DOEproject

## data

# 导⼊必要的库  
library(dplyr)

##   
## 载入程辑包：'dplyr'

## The following objects are masked from 'package:stats':  
##   
## filter, lag

## The following objects are masked from 'package:base':  
##   
## intersect, setdiff, setequal, union

library(ggplot2)  
library(readxl)

## Warning: 程辑包'readxl'是用R版本4.2.3 来建造的

library(corrplot)

## Warning: 程辑包'corrplot'是用R版本4.2.3 来建造的

## corrplot 0.92 loaded

library(leaps)

## Warning: 程辑包'leaps'是用R版本4.2.3 来建造的

library(agricolae)

## Warning: 程辑包'agricolae'是用R版本4.2.3 来建造的

# 读取数据  
data <- read\_excel("C:/Users/zhuan/Desktop/清华大学/2023春 大四下/实验设计与分析/大作业/帕金森数据.xlsx")  
# 查看数据的基本信息  
attach(data)  
str(data)

## tibble [5,875 × 23] (S3: tbl\_df/tbl/data.frame)  
## $ subject# : num [1:5875] 1 1 1 1 1 1 1 1 1 1 ...  
## $ age : num [1:5875] 72 72 72 72 72 72 72 72 72 72 ...  
## $ sex : num [1:5875] 0 0 0 0 0 0 0 0 0 0 ...  
## $ method : num [1:5875] 1 1 1 1 1 1 1 1 1 1 ...  
## $ test\_time : num [1:5875] 5.64 12.67 19.68 25.65 33.64 ...  
## $ motor\_UPDRS : num [1:5875] 28.2 28.4 28.7 28.9 29.2 ...  
## $ total\_UPDRS : num [1:5875] 34.4 34.9 35.4 35.8 36.4 ...  
## $ Jitter(%) : num [1:5875] 0.00662 0.003 0.00481 0.00528 0.00335 0.00353 0.00422 0.00476 0.00432 0.00496 ...  
## $ Jitter(Abs) : num [1:5875] 3.38e-05 1.68e-05 2.46e-05 2.66e-05 2.01e-05 ...  
## $ Jitter:RAP : num [1:5875] 0.00401 0.00132 0.00205 0.00191 0.00093 0.00119 0.00212 0.00226 0.00156 0.00258 ...  
## $ Jitter:PPQ5 : num [1:5875] 0.00317 0.0015 0.00208 0.00264 0.0013 0.00159 0.00221 0.00259 0.00207 0.00253 ...  
## $ Jitter:DDP : num [1:5875] 0.01204 0.00395 0.00616 0.00573 0.00278 ...  
## $ Shimmer : num [1:5875] 0.0256 0.0202 0.0168 0.0231 0.017 ...  
## $ Shimmer(dB) : num [1:5875] 0.23 0.179 0.181 0.327 0.176 0.214 0.445 0.212 0.371 0.31 ...  
## $ Shimmer:APQ3 : num [1:5875] 0.01438 0.00994 0.00734 0.01106 0.00679 ...  
## $ Shimmer:APQ5 : num [1:5875] 0.01309 0.01072 0.00844 0.01265 0.00929 ...  
## $ Shimmer:APQ11: num [1:5875] 0.0166 0.0169 0.0146 0.0196 0.0182 ...  
## $ Shimmer:DDA : num [1:5875] 0.0431 0.0298 0.022 0.0332 0.0204 ...  
## $ NHR : num [1:5875] 0.0143 0.0111 0.0202 0.0278 0.0116 ...  
## $ HNR : num [1:5875] 21.6 27.2 23 24.4 26.1 ...  
## $ RPDE : num [1:5875] 0.419 0.435 0.462 0.487 0.472 ...  
## $ DFA : num [1:5875] 0.548 0.565 0.544 0.578 0.561 ...  
## $ PPE : num [1:5875] 0.16 0.108 0.21 0.333 0.194 ...

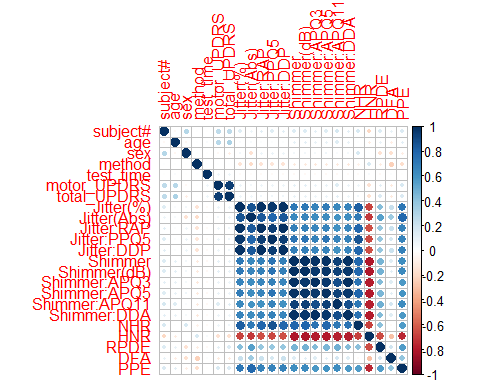
summary(data)

