide:Wine.Color  1  1.679 7042.4 1889.3
## - citric.acid:Wine.Color          1  1.812 7042.5 1889.4
## - pH:fixed.acidity                1  1.876 7042.6 1889.4
## - sulphates:fixed.acidity        1  2.230 7042.9 1889.7
## - residual.sugar:Wine.Color       1  2.280 7043.0 1889.7
## - residual.sugar:density         1  2.469 7043.2 1889.8
## - free.sulfur.dioxide:citric.acid 1  2.771 7043.5 1890.0
## <none>                           7040.7 1890.1
## - sulphates:free.sulfur.dioxide  1  2.947 7043.7 1890.2
## - alcohol:sulphates             1  2.978 7043.7 1890.2
## - volatile.acidity:sulphates     1  3.174 7043.9 1890.3
## - fixed.acidity:total.sulfur.dioxide 1  3.253 7044.0 1890.4
## - sulphates:citric.acid         1  3.297 7044.0 1890.4
## - alcohol:total.sulfur.dioxide   1  3.528 7044.2 1890.6
## - residual.sugar:sulphates       1  4.168 7044.9 1891.0
## - volatile.acidity:free.sulfur.dioxide 1  4.265 7045.0 1891.1
## - sulphates:density             1  5.001 7045.7 1891.6

```

```

## - sulphates:Wine.Color           1   5.127 7045.8 1891.7
## - alcohol:free.sulfur.dioxide    1   5.428 7046.1 1891.9
## - volatile.acidity:fixed.acidity 1   5.637 7046.4 1892.0
## - free.sulfur.dioxide:density    1   6.036 7046.8 1892.3
## - alcohol:pH                     1   6.252 7047.0 1892.5
## - pH:citric.acid                1   6.600 7047.3 1892.7
## - citric.acid:density            1   6.929 7047.6 1893.0
## - residual.sugar:pH               1   9.829 7050.5 1895.0
## - alcohol:citric.acid            1   9.930 7050.6 1895.0
## - residual.sugar:free.sulfur.dioxide 1   10.062 7050.8 1895.1
## - fixed.acidity:citric.acid      1   11.181 7051.9 1895.9
## - volatile.acidity:residual.sugar 1   12.062 7052.8 1896.5
## - alcohol:density                 1   12.361 7053.1 1896.7
## - free.sulfur.dioxide:Wine.Color   1   14.360 7055.1 1898.1
## - residual.sugar:alcohol          1   15.028 7055.7 1898.6
## - residual.sugar:citric.acid      1   17.169 7057.9 1900.1
## - volatile.acidity:density        1   17.290 7058.0 1900.2
## - residual.sugar:total.sulfur.dioxide 1   18.189 7058.9 1900.8
## - sulphates:total.sulfur.dioxide   1   22.427 7063.1 1903.7
## - density:Wine.Color              2   39.187 7079.9 1913.3
## - pH:Wine.Color                   1   39.466 7080.2 1915.5
## - volatile.acidity:alcohol         1   45.611 7086.3 1919.8
## - free.sulfur.dioxide:total.sulfur.dioxide 1   51.270 7092.0 1923.7
##
## Step: AIC=1888.46
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##          sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##          citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
##          pH:Wine.Color + sulphates:Wine.Color + free.sulfur.dioxide:Wine.Color +
##          total.sulfur.dioxide:Wine.Color + citric.acid:Wine.Color +
##          fixed.acidity:citric.acid + free.sulfur.dioxide:citric.acid +
##          sulphates:citric.acid + pH:citric.acid + alcohol:citric.acid +
##          residual.sugar:citric.acid + volatile.acidity:citric.acid +
##          citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##          total.sulfur.dioxide:density + alcohol:total.sulfur.dioxide +
##          residual.sugar:total.sulfur.dioxide + sulphates:fixed.acidity +
##          pH:fixed.acidity + residual.sugar:fixed.acidity + volatile.acidity:fixed.acidity +
##          sulphates:free.sulfur.dioxide + alcohol:free.sulfur.dioxide +
##          residual.sugar:free.sulfur.dioxide + volatile.acidity:free.sulfur.dioxide +
##          free.sulfur.dioxide:density + pH:sulphates + alcohol:sulphates +
##          residual.sugar:sulphates + volatile.acidity:sulphates + sulphates:density +
##          alcohol:pH + residual.sugar:pH + volatile.acidity:pH + pH:density +
##          residual.sugar:alcohol + volatile.acidity:alcohol + alcohol:density +
##          volatile.acidity:residual.sugar + residual.sugar:density +
##          volatile.acidity:density
##
##                                     Df Sum of Sq   RSS   AIC
## - volatile.acidity:citric.acid    1   0.787 7042.0 1887.0
## - residual.sugar:fixed.acidity    1   0.875 7042.1 1887.1
## - pH:sulphates                  1   1.053 7042.3 1887.2
## - pH:density                     1   1.145 7042.3 1887.3
## - citric.acid:Wine.Color          1   1.477 7042.7 1887.5
## - total.sulfur.dioxide:Wine.Color 1   1.477 7042.7 1887.5

```

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## - sulphates:fixed.acidity           1   1.767 7043.0 1887.7
## - volatile.acidity:pH              1   1.866 7043.1 1887.8
## - total.sulfur.dioxide:density     1   1.887 7043.1 1887.8
## - residual.sugar:Wine.Color        1   2.011 7043.2 1887.9
## - pH:fixed.acidity                 1   2.368 7043.6 1888.1
## - residual.sugar:density          1   2.378 7043.6 1888.1
## - fixed.acidity:total.sulfur.dioxide 1   2.795 7044.0 1888.4
## - alcohol:sulphates               1   2.874 7044.1 1888.5
## <none>                            7041.2 1888.5
## - sulphates:free.sulfur.dioxide    1   2.948 7044.1 1888.5
## - free.sulfur.dioxide:citric.acid 1   3.151 7044.3 1888.7
## - volatile.acidity:sulphates       1   3.599 7044.8 1889.0
## - sulphates:citric.acid          1   3.841 7045.0 1889.1
## - residual.sugar:sulphates        1   3.944 7045.1 1889.2
## - alcohol:total.sulfur.dioxide    1   4.004 7045.2 1889.2
## - volatile.acidity:free.sulfur.dioxide 1   4.554 7045.8 1889.6
## - sulphates:density               1   4.760 7046.0 1889.8
## - sulphates:Wine.Color            1   5.008 7046.2 1890.0
## - volatile.acidity:fixed.acidity   1   5.176 7046.4 1890.1
## - alcohol:free.sulfur.dioxide     1   5.535 7046.7 1890.3
## - free.sulfur.dioxide:density     1   6.155 7047.4 1890.7
## - alcohol:pH                      1   6.477 7047.7 1891.0
## - pH:citric.acid                 1   6.533 7047.7 1891.0
## - citric.acid:density             1   6.810 7048.0 1891.2
## - alcohol:citric.acid            1   9.764 7051.0 1893.2
## - residual.sugar:pH               1   10.106 7051.3 1893.5
## - residual.sugar:free.sulfur.dioxide 1   10.202 7051.4 1893.6
## - fixed.acidity:citric.acid       1   10.718 7051.9 1893.9
## - volatile.acidity:residual.sugar 1   11.712 7052.9 1894.6
## - alcohol:density                 1   14.204 7055.4 1896.3
## - free.sulfur.dioxide:Wine.Color   1   14.365 7055.6 1896.5
## - residual.sugar:alcohol           1   16.461 7057.7 1897.9
## - volatile.acidity:density         1   17.014 7058.2 1898.3
## - residual.sugar:citric.acid       1   17.023 7058.2 1898.3
## - residual.sugar:total.sulfur.dioxide 1   19.424 7060.6 1900.0
## - sulphates:total.sulfur.dioxide   1   21.988 7063.2 1901.7
## - volatile.acidity:alcohol          1   45.323 7086.5 1917.9
## - pH:Wine.Color                   1   51.359 7092.6 1922.1
## - free.sulfur.dioxide:total.sulfur.dioxide 1   51.724 7092.9 1922.3
## - density:Wine.Color               2   71.234 7112.4 1933.8
##
## Step: AIC=1887.01
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##          sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##          citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
##          pH:Wine.Color + sulphates:Wine.Color + free.sulfur.dioxide:Wine.Color +
##          total.sulfur.dioxide:Wine.Color + citric.acid:Wine.Color +
##          fixed.acidity:citric.acid + free.sulfur.dioxide:citric.acid +
##          sulphates:citric.acid + pH:citric.acid + alcohol:citric.acid +
##          residual.sugar:citric.acid + citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##          total.sulfur.dioxide:density + alcohol:total.sulfur.dioxide +
##          residual.sugar:total.sulfur.dioxide + sulphates:fixed.acidity +
##          pH:fixed.acidity + residual.sugar:fixed.acidity + volatile.acidity:fixed.acidity +

```

```

##   sulphates:free.sulfur.dioxide + alcohol:free.sulfur.dioxide +
##   residual.sugar:free.sulfur.dioxide + volatile.acidity:free.sulfur.dioxide +
##   free.sulfur.dioxide:density + pH:sulphates + alcohol:sulphates +
##   residual.sugar:sulphates + volatile.acidity:sulphates + sulphates:density +
##   alcohol:pH + residual.sugar:pH + volatile.acidity:pH + pH:density +
##   residual.sugar:alcohol + volatile.acidity:alcohol + alcohol:density +
##   volatile.acidity:residual.sugar + residual.sugar:density +
##   volatile.acidity:density
##
##                                     Df Sum of Sq    RSS     AIC
## - residual.sugar:fixed.acidity      1  0.946 7042.9 1885.7
## - citric.acid:Wine.Color          1  0.982 7043.0 1885.7
## - pH:sulphates                   1  1.084 7043.1 1885.8
## - pH:density                     1  1.212 7043.2 1885.8
## - total.sulfur.dioxide:Wine.Color 1  1.429 7043.4 1886.0
## - volatile.acidity:pH             1  1.554 7043.5 1886.1
## - residual.sugar:Wine.Color       1  1.730 7043.7 1886.2
## - total.sulfur.dioxide:density   1  1.755 7043.7 1886.2
## - sulphates:fixed.acidity        1  1.850 7043.8 1886.3
## - pH:fixed.acidity               1  2.213 7044.2 1886.5
## - residual.sugar:density         1  2.419 7044.4 1886.7
## - alcohol:sulphates              1  2.705 7044.7 1886.9
## <none>                           7042.0 1887.0
## - fixed.acidity:total.sulfur.dioxide 1  2.901 7044.9 1887.0
## - sulphates:free.sulfur.dioxide   1  3.039 7045.0 1887.1
## - free.sulfur.dioxide:citric.acid 1  3.070 7045.1 1887.1
## - volatile.acidity:sulphates     1  3.336 7045.3 1887.3
## - alcohol:total.sulfur.dioxide   1  3.838 7045.8 1887.7
## - sulphates:citric.acid         1  3.918 7045.9 1887.7
## - residual.sugar:sulphates       1  3.928 7045.9 1887.7
## - volatile.acidity:fixed.acidity 1  4.518 7046.5 1888.2
## - sulphates:density              1  4.680 7046.7 1888.3
## - sulphates:Wine.Color           1  4.953 7046.9 1888.5
## - volatile.acidity:free.sulfur.dioxide 1  5.308 7047.3 1888.7
## - alcohol:free.sulfur.dioxide    1  5.356 7047.3 1888.7
## - free.sulfur.dioxide:density   1  5.885 7047.9 1889.1
## - pH:citric.acid                1  6.528 7048.5 1889.5
## - alcohol:pH                     1  6.681 7048.7 1889.7
## - citric.acid:density            1  7.040 7049.0 1889.9
## - residual.sugar:free.sulfur.dioxide 1  9.859 7051.8 1891.9
## - alcohol:citric.acid            1 10.100 7052.1 1892.0
## - residual.sugar:pH              1 10.124 7052.1 1892.0
## - fixed.acidity:citric.acid     1 10.873 7052.9 1892.6
## - volatile.acidity:residual.sugar 1 11.123 7053.1 1892.7
## - free.sulfur.dioxide:Wine.Color 1 14.466 7056.5 1895.1
## - alcohol:density                1 14.727 7056.7 1895.2
## - volatile.acidity:density       1 16.619 7058.6 1896.6
## - residual.sugar:alcohol          1 16.641 7058.6 1896.6
## - residual.sugar:citric.acid     1 17.086 7059.1 1896.9
## - residual.sugar:total.sulfur.dioxide 1 18.936 7060.9 1898.2
## - sulphates:total.sulfur.dioxide 1 22.234 7064.2 1900.5
## - volatile.acidity:alcohol        1 45.589 7087.6 1916.6
## - pH:Wine.Color                  1 50.572 7092.6 1920.1
## - free.sulfur.dioxide:total.sulfur.dioxide 1 51.372 7093.4 1920.6

```

```

## - density:Wine.Color
2      70.747 7112.7 1932.0
##
## Step: AIC=1885.67
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##          sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##          citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
##          pH:Wine.Color + sulphates:Wine.Color + free.sulfur.dioxide:Wine.Color +
##          total.sulfur.dioxide:Wine.Color + citric.acid:Wine.Color +
##          fixed.acidity:citric.acid + free.sulfur.dioxide:citric.acid +
##          sulphates:citric.acid + pH:citric.acid + alcohol:citric.acid +
##          residual.sugar:citric.acid + citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##          total.sulfur.dioxide:density + alcohol:total.sulfur.dioxide +
##          residual.sugar:total.sulfur.dioxide + sulphates:fixed.acidity +
##          pH:fixed.acidity + volatile.acidity:fixed.acidity + sulphates:free.sulfur.dioxide +
##          alcohol:free.sulfur.dioxide + residual.sugar:free.sulfur.dioxide +
##          volatile.acidity:free.sulfur.dioxide + free.sulfur.dioxide:density +
##          pH:sulphates + alcohol:sulphates + residual.sugar:sulphates +
##          volatile.acidity:sulphates + sulphates:density + alcohol:pH +
##          residual.sugar:pH + volatile.acidity:pH + pH:density + residual.sugar:alcohol +
##          volatile.acidity:alcohol + alcohol:density + volatile.acidity:residual.sugar +
##          residual.sugar:density + volatile.acidity:density
##
##                                     Df Sum of Sq   RSS   AIC
## - pH:sulphates                  1  1.013 7043.9 1884.4
## - citric.acid:Wine.Color        1  1.081 7044.0 1884.4
## - pH:density                     1  1.215 7044.1 1884.5
## - total.sulfur.dioxide:Wine.Color 1  1.564 7044.5 1884.8
## - volatile.acidity:pH            1  1.727 7044.7 1884.9
## - sulphates:fixed.acidity       1  1.904 7044.8 1885.0
## - total.sulfur.dioxide:density   1  1.981 7044.9 1885.0
## - pH:fixed.acidity               1  1.996 7044.9 1885.1
## - residual.sugar:density         1  1.997 7044.9 1885.1
## - residual.sugar:Wine.Color       1  2.606 7045.5 1885.5
## - alcohol:sulphates              1  2.841 7045.8 1885.6
## <none>                           7042.9 1885.7
## - free.sulfur.dioxide:citric.acid 1  2.928 7045.9 1885.7
## - sulphates:free.sulfur.dioxide  1  2.941 7045.9 1885.7
## - volatile.acidity:sulphates     1  3.421 7046.4 1886.0
## - residual.sugar:sulphates       1  3.719 7046.7 1886.2
## - sulphates:citric.acid          1  3.743 7046.7 1886.3
## - alcohol:total.sulfur.dioxide    1  4.210 7047.1 1886.6
## - volatile.acidity:fixed.acidity  1  4.242 7047.2 1886.6
## - sulphates:density              1  4.676 7047.6 1886.9
## - sulphates:Wine.Color            1  4.686 7047.6 1886.9
## - fixed.acidity:total.sulfur.dioxide 1  4.729 7047.7 1887.0
## - volatile.acidity:free.sulfur.dioxide 1  5.359 7048.3 1887.4
## - alcohol:free.sulfur.dioxide      1  5.730 7048.7 1887.7
## - pH:citric.acid                 1  6.330 7049.3 1888.1
## - alcohol:pH                      1  6.416 7049.3 1888.1
## - free.sulfur.dioxide:density     1  6.435 7049.4 1888.1
## - citric.acid:density             1  7.025 7050.0 1888.5
## - alcohol:citric.acid              1 10.127 7053.1 1890.7
## - residual.sugar:free.sulfur.dioxide 1 10.601 7053.5 1891.0

```

```

## - fixed.acidity:citric.acid          1  10.626 7053.6 1891.0
## - volatile.acidity:residual.sugar   1  10.870 7053.8 1891.2
## - residual.sugar:pH                 1  11.897 7054.8 1891.9
## - free.sulfur.dioxide:Wine.Color    1  15.250 7058.2 1894.3
## - alcohol:density                  1  15.358 7058.3 1894.3
## - volatile.acidity:density         1  16.231 7059.2 1895.0
## - residual.sugar:citric.acid       1  16.480 7059.4 1895.1
## - residual.sugar:alcohol           1  17.460 7060.4 1895.8
## - residual.sugar:total.sulfur.dioxide 1  19.969 7062.9 1897.5
## - sulphates:total.sulfur.dioxide   1  21.850 7064.8 1898.8
## - volatile.acidity:alcohol          1  45.194 7088.1 1915.0
## - free.sulfur.dioxide:total.sulfur.dioxide 1  51.678 7094.6 1919.5
## - pH:Wine.Color                   1  52.000 7094.9 1919.7
## - density:Wine.Color              2  72.580 7115.5 1931.9
##
## Step: AIC=1884.37
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##          sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##          citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
##          pH:Wine.Color + sulphates:Wine.Color + free.sulfur.dioxide:Wine.Color +
##          total.sulfur.dioxide:Wine.Color + citric.acid:Wine.Color +
##          fixed.acidity:citric.acid + free.sulfur.dioxide:citric.acid +
##          sulphates:citric.acid + pH:citric.acid + alcohol:citric.acid +
##          residual.sugar:citric.acid + citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##          total.sulfur.dioxide:density + alcohol:total.sulfur.dioxide +
##          residual.sugar:total.sulfur.dioxide + sulphates:fixed.acidity +
##          pH:fixed.acidity + volatile.acidity:fixed.acidity + sulphates:free.sulfur.dioxide +
##          alcohol:free.sulfur.dioxide + residual.sugar:free.sulfur.dioxide +
##          volatile.acidity:free.sulfur.dioxide + free.sulfur.dioxide:density +
##          alcohol:sulphates + residual.sugar:sulphates + volatile.acidity:sulphates +
##          sulphates:density + alcohol:pH + residual.sugar:pH + volatile.acidity:pH +
##          pH:density + residual.sugar:alcohol + volatile.acidity:alcohol +
##          alcohol:density + volatile.acidity:residual.sugar + residual.sugar:density +
##          volatile.acidity:density
##
##                                     Df Sum of Sq   RSS   AIC
## - pH:density                      1  0.901 7044.8 1883.0
## - sulphates:fixed.acidity         1  0.940 7044.9 1883.0
## - citric.acid:Wine.Color          1  1.258 7045.2 1883.2
## - total.sulfur.dioxide:Wine.Color 1  1.563 7045.5 1883.5
## - volatile.acidity:pH             1  1.783 7045.7 1883.6
## - alcohol:sulphates              1  1.862 7045.8 1883.7
## - residual.sugar:density          1  2.030 7046.0 1883.8
## - pH:fixed.acidity                1  2.092 7046.0 1883.8
## - sulphates:free.sulfur.dioxide   1  2.290 7046.2 1884.0
## - total.sulfur.dioxide:density    1  2.353 7046.3 1884.0
## - residual.sugar:Wine.Color        1  2.486 7046.4 1884.1
## - residual.sugar:sulphates         1  2.741 7046.7 1884.3
## - free.sulfur.dioxide:citric.acid 1  2.775 7046.7 1884.3
## <none>                           7043.9 1884.4
## - sulphates:citric.acid          1  3.271 7047.2 1884.7
## - volatile.acidity:sulphates      1  3.501 7047.4 1884.8
## - sulphates:Wine.Color            1  3.705 7047.6 1885.0

```

```

## - sulphates:density 1 3.713 7047.7 1885.0
## - volatile.acidity:fixed.acidity 1 4.322 7048.3 1885.4
## - alcohol:total.sulfur.dioxide 1 4.571 7048.5 1885.5
## - volatile.acidity:free.sulfur.dioxide 1 5.401 7049.3 1886.1
## - alcohol:free.sulfur.dioxide 1 5.694 7049.6 1886.3
## - fixed.acidity:total.sulfur.dioxide 1 5.748 7049.7 1886.4
## - alcohol:pH 1 5.865 7049.8 1886.5
## - free.sulfur.dioxide:density 1 6.312 7050.3 1886.8
## - pH:citric.acid 1 6.835 7050.8 1887.1
## - citric.acid:density 1 7.462 7051.4 1887.6
## - residual.sugar:free.sulfur.dioxide 1 10.384 7054.3 1889.6
## - alcohol:citric.acid 1 10.929 7054.9 1890.0
## - volatile.acidity:residual.sugar 1 10.965 7054.9 1890.0
## - residual.sugar:pH 1 10.971 7054.9 1890.0
## - fixed.acidity:citric.acid 1 11.504 7055.4 1890.4
## - free.sulfur.dioxide:Wine.Color 1 15.015 7059.0 1892.8
## - alcohol:density 1 15.312 7059.3 1893.0
## - residual.sugar:citric.acid 1 16.945 7060.9 1894.2
## - volatile.acidity:density 1 17.058 7061.0 1894.2
## - residual.sugar:alcohol 1 17.292 7061.2 1894.4
## - residual.sugar:total.sulfur.dioxide 1 20.677 7064.6 1896.7
## - sulphates:total.sulfur.dioxide 1 21.878 7065.8 1897.6
## - volatile.acidity:alcohol 1 46.586 7090.5 1914.7
## - free.sulfur.dioxide:total.sulfur.dioxide 1 51.394 7095.3 1918.0
## - pH:Wine.Color 1 54.694 7098.6 1920.3
## - density:Wine.Color 2 78.373 7122.3 1934.6
##
## Step: AIC=1883
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
## sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
## citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
## pH:Wine.Color + sulphates:Wine.Color + free.sulfur.dioxide:Wine.Color +
## total.sulfur.dioxide:Wine.Color + citric.acid:Wine.Color +
## fixed.acidity:citric.acid + free.sulfur.dioxide:citric.acid +
## sulphates:citric.acid + pH:citric.acid + alcohol:citric.acid +
## residual.sugar:citric.acid + citric.acid:density + fixed.acidity:total.sulfur.dioxide +
## free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
## total.sulfur.dioxide:density + alcohol:total.sulfur.dioxide +
## residual.sugar:total.sulfur.dioxide + sulphates:fixed.acidity +
## pH:fixed.acidity + volatile.acidity:fixed.acidity + sulphates:free.sulfur.dioxide +
## alcohol:free.sulfur.dioxide + residual.sugar:free.sulfur.dioxide +
## volatile.acidity:free.sulfur.dioxide + free.sulfur.dioxide:density +
## alcohol:sulphates + residual.sugar:sulphates + volatile.acidity:sulphates +
## sulphates:density + alcohol:pH + residual.sugar:pH + volatile.acidity:pH +
## residual.sugar:alcohol + volatile.acidity:alcohol + alcohol:density +
## volatile.acidity:residual.sugar + residual.sugar:density +
## volatile.acidity:density
##
##                                     Df Sum of Sq   RSS   AIC
## - citric.acid:Wine.Color 1  0.821 7045.7 1881.6
## - sulphates:fixed.acidity 1  1.444 7046.3 1882.0
## - total.sulfur.dioxide:Wine.Color 1  1.575 7046.4 1882.1
## - volatile.acidity:pH 1  1.767 7046.6 1882.2
## - residual.sugar:density 1  1.805 7046.7 1882.2

```

```

## - total.sulfur.dioxide:density           1   2.092 7046.9 1882.5
## - residual.sugar:Wine.Color            1   2.259 7047.1 1882.6
## - sulphates:free.sulfur.dioxide        1   2.331 7047.2 1882.6
## - alcohol:sulphates                  1   2.453 7047.3 1882.7
## <none>                                7044.8 1883.0
## - free.sulfur.dioxide:citric.acid      1   2.923 7047.8 1883.0
## - sulphates:citric.acid                1   3.071 7047.9 1883.1
## - volatile.acidity:sulphates          1   3.438 7048.3 1883.4
## - residual.sugar:sulphates            1   3.507 7048.4 1883.4
## - pH:fixed.acidity                   1   4.373 7049.2 1884.0
## - alcohol:total.sulfur.dioxide        1   4.379 7049.2 1884.0
## - sulphates:Wine.Color               1   4.404 7049.3 1884.1
## - volatile.acidity:fixed.acidity     1   4.803 7049.6 1884.3
## - sulphates:density                 1   4.992 7049.8 1884.5
## - fixed.acidity:total.sulfur.dioxide 1   5.189 7050.0 1884.6
## - volatile.acidity:free.sulfur.dioxide 1   5.222 7050.1 1884.6
## - alcohol:free.sulfur.dioxide        1   5.707 7050.6 1885.0
## - free.sulfur.dioxide:density        1   6.302 7051.1 1885.4
## - pH:citric.acid                   1   6.470 7051.3 1885.5
## - citric.acid:density              1   6.617 7051.5 1885.6
## - alcohol:pH                        1   7.713 7052.6 1886.4
## - alcohol:citric.acid              1   10.049 7054.9 1888.0
## - residual.sugar:free.sulfur.dioxide 1   10.343 7055.2 1888.2
## - fixed.acidity:citric.acid         1   10.895 7055.7 1888.6
## - volatile.acidity:residual.sugar    1   11.390 7056.2 1888.9
## - free.sulfur.dioxide:Wine.Color     1   14.924 7059.8 1891.4
## - alcohol:density                  1   15.188 7060.0 1891.5
## - residual.sugar:citric.acid        1   16.043 7060.9 1892.2
## - residual.sugar:alcohol            1   17.562 7062.4 1893.2
## - volatile.acidity:density          1   17.953 7062.8 1893.5
## - residual.sugar:pH                 1   19.241 7064.1 1894.4
## - residual.sugar:total.sulfur.dioxide 1   20.011 7064.9 1894.9
## - sulphates:total.sulfur.dioxide    1   22.544 7067.4 1896.7
## - volatile.acidity:alcohol           1   47.607 7092.5 1914.0
## - free.sulfur.dioxide:total.sulfur.dioxide 1   51.378 7096.2 1916.6
## - pH:Wine.Color                     1   78.267 7123.1 1935.1
## - density:Wine.Color                2   94.236 7139.1 1944.1
##
## Step: AIC=1881.57
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##          sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##          citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
##          pH:Wine.Color + sulphates:Wine.Color + free.sulfur.dioxide:Wine.Color +
##          total.sulfur.dioxide:Wine.Color + fixed.acidity:citric.acid +
##          free.sulfur.dioxide:citric.acid + sulphates:citric.acid +
##          pH:citric.acid + alcohol:citric.acid + residual.sugar:citric.acid +
##          citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##          total.sulfur.dioxide:density + alcohol:total.sulfur.dioxide +
##          residual.sugar:total.sulfur.dioxide + sulphates:fixed.acidity +
##          pH:fixed.acidity + volatile.acidity:fixed.acidity + sulphates:free.sulfur.dioxide +
##          alcohol:free.sulfur.dioxide + residual.sugar:free.sulfur.dioxide +
##          volatile.acidity:free.sulfur.dioxide + free.sulfur.dioxide:density +
##          alcohol:sulphates + residual.sugar:sulphates + volatile.acidity:sulphates +

```

```

##      sulphates:density + alcohol:pH + residual.sugar:pH + volatile.acidity:pH +
##      residual.sugar:alcohol + volatile.acidity:alcohol + alcohol:density +
##      volatile.acidity:residual.sugar + residual.sugar:density +
##      volatile.acidity:density
##
##                                     Df Sum of Sq    RSS     AIC
## - sulphates:fixed.acidity          1   1.297 7047.0 1880.5
## - residual.sugar:density          1   1.585 7047.3 1880.7
## - total.sulfur.dioxide:density    1   1.653 7047.3 1880.7
## - volatile.acidity:pH             1   1.694 7047.4 1880.8
## - residual.sugar:Wine.Color       1   1.900 7047.6 1880.9
## - total.sulfur.dioxide:Wine.Color 1   2.233 7047.9 1881.1
## - sulphates:free.sulfur.dioxide   1   2.338 7048.0 1881.2
## - alcohol:sulphates              1   2.564 7048.2 1881.3
## <none>                            7045.7 1881.6
## - volatile.acidity:sulphates     1   3.549 7049.2 1882.0
## - residual.sugar:sulphates       1   3.589 7049.3 1882.1
## - sulphates:citric.acid         1   3.660 7049.3 1882.1
## - free.sulfur.dioxide:citric.acid 1   3.749 7049.4 1882.2
## - alcohol:total.sulfur.dioxide   1   3.837 7049.5 1882.2
## - pH:fixed.acidity               1   4.368 7050.0 1882.6
## - sulphates:Wine.Color           1   4.852 7050.5 1882.9
## - volatile.acidity:fixed.acidity 1   4.856 7050.5 1883.0
## - volatile.acidity:free.sulfur.dioxide 1   5.115 7050.8 1883.1
## - sulphates:density              1   5.290 7051.0 1883.2
## - alcohol:free.sulfur.dioxide    1   5.310 7051.0 1883.3
## - fixed.acidity:total.sulfur.dioxide 1   5.486 7051.2 1883.4
## - free.sulfur.dioxide:density    1   5.796 7051.5 1883.6
## - citric.acid:density            1   6.166 7051.8 1883.9
## - pH:citric.acid                1   6.347 7052.0 1884.0
## - alcohol:pH                     1   7.938 7053.6 1885.1
## - alcohol:citric.acid            1   9.351 7055.0 1886.1
## - residual.sugar:free.sulfur.dioxide 1   9.795 7055.5 1886.4
## - fixed.acidity:citric.acid      1  10.093 7055.8 1886.6
## - volatile.acidity:residual.sugar 1  11.658 7057.3 1887.7
## - free.sulfur.dioxide:Wine.Color 1  14.240 7059.9 1889.5
## - alcohol:density                 1  14.640 7060.3 1889.7
## - residual.sugar:alcohol          1  17.238 7062.9 1891.5
## - residual.sugar:citric.acid      1  17.861 7063.5 1892.0
## - volatile.acidity:density        1  18.139 7063.8 1892.2
## - residual.sugar:pH               1  18.952 7064.6 1892.7
## - residual.sugar:total.sulfur.dioxide 1  19.190 7064.9 1892.9
## - sulphates:total.sulfur.dioxide 1  22.640 7068.3 1895.3
## - volatile.acidity:alcohol         1  47.817 7093.5 1912.7
## - free.sulfur.dioxide:total.sulfur.dioxide 1  51.087 7096.8 1915.0
## - pH:Wine.Color                   1  77.455 7123.1 1933.1
## - density:Wine.Color              2  93.814 7139.5 1942.4
##
## Step:  AIC=1880.47
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##          sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##          citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
##          pH:Wine.Color + sulphates:Wine.Color + free.sulfur.dioxide:Wine.Color +
##          total.sulfur.dioxide:Wine.Color + fixed.acidity:citric.acid +

```

```

## free.sulfur.dioxide:citric.acid + sulphates:citric.acid +
## pH:citric.acid + alcohol:citric.acid + residual.sugar:citric.acid +
## citric.acid:density + fixed.acidity:total.sulfur.dioxide +
## free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
## total.sulfur.dioxide:density + alcohol:total.sulfur.dioxide +
## residual.sugar:total.sulfur.dioxide + pH:fixed.acidity +
## volatile.acidity:fixed.acidity + sulphates:free.sulfur.dioxide +
## alcohol:free.sulfur.dioxide + residual.sugar:free.sulfur.dioxide +
## volatile.acidity:free.sulfur.dioxide + free.sulfur.dioxide:density +
## alcohol:sulphates + residual.sugar:sulphates + volatile.acidity:sulphates +
## sulphates:density + alcohol:pH + residual.sugar:pH + volatile.acidity:pH +
## residual.sugar:alcohol + volatile.acidity:alcohol + alcohol:density +
## volatile.acidity:residual.sugar + residual.sugar:density +
## volatile.acidity:density
##
##                                     Df Sum of Sq    RSS   AIC
## - volatile.acidity:pH           1   1.404 7048.4 1879.5
## - alcohol:sulphates            1   1.564 7048.5 1879.6
## - total.sulfur.dioxide:density 1   1.695 7048.7 1879.7
## - residual.sugar:Wine.Color    1   1.846 7048.8 1879.8
## - residual.sugar:density       1   1.958 7048.9 1879.8
## - total.sulfur.dioxide:Wine.Color 1   2.262 7049.2 1880.0
## - residual.sugar:sulphates     1   2.374 7049.3 1880.1
## - sulphates:free.sulfur.dioxide 1   2.487 7049.5 1880.2
## <none>                           7047.0 1880.5
## - free.sulfur.dioxide:citric.acid 1   3.528 7050.5 1880.9
## - alcohol:total.sulfur.dioxide   1   3.653 7050.6 1881.0
## - sulphates:Wine.Color          1   3.770 7050.7 1881.1
## - volatile.acidity:sulphates    1   3.795 7050.8 1881.1
## - sulphates:density             1   4.105 7051.1 1881.3
## - pH:fixed.acidity              1   4.366 7051.3 1881.5
## - alcohol:free.sulfur.dioxide   1   5.255 7052.2 1882.1
## - volatile.acidity:free.sulfur.dioxide 1   5.266 7052.2 1882.1
## - free.sulfur.dioxide:density   1   5.719 7052.7 1882.5
## - volatile.acidity:fixed.acidity 1   6.171 7053.1 1882.8
## - fixed.acidity:total.sulfur.dioxide 1   6.260 7053.2 1882.8
## - sulphates:citric.acid         1   6.422 7053.4 1882.9
## - pH:citric.acid               1   6.878 7053.8 1883.2
## - alcohol:pH                   1   7.834 7054.8 1883.9
## - citric.acid:density          1   8.069 7055.0 1884.1
## - residual.sugar:free.sulfur.dioxide 1   9.664 7056.6 1885.2
## - alcohol:citric.acid          1   10.840 7057.8 1886.0
## - fixed.acidity:citric.acid    1   12.207 7059.2 1887.0
## - volatile.acidity:residual.sugar 1   13.049 7060.0 1887.5
## - free.sulfur.dioxide:Wine.Color 1   14.456 7061.4 1888.5
## - alcohol:density               1   14.917 7061.9 1888.8
## - residual.sugar:alcohol        1   16.982 7063.9 1890.3
## - residual.sugar:pH             1   18.822 7065.8 1891.5
## - residual.sugar:total.sulfur.dioxide 1   19.297 7066.3 1891.9
## - residual.sugar:citric.acid    1   20.806 7067.8 1892.9
## - volatile.acidity:density      1   20.971 7067.9 1893.0
## - sulphates:total.sulfur.dioxide 1   21.471 7068.4 1893.4
## - volatile.acidity:alcohol       1   50.710 7097.7 1913.6
## - free.sulfur.dioxide:total.sulfur.dioxide 1   50.878 7097.8 1913.7

```

```

## - pH:Wine.Color           1  76.282 7123.2 1931.2
## - density:Wine.Color      2  94.924 7141.9 1942.0
##
## Step: AIC=1879.45
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##          sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##          citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
##          pH:Wine.Color + sulphates:Wine.Color + free.sulfur.dioxide:Wine.Color +
##          total.sulfur.dioxide:Wine.Color + fixed.acidity:citric.acid +
##          free.sulfur.dioxide:citric.acid + sulphates:citric.acid +
##          pH:citric.acid + alcohol:citric.acid + residual.sugar:citric.acid +
##          citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##          total.sulfur.dioxide:density + alcohol:total.sulfur.dioxide +
##          residual.sugar:total.sulfur.dioxide + pH:fixed.acidity +
##          volatile.acidity:fixed.acidity + sulphates:free.sulfur.dioxide +
##          alcohol:free.sulfur.dioxide + residual.sugar:free.sulfur.dioxide +
##          volatile.acidity:free.sulfur.dioxide + free.sulfur.dioxide:density +
##          alcohol:sulphates + residual.sugar:sulphates + volatile.acidity:sulphates +
##          sulphates:density + alcohol:pH + residual.sugar:pH + residual.sugar:alcohol +
##          volatile.acidity:alcohol + alcohol:density + volatile.acidity:residual.sugar +
##          residual.sugar:density + volatile.acidity:density
##
##                                     Df Sum of Sq   RSS   AIC
## - total.sulfur.dioxide:density    1  1.365 7049.7 1878.4
## - alcohol:sulphates               1  1.384 7049.8 1878.4
## - residual.sugar:Wine.Color       1  2.133 7050.5 1878.9
## - residual.sugar:sulphates        1  2.317 7050.7 1879.1
## - total.sulfur.dioxide:Wine.Color 1  2.511 7050.9 1879.2
## - sulphates:free.sulfur.dioxide   1  2.522 7050.9 1879.2
## <none>                           7048.4 1879.5
## - alcohol:total.sulfur.dioxide    1  3.191 7051.6 1879.7
## - residual.sugar:density          1  3.427 7051.8 1879.8
## - free.sulfur.dioxide:citric.acid 1  3.568 7051.9 1879.9
## - sulphates:Wine.Color            1  3.824 7052.2 1880.1
## - sulphates:density               1  3.844 7052.2 1880.1
## - volatile.acidity:sulphates      1  4.269 7052.6 1880.4
## - pH:fixed.acidity                1  4.743 7053.1 1880.7
## - fixed.acidity:total.sulfur.dioxide 1  5.138 7053.5 1881.0
## - volatile.acidity:free.sulfur.dioxide 1  5.357 7053.7 1881.2
## - alcohol:free.sulfur.dioxide      1  5.411 7053.8 1881.2
## - free.sulfur.dioxide:density      1  5.884 7054.3 1881.5
## - sulphates:citric.acid            1  6.716 7055.1 1882.1
## - alcohol:pH                      1  8.414 7056.8 1883.3
## - residual.sugar:free.sulfur.dioxide 1  9.803 7058.2 1884.3
## - citric.acid:density              1 10.131 7058.5 1884.5
## - pH:citric.acid                  1 10.289 7058.7 1884.6
## - alcohol:citric.acid              1 13.699 7062.1 1887.0
## - fixed.acidity:citric.acid        1 13.914 7062.3 1887.1
## - free.sulfur.dioxide:Wine.Color    1 14.446 7062.8 1887.5
## - alcohol:density                  1 15.900 7064.3 1888.5
## - residual.sugar:alcohol             1 16.335 7064.7 1888.8
## - residual.sugar:total.sulfur.dioxide 1 18.668 7067.0 1890.4
## - residual.sugar:pH                  1 18.900 7067.3 1890.6

```

```

## - sulphates:total.sulfur.dioxide           1  22.017 7070.4 1892.7
## - volatile.acidity:fixed.acidity          1  22.407 7070.8 1893.0
## - residual.sugar:citric.acid              1  24.249 7072.6 1894.3
## - volatile.acidity:residual.sugar         1  29.117 7077.5 1897.7
## - free.sulfur.dioxide:total.sulfur.dioxide 1  51.224 7099.6 1912.9
## - volatile.acidity:density                1  53.285 7101.7 1914.3
## - pH:Wine.Color                           1  86.892 7135.3 1937.5
## - volatile.acidity:alcohol                 1  89.120 7137.5 1939.0
## - density:Wine.Color                      2  101.072 7149.4 1945.2
##
## Step: AIC=1878.4
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##          sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##          citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
##          pH:Wine.Color + sulphates:Wine.Color + free.sulfur.dioxide:Wine.Color +
##          total.sulfur.dioxide:Wine.Color + fixed.acidity:citric.acid +
##          free.sulfur.dioxide:citric.acid + sulphates:citric.acid +
##          pH:citric.acid + alcohol:citric.acid + residual.sugar:citric.acid +
##          citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##          alcohol:total.sulfur.dioxide + residual.sugar:total.sulfur.dioxide +
##          pH:fixed.acidity + volatile.acidity:fixed.acidity + sulphates:free.sulfur.dioxide +
##          alcohol:free.sulfur.dioxide + residual.sugar:free.sulfur.dioxide +
##          volatile.acidity:free.sulfur.dioxide + free.sulfur.dioxide:density +
##          alcohol:sulphates + residual.sugar:sulphates + volatile.acidity:sulphates +
##          sulphates:density + alcohol:pH + residual.sugar:pH + residual.sugar:alcohol +
##          volatile.acidity:alcohol + alcohol:density + volatile.acidity:residual.sugar +
##          residual.sugar:density + volatile.acidity:density
##
##                                         Df Sum of Sq   RSS   AIC
## - alcohol:sulphates                  1  1.498 7051.2 1877.4
## - alcohol:total.sulfur.dioxide       1  1.952 7051.7 1877.8
## - residual.sugar:Wine.Color          1  2.471 7052.2 1878.1
## - residual.sugar:sulphates          1  2.513 7052.2 1878.1
## <none>                                7049.7 1878.4
## - sulphates:free.sulfur.dioxide     1  3.295 7053.0 1878.7
## - fixed.acidity:total.sulfur.dioxide 1  3.790 7053.5 1879.0
## - free.sulfur.dioxide:citric.acid   1  3.802 7053.5 1879.0
## - alcohol:free.sulfur.dioxide       1  4.094 7053.8 1879.2
## - sulphates:Wine.Color              1  4.196 7053.9 1879.3
## - volatile.acidity:sulphates        1  4.360 7054.1 1879.4
## - sulphates:density                 1  4.373 7054.1 1879.4
## - free.sulfur.dioxide:density       1  4.537 7054.3 1879.5
## - volatile.acidity:free.sulfur.dioxide 1  5.300 7055.0 1880.1
## - pH:fixed.acidity                  1  5.400 7055.1 1880.2
## - total.sulfur.dioxide:Wine.Color    1  6.240 7056.0 1880.7
## - residual.sugar:density            1  6.331 7056.1 1880.8
## - sulphates:citric.acid             1  6.736 7056.5 1881.1
## - residual.sugar:free.sulfur.dioxide 1  8.486 7058.2 1882.3
## - alcohol:pH                        1  9.362 7059.1 1882.9
## - citric.acid:density               1  9.936 7059.7 1883.3
## - pH:citric.acid                   1 10.297 7060.0 1883.5
## - free.sulfur.dioxide:Wine.Color     1 13.108 7062.8 1885.5
## - fixed.acidity:citric.acid         1 13.434 7063.2 1885.7

```

```

## - alcohol:citric.acid
## - residual.sugar:alcohol
## - alcohol:density
## - residual.sugar:pH
## - volatile.acidity:fixed.acidity
## - residual.sugar:citric.acid
## - sulphates:total.sulfur.dioxide
## - residual.sugar:total.sulfur.dioxide
## - volatile.acidity:residual.sugar
## - free.sulfur.dioxide:total.sulfur.dioxide
## - volatile.acidity:density
## - pH:Wine.Color
## - volatile.acidity:alcohol
## - density:Wine.Color
1   13.883 7063.6 1886.0
1   15.096 7064.8 1886.9
1   15.457 7065.2 1887.1
1   19.633 7069.4 1890.0
1   22.328 7072.1 1891.9
1   23.977 7073.7 1893.0
1   26.959 7076.7 1895.1
1   29.541 7079.3 1896.9
1   29.582 7079.3 1896.9
1   51.010 7100.7 1911.7
1   54.766 7104.5 1914.3
1   85.548 7135.3 1935.5
1   92.208 7141.9 1940.1
2   101.182 7150.9 1944.2
##
## Step: AIC=1877.44
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##      sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##      citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
##      pH:Wine.Color + sulphates:Wine.Color + free.sulfur.dioxide:Wine.Color +
##      total.sulfur.dioxide:Wine.Color + fixed.acidity:citric.acid +
##      free.sulfur.dioxide:citric.acid + sulphates:citric.acid +
##      pH:citric.acid + alcohol:citric.acid + residual.sugar:citric.acid +
##      citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##      free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##      alcohol:total.sulfur.dioxide + residual.sugar:total.sulfur.dioxide +
##      pH:fixed.acidity + volatile.acidity:fixed.acidity + sulphates:free.sulfur.dioxide +
##      alcohol:free.sulfur.dioxide + residual.sugar:free.sulfur.dioxide +
##      volatile.acidity:free.sulfur.dioxide + free.sulfur.dioxide:density +
##      residual.sugar:sulphates + volatile.acidity:sulphates + sulphates:density +
##      alcohol:pH + residual.sugar:pH + residual.sugar:alcohol +
##      volatile.acidity:alcohol + alcohol:density + volatile.acidity:residual.sugar +
##      residual.sugar:density + volatile.acidity:density
##
##                                     Df Sum of Sq    RSS    AIC
## - residual.sugar:sulphates          1   1.337 7052.6 1876.4
## - alcohol:total.sulfur.dioxide       1   2.021 7053.3 1876.8
## - residual.sugar:Wine.Color         1   2.662 7053.9 1877.3
## <none>                                7051.2 1877.4
## - sulphates:free.sulfur.dioxide     1   2.963 7054.2 1877.5
## - sulphates:Wine.Color              1   2.980 7054.2 1877.5
## - fixed.acidity:total.sulfur.dioxide 1   2.995 7054.2 1877.5
## - sulphates:density                 1   3.048 7054.3 1877.6
## - alcohol:free.sulfur.dioxide        1   3.699 7054.9 1878.0
## - free.sulfur.dioxide:density        1   4.327 7055.6 1878.4
## - volatile.acidity:sulphates         1   4.332 7055.6 1878.5
## - free.sulfur.dioxide:citric.acid    1   4.659 7055.9 1878.7
## - volatile.acidity:free.sulfur.dioxide 1   5.363 7056.6 1879.2
## - pH:fixed.acidity                  1   5.648 7056.9 1879.4
## - total.sulfur.dioxide:Wine.Color     1   5.703 7056.9 1879.4
## - sulphates:citric.acid             1   6.445 7057.7 1879.9
## - residual.sugar:density            1   6.503 7057.7 1880.0
## - residual.sugar:free.sulfur.dioxide 1   8.550 7059.8 1881.4
## - alcohol:pH                         1   9.997 7061.2 1882.4

```

```

## - pH:citric.acid
## - citric.acid:density
## - free.sulfur.dioxide:Wine.Color
## - fixed.acidity:citric.acid
## - residual.sugar:alcohol
## - alcohol:density
## - alcohol:citric.acid
## - residual.sugar:pH
## - volatile.acidity:fixed.acidity
## - residual.sugar:citric.acid
## - sulphates:total.sulfur.dioxide
## - residual.sugar:total.sulfur.dioxide
## - volatile.acidity:residual.sugar
## - free.sulfur.dioxide:total.sulfur.dioxide
## - volatile.acidity:density
## - pH:Wine.Color
## - volatile.acidity:alcohol
## - density:Wine.Color
1 10.485 7061.7 1882.7
1 11.013 7062.2 1883.1
1 12.679 7063.9 1884.2
1 13.551 7064.8 1884.8
1 14.142 7065.4 1885.3
1 14.401 7065.6 1885.4
1 15.746 7067.0 1886.4
1 19.312 7070.5 1888.8
1 22.079 7073.3 1890.8
1 24.678 7075.9 1892.6
1 28.134 7079.4 1895.0
1 29.574 7080.8 1896.0
1 29.655 7080.9 1896.0
1 51.251 7102.5 1910.9
1 55.373 7106.6 1913.8
1 84.064 7135.3 1933.5
1 96.657 7147.9 1942.2
2 101.857 7153.1 1943.7
##
## Step: AIC=1876.37
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##   sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##   citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
##   pH:Wine.Color + sulphates:Wine.Color + free.sulfur.dioxide:Wine.Color +
##   total.sulfur.dioxide:Wine.Color + fixed.acidity:citric.acid +
##   free.sulfur.dioxide:citric.acid + sulphates:citric.acid +
##   pH:citric.acid + alcohol:citric.acid + residual.sugar:citric.acid +
##   citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##   free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##   alcohol:total.sulfur.dioxide + residual.sugar:total.sulfur.dioxide +
##   pH:fixed.acidity + volatile.acidity:fixed.acidity + sulphates:free.sulfur.dioxide +
##   alcohol:free.sulfur.dioxide + residual.sugar:free.sulfur.dioxide +
##   volatile.acidity:free.sulfur.dioxide + free.sulfur.dioxide:density +
##   volatile.acidity:sulphates + sulphates:density + alcohol:pH +
##   residual.sugar:pH + residual.sugar:alcohol + volatile.acidity:alcohol +
##   alcohol:density + volatile.acidity:residual.sugar + residual.sugar:density +
##   volatile.acidity:density
##
##                                     Df Sum of Sq    RSS     AIC
## - sulphates:Wine.Color          1  1.669 7054.2 1875.5
## - sulphates:density            1  1.722 7054.3 1875.6
## - alcohol:total.sulfur.dioxide  1  1.834 7054.4 1875.6
## - residual.sugar:Wine.Color     1  2.179 7054.7 1875.9
## - sulphates:free.sulfur.dioxide 1  2.418 7055.0 1876.0
## - fixed.acidity:total.sulfur.dioxide 1  2.727 7055.3 1876.3
## <none>                           7052.6 1876.4
## - alcohol:free.sulfur.dioxide   1  3.857 7056.4 1877.0
## - free.sulfur.dioxide:density   1  4.347 7056.9 1877.4
## - free.sulfur.dioxide:citric.acid 1  4.795 7057.4 1877.7
## - volatile.acidity:sulphates    1  5.150 7057.7 1877.9
## - volatile.acidity:free.sulfur.dioxide 1  5.379 7057.9 1878.1
## - total.sulfur.dioxide:Wine.Color 1  5.555 7058.1 1878.2
## - pH:fixed.acidity              1  5.638 7058.2 1878.3
## - sulphates:citric.acid        1  6.234 7058.8 1878.7

```

```

## - residual.sugar:density
## - residual.sugar:free.sulfur.dioxide
## - alcohol:pH
## - pH:citric.acid
## - citric.acid:density
## - free.sulfur.dioxide:Wine.Color
## - fixed.acidity:citric.acid
## - residual.sugar:alcohol
## - alcohol:density
## - alcohol:citric.acid
## - residual.sugar:pH
## - volatile.acidity:fixed.acidity
## - residual.sugar:citric.acid
## - sulphates:total.sulfur.dioxide
## - residual.sugar:total.sulfur.dioxide
## - volatile.acidity:residual.sugar
## - free.sulfur.dioxide:total.sulfur.dioxide
## - volatile.acidity:density
## - pH:Wine.Color
## - density:Wine.Color
## - volatile.acidity:alcohol
##
## Step: AIC=1875.53
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##   sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##   citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
##   pH:Wine.Color + free.sulfur.dioxide:Wine.Color + total.sulfur.dioxide:Wine.Color +
##   fixed.acidity:citric.acid + free.sulfur.dioxide:citric.acid +
##   sulphates:citric.acid + pH:citric.acid + alcohol:citric.acid +
##   residual.sugar:citric.acid + citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##   free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##   alcohol:total.sulfur.dioxide + residual.sugar:total.sulfur.dioxide +
##   pH:fixed.acidity + volatile.acidity:fixed.acidity + sulphates:free.sulfur.dioxide +
##   alcohol:free.sulfur.dioxide + residual.sugar:free.sulfur.dioxide +
##   volatile.acidity:free.sulfur.dioxide + free.sulfur.dioxide:density +
##   volatile.acidity:sulphates + sulphates:density + alcohol:pH +
##   residual.sugar:pH + residual.sugar:alcohol + volatile.acidity:alcohol +
##   alcohol:density + volatile.acidity:residual.sugar + residual.sugar:density +
##   volatile.acidity:density
##
##                                     Df Sum of Sq    RSS     AIC
## - sulphates:density             1    0.450 7054.7 1873.8
## - alcohol:total.sulfur.dioxide  1    1.589 7055.8 1874.6
## - sulphates:free.sulfur.dioxide 1    2.305 7056.5 1875.1
## - fixed.acidity:total.sulfur.dioxide 1    2.660 7056.9 1875.4
## <none>                           7054.2 1875.5
## - residual.sugar:Wine.Color    1    2.910 7057.1 1875.5
## - alcohol:free.sulfur.dioxide  1    3.563 7057.8 1876.0
## - free.sulfur.dioxide:density  1    4.134 7058.4 1876.4
## - free.sulfur.dioxide:citric.acid 1    4.695 7058.9 1876.8
## - volatile.acidity:free.sulfur.dioxide 1    5.624 7059.9 1877.4
## - pH:fixed.acidity              1    5.797 7060.0 1877.5
## - sulphates:citric.acid       1    6.395 7060.6 1878.0
## - residual.sugar:density       1    6.868 7061.1 1878.3

```

```

## - total.sulfur.dioxide:Wine.Color      1    7.439 7061.7 1878.7
## - residual.sugar:free.sulfur.dioxide   1    8.397 7062.6 1879.4
## - alcohol:pH                          1    8.717 7063.0 1879.6
## - volatile.acidity:sulphates          1    9.763 7064.0 1880.3
## - pH:citric.acid                     1   10.730 7065.0 1881.0
## - citric.acid:density                1   11.110 7065.3 1881.2
## - free.sulfur.dioxide:Wine.Color      1   12.283 7066.5 1882.0
## - fixed.acidity:citric.acid          1   13.417 7067.7 1882.8
## - residual.sugar:alcohol              1   15.656 7069.9 1884.4
## - alcohol:citric.acid                1   15.764 7070.0 1884.5
## - alcohol:density                     1   17.299 7071.5 1885.5
## - residual.sugar:pH                  1   21.181 7075.4 1888.2
## - volatile.acidity:fixed.acidity     1   22.165 7076.4 1888.9
## - residual.sugar:citric.acid         1   24.783 7079.0 1890.7
## - residual.sugar:total.sulfur.dioxide 1   30.057 7084.3 1894.4
## - sulphates:total.sulfur.dioxide     1   30.346 7084.6 1894.6
## - volatile.acidity:residual.sugar    1   33.809 7088.0 1897.0
## - free.sulfur.dioxide:total.sulfur.dioxide 1   51.791 7106.0 1909.4
## - volatile.acidity:density           1   63.307 7117.5 1917.3
## - pH:Wine.Color                      1   84.983 7139.2 1932.2
## - density:Wine.Color                 2   100.210 7154.4 1940.6
## - volatile.acidity:alcohol            1   102.897 7157.1 1944.5
##
## Step: AIC=1873.84
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##          sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##          citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
##          pH:Wine.Color + free.sulfur.dioxide:Wine.Color + total.sulfur.dioxide:Wine.Color +
##          fixed.acidity:citric.acid + free.sulfur.dioxide:citric.acid +
##          sulphates:citric.acid + pH:citric.acid + alcohol:citric.acid +
##          residual.sugar:citric.acid + citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##          alcohol:total.sulfur.dioxide + residual.sugar:total.sulfur.dioxide +
##          pH:fixed.acidity + volatile.acidity:fixed.acidity + sulphates:free.sulfur.dioxide +
##          alcohol:free.sulfur.dioxide + residual.sugar:free.sulfur.dioxide +
##          volatile.acidity:free.sulfur.dioxide + free.sulfur.dioxide:density +
##          volatile.acidity:sulphates + alcohol:pH + residual.sugar:pH +
##          residual.sugar:alcohol + volatile.acidity:alcohol + alcohol:density +
##          volatile.acidity:residual.sugar + residual.sugar:density +
##          volatile.acidity:density
##
##                                         Df Sum of Sq   RSS   AIC
## - alcohol:total.sulfur.dioxide       1    1.647 7056.3 1873.0
## - sulphates:free.sulfur.dioxide     1    2.388 7057.1 1873.5
## - fixed.acidity:total.sulfur.dioxide 1    2.522 7057.2 1873.6
## <none>                                7054.7 1873.8
## - residual.sugar:Wine.Color          1    3.179 7057.9 1874.0
## - alcohol:free.sulfur.dioxide        1    3.581 7058.3 1874.3
## - free.sulfur.dioxide:density        1    4.023 7058.7 1874.6
## - free.sulfur.dioxide:citric.acid    1    4.898 7059.6 1875.2
## - volatile.acidity:free.sulfur.dioxide 1    5.886 7060.6 1875.9
## - sulphates:citric.acid              1    5.968 7060.7 1876.0
## - pH:fixed.acidity                   1    6.005 7060.7 1876.0
## - residual.sugar:density             1    6.747 7061.4 1876.5

```

```

## - total.sulfur.dioxide:Wine.Color      1    7.316 7062.0 1876.9
## - residual.sugar:free.sulfur.dioxide   1    8.266 7063.0 1877.6
## - alcohol:pH                          1    8.532 7063.2 1877.8
## - volatile.acidity:sulphates          1    9.523 7064.2 1878.5
## - pH:citric.acid                     1   10.534 7065.2 1879.2
## - citric.acid:density                1   10.955 7065.6 1879.4
## - free.sulfur.dioxide:Wine.Color      1   12.204 7066.9 1880.3
## - fixed.acidity:citric.acid          1   13.184 7067.9 1881.0
## - alcohol:citric.acid                1   15.608 7070.3 1882.7
## - residual.sugar:alcohol              1   16.530 7071.2 1883.3
## - alcohol:density                     1   18.376 7073.1 1884.6
## - residual.sugar:pH                  1   21.062 7075.7 1886.5
## - volatile.acidity:fixed.acidity     1   22.751 7077.4 1887.6
## - residual.sugar:citric.acid         1   24.392 7079.1 1888.8
## - sulphates:total.sulfur.dioxide    1   30.610 7085.3 1893.0
## - residual.sugar:total.sulfur.dioxide 1   30.873 7085.6 1893.2
## - volatile.acidity:residual.sugar    1   33.725 7088.4 1895.2
## - free.sulfur.dioxide:total.sulfur.dioxide 1   51.821 7106.5 1907.7
## - volatile.acidity:density          1   63.620 7118.3 1915.8
## - pH:Wine.Color                      1   84.901 7139.6 1930.5
## - density:Wine.Color                 2   99.815 7154.5 1938.7
## - volatile.acidity:alcohol           1  102.599 7157.3 1942.6
##
## Step: AIC=1872.98
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##          sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##          citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
##          pH:Wine.Color + free.sulfur.dioxide:Wine.Color + total.sulfur.dioxide:Wine.Color +
##          fixed.acidity:citric.acid + free.sulfur.dioxide:citric.acid +
##          sulphates:citric.acid + pH:citric.acid + alcohol:citric.acid +
##          residual.sugar:citric.acid + citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##          residual.sugar:total.sulfur.dioxide + pH:fixed.acidity +
##          volatile.acidity:fixed.acidity + sulphates:free.sulfur.dioxide +
##          alcohol:free.sulfur.dioxide + residual.sugar:free.sulfur.dioxide +
##          volatile.acidity:free.sulfur.dioxide + free.sulfur.dioxide:density +
##          volatile.acidity:sulphates + alcohol:pH + residual.sugar:pH +
##          residual.sugar:alcohol + volatile.acidity:alcohol + alcohol:density +
##          volatile.acidity:residual.sugar + residual.sugar:density +
##          volatile.acidity:density
##
##                                         Df Sum of Sq   RSS   AIC
## - alcohol:free.sulfur.dioxide        1    2.168 7058.5 1872.5
## - sulphates:free.sulfur.dioxide     1    2.737 7059.1 1872.9
## - fixed.acidity:total.sulfur.dioxide 1    2.743 7059.1 1872.9
## <none>                                7056.3 1873.0
## - residual.sugar:Wine.Color         1    3.357 7059.7 1873.3
## - free.sulfur.dioxide:density       1    3.912 7060.2 1873.7
## - free.sulfur.dioxide:citric.acid   1    4.551 7060.9 1874.1
## - sulphates:citric.acid            1    5.641 7062.0 1874.9
## - volatile.acidity:free.sulfur.dioxide 1    5.933 7062.3 1875.1
## - pH:fixed.acidity                  1    6.095 7062.4 1875.2
## - total.sulfur.dioxide:Wine.Color    1    7.150 7063.5 1876.0
## - residual.sugar:density            1    7.920 7064.3 1876.5

```

```

## - alcohol:pH
## - volatile.acidity:sulphates
## - residual.sugar:free.sulfur.dioxide
## - pH:citric.acid
## - citric.acid:density
## - free.sulfur.dioxide:Wine.Color
## - fixed.acidity:citric.acid
## - residual.sugar:alcohol
## - alcohol:citric.acid
## - alcohol:density
## - residual.sugar:pH
## - volatile.acidity:fixed.acidity
## - residual.sugar:citric.acid
## - sulphates:total.sulfur.dioxide
## - volatile.acidity:residual.sugar
## - residual.sugar:total.sulfur.dioxide
## - free.sulfur.dioxide:total.sulfur.dioxide
## - volatile.acidity:density
## - pH:Wine.Color
## - density:Wine.Color
## - volatile.acidity:alcohol
## Step: AIC=1872.49
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
## sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
## citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
## pH:Wine.Color + free.sulfur.dioxide:Wine.Color + total.sulfur.dioxide:Wine.Color +
## fixed.acidity:citric.acid + free.sulfur.dioxide:citric.acid +
## sulphates:citric.acid + pH:citric.acid + alcohol:citric.acid +
## residual.sugar:citric.acid + citric.acid:density + fixed.acidity:total.sulfur.dioxide +
## free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
## residual.sugar:total.sulfur.dioxide + pH:fixed.acidity +
## volatile.acidity:fixed.acidity + sulphates:free.sulfur.dioxide +
## residual.sugar:free.sulfur.dioxide + volatile.acidity:free.sulfur.dioxide +
## free.sulfur.dioxide:density + volatile.acidity:sulphates +
## alcohol:pH + residual.sugar:pH + residual.sugar:alcohol +
## volatile.acidity:alcohol + alcohol:density + volatile.acidity:residual.sugar +
## residual.sugar:density + volatile.acidity:density
##
##                                         Df Sum of Sq    RSS     AIC
## - free.sulfur.dioxide:density      1     1.756 7060.3 1871.7
## <none>                               7058.5 1872.5
## - residual.sugar:Wine.Color       1     3.270 7061.8 1872.8
## - sulphates:free.sulfur.dioxide   1     4.388 7062.9 1873.5
## - fixed.acidity:total.sulfur.dioxide  1     4.841 7063.3 1873.8
## - free.sulfur.dioxide:citric.acid  1     4.883 7063.4 1873.9
## - sulphates:citric.acid          1     5.123 7063.6 1874.0
## - pH:fixed.acidity                1     5.807 7064.3 1874.5
## - volatile.acidity:free.sulfur.dioxide 1     6.105 7064.6 1874.7
## - residual.sugar:free.sulfur.dioxide 1     7.563 7066.1 1875.7
## - residual.sugar:density          1     7.686 7066.2 1875.8
## - total.sulfur.dioxide:Wine.Color   1     7.848 7066.3 1875.9
## - volatile.acidity:sulphates        1     8.372 7066.9 1876.3
## - alcohol:pH                      1     8.502 7067.0 1876.4

```

```

## - pH:citric.acid
## - citric.acid:density
## - free.sulfur.dioxide:Wine.Color
## - fixed.acidity:citric.acid
## - alcohol:citric.acid
## - residual.sugar:alcohol
## - alcohol:density
## - residual.sugar:pH
## - volatile.acidity:fixed.acidity
## - residual.sugar:citric.acid
## - sulphates:total.sulfur.dioxide
## - volatile.acidity:residual.sugar
## - residual.sugar:total.sulfur.dioxide
## - free.sulfur.dioxide:total.sulfur.dioxide
## - volatile.acidity:density
## - pH:Wine.Color
## - density:Wine.Color
## - volatile.acidity:alcohol
## Step: AIC=1871.71
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##      sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##      citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
##      pH:Wine.Color + free.sulfur.dioxide:Wine.Color + total.sulfur.dioxide:Wine.Color +
##      fixed.acidity:citric.acid + free.sulfur.dioxide:citric.acid +
##      sulphates:citric.acid + pH:citric.acid + alcohol:citric.acid +
##      residual.sugar:citric.acid + citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##      free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##      residual.sugar:total.sulfur.dioxide + pH:fixed.acidity +
##      volatile.acidity:fixed.acidity + sulphates:free.sulfur.dioxide +
##      residual.sugar:free.sulfur.dioxide + volatile.acidity:free.sulfur.dioxide +
##      volatile.acidity:sulphates + alcohol:pH + residual.sugar:pH +
##      residual.sugar:alcohol + volatile.acidity:alcohol + alcohol:density +
##      volatile.acidity:residual.sugar + residual.sugar:density +
##      volatile.acidity:density
##
## <none>
## - residual.sugar:Wine.Color
## - sulphates:free.sulfur.dioxide
## - sulphates:citric.acid
## - pH:fixed.acidity
## - free.sulfur.dioxide:citric.acid
## - volatile.acidity:free.sulfur.dioxide
## - residual.sugar:free.sulfur.dioxide
## - residual.sugar:density
## - fixed.acidity:total.sulfur.dioxide
## - volatile.acidity:sulphates
## - total.sulfur.dioxide:Wine.Color
## - alcohol:pH
## - free.sulfur.dioxide:Wine.Color
## - pH:citric.acid
## - citric.acid:density
## - fixed.acidity:citric.acid

```

	Df	Sum of Sq	RSS	AIC
		7060.3	1871.7	
## - residual.sugar:Wine.Color	1	3.065	7063.3	1871.8
## - sulphates:free.sulfur.dioxide	1	4.455	7064.7	1872.8
## - sulphates:citric.acid	1	4.927	7065.2	1873.1
## - pH:fixed.acidity	1	5.973	7066.2	1873.8
## - free.sulfur.dioxide:citric.acid	1	6.048	7066.3	1873.9
## - volatile.acidity:free.sulfur.dioxide	1	6.855	7067.1	1874.5
## - residual.sugar:free.sulfur.dioxide	1	7.241	7067.5	1874.7
## - residual.sugar:density	1	7.586	7067.8	1875.0
## - fixed.acidity:total.sulfur.dioxide	1	7.651	7067.9	1875.0
## - volatile.acidity:sulphates	1	7.879	7068.1	1875.2
## - total.sulfur.dioxide:Wine.Color	1	8.220	7068.5	1875.4
## - alcohol:pH	1	8.572	7068.8	1875.7
## - free.sulfur.dioxide:Wine.Color	1	8.860	7069.1	1875.8
## - pH:citric.acid	1	9.898	7070.2	1876.6
## - citric.acid:density	1	10.182	7070.4	1876.8
## - fixed.acidity:citric.acid	1	12.802	7073.1	1878.6

```

## - alcohol:citric.acid
## - residual.sugar:alcohol
## - alcohol:density
## - residual.sugar:pH
## - volatile.acidity:fixed.acidity
## - residual.sugar:citric.acid
## - volatile.acidity:residual.sugar
## - sulphates:total.sulfur.dioxide
## - residual.sugar:total.sulfur.dioxide
## - free.sulfur.dioxide:total.sulfur.dioxide
## - volatile.acidity:density
## - pH:Wine.Color
## - density:Wine.Color
## - volatile.acidity:alcohol
1   14.677 7074.9 1879.9
1   16.863 7077.1 1881.4
1   18.690 7078.9 1882.7
1   18.888 7079.1 1882.8
1   21.294 7081.6 1884.5
1   23.435 7083.7 1886.0
1   31.850 7092.1 1891.8
1   31.917 7092.2 1891.8
1   39.289 7099.5 1896.9
1   58.954 7119.2 1910.5
1   59.315 7119.6 1910.7
1   88.081 7148.3 1930.5
2   97.271 7157.5 1934.8
1   103.463 7163.7 1941.0

newbackAIC <- lm(Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
                  sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
                  citric.acid + density:Wine.Color + volatile.acidity:Wine.Color +
                  residual.sugar:Wine.Color + pH:Wine.Color + sulphates:Wine.Color +
                  free.sulfur.dioxide:Wine.Color + citric.acid:Wine.Color +
                  fixed.acidity:citric.acid + pH:citric.acid + alcohol:citric.acid +
                  residual.sugar:citric.acid + citric.acid:density + free.sulfur.dioxide:total.sulfur.
                  sulphates:total.sulfur.dioxide + alcohol:total.sulfur.dioxide +
                  residual.sugar:total.sulfur.dioxide + sulphates:fixed.acidity +
                  pH:fixed.acidity + volatile.acidity:fixed.acidity + sulphates:free.sulfur.dioxide +
                  alcohol:free.sulfur.dioxide + residual.sugar:free.sulfur.dioxide +
                  free.sulfur.dioxide:density + pH:sulphates + alcohol:sulphates +
                  residual.sugar:sulphates + volatile.acidity:sulphates + sulphates:density +
                  alcohol:pH + residual.sugar:pH + residual.sugar:alcohol +
                  volatile.acidity:alcohol + alcohol:density + volatile.acidity:residual.sugar +
                  residual.sugar:density + volatile.acidity:density, data=train)

# backward BIC
n <- length(newest$residuals)
backBIC <- step(newest, direction="backward", data=train, k=log(n))

## Start: AIC=2336.33
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##       sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##       citric.acid + density:Wine.Color + volatile.acidity:Wine.Color +
##       residual.sugar:Wine.Color + alcohol:Wine.Color + pH:Wine.Color +
##       sulphates:Wine.Color + free.sulfur.dioxide:Wine.Color + fixed.acidity:Wine.Color +
##       total.sulfur.dioxide:Wine.Color + citric.acid:Wine.Color +
##       citric.acid:total.sulfur.dioxide + citric.acid:fixed.acidity +
##       citric.acid:free.sulfur.dioxide + citric.acid:sulphates +
##       citric.acid:pH + citric.acid:alcohol + citric.acid:residual.sugar +
##       citric.acid:volatile.acidity + citric.acid:density + total.sulfur.dioxide:fixed.acidity +
##       total.sulfur.dioxide:free.sulfur.dioxide + total.sulfur.dioxide:sulphates +
##       total.sulfur.dioxide:density + total.sulfur.dioxide:pH +
##       total.sulfur.dioxide:alcohol + total.sulfur.dioxide:residual.sugar +
##       total.sulfur.dioxide:volatile.acidity + total.sulfur.dioxide:Wine.Color +
##       fixed.acidity:free.sulfur.dioxide + fixed.acidity:sulphates +
##       fixed.acidity:pH + fixed.acidity:alcohol + fixed.acidity:residual.sugar +
##       fixed.acidity:volatile.acidity + fixed.acidity:density +
##       free.sulfur.dioxide:sulphates + free.sulfur.dioxide:pH +

```

```

## free.sulfur.dioxide:alcohol + free.sulfur.dioxide:residual.sugar +
## free.sulfur.dioxide:volatile.acidity + free.sulfur.dioxide:density +
## sulphates:pH + sulphates:alcohol + sulphates:residual.sugar +
## sulphates:volatile.acidity + sulphates:density + pH:alcohol +
## pH:residual.sugar + pH:volatile.acidity + pH:density + alcohol:residual.sugar +
## alcohol:volatile.acidity + alcohol:density + residual.sugar:volatile.acidity +
## residual.sugar:density + volatile.acidity:density
##
##                                     Df Sum of Sq   RSS   AIC
## - fixed.acidity:density           1  0.001 7039.9 2327.8
## - alcohol:Wine.Color              1  0.011 7039.9 2327.8
## - volatile.acidity:total.sulfur.dioxide 1  0.025 7039.9 2327.8
## - volatile.acidity:Wine.Color      1  0.043 7039.9 2327.9
## - alcohol:fixed.acidity          1  0.117 7040.0 2327.9
## - free.sulfur.dioxide:fixed.acidity 1  0.160 7040.0 2327.9
## - total.sulfur.dioxide:citric.acid 1  0.230 7040.1 2328.0
## - fixed.acidity:Wine.Color        1  0.304 7040.2 2328.0
## - pH:total.sulfur.dioxide         1  0.380 7040.2 2328.1
## - pH:free.sulfur.dioxide          1  0.452 7040.3 2328.2
## - residual.sugar:fixed.acidity    1  0.537 7040.4 2328.2
## - citric.acid:Wine.Color          1  0.578 7040.4 2328.2
## - pH:density                      1  0.827 7040.7 2328.4
## - volatile.acidity:citric.acid    1  0.907 7040.8 2328.5
## - free.sulfur.dioxide:citric.acid 1  0.925 7040.8 2328.5
## - volatile.acidity:pH              1  1.054 7040.9 2328.6
## - total.sulfur.dioxide:Wine.Color 1  1.265 7041.1 2328.7
## - pH:sulphates                   1  1.335 7041.2 2328.8
## - residual.sugar:density          1  1.532 7041.4 2328.9
## - total.sulfur.dioxide:density    1  1.676 7041.5 2329.0
## - pH:fixed.acidity                1  1.860 7041.7 2329.1
## - fixed.acidity:total.sulfur.dioxide 1  1.916 7041.8 2329.2
## - residual.sugar:Wine.Color        1  1.967 7041.8 2329.2
## - volatile.acidity:free.sulfur.dioxide 1  2.298 7042.2 2329.4
## - sulphates:fixed.acidity          1  2.325 7042.2 2329.4
## - sulphates:free.sulfur.dioxide    1  2.684 7042.5 2329.7
## - alcohol:sulphates               1  2.903 7042.8 2329.8
## - alcohol:total.sulfur.dioxide     1  3.153 7043.0 2330.0
## - volatile.acidity:sulphates       1  3.319 7043.2 2330.1
## - sulphates:citric.acid           1  3.507 7043.4 2330.3
## - free.sulfur.dioxide:density      1  3.660 7043.5 2330.4
## - alcohol:free.sulfur.dioxide      1  4.079 7043.9 2330.7
## - residual.sugar:sulphates         1  4.135 7044.0 2330.7
## - sulphates:Wine.Color             1  4.882 7044.7 2331.2
## - sulphates:density                1  4.914 7044.8 2331.2
## - volatile.acidity:fixed.acidity    1  5.724 7045.6 2331.8
## - alcohol:pH                       1  5.734 7045.6 2331.8
## - citric.acid:density              1  5.956 7045.8 2332.0
## - residual.sugar:free.sulfur.dioxide 1  6.125 7046.0 2332.1
## - pH:citric.acid                  1  6.463 7046.3 2332.3
## - alcohol:density                  1  6.862 7046.7 2332.6
## - density:Wine.Color               2  19.993 7059.8 2333.2
## - residual.sugar:pH                 1  8.216 7048.1 2333.6
## - volatile.acidity:residual.sugar   1  8.450 7048.3 2333.7
## - alcohol:citric.acid              1  8.501 7048.4 2333.8

```

```

## - fixed.acidity:citric.acid          1  11.062 7050.9 2335.5
## - residual.sugar:alcohol            1  11.540 7051.4 2335.9
## - volatile.acidity:density          1  11.903 7051.8 2336.1
## <none>                                7039.9 2336.3
## - residual.sugar:total.sulfur.dioxide 1  12.796 7052.7 2336.7
## - free.sulfur.dioxide:Wine.Color     1  12.990 7052.8 2336.9
## - residual.sugar:citric.acid         1  15.435 7055.3 2338.6
## - sulphates:total.sulfur.dioxide    1  21.442 7061.3 2342.7
## - pH:Wine.Color                      1  23.016 7062.9 2343.8
## - volatile.acidity:alcohol           1  39.628 7079.5 2355.3
## - free.sulfur.dioxide:total.sulfur.dioxide 1  49.085 7088.9 2361.9
##
## Step: AIC=2327.83
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##          sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##          citric.acid + density:Wine.Color + volatile.acidity:Wine.Color +
##          residual.sugar:Wine.Color + alcohol:Wine.Color + pH:Wine.Color +
##          sulphates:Wine.Color + free.sulfur.dioxide:Wine.Color + fixed.acidity:Wine.Color +
##          total.sulfur.dioxide:Wine.Color + citric.acid:Wine.Color +
##          total.sulfur.dioxide:citric.acid + fixed.acidity:citric.acid +
##          free.sulfur.dioxide:citric.acid + sulphates:citric.acid +
##          pH:citric.acid + alcohol:citric.acid + residual.sugar:citric.acid +
##          volatile.acidity:citric.acid + citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##          total.sulfur.dioxide:density + pH:total.sulfur.dioxide +
##          alcohol:total.sulfur.dioxide + residual.sugar:total.sulfur.dioxide +
##          volatile.acidity:total.sulfur.dioxide + free.sulfur.dioxide:fixed.acidity +
##          sulphates:fixed.acidity + pH:fixed.acidity + alcohol:fixed.acidity +
##          residual.sugar:fixed.acidity + volatile.acidity:fixed.acidity +
##          sulphates:free.sulfur.dioxide + pH:free.sulfur.dioxide +
##          alcohol:free.sulfur.dioxide + residual.sugar:free.sulfur.dioxide +
##          volatile.acidity:free.sulfur.dioxide + free.sulfur.dioxide:density +
##          pH:sulphates + alcohol:sulphates + residual.sugar:sulphates +
##          volatile.acidity:sulphates + sulphates:density + alcohol:pH +
##          residual.sugar:pH + volatile.acidity:pH + pH:density + residual.sugar:alcohol +
##          volatile.acidity:alcohol + alcohol:density + volatile.acidity:residual.sugar +
##          residual.sugar:density + volatile.acidity:density
##
##                                     Df Sum of Sq   RSS   AIC
## - alcohol:Wine.Color             1  0.011 7039.9 2319.3
## - volatile.acidity:total.sulfur.dioxide 1  0.024 7039.9 2319.3
## - volatile.acidity:Wine.Color       1  0.042 7039.9 2319.4
## - alcohol:fixed.acidity          1  0.149 7040.0 2319.4
## - free.sulfur.dioxide:fixed.acidity 1  0.165 7040.0 2319.4
## - total.sulfur.dioxide:citric.acid 1  0.230 7040.1 2319.5
## - pH:total.sulfur.dioxide        1  0.395 7040.3 2319.6
## - pH:free.sulfur.dioxide         1  0.457 7040.3 2319.7
## - fixed.acidity:Wine.Color        1  0.544 7040.4 2319.7
## - citric.acid:Wine.Color          1  0.640 7040.5 2319.8
## - residual.sugar:fixed.acidity    1  0.891 7040.7 2320.0
## - pH:density                     1  0.895 7040.8 2320.0
## - volatile.acidity:citric.acid    1  0.907 7040.8 2320.0
## - free.sulfur.dioxide:citric.acid 1  0.927 7040.8 2320.0
## - volatile.acidity:pH              1  1.054 7040.9 2320.1

```

```

## - total.sulfur.dioxide:Wine.Color      1    1.300 7041.2 2320.2
## - pH:sulphates                        1    1.338 7041.2 2320.3
## - residual.sugar:density              1    1.548 7041.4 2320.4
## - total.sulfur.dioxide:density        1    1.740 7041.6 2320.6
## - pH:fixed.acidity                   1    1.869 7041.7 2320.6
## - fixed.acidity:total.sulfur.dioxide 1    1.989 7041.8 2320.7
## - residual.sugar:Wine.Color          1    2.060 7041.9 2320.8
## - volatile.acidity:free.sulfur.dioxide 1    2.307 7042.2 2320.9
## - sulphates:fixed.acidity           1    2.324 7042.2 2320.9
## - sulphates:free.sulfur.dioxide     1    2.710 7042.6 2321.2
## - alcohol:sulphates                1    2.958 7042.8 2321.4
## - alcohol:total.sulfur.dioxide      1    3.200 7043.1 2321.6
## - volatile.acidity:sulphates        1    3.319 7043.2 2321.7
## - sulphates:citric.acid            1    3.543 7043.4 2321.8
## - free.sulfur.dioxide:density       1    3.668 7043.5 2321.9
## - alcohol:free.sulfur.dioxide       1    4.083 7043.9 2322.2
## - residual.sugar:sulphates         1    4.327 7044.2 2322.3
## - sulphates:Wine.Color             1    5.070 7044.9 2322.9
## - sulphates:density                1    5.103 7045.0 2322.9
## - volatile.acidity:fixed.acidity   1    5.724 7045.6 2323.3
## - alcohol:pH                      1    6.018 7045.9 2323.5
## - residual.sugar:free.sulfur.dioxide 1    6.145 7046.0 2323.6
## - citric.acid:density              1    6.447 7046.3 2323.8
## - pH:citric.acid                  1    6.470 7046.3 2323.8
## - alcohol:density                 1    6.908 7046.8 2324.1
## - volatile.acidity:residual.sugar  1    8.754 7048.6 2325.4
## - residual.sugar:pH                1    8.781 7048.6 2325.4
## - alcohol:citric.acid             1    8.850 7048.7 2325.5
## - density:Wine.Color              2    23.263 7063.1 2327.0
## - fixed.acidity:citric.acid       1    11.112 7051.0 2327.1
## - residual.sugar:alcohol          1    11.570 7051.4 2327.4
## <none>                            7039.9 2327.8
## - volatile.acidity:density        1    12.314 7052.2 2327.9
## - free.sulfur.dioxide:Wine.Color   1    13.049 7052.9 2328.4
## - residual.sugar:total.sulfur.dioxide 1    13.324 7053.2 2328.6
## - residual.sugar:citric.acid      1    16.492 7056.3 2330.8
## - sulphates:total.sulfur.dioxide  1    21.510 7061.4 2334.3
## - pH:Wine.Color                   1    26.005 7065.9 2337.4
## - volatile.acidity:alcohol        1    40.448 7080.3 2347.4
## - free.sulfur.dioxide:total.sulfur.dioxide 1    49.198 7089.1 2353.5
##
## Step: AIC=2319.34
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##          sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##          citric.acid + density:Wine.Color + volatile.acidity:Wine.Color +
##          residual.sugar:Wine.Color + pH:Wine.Color + sulphates:Wine.Color +
##          free.sulfur.dioxide:Wine.Color + fixed.acidity:Wine.Color +
##          total.sulfur.dioxide:Wine.Color + citric.acid:Wine.Color +
##          total.sulfur.dioxide:citric.acid + fixed.acidity:citric.acid +
##          free.sulfur.dioxide:citric.acid + sulphates:citric.acid +
##          pH:citric.acid + alcohol:citric.acid + residual.sugar:citric.acid +
##          volatile.acidity:citric.acid + citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##          total.sulfur.dioxide:density + pH:total.sulfur.dioxide +

```

```

## alcohol:total.sulfur.dioxide + residual.sugar:total.sulfur.dioxide +
## volatile.acidity:total.sulfur.dioxide + free.sulfur.dioxide:fixed.acidity +
## sulphates:fixed.acidity + pH:fixed.acidity + alcohol:fixed.acidity +
## residual.sugar:fixed.acidity + volatile.acidity:fixed.acidity +
## sulphates:free.sulfur.dioxide + pH:free.sulfur.dioxide +
## alcohol:free.sulfur.dioxide + residual.sugar:free.sulfur.dioxide +
## volatile.acidity:free.sulfur.dioxide + free.sulfur.dioxide:density +
## pH:sulphates + alcohol:sulphates + residual.sugar:sulphates +
## volatile.acidity:sulphates + sulphates:density + alcohol:pH +
## residual.sugar:pH + volatile.acidity:pH + pH:density + residual.sugar:alcohol +
## volatile.acidity:alcohol + alcohol:density + volatile.acidity:residual.sugar +
## residual.sugar:density + volatile.acidity:density
##
##                                     Df Sum of Sq   RSS   AIC
## - volatile.acidity:total.sulfur.dioxide    1  0.022 7039.9 2310.9
## - volatile.acidity:Wine.Color             1  0.040 7039.9 2310.9
## - alcohol:fixed.acidity                  1  0.144 7040.0 2310.9
## - free.sulfur.dioxide:fixed.acidity      1  0.164 7040.0 2311.0
## - total.sulfur.dioxide:citric.acid       1  0.223 7040.1 2311.0
## - pH:total.sulfur.dioxide                1  0.390 7040.3 2311.1
## - pH:free.sulfur.dioxide                 1  0.453 7040.3 2311.2
## - fixed.acidity:Wine.Color              1  0.571 7040.4 2311.2
## - citric.acid:Wine.Color                1  0.674 7040.5 2311.3
## - residual.sugar:fixed.acidity          1  0.881 7040.7 2311.5
## - pH:density                           1  0.889 7040.8 2311.5
## - free.sulfur.dioxide:citric.acid       1  0.931 7040.8 2311.5
## - volatile.acidity:citric.acid          1  0.932 7040.8 2311.5
## - volatile.acidity:pH                   1  1.055 7040.9 2311.6
## - total.sulfur.dioxide:Wine.Color        1  1.291 7041.2 2311.7
## - pH:sulphates                         1  1.356 7041.2 2311.8
## - residual.sugar:density               1  1.545 7041.4 2311.9
## - total.sulfur.dioxide:density          1  1.730 7041.6 2312.1
## - pH:fixed.acidity                     1  1.877 7041.7 2312.2
## - fixed.acidity:total.sulfur.dioxide     1  1.996 7041.9 2312.2
## - residual.sugar:Wine.Color             1  2.123 7042.0 2312.3
## - volatile.acidity:free.sulfur.dioxide    1  2.325 7042.2 2312.5
## - sulphates:fixed.acidity               1  2.351 7042.2 2312.5
## - sulphates:free.sulfur.dioxide          1  2.719 7042.6 2312.7
## - alcohol:sulphates                    1  2.950 7042.8 2312.9
## - volatile.acidity:sulphates            1  3.315 7043.2 2313.2
## - alcohol:total.sulfur.dioxide          1  3.440 7043.3 2313.2
## - sulphates:citric.acid                1  3.532 7043.4 2313.3
## - free.sulfur.dioxide:density           1  3.658 7043.5 2313.4
## - alcohol:free.sulfur.dioxide           1  4.078 7043.9 2313.7
## - residual.sugar:sulphates             1  4.405 7044.3 2313.9
## - sulphates:density                   1  5.137 7045.0 2314.4
## - sulphates:Wine.Color                1  5.223 7045.1 2314.5
## - volatile.acidity:fixed.acidity        1  5.831 7045.7 2314.9
## - alcohol:pH                          1  6.093 7046.0 2315.1
## - residual.sugar:free.sulfur.dioxide     1  6.138 7046.0 2315.1
## - pH:citric.acid                     1  6.460 7046.3 2315.3
## - citric.acid:density                 1  6.495 7046.4 2315.4
## - residual.sugar:pH                   1  8.842 7048.7 2317.0
## - volatile.acidity:residual.sugar       1  8.884 7048.8 2317.0

```

```

## - alcohol:citric.acid           1     8.885 7048.8 2317.0
## - alcohol:density                1     9.346 7049.2 2317.3
## - fixed.acidity:citric.acid     1    11.202 7051.1 2318.6
## <none>                           7039.9 2319.3
## - volatile.acidity:density      1    12.385 7052.3 2319.5
## - density:Wine.Color             2    24.784 7064.7 2319.6
## - free.sulfur.dioxide:Wine.Color 1    13.039 7052.9 2319.9
## - residual.sugar:total.sulfur.dioxide 1    13.375 7053.2 2320.2
## - residual.sugar:alcohol          1    13.851 7053.7 2320.5
## - residual.sugar:citric.acid      1    16.577 7056.4 2322.4
## - sulphates:total.sulfur.dioxide 1    21.656 7061.5 2325.9
## - pH:Wine.Color                  1    26.042 7065.9 2328.9
## - volatile.acidity:alcohol        1    41.280 7081.1 2339.5
## - free.sulfur.dioxide:total.sulfur.dioxide 1    49.308 7089.2 2345.1
##
## Step: AIC=2310.86
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##          sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##          citric.acid + density:Wine.Color + volatile.acidity:Wine.Color +
##          residual.sugar:Wine.Color + pH:Wine.Color + sulphates:Wine.Color +
##          free.sulfur.dioxide:Wine.Color + fixed.acidity:Wine.Color +
##          total.sulfur.dioxide:Wine.Color + citric.acid:Wine.Color +
##          total.sulfur.dioxide:citric.acid + fixed.acidity:citric.acid +
##          free.sulfur.dioxide:citric.acid + sulphates:citric.acid +
##          pH:citric.acid + alcohol:citric.acid + residual.sugar:citric.acid +
##          volatile.acidity:citric.acid + citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##          total.sulfur.dioxide:density + pH:total.sulfur.dioxide +
##          alcohol:total.sulfur.dioxide + residual.sugar:total.sulfur.dioxide +
##          free.sulfur.dioxide:fixed.acidity + sulphates:fixed.acidity +
##          pH:fixed.acidity + alcohol:fixed.acidity + residual.sugar:fixed.acidity +
##          volatile.acidity:fixed.acidity + sulphates:free.sulfur.dioxide +
##          pH:free.sulfur.dioxide + alcohol:free.sulfur.dioxide + residual.sugar:free.sulfur.dioxide +
##          volatile.acidity:free.sulfur.dioxide + free.sulfur.dioxide:density +
##          pH:sulphates + alcohol:sulphates + residual.sugar:sulphates +
##          volatile.acidity:sulphates + sulphates:density + alcohol:pH +
##          residual.sugar:pH + volatile.acidity:pH + pH:density + residual.sugar:alcohol +
##          volatile.acidity:alcohol + alcohol:density + volatile.acidity:residual.sugar +
##          residual.sugar:density + volatile.acidity:density
##
##                                         Df Sum of Sq   RSS   AIC
## - volatile.acidity:Wine.Color      1    0.020 7039.9 2302.4
## - alcohol:fixed.acidity            1    0.143 7040.0 2302.5
## - free.sulfur.dioxide:fixed.acidity 1    0.165 7040.1 2302.5
## - total.sulfur.dioxide:citric.acid 1    0.201 7040.1 2302.5
## - pH:total.sulfur.dioxide          1    0.376 7040.3 2302.6
## - pH:free.sulfur.dioxide           1    0.445 7040.3 2302.7
## - fixed.acidity:Wine.Color          1    0.591 7040.5 2302.8
## - citric.acid:Wine.Color            1    0.719 7040.6 2302.9
## - pH:density                       1    0.881 7040.8 2303.0
## - residual.sugar:fixed.acidity       1    0.893 7040.8 2303.0
## - volatile.acidity:citric.acid       1    0.948 7040.8 2303.0
## - free.sulfur.dioxide:citric.acid     1    0.980 7040.9 2303.1
## - volatile.acidity:pH                 1    1.040 7040.9 2303.1

```

```

## - total.sulfur.dioxide:Wine.Color      1    1.335 7041.2 2303.3
## - pH:sulphates                        1    1.347 7041.2 2303.3
## - residual.sugar:density              1    1.684 7041.6 2303.5
## - total.sulfur.dioxide:density        1    1.725 7041.6 2303.6
## - pH:fixed.acidity                   1    1.862 7041.8 2303.7
## - fixed.acidity:total.sulfur.dioxide 1    1.980 7041.9 2303.7
## - residual.sugar:Wine.Color          1    2.101 7042.0 2303.8
## - sulphates:fixed.acidity           1    2.352 7042.2 2304.0
## - sulphates:free.sulfur.dioxide     1    2.732 7042.6 2304.3
## - alcohol:sulphates                 1    2.952 7042.8 2304.4
## - volatile.acidity:sulphates        1    3.294 7043.2 2304.7
## - alcohol:total.sulfur.dioxide      1    3.429 7043.3 2304.8
## - sulphates:citric.acid            1    3.518 7043.4 2304.8
## - free.sulfur.dioxide:density       1    3.645 7043.5 2304.9
## - volatile.acidity:free.sulfur.dioxide 1    3.833 7043.7 2305.0
## - alcohol:free.sulfur.dioxide       1    4.070 7044.0 2305.2
## - residual.sugar:sulphates          1    4.402 7044.3 2305.4
## - sulphates:density                 1    5.134 7045.0 2305.9
## - sulphates:Wine.Color              1    5.261 7045.2 2306.0
## - volatile.acidity:fixed.acidity    1    5.980 7045.9 2306.5
## - alcohol:pH                         1    6.079 7046.0 2306.6
## - residual.sugar:free.sulfur.dioxide 1    6.116 7046.0 2306.6
## - pH:citric.acid                   1    6.452 7046.3 2306.8
## - citric.acid:density               1    6.538 7046.4 2306.9
## - residual.sugar:pH                  1    8.820 7048.7 2308.5
## - alcohol:citric.acid               1    8.896 7048.8 2308.6
## - volatile.acidity:residual.sugar   1    9.042 7048.9 2308.7
## - alcohol:density                   1    9.357 7049.2 2308.9
## - fixed.acidity:citric.acid         1    11.251 7051.1 2310.2
## <none>                                7039.9 2310.9
## - density:Wine.Color                2    24.771 7064.7 2311.1
## - volatile.acidity:density          1    13.171 7053.1 2311.5
## - residual.sugar:total.sulfur.dioxide 1    13.657 7053.5 2311.9
## - residual.sugar:alcohol             1    13.960 7053.8 2312.1
## - free.sulfur.dioxide:Wine.Color    1    14.165 7054.1 2312.2
## - residual.sugar:citric.acid        1    16.600 7056.5 2313.9
## - sulphates:total.sulfur.dioxide    1    21.805 7061.7 2317.5
## - pH:Wine.Color                      1    26.049 7065.9 2320.5
## - volatile.acidity:alcohol           1    41.305 7081.2 2331.0
## - free.sulfur.dioxide:total.sulfur.dioxide 1    50.143 7090.0 2337.1
##
## Step: AIC=2302.38
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##          sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##          citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
##          pH:Wine.Color + sulphates:Wine.Color + free.sulfur.dioxide:Wine.Color +
##          fixed.acidity:Wine.Color + total.sulfur.dioxide:Wine.Color +
##          citric.acid:Wine.Color + total.sulfur.dioxide:citric.acid +
##          fixed.acidity:citric.acid + free.sulfur.dioxide:citric.acid +
##          sulphates:citric.acid + pH:citric.acid + alcohol:citric.acid +
##          residual.sugar:citric.acid + volatile.acidity:citric.acid +
##          citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##          total.sulfur.dioxide:density + pH:total.sulfur.dioxide +

```

```

## alcohol:total.sulfur.dioxide + residual.sugar:total.sulfur.dioxide +
## free.sulfur.dioxide:fixed.acidity + sulphates:fixed.acidity +
## pH:fixed.acidity + alcohol:fixed.acidity + residual.sugar:fixed.acidity +
## volatile.acidity:fixed.acidity + sulphates:free.sulfur.dioxide +
## pH:free.sulfur.dioxide + alcohol:free.sulfur.dioxide + residual.sugar:free.sulfur.dioxide +
## volatile.acidity:free.sulfur.dioxide + free.sulfur.dioxide:density +
## pH:sulphates + alcohol:sulphates + residual.sugar:sulphates +
## volatile.acidity:sulphates + sulphates:density + alcohol:pH +
## residual.sugar:pH + volatile.acidity:pH + pH:density + residual.sugar:alcohol +
## volatile.acidity:alcohol + alcohol:density + volatile.acidity:residual.sugar +
## residual.sugar:density + volatile.acidity:density
##
##                                     Df Sum of Sq   RSS   AIC
## - alcohol:fixed.acidity           1  0.142 7040.1 2294.0
## - free.sulfur.dioxide:fixed.acidity 1  0.176 7040.1 2294.0
## - total.sulfur.dioxide:citric.acid 1  0.198 7040.1 2294.0
## - pH:total.sulfur.dioxide         1  0.378 7040.3 2294.1
## - pH:free.sulfur.dioxide          1  0.460 7040.4 2294.2
## - fixed.acidity:Wine.Color        1  0.572 7040.5 2294.3
## - citric.acid:Wine.Color          1  0.856 7040.8 2294.5
## - pH:density                      1  0.877 7040.8 2294.5
## - residual.sugar:fixed.acidity    1  0.903 7040.8 2294.5
## - volatile.acidity:citric.acid    1  0.930 7040.8 2294.5
## - free.sulfur.dioxide:citric.acid 1  0.965 7040.9 2294.6
## - volatile.acidity:pH              1  1.064 7041.0 2294.6
## - total.sulfur.dioxide:Wine.Color 1  1.316 7041.2 2294.8
## - pH:sulphates                    1  1.334 7041.2 2294.8
## - total.sulfur.dioxide:density    1  1.745 7041.7 2295.1
## - residual.sugar:density          1  1.787 7041.7 2295.1
## - pH:fixed.acidity                1  1.878 7041.8 2295.2
## - fixed.acidity:total.sulfur.dioxide 1  1.973 7041.9 2295.2
## - residual.sugar:Wine.Color        1  2.153 7042.1 2295.4
## - sulphates:fixed.acidity          1  2.333 7042.2 2295.5
## - sulphates:free.sulfur.dioxide    1  2.717 7042.6 2295.8
## - alcohol:sulphates               1  2.946 7042.9 2295.9
## - volatile.acidity:sulphates       1  3.287 7043.2 2296.2
## - alcohol:total.sulfur.dioxide     1  3.459 7043.4 2296.3
## - sulphates:citric.acid           1  3.502 7043.4 2296.3
## - volatile.acidity:free.sulfur.dioxide 1  3.878 7043.8 2296.6
## - free.sulfur.dioxide:density      1  3.902 7043.8 2296.6
## - alcohol:free.sulfur.dioxide      1  4.236 7044.1 2296.8
## - residual.sugar:sulphates         1  4.383 7044.3 2296.9
## - sulphates:density                1  5.140 7045.0 2297.5
## - sulphates:Wine.Color             1  5.252 7045.2 2297.5
## - volatile.acidity:fixed.acidity   1  6.004 7045.9 2298.1
## - alcohol:pH                       1  6.068 7046.0 2298.1
## - pH:citric.acid                  1  6.456 7046.4 2298.4
## - residual.sugar:free.sulfur.dioxide 1  6.476 7046.4 2298.4
## - citric.acid:density              1  6.889 7046.8 2298.7
## - residual.sugar:pH                 1  8.850 7048.8 2300.0
## - alcohol:citric.acid              1  9.080 7049.0 2300.2
## - alcohol:density                  1  9.337 7049.2 2300.4
## - fixed.acidity:citric.acid        1 11.316 7051.2 2301.8
## <none>                                7039.9 2302.4

```

```

## - volatile.acidity:residual.sugar           1  12.494 7052.4 2302.6
## - residual.sugar:total.sulfur.dioxide     1  13.741 7053.7 2303.4
## - residual.sugar:alcohol                  1  13.943 7053.9 2303.6
## - density:Wine.Color                     2  26.380 7066.3 2303.7
## - free.sulfur.dioxide:Wine.Color          1  14.689 7054.6 2304.1
## - residual.sugar:citric.acid             1  17.443 7057.4 2306.0
## - volatile.acidity:density               1  17.810 7057.7 2306.3
## - sulphates:total.sulfur.dioxide         1  21.797 7061.7 2309.0
## - pH:Wine.Color                          1  26.506 7066.4 2312.3
## - volatile.acidity:alcohol                1  45.837 7085.7 2325.7
## - free.sulfur.dioxide:total.sulfur.dioxide 1  50.324 7090.2 2328.8
##
## Step: AIC=2293.98
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##          sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##          citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
##          pH:Wine.Color + sulphates:Wine.Color + free.sulfur.dioxide:Wine.Color +
##          fixed.acidity:Wine.Color + total.sulfur.dioxide:Wine.Color +
##          citric.acid:Wine.Color + total.sulfur.dioxide:citric.acid +
##          fixed.acidity:citric.acid + free.sulfur.dioxide:citric.acid +
##          sulphates:citric.acid + pH:citric.acid + alcohol:citric.acid +
##          residual.sugar:citric.acid + volatile.acidity:citric.acid +
##          citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##          total.sulfur.dioxide:density + pH:total.sulfur.dioxide +
##          alcohol:total.sulfur.dioxide + residual.sugar:total.sulfur.dioxide +
##          free.sulfur.dioxide:fixed.acidity + sulphates:fixed.acidity +
##          pH:fixed.acidity + residual.sugar:fixed.acidity + volatile.acidity:fixed.acidity +
##          sulphates:free.sulfur.dioxide + pH:free.sulfur.dioxide +
##          alcohol:free.sulfur.dioxide + residual.sugar:free.sulfur.dioxide +
##          volatile.acidity:free.sulfur.dioxide + free.sulfur.dioxide:density +
##          pH:sulphates + alcohol:sulphates + residual.sugar:sulphates +
##          volatile.acidity:sulphates + sulphates:density + alcohol:pH +
##          residual.sugar:pH + volatile.acidity:pH + pH:density + residual.sugar:alcohol +
##          volatile.acidity:alcohol + alcohol:density + volatile.acidity:residual.sugar +
##          residual.sugar:density + volatile.acidity:density
##
##                                     Df Sum of Sq   RSS   AIC
## - free.sulfur.dioxide:fixed.acidity      1  0.166 7040.2 2285.6
## - total.sulfur.dioxide:citric.acid      1  0.214 7040.3 2285.6
## - pH:total.sulfur.dioxide                1  0.336 7040.4 2285.7
## - pH:free.sulfur.dioxide                 1  0.443 7040.5 2285.8
## - fixed.acidity:Wine.Color              1  0.485 7040.5 2285.8
## - citric.acid:Wine.Color                1  0.832 7040.9 2286.1
## - pH:density                           1  0.870 7040.9 2286.1
## - residual.sugar:fixed.acidity          1  0.888 7040.9 2286.1
## - volatile.acidity:citric.acid          1  0.922 7041.0 2286.1
## - free.sulfur.dioxide:citric.acid       1  1.020 7041.1 2286.2
## - volatile.acidity:pH                   1  1.074 7041.1 2286.2
## - total.sulfur.dioxide:Wine.Color        1  1.291 7041.3 2286.4
## - pH:sulphates                         1  1.328 7041.4 2286.4
## - total.sulfur.dioxide:density          1  1.721 7041.8 2286.7
## - residual.sugar:density                1  1.798 7041.8 2286.7
## - fixed.acidity:total.sulfur.dioxide    1  1.859 7041.9 2286.8