## subject# age sex method   
## Min. : 1.00 Min. :36.0 Min. :0.0000 Min. :1.000   
## 1st Qu.:10.00 1st Qu.:58.0 1st Qu.:0.0000 1st Qu.:2.000   
## Median :22.00 Median :65.0 Median :0.0000 Median :3.000   
## Mean :21.49 Mean :64.8 Mean :0.3178 Mean :3.501   
## 3rd Qu.:33.00 3rd Qu.:72.0 3rd Qu.:1.0000 3rd Qu.:5.000   
## Max. :42.00 Max. :85.0 Max. :1.0000 Max. :6.000   
## test\_time motor\_UPDRS total\_UPDRS Jitter(%)   
## Min. : -4.263 Min. : 5.038 Min. : 7.00 Min. :0.000830   
## 1st Qu.: 46.847 1st Qu.:15.000 1st Qu.:21.37 1st Qu.:0.003580   
## Median : 91.523 Median :20.871 Median :27.58 Median :0.004900   
## Mean : 92.864 Mean :21.296 Mean :29.02 Mean :0.006154   
## 3rd Qu.:138.445 3rd Qu.:27.596 3rd Qu.:36.40 3rd Qu.:0.006800   
## Max. :215.490 Max. :39.511 Max. :54.99 Max. :0.099990   
## Jitter(Abs) Jitter:RAP Jitter:PPQ5 Jitter:DDP   
## Min. :2.250e-06 Min. :0.000330 Min. :0.000430 Min. :0.000980   
## 1st Qu.:2.244e-05 1st Qu.:0.001580 1st Qu.:0.001820 1st Qu.:0.004730   
## Median :3.453e-05 Median :0.002250 Median :0.002490 Median :0.006750   
## Mean :4.403e-05 Mean :0.002987 Mean :0.003277 Mean :0.008962   
## 3rd Qu.:5.333e-05 3rd Qu.:0.003290 3rd Qu.:0.003460 3rd Qu.:0.009870   
## Max. :4.456e-04 Max. :0.057540 Max. :0.069560 Max. :0.172630   
## Shimmer Shimmer(dB) Shimmer:APQ3 Shimmer:APQ5   
## Min. :0.00306 Min. :0.026 Min. :0.00161 Min. :0.00194   
## 1st Qu.:0.01912 1st Qu.:0.175 1st Qu.:0.00928 1st Qu.:0.01079   
## Median :0.02751 Median :0.253 Median :0.01370 Median :0.01594   
## Mean :0.03404 Mean :0.311 Mean :0.01716 Mean :0.02014   
## 3rd Qu.:0.03975 3rd Qu.:0.365 3rd Qu.:0.02057 3rd Qu.:0.02375   
## Max. :0.26863 Max. :2.107 Max. :0.16267 Max. :0.16702   
## Shimmer:APQ11 Shimmer:DDA NHR HNR   
## Min. :0.00249 Min. :0.00484 Min. :0.000286 Min. : 1.659   
## 1st Qu.:0.01566 1st Qu.:0.02783 1st Qu.:0.010955 1st Qu.:19.406   
## Median :0.02271 Median :0.04111 Median :0.018448 Median :21.920   
## Mean :0.02748 Mean :0.05147 Mean :0.032120 Mean :21.680   
## 3rd Qu.:0.03272 3rd Qu.:0.06173 3rd Qu.:0.031463 3rd Qu.:24.444   
## Max. :0.27546 Max. :0.48802 Max. :0.748260 Max. :37.875   
## RPDE DFA PPE   
## Min. :0.1510 Min. :0.5140 Min. :0.02198   
## 1st Qu.:0.4698 1st Qu.:0.5962 1st Qu.:0.15634   
## Median :0.5423 Median :0.6436 Median :0.20550   
## Mean :0.5415 Mean :0.6532 Mean :0.21959   
## 3rd Qu.:0.6140 3rd Qu.:0.7113 3rd Qu.:0.26449   
## Max. :0.9661 Max. :0.8656 Max. :0.73173

# 计算每列的缺失值数量  
missing\_values <- sapply(data, function(x) sum(is.na(x)))  
# 打印结果  
print(missing\_values)

## subject# age sex method test\_time   
## 0 0 0 0 0   
## motor\_UPDRS total\_UPDRS Jitter(%) Jitter(Abs) Jitter:RAP   
## 0 0 0 0 0   
## Jitter:PPQ5 Jitter:DDP Shimmer Shimmer(dB) Shimmer:APQ3   
## 0 0 0 0 0   
## Shimmer:APQ5 Shimmer:APQ11 Shimmer:DDA NHR HNR   
## 0 0 0 0 0   
## RPDE DFA PPE   
## 0 0 0

# 计算所有数值变量的相关性  
correlation\_matrix <- cor(data %>% select\_if(is.numeric))  
correlation\_matrix <- round(correlation\_matrix, 3)  
# 打印相关性矩阵  
# print(correlation\_matrix)  
# 使⽤ corrplot 来可视化相关性矩阵  
corrplot(correlation\_matrix, method = "circle")



## regression for the 6 methods respectively

### method 1

## full model  
data1 <- data[method == 1,]  
mod1 = lm(total\_UPDRS ~ .- method - motor\_UPDRS, data = data1)  
summary(mod1)

##   
## Call:  
## lm(formula = total\_UPDRS ~ . - method - motor\_UPDRS, data = data1)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -25.310 -6.602 -1.523 6.183 23.728   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 4.355e+01 8.079e+00 5.391 8.82e-08 \*\*\*  
## `subject#` 2.607e-01 2.667e-02 9.775 < 2e-16 \*\*\*  
## age 2.981e-01 3.570e-02 8.349 2.39e-16 \*\*\*  
## sex -4.074e+00 7.510e-01 -5.425 7.35e-08 \*\*\*  
## test\_time 1.460e-02 5.623e-03 2.597 0.00954 \*\*   
## `Jitter(%)` -4.250e+02 5.250e+02 -0.810 0.41838   
## `Jitter(Abs)` -1.693e+04 2.063e+04 -0.821 0.41198   
## `Jitter:RAP` -6.409e+04 1.086e+05 -0.590 0.55529   
## `Jitter:PPQ5` 1.636e+02 4.409e+02 0.371 0.71073   
## `Jitter:DDP` 2.171e+04 3.621e+04 0.600 0.54883   
## Shimmer -1.450e+02 1.392e+02 -1.041 0.29801   
## `Shimmer(dB)` 1.909e+01 1.074e+01 1.778 0.07576 .   
## `Shimmer:APQ3` -3.322e+04 1.072e+05 -0.310 0.75671   
## `Shimmer:APQ5` -2.457e+01 1.172e+02 -0.210 0.83400   
## `Shimmer:APQ11` 4.100e+01 4.985e+01 0.823 0.41098   
## `Shimmer:DDA` 1.103e+04 3.573e+04 0.309 0.75758   
## NHR -2.693e+01 1.375e+01 -1.958 0.05050 .   
## HNR -5.306e-01 1.733e-01 -3.062 0.00226 \*\*   
## RPDE -6.417e+00 4.549e+00 -1.411 0.15872   
## DFA -4.185e+01 5.764e+00 -7.260 7.98e-13 \*\*\*  
## PPE 1.690e+01 6.823e+00 2.477 0.01341 \*   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 9.233 on 956 degrees of freedom  
## Multiple R-squared: 0.2712, Adjusted R-squared: 0.2559   
## F-statistic: 17.79 on 20 and 956 DF, p-value: < 2.2e-16

## use mallows' Cp criterion to choose model  
predictors1 <- data1[, c(-4,-6,-7)]  
response1 <- data1$total\_UPDRS  
leapSet1 <- leaps(x = predictors1, y = response1, nbest = 3)  
leapSet1$which[which.min(leapSet1$Cp),]

## 1 2 3 4 5 6 7 8 9 A B C D   
## TRUE TRUE TRUE TRUE FALSE FALSE FALSE FALSE TRUE FALSE TRUE TRUE FALSE   
## E F G H I J K   
## FALSE FALSE TRUE TRUE TRUE TRUE TRUE

selectmod1 <- lm(total\_UPDRS ~ `subject#`+age+sex+test\_time+`Jitter:DDP`  
 +`Shimmer:APQ3`+`Shimmer(dB)`+NHR+HNR+RPDE+DFA+PPE, data1)  
anova(selectmod1, mod1)

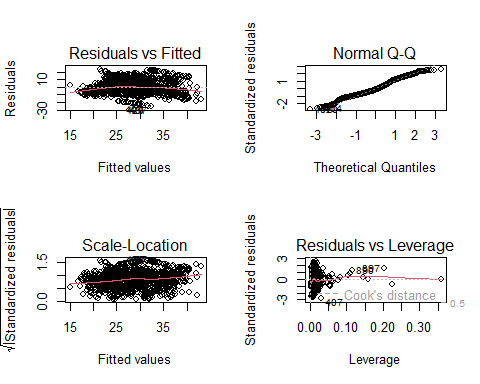
## Analysis of Variance Table  
##   
## Model 1: total\_UPDRS ~ `subject#` + age + sex + test\_time + `Jitter:DDP` +   
## `Shimmer:APQ3` + `Shimmer(dB)` + NHR + HNR + RPDE + DFA +   
## PPE  
## Model 2: total\_UPDRS ~ (`subject#` + age + sex + method + test\_time +   
## motor\_UPDRS + `Jitter(%)` + `Jitter(Abs)` + `Jitter:RAP` +   
## `Jitter:PPQ5` + `Jitter:DDP` + Shimmer + `Shimmer(dB)` +   
## `Shimmer:APQ3` + `Shimmer:APQ5` + `Shimmer:APQ11` + `Shimmer:DDA` +   
## NHR + HNR + RPDE + DFA + PPE) - method - motor\_UPDRS  
## Res.Df RSS Df Sum of Sq F Pr(>F)  
## 1 964 81804   
## 2 956 81490 8 314.18 0.4607 0.8839

p-value = 0.8839, which means that we can conclude the two models are the same.

summary(selectmod1)

##   
## Call:  
## lm(formula = total\_UPDRS ~ `subject#` + age + sex + test\_time +   
## `Jitter:DDP` + `Shimmer:APQ3` + `Shimmer(dB)` + NHR + HNR +   
## RPDE + DFA + PPE, data = data1)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -24.846 -6.495 -1.427 6.540 22.915   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 4.678e+01 7.824e+00 5.979 3.15e-09 \*\*\*  
## `subject#` 2.600e-01 2.603e-02 9.988 < 2e-16 \*\*\*  
## age 2.987e-01 3.534e-02 8.451 < 2e-16 \*\*\*  
## sex -3.750e+00 6.977e-01 -5.375 9.63e-08 \*\*\*  
## test\_time 1.474e-02 5.586e-03 2.639 0.008440 \*\*   
## `Jitter:DDP` 1.474e+02 5.594e+01 2.636 0.008535 \*\*   
## `Shimmer:APQ3` -2.514e+02 9.255e+01 -2.716 0.006722 \*\*   
## `Shimmer(dB)` 1.300e+01 6.060e+00 2.146 0.032136 \*   
## NHR -3.778e+01 1.098e+01 -3.442 0.000603 \*\*\*  
## HNR -5.747e-01 1.667e-01 -3.447 0.000592 \*\*\*  
## RPDE -8.248e+00 4.359e+00 -1.892 0.058762 .   
## DFA -4.403e+01 5.449e+00 -8.082 1.90e-15 \*\*\*  
## PPE 1.305e+01 5.830e+00 2.239 0.025372 \*   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 9.212 on 964 degrees of freedom  
## Multiple R-squared: 0.2684, Adjusted R-squared: 0.2593   
## F-statistic: 29.47 on 12 and 964 DF, p-value: < 2.2e-16

## diagnostics  
par(mfrow=c(2,2))  
plot(selectmod1)



## as.factor(sex) & ANOVA  
data1$sex <- as.factor(data1$sex)  
fselectmod1 <- aov(total\_UPDRS ~ `subject#`+age+sex+test\_time+`Jitter:DDP`  
 +`Shimmer:APQ3`+`Shimmer(dB)`+NHR+HNR+RPDE+DFA+PPE, data1)  
summary(fselectmod1)

## Df Sum Sq Mean Sq F value Pr(>F)   
## `subject#` 1 7536 7536 88.803 < 2e-16 \*\*\*  
## age 1 11493 11493 135.434 < 2e-16 \*\*\*  
## sex 1 3145 3145 37.062 1.65e-09 \*\*\*  
## test\_time 1 497 497 5.856 0.01571 \*   
## `Jitter:DDP` 1 781 781 9.200 0.00249 \*\*   
## `Shimmer:APQ3` 1 21 21 0.243 0.62199   
## `Shimmer(dB)` 1 517 517 6.090 0.01377 \*   
## NHR 1 21 21 0.245 0.62053   
## HNR 1 399 399 4.699 0.03043 \*   
## RPDE 1 55 55 0.654 0.41897   
## DFA 1 5118 5118 60.309 2.07e-14 \*\*\*  
## PPE 1 425 425 5.014 0.02537 \*   
## Residuals 964 81804 85   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