```

```

## - pH:fixed.acidity 1 2.017 7042.1 2286.9
## - residual.sugar:Wine.Color 1 2.127 7042.2 2287.0
## - sulphates:fixed.acidity 1 2.273 7042.3 2287.1
## - sulphates:free.sulfur.dioxide 1 2.686 7042.7 2287.3
## - alcohol:sulphates 1 3.088 7043.1 2287.6
## - volatile.acidity:sulphates 1 3.232 7043.3 2287.7
## - sulphates:citric.acid 1 3.518 7043.6 2287.9
## - alcohol:total.sulfur.dioxide 1 3.589 7043.6 2288.0
## - free.sulfur.dioxide:density 1 3.894 7043.9 2288.2
## - volatile.acidity:free.sulfur.dioxide 1 3.980 7044.0 2288.2
## - alcohol:free.sulfur.dioxide 1 4.235 7044.3 2288.4
## - residual.sugar:sulphates 1 4.348 7044.4 2288.5
## - sulphates:density 1 5.158 7045.2 2289.1
## - sulphates:Wine.Color 1 5.253 7045.3 2289.1
## - volatile.acidity:fixed.acidity 1 5.889 7045.9 2289.6
## - alcohol:pH 1 6.174 7046.2 2289.8
## - residual.sugar:free.sulfur.dioxide 1 6.471 7046.5 2290.0
## - pH:citric.acid 1 6.759 7046.8 2290.2
## - citric.acid:density 1 6.934 7047.0 2290.3
## - residual.sugar:pH 1 8.976 7049.0 2291.7
## - alcohol:citric.acid 1 10.153 7050.2 2292.5
## - fixed.acidity:citric.acid 1 11.295 7051.3 2293.3
## <none> 7040.1 2294.0
## - volatile.acidity:residual.sugar 1 12.419 7052.5 2294.1
## - alcohol:density 1 12.503 7052.6 2294.2
## - residual.sugar:total.sulfur.dioxide 1 13.625 7053.7 2295.0
## - free.sulfur.dioxide:Wine.Color 1 14.827 7054.9 2295.8
## - density:Wine.Color 2 27.134 7067.2 2295.8
## - residual.sugar:alcohol 1 15.196 7055.2 2296.1
## - residual.sugar:citric.acid 1 17.473 7057.5 2297.6
## - volatile.acidity:density 1 17.685 7057.7 2297.8
## - sulphates:total.sulfur.dioxide 1 21.771 7061.8 2300.6
## - pH:Wine.Color 1 27.052 7067.1 2304.3
## - volatile.acidity:alcohol 1 45.911 7086.0 2317.3
## - free.sulfur.dioxide:total.sulfur.dioxide 1 50.834 7090.9 2320.7
##
## Step: AIC=2285.6
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##      sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##      citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
##      pH:Wine.Color + sulphates:Wine.Color + free.sulfur.dioxide:Wine.Color +
##      fixed.acidity:Wine.Color + total.sulfur.dioxide:Wine.Color +
##      citric.acid:Wine.Color + total.sulfur.dioxide:citric.acid +
##      fixed.acidity:citric.acid + free.sulfur.dioxide:citric.acid +
##      sulphates:citric.acid + pH:citric.acid + alcohol:citric.acid +
##      residual.sugar:citric.acid + volatile.acidity:citric.acid +
##      citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##      free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##      total.sulfur.dioxide:density + pH:total.sulfur.dioxide +
##      alcohol:total.sulfur.dioxide + residual.sugar:total.sulfur.dioxide +
##      sulphates:fixed.acidity + pH:fixed.acidity + residual.sugar:fixed.acidity +
##      volatile.acidity:fixed.acidity + sulphates:free.sulfur.dioxide +
##      pH:free.sulfur.dioxide + alcohol:free.sulfur.dioxide + residual.sugar:free.sulfur.dioxide +
##      volatile.acidity:free.sulfur.dioxide + free.sulfur.dioxide:density +

```

```

## pH:sulphates + alcohol:sulphates + residual.sugar:sulphates +
## volatile.acidity:sulphates + sulphates:density + alcohol:pH +
## residual.sugar:pH + volatile.acidity:pH + pH:density + residual.sugar:alcohol +
## volatile.acidity:alcohol + alcohol:density + volatile.acidity:residual.sugar +
## residual.sugar:density + volatile.acidity:density
##
##                                     Df Sum of Sq    RSS     AIC
## - pH:total.sulfur.dioxide      1   0.209 7040.4 2277.2
## - total.sulfur.dioxide:citric.acid 1   0.265 7040.5 2277.3
## - pH:free.sulfur.dioxide       1   0.281 7040.5 2277.3
## - fixed.acidity:Wine.Color     1   0.423 7040.6 2277.4
## - citric.acid:Wine.Color       1   0.778 7041.0 2277.6
## - pH:density                   1   0.839 7041.1 2277.7
## - volatile.acidity:citric.acid 1   0.863 7041.1 2277.7
## - residual.sugar:fixed.acidity 1   0.882 7041.1 2277.7
## - free.sulfur.dioxide:citric.acid 1   0.930 7041.1 2277.8
## - volatile.acidity:pH          1   1.116 7041.3 2277.9
## - pH:sulphates                 1   1.353 7041.6 2278.0
## - total.sulfur.dioxide:Wine.Color 1   1.381 7041.6 2278.1
## - total.sulfur.dioxide:density   1   1.666 7041.9 2278.3
## - pH:fixed.acidity              1   2.057 7042.3 2278.5
## - fixed.acidity:total.sulfur.dioxide 1   2.108 7042.3 2278.6
## - residual.sugar:Wine.Color      1   2.118 7042.3 2278.6
## - residual.sugar:density         1   2.122 7042.3 2278.6
## - sulphates:fixed.acidity        1   2.234 7042.5 2278.7
## - alcohol:sulphates              1   3.036 7043.3 2279.2
## - sulphates:free.sulfur.dioxide 1   3.052 7043.3 2279.2
## - volatile.acidity:sulphates      1   3.203 7043.4 2279.3
## - sulphates:citric.acid          1   3.488 7043.7 2279.5
## - alcohol:total.sulfur.dioxide    1   3.676 7043.9 2279.7
## - volatile.acidity:free.sulfur.dioxide 1   4.182 7044.4 2280.0
## - residual.sugar:sulphates        1   4.297 7044.5 2280.1
## - sulphates:density               1   5.102 7045.3 2280.7
## - sulphates:Wine.Color            1   5.238 7045.5 2280.8
## - alcohol:free.sulfur.dioxide      1   5.541 7045.8 2281.0
## - volatile.acidity:fixed.acidity   1   5.727 7045.9 2281.1
## - alcohol:pH                      1   6.116 7046.3 2281.4
## - free.sulfur.dioxide:density      1   6.236 7046.5 2281.4
## - pH:citric.acid                  1   6.726 7046.9 2281.8
## - citric.acid:density              1   6.778 7047.0 2281.8
## - residual.sugar:pH                1   8.948 7049.2 2283.3
## - residual.sugar:free.sulfur.dioxide 1   9.927 7050.1 2284.0
## - alcohol:citric.acid              1   10.007 7050.2 2284.1
## - fixed.acidity:citric.acid        1   11.130 7051.3 2284.8
## <none>                                7040.2 2285.6
## - volatile.acidity:residual.sugar 1   12.288 7052.5 2285.7
## - alcohol:density                  1   12.553 7052.8 2285.8
## - free.sulfur.dioxide:Wine.Color    1   14.692 7054.9 2287.3
## - density:Wine.Color                2   27.235 7067.5 2287.5
## - residual.sugar:alcohol             1   15.077 7055.3 2287.6
## - residual.sugar:total.sulfur.dioxide 1   15.407 7055.6 2287.8
## - residual.sugar:citric.acid        1   17.311 7057.5 2289.1
## - volatile.acidity:density           1   17.521 7057.7 2289.3
## - sulphates:total.sulfur.dioxide    1   22.490 7062.7 2292.7

```

```

## - pH:Wine.Color           1  27.040 7067.3 2295.9
## - volatile.acidity:alcohol 1  45.765 7086.0 2308.8
## - free.sulfur.dioxide:total.sulfur.dioxide 1  50.833 7091.1 2312.3
##
## Step: AIC=2277.25
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##          sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##          citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
##          pH:Wine.Color + sulphates:Wine.Color + free.sulfur.dioxide:Wine.Color +
##          fixed.acidity:Wine.Color + total.sulfur.dioxide:Wine.Color +
##          citric.acid:Wine.Color + total.sulfur.dioxide:citric.acid +
##          fixed.acidity:citric.acid + free.sulfur.dioxide:citric.acid +
##          sulphates:citric.acid + pH:citric.acid + alcohol:citric.acid +
##          residual.sugar:citric.acid + volatile.acidity:citric.acid +
##          citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##          total.sulfur.dioxide:density + alcohol:total.sulfur.dioxide +
##          residual.sugar:total.sulfur.dioxide + sulphates:fixed.acidity +
##          pH:fixed.acidity + residual.sugar:fixed.acidity + volatile.acidity:fixed.acidity +
##          sulphates:free.sulfur.dioxide + pH:free.sulfur.dioxide +
##          alcohol:free.sulfur.dioxide + residual.sugar:free.sulfur.dioxide +
##          volatile.acidity:free.sulfur.dioxide + free.sulfur.dioxide:density +
##          pH:sulphates + alcohol:sulphates + residual.sugar:sulphates +
##          volatile.acidity:sulphates + sulphates:density + alcohol:pH +
##          residual.sugar:pH + volatile.acidity:pH + pH:density + residual.sugar:alcohol +
##          volatile.acidity:alcohol + alcohol:density + volatile.acidity:residual.sugar +
##          residual.sugar:density + volatile.acidity:density
##
##                                     Df Sum of Sq   RSS   AIC
## - pH:free.sulfur.dioxide      1  0.127 7040.6 2268.8
## - total.sulfur.dioxide:citric.acid 1  0.178 7040.6 2268.9
## - fixed.acidity:Wine.Color     1  0.332 7040.8 2269.0
## - citric.acid:Wine.Color      1  0.880 7041.3 2269.4
## - volatile.acidity:citric.acid 1  0.883 7041.3 2269.4
## - residual.sugar:fixed.acidity 1  0.941 7041.4 2269.4
## - pH:density                  1  1.096 7041.5 2269.5
## - free.sulfur.dioxide:citric.acid 1  1.096 7041.5 2269.5
## - volatile.acidity:pH          1  1.307 7041.7 2269.7
## - pH:sulphates                1  1.310 7041.7 2269.7
## - total.sulfur.dioxide:Wine.Color 1  1.453 7041.9 2269.8
## - total.sulfur.dioxide:density 1  1.470 7041.9 2269.8
## - pH:fixed.acidity             1  1.899 7042.3 2270.1
## - fixed.acidity:total.sulfur.dioxide 1  1.971 7042.4 2270.1
## - residual.sugar:Wine.Color     1  2.024 7042.5 2270.2
## - sulphates:fixed.acidity       1  2.260 7042.7 2270.3
## - residual.sugar:density        1  2.435 7042.9 2270.4
## - sulphates:free.sulfur.dioxide 1  3.068 7043.5 2270.9
## - alcohol:sulphates            1  3.071 7043.5 2270.9
## - volatile.acidity:sulphates    1  3.232 7043.7 2271.0
## - sulphates:citric.acid         1  3.424 7043.9 2271.1
## - alcohol:total.sulfur.dioxide 1  3.514 7043.9 2271.2
## - volatile.acidity:free.sulfur.dioxide 1  4.203 7044.6 2271.7
## - residual.sugar:sulphates       1  4.267 7044.7 2271.7
## - sulphates:density             1  5.126 7045.6 2272.3

```

```

## - sulphates:Wine.Color           1   5.246 7045.7 2272.4
## - alcohol:free.sulfur.dioxide    1   5.406 7045.8 2272.5
## - volatile.acidity:fixed.acidity 1   5.609 7046.0 2272.7
## - free.sulfur.dioxide:density    1   6.068 7046.5 2273.0
## - alcohol:pH                     1   6.228 7046.7 2273.1
## - pH:citric.acid                1   6.537 7047.0 2273.3
## - citric.acid:density            1   6.738 7047.2 2273.4
## - residual.sugar:pH               1   9.146 7049.6 2275.1
## - residual.sugar:free.sulfur.dioxide 1   9.718 7050.1 2275.5
## - alcohol:citric.acid             1   9.875 7050.3 2275.6
## - fixed.acidity:citric.acid      1   11.013 7051.4 2276.4
## - volatile.acidity:residual.sugar 1   12.153 7052.6 2277.2
## <none>                           7040.4 2277.2
## - alcohol:density                 1   12.417 7052.8 2277.4
## - free.sulfur.dioxide:Wine.Color   1   14.633 7055.1 2278.9
## - residual.sugar:alcohol            1   14.869 7055.3 2279.1
## - residual.sugar:citric.acid       1   17.194 7057.6 2280.7
## - volatile.acidity:density          1   17.407 7057.8 2280.8
## - residual.sugar:total.sulfur.dioxide 1   17.525 7058.0 2280.9
## - sulphates:total.sulfur.dioxide   1   22.682 7063.1 2284.5
## - density:Wine.Color                2   38.851 7079.3 2287.2
## - pH:Wine.Color                      1   39.219 7079.6 2296.0
## - volatile.acidity:alcohol            1   45.642 7086.1 2300.4
## - free.sulfur.dioxide:total.sulfur.dioxide 1   50.924 7091.4 2304.1
##
## Step: AIC=2268.84
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##          sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##          citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
##          pH:Wine.Color + sulphates:Wine.Color + free.sulfur.dioxide:Wine.Color +
##          fixed.acidity:Wine.Color + total.sulfur.dioxide:Wine.Color +
##          citric.acid:Wine.Color + total.sulfur.dioxide:citric.acid +
##          fixed.acidity:citric.acid + free.sulfur.dioxide:citric.acid +
##          sulphates:citric.acid + pH:citric.acid + alcohol:citric.acid +
##          residual.sugar:citric.acid + volatile.acidity:citric.acid +
##          citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##          total.sulfur.dioxide:density + alcohol:total.sulfur.dioxide +
##          residual.sugar:total.sulfur.dioxide + sulphates:fixed.acidity +
##          pH:fixed.acidity + residual.sugar:fixed.acidity + volatile.acidity:fixed.acidity +
##          sulphates:free.sulfur.dioxide + alcohol:free.sulfur.dioxide +
##          residual.sugar:free.sulfur.dioxide + volatile.acidity:free.sulfur.dioxide +
##          free.sulfur.dioxide:density + pH:sulphates + alcohol:sulphates +
##          residual.sugar:sulphates + volatile.acidity:sulphates + sulphates:density +
##          alcohol:pH + residual.sugar:pH + volatile.acidity:pH + pH:density +
##          residual.sugar:alcohol + volatile.acidity:alcohol + alcohol:density +
##          volatile.acidity:residual.sugar + residual.sugar:density +
##          volatile.acidity:density
##
##                                     Df Sum of Sq   RSS   AIC
## - total.sulfur.dioxide:citric.acid 1   0.164 7040.7 2260.5
## - fixed.acidity:Wine.Color           1   0.400 7041.0 2260.6
## - citric.acid:Wine.Color              1   0.856 7041.4 2260.9
## - volatile.acidity:citric.acid      1   0.896 7041.4 2261.0

```

```

## - residual.sugar:fixed.acidity          1  0.902 7041.5 2261.0
## - pH:density                          1  1.107 7041.7 2261.1
## - pH:sulphates                        1  1.274 7041.8 2261.2
## - free.sulfur.dioxide:citric.acid    1  1.390 7041.9 2261.3
## - volatile.acidity:pH                 1  1.393 7041.9 2261.3
## - total.sulfur.dioxide:density       1  1.474 7042.0 2261.4
## - total.sulfur.dioxide:Wine.Color    1  1.547 7042.1 2261.4
## - pH:fixed.acidity                   1  1.935 7042.5 2261.7
## - residual.sugar:Wine.Color          1  2.087 7042.6 2261.8
## - sulphates:fixed.acidity           1  2.247 7042.8 2261.9
## - residual.sugar:density            1  2.414 7043.0 2262.0
## - fixed.acidity:total.sulfur.dioxide 1  2.566 7043.1 2262.1
## - sulphates:free.sulfur.dioxide     1  2.998 7043.6 2262.4
## - alcohol:sulphates                1  3.019 7043.6 2262.4
## - volatile.acidity:sulphates        1  3.238 7043.8 2262.6
## - sulphates:citric.acid            1  3.440 7044.0 2262.7
## - alcohol:total.sulfur.dioxide      1  3.490 7044.0 2262.8
## - residual.sugar:sulphates          1  4.207 7044.8 2263.3
## - volatile.acidity:free.sulfur.dioxide 1  4.270 7044.8 2263.3
## - sulphates:density                1  5.067 7045.6 2263.9
## - sulphates:Wine.Color             1  5.191 7045.7 2263.9
## - alcohol:free.sulfur.dioxide       1  5.383 7045.9 2264.1
## - volatile.acidity:fixed.acidity    1  5.590 7046.1 2264.2
## - free.sulfur.dioxide:density       1  6.084 7046.6 2264.6
## - alcohol:pH                      1  6.326 7046.9 2264.7
## - pH:citric.acid                  1  6.734 7047.3 2265.0
## - citric.acid:density              1  6.772 7047.3 2265.1
## - residual.sugar:pH                1  9.653 7050.2 2267.1
## - alcohol:citric.acid              1  9.989 7050.5 2267.3
## - residual.sugar:free.sulfur.dioxide 1 10.016 7050.6 2267.3
## - fixed.acidity:citric.acid        1 11.125 7051.7 2268.1
## - volatile.acidity:residual.sugar   1 12.058 7052.6 2268.7
## <none>                                7040.6 2268.8
## - alcohol:density                  1 12.474 7053.0 2269.0
## - free.sulfur.dioxide:Wine.Color    1 14.523 7055.1 2270.4
## - residual.sugar:alcohol            1 15.130 7055.7 2270.9
## - volatile.acidity:density          1 17.312 7057.9 2272.4
## - residual.sugar:citric.acid        1 17.329 7057.9 2272.4
## - residual.sugar:total.sulfur.dioxide 1 17.473 7058.0 2272.5
## - sulphates:total.sulfur.dioxide    1 22.582 7063.1 2276.0
## - density:Wine.Color                2 38.865 7079.4 2278.8
## - pH:Wine.Color                     1 39.127 7079.7 2287.5
## - volatile.acidity:alcohol           1 45.518 7086.1 2291.9
## - free.sulfur.dioxide:total.sulfur.dioxide 1 51.184 7091.7 2295.8
##
## Step: AIC=2260.46
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##          sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##          citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
##          pH:Wine.Color + sulphates:Wine.Color + free.sulfur.dioxide:Wine.Color +
##          fixed.acidity:Wine.Color + total.sulfur.dioxide:Wine.Color +
##          citric.acid:Wine.Color + fixed.acidity:citric.acid + free.sulfur.dioxide:citric.acid +
##          sulphates:citric.acid + pH:citric.acid + alcohol:citric.acid +
##          residual.sugar:citric.acid + volatile.acidity:citric.acid +

```

```

## citric.acid:density + fixed.acidity:total.sulfur.dioxide +
## free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
## total.sulfur.dioxide:density + alcohol:total.sulfur.dioxide +
## residual.sugar:total.sulfur.dioxide + sulphates:fixed.acidity +
## pH:fixed.acidity + residual.sugar:fixed.acidity + volatile.acidity:fixed.acidity +
## sulphates:free.sulfur.dioxide + alcohol:free.sulfur.dioxide +
## residual.sugar:free.sulfur.dioxide + volatile.acidity:free.sulfur.dioxide +
## free.sulfur.dioxide:density + pH:sulphates + alcohol:sulphates +
## residual.sugar:sulphates + volatile.acidity:sulphates + sulphates:density +
## alcohol:pH + residual.sugar:pH + volatile.acidity:pH + pH:density +
## residual.sugar:alcohol + volatile.acidity:alcohol + alcohol:density +
## volatile.acidity:residual.sugar + residual.sugar:density +
## volatile.acidity:density
##
##                                     Df Sum of Sq    RSS     AIC
## - fixed.acidity:Wine.Color      1   0.480 7041.2 2252.3
## - residual.sugar:fixed.acidity  1   0.812 7041.5 2252.5
## - volatile.acidity:citric.acid 1   0.950 7041.7 2252.6
## - pH:density                   1   1.128 7041.8 2252.7
## - pH:sulphates                1   1.261 7042.0 2252.8
## - volatile.acidity:pH          1   1.414 7042.1 2252.9
## - total.sulfur.dioxide:density 1   1.561 7042.3 2253.0
## - total.sulfur.dioxide:Wine.Color 1   1.679 7042.4 2253.1
## - citric.acid:Wine.Color       1   1.812 7042.5 2253.2
## - pH:fixed.acidity             1   1.876 7042.6 2253.3
## - sulphates:fixed.acidity      1   2.230 7042.9 2253.5
## - residual.sugar:Wine.Color    1   2.280 7043.0 2253.5
## - residual.sugar:density       1   2.469 7043.2 2253.7
## - free.sulfur.dioxide:citric.acid 1   2.771 7043.5 2253.9
## - sulphates:free.sulfur.dioxide 1   2.947 7043.7 2254.0
## - alcohol:sulphates            1   2.978 7043.7 2254.0
## - volatile.acidity:sulphates   1   3.174 7043.9 2254.2
## - fixed.acidity:total.sulfur.dioxide 1   3.253 7044.0 2254.2
## - sulphates:citric.acid        1   3.297 7044.0 2254.2
## - alcohol:total.sulfur.dioxide 1   3.528 7044.2 2254.4
## - residual.sugar:sulphates     1   4.168 7044.9 2254.9
## - volatile.acidity:free.sulfur.dioxide 1   4.265 7045.0 2254.9
## - sulphates:density            1   5.001 7045.7 2255.4
## - sulphates:Wine.Color         1   5.127 7045.8 2255.5
## - alcohol:free.sulfur.dioxide 1   5.428 7046.1 2255.7
## - volatile.acidity:fixed.acidity 1   5.637 7046.4 2255.9
## - free.sulfur.dioxide:density 1   6.036 7046.8 2256.2
## - alcohol:pH                  1   6.252 7047.0 2256.3
## - pH:citric.acid              1   6.600 7047.3 2256.6
## - citric.acid:density          1   6.929 7047.6 2256.8
## - residual.sugar:pH            1   9.829 7050.5 2258.8
## - alcohol:citric.acid          1   9.930 7050.6 2258.9
## - residual.sugar:free.sulfur.dioxide 1   10.062 7050.8 2259.0
## - fixed.acidity:citric.acid    1   11.181 7051.9 2259.7
## - volatile.acidity:residual.sugar 1   12.062 7052.8 2260.3
## <none>                           7040.7 2260.5
## - alcohol:density              1   12.361 7053.1 2260.6
## - free.sulfur.dioxide:Wine.Color 1   14.360 7055.1 2261.9
## - residual.sugar:alcohol        1   15.028 7055.7 2262.4

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```

## - residual.sugar:citric.acid           1  17.169 7057.9 2263.9
## - volatile.acidity:density            1  17.290 7058.0 2264.0
## - residual.sugar:total.sulfur.dioxide 1  18.189 7058.9 2264.6
## - sulphates:total.sulfur.dioxide      1  22.427 7063.1 2267.5
## - density:Wine.Color                  2  39.187 7079.9 2270.7
## - pH:Wine.Color                       1  39.466 7080.2 2279.3
## - volatile.acidity:alcohol             1  45.611 7086.3 2283.6
## - free.sulfur.dioxide:total.sulfur.dioxide 1  51.270 7092.0 2287.5
##
## Step: AIC=2252.29
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##          sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##          citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
##          pH:Wine.Color + sulphates:Wine.Color + free.sulfur.dioxide:Wine.Color +
##          total.sulfur.dioxide:Wine.Color + citric.acid:Wine.Color +
##          fixed.acidity:citric.acid + free.sulfur.dioxide:citric.acid +
##          sulphates:citric.acid + pH:citric.acid + alcohol:citric.acid +
##          residual.sugar:citric.acid + volatile.acidity:citric.acid +
##          citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##          total.sulfur.dioxide:density + alcohol:total.sulfur.dioxide +
##          residual.sugar:total.sulfur.dioxide + sulphates:fixed.acidity +
##          pH:fixed.acidity + residual.sugar:fixed.acidity + volatile.acidity:fixed.acidity +
##          sulphates:free.sulfur.dioxide + alcohol:free.sulfur.dioxide +
##          residual.sugar:free.sulfur.dioxide + volatile.acidity:free.sulfur.dioxide +
##          free.sulfur.dioxide:density + pH:sulphates + alcohol:sulphates +
##          residual.sugar:sulphates + volatile.acidity:sulphates + sulphates:density +
##          alcohol:pH + residual.sugar:pH + volatile.acidity:pH + pH:density +
##          residual.sugar:alcohol + volatile.acidity:alcohol + alcohol:density +
##          volatile.acidity:residual.sugar + residual.sugar:density +
##          volatile.acidity:density
##
##                                     Df Sum of Sq   RSS   AIC
## - volatile.acidity:citric.acid       1  0.787 7042.0 2244.3
## - residual.sugar:fixed.acidity      1  0.875 7042.1 2244.4
## - pH:sulphates                      1  1.053 7042.3 2244.5
## - pH:density                        1  1.145 7042.3 2244.6
## - citric.acid:Wine.Color            1  1.477 7042.7 2244.8
## - total.sulfur.dioxide:Wine.Color    1  1.477 7042.7 2244.8
## - sulphates:fixed.acidity           1  1.767 7043.0 2245.0
## - volatile.acidity:pH                1  1.866 7043.1 2245.1
## - total.sulfur.dioxide:density       1  1.887 7043.1 2245.1
## - residual.sugar:Wine.Color          1  2.011 7043.2 2245.2
## - pH:fixed.acidity                   1  2.368 7043.6 2245.4
## - residual.sugar:density             1  2.378 7043.6 2245.4
## - fixed.acidity:total.sulfur.dioxide 1  2.795 7044.0 2245.7
## - alcohol:sulphates                 1  2.874 7044.1 2245.8
## - sulphates:free.sulfur.dioxide      1  2.948 7044.1 2245.8
## - free.sulfur.dioxide:citric.acid    1  3.151 7044.3 2246.0
## - volatile.acidity:sulphates          1  3.599 7044.8 2246.3
## - sulphates:citric.acid              1  3.841 7045.0 2246.5
## - residual.sugar:sulphates            1  3.944 7045.1 2246.5
## - alcohol:total.sulfur.dioxide        1  4.004 7045.2 2246.6
## - volatile.acidity:free.sulfur.dioxide 1  4.554 7045.8 2247.0

```

```

## - sulphates:density 1 4.760 7046.0 2247.1
## - sulphates:Wine.Color 1 5.008 7046.2 2247.3
## - volatile.acidity:fixed.acidity 1 5.176 7046.4 2247.4
## - alcohol:free.sulfur.dioxide 1 5.535 7046.7 2247.7
## - free.sulfur.dioxide:density 1 6.155 7047.4 2248.1
## - alcohol:pH 1 6.477 7047.7 2248.3
## - pH:citric.acid 1 6.533 7047.7 2248.3
## - citric.acid:density 1 6.810 7048.0 2248.5
## - alcohol:citric.acid 1 9.764 7051.0 2250.6
## - residual.sugar:pH 1 10.106 7051.3 2250.8
## - residual.sugar:free.sulfur.dioxide 1 10.202 7051.4 2250.9
## - fixed.acidity:citric.acid 1 10.718 7051.9 2251.2
## - volatile.acidity:residual.sugar 1 11.712 7052.9 2251.9
## <none> 7041.2 2252.3
## - alcohol:density 1 14.204 7055.4 2253.7
## - free.sulfur.dioxide:Wine.Color 1 14.365 7055.6 2253.8
## - residual.sugar:alcohol 1 16.461 7057.7 2255.2
## - volatile.acidity:density 1 17.014 7058.2 2255.6
## - residual.sugar:citric.acid 1 17.023 7058.2 2255.6
## - residual.sugar:total.sulfur.dioxide 1 19.424 7060.6 2257.3
## - sulphates:total.sulfur.dioxide 1 21.988 7063.2 2259.1
## - volatile.acidity:alcohol 1 45.323 7086.5 2275.2
## - pH:Wine.Color 1 51.359 7092.6 2279.4
## - free.sulfur.dioxide:total.sulfur.dioxide 1 51.724 7092.9 2279.7
## - density:Wine.Color 2 71.234 7112.4 2284.6
##
## Step: AIC=2244.34
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##   sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##   citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
##   pH:Wine.Color + sulphates:Wine.Color + free.sulfur.dioxide:Wine.Color +
##   total.sulfur.dioxide:Wine.Color + citric.acid:Wine.Color +
##   fixed.acidity:citric.acid + free.sulfur.dioxide:citric.acid +
##   sulphates:citric.acid + pH:citric.acid + alcohol:citric.acid +
##   residual.sugar:citric.acid + citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##   free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##   total.sulfur.dioxide:density + alcohol:total.sulfur.dioxide +
##   residual.sugar:total.sulfur.dioxide + sulphates:fixed.acidity +
##   pH:fixed.acidity + residual.sugar:fixed.acidity + volatile.acidity:fixed.acidity +
##   sulphates:free.sulfur.dioxide + alcohol:free.sulfur.dioxide +
##   residual.sugar:free.sulfur.dioxide + volatile.acidity:free.sulfur.dioxide +
##   free.sulfur.dioxide:density + pH:sulphates + alcohol:sulphates +
##   residual.sugar:sulphates + volatile.acidity:sulphates + sulphates:density +
##   alcohol:pH + residual.sugar:pH + volatile.acidity:pH + pH:density +
##   residual.sugar:alcohol + volatile.acidity:alcohol + alcohol:density +
##   volatile.acidity:residual.sugar + residual.sugar:density +
##   volatile.acidity:density
##
##                                     Df Sum of Sq    RSS     AIC
## - residual.sugar:fixed.acidity  1  0.946 7042.9 2236.5
## - citric.acid:Wine.Color      1  0.982 7043.0 2236.5
## - pH:sulphates                1  1.084 7043.1 2236.6
## - pH:density                  1  1.212 7043.2 2236.7
## - total.sulfur.dioxide:Wine.Color 1  1.429 7043.4 2236.8

```

```

## - volatile.acidity:pH           1   1.554 7043.5 2236.9
## - residual.sugar:Wine.Color    1   1.730 7043.7 2237.1
## - total.sulfur.dioxide:density 1   1.755 7043.7 2237.1
## - sulphates:fixed.acidity      1   1.850 7043.8 2237.1
## - pH:fixed.acidity             1   2.213 7044.2 2237.4
## - residual.sugar:density       1   2.419 7044.4 2237.5
## - alcohol:sulphates            1   2.705 7044.7 2237.7
## - fixed.acidity:total.sulfur.dioxide 1   2.901 7044.9 2237.9
## - sulphates:free.sulfur.dioxide 1   3.039 7045.0 2238.0
## - free.sulfur.dioxide:citric.acid 1   3.070 7045.1 2238.0
## - volatile.acidity:sulphates     1   3.336 7045.3 2238.2
## - alcohol:total.sulfur.dioxide   1   3.838 7045.8 2238.5
## - sulphates:citric.acid         1   3.918 7045.9 2238.6
## - residual.sugar:sulphates       1   3.928 7045.9 2238.6
## - volatile.acidity:fixed.acidity 1   4.518 7046.5 2239.0
## - sulphates:density              1   4.680 7046.7 2239.1
## - sulphates:Wine.Color           1   4.953 7046.9 2239.3
## - volatile.acidity:free.sulfur.dioxide 1   5.308 7047.3 2239.5
## - alcohol:free.sulfur.dioxide     1   5.356 7047.3 2239.6
## - free.sulfur.dioxide:density     1   5.885 7047.9 2239.9
## - pH:citric.acid                1   6.528 7048.5 2240.4
## - alcohol:pH                     1   6.681 7048.7 2240.5
## - citric.acid:density            1   7.040 7049.0 2240.7
## - residual.sugar:free.sulfur.dioxide 1   9.859 7051.8 2242.7
## - alcohol:citric.acid            1   10.100 7052.1 2242.9
## - residual.sugar:pH               1   10.124 7052.1 2242.9
## - fixed.acidity:citric.acid       1   10.873 7052.9 2243.4
## - volatile.acidity:residual.sugar 1   11.123 7053.1 2243.6
## <none>                           7042.0 2244.3
## - free.sulfur.dioxide:Wine.Color 1   14.466 7056.5 2245.9
## - alcohol:density                 1   14.727 7056.7 2246.1
## - volatile.acidity:density        1   16.619 7058.6 2247.4
## - residual.sugar:alcohol           1   16.641 7058.6 2247.4
## - residual.sugar:citric.acid       1   17.086 7059.1 2247.7
## - residual.sugar:total.sulfur.dioxide 1   18.936 7060.9 2249.0
## - sulphates:total.sulfur.dioxide   1   22.234 7064.2 2251.3
## - volatile.acidity:alcohol          1   45.589 7087.6 2267.5
## - pH:Wine.Color                   1   50.572 7092.6 2270.9
## - free.sulfur.dioxide:total.sulfur.dioxide 1   51.372 7093.4 2271.5
## - density:Wine.Color              2   70.747 7112.7 2276.3
##
## Step: AIC=2236.5
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##          sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##          citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
##          pH:Wine.Color + sulphates:Wine.Color + free.sulfur.dioxide:Wine.Color +
##          total.sulfur.dioxide:Wine.Color + citric.acid:Wine.Color +
##          fixed.acidity:citric.acid + free.sulfur.dioxide:citric.acid +
##          sulphates:citric.acid + pH:citric.acid + alcohol:citric.acid +
##          residual.sugar:citric.acid + citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##          total.sulfur.dioxide:density + alcohol:total.sulfur.dioxide +
##          residual.sugar:total.sulfur.dioxide + sulphates:fixed.acidity +
##          pH:fixed.acidity + volatile.acidity:fixed.acidity + sulphates:free.sulfur.dioxide +

```

```

##      alcohol:free.sulfur.dioxide + residual.sugar:free.sulfur.dioxide +
##      volatile.acidity:free.sulfur.dioxide + free.sulfur.dioxide:density +
##      pH:sulphates + alcohol:sulphates + residual.sugar:sulphates +
##      volatile.acidity:sulphates + sulphates:density + alcohol:pH +
##      residual.sugar:pH + volatile.acidity:pH + pH:density + residual.sugar:alcohol +
##      volatile.acidity:alcohol + alcohol:density + volatile.acidity:residual.sugar +
##      residual.sugar:density + volatile.acidity:density
##
##      Df Sum of Sq   RSS   AIC
##      - pH:sulphates           1  1.013 7043.9 2228.7
##      - citric.acid:Wine.Color 1  1.081 7044.0 2228.8
##      - pH:density              1  1.215 7044.1 2228.8
##      - total.sulfur.dioxide:Wine.Color 1  1.564 7044.5 2229.1
##      - volatile.acidity:pH     1  1.727 7044.7 2229.2
##      - sulphates:fixed.acidity 1  1.904 7044.8 2229.3
##      - total.sulfur.dioxide:density 1  1.981 7044.9 2229.4
##      - pH:fixed.acidity        1  1.996 7044.9 2229.4
##      - residual.sugar:density   1  1.997 7044.9 2229.4
##      - residual.sugar:Wine.Color 1  2.606 7045.5 2229.8
##      - alcohol:sulphates       1  2.841 7045.8 2230.0
##      - free.sulfur.dioxide:citric.acid 1  2.928 7045.9 2230.0
##      - sulphates:free.sulfur.dioxide 1  2.941 7045.9 2230.1
##      - volatile.acidity:sulphates 1  3.421 7046.4 2230.4
##      - residual.sugar:sulphates 1  3.719 7046.7 2230.6
##      - sulphates:citric.acid    1  3.743 7046.7 2230.6
##      - alcohol:total.sulfur.dioxide 1  4.210 7047.1 2230.9
##      - volatile.acidity:fixed.acidity 1  4.242 7047.2 2231.0
##      - sulphates:density        1  4.676 7047.6 2231.3
##      - sulphates:Wine.Color     1  4.686 7047.6 2231.3
##      - fixed.acidity:total.sulfur.dioxide 1  4.729 7047.7 2231.3
##      - volatile.acidity:free.sulfur.dioxide 1  5.359 7048.3 2231.7
##      - alcohol:free.sulfur.dioxide 1  5.730 7048.7 2232.0
##      - pH:citric.acid          1  6.330 7049.3 2232.4
##      - alcohol:pH               1  6.416 7049.3 2232.5
##      - free.sulfur.dioxide:density 1  6.435 7049.4 2232.5
##      - citric.acid:density      1  7.025 7050.0 2232.9
##      - alcohol:citric.acid     1  10.127 7053.1 2235.1
##      - residual.sugar:free.sulfur.dioxide 1  10.601 7053.5 2235.4
##      - fixed.acidity:citric.acid 1  10.626 7053.6 2235.4
##      - volatile.acidity:residual.sugar 1  10.870 7053.8 2235.6
##      - residual.sugar:pH         1  11.897 7054.8 2236.3
##      <none>                         7042.9 2236.5
##      - free.sulfur.dioxide:Wine.Color 1  15.250 7058.2 2238.6
##      - alcohol:density           1  15.358 7058.3 2238.7
##      - volatile.acidity:density 1  16.231 7059.2 2239.3
##      - residual.sugar:citric.acid 1  16.480 7059.4 2239.5
##      - residual.sugar:alcohol    1  17.460 7060.4 2240.1
##      - residual.sugar:total.sulfur.dioxide 1  19.969 7062.9 2241.9
##      - sulphates:total.sulfur.dioxide 1  21.850 7064.8 2243.2
##      - volatile.acidity:alcohol   1  45.194 7088.1 2259.3
##      - free.sulfur.dioxide:total.sulfur.dioxide 1  51.678 7094.6 2263.8
##      - pH:Wine.Color             1  52.000 7094.9 2264.1
##      - density:Wine.Color        2  72.580 7115.5 2269.8
##

```

```

## Step: AIC=2228.71
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##          sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##          citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
##          pH:Wine.Color + sulphates:Wine.Color + free.sulfur.dioxide:Wine.Color +
##          total.sulfur.dioxide:Wine.Color + citric.acid:Wine.Color +
##          fixed.acidity:citric.acid + free.sulfur.dioxide:citric.acid +
##          sulphates:citric.acid + pH:citric.acid + alcohol:citric.acid +
##          residual.sugar:citric.acid + citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##          total.sulfur.dioxide:density + alcohol:total.sulfur.dioxide +
##          residual.sugar:total.sulfur.dioxide + sulphates:fixed.acidity +
##          pH:fixed.acidity + volatile.acidity:fixed.acidity + sulphates:free.sulfur.dioxide +
##          alcohol:free.sulfur.dioxide + residual.sugar:free.sulfur.dioxide +
##          volatile.acidity:free.sulfur.dioxide + free.sulfur.dioxide:density +
##          alcohol:sulphates + residual.sugar:sulphates + volatile.acidity:sulphates +
##          sulphates:density + alcohol:pH + residual.sugar:pH + volatile.acidity:pH +
##          pH:density + residual.sugar:alcohol + volatile.acidity:alcohol +
##          alcohol:density + volatile.acidity:residual.sugar + residual.sugar:density +
##          volatile.acidity:density
##
##                                     Df Sum of Sq    RSS     AIC
## - pH:density                   1   0.901 7044.8 2220.8
## - sulphates:fixed.acidity      1   0.940 7044.9 2220.9
## - citric.acid:Wine.Color       1   1.258 7045.2 2221.1
## - total.sulfur.dioxide:Wine.Color 1   1.563 7045.5 2221.3
## - volatile.acidity:pH          1   1.783 7045.7 2221.5
## - alcohol:sulphates            1   1.862 7045.8 2221.5
## - residual.sugar:density        1   2.030 7046.0 2221.6
## - pH:fixed.acidity              1   2.092 7046.0 2221.7
## - sulphates:free.sulfur.dioxide 1   2.290 7046.2 2221.8
## - total.sulfur.dioxide:density   1   2.353 7046.3 2221.8
## - residual.sugar:Wine.Color      1   2.486 7046.4 2221.9
## - residual.sugar:sulphates        1   2.741 7046.7 2222.1
## - free.sulfur.dioxide:citric.acid 1   2.775 7046.7 2222.2
## - sulphates:citric.acid          1   3.271 7047.2 2222.5
## - volatile.acidity:sulphates      1   3.501 7047.4 2222.7
## - sulphates:Wine.Color            1   3.705 7047.6 2222.8
## - sulphates:density                1   3.713 7047.7 2222.8
## - volatile.acidity:fixed.acidity    1   4.322 7048.3 2223.2
## - alcohol:total.sulfur.dioxide      1   4.571 7048.5 2223.4
## - volatile.acidity:free.sulfur.dioxide 1   5.401 7049.3 2224.0
## - alcohol:free.sulfur.dioxide        1   5.694 7049.6 2224.2
## - fixed.acidity:total.sulfur.dioxide 1   5.748 7049.7 2224.2
## - alcohol:pH                      1   5.865 7049.8 2224.3
## - free.sulfur.dioxide:density        1   6.312 7050.3 2224.6
## - pH:citric.acid                  1   6.835 7050.8 2225.0
## - citric.acid:density                1   7.462 7051.4 2225.4
## - residual.sugar:free.sulfur.dioxide 1   10.384 7054.3 2227.4
## - alcohol:citric.acid                1   10.929 7054.9 2227.8
## - volatile.acidity:residual.sugar      1   10.965 7054.9 2227.8
## - residual.sugar:pH                  1   10.971 7054.9 2227.8
## - fixed.acidity:citric.acid          1   11.504 7055.4 2228.2
## <none>                                7043.9 2228.7

```

```

## - free.sulfur.dioxide:Wine.Color      1  15.015 7059.0 2230.7
## - alcohol:density                   1  15.312 7059.3 2230.9
## - residual.sugar:citric.acid       1  16.945 7060.9 2232.0
## - volatile.acidity:density         1  17.058 7061.0 2232.1
## - residual.sugar:alcohol           1  17.292 7061.2 2232.2
## - residual.sugar:total.sulfur.dioxide 1  20.677 7064.6 2234.6
## - sulphates:total.sulfur.dioxide   1  21.878 7065.8 2235.4
## - volatile.acidity:alcohol          1  46.586 7090.5 2252.5
## - free.sulfur.dioxide:total.sulfur.dioxide 1  51.394 7095.3 2255.8
## - pH:Wine.Color                    1  54.694 7098.6 2258.1
## - density:Wine.Color               2  78.373 7122.3 2265.9
##
## Step: AIC=2220.84
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##          sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##          citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
##          pH:Wine.Color + sulphates:Wine.Color + free.sulfur.dioxide:Wine.Color +
##          total.sulfur.dioxide:Wine.Color + citric.acid:Wine.Color +
##          fixed.acidity:citric.acid + free.sulfur.dioxide:citric.acid +
##          sulphates:citric.acid + pH:citric.acid + alcohol:citric.acid +
##          residual.sugar:citric.acid + citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##          total.sulfur.dioxide:density + alcohol:total.sulfur.dioxide +
##          residual.sugar:total.sulfur.dioxide + sulphates:fixed.acidity +
##          pH:fixed.acidity + volatile.acidity:fixed.acidity + sulphates:free.sulfur.dioxide +
##          alcohol:free.sulfur.dioxide + residual.sugar:free.sulfur.dioxide +
##          volatile.acidity:free.sulfur.dioxide + free.sulfur.dioxide:density +
##          alcohol:sulphates + residual.sugar:sulphates + volatile.acidity:sulphates +
##          sulphates:density + alcohol:pH + residual.sugar:pH + volatile.acidity:pH +
##          residual.sugar:alcohol + volatile.acidity:alcohol + alcohol:density +
##          volatile.acidity:residual.sugar + residual.sugar:density +
##          volatile.acidity:density
##
##                                         Df Sum of Sq    RSS     AIC
## - citric.acid:Wine.Color           1  0.821 7045.7 2212.9
## - sulphates:fixed.acidity         1  1.444 7046.3 2213.3
## - total.sulfur.dioxide:Wine.Color 1  1.575 7046.4 2213.4
## - volatile.acidity:pH             1  1.767 7046.6 2213.6
## - residual.sugar:density          1  1.805 7046.7 2213.6
## - total.sulfur.dioxide:density    1  2.092 7046.9 2213.8
## - residual.sugar:Wine.Color        1  2.259 7047.1 2213.9
## - sulphates:free.sulfur.dioxide   1  2.331 7047.2 2214.0
## - alcohol:sulphates              1  2.453 7047.3 2214.1
## - free.sulfur.dioxide:citric.acid 1  2.923 7047.8 2214.4
## - sulphates:citric.acid          1  3.071 7047.9 2214.5
## - volatile.acidity:sulphates      1  3.438 7048.3 2214.7
## - residual.sugar:sulphates        1  3.507 7048.4 2214.8
## - pH:fixed.acidity                1  4.373 7049.2 2215.4
## - alcohol:total.sulfur.dioxide    1  4.379 7049.2 2215.4
## - sulphates:Wine.Color            1  4.404 7049.3 2215.4
## - volatile.acidity:fixed.acidity   1  4.803 7049.6 2215.7
## - sulphates:density               1  4.992 7049.8 2215.8
## - fixed.acidity:total.sulfur.dioxide 1  5.189 7050.0 2215.9
## - volatile.acidity:free.sulfur.dioxide 1  5.222 7050.1 2216.0

```

```

## - alcohol:free.sulfur.dioxide           1   5.707 7050.6 2216.3
## - free.sulfur.dioxide:density          1   6.302 7051.1 2216.7
## - pH:citric.acid                      1   6.470 7051.3 2216.8
## - citric.acid:density                 1   6.617 7051.5 2216.9
## - alcohol:pH                          1   7.713 7052.6 2217.7
## - alcohol:citric.acid                1   10.049 7054.9 2219.3
## - residual.sugar:free.sulfur.dioxide  1   10.343 7055.2 2219.5
## - fixed.acidity:citric.acid          1   10.895 7055.7 2219.9
## - volatile.acidity:residual.sugar    1   11.390 7056.2 2220.3
## <none>                                7044.8 2220.8
## - free.sulfur.dioxide:Wine.Color      1   14.924 7059.8 2222.7
## - alcohol:density                     1   15.188 7060.0 2222.9
## - residual.sugar:citric.acid        1   16.043 7060.9 2223.5
## - residual.sugar:alcohol             1   17.562 7062.4 2224.6
## - volatile.acidity:density          1   17.953 7062.8 2224.8
## - residual.sugar:pH                  1   19.241 7064.1 2225.7
## - residual.sugar:total.sulfur.dioxide 1   20.011 7064.9 2226.2
## - sulphates:total.sulfur.dioxide     1   22.544 7067.4 2228.0
## - volatile.acidity:alcohol           1   47.607 7092.5 2245.3
## - free.sulfur.dioxide:total.sulfur.dioxide 1   51.378 7096.2 2247.9
## - pH:Wine.Color                      1   78.267 7123.1 2266.5
## - density:Wine.Color                 2   94.236 7139.1 2269.0
##
## Step: AIC=2212.92
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##          sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##          citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
##          pH:Wine.Color + sulphates:Wine.Color + free.sulfur.dioxide:Wine.Color +
##          total.sulfur.dioxide:Wine.Color + fixed.acidity:citric.acid +
##          free.sulfur.dioxide:citric.acid + sulphates:citric.acid +
##          pH:citric.acid + alcohol:citric.acid + residual.sugar:citric.acid +
##          citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##          total.sulfur.dioxide:density + alcohol:total.sulfur.dioxide +
##          residual.sugar:total.sulfur.dioxide + sulphates:fixed.acidity +
##          pH:fixed.acidity + volatile.acidity:fixed.acidity + sulphates:free.sulfur.dioxide +
##          alcohol:free.sulfur.dioxide + residual.sugar:free.sulfur.dioxide +
##          volatile.acidity:free.sulfur.dioxide + free.sulfur.dioxide:density +
##          alcohol:sulphates + residual.sugar:sulphates + volatile.acidity:sulphates +
##          sulphates:density + alcohol:pH + residual.sugar:pH + volatile.acidity:pH +
##          residual.sugar:alcohol + volatile.acidity:alcohol + alcohol:density +
##          volatile.acidity:residual.sugar + residual.sugar:density +
##          volatile.acidity:density
##
##                                     Df Sum of Sq   RSS   AIC
## - sulphates:fixed.acidity          1   1.297 7047.0 2205.3
## - residual.sugar:density          1   1.585 7047.3 2205.5
## - total.sulfur.dioxide:density    1   1.653 7047.3 2205.6
## - volatile.acidity:pH              1   1.694 7047.4 2205.6
## - residual.sugar:Wine.Color       1   1.900 7047.6 2205.7
## - total.sulfur.dioxide:Wine.Color 1   2.233 7047.9 2206.0
## - sulphates:free.sulfur.dioxide   1   2.338 7048.0 2206.1
## - alcohol:sulphates               1   2.564 7048.2 2206.2
## - volatile.acidity:sulphates      1   3.549 7049.2 2206.9

```

```

## - residual.sugar:sulphates          1  3.589 7049.3 2206.9
## - sulphates:citric.acid           1  3.660 7049.3 2207.0
## - free.sulfur.dioxide:citric.acid 1  3.749 7049.4 2207.0
## - alcohol:total.sulfur.dioxide    1  3.837 7049.5 2207.1
## - pH:fixed.acidity                1  4.368 7050.0 2207.5
## - sulphates:Wine.Color            1  4.852 7050.5 2207.8
## - volatile.acidity:fixed.acidity   1  4.856 7050.5 2207.8
## - volatile.acidity:free.sulfur.dioxide 1  5.115 7050.8 2208.0
## - sulphates:density               1  5.290 7051.0 2208.1
## - alcohol:free.sulfur.dioxide     1  5.310 7051.0 2208.1
## - fixed.acidity:total.sulfur.dioxide 1  5.486 7051.2 2208.2
## - free.sulfur.dioxide:density     1  5.796 7051.5 2208.4
## - citric.acid:density             1  6.166 7051.8 2208.7
## - pH:citric.acid                 1  6.347 7052.0 2208.8
## - alcohol:pH                      1  7.938 7053.6 2209.9
## - alcohol:citric.acid             1  9.351 7055.0 2210.9
## - residual.sugar:free.sulfur.dioxide 1  9.795 7055.5 2211.2
## - fixed.acidity:citric.acid       1 10.093 7055.8 2211.4
## - volatile.acidity:residual.sugar 1 11.658 7057.3 2212.5
## <none>                           1 7045.7 2212.9
## - free.sulfur.dioxide:Wine.Color   1 14.240 7059.9 2214.3
## - alcohol:density                  1 14.640 7060.3 2214.6
## - residual.sugar:alcohol            1 17.238 7062.9 2216.4
## - residual.sugar:citric.acid       1 17.861 7063.5 2216.8
## - volatile.acidity:density         1 18.139 7063.8 2217.0
## - residual.sugar:pH                1 18.952 7064.6 2217.6
## - residual.sugar:total.sulfur.dioxide 1 19.190 7064.9 2217.8
## - sulphates:total.sulfur.dioxide   1 22.640 7068.3 2220.1
## - volatile.acidity:alcohol          1 47.817 7093.5 2237.6
## - free.sulfur.dioxide:total.sulfur.dioxide 1 51.087 7096.8 2239.8
## - pH:Wine.Color                   1 77.455 7123.1 2258.0
## - density:Wine.Color               2 93.814 7139.5 2260.7
##
## Step: AIC=2205.32
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##          sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##          citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
##          pH:Wine.Color + sulphates:Wine.Color + free.sulfur.dioxide:Wine.Color +
##          total.sulfur.dioxide:Wine.Color + fixed.acidity:citric.acid +
##          free.sulfur.dioxide:citric.acid + sulphates:citric.acid +
##          pH:citric.acid + alcohol:citric.acid + residual.sugar:citric.acid +
##          citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##          total.sulfur.dioxide:density + alcohol:total.sulfur.dioxide +
##          residual.sugar:total.sulfur.dioxide + pH:fixed.acidity +
##          volatile.acidity:fixed.acidity + sulphates:free.sulfur.dioxide +
##          alcohol:free.sulfur.dioxide + residual.sugar:free.sulfur.dioxide +
##          volatile.acidity:free.sulfur.dioxide + free.sulfur.dioxide:density +
##          alcohol:sulphates + residual.sugar:sulphates + volatile.acidity:sulphates +
##          sulphates:density + alcohol:pH + residual.sugar:pH + volatile.acidity:pH +
##          residual.sugar:alcohol + volatile.acidity:alcohol + alcohol:density +
##          volatile.acidity:residual.sugar + residual.sugar:density +
##          volatile.acidity:density
##

```

```

##                                     Df Sum of Sq   RSS   AIC
## - volatile.acidity:pH             1   1.404 7048.4 2197.8
## - alcohol:sulphates              1   1.564 7048.5 2197.9
## - total.sulfur.dioxide:density   1   1.695 7048.7 2198.0
## - residual.sugar:Wine.Color      1   1.846 7048.8 2198.1
## - residual.sugar:density         1   1.958 7048.9 2198.2
## - total.sulfur.dioxide:Wine.Color 1   2.262 7049.2 2198.4
## - residual.sugar:sulphates       1   2.374 7049.3 2198.5
## - sulphates:free.sulfur.dioxide 1   2.487 7049.5 2198.6
## - free.sulfur.dioxide:citric.acid 1   3.528 7050.5 2199.3
## - alcohol:total.sulfur.dioxide   1   3.653 7050.6 2199.4
## - sulphates:Wine.Color          1   3.770 7050.7 2199.4
## - volatile.acidity:sulphates     1   3.795 7050.8 2199.5
## - sulphates:density              1   4.105 7051.1 2199.7
## - pH:fixed.acidity               1   4.366 7051.3 2199.9
## - alcohol:free.sulfur.dioxide    1   5.255 7052.2 2200.5
## - volatile.acidity:free.sulfur.dioxide 1   5.266 7052.2 2200.5
## - free.sulfur.dioxide:density    1   5.719 7052.7 2200.8
## - volatile.acidity:fixed.acidity 1   6.171 7053.1 2201.1
## - fixed.acidity:total.sulfur.dioxide 1   6.260 7053.2 2201.2
## - sulphates:citric.acid         1   6.422 7053.4 2201.3
## - pH:citric.acid                1   6.878 7053.8 2201.6
## - alcohol:pH                     1   7.834 7054.8 2202.3
## - citric.acid:density            1   8.069 7055.0 2202.4
## - residual.sugar:free.sulfur.dioxide 1   9.664 7056.6 2203.5
## - alcohol:citric.acid            1  10.840 7057.8 2204.4
## - fixed.acidity:citric.acid      1  12.207 7059.2 2205.3
## <none>                           7047.0 2205.3
## - volatile.acidity:residual.sugar 1  13.049 7060.0 2205.9
## - free.sulfur.dioxide:Wine.Color 1  14.456 7061.4 2206.9
## - alcohol:density                 1  14.917 7061.9 2207.2
## - residual.sugar:alcohol          1  16.982 7063.9 2208.6
## - residual.sugar:pH                1  18.822 7065.8 2209.9
## - residual.sugar:total.sulfur.dioxide 1  19.297 7066.3 2210.2
## - residual.sugar:citric.acid       1  20.806 7067.8 2211.3
## - volatile.acidity:density        1  20.971 7067.9 2211.4
## - sulphates:total.sulfur.dioxide 1  21.471 7068.4 2211.7
## - volatile.acidity:alcohol         1  50.710 7097.7 2232.0
## - free.sulfur.dioxide:total.sulfur.dioxide 1  50.878 7097.8 2232.1
## - pH:Wine.Color                  1  76.282 7123.2 2249.6
## - density:Wine.Color              2  94.924 7141.9 2253.9
##
## Step:  AIC=2197.8
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##           sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##           citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
##           pH:Wine.Color + sulphates:Wine.Color + free.sulfur.dioxide:Wine.Color +
##           total.sulfur.dioxide:Wine.Color + fixed.acidity:citric.acid +
##           free.sulfur.dioxide:citric.acid + sulphates:citric.acid +
##           pH:citric.acid + alcohol:citric.acid + residual.sugar:citric.acid +
##           citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##           free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##           total.sulfur.dioxide:density + alcohol:total.sulfur.dioxide +
##           residual.sugar:total.sulfur.dioxide + pH:fixed.acidity +

```

```

## volatile.acidity:fixed.acidity + sulphates:free.sulfur.dioxide +
## alcohol:free.sulfur.dioxide + residual.sugar:free.sulfur.dioxide +
## volatile.acidity:free.sulfur.dioxide + free.sulfur.dioxide:density +
## alcohol:sulphates + residual.sugar:sulphates + volatile.acidity:sulphates +
## sulphates:density + alcohol:pH + residual.sugar:pH + residual.sugar:alcohol +
## volatile.acidity:alcohol + alcohol:density + volatile.acidity:residual.sugar +
## residual.sugar:density + volatile.acidity:density
##
##                                     Df Sum of Sq   RSS   AIC
## - total.sulfur.dioxide:density      1   1.365 7049.7 2190.2
## - alcohol:sulphates                1   1.384 7049.8 2190.3
## - residual.sugar:Wine.Color        1   2.133 7050.5 2190.8
## - residual.sugar:sulphates         1   2.317 7050.7 2190.9
## - total.sulfur.dioxide:Wine.Color   1   2.511 7050.9 2191.1
## - sulphates:free.sulfur.dioxide    1   2.522 7050.9 2191.1
## - alcohol:total.sulfur.dioxide     1   3.191 7051.6 2191.5
## - residual.sugar:density          1   3.427 7051.8 2191.7
## - free.sulfur.dioxide:citric.acid 1   3.568 7051.9 2191.8
## - sulphates:Wine.Color            1   3.824 7052.2 2192.0
## - sulphates:density               1   3.844 7052.2 2192.0
## - volatile.acidity:sulphates       1   4.269 7052.6 2192.3
## - pH:fixed.acidity                 1   4.743 7053.1 2192.6
## - fixed.acidity:total.sulfur.dioxide 1   5.138 7053.5 2192.9
## - volatile.acidity:free.sulfur.dioxide 1   5.357 7053.7 2193.0
## - alcohol:free.sulfur.dioxide       1   5.411 7053.8 2193.1
## - free.sulfur.dioxide:density       1   5.884 7054.3 2193.4
## - sulphates:citric.acid           1   6.716 7055.1 2194.0
## - alcohol:pH                      1   8.414 7056.8 2195.2
## - residual.sugar:free.sulfur.dioxide 1   9.803 7058.2 2196.1
## - citric.acid:density              1   10.131 7058.5 2196.3
## - pH:citric.acid                  1   10.289 7058.7 2196.4
## <none>                                7048.4 2197.8
## - alcohol:citric.acid             1   13.699 7062.1 2198.8
## - fixed.acidity:citric.acid       1   13.914 7062.3 2199.0
## - free.sulfur.dioxide:Wine.Color   1   14.446 7062.8 2199.3
## - alcohol:density                  1   15.900 7064.3 2200.3
## - residual.sugar:alcohol           1   16.335 7064.7 2200.7
## - residual.sugar:total.sulfur.dioxide 1   18.668 7067.0 2202.3
## - residual.sugar:pH                1   18.900 7067.3 2202.4
## - sulphates:total.sulfur.dioxide   1   22.017 7070.4 2204.6
## - volatile.acidity:fixed.acidity    1   22.407 7070.8 2204.9
## - residual.sugar:citric.acid       1   24.249 7072.6 2206.1
## - volatile.acidity:residual.sugar   1   29.117 7077.5 2209.5
## - free.sulfur.dioxide:total.sulfur.dioxide 1   51.224 7099.6 2224.8
## - volatile.acidity:density          1   53.285 7101.7 2226.2
## - pH:Wine.Color                   1   86.892 7135.3 2249.3
## - density:Wine.Color                2   101.072 7149.4 2250.6
## - volatile.acidity:alcohol           1   89.120 7137.5 2250.9
##
## Step:  AIC=2190.25
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##          sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##          citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
##          pH:Wine.Color + sulphates:Wine.Color + free.sulfur.dioxide:Wine.Color +

```

```

##  total.sulfur.dioxide:Wine.Color + fixed.acidity:citric.acid +
##  free.sulfur.dioxide:citric.acid + sulphates:citric.acid +
##  pH:citric.acid + alcohol:citric.acid + residual.sugar:citric.acid +
##  citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##  free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##  alcohol:total.sulfur.dioxide + residual.sugar:total.sulfur.dioxide +
##  pH:fixed.acidity + volatile.acidity:fixed.acidity + sulphates:free.sulfur.dioxide +
##  alcohol:free.sulfur.dioxide + residual.sugar:free.sulfur.dioxide +
##  volatile.acidity:free.sulfur.dioxide + free.sulfur.dioxide:density +
##  alcohol:sulphates + residual.sugar:sulphates + volatile.acidity:sulphates +
##  sulphates:density + alcohol:pH + residual.sugar:pH + residual.sugar:alcohol +
##  volatile.acidity:alcohol + alcohol:density + volatile.acidity:residual.sugar +
##  residual.sugar:density + volatile.acidity:density
##
##                                     Df Sum of Sq    RSS     AIC
## - alcohol:sulphates             1   1.498 7051.2 2182.8
## - alcohol:total.sulfur.dioxide  1   1.952 7051.7 2183.1
## - residual.sugar:Wine.Color    1   2.471 7052.2 2183.5
## - residual.sugar:sulphates    1   2.513 7052.2 2183.5
## - sulphates:free.sulfur.dioxide 1   3.295 7053.0 2184.1
## - fixed.acidity:total.sulfur.dioxide 1   3.790 7053.5 2184.4
## - free.sulfur.dioxide:citric.acid 1   3.802 7053.5 2184.4
## - alcohol:free.sulfur.dioxide   1   4.094 7053.8 2184.6
## - sulphates:Wine.Color         1   4.196 7053.9 2184.7
## - volatile.acidity:sulphates   1   4.360 7054.1 2184.8
## - sulphates:density            1   4.373 7054.1 2184.8
## - free.sulfur.dioxide:density   1   4.537 7054.3 2184.9
## - volatile.acidity:free.sulfur.dioxide 1   5.300 7055.0 2185.4
## - pH:fixed.acidity              1   5.400 7055.1 2185.5
## - total.sulfur.dioxide:Wine.Color 1   6.240 7056.0 2186.1
## - residual.sugar:density        1   6.331 7056.1 2186.2
## - sulphates:citric.acid        1   6.736 7056.5 2186.4
## - residual.sugar:free.sulfur.dioxide 1   8.486 7058.2 2187.7
## - alcohol:pH                   1   9.362 7059.1 2188.3
## - citric.acid:density          1   9.936 7059.7 2188.7
## - pH:citric.acid               1  10.297 7060.0 2188.9
## <none>                         7049.7 2190.2
## - free.sulfur.dioxide:Wine.Color 1  13.108 7062.8 2190.9
## - fixed.acidity:citric.acid    1  13.434 7063.2 2191.1
## - alcohol:citric.acid          1  13.883 7063.6 2191.4
## - residual.sugar:alcohol        1  15.096 7064.8 2192.2
## - alcohol:density               1  15.457 7065.2 2192.5
## - residual.sugar:pH             1  19.633 7069.4 2195.4
## - volatile.acidity:fixed.acidity 1  22.328 7072.1 2197.2
## - residual.sugar:citric.acid   1  23.977 7073.7 2198.4
## - sulphates:total.sulfur.dioxide 1  26.959 7076.7 2200.5
## - residual.sugar:total.sulfur.dioxide 1  29.541 7079.3 2202.2
## - volatile.acidity:residual.sugar 1  29.582 7079.3 2202.3
## - free.sulfur.dioxide:total.sulfur.dioxide 1  51.010 7100.7 2217.1
## - volatile.acidity:density      1  54.766 7104.5 2219.7
## - pH:Wine.Color                 1  85.548 7135.3 2240.9
## - density:Wine.Color            2 101.182 7150.9 2243.1
## - volatile.acidity:alcohol       1  92.208 7141.9 2245.4
##

```

```

## Step: AIC=2182.8
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##          sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##          citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
##          pH:Wine.Color + sulphates:Wine.Color + free.sulfur.dioxide:Wine.Color +
##          total.sulfur.dioxide:Wine.Color + fixed.acidity:citric.acid +
##          free.sulfur.dioxide:citric.acid + sulphates:citric.acid +
##          pH:citric.acid + alcohol:citric.acid + residual.sugar:citric.acid +
##          citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##          alcohol:total.sulfur.dioxide + residual.sugar:total.sulfur.dioxide +
##          pH:fixed.acidity + volatile.acidity:fixed.acidity + sulphates:free.sulfur.dioxide +
##          alcohol:free.sulfur.dioxide + residual.sugar:free.sulfur.dioxide +
##          volatile.acidity:free.sulfur.dioxide + free.sulfur.dioxide:density +
##          residual.sugar:sulphates + volatile.acidity:sulphates + sulphates:density +
##          alcohol:pH + residual.sugar:pH + residual.sugar:alcohol +
##          volatile.acidity:alcohol + alcohol:density + volatile.acidity:residual.sugar +
##          residual.sugar:density + volatile.acidity:density
##
##                                     Df Sum of Sq   RSS   AIC
## - residual.sugar:sulphates           1   1.337 7052.6 2175.2
## - alcohol:total.sulfur.dioxide        1   2.021 7053.3 2175.7
## - residual.sugar:Wine.Color          1   2.662 7053.9 2176.2
## - sulphates:free.sulfur.dioxide       1   2.963 7054.2 2176.4
## - sulphates:Wine.Color              1   2.980 7054.2 2176.4
## - fixed.acidity:total.sulfur.dioxide 1   2.995 7054.2 2176.4
## - sulphates:density                 1   3.048 7054.3 2176.4
## - alcohol:free.sulfur.dioxide         1   3.699 7054.9 2176.9
## - free.sulfur.dioxide:density         1   4.327 7055.6 2177.3
## - volatile.acidity:sulphates          1   4.332 7055.6 2177.3
## - free.sulfur.dioxide:citric.acid     1   4.659 7055.9 2177.5
## - volatile.acidity:free.sulfur.dioxide 1   5.363 7056.6 2178.0
## - pH:fixed.acidity                   1   5.648 7056.9 2178.2
## - total.sulfur.dioxide:Wine.Color      1   5.703 7056.9 2178.3
## - sulphates:citric.acid              1   6.445 7057.7 2178.8
## - residual.sugar:density             1   6.503 7057.7 2178.8
## - residual.sugar:free.sulfur.dioxide    1   8.550 7059.8 2180.2
## - alcohol:pH                         1   9.997 7061.2 2181.2
## - pH:citric.acid                     1  10.485 7061.7 2181.6
## - citric.acid:density                1  11.013 7062.2 2181.9
## <none>                                7051.2 2182.8
## - free.sulfur.dioxide:Wine.Color       1  12.679 7063.9 2183.1
## - fixed.acidity:citric.acid            1  13.551 7064.8 2183.7
## - residual.sugar:alcohol               1  14.142 7065.4 2184.1
## - alcohol:density                      1  14.401 7065.6 2184.3
## - alcohol:citric.acid                  1  15.746 7067.0 2185.2
## - residual.sugar:pH                     1  19.312 7070.5 2187.7
## - volatile.acidity:fixed.acidity        1  22.079 7073.3 2189.6
## - residual.sugar:citric.acid            1  24.678 7075.9 2191.4
## - sulphates:total.sulfur.dioxide        1  28.134 7079.4 2193.8
## - residual.sugar:total.sulfur.dioxide     1  29.574 7080.8 2194.8
## - volatile.acidity:residual.sugar        1  29.655 7080.9 2194.9
## - free.sulfur.dioxide:total.sulfur.dioxide 1  51.251 7102.5 2209.8
## - volatile.acidity:density              1  55.373 7106.6 2212.6

```

```

## - pH:Wine.Color           1  84.064 7135.3 2232.4
## - density:Wine.Color      2 101.857 7153.1 2236.1
## - volatile.acidity:alcohol 1  96.657 7147.9 2241.0
##
## Step: AIC=2175.23
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##          sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##          citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
##          pH:Wine.Color + sulphates:Wine.Color + free.sulfur.dioxide:Wine.Color +
##          total.sulfur.dioxide:Wine.Color + fixed.acidity:citric.acid +
##          free.sulfur.dioxide:citric.acid + sulphates:citric.acid +
##          pH:citric.acid + alcohol:citric.acid + residual.sugar:citric.acid +
##          citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##          alcohol:total.sulfur.dioxide + residual.sugar:total.sulfur.dioxide +
##          pH:fixed.acidity + volatile.acidity:fixed.acidity + sulphates:free.sulfur.dioxide +
##          alcohol:free.sulfur.dioxide + residual.sugar:free.sulfur.dioxide +
##          volatile.acidity:free.sulfur.dioxide + free.sulfur.dioxide:density +
##          volatile.acidity:sulphates + sulphates:density + alcohol:pH +
##          residual.sugar:pH + residual.sugar:alcohol + volatile.acidity:alcohol +
##          alcohol:density + volatile.acidity:residual.sugar + residual.sugar:density +
##          volatile.acidity:density
##
##                                     Df Sum of Sq   RSS   AIC
## - sulphates:Wine.Color       1  1.669 7054.2 2167.9
## - sulphates:density         1  1.722 7054.3 2167.9
## - alcohol:total.sulfur.dioxide 1  1.834 7054.4 2168.0
## - residual.sugar:Wine.Color  1  2.179 7054.7 2168.2
## - sulphates:free.sulfur.dioxide 1  2.418 7055.0 2168.4
## - fixed.acidity:total.sulfur.dioxide 1  2.727 7055.3 2168.6
## - alcohol:free.sulfur.dioxide  1  3.857 7056.4 2169.4
## - free.sulfur.dioxide:density 1  4.347 7056.9 2169.8
## - free.sulfur.dioxide:citric.acid 1  4.795 7057.4 2170.1
## - volatile.acidity:sulphates  1  5.150 7057.7 2170.3
## - volatile.acidity:free.sulfur.dioxide 1  5.379 7057.9 2170.5
## - total.sulfur.dioxide:Wine.Color 1  5.555 7058.1 2170.6
## - pH:fixed.acidity            1  5.638 7058.2 2170.7
## - sulphates:citric.acid      1  6.234 7058.8 2171.1
## - residual.sugar:density     1  7.211 7059.8 2171.7
## - residual.sugar:free.sulfur.dioxide 1  8.649 7061.2 2172.7
## - alcohol:pH                 1  9.292 7061.9 2173.2
## - pH:citric.acid             1 10.452 7063.0 2174.0
## - citric.acid:density        1 10.959 7063.5 2174.3
## <none>                         7052.6 2175.2
## - free.sulfur.dioxide:Wine.Color 1 12.300 7064.9 2175.3
## - fixed.acidity:citric.acid    1 13.465 7066.0 2176.1
## - residual.sugar:alcohol       1 14.416 7067.0 2176.7
## - alcohol:density              1 15.593 7068.2 2177.6
## - alcohol:citric.acid         1 15.633 7068.2 2177.6
## - residual.sugar:pH            1 20.836 7073.4 2181.2
## - volatile.acidity:fixed.acidity 1 22.455 7075.0 2182.3
## - residual.sugar:citric.acid   1 24.949 7077.5 2184.0
## - sulphates:total.sulfur.dioxide 1 28.004 7080.6 2186.2
## - residual.sugar:total.sulfur.dioxide 1 28.786 7081.4 2186.7

```

```

## - volatile.acidity:residual.sugar      1  31.006 7083.6 2188.2
## - free.sulfur.dioxide:total.sulfur.dioxide 1  50.457 7103.0 2201.7
## - volatile.acidity:density           1  58.569 7111.1 2207.3
## - pH:Wine.Color                     1  85.443 7138.0 2225.7
## - density:Wine.Color                2 100.643 7153.2 2227.7
## - volatile.acidity:alcohol          1  99.066 7151.6 2235.1
##
## Step: AIC=2167.89
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##          sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##          citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
##          pH:Wine.Color + free.sulfur.dioxide:Wine.Color + total.sulfur.dioxide:Wine.Color +
##          fixed.acidity:citric.acid + free.sulfur.dioxide:citric.acid +
##          sulphates:citric.acid + pH:citric.acid + alcohol:citric.acid +
##          residual.sugar:citric.acid + citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##          alcohol:total.sulfur.dioxide + residual.sugar:total.sulfur.dioxide +
##          pH:fixed.acidity + volatile.acidity:fixed.acidity + sulphates:free.sulfur.dioxide +
##          alcohol:free.sulfur.dioxide + residual.sugar:free.sulfur.dioxide +
##          volatile.acidity:free.sulfur.dioxide + free.sulfur.dioxide:density +
##          volatile.acidity:sulphates + sulphates:density + alcohol:pH +
##          residual.sugar:pH + residual.sugar:alcohol + volatile.acidity:alcohol +
##          alcohol:density + volatile.acidity:residual.sugar + residual.sugar:density +
##          volatile.acidity:density
##
##                                     Df Sum of Sq   RSS   AIC
## - sulphates:density            1    0.450 7054.7 2159.7
## - alcohol:total.sulfur.dioxide 1    1.589 7055.8 2160.5
## - sulphates:free.sulfur.dioxide 1    2.305 7056.5 2161.0
## - fixed.acidity:total.sulfur.dioxide 1    2.660 7056.9 2161.2
## - residual.sugar:Wine.Color     1    2.910 7057.1 2161.4
## - alcohol:free.sulfur.dioxide   1    3.563 7057.8 2161.9
## - free.sulfur.dioxide:density   1    4.134 7058.4 2162.3
## - free.sulfur.dioxide:citric.acid 1    4.695 7058.9 2162.7
## - volatile.acidity:free.sulfur.dioxide 1    5.624 7059.9 2163.3
## - pH:fixed.acidity             1    5.797 7060.0 2163.4
## - sulphates:citric.acid        1    6.395 7060.6 2163.8
## - residual.sugar:density       1    6.868 7061.1 2164.2
## - total.sulfur.dioxide:Wine.Color 1    7.439 7061.7 2164.6
## - residual.sugar:free.sulfur.dioxide 1    8.397 7062.6 2165.2
## - alcohol:pH                   1    8.717 7063.0 2165.4
## - volatile.acidity:sulphates    1    9.763 7064.0 2166.2
## - pH:citric.acid              1   10.730 7065.0 2166.8
## - citric.acid:density          1   11.110 7065.3 2167.1
## <none>                         7054.2 2167.9
## - free.sulfur.dioxide:Wine.Color 1   12.283 7066.5 2167.9
## - fixed.acidity:citric.acid    1   13.417 7067.7 2168.7
## - residual.sugar:alcohol        1   15.656 7069.9 2170.3
## - alcohol:citric.acid          1   15.764 7070.0 2170.3
## - alcohol:density              1   17.299 7071.5 2171.4
## - residual.sugar:pH             1   21.181 7075.4 2174.1
## - volatile.acidity:fixed.acidity 1   22.165 7076.4 2174.8
## - residual.sugar:citric.acid   1   24.783 7079.0 2176.6
## - residual.sugar:total.sulfur.dioxide 1   30.057 7084.3 2180.2

```

```

## - sulphates:total.sulfur.dioxide           1  30.346 7084.6 2180.4
## - volatile.acidity:residual.sugar         1  33.809 7088.0 2182.8
## - free.sulfur.dioxide:total.sulfur.dioxide 1  51.791 7106.0 2195.2
## - volatile.acidity:density                1  63.307 7117.5 2203.2
## - pH:Wine.Color                          1  84.983 7139.2 2218.1
## - density:Wine.Color                     2 100.210 7154.4 2220.0
## - volatile.acidity:alcohol                1 102.897 7157.1 2230.3
##
## Step: AIC=2159.71
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##          sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##          citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
##          pH:Wine.Color + free.sulfur.dioxide:Wine.Color + total.sulfur.dioxide:Wine.Color +
##          fixed.acidity:citric.acid + free.sulfur.dioxide:citric.acid +
##          sulphates:citric.acid + pH:citric.acid + alcohol:citric.acid +
##          residual.sugar:citric.acid + citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##          alcohol:total.sulfur.dioxide + residual.sugar:total.sulfur.dioxide +
##          pH:fixed.acidity + volatile.acidity:fixed.acidity + sulphates:free.sulfur.dioxide +
##          alcohol:free.sulfur.dioxide + residual.sugar:free.sulfur.dioxide +
##          volatile.acidity:free.sulfur.dioxide + free.sulfur.dioxide:density +
##          volatile.acidity:sulphates + alcohol:pH + residual.sugar:pH +
##          residual.sugar:alcohol + volatile.acidity:alcohol + alcohol:density +
##          volatile.acidity:residual.sugar + residual.sugar:density +
##          volatile.acidity:density
##
##                                         Df Sum of Sq   RSS   AIC
## - alcohol:total.sulfur.dioxide           1   1.647 7056.3 2152.3
## - sulphates:free.sulfur.dioxide         1   2.388 7057.1 2152.9
## - fixed.acidity:total.sulfur.dioxide    1   2.522 7057.2 2153.0
## - residual.sugar:Wine.Color            1   3.179 7057.9 2153.4
## - alcohol:free.sulfur.dioxide          1   3.581 7058.3 2153.7
## - free.sulfur.dioxide:density          1   4.023 7058.7 2154.0
## - free.sulfur.dioxide:citric.acid      1   4.898 7059.6 2154.6
## - volatile.acidity:free.sulfur.dioxide  1   5.886 7060.6 2155.3
## - sulphates:citric.acid               1   5.968 7060.7 2155.3
## - pH:fixed.acidity                   1   6.005 7060.7 2155.4
## - residual.sugar:density             1   6.747 7061.4 2155.9
## - total.sulfur.dioxide:Wine.Color     1   7.316 7062.0 2156.3
## - residual.sugar:free.sulfur.dioxide  1   8.266 7063.0 2156.9
## - alcohol:pH                         1   8.532 7063.2 2157.1
## - volatile.acidity:sulphates          1   9.523 7064.2 2157.8
## - pH:citric.acid                    1  10.534 7065.2 2158.5
## - citric.acid:density               1  10.955 7065.6 2158.8
## - free.sulfur.dioxide:Wine.Color     1  12.204 7066.9 2159.7
## <none>                                7054.7 2159.7
## - fixed.acidity:citric.acid          1  13.184 7067.9 2160.4
## - alcohol:citric.acid               1  15.608 7070.3 2162.0
## - residual.sugar:alcohol             1  16.530 7071.2 2162.7
## - alcohol:density                  1  18.376 7073.1 2164.0
## - residual.sugar:pH                 1  21.062 7075.7 2165.8
## - volatile.acidity:fixed.acidity    1  22.751 7077.4 2167.0
## - residual.sugar:citric.acid        1  24.392 7079.1 2168.1
## - sulphates:total.sulfur.dioxide    1  30.610 7085.3 2172.4

```

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## - residual.sugar:total.sulfur.dioxide      1  30.873 7085.6 2172.6
## - volatile.acidity:residual.sugar         1  33.725 7088.4 2174.6
## - free.sulfur.dioxide:total.sulfur.dioxide 1  51.821 7106.5 2187.1
## - volatile.acidity:density                1  63.620 7118.3 2195.2
## - pH:Wine.Color                          1  84.901 7139.6 2209.8
## - density:Wine.Color                     2  99.815 7154.5 2211.6
## - volatile.acidity:alcohol                1 102.599 7157.3 2222.0
##
## Step: AIC=2152.35
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##          sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##          citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
##          pH:Wine.Color + free.sulfur.dioxide:Wine.Color + total.sulfur.dioxide:Wine.Color +
##          fixed.acidity:citric.acid + free.sulfur.dioxide:citric.acid +
##          sulphates:citric.acid + pH:citric.acid + alcohol:citric.acid +
##          residual.sugar:citric.acid + citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##          residual.sugar:total.sulfur.dioxide + pH:fixed.acidity +
##          volatile.acidity:fixed.acidity + sulphates:free.sulfur.dioxide +
##          alcohol:free.sulfur.dioxide + residual.sugar:free.sulfur.dioxide +
##          volatile.acidity:free.sulfur.dioxide + free.sulfur.dioxide:density +
##          volatile.acidity:sulphates + alcohol:pH + residual.sugar:pH +
##          residual.sugar:alcohol + volatile.acidity:alcohol + alcohol:density +
##          volatile.acidity:residual.sugar + residual.sugar:density +
##          volatile.acidity:density
##
##                                         Df Sum of Sq   RSS   AIC
## - alcohol:free.sulfur.dioxide           1   2.168 7058.5 2145.4
## - sulphates:free.sulfur.dioxide        1   2.737 7059.1 2145.8
## - fixed.acidity:total.sulfur.dioxide   1   2.743 7059.1 2145.8
## - residual.sugar:Wine.Color            1   3.357 7059.7 2146.2
## - free.sulfur.dioxide:density          1   3.912 7060.2 2146.6
## - free.sulfur.dioxide:citric.acid     1   4.551 7060.9 2147.0
## - sulphates:citric.acid               1   5.641 7062.0 2147.8
## - volatile.acidity:free.sulfur.dioxide 1   5.933 7062.3 2148.0
## - pH:fixed.acidity                   1   6.095 7062.4 2148.1
## - total.sulfur.dioxide:Wine.Color     1   7.150 7063.5 2148.8
## - residual.sugar:density              1   7.920 7064.3 2149.3
## - alcohol:pH                         1   8.875 7065.2 2150.0
## - volatile.acidity:sulphates           1   9.372 7065.7 2150.4
## - residual.sugar:free.sulfur.dioxide   1   9.665 7066.0 2150.6
## - pH:citric.acid                    1  10.603 7066.9 2151.2
## - citric.acid:density                1  11.325 7067.7 2151.7
## <none>                                7056.3 2152.3
## - free.sulfur.dioxide:Wine.Color       1  12.553 7068.9 2152.6
## - fixed.acidity:citric.acid           1  13.453 7069.8 2153.2
## - residual.sugar:alcohol              1  14.884 7071.2 2154.2
## - alcohol:citric.acid                1  15.738 7072.1 2154.8
## - alcohol:density                   1  16.905 7073.2 2155.6
## - residual.sugar:pH                  1  20.557 7076.9 2158.1
## - volatile.acidity:fixed.acidity     1  22.676 7079.0 2159.6
## - residual.sugar:citric.acid         1  24.586 7080.9 2160.9
## - sulphates:total.sulfur.dioxide     1  31.415 7087.7 2165.6
## - volatile.acidity:residual.sugar    1  33.183 7089.5 2166.8

```

```

## - residual.sugar:total.sulfur.dioxide      1  39.026 7095.4 2170.9
## - free.sulfur.dioxide:total.sulfur.dioxide 1  51.805 7108.1 2179.7
## - volatile.acidity:density                1  63.203 7119.5 2187.6
## - pH:Wine.Color                          1  83.964 7140.3 2201.8
## - density:Wine.Color                     2  99.255 7155.6 2203.8
## - volatile.acidity:alcohol               1 103.641 7160.0 2215.3
##
## Step: AIC=2145.36
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##          sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##          citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
##          pH:Wine.Color + free.sulfur.dioxide:Wine.Color + total.sulfur.dioxide:Wine.Color +
##          fixed.acidity:citric.acid + free.sulfur.dioxide:citric.acid +
##          sulphates:citric.acid + pH:citric.acid + alcohol:citric.acid +
##          residual.sugar:citric.acid + citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##          residual.sugar:total.sulfur.dioxide + pH:fixed.acidity +
##          volatile.acidity:fixed.acidity + sulphates:free.sulfur.dioxide +
##          residual.sugar:free.sulfur.dioxide + volatile.acidity:free.sulfur.dioxide +
##          free.sulfur.dioxide:density + volatile.acidity:sulphates +
##          alcohol:pH + residual.sugar:pH + residual.sugar:alcohol +
##          volatile.acidity:alcohol + alcohol:density + volatile.acidity:residual.sugar +
##          residual.sugar:density + volatile.acidity:density
##
##                                         Df Sum of Sq   RSS   AIC
## - free.sulfur.dioxide:density           1   1.756 7060.3 2138.1
## - residual.sugar:Wine.Color            1   3.270 7061.8 2139.1
## - sulphates:free.sulfur.dioxide        1   4.388 7062.9 2139.9
## - fixed.acidity:total.sulfur.dioxide   1   4.841 7063.3 2140.2
## - free.sulfur.dioxide:citric.acid     1   4.883 7063.4 2140.2
## - sulphates:citric.acid              1   5.123 7063.6 2140.4
## - pH:fixed.acidity                   1   5.807 7064.3 2140.9
## - volatile.acidity:free.sulfur.dioxide 1   6.105 7064.6 2141.1
## - residual.sugar:free.sulfur.dioxide   1   7.563 7066.1 2142.1
## - residual.sugar:density              1   7.686 7066.2 2142.2
## - total.sulfur.dioxide:Wine.Color     1   7.848 7066.3 2142.3
## - volatile.acidity:sulphates          1   8.372 7066.9 2142.7
## - alcohol:pH                         1   8.502 7067.0 2142.8
## - pH:citric.acid                    1   9.944 7068.4 2143.8
## - citric.acid:density                1  10.408 7068.9 2144.1
## - free.sulfur.dioxide:Wine.Color     1  10.452 7069.0 2144.1
## <none>                                7058.5 2145.4
## - fixed.acidity:citric.acid          1  13.026 7071.5 2145.9
## - alcohol:citric.acid               1  14.928 7073.4 2147.2
## - residual.sugar:alcohol             1  18.329 7076.8 2149.6
## - alcohol:density                   1  19.423 7077.9 2150.3
## - residual.sugar:pH                 1  20.046 7078.5 2150.8
## - volatile.acidity:fixed.acidity    1  22.312 7080.8 2152.3
## - residual.sugar:citric.acid        1  23.535 7082.0 2153.2
## - sulphates:total.sulfur.dioxide   1  32.595 7091.1 2159.4
## - volatile.acidity:residual.sugar   1  33.038 7091.5 2159.8
## - residual.sugar:total.sulfur.dioxide 1  40.855 7099.4 2165.1
## - free.sulfur.dioxide:total.sulfur.dioxide 1  58.592 7117.1 2177.4
## - volatile.acidity:density          1  61.058 7119.6 2179.1

```

```

## - density:Wine.Color          2  98.590 7157.1 2196.3
## - pH:Wine.Color               1  87.460 7146.0 2197.2
## - volatile.acidity:alcohol    1 102.290 7160.8 2207.4
##
## Step: AIC=2138.08
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##           sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##           citric.acid + density:Wine.Color + residual.sugar:Wine.Color +
##           pH:Wine.Color + free.sulfur.dioxide:Wine.Color + total.sulfur.dioxide:Wine.Color +
##           fixed.acidity:citric.acid + free.sulfur.dioxide:citric.acid +
##           sulphates:citric.acid + pH:citric.acid + alcohol:citric.acid +
##           residual.sugar:citric.acid + citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##           free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##           residual.sugar:total.sulfur.dioxide + pH:fixed.acidity +
##           volatile.acidity:fixed.acidity + sulphates:free.sulfur.dioxide +
##           residual.sugar:free.sulfur.dioxide + volatile.acidity:free.sulfur.dioxide +
##           volatile.acidity:sulphates + alcohol:pH + residual.sugar:pH +
##           residual.sugar:alcohol + volatile.acidity:alcohol + alcohol:density +
##           volatile.acidity:residual.sugar + residual.sugar:density +
##           volatile.acidity:density
##
##                                     Df Sum of Sq   RSS   AIC
## - residual.sugar:Wine.Color      1  3.065 7063.3 2131.7
## - sulphates:free.sulfur.dioxide  1  4.455 7064.7 2132.7
## - sulphates:citric.acid         1  4.927 7065.2 2133.0
## - pH:fixed.acidity              1  5.973 7066.2 2133.7
## - free.sulfur.dioxide:citric.acid 1  6.048 7066.3 2133.8
## - volatile.acidity:free.sulfur.dioxide 1  6.855 7067.1 2134.3
## - residual.sugar:free.sulfur.dioxide 1  7.241 7067.5 2134.6
## - residual.sugar:density         1  7.586 7067.8 2134.8
## - fixed.acidity:total.sulfur.dioxide 1  7.651 7067.9 2134.9
## - volatile.acidity:sulphates      1  7.879 7068.1 2135.1
## - total.sulfur.dioxide:Wine.Color 1  8.220 7068.5 2135.3
## - alcohol:pH                     1  8.572 7068.8 2135.5
## - free.sulfur.dioxide:Wine.Color 1  8.860 7069.1 2135.7
## - pH:citric.acid                1  9.898 7070.2 2136.4
## - citric.acid:density            1 10.182 7070.4 2136.7
## <none>                           7060.3 2138.1
## - fixed.acidity:citric.acid     1 12.802 7073.1 2138.5
## - alcohol:citric.acid            1 14.677 7074.9 2139.8
## - residual.sugar:alcohol          1 16.863 7077.1 2141.3
## - alcohol:density                 1 18.690 7078.9 2142.5
## - residual.sugar:pH               1 18.888 7079.1 2142.7
## - volatile.acidity:fixed.acidity 1 21.294 7081.6 2144.3
## - residual.sugar:citric.acid     1 23.435 7083.7 2145.8
## - volatile.acidity:residual.sugar 1 31.850 7092.1 2151.6
## - sulphates:total.sulfur.dioxide 1 31.917 7092.2 2151.7
## - residual.sugar:total.sulfur.dioxide 1 39.289 7099.5 2156.8
## - free.sulfur.dioxide:total.sulfur.dioxide 1 58.954 7119.2 2170.3
## - volatile.acidity:density        1 59.315 7119.6 2170.6
## - density:Wine.Color              2  97.271 7157.5 2188.1
## - pH:Wine.Color                  1  88.081 7148.3 2190.3
## - volatile.acidity:alcohol         1 103.463 7163.7 2200.9
##

```

```

## Step: AIC=2131.71
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##      sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##      citric.acid + density:Wine.Color + pH:Wine.Color + free.sulfur.dioxide:Wine.Color +
##      total.sulfur.dioxide:Wine.Color + fixed.acidity:citric.acid +
##      free.sulfur.dioxide:citric.acid + sulphates:citric.acid +
##      pH:citric.acid + alcohol:citric.acid + residual.sugar:citric.acid +
##      citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##      free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##      residual.sugar:total.sulfur.dioxide + pH:fixed.acidity +
##      volatile.acidity:fixed.acidity + sulphates:free.sulfur.dioxide +
##      residual.sugar:free.sulfur.dioxide + volatile.acidity:free.sulfur.dioxide +
##      volatile.acidity:sulphates + alcohol:pH + residual.sugar:pH +
##      residual.sugar:alcohol + volatile.acidity:alcohol + alcohol:density +
##      volatile.acidity:residual.sugar + residual.sugar:density +
##      volatile.acidity:density
##
##                                     Df Sum of Sq    RSS    AIC
## - sulphates:free.sulfur.dioxide   1   4.375 7067.7 2126.2
## - sulphates:citric.acid          1   4.489 7067.8 2126.3
## - pH:fixed.acidity               1   5.708 7069.0 2127.2
## - free.sulfur.dioxide:citric.acid 1   5.910 7069.2 2127.3
## - volatile.acidity:free.sulfur.dioxide 1   6.005 7069.3 2127.4
## - residual.sugar:free.sulfur.dioxide 1   6.422 7069.7 2127.7
## - free.sulfur.dioxide:Wine.Color    1   7.377 7070.7 2128.3
## - total.sulfur.dioxide:Wine.Color    1   7.398 7070.7 2128.3
## - fixed.acidity:total.sulfur.dioxide 1   7.725 7071.0 2128.6
## - volatile.acidity:sulphates        1   8.029 7071.4 2128.8
## - alcohol:pH                      1   8.787 7072.1 2129.3
## - pH:citric.acid                  1   9.719 7073.0 2129.9
## - residual.sugar:density          1  10.005 7073.3 2130.2
## - citric.acid:density             1  10.135 7073.5 2130.2
## <none>                           7063.3 2131.7
## - fixed.acidity:citric.acid       1  12.755 7076.1 2132.1
## - residual.sugar:alcohol          1  14.877 7078.2 2133.5
## - alcohol:citric.acid            1  15.301 7078.6 2133.8
## - residual.sugar:pH              1  17.581 7080.9 2135.4
## - alcohol:density                1  18.960 7082.3 2136.3
## - volatile.acidity:fixed.acidity  1  21.410 7084.7 2138.1
## - residual.sugar:citric.acid     1  22.717 7086.0 2138.9
## - volatile.acidity:residual.sugar 1  29.229 7092.6 2143.4
## - sulphates:total.sulfur.dioxide 1  31.254 7094.6 2144.8
## - residual.sugar:total.sulfur.dioxide 1  36.256 7099.6 2148.3
## - free.sulfur.dioxide:total.sulfur.dioxide 1  56.098 7119.4 2162.0
## - volatile.acidity:density        1  61.955 7125.3 2166.0
## - density:Wine.Color              2  98.770 7162.1 2182.8
## - pH:Wine.Color                  1  87.994 7151.3 2183.9
## - volatile.acidity:alcohol        1 108.202 7171.5 2197.7
##
## Step: AIC=2126.25
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##      sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##      citric.acid + density:Wine.Color + pH:Wine.Color + free.sulfur.dioxide:Wine.Color +
##      total.sulfur.dioxide:Wine.Color + fixed.acidity:citric.acid +

```

```

## free.sulfur.dioxide:citric.acid + sulphates:citric.acid +
## pH:citric.acid + alcohol:citric.acid + residual.sugar:citric.acid +
## citric.acid:density + fixed.acidity:total.sulfur.dioxide +
## free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
## residual.sugar:total.sulfur.dioxide + pH:fixed.acidity +
## volatile.acidity:fixed.acidity + residual.sugar:free.sulfur.dioxide +
## volatile.acidity:free.sulfur.dioxide + volatile.acidity:sulphates +
## alcohol:pH + residual.sugar:pH + residual.sugar:alcohol +
## volatile.acidity:alcohol + alcohol:density + volatile.acidity:residual.sugar +
## residual.sugar:density + volatile.acidity:density
##
##                                     Df Sum of Sq    RSS     AIC
## - free.sulfur.dioxide:Wine.Color      1   4.400 7072.1 2120.8
## - sulphates:citric.acid             1   4.968 7072.7 2121.2
## - volatile.acidity:free.sulfur.dioxide 1   5.020 7072.7 2121.2
## - pH:fixed.acidity                 1   6.189 7073.9 2122.0
## - free.sulfur.dioxide:citric.acid    1   6.781 7074.5 2122.4
## - fixed.acidity:total.sulfur.dioxide 1   7.299 7075.0 2122.8
## - residual.sugar:free.sulfur.dioxide 1   7.393 7075.1 2122.9
## - alcohol:pH                       1   9.133 7076.8 2124.1
## - pH:citric.acid                  1   9.248 7076.9 2124.2
## - total.sulfur.dioxide:Wine.Color    1   9.645 7077.3 2124.4
## - residual.sugar:density           1   9.860 7077.6 2124.6
## - citric.acid:density              1  10.121 7077.8 2124.8
## - volatile.acidity:sulphates       1  12.043 7079.7 2126.1
## <none>                            7067.7 2126.2
## - fixed.acidity:citric.acid        1  12.369 7080.1 2126.3
## - residual.sugar:alcohol           1  14.566 7082.3 2127.8
## - alcohol:citric.acid             1  15.572 7083.3 2128.5
## - residual.sugar:pH                1  17.637 7085.3 2130.0
## - alcohol:density                 1  18.423 7086.1 2130.5
## - volatile.acidity:fixed.acidity   1  20.497 7088.2 2131.9
## - residual.sugar:citric.acid       1  22.951 7090.6 2133.6
## - volatile.acidity:residual.sugar  1  29.836 7097.5 2138.4
## - sulphates:total.sulfur.dioxide   1  31.365 7099.1 2139.4
## - residual.sugar:total.sulfur.dioxide 1  36.516 7104.2 2143.0
## - free.sulfur.dioxide:total.sulfur.dioxide 1  53.864 7121.6 2155.0
## - volatile.acidity:density         1  61.869 7129.6 2160.5
## - density:Wine.Color               2  96.376 7164.1 2175.6
## - pH:Wine.Color                   1  85.953 7153.7 2177.0
## - volatile.acidity:alcohol         1 107.715 7175.4 2191.9
##
## Step:  AIC=2120.8
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##          sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##          citric.acid + density:Wine.Color + pH:Wine.Color + total.sulfur.dioxide:Wine.Color +
##          fixed.acidity:citric.acid + free.sulfur.dioxide:citric.acid +
##          sulphates:citric.acid + pH:citric.acid + alcohol:citric.acid +
##          residual.sugar:citric.acid + citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##          residual.sugar:total.sulfur.dioxide + pH:fixed.acidity +
##          volatile.acidity:fixed.acidity + residual.sugar:free.sulfur.dioxide +
##          volatile.acidity:free.sulfur.dioxide + volatile.acidity:sulphates +
##          alcohol:pH + residual.sugar:pH + residual.sugar:alcohol +

```

```

##      volatile.acidity:alcohol + alcohol:density + volatile.acidity:residual.sugar +
##      residual.sugar:density + volatile.acidity:density
##
##                                     Df Sum of Sq   RSS   AIC
## - volatile.acidity:free.sulfur.dioxide    1   2.147 7074.2 2113.8
## - sulphates:citric.acid                 1   5.305 7077.4 2116.0
## - pH:fixed.acidity                      1   5.975 7078.1 2116.4
## - fixed.acidity:total.sulfur.dioxide     1   6.730 7078.8 2117.0
## - residual.sugar:free.sulfur.dioxide     1   6.863 7079.0 2117.1
## - free.sulfur.dioxide:citric.acid        1   7.196 7079.3 2117.3
## - pH:citric.acid                        1   9.401 7081.5 2118.8
## - alcohol:pH                            1   9.481 7081.6 2118.9
## - residual.sugar:density                1  11.078 7083.2 2120.0
## - citric.acid:density                  1  11.315 7083.4 2120.1
## - volatile.acidity:sulphates            1  11.898 7084.0 2120.5
## <none>                                7072.1 2120.8
## - fixed.acidity:citric.acid             1  13.173 7085.3 2121.4
## - residual.sugar:alcohol                1  14.647 7086.7 2122.4
## - alcohol:citric.acid                  1  16.590 7088.7 2123.8
## - residual.sugar:pH                    1  18.289 7090.4 2125.0
## - total.sulfur.dioxide:Wine.Color       1  18.496 7090.6 2125.1
## - alcohol:density                      1  19.874 7092.0 2126.1
## - volatile.acidity:fixed.acidity        1  21.420 7093.5 2127.1
## - residual.sugar:citric.acid           1  24.579 7096.7 2129.3
## - volatile.acidity:residual.sugar       1  28.457 7100.6 2132.0
## - sulphates:total.sulfur.dioxide       1  32.369 7104.5 2134.7
## - residual.sugar:total.sulfur.dioxide   1  34.212 7106.3 2135.9
## - free.sulfur.dioxide:total.sulfur.dioxide 1  50.359 7122.5 2147.1
## - volatile.acidity:density              1  62.295 7134.4 2155.3
## - density:Wine.Color                   2  96.041 7168.1 2169.9
## - pH:Wine.Color                        1  88.154 7160.3 2173.0
## - volatile.acidity:alcohol              1 106.401 7178.5 2185.5
##
## Step:  AIC=2113.79
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##          sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##          citric.acid + density:Wine.Color + pH:Wine.Color + total.sulfur.dioxide:Wine.Color +
##          fixed.acidity:citric.acid + free.sulfur.dioxide:citric.acid +
##          sulphates:citric.acid + pH:citric.acid + alcohol:citric.acid +
##          residual.sugar:citric.acid + citric.acid:density + fixed.acidity:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##          residual.sugar:total.sulfur.dioxide + pH:fixed.acidity +
##          volatile.acidity:fixed.acidity + residual.sugar:free.sulfur.dioxide +
##          volatile.acidity:sulphates + alcohol:pH + residual.sugar:pH +
##          residual.sugar:alcohol + volatile.acidity:alcohol + alcohol:density +
##          volatile.acidity:residual.sugar + residual.sugar:density +
##          volatile.acidity:density
##
##                                     Df Sum of Sq   RSS   AIC
## - free.sulfur.dioxide:citric.acid      1   5.660 7079.9 2109.2
## - sulphates:citric.acid                1   5.661 7079.9 2109.2
## - pH:fixed.acidity                     1   6.130 7080.4 2109.5
## - fixed.acidity:total.sulfur.dioxide    1   6.381 7080.6 2109.7
## - residual.sugar:free.sulfur.dioxide    1   6.818 7081.1 2110.0

```