## Fisher's LSD  
LSD.test(fselectmod1, "sex", group = F, console = T)

##   
## Study: fselectmod1 ~ "sex"  
##   
## LSD t Test for total\_UPDRS   
##   
## Mean Square Error: 84.85871   
##   
## sex, means and individual ( 95 %) CI  
##   
## total\_UPDRS std r LCL UCL Min Max  
## 0 29.67886 11.010983 662 28.97625 30.38146 7.0000 54.992  
## 1 27.43758 9.871406 315 26.41902 28.45614 7.0883 48.530  
##   
## Alpha: 0.05 ; DF Error: 964  
## Critical Value of t: 1.962428   
##   
## Comparison between treatments means  
##   
## difference pvalue signif. LCL UCL  
## 0 - 1 2.241274 4e-04 \*\*\* 1.003889 3.47866

### method 2

data2 <- data[method == 2,]  
mod2 = lm(total\_UPDRS ~ .- method - motor\_UPDRS, data = data2)  
summary(mod2)

##   
## Call:  
## lm(formula = total\_UPDRS ~ . - method - motor\_UPDRS, data = data2)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -27.5799 -6.6185 -0.5487 6.9069 22.6991   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 4.382e+01 7.638e+00 5.737 1.29e-08 \*\*\*  
## `subject#` 2.760e-01 2.640e-02 10.455 < 2e-16 \*\*\*  
## age 3.132e-01 3.569e-02 8.776 < 2e-16 \*\*\*  
## sex -4.775e+00 7.586e-01 -6.295 4.68e-10 \*\*\*  
## test\_time 1.303e-02 5.582e-03 2.334 0.019792 \*   
## `Jitter(%)` -4.294e+02 4.350e+02 -0.987 0.323870   
## `Jitter(Abs)` -3.888e+04 1.901e+04 -2.045 0.041093 \*   
## `Jitter:RAP` 2.046e+05 1.096e+05 1.867 0.062262 .   
## `Jitter:PPQ5` 1.505e+02 3.531e+02 0.426 0.669953   
## `Jitter:DDP` -6.790e+04 3.653e+04 -1.859 0.063388 .   
## Shimmer 7.522e+00 1.509e+02 0.050 0.960262   
## `Shimmer(dB)` -5.923e+00 1.089e+01 -0.544 0.586690   
## `Shimmer:APQ3` 4.909e+04 1.104e+05 0.445 0.656760   
## `Shimmer:APQ5` 6.146e+01 1.254e+02 0.490 0.624303   
## `Shimmer:APQ11` 1.027e+01 5.069e+01 0.203 0.839459   
## `Shimmer:DDA` -1.641e+04 3.681e+04 -0.446 0.655893   
## NHR -1.736e+01 1.411e+01 -1.230 0.218993   
## HNR -6.334e-01 1.629e-01 -3.889 0.000108 \*\*\*  
## RPDE -9.733e-01 4.319e+00 -0.225 0.821737   
## DFA -3.948e+01 5.622e+00 -7.022 4.14e-12 \*\*\*  
## PPE 1.706e+01 6.956e+00 2.452 0.014367 \*   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 9.278 on 960 degrees of freedom  
## Multiple R-squared: 0.2652, Adjusted R-squared: 0.2499   
## F-statistic: 17.33 on 20 and 960 DF, p-value: < 2.2e-16

## choose model  
predictors2 <- data2[, c(-4,-6,-7)]  
response2 <- data2$total\_UPDRS  
leapSet2 <- leaps(x = predictors2, y = response2, nbest = 3)  
leapSet2$which[which.min(leapSet2$Cp),]

## 1 2 3 4 5 6 7 8 9 A B C D   
## TRUE TRUE TRUE TRUE FALSE TRUE TRUE FALSE TRUE FALSE FALSE FALSE FALSE   
## E F G H I J K   
## FALSE TRUE TRUE TRUE FALSE TRUE TRUE

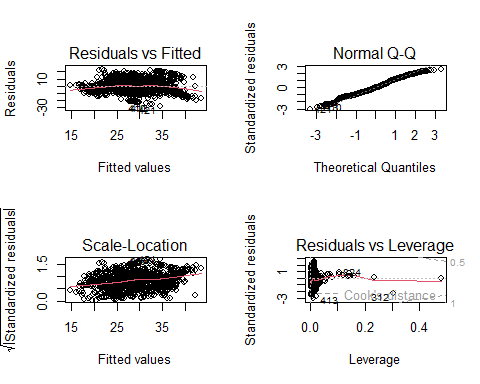
selectmod2 <- lm(total\_UPDRS ~ `subject#`+age+sex+test\_time+`Jitter(Abs)`  
 +`Jitter:RAP`+`Jitter:DDP`+`Shimmer:DDA`+NHR+HNR+DFA+PPE, data2)  
anova(selectmod2, mod2)

## Analysis of Variance Table  
##   
## Model 1: total\_UPDRS ~ `subject#` + age + sex + test\_time + `Jitter(Abs)` +   
## `Jitter:RAP` + `Jitter:DDP` + `Shimmer:DDA` + NHR + HNR +   
## DFA + PPE  
## Model 2: total\_UPDRS ~ (`subject#` + age + sex + method + test\_time +   
## motor\_UPDRS + `Jitter(%)` + `Jitter(Abs)` + `Jitter:RAP` +   
## `Jitter:PPQ5` + `Jitter:DDP` + Shimmer + `Shimmer(dB)` +   
## `Shimmer:APQ3` + `Shimmer:APQ5` + `Shimmer:APQ11` + `Shimmer:DDA` +   
## NHR + HNR + RPDE + DFA + PPE) - method - motor\_UPDRS  
## Res.Df RSS Df Sum of Sq F Pr(>F)  
## 1 968 82839   
## 2 960 82638 8 200.36 0.2909 0.9691

summary(selectmod2)

##   
## Call:  
## lm(formula = total\_UPDRS ~ `subject#` + age + sex + test\_time +   
## `Jitter(Abs)` + `Jitter:RAP` + `Jitter:DDP` + `Shimmer:DDA` +   
## NHR + HNR + DFA + PPE, data = data2)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -27.5526 -6.7156 -0.5571 7.0865 22.6788   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 4.366e+01 6.472e+00 6.747 2.60e-11 \*\*\*  
## `subject#` 2.738e-01 2.600e-02 10.531 < 2e-16 \*\*\*  
## age 3.088e-01 3.523e-02 8.765 < 2e-16 \*\*\*  
## sex -4.736e+00 7.268e-01 -6.516 1.16e-10 \*\*\*  
## test\_time 1.272e-02 5.537e-03 2.297 0.021817 \*   
## `Jitter(Abs)` -4.578e+04 1.719e+04 -2.664 0.007855 \*\*   
## `Jitter:RAP` 2.004e+05 1.088e+05 1.841 0.065952 .   
## `Jitter:DDP` -6.664e+04 3.628e+04 -1.837 0.066536 .   
## `Shimmer:DDA` -4.127e+01 1.156e+01 -3.570 0.000375 \*\*\*  
## NHR -1.874e+01 1.016e+01 -1.844 0.065461 .   
## HNR -6.435e-01 1.470e-01 -4.379 1.32e-05 \*\*\*  
## DFA -3.902e+01 5.481e+00 -7.120 2.10e-12 \*\*\*  
## PPE 1.416e+01 6.138e+00 2.307 0.021286 \*   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 9.251 on 968 degrees of freedom  
## Multiple R-squared: 0.2634, Adjusted R-squared: 0.2543   
## F-statistic: 28.85 on 12 and 968 DF, p-value: < 2.2e-16

## diagnostics  
par(mfrow=c(2,2))  
plot(selectmod2)



## as.factor(sex)  
data2$sex <- as.factor(data2$sex)  
fselectmod2 <- aov(total\_UPDRS ~ `subject#`+age+sex+test\_time+`Jitter(Abs)`  
 +`Jitter:RAP`+`Jitter:DDP`+`Shimmer:DDA`+NHR+HNR+DFA+PPE, data2)  
summary(fselectmod2)

## Df Sum Sq Mean Sq F value Pr(>F)   
## `subject#` 1 7360 7360 86.006 < 2e-16 \*\*\*  
## age 1 11337 11337 132.473 < 2e-16 \*\*\*  
## sex 1 3036 3036 35.480 3.60e-09 \*\*\*  
## test\_time 1 443 443 5.179 0.0231 \*   
## `Jitter(Abs)` 1 95 95 1.112 0.2920   
## `Jitter:RAP` 1 506 506 5.913 0.0152 \*   
## `Jitter:DDP` 1 287 287 3.357 0.0672 .   
## `Shimmer:DDA` 1 114 114 1.332 0.2487   
## NHR 1 168 168 1.966 0.1612   
## HNR 1 1821 1821 21.280 4.50e-06 \*\*\*  
## DFA 1 4006 4006 46.812 1.38e-11 \*\*\*  
## PPE 1 455 455 5.321 0.0213 \*   
## Residuals 968 82839 86   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

## Fisher's LSD  
LSD.test(fselectmod2, "sex", group = F, console = T)

##   
## Study: fselectmod2 ~ "sex"  
##   
## LSD t Test for total\_UPDRS   
##   
## Mean Square Error: 85.57713   
##   
## sex, means and individual ( 95 %) CI  
##   
## total\_UPDRS std r LCL UCL Min Max  
## 0 29.72876 11.009410 671 29.02793 30.42958 7.0000 54.992  
## 1 27.53226 9.892022 310 26.50119 28.56334 7.0883 48.530  
##   
## Alpha: 0.05 ; DF Error: 968  
## Critical Value of t: 1.962418   
##   
## Comparison between treatments means  
##   
## difference pvalue signif. LCL UCL  
## 0 - 1 2.196496 6e-04 \*\*\* 0.9497937 3.443198

### method 3

data3 <- data[method == 3,]  
mod3 = lm(total\_UPDRS ~ .- method - motor\_UPDRS, data = data3)  
summary(mod3)

##   
## Call:  
## lm(formula = total\_UPDRS ~ . - method - motor\_UPDRS, data = data3)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -26.2963 -6.8835 -0.9794 6.8794 22.1776   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 2.319e+01 7.283e+00 3.184 0.00150 \*\*   
## `subject#` 2.769e-01 2.650e-02 10.451 < 2e-16 \*\*\*  
## age 3.067e-01 3.589e-02 8.546 < 2e-16 \*\*\*  
## sex -5.370e+00 8.162e-01 -6.579 7.76e-11 \*\*\*  
## test\_time 1.492e-02 5.599e-03 2.665 0.00783 \*\*   
## `Jitter(%)` -8.872e+01 5.000e+02 -0.177 0.85920   
## `Jitter(Abs)` -9.844e+04 3.042e+04 -3.236 0.00125 \*\*   
## `Jitter:RAP` -1.078e+05 1.111e+05 -0.970 0.33214   
## `Jitter:PPQ5` -8.784e-01 4.406e+02 -0.002 0.99841   
## `Jitter:DDP` 3.631e+04 3.704e+04 0.980 0.32715   
## Shimmer -2.949e+01 1.768e+02 -0.167 0.86761   
## `Shimmer(dB)` -4.299e+00 1.274e+01 -0.337 0.73584   
## `Shimmer:APQ3` -8.378e+04 1.101e+05 -0.761 0.44703   
## `Shimmer:APQ5` 9.980e+01 1.359e+02 0.734 0.46293   
## `Shimmer:APQ11` 9.188e-01 7.297e+01 0.013 0.98996   
## `Shimmer:DDA` 2.791e+04 3.671e+04 0.760 0.44721   
## NHR -2.399e+01 1.621e+01 -1.480 0.13909   
## HNR -1.455e-01 1.566e-01 -0.929 0.35309   
## RPDE 8.289e+00 4.275e+00 1.939 0.05279 .   
## DFA -3.516e+01 5.492e+00 -6.402 2.40e-10 \*\*\*  
## PPE 2.545e+01 6.978e+00 3.647 0.00028 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 9.301 on 959 degrees of freedom  
## Multiple R-squared: 0.2602, Adjusted R-squared: 0.2448   
## F-statistic: 16.87 on 20 and 959 DF, p-value: < 2.2e-16