```

## - alcohol:pH
## - pH:citric.acid
## - citric.acid:density
## <none>
## - volatile.acidity:sulphates
## - residual.sugar:density
## - fixed.acidity:citric.acid
## - residual.sugar:alcohol
## - alcohol:citric.acid
## - total.sulfur.dioxide:Wine.Color
## - residual.sugar:pH
## - alcohol:density
## - volatile.acidity:fixed.acidity
## - residual.sugar:citric.acid
## - volatile.acidity:residual.sugar
## - sulphates:total.sulfur.dioxide
## - residual.sugar:total.sulfur.dioxide
## - free.sulfur.dioxide:total.sulfur.dioxide
## - volatile.acidity:density
## - density:Wine.Color
## - pH:Wine.Color
## - volatile.acidity:alcohol
##
## Step: AIC=2109.22
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##       sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##       citric.acid + density:Wine.Color + pH:Wine.Color + total.sulfur.dioxide:Wine.Color +
##       fixed.acidity:citric.acid + sulphates:citric.acid + pH:citric.acid +
##       alcohol:citric.acid + residual.sugar:citric.acid + citric.acid:density +
##       fixed.acidity:total.sulfur.dioxide + free.sulfur.dioxide:total.sulfur.dioxide +
##       sulphates:total.sulfur.dioxide + residual.sugar:total.sulfur.dioxide +
##       pH:fixed.acidity + volatile.acidity:fixed.acidity + residual.sugar:free.sulfur.dioxide +
##       volatile.acidity:sulphates + alcohol:pH + residual.sugar:pH +
##       residual.sugar:alcohol + volatile.acidity:alcohol + alcohol:density +
##       volatile.acidity:residual.sugar + residual.sugar:density +
##       volatile.acidity:density
##
##                                     Df Sum of Sq   RSS   AIC
## - residual.sugar:free.sulfur.dioxide    1   5.641 7085.5 2104.6
## - sulphates:citric.acid                1   6.007 7085.9 2104.9
## - pH:fixed.acidity                     1   6.626 7086.5 2105.3
## - fixed.acidity:total.sulfur.dioxide    1   8.657 7088.6 2106.7
## - citric.acid:density                  1   9.207 7089.1 2107.1
## - alcohol:pH                          1   9.633 7089.5 2107.4
## - pH:citric.acid                      1  10.845 7090.8 2108.2
## <none>                                7079.9 2109.2
## - residual.sugar:density               1  12.626 7092.5 2109.4
## - fixed.acidity:citric.acid            1  13.052 7093.0 2109.7
## - alcohol:citric.acid                 1  13.135 7093.0 2109.8
## - volatile.acidity:sulphates           1  13.352 7093.3 2109.9
## - residual.sugar:alcohol                1  14.128 7094.0 2110.5
## - residual.sugar:pH                   1  17.832 7097.7 2113.1
## - total.sulfur.dioxide:Wine.Color      1  19.280 7099.2 2114.0
## - residual.sugar:citric.acid           1  19.326 7099.2 2114.1

```

```

## - alcohol:density
## - volatile.acidity:fixed.acidity
## - volatile.acidity:residual.sugar
## - sulphates:total.sulfur.dioxide
## - residual.sugar:total.sulfur.dioxide
## - free.sulfur.dioxide:total.sulfur.dioxide
## - volatile.acidity:density
## - density:Wine.Color
## - pH:Wine.Color
## - volatile.acidity:alcohol
## 
## Step: AIC=2104.62
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##     sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##     citric.acid + density:Wine.Color + pH:Wine.Color + total.sulfur.dioxide:Wine.Color +
##     fixed.acidity:citric.acid + sulphates:citric.acid + pH:citric.acid +
##     alcohol:citric.acid + residual.sugar:citric.acid + citric.acid:density +
##     fixed.acidity:total.sulfur.dioxide + free.sulfur.dioxide:total.sulfur.dioxide +
##     sulphates:total.sulfur.dioxide + residual.sugar:total.sulfur.dioxide +
##     pH:fixed.acidity + volatile.acidity:fixed.acidity + volatile.acidity:sulphates +
##     alcohol:pH + residual.sugar:pH + residual.sugar:alcohol +
##     volatile.acidity:alcohol + alcohol:density + volatile.acidity:residual.sugar +
##     residual.sugar:density + volatile.acidity:density
## 
##                                     Df Sum of Sq    RSS    AIC
## - sulphates:citric.acid          1   5.942 7091.5 2100.2
## - pH:fixed.acidity               1   6.651 7092.2 2100.7
## - fixed.acidity:total.sulfur.dioxide  1   8.716 7094.3 2102.2
## - citric.acid:density            1   9.989 7095.5 2103.0
## - alcohol:pH                      1  10.169 7095.7 2103.2
## - residual.sugar:density          1  11.449 7097.0 2104.0
## - pH:citric.acid                 1  11.634 7097.2 2104.2
## <none>                           7085.5 2104.6
## - volatile.acidity:sulphates      1  13.570 7099.1 2105.5
## - fixed.acidity:citric.acid       1  13.883 7099.4 2105.7
## - alcohol:citric.acid             1  14.279 7099.8 2106.0
## - residual.sugar:alcohol           1  15.393 7100.9 2106.8
## - residual.sugar:pH                1  19.597 7105.1 2109.7
## - alcohol:density                  1  20.606 7106.2 2110.3
## - residual.sugar:citric.acid       1  20.831 7106.4 2110.5
## - volatile.acidity:fixed.acidity    1  21.426 7107.0 2110.9
## - total.sulfur.dioxide:Wine.Color  1  23.946 7109.5 2112.7
## - volatile.acidity:residual.sugar   1  26.575 7112.1 2114.5
## - residual.sugar:total.sulfur.dioxide 1  29.967 7115.5 2116.8
## - sulphates:total.sulfur.dioxide   1  32.469 7118.0 2118.5
## - volatile.acidity:density          1  65.430 7151.0 2141.2
## - free.sulfur.dioxide:total.sulfur.dioxide 1  69.746 7155.3 2144.1
## - density:Wine.Color                2  99.450 7185.0 2155.9
## - pH:Wine.Color                     1  89.985 7175.5 2158.0
## - volatile.acidity:alcohol           1 107.312 7192.9 2169.8
## 
## Step: AIC=2100.23
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##     sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +

```

```

## citric.acid + density:Wine.Color + pH:Wine.Color + total.sulfur.dioxide:Wine.Color +
## fixed.acidity:citric.acid + pH:citric.acid + alcohol:citric.acid +
## residual.sugar:citric.acid + citric.acid:density + fixed.acidity:total.sulfur.dioxide +
## free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
## residual.sugar:total.sulfur.dioxide + pH:fixed.acidity +
## volatile.acidity:fixed.acidity + volatile.acidity:sulphates +
## alcohol:pH + residual.sugar:pH + residual.sugar:alcohol +
## volatile.acidity:alcohol + alcohol:density + volatile.acidity:residual.sugar +
## residual.sugar:density + volatile.acidity:density
##
##                                     Df Sum of Sq   RSS   AIC
## - citric.acid:density           1   5.800 7097.3 2095.7
## - pH:fixed.acidity             1   6.650 7098.1 2096.3
## - fixed.acidity:total.sulfur.dioxide  1   7.571 7099.1 2097.0
## - volatile.acidity:sulphates    1   9.453 7100.9 2098.3
## - residual.sugar:density       1   9.729 7101.2 2098.4
## - pH:citric.acid              1  10.056 7101.5 2098.7
## - alcohol:citric.acid         1  10.306 7101.8 2098.8
## - alcohol:pH                  1  11.152 7102.6 2099.4
## - fixed.acidity:citric.acid   1  11.553 7103.0 2099.7
## <none>                         7091.5 2100.2
## - residual.sugar:citric.acid  1  15.619 7107.1 2102.5
## - residual.sugar:alcohol       1  17.006 7108.5 2103.5
## - residual.sugar:pH            1  19.893 7111.4 2105.5
## - volatile.acidity:fixed.acidity 1  20.005 7111.5 2105.5
## - alcohol:density              1  21.389 7112.9 2106.5
## - total.sulfur.dioxide:Wine.Color 1  23.555 7115.0 2108.0
## - volatile.acidity:residual.sugar 1  23.759 7115.2 2108.1
## - residual.sugar:total.sulfur.dioxide 1  29.589 7121.1 2112.1
## - sulphates:total.sulfur.dioxide 1  29.860 7121.3 2112.3
## - volatile.acidity:density      1  61.429 7152.9 2134.0
## - free.sulfur.dioxide:total.sulfur.dioxide 1  69.425 7160.9 2139.5
## - density:Wine.Color            2  95.083 7186.6 2148.5
## - pH:Wine.Color                 1  86.593 7178.1 2151.2
## - volatile.acidity:alcohol      1 105.276 7196.8 2163.9
##
## Step:  AIC=2095.74
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##          sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##          citric.acid + density:Wine.Color + pH:Wine.Color + total.sulfur.dioxide:Wine.Color +
##          fixed.acidity:citric.acid + pH:citric.acid + alcohol:citric.acid +
##          residual.sugar:citric.acid + fixed.acidity:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##          residual.sugar:total.sulfur.dioxide + pH:fixed.acidity +
##          volatile.acidity:fixed.acidity + volatile.acidity:sulphates +
##          alcohol:pH + residual.sugar:pH + residual.sugar:alcohol +
##          volatile.acidity:alcohol + alcohol:density + volatile.acidity:residual.sugar +
##          residual.sugar:density + volatile.acidity:density
##
##                                     Df Sum of Sq   RSS   AIC
## - alcohol:citric.acid          1   4.528 7101.8 2090.4
## - pH:citric.acid               1   4.532 7101.8 2090.4
## - residual.sugar:density        1   5.198 7102.5 2090.8
## - fixed.acidity:citric.acid    1   6.842 7104.1 2092.0

```

```

## - fixed.acidity:total.sulfur.dioxide      1    7.166 7104.5 2092.2
## - pH:fixed.acidity                      1    7.721 7105.0 2092.6
## - volatile.acidity:sulphates            1    9.643 7106.9 2093.9
## - alcohol:pH                            1   10.989 7108.3 2094.8
## - residual.sugar:citric.acid           1   11.427 7108.7 2095.1
## <none>                                7097.3 2095.7
## - volatile.acidity:fixed.acidity       1   15.918 7113.2 2098.2
## - residual.sugar:alcohol                1   18.869 7116.2 2100.2
## - alcohol:density                      1   18.979 7116.3 2100.3
## - volatile.acidity:residual.sugar      1   20.362 7117.6 2101.3
## - residual.sugar:pH                   1   20.963 7118.3 2101.7
## - total.sulfur.dioxide:Wine.Color     1   21.683 7119.0 2102.2
## - residual.sugar:total.sulfur.dioxide 1   28.543 7125.8 2106.9
## - sulphates:total.sulfur.dioxide     1   31.109 7128.4 2108.7
## - volatile.acidity:density            1   55.688 7153.0 2125.5
## - free.sulfur.dioxide:total.sulfur.dioxide 1   66.838 7164.1 2133.2
## - density:Wine.Color                  2   96.300 7193.6 2144.8
## - pH:Wine.Color                       1   88.797 7186.1 2148.2
## - volatile.acidity:alcohol             1   99.651 7196.9 2155.6
##
## Step: AIC=2090.37
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##          sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##          citric.acid + density:Wine.Color + pH:Wine.Color + total.sulfur.dioxide:Wine.Color +
##          fixed.acidity:citric.acid + pH:citric.acid + residual.sugar:citric.acid +
##          fixed.acidity:total.sulfur.dioxide + free.sulfur.dioxide:total.sulfur.dioxide +
##          sulphates:total.sulfur.dioxide + residual.sugar:total.sulfur.dioxide +
##          pH:fixed.acidity + volatile.acidity:fixed.acidity + volatile.acidity:sulphates +
##          alcohol:pH + residual.sugar:pH + residual.sugar:alcohol +
##          volatile.acidity:alcohol + alcohol:density + volatile.acidity:residual.sugar +
##          residual.sugar:density + volatile.acidity:density
##
##                                     Df Sum of Sq   RSS   AIC
## - pH:citric.acid                 1   2.780 7104.6 2083.8
## - residual.sugar:density         1   4.486 7106.3 2085.0
## - fixed.acidity:citric.acid     1   6.331 7108.1 2086.2
## - pH:fixed.acidity               1   7.087 7108.9 2086.8
## - fixed.acidity:total.sulfur.dioxide 1   7.133 7108.9 2086.8
## - alcohol:pH                     1   7.847 7109.7 2087.3
## - volatile.acidity:sulphates    1   10.032 7111.8 2088.8
## <none>                           7101.8 2090.4
## - residual.sugar:citric.acid    1  14.347 7116.2 2091.8
## - alcohol:density                1  15.246 7117.1 2092.4
## - volatile.acidity:fixed.acidity 1  16.670 7118.5 2093.4
## - residual.sugar:alcohol         1  17.045 7118.9 2093.6
## - total.sulfur.dioxide:Wine.Color 1  21.887 7123.7 2096.9
## - volatile.acidity:residual.sugar 1  22.502 7124.3 2097.4
## - residual.sugar:pH              1  23.590 7125.4 2098.1
## - residual.sugar:total.sulfur.dioxide 1  28.177 7130.0 2101.3
## - sulphates:total.sulfur.dioxide 1  32.201 7134.0 2104.0
## - volatile.acidity:density       1  56.857 7158.7 2120.9
## - free.sulfur.dioxide:total.sulfur.dioxide 1  65.994 7167.8 2127.2
## - density:Wine.Color             2  96.693 7198.5 2139.6
## - pH:Wine.Color                  1  89.365 7191.2 2143.2

```

```

## - volatile.acidity:alcohol          1   95.297 7197.1 2147.2
##
## Step: AIC=2083.79
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##           sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##           citric.acid + density:Wine.Color + pH:Wine.Color + total.sulfur.dioxide:Wine.Color +
##           fixed.acidity:citric.acid + residual.sugar:citric.acid +
##           fixed.acidity:total.sulfur.dioxide + free.sulfur.dioxide:total.sulfur.dioxide +
##           sulphates:total.sulfur.dioxide + residual.sugar:total.sulfur.dioxide +
##           pH:fixed.acidity + volatile.acidity:fixed.acidity + volatile.acidity:sulphates +
##           alcohol:pH + residual.sugar:pH + residual.sugar:alcohol +
##           volatile.acidity:alcohol + alcohol:density + volatile.acidity:residual.sugar +
##           residual.sugar:density + volatile.acidity:density
##
##                                     Df Sum of Sq    RSS     AIC
## - fixed.acidity:citric.acid      1   4.682 7109.3 2078.5
## - pH:fixed.acidity               1   4.782 7109.4 2078.6
## - residual.sugar:density        1   6.196 7110.8 2079.6
## - fixed.acidity:total.sulfur.dioxide  1   7.415 7112.0 2080.4
## - alcohol:pH                     1   7.837 7112.4 2080.7
## - volatile.acidity:sulphates    1   9.786 7114.4 2082.0
## <none>                           7104.6 2083.8
## - residual.sugar:citric.acid    1  12.433 7117.0 2083.9
## - alcohol:density                1  16.230 7120.8 2086.5
## - residual.sugar:alcohol         1  16.685 7121.3 2086.8
## - volatile.acidity:fixed.acidity 1  20.688 7125.3 2089.5
## - total.sulfur.dioxide:Wine.Color 1  23.420 7128.0 2091.4
## - residual.sugar:pH              1  24.351 7128.9 2092.1
## - volatile.acidity:residual.sugar 1  25.819 7130.4 2093.1
## - residual.sugar:total.sulfur.dioxide 1  28.671 7133.3 2095.0
## - sulphates:total.sulfur.dioxide 1  32.073 7136.7 2097.4
## - free.sulfur.dioxide:total.sulfur.dioxide 1  66.986 7171.6 2121.3
## - volatile.acidity:density       1  68.233 7172.8 2122.1
## - density:Wine.Color             2  94.338 7198.9 2131.4
## - pH:Wine.Color                  1  87.038 7191.6 2135.0
## - volatile.acidity:alcohol        1 103.764 7208.4 2146.3
##
## Step: AIC=2078.52
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##           sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##           citric.acid + density:Wine.Color + pH:Wine.Color + total.sulfur.dioxide:Wine.Color +
##           residual.sugar:citric.acid + fixed.acidity:total.sulfur.dioxide +
##           free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##           residual.sugar:total.sulfur.dioxide + pH:fixed.acidity +
##           volatile.acidity:fixed.acidity + volatile.acidity:sulphates +
##           alcohol:pH + residual.sugar:pH + residual.sugar:alcohol +
##           volatile.acidity:alcohol + alcohol:density + volatile.acidity:residual.sugar +
##           residual.sugar:density + volatile.acidity:density
##
##                                     Df Sum of Sq    RSS     AIC
## - residual.sugar:density         1   6.696 7116.0 2074.6
## - alcohol:pH                     1   8.487 7117.8 2075.9
## - volatile.acidity:sulphates    1   9.631 7118.9 2076.7
## - residual.sugar:citric.acid    1  11.152 7120.4 2077.7

```

```

## <none>
## - fixed.acidity:total.sulfur.dioxide      1 12.656 7121.9 2078.7
## - pH:fixed.acidity                      1 13.584 7122.9 2079.4
## - alcohol:density                        1 17.402 7126.7 2082.0
## - residual.sugar:alcohol                 1 17.411 7126.7 2082.0
## - volatile.acidity:fixed.acidity        1 19.912 7129.2 2083.7
## - residual.sugar:pH                     1 22.896 7132.2 2085.8
## - total.sulfur.dioxide:Wine.Color       1 25.233 7134.5 2087.4
## - volatile.acidity:residual.sugar       1 28.048 7137.3 2089.3
## - residual.sugar:total.sulfur.dioxide   1 28.373 7137.7 2089.5
## - sulphates:total.sulfur.dioxide       1 31.502 7140.8 2091.7
## - free.sulfur.dioxide:total.sulfur.dioxide 1 66.689 7176.0 2115.8
## - volatile.acidity:density              1 73.005 7182.3 2120.1
## - density:Wine.Color                   2 97.420 7206.7 2128.2
## - pH:Wine.Color                        1 89.361 7198.6 2131.2
## - volatile.acidity:alcohol              1 103.676 7213.0 2141.0
##
## Step: AIC=2074.64
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##          sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##          citric.acid + density:Wine.Color + pH:Wine.Color + total.sulfur.dioxide:Wine.Color +
##          residual.sugar:citric.acid + fixed.acidity:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##          residual.sugar:total.sulfur.dioxide + pH:fixed.acidity +
##          volatile.acidity:fixed.acidity + volatile.acidity:sulphates +
##          alcohol:pH + residual.sugar:pH + residual.sugar:alcohol +
##          volatile.acidity:alcohol + alcohol:density + volatile.acidity:residual.sugar +
##          volatile.acidity:density
##
##                                         Df Sum of Sq    RSS     AIC
## - alcohol:pH                           1  7.969 7123.9 2071.6
## - volatile.acidity:sulphates           1  8.451 7124.4 2072.0
## - fixed.acidity:total.sulfur.dioxide  1 11.972 7127.9 2074.4
## <none>                                7116.0 2074.6
## - pH:fixed.acidity                    1 13.136 7129.1 2075.2
## - volatile.acidity:fixed.acidity      1 14.658 7130.6 2076.2
## - alcohol:density                     1 16.322 7132.3 2077.4
## - residual.sugar:citric.acid         1 16.667 7132.6 2077.6
## - residual.sugar:alcohol              1 22.236 7138.2 2081.4
## - residual.sugar:total.sulfur.dioxide 1 24.056 7140.0 2082.7
## - total.sulfur.dioxide:Wine.Color    1 25.045 7141.0 2083.4
## - residual.sugar:pH                  1 27.090 7143.1 2084.8
## - sulphates:total.sulfur.dioxide    1 30.305 7146.3 2087.0
## - volatile.acidity:residual.sugar   1 34.443 7150.4 2089.8
## - free.sulfur.dioxide:total.sulfur.dioxide 1 62.851 7178.8 2109.2
## - volatile.acidity:density           1 70.341 7186.3 2114.3
## - density:Wine.Color                2 90.958 7206.9 2119.9
## - pH:Wine.Color                      1 82.879 7198.9 2122.9
## - volatile.acidity:alcohol            1 98.330 7214.3 2133.4
##
## Step: AIC=2071.62
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##          sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##          citric.acid + density:Wine.Color + pH:Wine.Color + total.sulfur.dioxide:Wine.Color +

```

```

## residual.sugar:citric.acid + fixed.acidity:total.sulfur.dioxide +
## free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
## residual.sugar:total.sulfur.dioxide + pH:fixed.acidity +
## volatile.acidity:fixed.acidity + volatile.acidity:sulphates +
## residual.sugar:pH + residual.sugar:alcohol + volatile.acidity:alcohol +
## alcohol:density + volatile.acidity:residual.sugar + volatile.acidity:density
##
##                                     Df Sum of Sq   RSS   AIC
## - volatile.acidity:sulphates      1    8.490 7132.4 2069.0
## - pH:fixed.acidity                1    9.092 7133.0 2069.4
## <none>                           7123.9 2071.6
## - fixed.acidity:total.sulfur.dioxide 1   12.441 7136.4 2071.7
## - alcohol:density                 1   14.685 7138.6 2073.2
## - volatile.acidity:fixed.acidity   1   16.294 7140.2 2074.3
## - residual.sugar:citric.acid     1   17.329 7141.3 2075.0
## - residual.sugar:alcohol         1   18.163 7142.1 2075.6
## - residual.sugar:total.sulfur.dioxide 1   23.424 7147.4 2079.2
## - total.sulfur.dioxide:Wine.Color 1   25.809 7149.8 2080.8
## - sulphates:total.sulfur.dioxide 1   31.230 7155.2 2084.6
## - volatile.acidity:residual.sugar 1   34.392 7158.3 2086.7
## - residual.sugar:pH              1   41.779 7165.7 2091.8
## - free.sulfur.dioxide:total.sulfur.dioxide 1   62.677 7186.6 2106.1
## - volatile.acidity:density       1   73.678 7197.6 2113.5
## - density:Wine.Color            2   95.854 7219.8 2120.1
## - pH:Wine.Color                 1   87.056 7211.0 2122.6
## - volatile.acidity:alcohol       1   115.505 7239.4 2141.9
##
## Step:  AIC=2068.96
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##          sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##          citric.acid + density:Wine.Color + pH:Wine.Color + total.sulfur.dioxide:Wine.Color +
##          residual.sugar:citric.acid + fixed.acidity:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##          residual.sugar:total.sulfur.dioxide + pH:fixed.acidity +
##          volatile.acidity:fixed.acidity + residual.sugar:pH + residual.sugar:alcohol +
##          volatile.acidity:alcohol + alcohol:density + volatile.acidity:residual.sugar +
##          volatile.acidity:density
##
##                                     Df Sum of Sq   RSS   AIC
## - fixed.acidity:total.sulfur.dioxide 1   10.746 7143.2 2067.8
## - pH:fixed.acidity                  1   11.311 7143.7 2068.2
## <none>                           7132.4 2069.0
## - alcohol:density                 1   13.317 7145.7 2069.6
## - volatile.acidity:fixed.acidity   1   15.496 7147.9 2071.1
## - residual.sugar:citric.acid     1   16.631 7149.1 2071.9
## - residual.sugar:alcohol         1   17.367 7149.8 2072.4
## - residual.sugar:total.sulfur.dioxide 1   23.632 7156.1 2076.7
## - sulphates:total.sulfur.dioxide 1   24.159 7156.6 2077.0
## - volatile.acidity:residual.sugar 1   27.497 7159.9 2079.3
## - total.sulfur.dioxide:Wine.Color 1   29.214 7161.6 2080.5
## - residual.sugar:pH              1   41.735 7174.2 2089.1
## - free.sulfur.dioxide:total.sulfur.dioxide 1   62.378 7194.8 2103.1
## - volatile.acidity:density       1   65.231 7197.7 2105.1
## - density:Wine.Color            2   92.809 7225.2 2115.3

```

```

## - pH:Wine.Color           1   83.900 7216.3 2117.8
## - volatile.acidity:alcohol 1   107.053 7239.5 2133.5
##
## Step: AIC=2067.84
## Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
##          sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
##          citric.acid + density:Wine.Color + pH:Wine.Color + total.sulfur.dioxide:Wine.Color +
##          residual.sugar:citric.acid + free.sulfur.dioxide:total.sulfur.dioxide +
##          sulphates:total.sulfur.dioxide + residual.sugar:total.sulfur.dioxide +
##          pH:fixed.acidity + volatile.acidity:fixed.acidity + residual.sugar:pH +
##          residual.sugar:alcohol + volatile.acidity:alcohol + alcohol:density +
##          volatile.acidity:residual.sugar + volatile.acidity:density
##
##                                     Df Sum of Sq    RSS    AIC
## <none>                         7143.2 2067.8
## - residual.sugar:citric.acid      1   12.641 7155.8 2068.0
## - alcohol:density                 1   13.553 7156.7 2068.6
## - pH:fixed.acidity                1   13.772 7156.9 2068.8
## - residual.sugar:alcohol          1   18.395 7161.6 2071.9
## - volatile.acidity:fixed.acidity   1   18.534 7161.7 2072.0
## - sulphates:total.sulfur.dioxide  1   20.937 7164.1 2073.7
## - total.sulfur.dioxide:Wine.Color 1   21.554 7164.7 2074.1
## - volatile.acidity:residual.sugar  1   28.489 7171.7 2078.8
## - residual.sugar:total.sulfur.dioxide 1   30.146 7173.3 2080.0
## - residual.sugar:pH               1   43.871 7187.0 2089.3
## - volatile.acidity:density        1   64.854 7208.0 2103.6
## - free.sulfur.dioxide:total.sulfur.dioxide 1   68.110 7211.3 2105.8
## - density:Wine.Color              2   82.091 7225.3 2106.8
## - pH:Wine.Color                  1   73.227 7216.4 2109.3
## - volatile.acidity:alcohol         1   103.029 7246.2 2129.5

newbackBIC <- lm(Quality ~ volatile.acidity + residual.sugar + alcohol + pH +
                  sulphates + free.sulfur.dioxide + fixed.acidity + total.sulfur.dioxide +
                  citric.acid + density:Wine.Color + pH:Wine.Color + free.sulfur.dioxide:Wine.Color +
                  fixed.acidity:citric.acid + free.sulfur.dioxide:total.sulfur.dioxide +
                  sulphates:total.sulfur.dioxide + residual.sugar:total.sulfur.dioxide +
                  volatile.acidity:fixed.acidity + sulphates:free.sulfur.dioxide +
                  residual.sugar:pH + volatile.acidity:alcohol + volatile.acidity:residual.sugar +
                  volatile.acidity:density, data=train)

# forward AIC
init <- lm(Quality~1, data=train)
forwardAIC <- step(init, scope = list(lower=~1, upper=~ volatile.acidity + residual.sugar + alcohol + pH +
                                         +
                                         density:Wine.Color + volatile.acidity:Wine.Color + residual.sugar +
                                         +
                                         citric.acid:total.sulfur.dioxide + citric.acid:fixed.acidity +
                                         +
                                         total.sulfur.dioxide:fixed.acidity + total.sulfur.dioxide:free.sulfur.dioxide +
                                         +
                                         fixed.acidity:free.sulfur.dioxide + fixed.acidity:sulphates +
                                         +
                                         free.sulfur.dioxide:sulphates + free.sulfur.dioxide:pH + free.sulfur.dioxide:density))

```

```

          sulphates:pH + sulphates:alcohol + sulphates:residual.sugar +
+
pH:alcohol + pH:residual.sugar + pH:volatile.acidity + pH:densi +
+
alcohol:residual.sugar + alcohol:volatile.acidity + alcohol:densi +
+
residual.sugar:volatile.acidity + residual.sugar:density +
+
volatile.acidity:density), direction="forward", data=train)

## Start: AIC=2741.79
## Quality ~ 1
##
##                                     Df Sum of Sq   RSS   AIC
## + alcohol                      1   736.80 7834.1 2303.3
## + density:Wine.Color           2   326.51 8244.4 2555.5
## + volatile.acidity             1   227.25 8343.7 2612.1
## + fixed.acidity                1    29.22 8541.7 2727.1
## + free.sulfur.dioxide          1    24.86 8546.1 2729.6
## + citric.acid                 1    17.11 8553.8 2734.0
## + pH                           1    13.67 8557.3 2736.0
## + sulphates                    1     7.52 8563.4 2739.5
## + total.sulfur.dioxide         1     4.61 8566.3 2741.2
## <none>                         8570.9 2741.8
## + residual.sugar               1     1.87 8569.1 2742.7
##
## Step: AIC=2303.35
## Quality ~ alcohol
##
##                                     Df Sum of Sq   RSS   AIC
## + volatile.acidity             1   197.862 7636.3 2180.0
## + free.sulfur.dioxide          1   103.816 7730.3 2240.0
## + residual.sugar               1    88.445 7745.7 2249.7
## + density:Wine.Color           2    77.542 7756.6 2258.6
## + alcohol:Wine.Color            1    45.851 7788.3 2276.6
## + total.sulfur.dioxide         1    29.099 7805.0 2287.1
## + citric.acid                  1    22.444 7811.7 2291.3
## + fixed.acidity                 1     5.885 7828.2 2301.7
## + sulphates                     1     5.693 7828.4 2301.8
## <none>                          7834.1 2303.3
## + pH                            1     0.018 7834.1 2305.3
## + alcohol:density                1     0.013 7834.1 2305.3
##
## Step: AIC=2180
## Quality ~ alcohol + volatile.acidity
##
##                                     Df Sum of Sq   RSS   AIC
## + volatile.acidity:alcohol      1    45.630 7590.6 2152.6
## + residual.sugar                1    44.214 7592.1 2153.6
## + density:Wine.Color            2    41.505 7594.8 2157.3
## + sulphates                     1    37.701 7598.6 2157.8
## + alcohol:density                1    33.229 7603.0 2160.6
## + free.sulfur.dioxide           1    27.863 7608.4 2164.1
## + pH                            1    18.022 7618.2 2170.4

```

```

## + volatile.acidity:Wine.Color 1 17.302 7619.0 2170.9
## + volatile.acidity:density 1 17.242 7619.0 2170.9
## + alcohol:Wine.Color 1 9.511 7626.8 2175.9
## <none> 7636.3 2180.0
## + citric.acid 1 0.999 7635.3 2181.4
## + total.sulfur.dioxide 1 0.854 7635.4 2181.5
## + fixed.acidity 1 0.560 7635.7 2181.6
##
## Step: AIC=2152.64
## Quality ~ alcohol + volatile.acidity + alcohol:volatile.acidity
##
## Df Sum of Sq RSS AIC
## + sulphates 1 35.045 7555.6 2132.0
## + residual.sugar 1 26.352 7564.3 2137.6
## + density:Wine.Color 2 27.737 7562.9 2138.7
## + free.sulfur.dioxide 1 23.046 7567.6 2139.7
## + volatile.acidity:Wine.Color 1 22.469 7568.2 2140.1
## + volatile.acidity:density 1 21.794 7568.8 2140.6
## + alcohol:density 1 18.671 7572.0 2142.6
## + pH 1 14.291 7576.4 2145.4
## + alcohol:Wine.Color 1 8.841 7581.8 2148.9
## <none> 7590.6 2152.6
## + total.sulfur.dioxide 1 2.338 7588.3 2153.1
## + fixed.acidity 1 1.432 7589.2 2153.7
## + citric.acid 1 0.602 7590.0 2154.2
##
## Step: AIC=2131.96
## Quality ~ alcohol + volatile.acidity + sulphates + alcohol:volatile.acidity
##
## Df Sum of Sq RSS AIC
## + residual.sugar 1 36.683 7518.9 2110.1
## + free.sulfur.dioxide 1 32.357 7523.2 2112.9
## + volatile.acidity:density 1 10.444 7545.2 2127.2
## + pH 1 9.416 7546.2 2127.8
## + density:Wine.Color 2 11.356 7544.2 2128.6
## + volatile.acidity:Wine.Color 1 7.299 7548.3 2129.2
## + sulphates:density 1 6.757 7548.8 2129.6
## + alcohol:density 1 6.126 7549.5 2130.0
## + citric.acid 1 3.134 7552.5 2131.9
## <none> 7555.6 2132.0
## + alcohol:sulphates 1 1.902 7553.7 2132.7
## + volatile.acidity:sulphates 1 0.708 7554.9 2133.5
## + sulphates:Wine.Color 1 0.699 7554.9 2133.5
## + fixed.acidity 1 0.290 7555.3 2133.8
## + alcohol:Wine.Color 1 0.085 7555.5 2133.9
## + total.sulfur.dioxide 1 0.054 7555.5 2133.9
##
## Step: AIC=2110.11
## Quality ~ alcohol + volatile.acidity + sulphates + residual.sugar +
##     alcohol:volatile.acidity
##
## Df Sum of Sq RSS AIC
## + volatile.acidity:Wine.Color 1 22.8614 7496.1 2097.2
## + pH 1 19.4464 7499.5 2099.4

```

```

## + free.sulfur.dioxide      1  15.6887 7503.2 2101.9
## + density:Wine.Color      2  18.2500 7500.7 2102.2
## + residual.sugar:sulphates 1  11.0614 7507.9 2104.9
## + total.sulfur.dioxide     1   8.5416 7510.4 2106.5
## + sulphates:Wine.Color     1   6.5613 7512.4 2107.8
## + citric.acid              1   5.9891 7512.9 2108.2
## + volatile.acidity:residual.sugar 1   5.4142 7513.5 2108.6
## + alcohol:Wine.Color        1   4.1449 7514.8 2109.4
## <none>                      7518.9 2110.1
## + alcohol:sulphates         1   1.7862 7517.1 2110.9
## + alcohol:density            1   1.6126 7517.3 2111.1
## + residual.sugar:density     1   1.1544 7517.8 2111.4
## + volatile.acidity:sulphates 1   0.8330 7518.1 2111.6
## + sulphates:density          1   0.4524 7518.5 2111.8
## + volatile.acidity:density    1   0.3281 7518.6 2111.9
## + residual.sugar:alcohol      1   0.1231 7518.8 2112.0
## + residual.sugar:Wine.Color    1   0.1005 7518.8 2112.1
## + fixed.acidity               1   0.0089 7518.9 2112.1
##
## Step: AIC=2097.19
## Quality ~ alcohol + volatile.acidity + sulphates + residual.sugar +
##           alcohol:volatile.acidity + volatile.acidity:Wine.Color
##
##                                     Df Sum of Sq   RSS   AIC
## + free.sulfur.dioxide      1  25.5528 7470.5 2082.5
## + alcohol:density            1  22.0921 7474.0 2084.7
## + alcohol:Wine.Color        1  17.7110 7478.3 2087.6
## + density:Wine.Color        2  19.3529 7476.7 2088.5
## + pH                          1  13.4439 7482.6 2090.4
## + residual.sugar:Wine.Color  1  12.2581 7483.8 2091.2
## + sulphates:density          1  11.4494 7484.6 2091.7
## + residual.sugar:sulphates    1   6.5983 7489.5 2094.9
## + citric.acid                1   4.9544 7491.1 2095.9
## + sulphates:Wine.Color        1   4.3204 7491.7 2096.4
## + volatile.acidity:density    1   3.0807 7493.0 2097.2
## <none>                      7496.1 2097.2
## + fixed.acidity               1   2.4413 7493.6 2097.6
## + residual.sugar:density      1   1.7546 7494.3 2098.0
## + alcohol:sulphates          1   1.6251 7494.4 2098.1
## + volatile.acidity:residual.sugar 1   0.9008 7495.2 2098.6
## + total.sulfur.dioxide        1   0.0916 7496.0 2099.1
## + residual.sugar:alcohol       1   0.0720 7496.0 2099.1
## + volatile.acidity:sulphates   1   0.0009 7496.1 2099.2
##
## Step: AIC=2082.46
## Quality ~ alcohol + volatile.acidity + sulphates + residual.sugar +
##           free.sulfur.dioxide + alcohol:volatile.acidity + volatile.acidity:Wine.Color
##
##                                     Df Sum of Sq   RSS   AIC
## + alcohol:free.sulfur.dioxide 1  36.654 7433.8 2060.4
## + free.sulfur.dioxide:density 1  30.480 7440.0 2064.4
## + total.sulfur.dioxide        1  17.552 7452.9 2072.9
## + alcohol:density              1  14.870 7455.6 2074.7
## + alcohol:Wine.Color           1  11.229 7459.3 2077.1

```

```

## + pH
## + residual.sugar:Wine.Color
## + residual.sugar:free.sulfur.dioxide
## + density:Wine.Color
## + residual.sugar:sulphates
## + sulphates:density
## + citric.acid
## + free.sulfur.dioxide:Wine.Color
## <none>
## + alcohol:sulphates
## + sulphates:Wine.Color
## + volatile.acidity:density
## + sulphates:free.sulfur.dioxide
## + residual.sugar:density
## + fixed.acidity
## + volatile.acidity:residual.sugar
## + volatile.acidity:free.sulfur.dioxide
## + volatile.acidity:sulphates
## + residual.sugar:alcohol
##
## Step: AIC=2060.36
## Quality ~ alcohol + volatile.acidity + sulphates + residual.sugar +
##      free.sulfur.dioxide + alcohol:volatile.acidity + volatile.acidity:Wine.Color +
##      alcohol:free.sulfur.dioxide
##
##          Df Sum of Sq    RSS   AIC
## + total.sulfur.dioxide
## + alcohol:density
## + pH
## + residual.sugar:Wine.Color
## + residual.sugar:sulphates
## + sulphates:density
## + density:Wine.Color
## + alcohol:Wine.Color
## + free.sulfur.dioxide:density
## + free.sulfur.dioxide:Wine.Color
## + sulphates:free.sulfur.dioxide
## <none>
## + citric.acid
## + residual.sugar:alcohol
## + volatile.acidity:density
## + sulphates:Wine.Color
## + residual.sugar:density
## + residual.sugar:free.sulfur.dioxide
## + fixed.acidity
## + volatile.acidity:residual.sugar
## + volatile.acidity:sulphates
## + volatile.acidity:free.sulfur.dioxide
## + alcohol:sulphates
##
## Step: AIC=2051.19
## Quality ~ alcohol + volatile.acidity + sulphates + residual.sugar +
##      free.sulfur.dioxide + total.sulfur.dioxide + alcohol:volatile.acidity +
##      volatile.acidity:Wine.Color + alcohol:free.sulfur.dioxide

```

```

##                                     Df Sum of Sq   RSS   AIC
## + sulphates:total.sulfur.dioxide    1  18.4757 7398.4 2041.0
## + total.sulfur.dioxide:Wine.Color   1  14.7119 7402.2 2043.5
## + residual.sugar:total.sulfur.dioxide 1  12.8945 7404.0 2044.7
## + alcohol:density                  1  12.1476 7404.8 2045.2
## + free.sulfur.dioxide:total.sulfur.dioxide 1  11.9071 7405.0 2045.3
## + alcohol:Wine.Color               1  11.4283 7405.5 2045.6
## + pH                                1  11.1822 7405.7 2045.8
## + residual.sugar:Wine.Color         1  8.9930 7407.9 2047.2
## + density:Wine.Color                2  11.8104 7405.1 2047.4
## + sulphates:density                1  6.1281 7410.8 2049.1
## + free.sulfur.dioxide:Wine.Color    1  4.6494 7412.3 2050.1
## + residual.sugar:sulphates         1  4.3461 7412.6 2050.3
## + free.sulfur.dioxide:density      1  3.7944 7413.1 2050.7
## + sulphates:Wine.Color             1  3.4248 7413.5 2050.9
## <none>                            7416.9 2051.2
## + volatile.acidity:total.sulfur.dioxide 1  2.9585 7414.0 2051.2
## + sulphates:free.sulfur.dioxide     1  2.8614 7414.1 2051.3
## + alcohol:total.sulfur.dioxide     1  2.3898 7414.5 2051.6
## + residual.sugar:alcohol           1  1.8579 7415.1 2052.0
## + citric.acid                     1  1.5581 7415.4 2052.2
## + volatile.acidity:density        1  1.1627 7415.8 2052.4
## + residual.sugar:free.sulfur.dioxide 1  0.8503 7416.1 2052.6
## + residual.sugar:density          1  0.8358 7416.1 2052.6
## + fixed.acidity                   1  0.7386 7416.2 2052.7
## + total.sulfur.dioxide:density    1  0.5476 7416.4 2052.8
## + volatile.acidity:residual.sugar 1  0.4854 7416.4 2052.9
## + volatile.acidity:free.sulfur.dioxide 1  0.1076 7416.8 2053.1
## + alcohol:sulphates              1  0.0736 7416.8 2053.1
## + volatile.acidity:sulphates      1  0.0092 7416.9 2053.2
##
## Step:  AIC=2040.97
## Quality ~ alcohol + volatile.acidity + sulphates + residual.sugar +
##          free.sulfur.dioxide + total.sulfur.dioxide + alcohol:volatile.acidity +
##          volatile.acidity:Wine.Color + alcohol:free.sulfur.dioxide +
##          sulphates:total.sulfur.dioxide
##
##                                     Df Sum of Sq   RSS   AIC
## + sulphates:Wine.Color             1  25.8460 7372.6 2025.8
## + alcohol:Wine.Color               1  22.8169 7375.6 2027.8
## + density:Wine.Color              2  22.7412 7375.7 2029.9
## + alcohol:density                 1  19.2267 7379.2 2030.2
## + free.sulfur.dioxide:total.sulfur.dioxide 1  17.1862 7381.3 2031.6
## + pH                                1  13.3165 7385.1 2034.1
## + residual.sugar:total.sulfur.dioxide 1  12.5607 7385.9 2034.6
## + sulphates:density                1  11.9027 7386.5 2035.1
## + total.sulfur.dioxide:Wine.Color   1  11.2961 7387.1 2035.5
## + residual.sugar:Wine.Color         1  10.2979 7388.1 2036.1
## + free.sulfur.dioxide:Wine.Color    1  4.0234 7394.4 2040.3
## + volatile.acidity:total.sulfur.dioxide 1  3.5919 7394.8 2040.6
## + sulphates:free.sulfur.dioxide     1  3.4045 7395.0 2040.7
## + free.sulfur.dioxide:density      1  3.2477 7395.2 2040.8
## + citric.acid                     1  3.1899 7395.3 2040.8

```

```

## <none>
## + fixed.acidity
## + residual.sugar:alcohol
## + alcohol:total.sulfur.dioxide
## + volatile.acidity:density
## + residual.sugar:free.sulfur.dioxide
## + volatile.acidity:sulphates
## + residual.sugar:density
## + volatile.acidity:residual.sugar
## + alcohol:sulphates
## + total.sulfur.dioxide:density
## + residual.sugar:sulphates
## + volatile.acidity:free.sulfur.dioxide
## Step: AIC=2025.82
## Quality ~ alcohol + volatile.acidity + sulphates + residual.sugar +
##      free.sulfur.dioxide + total.sulfur.dioxide + alcohol:volatile.acidity +
##      volatile.acidity:Wine.Color + alcohol:free.sulfur.dioxide +
##      sulphates:total.sulfur.dioxide + sulphates:Wine.Color
##
##                                     Df Sum of Sq   RSS   AIC
## + residual.sugar:total.sulfur.dioxide    1  15.6850 7356.9 2017.4
## + free.sulfur.dioxide:total.sulfur.dioxide 1  15.1398 7357.5 2017.8
## + pH
## + alcohol:density
## + alcohol:sulphates
## + alcohol:total.sulfur.dioxide
## + sulphates:free.sulfur.dioxide
## <none>
## + volatile.acidity:free.sulfur.dioxide
## + residual.sugar:Wine.Color
## + density:Wine.Color
## + alcohol:Wine.Color
## + residual.sugar:alcohol
## + sulphates:density
## + total.sulfur.dioxide:density
## + volatile.acidity:density
## + residual.sugar:free.sulfur.dioxide
## + citric.acid
## + volatile.acidity:total.sulfur.dioxide
## + total.sulfur.dioxide:Wine.Color
## + residual.sugar:density
## + fixed.acidity
## + free.sulfur.dioxide:density
## + free.sulfur.dioxide:Wine.Color
## + volatile.acidity:sulphates
## + residual.sugar:sulphates
## + volatile.acidity:residual.sugar
## Step: AIC=2017.38
## Quality ~ alcohol + volatile.acidity + sulphates + residual.sugar +
##      free.sulfur.dioxide + total.sulfur.dioxide + alcohol:volatile.acidity +
##      volatile.acidity:Wine.Color + alcohol:free.sulfur.dioxide +
##      sulphates:total.sulfur.dioxide + sulphates:Wine.Color + residual.sugar:total.sulfur.dioxide

```

```

##                                     Df Sum of Sq   RSS   AIC
## + free.sulfur.dioxide:total.sulfur.dioxide 1   35.196 7321.7 1995.9
## + pH                                         1   12.779 7344.1 2010.9
## + residual.sugar:free.sulfur.dioxide       1   11.022 7345.9 2012.0
## + alcohol:density                          1    8.412 7348.5 2013.8
## + volatile.acidity:free.sulfur.dioxide     1    3.709 7353.2 2016.9
## + alcohol:Wine.Color                      1    3.313 7353.6 2017.2
## <none>                                      7356.9 2017.4
## + sulphates:free.sulfur.dioxide           1    2.880 7354.0 2017.5
## + free.sulfur.dioxide:density             1    2.791 7354.1 2017.5
## + density:Wine.Color                     2    5.535 7351.4 2017.7
## + alcohol:sulphates                      1    2.496 7354.4 2017.7
## + sulphates:density                      1    2.005 7354.9 2018.0
## + residual.sugar:density                 1    1.907 7355.0 2018.1
## + total.sulfur.dioxide:density           1    1.340 7355.6 2018.5
## + free.sulfur.dioxide:Wine.Color          1    1.312 7355.6 2018.5
## + volatile.acidity:total.sulfur.dioxide   1    1.257 7355.7 2018.5
## + volatile.acidity:density               1    1.241 7355.7 2018.6
## + residual.sugar:sulphates              1    1.093 7355.8 2018.7
## + citric.acid                         1    0.814 7356.1 2018.8
## + fixed.acidity                        1    0.786 7356.1 2018.9
## + alcohol:total.sulfur.dioxide          1    0.724 7356.2 2018.9
## + total.sulfur.dioxide:Wine.Color        1    0.314 7356.6 2019.2
## + residual.sugar:Wine.Color             1    0.081 7356.8 2019.3
## + volatile.acidity:residual.sugar       1    0.049 7356.9 2019.3
## + volatile.acidity:sulphates            1    0.016 7356.9 2019.4
## + residual.sugar:alcohol                1    0.004 7356.9 2019.4
##
## Step:  AIC=1995.89
## Quality ~ alcohol + volatile.acidity + sulphates + residual.sugar +
##          free.sulfur.dioxide + total.sulfur.dioxide + alcohol:volatile.acidity +
##          volatile.acidity:Wine.Color + alcohol:free.sulfur.dioxide +
##          sulphates:total.sulfur.dioxide + sulphates:Wine.Color + residual.sugar:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide
##
##                                     Df Sum of Sq   RSS   AIC
## + pH                                         1   11.8326 7309.9 1990.0
## + free.sulfur.dioxide:Wine.Color           1    7.5405 7314.2 1992.8
## + residual.sugar:free.sulfur.dioxide      1    6.2841 7315.4 1993.7
## + free.sulfur.dioxide:density             1    6.0520 7315.7 1993.8
## + total.sulfur.dioxide:Wine.Color         1    5.3117 7316.4 1994.3
## + alcohol:density                        1    4.4670 7317.2 1994.9
## + total.sulfur.dioxide:density           1    4.1717 7317.5 1995.1
## + residual.sugar:density                 1    3.6001 7318.1 1995.5
## + alcohol:sulphates                      1    3.1118 7318.6 1995.8
## <none>                                      7321.7 1995.9
## + sulphates:free.sulfur.dioxide          1    1.7566 7320.0 1996.7
## + alcohol:Wine.Color                     1    1.1860 7320.5 1997.1
## + residual.sugar:alcohol                 1    1.0362 7320.7 1997.2
## + volatile.acidity:density               1    0.9073 7320.8 1997.3
## + sulphates:density                      1    0.8353 7320.9 1997.3
## + residual.sugar:sulphates              1    0.7953 7320.9 1997.3
## + volatile.acidity:sulphates            1    0.7399 7321.0 1997.4

```

```

## + citric.acid 1 0.3433 7321.4 1997.7
## + alcohol:total.sulfur.dioxide 1 0.3042 7321.4 1997.7
## + volatile.acidity:total.sulfur.dioxide 1 0.1348 7321.6 1997.8
## + volatile.acidity:residual.sugar 1 0.1184 7321.6 1997.8
## + volatile.acidity:free.sulfur.dioxide 1 0.0718 7321.6 1997.8
## + fixed.acidity 1 0.0199 7321.7 1997.9
## + residual.sugar:Wine.Color 1 0.0151 7321.7 1997.9
## + density:Wine.Color 2 2.9083 7318.8 1997.9
##
## Step: AIC=1989.96
## Quality ~ alcohol + volatile.acidity + sulphates + residual.sugar +
##      free.sulfur.dioxide + total.sulfur.dioxide + pH + alcohol:volatile.acidity +
##      volatile.acidity:Wine.Color + alcohol:free.sulfur.dioxide +
##      sulphates:total.sulfur.dioxide + sulphates:Wine.Color + residual.sugar:total.sulfur.dioxide +
##      free.sulfur.dioxide:total.sulfur.dioxide
##
## Df Sum of Sq   RSS   AIC
## + alcohol:pH 1 11.7370 7298.1 1984.1
## + free.sulfur.dioxide:density 1 9.1283 7300.8 1985.8
## + free.sulfur.dioxide:Wine.Color 1 8.7394 7301.1 1986.1
## + residual.sugar:pH 1 8.6351 7301.2 1986.2
## + pH:density 1 7.5235 7302.4 1986.9
## + total.sulfur.dioxide:density 1 7.0384 7302.8 1987.2
## + alcohol:density 1 6.2707 7303.6 1987.8
## + residual.sugar:free.sulfur.dioxide 1 6.0703 7303.8 1987.9
## + pH:Wine.Color 1 4.8456 7305.0 1988.7
## + residual.sugar:density 1 4.5814 7305.3 1988.9
## + pH:sulphates 1 4.5785 7305.3 1988.9
## + total.sulfur.dioxide:Wine.Color 1 4.5543 7305.3 1988.9
## + volatile.acidity:pH 1 4.3459 7305.5 1989.0
## + alcohol:sulphates 1 3.6986 7306.2 1989.5
## <none> 7309.9 1990.0
## + fixed.acidity 1 2.7466 7307.1 1990.1
## + alcohol:Wine.Color 1 2.2690 7307.6 1990.4
## + pH:total.sulfur.dioxide 1 1.7438 7308.1 1990.8
## + sulphates:free.sulfur.dioxide 1 1.2641 7308.6 1991.1
## + volatile.acidity:density 1 1.2120 7308.7 1991.2
## + density:Wine.Color 2 4.0513 7305.8 1991.2
## + sulphates:density 1 1.0150 7308.9 1991.3
## + residual.sugar:alcohol 1 0.8787 7309.0 1991.4
## + residual.sugar:sulphates 1 0.8016 7309.1 1991.4
## + alcohol:total.sulfur.dioxide 1 0.4180 7309.5 1991.7
## + volatile.acidity:sulphates 1 0.4013 7309.5 1991.7
## + volatile.acidity:residual.sugar 1 0.3443 7309.5 1991.7
## + volatile.acidity:total.sulfur.dioxide 1 0.1208 7309.8 1991.9
## + citric.acid 1 0.1197 7309.8 1991.9
## + pH:free.sulfur.dioxide 1 0.0966 7309.8 1991.9
## + volatile.acidity:free.sulfur.dioxide 1 0.0503 7309.8 1991.9
## + residual.sugar:Wine.Color 1 0.0073 7309.9 1992.0
##
## Step: AIC=1984.09
## Quality ~ alcohol + volatile.acidity + sulphates + residual.sugar +
##      free.sulfur.dioxide + total.sulfur.dioxide + pH + alcohol:volatile.acidity +
##      volatile.acidity:Wine.Color + alcohol:free.sulfur.dioxide +

```