## choose model  
predictors3 <- data3[, c(-4,-6,-7)]  
response3 <- data3$total\_UPDRS  
leapSet3 <- leaps(x = predictors3, y = response3, nbest = 3)  
leapSet3$which[which.min(leapSet3$Cp),]

## 1 2 3 4 5 6 7 8 9 A B C D   
## TRUE TRUE TRUE TRUE FALSE TRUE FALSE FALSE TRUE FALSE FALSE FALSE FALSE   
## E F G H I J K   
## FALSE FALSE TRUE FALSE TRUE TRUE TRUE

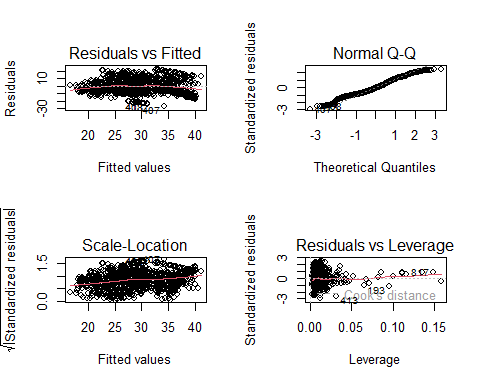
selectmod3 <- lm(total\_UPDRS ~ `subject#`+age+sex+test\_time+`Jitter(Abs)`  
 +`Jitter:DDP`+NHR+RPDE+DFA+PPE, data3)  
anova(selectmod3, mod3)

## Analysis of Variance Table  
##   
## Model 1: total\_UPDRS ~ `subject#` + age + sex + test\_time + `Jitter(Abs)` +   
## `Jitter:DDP` + NHR + RPDE + DFA + PPE  
## Model 2: total\_UPDRS ~ (`subject#` + age + sex + method + test\_time +   
## motor\_UPDRS + `Jitter(%)` + `Jitter(Abs)` + `Jitter:RAP` +   
## `Jitter:PPQ5` + `Jitter:DDP` + Shimmer + `Shimmer(dB)` +   
## `Shimmer:APQ3` + `Shimmer:APQ5` + `Shimmer:APQ11` + `Shimmer:DDA` +   
## NHR + HNR + RPDE + DFA + PPE) - method - motor\_UPDRS  
## Res.Df RSS Df Sum of Sq F Pr(>F)  
## 1 969 83286   
## 2 959 82957 10 328.95 0.3803 0.9555

summary(selectmod3)

##   
## Call:  
## lm(formula = total\_UPDRS ~ `subject#` + age + sex + test\_time +   
## `Jitter(Abs)` + `Jitter:DDP` + NHR + RPDE + DFA + PPE, data = data3)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -26.6123 -7.0416 -0.9035 6.9764 21.8530   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 1.779e+01 4.550e+00 3.910 9.89e-05 \*\*\*  
## `subject#` 2.799e-01 2.599e-02 10.767 < 2e-16 \*\*\*  
## age 3.043e-01 3.496e-02 8.706 < 2e-16 \*\*\*  
## sex -5.356e+00 8.018e-01 -6.680 4.03e-11 \*\*\*  
## test\_time 1.480e-02 5.551e-03 2.666 0.007798 \*\*   
## `Jitter(Abs)` -9.963e+04 2.749e+04 -3.624 0.000305 \*\*\*  
## `Jitter:DDP` 3.265e+02 1.067e+02 3.059 0.002280 \*\*   
## NHR -2.292e+01 8.673e+00 -2.643 0.008346 \*\*   
## RPDE 9.333e+00 3.738e+00 2.497 0.012682 \*   
## DFA -3.377e+01 5.254e+00 -6.426 2.05e-10 \*\*\*  
## PPE 2.499e+01 5.936e+00 4.211 2.78e-05 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 9.271 on 969 degrees of freedom  
## Multiple R-squared: 0.2573, Adjusted R-squared: 0.2497   
## F-statistic: 33.57 on 10 and 969 DF, p-value: < 2.2e-16

## diagnostics  
par(mfrow=c(2,2))  
plot(selectmod3)



## as.factor(sex)  
data3$sex <- as.factor(data3$sex)  
fselectmod3 <- aov(total\_UPDRS ~ `subject#`+age+sex+test\_time+`Jitter(Abs)`  
 +`Jitter:DDP`+NHR+RPDE+DFA+PPE, data3)  
summary(fselectmod3)

## Df Sum Sq Mean Sq F value Pr(>F)   
## `subject#` 1 7210 7210 83.886 < 2e-16 \*\*\*  
## age 1 11488 11488 133.663 < 2e-16 \*\*\*  
## sex 1 3005 3005 34.965 4.65e-09 \*\*\*  
## test\_time 1 503 503 5.854 0.015723 \*   
## `Jitter(Abs)` 1 28 28 0.330 0.565593   
## `Jitter:DDP` 1 1028 1028 11.956 0.000568 \*\*\*  
## NHR 1 2 2 0.028 0.867748   
## RPDE 1 1181 1181 13.741 0.000222 \*\*\*  
## DFA 1 2886 2886 33.574 9.27e-09 \*\*\*  
## PPE 1 1524 1524 17.730 2.78e-05 \*\*\*  
## Residuals 969 83286 86   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

## Fisher's LSD  
LSD.test(fselectmod3, "sex", group = F, console = T)

##   
## Study: fselectmod3 ~ "sex"  
##   
## LSD t Test for total\_UPDRS   
##   
## Mean Square Error: 85.95057   
##   
## sex, means and individual ( 95 %) CI  
##   
## total\_UPDRS std r LCL UCL Min Max  
## 0 29.72292 11.024366 671 29.02057 30.42527 7.0000 54.992  
## 1 27.57609 9.826001 309 26.54110 28.61108 7.0883 48.530  
##   
## Alpha: 0.05 ; DF Error: 969  
## Critical Value of t: 1.962415   
##   
## Comparison between treatments means  
##   
## difference pvalue signif. LCL UCL  
## 0 - 1 2.146821 8e-04 \*\*\* 0.8960215 3.397621

### method 4

data4 <- data[method == 4,]  
mod4 = lm(total\_UPDRS ~ .- method - motor\_UPDRS, data = data4)  
summary(mod4)

##   
## Call:  
## lm(formula = total\_UPDRS ~ . - method - motor\_UPDRS, data = data4)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -25.022 -6.728 -1.077 6.979 23.785   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 3.738e+01 7.534e+00 4.961 8.30e-07 \*\*\*  
## `subject#` 2.565e-01 2.679e-02 9.575 < 2e-16 \*\*\*  
## age 3.019e-01 3.510e-02 8.600 < 2e-16 \*\*\*  
## sex -5.083e+00 7.785e-01 -6.530 1.07e-10 \*\*\*  
## test\_time 1.694e-02 5.557e-03 3.048 0.00236 \*\*   
## `Jitter(%)` 9.180e+01 5.166e+02 0.178 0.85899   
## `Jitter(Abs)` -6.134e+04 2.226e+04 -2.755 0.00598 \*\*   
## `Jitter:RAP` -1.892e+05 1.113e+05 -1.700 0.08954 .   
## `Jitter:PPQ5` -9.176e+02 5.054e+02 -1.816 0.06973 .   
## `Jitter:DDP` 6.356e+04 3.711e+04 1.713 0.08710 .   
## Shimmer 2.748e+02 1.953e+02 1.407 0.15976   
## `Shimmer(dB)` -7.282e+00 1.178e+01 -0.618 0.53658   
## `Shimmer:APQ3` -1.805e+05 1.104e+05 -1.635 0.10230   
## `Shimmer:APQ5` 3.657e+01 1.435e+02 0.255 0.79892   
## `Shimmer:APQ11` -2.336e+01 8.061e+01 -0.290 0.77208   
## `Shimmer:DDA` 6.005e+04 3.678e+04 1.633 0.10289   
## NHR -5.170e+01 1.823e+01 -2.837 0.00466 \*\*   
## HNR -4.731e-01 1.638e-01 -2.888 0.00397 \*\*   
## RPDE 6.263e+00 4.500e+00 1.392 0.16430   
## DFA -4.121e+01 5.655e+00 -7.286 6.67e-13 \*\*\*  
## PPE 6.887e+00 6.827e+00 1.009 0.31339   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 9.227 on 956 degrees of freedom  
## Multiple R-squared: 0.2704, Adjusted R-squared: 0.2551   
## F-statistic: 17.71 on 20 and 956 DF, p-value: < 2.2e-16

## choose model  
predictors4 <- data4[, c(-4,-6,-7)]  
response4 <- data4$total\_UPDRS  
leapSet4 <- leaps(x = predictors4, y = response4, nbest = 3)  
leapSet4$which[which.min(leapSet4$Cp),]

## 1 2 3 4 5 6 7 8 9 A B C D   
## TRUE TRUE TRUE TRUE FALSE TRUE TRUE TRUE TRUE TRUE FALSE TRUE FALSE   
## E F G H I J K   
## FALSE TRUE TRUE TRUE TRUE TRUE FALSE

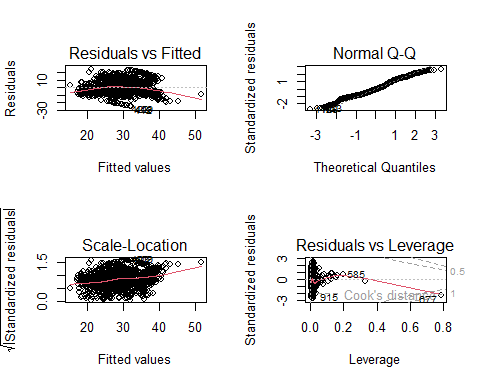
selectmod4 <- lm(total\_UPDRS ~ `subject#`+age+sex+test\_time+`Jitter(Abs)`+`Jitter:RAP`+`Jitter:PPQ5`  
 +`Jitter:DDP`+`Shimmer`+`Shimmer:APQ3`+`Shimmer:DDA`+NHR+HNR+RPDE+DFA, data4)  
anova(selectmod4, mod4)

## Analysis of Variance Table  
##   
## Model 1: total\_UPDRS ~ `subject#` + age + sex + test\_time + `Jitter(Abs)` +   
## `Jitter:RAP` + `Jitter:PPQ5` + `Jitter:DDP` + Shimmer + `Shimmer:APQ3` +   
## `Shimmer:DDA` + NHR + HNR + RPDE + DFA  
## Model 2: total\_UPDRS ~ (`subject#` + age + sex + method + test\_time +   
## motor\_UPDRS + `Jitter(%)` + `Jitter(Abs)` + `Jitter:RAP` +   
## `Jitter:PPQ5` + `Jitter:DDP` + Shimmer + `Shimmer(dB)` +   
## `Shimmer:APQ3` + `Shimmer:APQ5` + `Shimmer:APQ11` + `Shimmer:DDA` +   
## NHR + HNR + RPDE + DFA + PPE) - method - motor\_UPDRS  
## Res.Df RSS Df Sum of Sq F Pr(>F)  
## 1 961 81513   
## 2 956 81399 5 113.87 0.2675 0.9309

summary(selectmod4)