```

##      sulphates:total.sulfur.dioxide + sulphates:Wine.Color + residual.sugar:total.sulfur.dioxide +
##      free.sulfur.dioxide:total.sulfur.dioxide + alcohol:pH
##
##                                     Df Sum of Sq    RSS     AIC
##      + free.sulfur.dioxide:Wine.Color   1   7.5710 7290.6 1981.0
##      + free.sulfur.dioxide:density     1   6.4046 7291.7 1981.8
##      + alcohol:sulphates             1   5.9883 7292.2 1982.1
##      + volatile.acidity:pH           1   5.4499 7292.7 1982.4
##      + total.sulfur.dioxide:density   1   5.3234 7292.8 1982.5
##      + residual.sugar:free.sulfur.dioxide  1   5.2094 7292.9 1982.6
##      + pH:total.sulfur.dioxide        1   5.0264 7293.1 1982.7
##      + pH:sulphates                 1   5.0013 7293.1 1982.7
##      + pH:Wine.Color                1   4.6751 7293.5 1983.0
##      + pH:density                   1   4.4507 7293.7 1983.1
##      + alcohol:density              1   4.4483 7293.7 1983.1
##      + residual.sugar:density       1   4.3612 7293.8 1983.2
##      + fixed.acidity                1   4.3588 7293.8 1983.2
##      + total.sulfur.dioxide:Wine.Color 1   4.1922 7294.0 1983.3
##      + residual.sugar:pH            1   3.5702 7294.6 1983.7
##      + alcohol:Wine.Color           1   3.0974 7295.0 1984.0
##      <none>                         7298.1 1984.1
##      + residual.sugar:alcohol       1   2.7342 7295.4 1984.2
##      + sulphates:free.sulfur.dioxide 1   1.2694 7296.9 1985.2
##      + volatile.acidity:density     1   0.6751 7297.5 1985.6
##      + residual.sugar:sulphates     1   0.5317 7297.6 1985.7
##      + volatile.acidity:sulphates   1   0.4982 7297.6 1985.8
##      + volatile.acidity:residual.sugar 1   0.2360 7297.9 1985.9
##      + sulphates:density           1   0.2273 7297.9 1985.9
##      + volatile.acidity:total.sulfur.dioxide 1   0.2258 7297.9 1985.9
##      + pH:free.sulfur.dioxide       1   0.0704 7298.1 1986.0
##      + alcohol:total.sulfur.dioxide 1   0.0665 7298.1 1986.0
##      + citric.acid                1   0.0447 7298.1 1986.1
##      + volatile.acidity:free.sulfur.dioxide 1   0.0421 7298.1 1986.1
##      + residual.sugar:Wine.Color    1   0.0365 7298.1 1986.1
##      + density:Wine.Color          2   2.6871 7295.5 1986.3
##
## Step:  AIC=1981
## Quality ~ alcohol + volatile.acidity + sulphates + residual.sugar +
##      free.sulfur.dioxide + total.sulfur.dioxide + pH + alcohol:volatile.acidity +
##      volatile.acidity:Wine.Color + alcohol:free.sulfur.dioxide +
##      sulphates:total.sulfur.dioxide + sulphates:Wine.Color + residual.sugar:total.sulfur.dioxide +
##      free.sulfur.dioxide:total.sulfur.dioxide + alcohol:pH + free.sulfur.dioxide:Wine.Color
##
##                                     Df Sum of Sq    RSS     AIC
##      + residual.sugar:free.sulfur.dioxide 1   6.1583 7284.4 1978.9
##      + volatile.acidity:pH                 1   5.0570 7285.5 1979.6
##      + pH:total.sulfur.dioxide            1   4.9194 7285.7 1979.7
##      + sulphates:free.sulfur.dioxide     1   4.7402 7285.8 1979.8
##      + fixed.acidity                   1   4.6311 7285.9 1979.9
##      + alcohol:sulphates               1   4.3659 7286.2 1980.1
##      + residual.sugar:density          1   4.2461 7286.3 1980.2
##      + total.sulfur.dioxide:density     1   3.9132 7286.7 1980.4
##      + pH:density                     1   3.9077 7286.7 1980.4
##      + alcohol:density                1   3.8908 7286.7 1980.4

```

```

## + pH:sulphates
## + volatile.acidity:free.sulfur.dioxide
## + residual.sugar:pH
## + residual.sugar:alcohol
## + free.sulfur.dioxide:density
## <none>
## + volatile.acidity:sulphates
## + pH:Wine.Color
## + residual.sugar:Wine.Color
## + alcohol:Wine.Color
## + density:Wine.Color
## + total.sulfur.dioxide:Wine.Color
## + volatile.acidity:density
## + pH:free.sulfur.dioxide
## + sulphates:density
## + residual.sugar:sulphates
## + volatile.acidity:residual.sugar
## + volatile.acidity:total.sulfur.dioxide
## + alcohol:total.sulfur.dioxide
## + citric.acid
##
## Step: AIC=1978.86
## Quality ~ alcohol + volatile.acidity + sulphates + residual.sugar +
##       free.sulfur.dioxide + total.sulfur.dioxide + pH + alcohol:volatile.acidity +
##       volatile.acidity:Wine.Color + alcohol:free.sulfur.dioxide +
##       sulphates:total.sulfur.dioxide + sulphates:Wine.Color + residual.sugar:total.sulfur.dioxide +
##       free.sulfur.dioxide:total.sulfur.dioxide + alcohol:pH + free.sulfur.dioxide:Wine.Color +
##       residual.sugar:free.sulfur.dioxide
##
##                                     Df Sum of Sq   RSS   AIC
## + residual.sugar:density
## + total.sulfur.dioxide:density
## + pH:total.sulfur.dioxide
## + alcohol:density
## + volatile.acidity:pH
## + pH:density
## + alcohol:sulphates
## + fixed.acidity
## + sulphates:free.sulfur.dioxide
## + residual.sugar:pH
## + pH:sulphates
## + volatile.acidity:free.sulfur.dioxide
## + volatile.acidity:density
## <none>
## + residual.sugar:alcohol
## + volatile.acidity:residual.sugar
## + volatile.acidity:sulphates
## + pH:Wine.Color
## + density:Wine.Color
## + alcohol:Wine.Color
## + residual.sugar:Wine.Color
## + sulphates:density
## + residual.sugar:sulphates
## + pH:free.sulfur.dioxide

```

```

## + total.sulfur.dioxide:Wine.Color      1  0.2676 7284.1 1980.7
## + alcohol:total.sulfur.dioxide        1  0.1686 7284.2 1980.8
## + free.sulfur.dioxide:density        1  0.0584 7284.4 1980.8
## + volatile.acidity:total.sulfur.dioxide 1  0.0368 7284.4 1980.8
## + citric.acid                      1  0.0167 7284.4 1980.8
##
## Step: AIC=1973.31
## Quality ~ alcohol + volatile.acidity + sulphates + residual.sugar +
##          free.sulfur.dioxide + total.sulfur.dioxide + pH + alcohol:volatile.acidity +
##          volatile.acidity:Wine.Color + alcohol:free.sulfur.dioxide +
##          sulphates:total.sulfur.dioxide + sulphates:Wine.Color + residual.sugar:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + alcohol:pH + free.sulfur.dioxide:Wine.Color +
##          residual.sugar:free.sulfur.dioxide + residual.sugar:density
##
##                                     Df Sum of Sq   RSS   AIC
## + pH:total.sulfur.dioxide           1  8.0160 7265.2 1969.9
## + fixed.acidity                   1  6.9288 7266.3 1970.6
## + volatile.acidity:pH             1  5.4772 7267.7 1971.6
## + alcohol:sulphates              1  4.9929 7268.2 1972.0
## + residual.sugar:alcohol          1  4.2672 7268.9 1972.4
## + pH:sulphates                  1  4.2551 7269.0 1972.5
## + sulphates:free.sulfur.dioxide  1  3.6365 7269.6 1972.9
## <none>                           7273.2 1973.3
## + volatile.acidity:free.sulfur.dioxide 1  2.1911 7271.0 1973.8
## + pH:Wine.Color                 1  1.9252 7271.3 1974.0
## + residual.sugar:Wine.Color       1  1.8665 7271.3 1974.1
## + alcohol:Wine.Color             1  1.6406 7271.6 1974.2
## + volatile.acidity:residual.sugar 1  1.6258 7271.6 1974.2
## + volatile.acidity:sulphates     1  1.4048 7271.8 1974.4
## + residual.sugar:pH              1  1.2817 7271.9 1974.5
## + total.sulfur.dioxide:density   1  1.2343 7272.0 1974.5
## + alcohol:total.sulfur.dioxide   1  1.2155 7272.0 1974.5
## + alcohol:density                1  1.1599 7272.0 1974.5
## + pH:density                    1  0.9267 7272.3 1974.7
## + volatile.acidity:density       1  0.8745 7272.3 1974.7
## + density:Wine.Color            1  0.5679 7272.6 1974.9
## + pH:free.sulfur.dioxide         1  0.3608 7272.8 1975.1
## + sulphates:density             1  0.2990 7272.9 1975.1
## + citric.acid                  1  0.2464 7273.0 1975.2
## + free.sulfur.dioxide:density   1  0.2232 7273.0 1975.2
## + volatile.acidity:total.sulfur.dioxide 1  0.2053 7273.0 1975.2
## + total.sulfur.dioxide:Wine.Color 1  0.0412 7273.2 1975.3
## + residual.sugar:sulphates      1  0.0008 7273.2 1975.3
##
## Step: AIC=1969.91
## Quality ~ alcohol + volatile.acidity + sulphates + residual.sugar +
##          free.sulfur.dioxide + total.sulfur.dioxide + pH + alcohol:volatile.acidity +
##          volatile.acidity:Wine.Color + alcohol:free.sulfur.dioxide +
##          sulphates:total.sulfur.dioxide + sulphates:Wine.Color + residual.sugar:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + alcohol:pH + free.sulfur.dioxide:Wine.Color +
##          residual.sugar:free.sulfur.dioxide + residual.sugar:density +
##          total.sulfur.dioxide:pH
##
##                                     Df Sum of Sq   RSS   AIC

```

```

## + residual.sugar:pH
## + alcohol:sulphates
## + residual.sugar:alcohol
## + sulphates:free.sulfur.dioxide
## + fixed.acidity
## + pH:free.sulfur.dioxide
## <none>
## + total.sulfur.dioxide:density
## + alcohol:density
## + pH:sulphates
## + pH:density
## + residual.sugar:Wine.Color
## + volatile.acidity:pH
## + volatile.acidity:residual.sugar
## + volatile.acidity:free.sulfur.dioxide
## + volatile.acidity:sulphates
## + alcohol:Wine.Color
## + alcohol:total.sulfur.dioxide
## + density:Wine.Color
## + pH:Wine.Color
## + volatile.acidity:density
## + total.sulfur.dioxide:Wine.Color
## + volatile.acidity:total.sulfur.dioxide
## + residual.sugar:sulphates
## + sulphates:density
## + citric.acid
## + free.sulfur.dioxide:density
## Step: AIC=1967.49
## Quality ~ alcohol + volatile.acidity + sulphates + residual.sugar +
##       free.sulfur.dioxide + total.sulfur.dioxide + pH + alcohol:volatile.acidity +
##       volatile.acidity:Wine.Color + alcohol:free.sulfur.dioxide +
##       sulphates:total.sulfur.dioxide + sulphates:Wine.Color + residual.sugar:total.sulfur.dioxide +
##       free.sulfur.dioxide:total.sulfur.dioxide + alcohol:pH + free.sulfur.dioxide:Wine.Color +
##       residual.sugar:free.sulfur.dioxide + residual.sugar:density +
##       total.sulfur.dioxide:pH + residual.sugar:pH
##
##                                         Df Sum of Sq    RSS    AIC
## + residual.sugar:alcohol           1   5.8637 7252.8 1965.5
## + alcohol:sulphates              1   5.2391 7253.4 1966.0
## + sulphates:free.sulfur.dioxide  1   3.9426 7254.7 1966.8
## + fixed.acidity                  1   3.4639 7255.2 1967.2
## + pH:sulphates                  1   3.0116 7255.6 1967.5
## <none>                           7258.6 1967.5
## + residual.sugar:Wine.Color      1   2.8895 7255.7 1967.5
## + total.sulfur.dioxide:density   1   2.7969 7255.8 1967.6
## + volatile.acidity:residual.sugar 1   2.4411 7256.2 1967.8
## + alcohol:density                1   2.4209 7256.2 1967.8
## + pH:free.sulfur.dioxide         1   2.2494 7256.4 1968.0
## + pH:density                     1   1.8868 7256.8 1968.2
## + volatile.acidity:pH            1   1.8259 7256.8 1968.3
## + volatile.acidity:sulphates     1   1.6773 7257.0 1968.4
## + volatile.acidity:free.sulfur.dioxide 1   1.5044 7257.1 1968.5
## + alcohol:Wine.Color             1   1.2178 7257.4 1968.7

```

```

## + alcohol:total.sulfur.dioxide      1  1.0235 7257.6 1968.8
## + pH:Wine.Color                   1  0.6866 7258.0 1969.0
## + density:Wine.Color              1  0.6396 7258.0 1969.1
## + volatile.acidity:density       1  0.4091 7258.2 1969.2
## + total.sulfur.dioxide:Wine.Color 1  0.2112 7258.4 1969.3
## + residual.sugar:sulphates       1  0.1123 7258.5 1969.4
## + volatile.acidity:total.sulfur.dioxide 1  0.0198 7258.6 1969.5
## + sulphates:density              1  0.0035 7258.6 1969.5
## + free.sulfur.dioxide:density    1  0.0006 7258.6 1969.5
## + citric.acid                   1  0.0004 7258.6 1969.5
##
## Step: AIC=1965.53
## Quality ~ alcohol + volatile.acidity + sulphates + residual.sugar +
##          free.sulfur.dioxide + total.sulfur.dioxide + pH + alcohol:volatile.acidity +
##          volatile.acidity:Wine.Color + alcohol:free.sulfur.dioxide +
##          sulphates:total.sulfur.dioxide + sulphates:Wine.Color + residual.sugar:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + alcohol:pH + free.sulfur.dioxide:Wine.Color +
##          residual.sugar:free.sulfur.dioxide + residual.sugar:density +
##          total.sulfur.dioxide:pH + residual.sugar:pH + alcohol:residual.sugar
##
##                                         Df Sum of Sq   RSS   AIC
## + alcohol:density                  1  4.8601 7247.9 1964.2
## + alcohol:sulphates               1  4.6954 7248.1 1964.4
## + sulphates:free.sulfur.dioxide   1  4.5391 7248.2 1964.5
## + residual.sugar:Wine.Color       1  3.6782 7249.1 1965.0
## + fixed.acidity                  1  3.2712 7249.5 1965.3
## + total.sulfur.dioxide:density   1  3.1830 7249.6 1965.4
## + pH:sulphates                  1  2.9949 7249.8 1965.5
## <none>                           7252.8 1965.5
## + pH:density                     1  2.4627 7250.3 1965.9
## + volatile.acidity:sulphates     1  1.6854 7251.1 1966.4
## + pH:free.sulfur.dioxide         1  1.5739 7251.2 1966.5
## + volatile.acidity:pH            1  1.5234 7251.2 1966.5
## + volatile.acidity:free.sulfur.dioxide 1  1.5135 7251.3 1966.5
## + alcohol:Wine.Color             1  0.9905 7251.8 1966.9
## + pH:Wine.Color                 1  0.7473 7252.0 1967.0
## + volatile.acidity:residual.sugar 1  0.6293 7252.1 1967.1
## + density:Wine.Color             1  0.5571 7252.2 1967.2
## + total.sulfur.dioxide:Wine.Color 1  0.2865 7252.5 1967.3
## + alcohol:total.sulfur.dioxide   1  0.1652 7252.6 1967.4
## + residual.sugar:sulphates       1  0.0480 7252.7 1967.5
## + sulphates:density              1  0.0271 7252.7 1967.5
## + free.sulfur.dioxide:density    1  0.0141 7252.8 1967.5
## + volatile.acidity:density       1  0.0095 7252.8 1967.5
## + citric.acid                   1  0.0004 7252.8 1967.5
## + volatile.acidity:total.sulfur.dioxide 1  0.0004 7252.8 1967.5
##
## Step: AIC=1964.24
## Quality ~ alcohol + volatile.acidity + sulphates + residual.sugar +
##          free.sulfur.dioxide + total.sulfur.dioxide + pH + alcohol:volatile.acidity +
##          volatile.acidity:Wine.Color + alcohol:free.sulfur.dioxide +
##          sulphates:total.sulfur.dioxide + sulphates:Wine.Color + residual.sugar:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + alcohol:pH + free.sulfur.dioxide:Wine.Color +
##          residual.sugar:free.sulfur.dioxide + residual.sugar:density +

```

```

##      total.sulfur.dioxide:pH + residual.sugar:pH + alcohol:residual.sugar +
##      alcohol:density
##
##                                     Df Sum of Sq    RSS     AIC
##      fixed.acidity                 1   31.742 7216.2 1944.7
##      volatile.acidity:density      1    8.564 7239.3 1960.5
##      sulphates:density             1    5.943 7242.0 1962.2
##      pH:density                   1    5.218 7242.7 1962.7
##      sulphates:free.sulfur.dioxide 1    5.154 7242.8 1962.8
##      residual.sugar:Wine.Color     1    4.792 7243.1 1963.0
##      free.sulfur.dioxide:density    1    4.415 7243.5 1963.3
##      alcohol:sulphates             1    3.277 7244.6 1964.0
##      volatile.acidity:sulphates     1    3.199 7244.7 1964.1
##      <none>                         7247.9 1964.2
##      pH:sulphates                  1    2.923 7245.0 1964.3
##      volatile.acidity:pH            1    2.153 7245.8 1964.8
##      density:Wine.Color             1    1.945 7246.0 1964.9
##      volatile.acidity:free.sulfur.dioxide 1    1.747 7246.2 1965.1
##      pH:free.sulfur.dioxide         1    1.508 7246.4 1965.2
##      total.sulfur.dioxide:Wine.Color 1    0.876 7247.0 1965.7
##      volatile.acidity:residual.sugar 1    0.833 7247.1 1965.7
##      citric.acid                   1    0.596 7247.3 1965.8
##      residual.sugar:sulphates       1    0.161 7247.8 1966.1
##      total.sulfur.dioxide:density    1    0.156 7247.8 1966.1
##      pH:Wine.Color                  1    0.103 7247.8 1966.2
##      alcohol:Wine.Color              1    0.051 7247.9 1966.2
##      alcohol:total.sulfur.dioxide    1    0.033 7247.9 1966.2
##      volatile.acidity:total.sulfur.dioxide 1    0.011 7247.9 1966.2
##
## Step:  AIC=1944.74
## Quality ~ alcohol + volatile.acidity + sulphates + residual.sugar +
##          free.sulfur.dioxide + total.sulfur.dioxide + pH + fixed.acidity +
##          alcohol:volatile.acidity + volatile.acidity:Wine.Color +
##          alcohol:free.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##          sulphates:Wine.Color + residual.sugar:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + alcohol:pH + free.sulfur.dioxide:Wine.Color +
##          residual.sugar:free.sulfur.dioxide + residual.sugar:density +
##          total.sulfur.dioxide:pH + residual.sugar:pH + alcohol:residual.sugar +
##          alcohol:density
##
##                                     Df Sum of Sq    RSS     AIC
##      pH:fixed.acidity               1   11.2109 7205.0 1939.1
##      fixed.acidity:Wine.Color        1    9.3963 7206.8 1940.3
##      volatile.acidity:density        1    8.4943 7207.7 1941.0
##      free.sulfur.dioxide:fixed.acidity 1    5.7787 7210.4 1942.8
##      sulphates:free.sulfur.dioxide   1    5.0661 7211.1 1943.3
##      residual.sugar:Wine.Color        1    4.0546 7212.1 1944.0
##      volatile.acidity:sulphates       1    3.2945 7212.9 1944.5
##      <none>                         7216.2 1944.7
##      pH:free.sulfur.dioxide          1    2.2714 7213.9 1945.2
##      volatile.acidity:fixed.acidity    1    2.2543 7213.9 1945.2
##      density:Wine.Color                1    2.2506 7213.9 1945.2
##      fixed.acidity:density             1    2.1228 7214.0 1945.3
##      free.sulfur.dioxide:density        1    1.5260 7214.6 1945.7

```

```

## + volatile.acidity:free.sulfur.dioxide 1 1.4038 7214.8 1945.8
## + sulphates:density 1 1.3611 7214.8 1945.8
## + pH:sulphates 1 1.3474 7214.8 1945.8
## + total.sulfur.dioxide:Wine.Color 1 0.9902 7215.2 1946.1
## + volatile.acidity:residual.sugar 1 0.9852 7215.2 1946.1
## + alcohol:sulphates 1 0.9718 7215.2 1946.1
## + volatile.acidity:pH 1 0.7895 7215.4 1946.2
## + pH:density 1 0.7692 7215.4 1946.2
## + residual.sugar:fixed.acidity 1 0.5883 7215.6 1946.3
## + alcohol:total.sulfur.dioxide 1 0.4368 7215.7 1946.4
## + alcohol:Wine.Color 1 0.3779 7215.8 1946.5
## + total.sulfur.dioxide:density 1 0.2225 7215.9 1946.6
## + citric.acid 1 0.1190 7216.1 1946.7
## + fixed.acidity:total.sulfur.dioxide 1 0.0470 7216.1 1946.7
## + residual.sugar:sulphates 1 0.0417 7216.1 1946.7
## + sulphates:fixed.acidity 1 0.0269 7216.1 1946.7
## + alcohol:fixed.acidity 1 0.0128 7216.2 1946.7
## + pH:Wine.Color 1 0.0039 7216.2 1946.7
## + volatile.acidity:total.sulfur.dioxide 1 0.0027 7216.2 1946.7
##
## Step: AIC=1939.12
## Quality ~ alcohol + volatile.acidity + sulphates + residual.sugar +
##          free.sulfur.dioxide + total.sulfur.dioxide + pH + fixed.acidity +
##          alcohol:volatile.acidity + volatile.acidity:Wine.Color +
##          alcohol:free.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##          sulphates:Wine.Color + residual.sugar:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + alcohol:pH + free.sulfur.dioxide:Wine.Color +
##          residual.sugar:free.sulfur.dioxide + residual.sugar:density +
##          total.sulfur.dioxide:pH + residual.sugar:pH + alcohol:residual.sugar +
##          alcohol:density + pH:fixed.acidity
##
##                                     Df Sum of Sq    RSS    AIC
## + fixed.acidity:Wine.Color 1  9.4829 7195.5 1934.7
## + volatile.acidity:density 1  8.8840 7196.1 1935.1
## + fixed.acidity:density 1  4.7835 7200.2 1937.9
## + residual.sugar:Wine.Color 1  4.7331 7200.2 1937.9
## + free.sulfur.dioxide:fixed.acidity 1  4.3794 7200.6 1938.1
## + sulphates:free.sulfur.dioxide 1  3.6456 7201.3 1938.6
## <none>                                7205.0 1939.1
## + pH:sulphates 1  2.6981 7202.3 1939.3
## + pH:free.sulfur.dioxide 1  2.4516 7202.5 1939.5
## + volatile.acidity:sulphates 1  2.2338 7202.7 1939.6
## + volatile.acidity:fixed.acidity 1  2.0231 7202.9 1939.7
## + density:Wine.Color 1  1.9341 7203.0 1939.8
## + volatile.acidity:free.sulfur.dioxide 1  1.4855 7203.5 1940.1
## + sulphates:density 1  1.4510 7203.5 1940.1
## + volatile.acidity:residual.sugar 1  1.1522 7203.8 1940.3
## + residual.sugar:fixed.acidity 1  1.0673 7203.9 1940.4
## + free.sulfur.dioxide:density 1  1.0173 7203.9 1940.4
## + alcohol:sulphates 1  0.9492 7204.0 1940.5
## + total.sulfur.dioxide:Wine.Color 1  0.8207 7204.1 1940.6
## + volatile.acidity:pH 1  0.5181 7204.4 1940.8
## + total.sulfur.dioxide:density 1  0.3279 7204.6 1940.9
## + alcohol:Wine.Color 1  0.3088 7204.7 1940.9

```

```

## + alcohol:total.sulfur.dioxide      1  0.3044 7204.7 1940.9
## + citric.acid                     1  0.1821 7204.8 1941.0
## + pH:density                      1  0.1512 7204.8 1941.0
## + sulphates:fixed.acidity         1  0.0438 7204.9 1941.1
## + volatile.acidity:total.sulfur.dioxide 1  0.0339 7204.9 1941.1
## + alcohol:fixed.acidity           1  0.0274 7204.9 1941.1
## + residual.sugar:sulphates       1  0.0153 7204.9 1941.1
## + pH:Wine.Color                   1  0.0142 7204.9 1941.1
## + fixed.acidity:total.sulfur.dioxide 1  0.0011 7205.0 1941.1
##
## Step: AIC=1934.67
## Quality ~ alcohol + volatile.acidity + sulphates + residual.sugar +
##          free.sulfur.dioxide + total.sulfur.dioxide + pH + fixed.acidity +
##          alcohol:volatile.acidity + volatile.acidity:Wine.Color +
##          alcohol:free.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##          sulphates:Wine.Color + residual.sugar:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + alcohol:pH + free.sulfur.dioxide:Wine.Color +
##          residual.sugar:free.sulfur.dioxide + residual.sugar:density +
##          total.sulfur.dioxide:pH + residual.sugar:pH + alcohol:residual.sugar +
##          alcohol:density + pH:fixed.acidity + fixed.acidity:Wine.Color
##
##                                         Df Sum of Sq   RSS   AIC
## + free.sulfur.dioxide:fixed.acidity 1  15.4477 7180.0 1926.1
## + volatile.acidity:density          1  8.9808 7186.5 1930.5
## + fixed.acidity:total.sulfur.dioxide 1  7.2777 7188.2 1931.7
## + free.sulfur.dioxide:density      1  7.0129 7188.5 1931.9
## + pH:Wine.Color                   1  6.8186 7188.7 1932.0
## + sulphates:free.sulfur.dioxide    1  3.5320 7191.9 1934.3
## + residual.sugar:fixed.acidity     1  3.4768 7192.0 1934.3
## <none>                           7195.5 1934.7
## + residual.sugar:Wine.Color        1  2.5983 7192.9 1934.9
## + sulphates:density               1  2.5414 7192.9 1934.9
## + alcohol:Wine.Color              1  2.5202 7193.0 1935.0
## + alcohol:sulphates              1  2.2520 7193.2 1935.1
## + pH:sulphates                   1  1.6098 7193.9 1935.6
## + pH:free.sulfur.dioxide          1  1.5190 7194.0 1935.6
## + volatile.acidity:free.sulfur.dioxide 1  1.4906 7194.0 1935.7
## + density:Wine.Color             1  1.3522 7194.1 1935.7
## + total.sulfur.dioxide:Wine.Color 1  1.3077 7194.2 1935.8
## + total.sulfur.dioxide:density    1  0.8161 7194.7 1936.1
## + volatile.acidity:residual.sugar 1  0.7279 7194.7 1936.2
## + fixed.acidity:density          1  0.6001 7194.9 1936.3
## + alcohol:total.sulfur.dioxide    1  0.5009 7195.0 1936.3
## + citric.acid                   1  0.4854 7195.0 1936.3
## + volatile.acidity:fixed.acidity 1  0.4829 7195.0 1936.3
## + sulphates:fixed.acidity        1  0.2017 7195.3 1936.5
## + volatile.acidity:sulphates     1  0.1141 7195.4 1936.6
## + volatile.acidity:total.sulfur.dioxide 1  0.0818 7195.4 1936.6
## + residual.sugar:sulphates       1  0.0581 7195.4 1936.6
## + pH:density                     1  0.0420 7195.4 1936.6
## + volatile.acidity:pH            1  0.0017 7195.5 1936.7
## + alcohol:fixed.acidity          1  0.0004 7195.5 1936.7
##
## Step: AIC=1926.13

```

```

## Quality ~ alcohol + volatile.acidity + sulphates + residual.sugar +
##   free.sulfur.dioxide + total.sulfur.dioxide + pH + fixed.acidity +
##   alcohol:volatile.acidity + volatile.acidity:Wine.Color +
##   alcohol:free.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##   sulphates:Wine.Color + residual.sugar:total.sulfur.dioxide +
##   free.sulfur.dioxide:total.sulfur.dioxide + alcohol:pH + free.sulfur.dioxide:Wine.Color +
##   residual.sugar:free.sulfur.dioxide + residual.sugar:density +
##   total.sulfur.dioxide:pH + residual.sugar:pH + alcohol:residual.sugar +
##   alcohol:density + pH:fixed.acidity + fixed.acidity:Wine.Color +
##   free.sulfur.dioxide:fixed.acidity
##
##                                     Df Sum of Sq    RSS     AIC
## + volatile.acidity:density      1   11.7813 7168.2 1920.1
## + pH:Wine.Color                 1   10.9602 7169.1 1920.7
## + alcohol:Wine.Color            1   4.8487 7175.2 1924.8
## + density:Wine.Color            1   4.1219 7175.9 1925.3
## + sulphates:density             1   3.3406 7176.7 1925.8
## + sulphates:free.sulfur.dioxide 1   3.3041 7176.7 1925.9
## <none>                           7180.0 1926.1
## + residual.sugar:Wine.Color      1   2.5676 7177.5 1926.4
## + alcohol:sulphates              1   2.4269 7177.6 1926.5
## + pH:sulphates                  1   2.2339 7177.8 1926.6
## + volatile.acidity:free.sulfur.dioxide 1   2.1976 7177.8 1926.6
## + total.sulfur.dioxide:Wine.Color 1   1.6717 7178.4 1927.0
## + volatile.acidity:fixed.acidity   1   1.1892 7178.8 1927.3
## + volatile.acidity:residual.sugar 1   0.8377 7179.2 1927.6
## + fixed.acidity:density           1   0.7198 7179.3 1927.6
## + residual.sugar:fixed.acidity     1   0.6531 7179.4 1927.7
## + alcohol:total.sulfur.dioxide     1   0.5952 7179.4 1927.7
## + free.sulfur.dioxide:density      1   0.3399 7179.7 1927.9
## + citric.acid                   1   0.3049 7179.7 1927.9
## + alcohol:fixed.acidity            1   0.2191 7179.8 1928.0
## + fixed.acidity:total.sulfur.dioxide 1   0.1423 7179.9 1928.0
## + residual.sugar:sulphates         1   0.0995 7179.9 1928.1
## + volatile.acidity:total.sulfur.dioxide 1   0.0614 7180.0 1928.1
## + total.sulfur.dioxide:density      1   0.0579 7180.0 1928.1
## + pH:free.sulfur.dioxide           1   0.0539 7180.0 1928.1
## + pH:density                      1   0.0216 7180.0 1928.1
## + volatile.acidity:pH               1   0.0185 7180.0 1928.1
## + sulphates:fixed.acidity          1   0.0010 7180.0 1928.1
## + volatile.acidity:sulphates        1   0.0002 7180.0 1928.1
##
## Step:  AIC=1920.09
## Quality ~ alcohol + volatile.acidity + sulphates + residual.sugar +
##   free.sulfur.dioxide + total.sulfur.dioxide + pH + fixed.acidity +
##   alcohol:volatile.acidity + volatile.acidity:Wine.Color +
##   alcohol:free.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##   sulphates:Wine.Color + residual.sugar:total.sulfur.dioxide +
##   free.sulfur.dioxide:total.sulfur.dioxide + alcohol:pH + free.sulfur.dioxide:Wine.Color +
##   residual.sugar:free.sulfur.dioxide + residual.sugar:density +
##   total.sulfur.dioxide:pH + residual.sugar:pH + alcohol:residual.sugar +
##   alcohol:density + pH:fixed.acidity + fixed.acidity:Wine.Color +
##   free.sulfur.dioxide:fixed.acidity + volatile.acidity:density
##

```

```

##                                     Df Sum of Sq    RSS    AIC
## + pH:Wine.Color                  1   4.8616 7163.4 1918.8
## + sulphates:free.sulfur.dioxide  1   4.0416 7164.2 1919.3
## <none>                           7168.2 1920.1
## + total.sulfur.dioxide:Wine.Color 1   2.5137 7165.7 1920.4
## + pH:sulphates                  1   2.1275 7166.1 1920.6
## + alcohol:fixed.acidity         1   1.3743 7166.9 1921.2
## + volatile.acidity:sulphates    1   1.3502 7166.9 1921.2
## + volatile.acidity:residual.sugar 1   1.3044 7166.9 1921.2
## + volatile.acidity:free.sulfur.dioxide 1   1.2358 7167.0 1921.2
## + residual.sugar:Wine.Color      1   1.1884 7167.1 1921.3
## + alcohol:sulphates             1   1.0933 7167.2 1921.3
## + pH:density                    1   1.0742 7167.2 1921.3
## + alcohol:Wine.Color            1   0.7605 7167.5 1921.6
## + volatile.acidity:fixed.acidity 1   0.7443 7167.5 1921.6
## + alcohol:total.sulfur.dioxide  1   0.7183 7167.5 1921.6
## + residual.sugar:fixed.acidity   1   0.6520 7167.6 1921.6
## + volatile.acidity:total.sulfur.dioxide 1   0.6512 7167.6 1921.6
## + fixed.acidity:total.sulfur.dioxide 1   0.6493 7167.6 1921.6
## + citric.acid                  1   0.5916 7167.7 1921.7
## + sulphates:density             1   0.5736 7167.7 1921.7
## + free.sulfur.dioxide:density   1   0.5043 7167.7 1921.7
## + density:Wine.Color            1   0.4959 7167.8 1921.8
## + fixed.acidity:density         1   0.3599 7167.9 1921.8
## + pH:free.sulfur.dioxide        1   0.3284 7167.9 1921.9
## + residual.sugar:sulphates     1   0.1504 7168.1 1922.0
## + sulphates:fixed.acidity       1   0.1360 7168.1 1922.0
## + total.sulfur.dioxide:density  1   0.0373 7168.2 1922.1
## + volatile.acidity:pH           1   0.0002 7168.2 1922.1
##
## Step:  AIC=1918.76
## Quality ~ alcohol + volatile.acidity + sulphates + residual.sugar +
##          free.sulfur.dioxide + total.sulfur.dioxide + pH + fixed.acidity +
##          alcohol:volatile.acidity + volatile.acidity:Wine.Color +
##          alcohol:free.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##          sulphates:Wine.Color + residual.sugar:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + alcohol:pH + free.sulfur.dioxide:Wine.Color +
##          residual.sugar:free.sulfur.dioxide + residual.sugar:density +
##          total.sulfur.dioxide:pH + residual.sugar:pH + alcohol:residual.sugar +
##          alcohol:density + pH:fixed.acidity + fixed.acidity:Wine.Color +
##          free.sulfur.dioxide:fixed.acidity + volatile.acidity:density +
##          pH:Wine.Color
##
##                                     Df Sum of Sq    RSS    AIC
## + density:Wine.Color            1   32.507 7130.9 1898.5
## + sulphates:free.sulfur.dioxide 1   3.593 7159.8 1918.3
## + volatile.acidity:fixed.acidity 1   3.526 7159.9 1918.3
## + volatile.acidity:sulphates    1   3.423 7160.0 1918.4
## + sulphates:fixed.acidity       1   3.133 7160.3 1918.6
## <none>                           7163.4 1918.8
## + fixed.acidity:total.sulfur.dioxide 1   2.662 7160.7 1918.9
## + fixed.acidity:density         1   2.294 7161.1 1919.2
## + residual.sugar:Wine.Color      1   2.116 7161.3 1919.3
## + alcohol:Wine.Color            1   2.047 7161.3 1919.4

```

```

## + volatile.acidity:free.sulfur.dioxide 1 1.773 7161.6 1919.5
## + total.sulfur.dioxide:Wine.Color 1 1.770 7161.6 1919.5
## + alcohol:fixed.acidity 1 0.987 7162.4 1920.1
## + pH:sulphates 1 0.864 7162.5 1920.2
## + residual.sugar:fixed.acidity 1 0.780 7162.6 1920.2
## + alcohol:total.sulfur.dioxide 1 0.629 7162.8 1920.3
## + citric.acid 1 0.560 7162.8 1920.4
## + alcohol:sulphates 1 0.415 7163.0 1920.5
## + pH:density 1 0.349 7163.0 1920.5
## + volatile.acidity:pH 1 0.263 7163.1 1920.6
## + pH:free.sulfur.dioxide 1 0.237 7163.1 1920.6
## + volatile.acidity:residual.sugar 1 0.139 7163.2 1920.7
## + free.sulfur.dioxide:density 1 0.115 7163.3 1920.7
## + residual.sugar:sulphates 1 0.080 7163.3 1920.7
## + volatile.acidity:total.sulfur.dioxide 1 0.041 7163.3 1920.7
## + sulphates:density 1 0.002 7163.4 1920.8
## + total.sulfur.dioxide:density 1 0.002 7163.4 1920.8
##
## Step: AIC=1898.48
## Quality ~ alcohol + volatile.acidity + sulphates + residual.sugar +
##      free.sulfur.dioxide + total.sulfur.dioxide + pH + fixed.acidity +
##      alcohol:volatile.acidity + volatile.acidity:Wine.Color +
##      alcohol:free.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##      sulphates:Wine.Color + residual.sugar:total.sulfur.dioxide +
##      free.sulfur.dioxide:total.sulfur.dioxide + alcohol:pH + free.sulfur.dioxide:Wine.Color +
##      residual.sugar:free.sulfur.dioxide + residual.sugar:density +
##      total.sulfur.dioxide:pH + residual.sugar:pH + alcohol:residual.sugar +
##      alcohol:density + pH:fixed.acidity + fixed.acidity:Wine.Color +
##      free.sulfur.dioxide:fixed.acidity + volatile.acidity:density +
##      pH:Wine.Color + Wine.Color:density
##
##                                     Df Sum of Sq   RSS   AIC
## + volatile.acidity:pH 1 19.9286 7111.0 1886.8
## + volatile.acidity:fixed.acidity 1 8.6395 7122.2 1894.5
## + sulphates:free.sulfur.dioxide 1 6.4781 7124.4 1896.0
## + total.sulfur.dioxide:Wine.Color 1 3.4560 7127.4 1898.1
## + volatile.acidity:sulphates 1 3.3553 7127.5 1898.2
## <none> 7130.9 1898.5
## + volatile.acidity:residual.sugar 1 2.1560 7128.7 1899.0
## + volatile.acidity:free.sulfur.dioxide 1 1.8484 7129.0 1899.2
## + alcohol:total.sulfur.dioxide 1 1.2985 7129.6 1899.6
## + citric.acid 1 1.0674 7129.8 1899.7
## + sulphates:density 1 0.9548 7129.9 1899.8
## + pH:sulphates 1 0.8447 7130.0 1899.9
## + free.sulfur.dioxide:density 1 0.7032 7130.2 1900.0
## + sulphates:fixed.acidity 1 0.5231 7130.4 1900.1
## + alcohol:fixed.acidity 1 0.3755 7130.5 1900.2
## + residual.sugar:Wine.Color 1 0.3738 7130.5 1900.2
## + fixed.acidity:total.sulfur.dioxide 1 0.3088 7130.6 1900.3
## + alcohol:sulphates 1 0.2946 7130.6 1900.3
## + pH:density 1 0.2223 7130.7 1900.3
## + residual.sugar:fixed.acidity 1 0.1439 7130.7 1900.4
## + total.sulfur.dioxide:density 1 0.1196 7130.8 1900.4
## + volatile.acidity:total.sulfur.dioxide 1 0.0836 7130.8 1900.4

```

```

## + fixed.acidity:density           1  0.0602 7130.8 1900.4
## + pH:free.sulfur.dioxide         1  0.0551 7130.8 1900.4
## + residual.sugar:sulphates      1  0.0013 7130.9 1900.5
## + alcohol:Wine.Color            1  0.0008 7130.9 1900.5
##
## Step: AIC=1886.76
## Quality ~ alcohol + volatile.acidity + sulphates + residual.sugar +
##          free.sulfur.dioxide + total.sulfur.dioxide + pH + fixed.acidity +
##          alcohol:volatile.acidity + volatile.acidity:Wine.Color +
##          alcohol:free.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##          sulphates:Wine.Color + residual.sugar:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + alcohol:pH + free.sulfur.dioxide:Wine.Color +
##          residual.sugar:free.sulfur.dioxide + residual.sugar:density +
##          total.sulfur.dioxide:pH + residual.sugar:pH + alcohol:residual.sugar +
##          alcohol:density + pH:fixed.acidity + fixed.acidity:Wine.Color +
##          free.sulfur.dioxide:fixed.acidity + volatile.acidity:density +
##          pH:Wine.Color + Wine.Color:density + volatile.acidity:pH
##
##                                         Df Sum of Sq   RSS   AIC
## + sulphates:free.sulfur.dioxide  1  7.4291 7103.5 1883.6
## + total.sulfur.dioxide:Wine.Color 1  3.4287 7107.5 1886.4
## <none>                           7111.0 1886.8
## + volatile.acidity:sulphates    1  2.8410 7108.1 1886.8
## + alcohol:total.sulfur.dioxide  1  1.9600 7109.0 1887.4
## + free.sulfur.dioxide:density   1  1.7391 7109.2 1887.6
## + volatile.acidity:free.sulfur.dioxide 1  1.6938 7109.3 1887.6
## + volatile.acidity:residual.sugar 1  1.5098 7109.4 1887.7
## + pH:free.sulfur.dioxide        1  1.2928 7109.7 1887.9
## + pH:sulphates                1  1.0360 7109.9 1888.0
## + sulphates:density            1  0.8658 7110.1 1888.2
## + citric.acid                 1  0.6246 7110.3 1888.3
## + alcohol:fixed.acidity        1  0.5338 7110.4 1888.4
## + residual.sugar:fixed.acidity 1  0.3305 7110.6 1888.5
## + sulphates:fixed.acidity      1  0.2979 7110.7 1888.6
## + residual.sugar:Wine.Color    1  0.2745 7110.7 1888.6
## + alcohol:Wine.Color           1  0.1384 7110.8 1888.7
## + alcohol:sulphates            1  0.1257 7110.8 1888.7
## + pH:density                   1  0.0631 7110.9 1888.7
## + volatile.acidity:fixed.acidity 1  0.0430 7110.9 1888.7
## + volatile.acidity:total.sulfur.dioxide 1  0.0214 7110.9 1888.8
## + fixed.acidity:total.sulfur.dioxide 1  0.0126 7110.9 1888.8
## + residual.sugar:sulphates     1  0.0112 7110.9 1888.8
## + total.sulfur.dioxide:density 1  0.0019 7110.9 1888.8
## + fixed.acidity:density        1  0.0000 7111.0 1888.8
##
## Step: AIC=1883.64
## Quality ~ alcohol + volatile.acidity + sulphates + residual.sugar +
##          free.sulfur.dioxide + total.sulfur.dioxide + pH + fixed.acidity +
##          alcohol:volatile.acidity + volatile.acidity:Wine.Color +
##          alcohol:free.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##          sulphates:Wine.Color + residual.sugar:total.sulfur.dioxide +
##          free.sulfur.dioxide:total.sulfur.dioxide + alcohol:pH + free.sulfur.dioxide:Wine.Color +
##          residual.sugar:free.sulfur.dioxide + residual.sugar:density +
##          total.sulfur.dioxide:pH + residual.sugar:pH + alcohol:residual.sugar +

```

```

##      alcohol:density + pH:fixed.acidity + fixed.acidity:Wine.Color +
##      free.sulfur.dioxide:fixed.acidity + volatile.acidity:density +
##      pH:Wine.Color + Wine.Color:density + volatile.acidity:pH +
##      sulphates:free.sulfur.dioxide
##
##                                Df Sum of Sq    RSS     AIC
## <none>                         7103.5 1883.6
## + volatile.acidity:free.sulfur.dioxide  1   2.62357 7100.9 1883.8
## + total.sulfur.dioxide:Wine.Color      1   1.95218 7101.6 1884.3
## + volatile.acidity:residual.sugar     1   1.70947 7101.8 1884.5
## + alcohol:total.sulfur.dioxide       1   1.41510 7102.1 1884.7
## + volatile.acidity:sulphates        1   1.19685 7102.3 1884.8
## + sulphates:density                1   1.02926 7102.5 1884.9
## + free.sulfur.dioxide:density      1   0.93789 7102.6 1885.0
## + citric.acid                     1   0.78505 7102.7 1885.1
## + pH:free.sulfur.dioxide          1   0.70444 7102.8 1885.2
## + alcohol:fixed.acidity           1   0.36703 7103.2 1885.4
## + pH:sulphates                   1   0.33004 7103.2 1885.4
## + residual.sugar:Wine.Color       1   0.28902 7103.2 1885.4
## + residual.sugar:fixed.acidity    1   0.25968 7103.3 1885.5
## + pH:density                      1   0.25380 7103.3 1885.5
## + volatile.acidity:fixed.acidity  1   0.12044 7103.4 1885.6
## + alcohol:sulphates              1   0.10976 7103.4 1885.6
## + sulphates:fixed.acidity        1   0.08147 7103.4 1885.6
## + volatile.acidity:total.sulfur.dioxide 1   0.03449 7103.5 1885.6
## + residual.sugar:sulphates       1   0.03311 7103.5 1885.6
## + total.sulfur.dioxide:density   1   0.03233 7103.5 1885.6
## + fixed.acidity:density          1   0.01055 7103.5 1885.6
## + alcohol:Wine.Color             1   0.00292 7103.5 1885.6
## + fixed.acidity:total.sulfur.dioxide 1   0.00144 7103.5 1885.6

newforwAIC <- lm(Quality ~ alcohol + volatile.acidity + sulphates + residual.sugar +
                  free.sulfur.dioxide + total.sulfur.dioxide + pH + fixed.acidity +
                  alcohol:volatile.acidity + volatile.acidity:Wine.Color +
                  alcohol:free.sulfur.dioxide + sulphates:total.sulfur.dioxide +
                  sulphates:Wine.Color + residual.sugar:total.sulfur.dioxide +
                  free.sulfur.dioxide:total.sulfur.dioxide + alcohol:pH + free.sulfur.dioxide:Wine.Color +
                  residual.sugar:free.sulfur.dioxide + residual.sugar:density +
                  total.sulfur.dioxide:pH + residual.sugar:pH + alcohol:residual.sugar +
                  alcohol:density + pH:fixed.acidity + fixed.acidity:Wine.Color +
                  free.sulfur.dioxide:fixed.acidity + volatile.acidity:density +
                  pH:Wine.Color + Wine.Color:density + volatile.acidity:pH +
                  sulphates:free.sulfur.dioxide, data=train)

# forward BIC
forwardBIC <- step(init, scope = list(lower=~1, upper=~ volatile.acidity + residual.sugar + alcohol + pH +
                                         +
                                         density:Wine.Color + volatile.acidity:Wine.Color + residual.sugar +
                                         +
                                         citric.acid:total.sulfur.dioxide + citric.acid:fixed.acidity +
                                         +
                                         total.sulfur.dioxide:fixed.acidity + total.sulfur.dioxide:free.sulfur.dioxide +
                                         +
                                         fixed.acidity:free.sulfur.dioxide + fixed.acidity:sulphates + fixed.acidity:pH))

```

```

+
  free.sulfur.dioxide:sulphates + free.sulfur.dioxide:pH + free.s
+
  sulphates:pH + sulphates:alcohol + sulphates:residual.sugar + s
+
  pH:alcohol + pH:residual.sugar + pH:volatile.acidity + pH:densi
+
  alcohol:residual.sugar + alcohol:volatile.acidity + alcohol:dens
+
  residual.sugar:volatile.acidity + residual.sugar:density
+
  volatile.acidity:density), direction="forward", data=train, k=1
}

## Start: AIC=2748.29
## Quality ~ 1
##
## Df Sum of Sq   RSS   AIC
## + alcohol      1    736.80 7834.1 2316.3
## + density:Wine.Color  2    326.51 8244.4 2575.0
## + volatile.acidity  1    227.25 8343.7 2625.1
## + fixed.acidity   1     29.22 8541.7 2740.1
## + free.sulfur.dioxide  1     24.86 8546.1 2742.6
## + citric.acid    1     17.11 8553.8 2747.0
## <none>          8570.9 2748.3
## + pH             1     13.67 8557.3 2749.0
## + sulphates     1      7.52 8563.4 2752.5
## + total.sulfur.dioxide  1      4.61 8566.3 2754.2
## + residual.sugar 1      1.87 8569.1 2755.7
##
## Step: AIC=2316.34
## Quality ~ alcohol
##
## Df Sum of Sq   RSS   AIC
## + volatile.acidity  1    197.862 7636.3 2199.5
## + free.sulfur.dioxide  1    103.816 7730.3 2259.5
## + residual.sugar    1     88.445 7745.7 2269.2
## + density:Wine.Color  2     77.542 7756.6 2284.6
## + alcohol:Wine.Color  1     45.851 7788.3 2296.1
## + total.sulfur.dioxide  1     29.099 7805.0 2306.6
## + citric.acid      1     22.444 7811.7 2310.8
## <none>            7834.1 2316.3
## + fixed.acidity    1      5.885 7828.2 2321.2
## + sulphates        1      5.693 7828.4 2321.3
## + pH               1      0.018 7834.1 2324.8
## + alcohol:density   1      0.013 7834.1 2324.8
##
## Step: AIC=2199.49
## Quality ~ alcohol + volatile.acidity
##
## Df Sum of Sq   RSS   AIC
## + volatile.acidity:alcohol  1     45.630 7590.6 2178.6
## + residual.sugar         1     44.214 7592.1 2179.5
## + sulphates              1     37.701 7598.6 2183.7
## + alcohol:density        1     33.229 7603.0 2186.6

```

```

## + density:Wine.Color      2   41.505 7594.8 2189.8
## + free.sulfur.dioxide    1   27.863 7608.4 2190.1
## + pH                      1   18.022 7618.2 2196.4
## + volatile.acidity:Wine.Color 1   17.302 7619.0 2196.9
## + volatile.acidity:density 1   17.242 7619.0 2196.9
## <none>                   7636.3 2199.5
## + alcohol:Wine.Color      1   9.511 7626.8 2201.9
## + citric.acid            1   0.999 7635.3 2207.3
## + total.sulfur.dioxide    1   0.854 7635.4 2207.4
## + fixed.acidity           1   0.560 7635.7 2207.6
##
## Step: AIC=2178.62
## Quality ~ alcohol + volatile.acidity + alcohol:volatile.acidity
##
##                                     Df Sum of Sq   RSS   AIC
## + sulphates                  1   35.045 7555.6 2164.4
## + residual.sugar             1   26.352 7564.3 2170.1
## + free.sulfur.dioxide        1   23.046 7567.6 2172.2
## + volatile.acidity:Wine.Color 1   22.469 7568.2 2172.6
## + volatile.acidity:density   1   21.794 7568.8 2173.0
## + alcohol:density            1   18.671 7572.0 2175.1
## + density:Wine.Color         2   27.737 7562.9 2177.7
## + pH                         1   14.291 7576.4 2177.9
## <none>                      7590.6 2178.6
## + alcohol:Wine.Color         1   8.841 7581.8 2181.4
## + total.sulfur.dioxide       1   2.338 7588.3 2185.6
## + fixed.acidity              1   1.432 7589.2 2186.2
## + citric.acid               1   0.602 7590.0 2186.7
##
## Step: AIC=2164.45
## Quality ~ alcohol + volatile.acidity + sulphates + alcohol:volatile.acidity
##
##                                     Df Sum of Sq   RSS   AIC
## + residual.sugar             1   36.683 7518.9 2149.1
## + free.sulfur.dioxide        1   32.357 7523.2 2151.9
## <none>                      7555.6 2164.4
## + volatile.acidity:density   1   10.444 7545.2 2166.2
## + pH                          1   9.416 7546.2 2166.8
## + volatile.acidity:Wine.Color 1   7.299 7548.3 2168.2
## + sulphates:density          1   6.757 7548.8 2168.6
## + alcohol:density            1   6.126 7549.5 2169.0
## + citric.acid                1   3.134 7552.5 2170.9
## + alcohol:sulphates          1   1.902 7553.7 2171.7
## + volatile.acidity:sulphates 1   0.708 7554.9 2172.5
## + sulphates:Wine.Color       1   0.699 7554.9 2172.5
## + fixed.acidity              1   0.290 7555.3 2172.8
## + alcohol:Wine.Color          1   0.085 7555.5 2172.9
## + total.sulfur.dioxide       1   0.054 7555.5 2172.9
## + density:Wine.Color         2   11.356 7544.2 2174.1
##
## Step: AIC=2149.1
## Quality ~ alcohol + volatile.acidity + sulphates + residual.sugar +
##     alcohol:volatile.acidity
##

```

```

##                                     Df Sum of Sq   RSS   AIC
## + volatile.acidity:Wine.Color    1  22.8614 7496.1 2142.7
## + pH                            1  19.4464 7499.5 2144.9
## + free.sulfur.dioxide          1  15.6887 7503.2 2147.4
## <none>                          7518.9 2149.1
## + residual.sugar:sulphates    1  11.0614 7507.9 2150.4
## + total.sulfur.dioxide         1   8.5416 7510.4 2152.0
## + sulphates:Wine.Color        1   6.5613 7512.4 2153.3
## + citric.acid                 1   5.9891 7512.9 2153.7
## + volatile.acidity:residual.sugar 1   5.4142 7513.5 2154.1
## + density:Wine.Color           2  18.2500 7500.7 2154.2
## + alcohol:Wine.Color           1   4.1449 7514.8 2154.9
## + alcohol:sulphates           1   1.7862 7517.1 2156.4
## + alcohol:density              1   1.6126 7517.3 2156.5
## + residual.sugar:density       1   1.1544 7517.8 2156.8
## + volatile.acidity:sulphates   1   0.8330 7518.1 2157.1
## + sulphates:density            1   0.4524 7518.5 2157.3
## + volatile.acidity:density     1   0.3281 7518.6 2157.4
## + residual.sugar:alcohol       1   0.1231 7518.8 2157.5
## + residual.sugar:Wine.Color    1   0.1005 7518.8 2157.5
## + fixed.acidity                1   0.0089 7518.9 2157.6
##
## Step:  AIC=2142.67
## Quality ~ alcohol + volatile.acidity + sulphates + residual.sugar +
##          alcohol:volatile.acidity + volatile.acidity:Wine.Color
##
##                                     Df Sum of Sq   RSS   AIC
## + free.sulfur.dioxide          1  25.5528 7470.5 2134.4
## + alcohol:density              1  22.0921 7474.0 2136.7
## + alcohol:Wine.Color           1  17.7110 7478.3 2139.6
## + pH                            1  13.4439 7482.6 2142.4
## <none>                          7496.1 2142.7
## + residual.sugar:Wine.Color    1  12.2581 7483.8 2143.2
## + sulphates:density            1  11.4494 7484.6 2143.7
## + residual.sugar:sulphates    1   6.5983 7489.5 2146.8
## + density:Wine.Color           2  19.3529 7476.7 2147.0
## + citric.acid                 1   4.9544 7491.1 2147.9
## + sulphates:Wine.Color         1   4.3204 7491.7 2148.3
## + volatile.acidity:density     1   3.0807 7493.0 2149.2
## + fixed.acidity                1   2.4413 7493.6 2149.6
## + residual.sugar:density       1   1.7546 7494.3 2150.0
## + alcohol:sulphates           1   1.6251 7494.4 2150.1
## + volatile.acidity:residual.sugar 1   0.9008 7495.2 2150.6
## + total.sulfur.dioxide         1   0.0916 7496.0 2151.1
## + residual.sugar:alcohol       1   0.0720 7496.0 2151.1
## + volatile.acidity:sulphates   1   0.0009 7496.1 2151.2
##
## Step:  AIC=2134.44
## Quality ~ alcohol + volatile.acidity + sulphates + residual.sugar +
##          free.sulfur.dioxide + alcohol:volatile.acidity + volatile.acidity:Wine.Color
##
##                                     Df Sum of Sq   RSS   AIC
## + alcohol:free.sulfur.dioxide  1  36.654 7433.8 2118.8
## + free.sulfur.dioxide:density 1  30.480 7440.0 2122.9

```

```

## + total.sulfur.dioxide           1  17.552 7452.9 2131.4
## + alcohol:density               1  14.870 7455.6 2133.2
## <none>                           7470.5 2134.4
## + alcohol:Wine.Color            1  11.229 7459.3 2135.6
## + pH                             1  10.755 7459.7 2135.9
## + residual.sugar:Wine.Color     1  10.316 7460.2 2136.2
## + residual.sugar:free.sulfur.dioxide 1  8.798 7461.7 2137.2
## + residual.sugar:sulphates      1  7.363 7463.1 2138.1
## + sulphates:density             1  6.821 7463.7 2138.5
## + citric.acid                  1  4.102 7466.4 2140.2
## + free.sulfur.dioxide:Wine.Color 1  3.826 7466.7 2140.4
## + alcohol:sulphates            1  1.684 7468.8 2141.8
## + sulphates:Wine.Color          1  1.548 7469.0 2141.9
## + volatile.acidity:density      1  1.542 7469.0 2141.9
## + sulphates:free.sulfur.dioxide 1  1.298 7469.2 2142.1
## + residual.sugar:density        1  0.720 7469.8 2142.5
## + fixed.acidity                 1  0.566 7469.9 2142.6
## + volatile.acidity:residual.sugar 1  0.354 7470.1 2142.7
## + volatile.acidity:free.sulfur.dioxide 1  0.157 7470.3 2142.8
## + volatile.acidity:sulphates    1  0.044 7470.5 2142.9
## + residual.sugar:alcohol         1  0.041 7470.5 2142.9
## + density:Wine.Color            2  11.774 7458.7 2143.7
##
## Step: AIC=2118.83
## Quality ~ alcohol + volatile.acidity + sulphates + residual.sugar +
##          free.sulfur.dioxide + alcohol:volatile.acidity + volatile.acidity:Wine.Color +
##          alcohol:free.sulfur.dioxide
##
##                                     Df Sum of Sq   RSS   AIC
## + total.sulfur.dioxide           1  16.9285 7416.9 2116.2
## <none>                           7433.8 2118.8
## + alcohol:density               1  12.2577 7421.6 2119.2
## + pH                            1  9.2128 7424.6 2121.2
## + residual.sugar:Wine.Color     1  7.7756 7426.1 2122.2
## + residual.sugar:sulphates      1  6.2608 7427.6 2123.2
## + sulphates:density             1  5.8705 7428.0 2123.5
## + alcohol:Wine.Color            1  5.7844 7428.1 2123.5
## + free.sulfur.dioxide:density   1  5.1907 7428.7 2123.9
## + free.sulfur.dioxide:Wine.Color 1  4.2663 7429.6 2124.5
## + sulphates:free.sulfur.dioxide 1  3.5596 7430.3 2125.0
## + citric.acid                  1  1.6723 7432.2 2126.2
## + residual.sugar:alcohol         1  1.4537 7432.4 2126.4
## + volatile.acidity:density      1  1.3256 7432.5 2126.4
## + sulphates:Wine.Color          1  0.7587 7433.1 2126.8
## + residual.sugar:density        1  0.6622 7433.2 2126.9
## + residual.sugar:free.sulfur.dioxide 1  0.3818 7433.5 2127.1
## + fixed.acidity                 1  0.3517 7433.5 2127.1
## + volatile.acidity:residual.sugar 1  0.2514 7433.6 2127.2
## + volatile.acidity:sulphates    1  0.1314 7433.7 2127.2
## + volatile.acidity:free.sulfur.dioxide 1  0.0999 7433.7 2127.3
## + alcohol:sulphates            1  0.0349 7433.8 2127.3
## + density:Wine.Color            2  8.8705 7425.0 2130.0
##
## Step: AIC=2116.16

```

```

## Quality ~ alcohol + volatile.acidity + sulphates + residual.sugar +
##   free.sulfur.dioxide + total.sulfur.dioxide + alcohol:volatile.acidity +
##   volatile.acidity:Wine.Color + alcohol:free.sulfur.dioxide
##
##                                     Df Sum of Sq    RSS     AIC
## + sulphates:total.sulfur.dioxide      1  18.4757 7398.4 2112.4
## + total.sulfur.dioxide:Wine.Color      1  14.7119 7402.2 2114.9
## + residual.sugar:total.sulfur.dioxide  1  12.8945 7404.0 2116.1
## <none>                                7416.9 2116.2
## + alcohol:density                     1  12.1476 7404.8 2116.6
## + free.sulfur.dioxide:total.sulfur.dioxide 1  11.9071 7405.0 2116.8
## + alcohol:Wine.Color                  1  11.4283 7405.5 2117.1
## + pH                                  1  11.1822 7405.7 2117.3
## + residual.sugar:Wine.Color           1  8.9930 7407.9 2118.7
## + sulphates:density                  1  6.1281 7410.8 2120.6
## + free.sulfur.dioxide:Wine.Color       1  4.6494 7412.3 2121.6
## + residual.sugar:sulphates           1  4.3461 7412.6 2121.8
## + free.sulfur.dioxide:density        1  3.7944 7413.1 2122.2
## + sulphates:Wine.Color               1  3.4248 7413.5 2122.4
## + volatile.acidity:total.sulfur.dioxide 1  2.9585 7414.0 2122.7
## + sulphates:free.sulfur.dioxide       1  2.8614 7414.1 2122.8
## + alcohol:total.sulfur.dioxide        1  2.3898 7414.5 2123.1
## + residual.sugar:alcohol              1  1.8579 7415.1 2123.4
## + citric.acid                      1  1.5581 7415.4 2123.6
## + volatile.acidity:density           1  1.1627 7415.8 2123.9
## + residual.sugar:free.sulfur.dioxide 1  0.8503 7416.1 2124.1
## + residual.sugar:density             1  0.8358 7416.1 2124.1
## + fixed.acidity                     1  0.7386 7416.2 2124.2
## + total.sulfur.dioxide:density       1  0.5476 7416.4 2124.3
## + volatile.acidity:residual.sugar    1  0.4854 7416.4 2124.3
## + volatile.acidity:free.sulfur.dioxide 1  0.1076 7416.8 2124.6
## + alcohol:sulphates                 1  0.0736 7416.8 2124.6
## + volatile.acidity:sulphates         1  0.0092 7416.9 2124.7
## + density:Wine.Color                2  11.8104 7405.1 2125.3
##
## Step: AIC=2112.43
## Quality ~ alcohol + volatile.acidity + sulphates + residual.sugar +
##   free.sulfur.dioxide + total.sulfur.dioxide + alcohol:volatile.acidity +
##   volatile.acidity:Wine.Color + alcohol:free.sulfur.dioxide +
##   sulphates:total.sulfur.dioxide
##
##                                     Df Sum of Sq    RSS     AIC
## + sulphates:Wine.Color               1  25.8460 7372.6 2103.8
## + alcohol:Wine.Color                 1  22.8169 7375.6 2105.8
## + alcohol:density                   1  19.2267 7379.2 2108.2
## + free.sulfur.dioxide:total.sulfur.dioxide 1  17.1862 7381.3 2109.5
## + pH                                 1  13.3165 7385.1 2112.1
## <none>                                7398.4 2112.4
## + residual.sugar:total.sulfur.dioxide 1  12.5607 7385.9 2112.6
## + sulphates:density                 1  11.9027 7386.5 2113.0
## + total.sulfur.dioxide:Wine.Color    1  11.2961 7387.1 2113.4
## + residual.sugar:Wine.Color          1  10.2979 7388.1 2114.1
## + density:Wine.Color                2  22.7412 7375.7 2114.3
## + free.sulfur.dioxide:Wine.Color     1  4.0234 7394.4 2118.3

```

```

## + volatile.acidity:total.sulfur.dioxide      1  3.5919 7394.8 2118.6
## + sulphates:free.sulfur.dioxide            1  3.4045 7395.0 2118.7
## + free.sulfur.dioxide:density              1  3.2477 7395.2 2118.8
## + citric.acid                            1  3.1899 7395.3 2118.8
## + fixed.acidity                          1  2.7462 7395.7 2119.1
## + residual.sugar:alcohol                  1  2.2252 7396.2 2119.5
## + alcohol:total.sulfur.dioxide            1  2.1487 7396.3 2119.5
## + volatile.acidity:density                1  1.8260 7396.6 2119.7
## + residual.sugar:free.sulfur.dioxide       1  1.0241 7397.4 2120.2
## + volatile.acidity:sulphates              1  0.6675 7397.8 2120.5
## + residual.sugar:density                 1  0.6312 7397.8 2120.5
## + volatile.acidity:residual.sugar          1  0.5057 7397.9 2120.6
## + alcohol:sulphates                      1  0.4732 7398.0 2120.6
## + total.sulfur.dioxide:density            1  0.1191 7398.3 2120.8
## + residual.sugar:sulphates                1  0.0273 7398.4 2120.9
## + volatile.acidity:free.sulfur.dioxide     1  0.0053 7398.4 2120.9
##
## Step: AIC=2103.78
## Quality ~ alcohol + volatile.acidity + sulphates + residual.sugar +
##           free.sulfur.dioxide + total.sulfur.dioxide + alcohol:volatile.acidity +
##           volatile.acidity:Wine.Color + alcohol:free.sulfur.dioxide +
##           sulphates:total.sulfur.dioxide + sulphates:Wine.Color
##
##                                         Df Sum of Sq   RSS   AIC
## + residual.sugar:total.sulfur.dioxide      1  15.6850 7356.9 2101.8
## + free.sulfur.dioxide:total.sulfur.dioxide  1  15.1398 7357.5 2102.2
## <none>                                         7372.6 2103.8
## + pH                                         1  11.6510 7360.9 2104.5
## + alcohol:density                         1  8.5884 7364.0 2106.6
## + alcohol:sulphates                      1  3.4656 7369.1 2110.0
## + alcohol:total.sulfur.dioxide             1  3.3954 7369.2 2110.0
## + sulphates:free.sulfur.dioxide            1  3.0717 7369.5 2110.2
## + volatile.acidity:free.sulfur.dioxide      1  2.9818 7369.6 2110.3
## + residual.sugar:Wine.Color                1  1.9430 7370.7 2111.0
## + alcohol:Wine.Color                      1  1.6255 7371.0 2111.2
## + residual.sugar:alcohol                   1  1.4928 7371.1 2111.3
## + sulphates:density                       1  1.3374 7371.3 2111.4
## + total.sulfur.dioxide:density             1  1.1125 7371.5 2111.5
## + volatile.acidity:density                 1  0.9790 7371.6 2111.6
## + residual.sugar:free.sulfur.dioxide        1  0.9505 7371.6 2111.7
## + citric.acid                           1  0.7629 7371.8 2111.8
## + volatile.acidity:total.sulfur.dioxide     1  0.4826 7372.1 2112.0
## + total.sulfur.dioxide:Wine.Color           1  0.4643 7372.1 2112.0
## + residual.sugar:density                  1  0.4035 7372.2 2112.0
## + fixed.acidity                          1  0.3158 7372.3 2112.1
## + free.sulfur.dioxide:density              1  0.2934 7372.3 2112.1
## + free.sulfur.dioxide:Wine.Color            1  0.2429 7372.4 2112.1
## + volatile.acidity:sulphates               1  0.2351 7372.4 2112.1
## + residual.sugar:sulphates                 1  0.0732 7372.5 2112.2
## + volatile.acidity:residual.sugar           1  0.0016 7372.6 2112.3
## + density:Wine.Color                      2   4.6429 7368.0 2117.7
##
## Step: AIC=2101.84
## Quality ~ alcohol + volatile.acidity + sulphates + residual.sugar +

```

```

##   free.sulfur.dioxide + total.sulfur.dioxide + alcohol:volatile.acidity +
##   volatile.acidity:Wine.Color + alcohol:free.sulfur.dioxide +
##   sulphates:total.sulfur.dioxide + sulphates:Wine.Color + residual.sugar:total.sulfur.dioxide
##
##                                     Df Sum of Sq    RSS     AIC
## + free.sulfur.dioxide:total.sulfur.dioxide  1    35.196 7321.7 2086.8
## + pH                                         1    12.779 7344.1 2101.8
## <none>                                       7356.9 2101.8
## + residual.sugar:free.sulfur.dioxide       1    11.022 7345.9 2103.0
## + alcohol:density                         1     8.412 7348.5 2104.7
## + volatile.acidity:free.sulfur.dioxide    1     3.709 7353.2 2107.9
## + alcohol:Wine.Color                      1     3.313 7353.6 2108.1
## + sulphates:free.sulfur.dioxide           1     2.880 7354.0 2108.4
## + free.sulfur.dioxide:density             1     2.791 7354.1 2108.5
## + alcohol:sulphates                      1     2.496 7354.4 2108.7
## + sulphates:density                      1     2.005 7354.9 2109.0
## + residual.sugar:density                 1     1.907 7355.0 2109.1
## + total.sulfur.dioxide:density            1     1.340 7355.6 2109.4
## + free.sulfur.dioxide:Wine.Color          1     1.312 7355.6 2109.5
## + volatile.acidity:total.sulfur.dioxide   1     1.257 7355.7 2109.5
## + volatile.acidity:density               1     1.241 7355.7 2109.5
## + residual.sugar:sulphates              1     1.093 7355.8 2109.6
## + citric.acid                          1     0.814 7356.1 2109.8
## + fixed.acidity                        1     0.786 7356.1 2109.8
## + alcohol:total.sulfur.dioxide           1     0.724 7356.2 2109.9
## + total.sulfur.dioxide:Wine.Color        1     0.314 7356.6 2110.1
## + residual.sugar:Wine.Color              1     0.081 7356.8 2110.3
## + volatile.acidity:residual.sugar       1     0.049 7356.9 2110.3
## + volatile.acidity:sulphates            1     0.016 7356.9 2110.3
## + residual.sugar:alcohol                1     0.004 7356.9 2110.3
## + density:Wine.Color                   2     5.535 7351.4 2115.2
##
## Step:  AIC=2086.84
## Quality ~ alcohol + volatile.acidity + sulphates + residual.sugar +
##   free.sulfur.dioxide + total.sulfur.dioxide + alcohol:volatile.acidity +
##   volatile.acidity:Wine.Color + alcohol:free.sulfur.dioxide +
##   sulphates:total.sulfur.dioxide + sulphates:Wine.Color + residual.sugar:total.sulfur.dioxide +
##   free.sulfur.dioxide:total.sulfur.dioxide
##
##                                     Df Sum of Sq    RSS     AIC
## <none>                           7321.7 2086.8
## + pH                             1    11.8326 7309.9 2087.4
## + free.sulfur.dioxide:Wine.Color  1     7.5405 7314.2 2090.3
## + residual.sugar:free.sulfur.dioxide 1     6.2841 7315.4 2091.1
## + free.sulfur.dioxide:density     1     6.0520 7315.7 2091.3
## + total.sulfur.dioxide:Wine.Color 1     5.3117 7316.4 2091.8
## + alcohol:density                1     4.4670 7317.2 2092.3
## + total.sulfur.dioxide:density   1     4.1717 7317.5 2092.6
## + residual.sugar:density         1     3.6001 7318.1 2092.9
## + alcohol:sulphates              1     3.1118 7318.6 2093.3
## + sulphates:free.sulfur.dioxide  1     1.7566 7320.0 2094.2
## + alcohol:Wine.Color              1     1.1860 7320.5 2094.6
## + residual.sugar:alcohol          1     1.0362 7320.7 2094.7
## + volatile.acidity:density       1     0.9073 7320.8 2094.7

```

```

## + sulphates:density 1 0.8353 7320.9 2094.8
## + residual.sugar:sulphates 1 0.7953 7320.9 2094.8
## + volatile.acidity:sulphates 1 0.7399 7321.0 2094.8
## + citric.acid 1 0.3433 7321.4 2095.1
## + alcohol:total.sulfur.dioxide 1 0.3042 7321.4 2095.1
## + volatile.acidity:total.sulfur.dioxide 1 0.1348 7321.6 2095.2
## + volatile.acidity:residual.sugar 1 0.1184 7321.6 2095.3
## + volatile.acidity:free.sulfur.dioxide 1 0.0718 7321.6 2095.3
## + fixed.acidity 1 0.0199 7321.7 2095.3
## + residual.sugar:Wine.Color 1 0.0151 7321.7 2095.3
## + density:Wine.Color 2 2.9083 7318.8 2101.9

newforwBIC <- lm(Quality^4/5 ~ alcohol + volatile.acidity + free.sulfur.dioxide +
                     sulphates + residual.sugar + total.sulfur.dioxide + pH +
                     fixed.acidity + alcohol:volatile.acidity + alcohol:free.sulfur.dioxide +
                     sulphates:total.sulfur.dioxide + alcohol:density + alcohol:pH +
                     volatile.acidity:density, data=train)

# calc SSE function
calc_SSE <- function(mymodel, testing_data, transformation)
{
  y_hat <- predict(mymodel, testing_data[,c(2:13)])
  y_hat <- y_hat^(1/transformation)
  SSE <- sum((testing_data$Quality - y_hat)^2)
  return(SSE*3000/2100)
}

# COMPARE SSEs NON TRANSFORMED
calc_SSE(newbackAIC, test, 1) # 4585.088

## [1] 4581.556
calc_SSE(newforwAIC, test, 1) # 4554.559

## [1] 4554.559
calc_SSE(newbackBIC, test, 1) # 4576.628

## [1] 4564.299
calc_SSE(newforwBIC, test, 1) # 4565.236

## [1] 296150017

```

Final model (lowest SSE = newforwAIC)

```

# newforwAIC <- lm(Quality ~ alcohol + volatile.acidity + sulphates + residual.sugar +
#                      free.sulfur.dioxide + total.sulfur.dioxide + pH + fixed.acidity +
#                      alcohol:volatile.acidity + volatile.acidity:Wine.Color +
#                      alcohol:free.sulfur.dioxide + sulphates:total.sulfur.dioxide +
#                      sulphates:Wine.Color + residual.sugar:total.sulfur.dioxide +
#                      free.sulfur.dioxide:total.sulfur.dioxide + alcohol:pH + #free.sulfur.dioxide:Wine.C
#                      residual.sugar:free.sulfur.dioxide + residual.sugar:density +
#                      total.sulfur.dioxide:pH + residual.sugar:pH + alcohol:residual.sugar +
#                      alcohol:density + pH:fixed.acidity + fixed.acidity:Wine.Color +
# 
```

```

#           free.sulfur.dioxide:fixed.acidity + volatile.acidity:density +
#           pH:Wine.Color + Wine.Color:density + volatile.acidity:pH +
#           sulphates:free.sulfur.dioxide)
summary(newforwAIC)

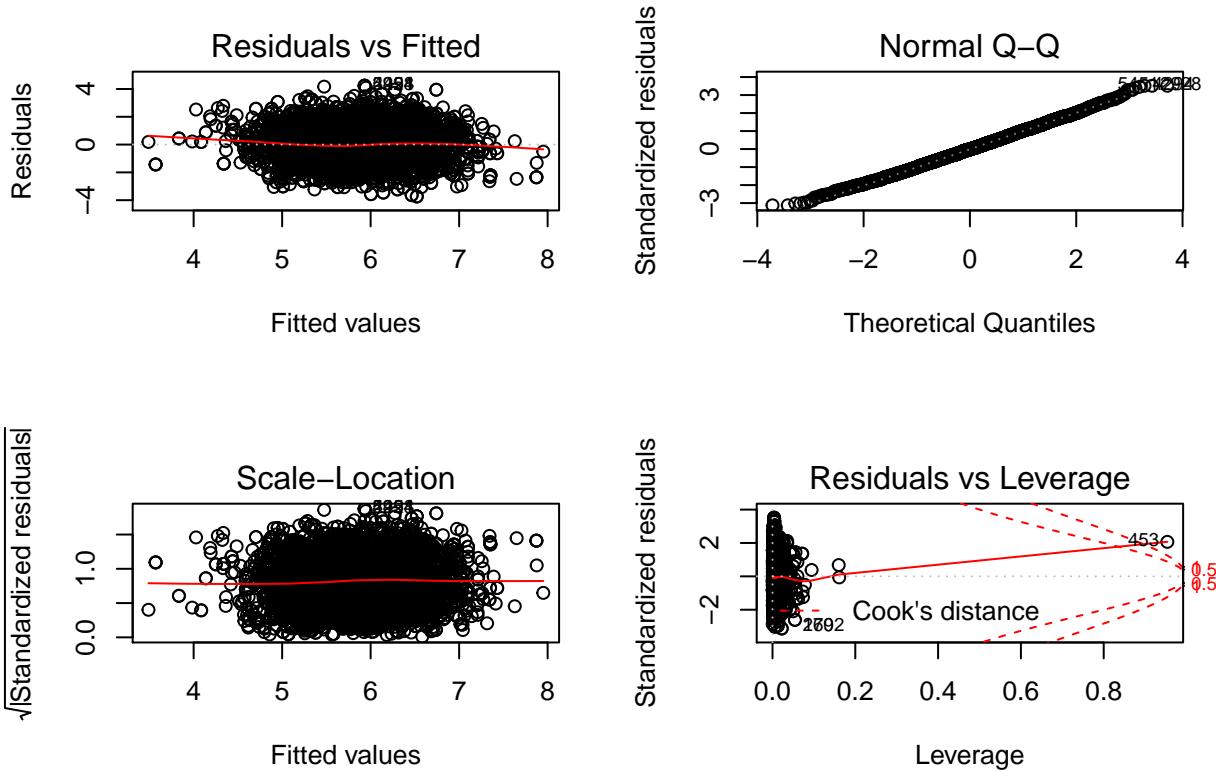
## 
## Call:
## lm(formula = Quality ~ alcohol + volatile.acidity + sulphates +
##      residual.sugar + free.sulfur.dioxide + total.sulfur.dioxide +
##      pH + fixed.acidity + alcohol:volatile.acidity + volatile.acidity:Wine.Color +
##      alcohol:free.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##      sulphates:Wine.Color + residual.sugar:total.sulfur.dioxide +
##      free.sulfur.dioxide:total.sulfur.dioxide + alcohol:pH + free.sulfur.dioxide:Wine.Color +
##      residual.sugar:free.sulfur.dioxide + residual.sugar:density +
##      total.sulfur.dioxide:pH + residual.sugar:pH + alcohol:residual.sugar +
##      alcohol:density + pH:fixed.acidity + fixed.acidity:Wine.Color +
##      free.sulfur.dioxide:fixed.acidity + volatile.acidity:density +
##      pH:Wine.Color + Wine.Color:density + volatile.acidity:pH +
##      sulphates:free.sulfur.dioxide, data = train)
##
## Residuals:
##    Min      1Q  Median      3Q     Max
## -3.7316 -0.8315 -0.0218  0.8082  4.2384
##
## Coefficients:
##                               Estimate Std. Error t value
## (Intercept)            3.026e+01  5.552e+00  5.449
## alcohol                  1.711e+01  3.476e+00  4.923
## volatile.acidity       -2.331e+02  6.784e+01 -3.436
## sulphates                1.834e+00  3.075e-01  5.964
## residual.sugar          2.322e+00  8.358e-01  2.778
## free.sulfur.dioxide     -1.756e-02  1.946e-02 -0.903
## total.sulfur.dioxide     1.622e-02  1.166e-02  1.390
## pH                      -7.157e+00  1.686e+00 -4.244
## fixed.acidity             -9.800e-01  2.968e-01 -3.302
## alcohol:volatile.acidity  8.490e-01  1.531e-01  5.545
## volatile.acidity:Wine.ColorW -2.102e-01  3.630e-01 -0.579
## alcohol:free.sulfur.dioxide  5.489e-05  1.282e-03  0.043
## sulphates:total.sulfur.dioxide -2.184e-02  3.945e-03 -5.536
## sulphates:Wine.ColorW      6.246e-01  3.583e-01  1.743
## residual.sugar:total.sulfur.dioxide  7.164e-04  1.303e-04  5.498
## free.sulfur.dioxide:total.sulfur.dioxide -1.638e-04  3.002e-05 -5.454
## alcohol:pH                 2.320e-01  1.092e-01  2.125
## free.sulfur.dioxide:Wine.ColorW  1.953e-02  5.490e-03  3.557
## residual.sugar:free.sulfur.dioxide -8.412e-04  3.278e-04 -2.566
## residual.sugar:density        -2.158e+00  8.425e-01 -2.562
## total.sulfur.dioxide:pH       -2.019e-03  3.532e-03 -0.571
## residual.sugar:pH              -9.692e-02  3.186e-02 -3.042
## alcohol:residual.sugar        1.427e-02  4.452e-03  3.206
## alcohol:density                -1.816e+01  3.554e+00 -5.110
## pH:fixed.acidity               3.095e-01  9.387e-02  3.298
## fixed.acidity:Wine.ColorW      4.381e-02  4.960e-02  0.883
## free.sulfur.dioxide:fixed.acidity  3.202e-03  1.308e-03  2.449
## volatile.acidity:density       2.124e+02  6.694e+01  3.173

```

```

## pH:Wine.ColorW           3.784e+00  5.883e-01  6.433
## Wine.ColorW:density      -1.357e+01 2.190e+00 -6.198
## volatile.acidity:pH       3.650e+00  9.648e-01  3.783
## sulphates:free.sulfur.dioxide 2.523e-02  1.118e-02  2.256
##
## Pr(>|t|)
## (Intercept)          5.31e-08 ***
## alcohol              8.79e-07 ***
## volatile.acidity     0.000594 ***
## sulphates            2.63e-09 ***
## residual.sugar       0.005496 **
## free.sulfur.dioxide 0.366713
## total.sulfur.dioxide 0.164456
## pH                   2.23e-05 ***
## fixed.acidity         0.000966 ***
## alcohol:volatile.acidity 3.09e-08 ***
## volatile.acidity:Wine.ColorW 0.562672
## alcohol:free.sulfur.dioxide 0.965852
## sulphates:total.sulfur.dioxide 3.26e-08 ***
## sulphates:Wine.ColorW 0.081388 .
## residual.sugar:total.sulfur.dioxide 4.03e-08 ***
## free.sulfur.dioxide:total.sulfur.dioxide 5.16e-08 ***
## alcohol:pH             0.033641 *
## free.sulfur.dioxide:Wine.ColorW 0.000378 ***
## residual.sugar:free.sulfur.dioxide 0.010310 *
## residual.sugar:density        0.010449 *
## total.sulfur.dioxide:pH       0.567692
## residual.sugar:pH            0.002361 **
## alcohol:residual.sugar       0.001356 **
## alcohol:density             3.35e-07 ***
## pH:fixed.acidity            0.000982 ***
## fixed.acidity:Wine.ColorW 0.377141
## free.sulfur.dioxide:fixed.acidity 0.014372 *
## volatile.acidity:density    0.001517 **
## pH:Wine.ColorW              1.37e-10 ***
## Wine.ColorW:density          6.18e-10 ***
## volatile.acidity:pH          0.000157 ***
## sulphates:free.sulfur.dioxide 0.024093 *
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.208 on 4868 degrees of freedom
## Multiple R-squared:  0.1712, Adjusted R-squared:  0.1659
## F-statistic: 32.44 on 31 and 4868 DF,  p-value: < 2.2e-16
par(mfrow=c(2,2))
plot(newforwAIC)

```



```
# delete bad leverage
# point 2796
train<-train[-2796,]
finalmodel <- lm(Quality ~ alcohol + volatile.acidity + sulphates + residual.sugar +
  free.sulfur.dioxide + total.sulfur.dioxide + pH + fixed.acidity +
  alcohol:volatile.acidity + volatile.acidity:Wine.Color +
  alcohol:free.sulfur.dioxide + sulphates:total.sulfur.dioxide +
  sulphates:Wine.Color + residual.sugar:total.sulfur.dioxide +
  free.sulfur.dioxide:total.sulfur.dioxide + alcohol:pH + free.sulfur.dioxide:Wine.Color +
  residual.sugar:free.sulfur.dioxide + residual.sugar:density +
  total.sulfur.dioxide:pH + residual.sugar:pH + alcohol:residual.sugar +
  alcohol:density + pH:fixed.acidity + fixed.acidity:Wine.Color +
  free.sulfur.dioxide:fixed.acidity + volatile.acidity:density +
  pH:Wine.Color + Wine.Color:density + volatile.acidity:pH +
  sulphates:free.sulfur.dioxide, data=train)
summary(finalmodel)

##
## Call:
## lm(formula = Quality ~ alcohol + volatile.acidity + sulphates +
##   residual.sugar + free.sulfur.dioxide + total.sulfur.dioxide +
##   pH + fixed.acidity + alcohol:volatile.acidity + volatile.acidity:Wine.Color +
##   alcohol:free.sulfur.dioxide + sulphates:total.sulfur.dioxide +
##   sulphates:Wine.Color + residual.sugar:total.sulfur.dioxide +
##   free.sulfur.dioxide:total.sulfur.dioxide + alcohol:pH + free.sulfur.dioxide:Wine.Color +
##   residual.sugar:free.sulfur.dioxide + residual.sugar:density +
##   total.sulfur.dioxide:pH + residual.sugar:pH + alcohol:residual.sugar +
##   alcohol:density + pH:fixed.acidity + fixed.acidity:Wine.Color +
##   free.sulfur.dioxide:fixed.acidity + volatile.acidity:density +
```

```

##      pH:Wine.Color + Wine.Color:density + volatile.acidity:pH +
##      sulphates:free.sulfur.dioxide, data = train)
##
## Residuals:
##      Min       1Q   Median      3Q      Max
## -3.6572 -0.8273 -0.0162  0.8149  4.2275
##
## Coefficients:
##                               Estimate Std. Error t value
## (Intercept)                2.851e+01  5.614e+00  5.077
## alcohol                   1.537e+01  3.575e+00  4.299
## volatile.acidity          -2.055e+02  6.911e+01 -2.974
## sulphates                  1.803e+00  3.077e-01  5.858
## residual.sugar              5.987e+00  1.960e+00  3.055
## free.sulfur.dioxide         -2.195e-02  1.957e-02 -1.122
## total.sulfur.dioxide        1.528e-02  1.167e-02  1.310
## pH                         -6.751e+00  1.697e+00 -3.978
## fixed.acidity               -9.417e-01  2.972e-01 -3.168
## alcohol:volatile.acidity    8.075e-01  1.544e-01  5.231
## volatile.acidity:Wine.ColorW -3.146e-01  3.664e-01 -0.859
## alcohol:free.sulfur.dioxide  3.135e-04  1.288e-03  0.243
## sulphates:total.sulfur.dioxide -2.138e-02  3.950e-03 -5.414
## sulphates:Wine.ColorW       6.068e-01  3.583e-01  1.694
## residual.sugar:total.sulfur.dioxide 7.350e-04  1.306e-04  5.629
## free.sulfur.dioxide:total.sulfur.dioxide -1.630e-04  3.002e-05 -5.432
## alcohol:pH                  2.106e-01  1.096e-01  1.921
## free.sulfur.dioxide:Wine.ColorW  1.903e-02  5.493e-03  3.465
## residual.sugar:free.sulfur.dioxide -7.899e-04  3.286e-04 -2.403
## residual.sugar:density        -5.739e+00  1.926e+00 -2.980
## total.sulfur.dioxide:pH       -1.851e-03  3.532e-03 -0.524
## residual.sugar:pH             -1.036e-01  3.201e-02 -3.235
## alcohol:residual.sugar        6.516e-03  5.819e-03  1.120
## alcohol:density               -1.630e+01  3.665e+00 -4.447
## pH:fixed.acidity              2.979e-01  9.401e-02  3.169
## fixed.acidity:Wine.ColorW    4.141e-02  4.959e-02  0.835
## free.sulfur.dioxide:fixed.acidity 3.421e-03  1.312e-03  2.609
## volatile.acidity:density     1.856e+02  6.816e+01  2.724
## pH:Wine.ColorW                3.763e+00  5.881e-01  6.399
## Wine.ColorW:density           -1.342e+01  2.191e+00 -6.124
## volatile.acidity:pH            3.508e+00  9.669e-01  3.628
## sulphates:free.sulfur.dioxide 2.546e-02  1.118e-02  2.278
##
## Pr(>|t|)

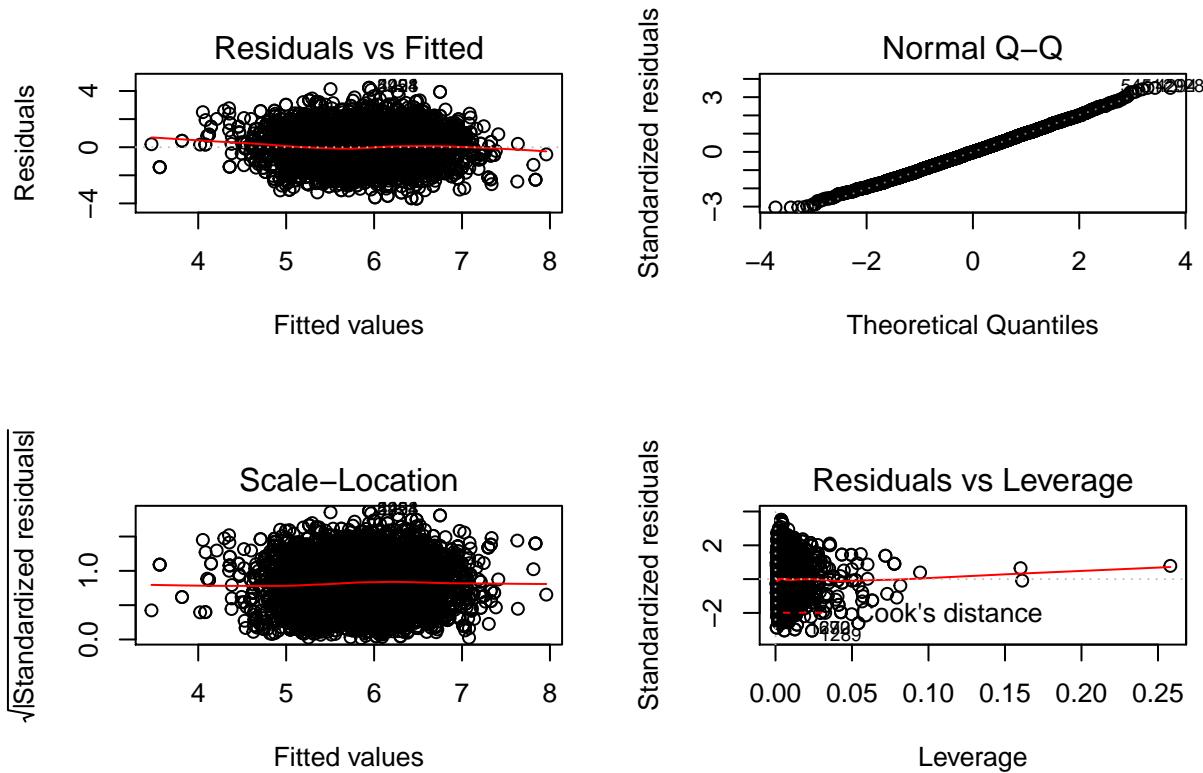
## (Intercept) 3.97e-07 ***
## alcohol      1.75e-05 ***
## volatile.acidity 0.002956 **
## sulphates    4.99e-09 ***
## residual.sugar 0.002260 **
## free.sulfur.dioxide 0.261988
## total.sulfur.dioxide 0.190330
## pH           7.05e-05 ***
## fixed.acidity 0.001544 **
## alcohol:volatile.acidity 1.75e-07 ***
## volatile.acidity:Wine.ColorW 0.390593
## alcohol:free.sulfur.dioxide 0.807640

```

```

## sulphates:total.sulfur.dioxide      6.48e-08 ***
## sulphates:Wine.ColorW              0.090413 .
## residual.sugar:total.sulfur.dioxide 1.91e-08 ***
## free.sulfur.dioxide:total.sulfur.dioxide 5.86e-08 ***
## alcohol:pH                         0.054842 .
## free.sulfur.dioxide:Wine.ColorW     0.000534 ***
## residual.sugar:free.sulfur.dioxide  0.016277 *
## residual.sugar:density             0.002893 **
## total.sulfur.dioxide:pH            0.600318
## residual.sugar:pH                 0.001222 **
## alcohol:residual.sugar            0.262872
## alcohol:density                  8.90e-06 ***
## pH:fixed.acidity                  0.001539 **
## fixed.acidity:Wine.ColorW         0.403722
## free.sulfur.dioxide:fixed.acidity 0.009119 **
## volatile.acidity:density          0.006476 **
## pH:Wine.ColorW                   1.71e-10 ***
## Wine.ColorW:density               9.82e-10 ***
## volatile.acidity:pH               0.000289 ***
## sulphates:free.sulfur.dioxide    0.022792 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.208 on 4867 degrees of freedom
## Multiple R-squared:  0.1719, Adjusted R-squared:  0.1666
## F-statistic: 32.58 on 31 and 4867 DF,  p-value: < 2.2e-16
par(mfrow=c(2,2))
plot(finalmodel)

```



```
# prediction values using 3000 values of testing data (use to write csv)
finalpred<-predict(newforwAIC, testing)
finalpred
```

	1	2	3	4	5	6	7
##	6.579716	5.149841	5.611107	5.417117	5.600163	5.715603	5.938105
##	8	9	10	11	12	13	14
##	5.636797	5.532506	6.459967	6.434486	5.441108	6.596045	6.867192
##	15	16	17	18	19	20	21
##	5.472886	5.876088	5.196287	5.711099	5.766430	5.972921	6.378490
##	22	23	24	25	26	27	28
##	6.301208	6.570569	5.735372	5.236101	5.647772	5.640303	5.173728
##	29	30	31	32	33	34	35
##	5.237066	6.537548	6.378330	5.790942	5.446953	5.576949	5.422508
##	36	37	38	39	40	41	42
##	7.215059	5.541252	5.802006	6.784525	6.445857	5.617334	7.213464
##	43	44	45	46	47	48	49
##	4.872043	6.419361	5.951529	5.178354	6.382570	6.399598	6.069871
##	50	51	52	53	54	55	56
##	5.972921	5.927137	4.896097	5.856261	5.934008	6.557160	5.222452
##	57	58	59	60	61	62	63
##	5.398872	4.186563	5.964495	5.998252	5.997825	5.999123	5.626965
##	64	65	66	67	68	69	70
##	6.520830	6.328043	5.366998	5.889633	6.599966	5.049338	6.102996
##	71	72	73	74	75	76	77
##	6.210748	6.065814	6.033504	5.812259	5.542817	5.542193	5.672785
##	78	79	80	81	82	83	84
##	5.562276	6.350139	5.665439	6.080048	5.737045	5.483243	5.623186
##	85	86	87	88	89	90	91
##	6.321987	6.035606	5.851121	6.168750	5.636548	5.498790	6.059957
##	92	93	94	95	96	97	98
##	6.881589	6.757606	5.655682	5.563132	5.740658	6.873900	5.722022
##	99	100	101	102	103	104	105
##	6.194532	6.174362	5.743208	5.940430	6.443050	5.397412	6.060168
##	106	107	108	109	110	111	112
##	6.483788	5.536648	5.428441	6.244048	5.853351	6.257293	6.062538
##	113	114	115	116	117	118	119
##	5.756746	5.729426	5.465221	5.821553	5.397412	6.479374	5.790790
##	120	121	122	123	124	125	126
##	5.604079	6.310717	6.419862	5.260341	5.251255	7.087295	6.060872
##	127	128	129	130	131	132	133
##	5.660744	5.854233	5.979460	4.901070	5.633724	5.381038	5.294581
##	134	135	136	137	138	139	140
##	5.361130	5.189186	4.915425	6.503332	6.200877	6.724794	6.016672
##	141	142	143	144	145	146	147
##	5.622131	6.025411	6.636020	5.395906	5.562163	5.248243	5.879461
##	148	149	150	151	152	153	154
##	5.251255	6.235194	5.746378	5.949477	6.495578	6.280717	6.478667
##	155	156	157	158	159	160	161
##	5.853645	6.022479	5.896068	5.667874	5.888442	4.576157	6.303679
##	162	163	164	165	166	167	168
##	5.538913	5.954400	4.914377	5.439056	5.576412	5.677377	5.969969
##	169	170	171	172	173	174	175
##	6.438122	5.600738	5.667386	5.392632	4.917825	6.442694	4.343763

##	176	177	178	179	180	181	182
##	5.196287	6.355849	5.091138	5.729876	6.500648	5.290806	6.008983
##	183	184	185	186	187	188	189
##	5.985433	6.417590	5.715603	5.731977	5.399497	6.590601	6.165811
##	190	191	192	193	194	195	196
##	5.528702	5.662301	5.236454	6.291234	5.271204	5.841438	5.889280
##	197	198	199	200	201	202	203
##	5.092652	5.412617	6.974071	6.097194	6.056829	5.785949	6.770552
##	204	205	206	207	208	209	210
##	5.878222	5.597073	5.761803	6.350918	6.611348	5.499079	6.477850
##	211	212	213	214	215	216	217
##	6.098469	6.130493	4.592273	6.040388	5.761669	5.784437	5.255348
##	218	219	220	221	222	223	224
##	6.975456	4.636926	6.523136	6.159797	5.287110	5.457904	5.927741
##	225	226	227	228	229	230	231
##	6.880456	4.977672	4.994411	5.602416	5.847121	6.113026	5.591621
##	232	233	234	235	236	237	238
##	5.556663	5.633891	4.886362	5.708543	6.656574	6.123382	6.598165
##	239	240	241	242	243	244	245
##	5.805294	5.724283	5.508213	5.425817	5.690977	4.858818	6.011235
##	246	247	248	249	250	251	252
##	6.084496	5.514244	5.766430	6.019312	6.321987	5.690255	6.674697
##	253	254	255	256	257	258	259
##	6.077062	6.389393	5.333737	5.587088	7.206679	6.059957	5.223793
##	260	261	262	263	264	265	266
##	5.174751	4.888789	6.230528	6.421165	5.363348	6.526562	6.703241
##	267	268	269	270	271	272	273
##	5.942172	5.410505	5.713883	6.184412	5.893307	4.431699	5.498373
##	274	275	276	277	278	279	280
##	5.783651	6.688013	6.103561	5.864123	6.346544	5.321265	6.109298
##	281	282	283	284	285	286	287
##	6.037349	7.272835	5.341445	5.409131	5.260550	5.411864	5.225371
##	288	289	290	291	292	293	294
##	6.214962	6.355849	5.024731	6.716218	5.621542	6.354205	5.043112
##	295	296	297	298	299	300	301
##	5.467062	5.225699	5.833390	6.005045	6.608380	6.662054	5.148388
##	302	303	304	305	306	307	308
##	6.181887	6.804562	6.148169	5.869954	6.554389	5.686800	6.208771
##	309	310	311	312	313	314	315
##	5.393008	5.997101	6.628647	6.289441	5.497736	5.314362	6.468634
##	316	317	318	319	320	321	322
##	7.031610	5.207214	6.485157	5.272151	5.828975	6.124035	4.339782
##	323	324	325	326	327	328	329
##	5.762960	5.389970	5.548675	6.585174	5.437020	6.606052	6.291123
##	330	331	332	333	334	335	336
##	6.722354	6.099216	5.995393	5.063122	6.004455	6.508427	5.204323
##	337	338	339	340	341	342	343
##	6.770778	5.815521	5.571420	6.327163	6.777091	5.857071	5.546142
##	344	345	346	347	348	349	350
##	5.364290	6.586627	5.510800	5.591237	6.244530	5.956647	5.857167
##	351	352	353	354	355	356	357
##	6.804976	5.485955	6.100880	6.112522	5.053620	4.698633	6.130474
##	358	359	360	361	362	363	364
##	6.216645	6.018316	5.327877	5.658577	5.975489	5.743208	5.580290

##	365	366	367	368	369	370	371
##	5.569229	6.492105	5.486329	6.045863	6.210651	5.924553	6.249719
##	372	373	374	375	376	377	378
##	6.762968	6.203711	5.465221	5.919109	7.051786	5.285681	4.937708
##	379	380	381	382	383	384	385
##	5.163629	6.077062	6.703845	5.195024	4.963051	5.554898	5.773530
##	386	387	388	389	390	391	392
##	5.922449	5.632286	6.216645	5.682973	5.778047	6.365973	5.560846
##	393	394	395	396	397	398	399
##	6.100758	5.331681	5.522023	6.245884	6.630663	5.638358	5.473538
##	400	401	402	403	404	405	406
##	4.977672	5.246891	6.335956	5.868441	5.800020	6.006536	6.143246
##	407	408	409	410	411	412	413
##	6.080048	5.183867	5.821553	5.558937	5.779627	6.921934	5.345232
##	414	415	416	417	418	419	420
##	7.070361	6.034107	6.210478	6.056299	5.091564	6.142457	4.807766
##	421	422	423	424	425	426	427
##	6.467673	6.098325	5.393008	5.583987	4.980628	6.249719	7.031610
##	428	429	430	431	432	433	434
##	5.447425	5.971261	5.314412	6.103660	6.565342	5.864469	5.978774
##	435	436	437	438	439	440	441
##	6.159704	6.353174	6.764096	5.237602	5.291376	5.717830	4.658770
##	442	443	444	445	446	447	448
##	5.835973	7.019567	5.613274	6.069909	6.057379	4.568996	5.325766
##	449	450	451	452	453	454	455
##	5.879791	5.042553	7.360731	5.467741	6.597325	6.607751	5.956400
##	456	457	458	459	460	461	462
##	5.938449	5.639196	6.115166	5.848258	5.812669	6.147125	5.627733
##	463	464	465	466	467	468	469
##	6.440505	6.399738	6.648801	4.989316	6.074682	5.297965	5.873350
##	470	471	472	473	474	475	476
##	5.766430	5.335355	6.365102	6.236808	5.795251	5.672595	6.587561
##	477	478	479	480	481	482	483
##	6.037490	6.358091	6.518738	6.213594	5.891187	5.326284	6.087589
##	484	485	486	487	488	489	490
##	5.568926	5.874680	5.292051	6.215340	5.308152	5.503126	5.473538
##	491	492	493	494	495	496	497
##	5.903525	6.052530	5.208009	6.591482	6.211670	6.403147	6.399598
##	498	499	500	501	502	503	504
##	5.159078	5.614271	5.783054	5.968771	6.050945	6.828844	5.988096
##	505	506	507	508	509	510	511
##	4.898315	5.614081	5.564606	6.165811	6.369334	5.857883	6.455495
##	512	513	514	515	516	517	518
##	4.884199	5.686377	5.723401	6.673620	5.435971	6.300927	5.831152
##	519	520	521	522	523	524	525
##	5.420791	5.716067	5.667129	6.098940	5.727960	5.025186	6.881589
##	526	527	528	529	530	531	532
##	6.558189	5.458354	5.455388	6.177378	6.061175	5.310226	6.052032
##	533	534	535	536	537	538	539
##	5.602077	6.432535	6.804562	5.684916	5.926585	5.555686	5.755548
##	540	541	542	543	544	545	546
##	5.969375	5.435000	6.097760	5.779627	5.620505	5.303525	5.157107
##	547	548	549	550	551	552	553
##	5.555686	5.869489	5.360065	5.653246	5.807621	6.868084	4.697772

##	554	555	556	557	558	559	560
##	6.151260	6.391036	6.151260	6.043242	5.919109	5.773530	5.807463
##	561	562	563	564	565	566	567
##	6.506546	5.793344	6.628647	6.853749	5.164111	6.676168	5.575027
##	568	569	570	571	572	573	574
##	5.276809	5.873040	5.787690	6.304682	5.495292	5.331681	6.049198
##	575	576	577	578	579	580	581
##	5.965629	5.797112	4.843144	5.677598	6.703845	6.452459	5.207214
##	582	583	584	585	586	587	588
##	4.920299	5.671875	5.983699	6.368145	5.239581	6.772092	5.452593
##	589	590	591	592	593	594	595
##	4.791188	5.476812	6.332384	5.361130	5.667571	5.648730	6.211670
##	596	597	598	599	600	601	602
##	5.594160	5.561609	6.028945	5.753291	5.892407	6.113026	6.011794
##	603	604	605	606	607	608	609
##	6.408405	5.897064	6.367786	5.878344	6.349380	5.994270	5.118274
##	610	611	612	613	614	615	616
##	6.084420	6.694447	6.797892	6.908303	6.550439	5.477673	6.065090
##	617	618	619	620	621	622	623
##	4.982590	4.791910	5.671566	5.898253	5.613463	5.859079	7.343388
##	624	625	626	627	628	629	630
##	4.671219	5.799134	6.762444	5.430734	6.062646	6.477850	5.318279
##	631	632	633	634	635	636	637
##	6.004178	5.385230	6.112879	4.878570	5.165728	5.866130	4.563962
##	638	639	640	641	642	643	644
##	5.573538	6.209117	6.289441	5.816530	5.397412	5.752259	5.695917
##	645	646	647	648	649	650	651
##	5.307878	5.580410	5.239891	5.244628	5.790595	6.320632	6.288742
##	652	653	654	655	656	657	658
##	6.196286	5.135019	5.091564	5.667386	6.237867	4.963051	7.148556
##	659	660	661	662	663	664	665
##	5.893622	5.813546	6.462361	6.342957	6.716315	5.574979	4.934384
##	666	667	668	669	670	671	672
##	5.868812	6.674623	6.358091	5.891187	5.476340	6.260698	6.560477
##	673	674	675	676	677	678	679
##	4.464241	5.571420	5.934618	5.641956	6.163299	6.373534	6.196734
##	680	681	682	683	684	685	686
##	5.359952	5.212230	5.392559	5.059632	6.025749	6.053122	6.016672
##	687	688	689	690	691	692	693
##	5.600940	6.025027	5.443012	6.194457	5.909669	6.419766	6.497972
##	694	695	696	697	698	699	700
##	5.718269	5.117840	5.690359	6.021877	5.637024	4.877857	7.294337
##	701	702	703	704	705	706	707
##	6.478262	5.319596	5.223793	5.792293	5.861182	6.361647	5.011067
##	708	709	710	711	712	713	714
##	7.272835	5.806625	5.982294	6.581612	5.285999	6.459047	6.107066
##	715	716	717	718	719	720	721
##	5.605735	5.759189	5.509006	5.346717	6.621630	4.898315	6.271722
##	722	723	724	725	726	727	728
##	5.785841	5.632286	5.779293	5.308030	6.573116	5.737364	5.433319
##	729	730	731	732	733	734	735
##	6.064891	5.563233	5.813546	6.570569	5.839459	5.447425	6.416823
##	736	737	738	739	740	741	742
##	6.048708	5.294581	6.508427	5.356643	5.178644	6.099802	6.192226

##	743	744	745	746	747	748	749
##	6.097036	5.886529	7.042402	5.271264	4.993673	5.013491	6.609205
##	750	751	752	753	754	755	756
##	6.004957	5.799134	6.376740	5.822872	5.639196	6.462361	6.600533
##	757	758	759	760	761	762	763
##	6.650098	5.828975	5.920576	5.933298	6.958528	5.304461	5.743208
##	764	765	766	767	768	769	770
##	6.010210	6.559931	6.673620	5.573144	6.478075	5.694306	5.796460
##	771	772	773	774	775	776	777
##	5.923344	6.465485	5.870893	6.178189	6.077479	5.986219	6.059655
##	778	779	780	781	782	783	784
##	5.630486	5.630284	6.328822	4.843396	6.611348	5.077499	6.042948
##	785	786	787	788	789	790	791
##	5.604999	5.725218	6.433648	6.271375	5.510733	6.077621	6.236789
##	792	793	794	795	796	797	798
##	6.428319	6.118525	6.215340	6.146493	5.498790	5.632499	5.777581
##	799	800	801	802	803	804	805
##	5.667490	4.085176	4.917616	5.516293	5.350503	6.426367	5.541252
##	806	807	808	809	810	811	812
##	6.291180	5.846595	5.790790	5.558937	6.325896	5.331681	5.428441
##	813	814	815	816	817	818	819
##	6.155463	6.257658	4.878939	6.760360	5.268575	5.870365	5.656740
##	820	821	822	823	824	825	826
##	6.305633	6.069909	4.622015	6.353454	5.822966	5.730367	5.404568
##	827	828	829	830	831	832	833
##	5.320731	6.089954	5.409995	6.184412	6.123382	6.902224	6.215430
##	834	835	836	837	838	839	840
##	5.348928	5.941228	5.670091	5.713883	5.191690	6.011794	5.776244
##	841	842	843	844	845	846	847
##	6.714788	5.885978	7.037120	5.881842	5.602077	5.064636	6.601223
##	848	849	850	851	852	853	854
##	5.700146	5.604079	5.486537	6.333836	5.873040	6.572075	5.519352
##	855	856	857	858	859	860	861
##	5.358344	5.545998	6.229639	5.428441	5.444404	5.902141	5.539296
##	862	863	864	865	866	867	868
##	4.791910	5.964647	6.198347	6.173711	5.339027	6.974071	6.454718
##	869	870	871	872	873	874	875
##	6.442724	5.985339	6.045212	5.192850	6.017337	5.481551	6.209271
##	876	877	878	879	880	881	882
##	6.071519	5.559081	5.577835	5.219873	7.025122	5.271264	5.805137
##	883	884	885	886	887	888	889
##	6.683523	6.741453	6.579145	6.251882	6.446066	5.251956	6.016672
##	890	891	892	893	894	895	896
##	5.191690	5.951529	6.042906	6.477850	6.478667	6.330164	5.480702
##	897	898	899	900	901	902	903
##	6.387244	5.969969	6.378960	6.202236	6.115166	6.067171	5.989051
##	904	905	906	907	908	909	910
##	6.508427	6.866505	5.581230	5.802850	5.282590	5.798448	5.807463
##	911	912	913	914	915	916	917
##	5.365166	5.870365	6.288903	5.882255	5.505511	5.762588	6.805026
##	918	919	920	921	922	923	924
##	6.010210	5.523887	5.601823	5.716170	5.607710	4.880469	6.374661
##	925	926	927	928	929	930	931
##	5.331681	5.332735	5.847121	5.787353	4.859571	5.121251	6.118543

##	932	933	934	935	936	937	938
##	4.905944	6.748093	5.457317	5.075561	5.501681	5.497297	5.344104
##	939	940	941	942	943	944	945
##	5.840731	5.681042	5.591621	6.176635	5.302962	5.548037	6.180699
##	946	947	948	949	950	951	952
##	5.537567	5.604061	6.095073	5.780726	5.504512	5.143284	5.457904
##	953	954	955	956	957	958	959
##	5.421405	5.506468	5.091138	6.520830	5.836365	5.859385	5.436192
##	960	961	962	963	964	965	966
##	6.291234	5.672595	6.237867	6.167092	6.017963	6.688590	5.239891
##	967	968	969	970	971	972	973
##	6.025749	5.667386	5.256381	6.353454	6.656332	5.992291	5.491705
##	974	975	976	977	978	979	980
##	6.136538	6.546257	5.594987	5.236279	5.663730	6.457839	6.213453
##	981	982	983	984	985	986	987
##	5.771280	5.298820	6.176135	5.629431	5.931638	7.079514	5.221084
##	988	989	990	991	992	993	994
##	6.352939	5.644179	5.351513	6.083446	5.735656	5.285309	5.301413
##	995	996	997	998	999	1000	1001
##	6.112879	5.602870	7.873101	6.943983	5.708054	6.019312	6.968275
##	1002	1003	1004	1005	1006	1007	1008
##	5.750923	7.214656	5.715603	5.464092	6.123943	6.225017	5.921745
##	1009	1010	1011	1012	1013	1014	1015
##	6.707689	5.597438	5.982294	5.275423	5.883245	5.195024	6.117164
##	1016	1017	1018	1019	1020	1021	1022
##	5.820863	6.139817	5.789820	5.677761	6.379181	5.765146	5.656334
##	1023	1024	1025	1026	1027	1028	1029
##	5.604999	5.866885	5.467741	5.019678	6.379702	5.994270	6.018316
##	1030	1031	1032	1033	1034	1035	1036
##	6.386623	4.891873	5.845044	4.549475	5.133775	5.182720	5.116012
##	1037	1038	1039	1040	1041	1042	1043
##	6.726906	6.158892	6.202236	6.694447	5.836365	5.487577	5.857167
##	1044	1045	1046	1047	1048	1049	1050
##	5.816943	5.332735	5.563212	5.853164	5.123641	5.503282	5.677590
##	1051	1052	1053	1054	1055	1056	1057
##	5.852461	5.021368	4.896097	5.928648	6.237587	5.626745	5.272809
##	1058	1059	1060	1061	1062	1063	1064
##	6.018280	5.776570	5.395906	5.285999	5.456724	6.181887	6.488717
##	1065	1066	1067	1068	1069	1070	1071
##	6.271722	6.769655	6.369334	5.369651	5.418331	6.538250	6.308732
##	1072	1073	1074	1075	1076	1077	1078
##	5.861051	6.355483	5.156003	5.885978	4.888789	5.837105	5.615117
##	1079	1080	1081	1082	1083	1084	1085
##	5.671566	5.944420	5.447425	6.553621	5.592139	4.775159	5.812259
##	1086	1087	1088	1089	1090	1091	1092
##	6.560477	6.121234	4.333185	5.365062	6.071519	6.074272	5.951780
##	1093	1094	1095	1096	1097	1098	1099
##	6.236834	5.714326	6.476686	6.035101	6.132056	6.125752	5.431609
##	1100	1101	1102	1103	1104	1105	1106
##	6.685232	6.250224	6.558189	6.212335	5.303022	5.883341	5.561609
##	1107	1108	1109	1110	1111	1112	1113
##	6.105998	5.708054	5.735372	7.215059	5.500883	5.487239	5.407452
##	1114	1115	1116	1117	1118	1119	1120
##	5.757416	6.029095	5.697502	5.750660	5.848734	5.130063	5.059632

##	1121	1122	1123	1124	1125	1126	1127
##	5.815521	5.796460	6.615191	5.851121	5.132336	5.816196	6.172161
##	1128	1129	1130	1131	1132	1133	1134
##	6.633933	6.562384	7.050400	5.664700	6.035606	6.214151	5.077147
##	1135	1136	1137	1138	1139	1140	1141
##	6.066602	5.529694	5.477004	5.902354	5.409984	6.464860	5.561609
##	1142	1143	1144	1145	1146	1147	1148
##	6.027942	6.065090	5.300714	5.256091	5.623639	5.418104	4.343763
##	1149	1150	1151	1152	1153	1154	1155
##	5.395802	6.408418	5.191690	5.863506	5.841256	5.132336	7.354156
##	1156	1157	1158	1159	1160	1161	1162
##	5.775982	6.113026	5.291253	6.282129	6.683523	5.656334	5.568926
##	1163	1164	1165	1166	1167	1168	1169
##	6.084175	6.546257	5.884568	5.258147	5.964664	6.995896	6.434636
##	1170	1171	1172	1173	1174	1175	1176
##	5.910729	5.193872	6.656219	6.510800	6.105725	5.866245	6.037490
##	1177	1178	1179	1180	1181	1182	1183
##	5.729615	6.171439	4.791188	6.321768	5.788350	6.114075	4.937394
##	1184	1185	1186	1187	1188	1189	1190
##	4.980617	6.562082	6.215067	5.067113	5.681246	5.875914	5.637395
##	1191	1192	1193	1194	1195	1196	1197
##	5.366998	6.088232	5.503282	5.290805	6.143337	6.106099	5.560139
##	1198	1199	1200	1201	1202	1203	1204
##	6.184598	5.569205	5.504719	5.361130	5.301413	5.956342	4.888602
##	1205	1206	1207	1208	1209	1210	1211
##	5.897001	6.688991	6.116775	5.255361	6.095826	4.085176	5.256155
##	1212	1213	1214	1215	1216	1217	1218
##	5.879407	6.031618	5.885978	6.652436	6.092488	5.521659	5.381805
##	1219	1220	1221	1222	1223	1224	1225
##	5.538292	6.214668	6.460484	5.414521	5.632772	5.460803	5.021368
##	1226	1227	1228	1229	1230	1231	1232
##	5.947371	6.007852	6.837750	5.677244	6.151876	6.163299	5.063122
##	1233	1234	1235	1236	1237	1238	1239
##	5.273869	5.446529	6.137266	6.599966	6.886817	6.443008	7.114307
##	1240	1241	1242	1243	1244	1245	1246
##	5.273869	5.328420	5.938548	5.781053	6.133221	5.949544	6.580547
##	1247	1248	1249	1250	1251	1252	1253
##	5.932020	5.783651	5.430730	6.383700	5.815521	6.855016	6.654231
##	1254	1255	1256	1257	1258	1259	1260
##	6.067018	5.543984	6.351014	5.859079	5.594034	5.338021	5.879461
##	1261	1262	1263	1264	1265	1266	1267
##	6.076031	5.762588	5.363136	6.268820	5.482746	5.667785	5.171599
##	1268	1269	1270	1271	1272	1273	1274
##	5.784437	5.673547	6.816963	5.722494	6.318935	5.650465	6.112900
##	1275	1276	1277	1278	1279	1280	1281
##	6.348206	6.339209	5.908546	6.080089	6.495578	5.880910	6.218805
##	1282	1283	1284	1285	1286	1287	1288
##	4.831985	6.041328	5.542817	5.893307	5.167992	3.944148	5.667129
##	1289	1290	1291	1292	1293	1294	1295
##	5.721030	5.286624	6.459047	5.384023	5.007605	6.344462	5.566708
##	1296	1297	1298	1299	1300	1301	1302
##	5.108830	4.384897	5.982176	5.222285	6.550439	5.910035	5.801950
##	1303	1304	1305	1306	1307	1308	1309
##	6.555078	5.530767	5.661841	5.091564	5.839496	5.763416	6.799967

##	1310	1311	1312	1313	1314	1315	1316
##	5.845831	4.942530	6.319157	5.829887	5.607710	5.473538	3.197348
##	1317	1318	1319	1320	1321	1322	1323
##	5.960625	5.891868	6.609887	4.997713	5.350910	5.966425	5.773530
##	1324	1325	1326	1327	1328	1329	1330
##	5.744989	5.460803	6.363212	6.030493	6.663598	6.173044	6.902790
##	1331	1332	1333	1334	1335	1336	1337
##	6.302973	5.566849	5.997214	6.266696	6.512346	6.429876	6.064493
##	1338	1339	1340	1341	1342	1343	1344
##	5.236463	4.942530	5.682973	5.511848	6.346544	5.484033	5.348928
##	1345	1346	1347	1348	1349	1350	1351
##	5.785875	4.958083	5.242382	6.245822	6.398961	6.804562	7.026698
##	1352	1353	1354	1355	1356	1357	1358
##	5.158554	5.078374	6.854856	6.253498	6.373534	6.118543	6.624716
##	1359	1360	1361	1362	1363	1364	1365
##	5.891417	6.353174	5.869489	5.388372	5.830594	5.395906	4.694325
##	1366	1367	1368	1369	1370	1371	1372
##	5.213760	5.752948	6.034826	6.498815	6.599056	6.340093	5.395161
##	1373	1374	1375	1376	1377	1378	1379
##	5.885978	5.851823	5.746942	7.032730	4.997713	6.033308	5.205924
##	1380	1381	1382	1383	1384	1385	1386
##	6.485157	6.378490	6.595144	5.735372	5.716067	5.663730	6.668882
##	1387	1388	1389	1390	1391	1392	1393
##	5.455091	5.677961	5.806547	4.795215	6.647662	5.638358	5.231533
##	1394	1395	1396	1397	1398	1399	1400
##	4.937708	6.037490	5.712559	6.328822	5.610016	6.288912	6.088330
##	1401	1402	1403	1404	1405	1406	1407
##	7.021047	6.611376	6.115166	4.877857	6.278613	6.031282	5.428441
##	1408	1409	1410	1411	1412	1413	1414
##	5.303022	6.393602	5.659515	5.738556	5.307551	4.138117	5.368360
##	1415	1416	1417	1418	1419	1420	1421
##	5.845044	5.303634	5.555823	5.870195	5.050155	6.501249	6.716218
##	1422	1423	1424	1425	1426	1427	1428
##	6.244048	5.634947	6.237191	5.046119	5.936250	5.713883	6.045789
##	1429	1430	1431	1432	1433	1434	1435
##	5.881308	5.418388	5.729588	5.619319	5.544622	6.074480	5.962509
##	1436	1437	1438	1439	1440	1441	1442
##	5.614933	5.424528	5.816943	5.430805	6.426562	6.288903	5.235685
##	1443	1444	1445	1446	1447	1448	1449
##	6.188259	5.656291	5.819389	5.982336	5.687858	6.321768	5.762694
##	1450	1451	1452	1453	1454	1455	1456
##	5.480702	5.836940	5.113902	6.146149	5.621995	5.621908	6.144421
##	1457	1458	1459	1460	1461	1462	1463
##	5.847173	5.225282	5.999290	5.428441	5.380133	5.303110	5.447425
##	1464	1465	1466	1467	1468	1469	1470
##	5.955963	5.834822	5.148388	6.184258	5.426561	5.789925	5.489000
##	1471	1472	1473	1474	1475	1476	1477
##	5.892328	6.472972	5.866245	5.870520	5.077265	6.205183	6.458456
##	1478	1479	1480	1481	1482	1483	1484
##	6.048387	5.083788	5.065939	5.680843	5.875289	6.125752	5.732980
##	1485	1486	1487	1488	1489	1490	1491
##	5.673548	5.207983	6.472972	4.895357	6.089727	5.631310	6.221890
##	1492	1493	1494	1495	1496	1497	1498
##	5.215701	5.500795	5.951156	5.978763	5.847357	6.508834	5.989854

##	1499	1500	1501	1502	1503	1504	1505
##	5.196287	5.989520	5.231434	6.1115166	6.355234	6.043242	6.911943
##	1506	1507	1508	1509	1510	1511	1512
##	6.314654	5.823086	5.878222	5.365899	5.284686	5.667895	5.868226
##	1513	1514	1515	1516	1517	1518	1519
##	5.479665	5.544622	5.641488	6.318020	4.846393	6.008983	5.579271
##	1520	1521	1522	1523	1524	1525	1526
##	5.989540	5.868001	5.559081	5.112733	6.602692	5.347868	5.307139
##	1527	1528	1529	1530	1531	1532	1533
##	5.519352	4.983587	5.322798	5.001277	5.798302	6.191027	5.807463
##	1534	1535	1536	1537	1538	1539	1540
##	5.784437	5.886529	6.675210	5.581456	4.870343	5.398047	5.581456
##	1541	1542	1543	1544	1545	1546	1547
##	5.571420	6.466323	6.347850	6.806902	5.949903	5.639828	5.741683
##	1548	1549	1550	1551	1552	1553	1554
##	5.706617	4.939012	6.742687	6.016672	6.364784	5.648609	5.152743
##	1555	1556	1557	1558	1559	1560	1561
##	6.245077	6.166702	5.663922	6.534277	6.570569	5.473828	5.340883
##	1562	1563	1564	1565	1566	1567	1568
##	6.858976	5.949477	5.666697	5.877076	4.989316	6.030520	5.099876
##	1569	1570	1571	1572	1573	1574	1575
##	5.648406	5.061602	6.050344	6.109595	5.612617	5.148388	5.078026
##	1576	1577	1578	1579	1580	1581	1582
##	5.342040	6.380100	6.674259	5.883341	5.413708	5.731119	6.383700
##	1583	1584	1585	1586	1587	1588	1589
##	6.250603	5.632499	5.780577	6.426562	6.399060	5.158486	4.986951
##	1590	1591	1592	1593	1594	1595	1596
##	6.136422	6.357995	5.773530	5.942172	5.532722	5.874914	5.637024
##	1597	1598	1599	1600	1601	1602	1603
##	5.005554	6.063180	6.142224	6.050604	5.968483	5.905180	6.392451
##	1604	1605	1606	1607	1608	1609	1610
##	5.758923	6.076904	5.615964	6.018316	5.699712	6.120342	7.213464
##	1611	1612	1613	1614	1615	1616	1617
##	6.271464	6.706156	5.875681	6.443895	6.517312	5.922125	6.042677
##	1618	1619	1620	1621	1622	1623	1624
##	5.534386	5.581230	5.587561	5.330539	6.720157	5.956807	5.996722
##	1625	1626	1627	1628	1629	1630	1631
##	5.161112	5.057500	6.661373	5.821819	6.137266	5.508213	6.040746
##	1632	1633	1634	1635	1636	1637	1638
##	6.858976	6.410455	6.263236	6.265547	5.258067	5.647772	5.486868
##	1639	1640	1641	1642	1643	1644	1645
##	6.587561	6.765578	5.795813	6.065760	6.741453	5.315962	5.349291
##	1646	1647	1648	1649	1650	1651	1652
##	4.138117	5.962191	5.332230	5.402400	5.743208	5.799134	5.698640
##	1653	1654	1655	1656	1657	1658	1659
##	4.750241	5.286391	5.249436	5.867110	5.938548	6.723354	6.147099
##	1660	1661	1662	1663	1664	1665	1666
##	5.321000	6.339861	5.622220	6.654231	6.459271	6.678961	5.649099
##	1667	1668	1669	1670	1671	1672	1673
##	6.902224	6.545644	5.143023	5.677598	6.213919	6.512697	6.123382
##	1674	1675	1676	1677	1678	1679	1680
##	6.069909	5.794386	6.028945	6.604440	6.683193	6.451820	5.503477
##	1681	1682	1683	1684	1685	1686	1687
##	6.484489	5.130897	6.364296	5.035414	5.112541	6.600699	5.627842

##	1688	1689	1690	1691	1692	1693	1694
##	5.878344	7.100711	5.681799	5.789956	5.909222	5.460250	6.128436
##	1695	1696	1697	1698	1699	1700	1701
##	5.742823	5.218744	5.858820	5.467062	6.032940	6.343937	5.963205
##	1702	1703	1704	1705	1706	1707	1708
##	6.095826	7.040092	5.148388	5.285092	4.885354	5.313391	5.607230
##	1709	1710	1711	1712	1713	1714	1715
##	6.063168	5.133775	7.045424	5.604079	6.176258	6.467230	5.637395
##	1716	1717	1718	1719	1720	1721	1722
##	6.310460	5.613864	5.925721	5.833179	5.029923	6.071775	6.104836
##	1723	1724	1725	1726	1727	1728	1729
##	6.394744	5.413781	5.743208	6.408070	5.953768	5.964664	6.397853
##	1730	1731	1732	1733	1734	1735	1736
##	6.115166	5.964642	6.100252	5.652876	4.894682	5.910396	6.365651
##	1737	1738	1739	1740	1741	1742	1743
##	6.547134	4.836703	5.424528	5.422931	5.722678	5.236454	5.397602
##	1744	1745	1746	1747	1748	1749	1750
##	6.288912	5.712456	5.857423	6.230528	6.182317	6.624116	5.641488
##	1751	1752	1753	1754	1755	1756	1757
##	5.726327	5.190484	6.823249	6.357995	6.320186	5.464092	6.170082
##	1758	1759	1760	1761	1762	1763	1764
##	5.366885	5.302244	6.172022	5.840657	6.155463	5.666771	5.195926
##	1765	1766	1767	1768	1769	1770	1771
##	5.697585	6.368050	6.129136	6.101551	5.740658	5.272809	4.568996
##	1772	1773	1774	1775	1776	1777	1778
##	6.478994	5.381805	6.133899	5.884568	6.636020	6.211387	5.568926
##	1779	1780	1781	1782	1783	1784	1785
##	6.624116	4.915425	5.321265	5.922125	5.326026	5.886574	5.908546
##	1786	1787	1788	1789	1790	1791	1792
##	5.886574	6.467673	5.727960	5.425776	5.802006	5.381805	5.106870
##	1793	1794	1795	1796	1797	1798	1799
##	5.791117	5.569229	7.009022	4.964041	5.813231	5.336855	5.859079
##	1800	1801	1802	1803	1804	1805	1806
##	5.185230	6.637550	6.110268	6.326033	6.797892	5.130863	5.866245
##	1807	1808	1809	1810	1811	1812	1813
##	6.858976	6.157587	6.974071	6.101944	6.089098	5.923344	4.847913
##	1814	1815	1816	1817	1818	1819	1820
##	6.151260	5.396830	6.344917	5.250180	5.645697	5.504512	5.802395
##	1821	1822	1823	1824	1825	1826	1827
##	5.426037	5.989596	5.242382	5.181506	5.340234	5.479665	5.761073
##	1828	1829	1830	1831	1832	1833	1834
##	6.433898	5.690039	6.204311	5.509006	6.285328	5.708147	5.376225
##	1835	1836	1837	1838	1839	1840	1841
##	5.716170	4.965992	5.959122	5.556663	5.449975	6.339209	5.570384
##	1842	1843	1844	1845	1846	1847	1848
##	5.457592	4.924634	6.289457	6.018479	5.449425	6.304423	6.084175
##	1849	1850	1851	1852	1853	1854	1855
##	5.409984	5.627934	5.531106	5.551173	5.376479	4.755168	6.609887
##	1856	1857	1858	1859	1860	1861	1862
##	6.037490	5.618229	4.592273	4.937708	5.181506	5.802395	5.930744
##	1863	1864	1865	1866	1867	1868	1869
##	4.250611	6.188923	6.078266	6.504480	5.316788	5.835760	6.797305
##	1870	1871	1872	1873	1874	1875	1876
##	6.709343	5.941488	6.478667	7.089109	4.891069	5.629364	5.632286

##	1877	1878	1879	1880	1881	1882	1883
##	5.982404	6.011235	6.209806	6.369667	6.079759	5.338145	5.046397
##	1884	1885	1886	1887	1888	1889	1890
##	5.866095	5.655367	6.901129	5.149580	6.462742	5.416085	6.133100
##	1891	1892	1893	1894	1895	1896	1897
##	6.628011	4.966711	5.860608	5.783651	5.368520	5.728152	5.782601
##	1898	1899	1900	1901	1902	1903	1904
##	7.079514	5.593635	5.108830	4.807079	5.816121	5.868908	5.427375
##	1905	1906	1907	1908	1909	1910	1911
##	5.276809	5.287557	5.555108	5.677761	5.423556	6.203711	5.874109
##	1912	1913	1914	1915	1916	1917	1918
##	5.655367	5.448121	6.069033	6.089098	7.031905	5.731119	5.711234
##	1919	1920	1921	1922	1923	1924	1925
##	5.288500	6.084199	6.466425	5.053959	6.089502	5.337255	5.461886
##	1926	1927	1928	1929	1930	1931	1932
##	5.187553	5.768346	6.197809	6.236834	5.661085	4.963303	5.824992
##	1933	1934	1935	1936	1937	1938	1939
##	5.258147	6.523642	4.914377	6.274421	6.279825	4.617411	6.369782
##	1940	1941	1942	1943	1944	1945	1946
##	6.504480	4.931537	5.938546	5.833179	4.978265	5.740658	5.426569
##	1947	1948	1949	1950	1951	1952	1953
##	5.074380	5.607710	5.023863	5.586888	4.937708	5.978763	5.835689
##	1954	1955	1956	1957	1958	1959	1960
##	5.231533	5.570217	5.836365	6.443318	5.573144	5.949477	5.822280
##	1961	1962	1963	1964	1965	1966	1967
##	5.385647	6.613192	6.369924	4.538011	5.315720	6.844689	5.233757
##	1968	1969	1970	1971	1972	1973	1974
##	6.110743	5.431609	6.270954	5.922021	5.955963	6.215740	7.114307
##	1975	1976	1977	1978	1979	1980	1981
##	6.458456	5.365814	6.300927	5.579271	5.531567	5.669251	6.599056
##	1982	1983	1984	1985	1986	1987	1988
##	6.184258	6.604440	5.260341	5.321000	6.237905	5.437020	5.064141
##	1989	1990	1991	1992	1993	1994	1995
##	6.204311	5.341445	5.553917	6.453534	5.529694	5.866245	5.349939
##	1996	1997	1998	1999	2000	2001	2002
##	5.255091	5.793087	5.552871	6.288700	6.137854	4.843396	5.676105
##	2003	2004	2005	2006	2007	2008	2009
##	5.699712	5.645697	5.784437	7.032730	5.686377	6.331713	4.798413
##	2010	2011	2012	2013	2014	2015	2016
##	5.194535	5.801554	5.793550	6.118543	5.903565	6.474615	5.248243
##	2017	2018	2019	2020	2021	2022	2023
##	6.190450	5.414521	5.709882	6.056287	6.368642	6.215067	7.876648
##	2024	2025	2026	2027	2028	2029	2030
##	5.586644	5.793225	5.724190	5.773849	6.026181	5.924941	6.418791
##	2031	2032	2033	2034	2035	2036	2037
##	5.955909	5.840945	5.382136	5.869954	5.639704	5.337898	6.562082
##	2038	2039	2040	2041	2042	2043	2044
##	5.397196	6.408405	5.335355	6.049198	4.937220	5.658375	4.820027
##	2045	2046	2047	2048	2049	2050	2051
##	7.030395	6.110268	6.374348	6.030346	4.980617	5.516293	5.112541
##	2052	2053	2054	2055	2056	2057	2058
##	5.207983	5.484033	6.108980	5.721274	5.357512	5.626745	6.925563
##	2059	2060	2061	2062	2063	2064	2065
##	6.867798	5.759189	6.600482	5.609922	5.164111	6.156282	5.393008

	2066	2067	2068	2069	2070	2071	2072
##	5.346717	6.103561	5.750923	5.152287	5.489000	5.221798	6.018280
##	2073	2074	2075	2076	2077	2078	2079
##	5.421013	5.773530	7.215059	6.837633	6.389942	6.339993	5.314862
##	2080	2081	2082	2083	2084	2085	2086
##	5.497046	6.762968	5.290843	5.103456	5.736743	6.117032	6.004178
##	2087	2088	2089	2090	2091	2092	2093
##	6.118543	6.025411	6.621192	5.674920	5.037642	5.813546	6.363953
##	2094	2095	2096	2097	2098	2099	2100
##	5.851442	5.932020	6.614354	6.467230	6.066997	5.881122	5.468645
##	2101	2102	2103	2104	2105	2106	2107
##	6.023605	6.690413	5.845882	6.192555	5.379781	5.043112	5.384614
##	2108	2109	2110	2111	2112	2113	2114
##	5.196783	5.660609	6.181363	5.735050	5.468645	6.174362	6.372011
##	2115	2116	2117	2118	2119	2120	2121
##	6.041292	5.862406	5.256938	6.213594	6.123179	5.647772	5.500044
##	2122	2123	2124	2125	2126	2127	2128
##	5.230915	5.914197	5.094760	5.953501	5.855913	5.669251	5.244628
##	2129	2130	2131	2132	2133	2134	2135
##	6.169897	6.657490	6.172338	6.286200	6.454718	6.075539	5.806020
##	2136	2137	2138	2139	2140	2141	2142
##	5.317220	5.862406	5.485214	6.168750	5.717376	6.382926	6.369667
##	2143	2144	2145	2146	2147	2148	2149
##	6.497865	5.885978	5.633891	5.645472	5.483680	5.790574	6.344917
##	2150	2151	2152	2153	2154	2155	2156
##	5.677761	5.712456	6.264170	5.835070	6.237587	6.061479	5.476812
##	2157	2158	2159	2160	2161	2162	2163
##	6.095514	6.017337	5.880485	5.273869	5.467956	5.878344	5.438993
##	2164	2165	2166	2167	2168	2169	2170
##	5.427058	5.487770	5.241120	6.627649	6.074480	5.427148	5.506295
##	2171	2172	2173	2174	2175	2176	2177
##	6.477103	5.197457	5.504038	6.233357	5.091564	6.524561	6.703780
##	2178	2179	2180	2181	2182	2183	2184
##	6.410455	5.225371	5.783054	5.864468	5.889633	6.958528	5.245780
##	2185	2186	2187	2188	2189	2190	2191
##	6.070673	6.118525	5.866245	5.808419	5.570384	5.687858	5.644179
##	2192	2193	2194	2195	2196	2197	2198
##	5.555823	5.605735	6.745762	5.498964	7.028880	5.077499	6.228630
##	2199	2200	2201	2202	2203	2204	2205
##	6.335918	6.084199	6.353174	5.677761	5.840065	6.769655	7.213309
##	2206	2207	2208	2209	2210	2211	2212
##	6.105229	6.722803	5.923044	6.678740	5.439198	5.841489	5.244628
##	2213	2214	2215	2216	2217	2218	2219
##	5.215607	6.641944	5.936308	6.130504	5.614481	6.426472	6.348014
##	2220	2221	2222	2223	2224	2225	2226
##	5.670091	6.340093	5.441010	4.888602	4.878939	5.696851	5.225585
##	2227	2228	2229	2230	2231	2232	2233
##	6.333520	5.685051	5.169054	5.376479	6.129136	6.439888	5.238427
##	2234	2235	2236	2237	2238	2239	2240
##	6.059957	5.723458	4.682496	5.677367	5.629667	6.472780	5.758366
##	2241	2242	2243	2244	2245	2246	2247
##	5.547093	5.586303	6.090921	5.410085	5.669251	5.855411	6.376740
##	2248	2249	2250	2251	2252	2253	2254
##	6.318465	5.332735	5.449975	5.108187	6.383700	5.884568	5.314862

##	2255	2256	2257	2258	2259	2260	2261
##	6.019408	6.134014	5.538913	5.389970	5.088336	5.681518	4.880240
##	2262	2263	2264	2265	2266	2267	2268
##	6.237117	5.108901	-5.664430	6.653859	5.669671	6.045506	5.587088
##	2269	2270	2271	2272	2273	2274	2275
##	5.816121	5.720279	5.728670	6.061479	6.546257	5.916051	5.090399
##	2276	2277	2278	2279	2280	2281	2282
##	6.746062	6.321052	6.545644	4.273331	5.504689	6.206079	6.339909
##	2283	2284	2285	2286	2287	2288	2289
##	5.215910	4.831157	5.483871	4.964041	6.942361	6.044807	6.047200
##	2290	2291	2292	2293	2294	2295	2296
##	6.485157	6.136915	6.380766	5.868525	6.528212	5.564606	5.505511
##	2297	2298	2299	2300	2301	2302	2303
##	6.148169	6.383089	5.766430	5.695857	6.614506	6.130493	6.097194
##	2304	2305	2306	2307	2308	2309	2310
##	6.770552	5.932020	5.049760	6.029282	5.322679	5.690255	5.340063
##	2311	2312	2313	2314	2315	2316	2317
##	5.555823	5.924941	6.230284	5.648406	5.922940	5.396830	5.841489
##	2318	2319	2320	2321	2322	2323	2324
##	6.445150	5.812157	6.271375	5.430730	6.344748	6.369924	5.481707
##	2325	2326	2327	2328	2329	2330	2331
##	7.021047	6.142412	6.661373	6.049477	5.989520	5.191690	5.886574
##	2332	2333	2334	2335	2336	2337	2338
##	5.148624	5.404518	6.511008	5.970621	5.584778	5.753560	5.541252
##	2339	2340	2341	2342	2343	2344	2345
##	6.071653	5.656740	5.587360	4.703225	6.050945	5.097670	5.465645
##	2346	2347	2348	2349	2350	2351	2352
##	5.244841	4.958568	5.287532	5.091564	7.196273	5.902354	6.531746
##	2353	2354	2355	2356	2357	2358	2359
##	5.501223	5.850072	6.209806	6.339999	5.247694	6.106006	5.230942
##	2360	2361	2362	2363	2364	2365	2366
##	5.456759	5.583987	6.421165	5.687858	6.254572	6.054698	4.514124
##	2367	2368	2369	2370	2371	2372	2373
##	4.936690	6.673620	5.618017	6.628011	4.704371	6.942361	5.743424
##	2374	2375	2376	2377	2378	2379	2380
##	5.787597	6.859615	5.299661	5.629332	7.098722	5.745350	5.568926
##	2381	2382	2383	2384	2385	2386	2387
##	5.984511	5.054481	5.314862	4.593487	5.925513	6.131178	5.949903
##	2388	2389	2390	2391	2392	2393	2394
##	6.445857	6.112522	5.315933	5.735188	5.699081	4.250611	6.097036
##	2395	2396	2397	2398	2399	2400	2401
##	5.491540	5.685602	5.346496	6.741453	6.202236	5.423558	6.323367
##	2402	2403	2404	2405	2406	2407	2408
##	6.269785	5.650686	6.358260	5.686800	6.033204	6.694447	7.208496
##	2409	2410	2411	2412	2413	2414	2415
##	6.174362	6.527281	5.930744	6.105229	5.868812	5.690039	6.392451
##	2416	2417	2418	2419	2420	2421	2422
##	5.990662	6.483162	4.980617	6.731298	5.659539	7.037120	5.656365
##	2423	2424	2425	2426	2427	2428	2429
##	6.048708	5.822872	5.241120	6.278613	5.365062	5.898253	6.506546
##	2430	2431	2432	2433	2434	2435	2436
##	5.459476	5.961171	5.187553	6.090183	6.232496	4.632722	6.600482
##	2437	2438	2439	2440	2441	2442	2443
##	6.920681	6.471313	6.040339	5.221084	5.890895	5.346350	5.928467

##	2444	2445	2446	2447	2448	2449	2450
##	6.403410	5.422350	5.608803	5.581230	7.215059	6.084039	7.255224
##	2451	2452	2453	2454	2455	2456	2457
##	5.704340	5.025513	5.435505	5.589052	5.587561	5.712565	6.897916
##	2458	2459	2460	2461	2462	2463	2464
##	5.030358	5.906584	5.501255	6.373262	5.625962	5.710041	6.166119
##	2465	2466	2467	2468	2469	2470	2471
##	6.745762	5.285092	6.095826	6.095826	5.144161	6.576393	5.816943
##	2472	2473	2474	2475	2476	2477	2478
##	6.873226	6.448064	6.475566	5.208009	6.269785	5.789820	5.467741
##	2479	2480	2481	2482	2483	2484	2485
##	5.735372	5.183867	6.580547	5.845956	5.735187	5.392559	6.025749
##	2486	2487	2488	2489	2490	2491	2492
##	6.442002	5.281365	5.812157	6.855828	5.726327	7.294337	5.714500
##	2493	2494	2495	2496	2497	2498	2499
##	6.230284	5.486868	6.460331	5.583760	5.236454	6.378960	6.242807
##	2500	2501	2502	2503	2504	2505	2506
##	5.954867	6.075539	6.358091	5.728152	6.669423	5.175135	6.120248
##	2507	2508	2509	2510	2511	2512	2513
##	6.217104	6.355016	4.728173	6.586536	5.510388	6.225017	6.411693
##	2514	2515	2516	2517	2518	2519	2520
##	6.190807	6.071653	5.346165	5.483680	6.237191	6.534277	5.621651
##	2521	2522	2523	2524	2525	2526	2527
##	6.369667	5.226872	5.724943	5.663730	5.368982	6.121801	4.669895
##	2528	2529	2530	2531	2532	2533	2534
##	5.398223	5.770726	6.562384	6.266696	5.737045	4.442481	6.206952
##	2535	2536	2537	2538	2539	2540	2541
##	7.037120	6.804749	6.136826	5.416804	5.980883	5.987401	5.223652
##	2542	2543	2544	2545	2546	2547	2548
##	6.330140	5.363881	5.112733	5.770307	5.266827	5.914876	5.481031
##	2549	2550	2551	2552	2553	2554	2555
##	5.302962	6.018280	5.657237	5.397400	6.112522	5.340234	5.857054
##	2556	2557	2558	2559	2560	2561	2562
##	5.594272	5.477673	4.993673	5.500795	5.083333	5.896675	5.042390
##	2563	2564	2565	2566	2567	2568	2569
##	5.181116	5.290843	5.339941	6.472780	5.994649	5.677598	6.120217
##	2570	2571	2572	2573	2574	2575	2576
##	5.804472	5.446492	6.174362	6.380766	5.885978	6.636020	5.417406
##	2577	2578	2579	2580	2581	2582	2583
##	5.839417	6.178492	4.732112	5.776243	6.452459	4.908580	5.916451
##	2584	2585	2586	2587	2588	2589	2590
##	5.385681	6.484004	5.282453	4.811279	5.545181	5.608803	5.955963
##	2591	2592	2593	2594	2595	2596	2597
##	6.459223	5.882247	5.666092	6.573552	5.319596	6.114091	6.398961
##	2598	2599	2600	2601	2602	2603	2604
##	6.602692	5.818049	5.129665	7.022673	6.282690	5.387876	5.789985
##	2605	2606	2607	2608	2609	2610	2611
##	5.455388	5.457576	5.648279	5.106870	5.790790	5.818264	5.801610
##	2612	2613	2614	2615	2616	2617	2618
##	6.678961	7.430215	5.708392	5.204597	6.260887	5.398845	5.959684
##	2619	2620	2621	2622	2623	2624	2625
##	4.744242	5.397602	5.928467	5.426561	4.428572	6.099214	6.358136
##	2626	2627	2628	2629	2630	2631	2632
##	6.434313	5.402524	5.819202	5.886574	6.188437	5.723458	5.415645

##	2633	2634	2635	2636	2637	2638	2639
##	5.939941	5.361130	6.984537	6.086904	6.358260	5.681973	5.281375
##	2640	2641	2642	2643	2644	2645	2646
##	6.082279	5.816517	5.824937	5.533595	6.241031	5.974591	6.103561
##	2647	2648	2649	2650	2651	2652	2653
##	6.386623	6.274421	5.676105	5.380133	5.833390	5.563233	5.790159
##	2654	2655	2656	2657	2658	2659	2660
##	6.496403	5.671430	6.313624	6.106099	5.865995	6.573552	5.831905
##	2661	2662	2663	2664	2665	2666	2667
##	4.920299	6.442724	6.033020	5.880835	5.687303	6.116775	6.454832
##	2668	2669	2670	2671	2672	2673	2674
##	5.607710	6.665829	5.511848	7.409674	4.880469	6.076929	6.426472
##	2675	2676	2677	2678	2679	2680	2681
##	6.477850	5.594160	5.845882	5.863817	4.603564	5.348928	5.429521
##	2682	2683	2684	2685	2686	2687	2688
##	5.218744	5.396198	5.449425	6.143246	5.484187	6.444705	6.460569
##	2689	2690	2691	2692	2693	2694	2695
##	5.914607	5.910729	6.165720	5.278843	5.322798	7.050681	7.365067
##	2696	2697	2698	2699	2700	2701	2702
##	5.583022	4.975057	6.134014	5.989051	5.655367	5.919109	6.522593
##	2703	2704	2705	2706	2707	2708	2709
##	5.891187	6.425260	5.660591	5.238427	6.018479	5.268575	6.203711
##	2710	2711	2712	2713	2714	2715	2716
##	5.162001	6.074480	5.677377	3.983969	6.178492	5.218313	6.497446
##	2717	2718	2719	2720	2721	2722	2723
##	6.179712	6.059655	5.769275	4.967334	6.161238	5.876814	6.291123
##	2724	2725	2726	2727	2728	2729	2730
##	5.231533	5.708543	5.579350	5.459874	6.484004	5.951338	5.612735
##	2731	2732	2733	2734	2735	2736	2737
##	5.795251	6.563317	5.457598	5.695340	6.531746	6.248079	6.477976
##	2738	2739	2740	2741	2742	2743	2744
##	5.290805	5.645478	5.677367	6.371172	5.815521	6.073476	5.823086
##	2745	2746	2747	2748	2749	2750	2751
##	6.049015	5.352773	6.865141	7.045424	6.769655	5.502329	7.016114
##	2752	2753	2754	2755	2756	2757	2758
##	6.132231	6.042948	5.248243	5.830594	6.633933	6.298325	5.461886
##	2759	2760	2761	2762	2763	2764	2765
##	6.369294	5.712990	6.503332	6.497597	4.442481	6.034602	5.866095
##	2766	2767	2768	2769	2770	2771	2772
##	5.467741	5.866245	5.435207	6.142224	6.031743	6.389550	5.284686
##	2773	2774	2775	2776	2777	2778	2779
##	5.608803	5.740410	5.628341	6.259047	5.592037	5.300918	5.253587
##	2780	2781	2782	2783	2784	2785	2786
##	6.268820	5.121251	5.245780	5.340063	6.070053	5.229092	5.911112
##	2787	2788	2789	2790	2791	2792	2793
##	6.144661	6.160877	4.896097	5.393008	6.296123	6.144421	5.705000
##	2794	2795	2796	2797	2798	2799	2800
##	5.968771	5.117840	5.581539	6.680573	5.171599	6.395656	6.149222
##	2801	2802	2803	2804	2805	2806	2807
##	6.118543	5.517366	5.466272	5.856261	6.089502	7.876648	5.651805
##	2808	2809	2810	2811	2812	2813	2814
##	5.764398	6.624716	5.345232	6.200454	5.487580	5.768346	6.711422
##	2815	2816	2817	2818	2819	2820	2821
##	5.506295	6.515870	5.228308	6.632714	5.715448	4.914377	5.646808

	2822	2823	2824	2825	2826	2827	2828
##	5.024731	5.735656	6.282381	5.555686	6.600533	5.719936	6.071653
##	2829	2830	2831	2832	2833	2834	2835
##	6.169506	5.404518	5.335034	5.678073	5.116106	4.732112	6.129518
##	2836	2837	2838	2839	2840	2841	2842
##	6.271375	6.096957	6.032338	5.865439	5.852228	5.060709	5.896675
##	2843	2844	2845	2846	2847	2848	2849
##	6.866505	6.084420	6.478075	5.624503	6.344954	5.500883	5.618892
##	2850	2851	2852	2853	2854	2855	2856
##	6.439692	6.328822	5.725913	5.684916	6.255982	5.794113	5.448121
##	2857	2858	2859	2860	2861	2862	2863
##	6.722804	6.523260	5.461886	5.335355	5.742732	6.365766	5.369219
##	2864	2865	2866	2867	2868	2869	2870
##	6.688590	5.980464	6.380628	5.393745	5.122423	5.632772	5.808419
##	2871	2872	2873	2874	2875	2876	2877
##	5.857728	6.160877	6.041029	6.837750	6.253189	5.425817	5.855411
##	2878	2879	2880	2881	2882	2883	2884
##	5.612272	6.480703	5.548675	4.980730	5.830594	5.627233	5.042553
##	2885	2886	2887	2888	2889	2890	2891
##	5.754466	5.888442	5.604999	6.375827	5.659539	5.487770	5.029496
##	2892	2893	2894	2895	2896	2897	2898
##	5.829302	5.610455	6.317417	6.058300	5.651594	6.296545	6.249719
##	2899	2900	2901	2902	2903	2904	2905
##	5.281300	5.351513	5.194199	5.578849	6.027942	5.252748	5.414765
##	2906	2907	2908	2909	2910	2911	2912
##	5.889426	5.620338	5.429521	4.997713	5.745350	4.799157	5.001277
##	2913	2914	2915	2916	2917	2918	2919
##	5.908546	5.687858	6.311161	6.027109	5.686800	5.979460	5.163629
##	2920	2921	2922	2923	2924	2925	2926
##	4.861634	5.266730	5.685602	5.489187	5.731977	5.572265	5.327877
##	2927	2928	2929	2930	2931	2932	2933
##	5.762588	5.816943	5.060709	5.536685	6.099216	5.771127	6.358136
##	2934	2935	2936	2937	2938	2939	2940
##	6.211154	5.346689	5.671430	5.136440	5.081275	5.446953	5.467062
##	2941	2942	2943	2944	2945	2946	2947
##	5.419495	5.472134	5.922940	6.504480	6.911943	6.097194	6.538250
##	2948	2949	2950	2951	2952	2953	2954
##	5.562276	5.677761	6.615191	5.782601	6.334229	4.964538	5.223113
##	2955	2956	2957	2958	2959	2960	2961
##	5.863506	6.128436	6.563317	6.484489	4.916242	4.963303	5.644157
##	2962	2963	2964	2965	2966	2967	2968
##	6.151260	5.599890	5.699901	5.555987	5.181116	6.770552	6.022479
##	2969	2970	2971	2972	2973	2974	2975
##	7.143651	5.485214	5.790790	6.271375	6.648801	6.444705	4.796958
##	2976	2977	2978	2979	2980	2981	2982
##	5.452627	5.713002	7.213464	5.910396	6.067248	5.532576	5.919109
##	2983	2984	2985	2986	2987	2988	2989
##	6.359656	6.124782	5.776908	5.244628	5.938548	5.481101	5.614876
##	2990	2991	2992	2993	2994	2995	2996
##	6.280717	6.043541	6.583029	5.865318	5.731977	4.926978	5.821273
##	2997	2998	2999	3000			
##	5.148307	6.028476	5.623045	5.779293			

```
results<-as.data.frame(cbind(1:3000, finalpred))
names(results)<-c("Case_number", "Y_hat")
```