##   
## Call:  
## lm(formula = total\_UPDRS ~ `subject#` + age + sex + test\_time +   
## `Jitter(Abs)` + `Jitter:RAP` + `Jitter:PPQ5` + `Jitter:DDP` +   
## Shimmer + `Shimmer:APQ3` + `Shimmer:DDA` + NHR + HNR + RPDE +   
## DFA, data = data4)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -24.512 -6.800 -1.181 7.006 23.350   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 3.811e+01 7.417e+00 5.138 3.36e-07 \*\*\*  
## `subject#` 2.578e-01 2.631e-02 9.798 < 2e-16 \*\*\*  
## age 3.021e-01 3.475e-02 8.693 < 2e-16 \*\*\*  
## sex -5.041e+00 7.627e-01 -6.610 6.38e-11 \*\*\*  
## test\_time 1.692e-02 5.538e-03 3.056 0.00230 \*\*   
## `Jitter(Abs)` -5.180e+04 1.920e+04 -2.698 0.00710 \*\*   
## `Jitter:RAP` -1.876e+05 1.108e+05 -1.692 0.09090 .   
## `Jitter:PPQ5` -6.991e+02 3.569e+02 -1.959 0.05045 .   
## `Jitter:DDP` 6.300e+04 3.695e+04 1.705 0.08854 .   
## Shimmer 1.971e+02 1.007e+02 1.957 0.05069 .   
## `Shimmer:APQ3` -1.823e+05 1.097e+05 -1.662 0.09682 .   
## `Shimmer:DDA` 6.067e+04 3.656e+04 1.659 0.09735 .   
## NHR -5.337e+01 1.745e+01 -3.059 0.00228 \*\*   
## HNR -5.116e-01 1.532e-01 -3.340 0.00087 \*\*\*  
## RPDE 6.995e+00 4.405e+00 1.588 0.11261   
## DFA -4.027e+01 5.531e+00 -7.281 6.90e-13 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 9.21 on 961 degrees of freedom  
## Multiple R-squared: 0.2694, Adjusted R-squared: 0.258   
## F-statistic: 23.62 on 15 and 961 DF, p-value: < 2.2e-16

## diagnostics  
par(mfrow=c(2,2))  
plot(selectmod4)



## as.factor(sex)  
data4$sex <- as.factor(data4$sex)  
fselectmod4 <- aov(total\_UPDRS ~ `subject#`+age+sex+test\_time+`Jitter(Abs)`+`Jitter:RAP`+`Jitter:PPQ5`  
 +`Jitter:DDP`+`Shimmer`+`Shimmer:APQ3`+`Shimmer:DDA`+NHR+HNR+RPDE+DFA, data4)  
summary(fselectmod4)

## Df Sum Sq Mean Sq F value Pr(>F)   
## `subject#` 1 6836 6836 80.598 < 2e-16 \*\*\*  
## age 1 11219 11219 132.271 < 2e-16 \*\*\*  
## sex 1 3055 3055 36.012 2.77e-09 \*\*\*  
## test\_time 1 537 537 6.337 0.011989 \*   
## `Jitter(Abs)` 1 0 0 0.001 0.974304   
## `Jitter:RAP` 1 936 936 11.038 0.000926 \*\*\*  
## `Jitter:PPQ5` 1 23 23 0.277 0.599064   
## `Jitter:DDP` 1 215 215 2.541 0.111281   
## Shimmer 1 1007 1007 11.868 0.000596 \*\*\*  
## `Shimmer:APQ3` 1 167 167 1.969 0.160917   
## `Shimmer:DDA` 1 193 193 2.280 0.131394   
## NHR 1 23 23 0.271 0.602846   
## HNR 1 960 960 11.318 0.000798 \*\*\*  
## RPDE 1 381 381 4.490 0.034358 \*   
## DFA 1 4496 4496 53.011 6.90e-13 \*\*\*  
## Residuals 961 81513 85   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

## Fisher's LSD  
LSD.test(fselectmod4, "sex", group = F, console = T)

##   
## Study: fselectmod4 ~ "sex"  
##   
## LSD t Test for total\_UPDRS   
##   
## Mean Square Error: 84.82078   
##   
## sex, means and individual ( 95 %) CI  
##   
## total\_UPDRS std r LCL UCL Min Max  
## 0 29.67029 10.969466 668 28.97100 30.36959 7.0000 54.992  
## 1 27.45956 9.913748 309 26.43138 28.48773 7.0882 48.530  
##   
## Alpha: 0.05 ; DF Error: 961  
## Critical Value of t: 1.962436   
##   
## Comparison between treatments means  
##   
## difference pvalue signif. LCL UCL  
## 0 - 1 2.210735 5e-04 \*\*\* 0.9672906 3.454179

### method 5

data5 <- data[method == 5,]  
mod5 = lm(total\_UPDRS ~ .- method - motor\_UPDRS, data = data5)  
summary(mod5)

##   
## Call:  
## lm(formula = total\_UPDRS ~ . - method - motor\_UPDRS, data = data5)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -24.0012 -6.7651 -0.9768 6.9762 22.8364   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 4.252e+01 7.546e+00 5.635 2.30e-08 \*\*\*  
## `subject#` 2.512e-01 2.735e-02 9.184 < 2e-16 \*\*\*  
## age 3.108e-01 3.596e-02 8.643 < 2e-16 \*\*\*  
## sex -4.961e+00 8.363e-01 -5.932 4.16e-09 \*\*\*  
## test\_time 1.863e-02 5.623e-03 3.313 0.000957 \*\*\*  
## `Jitter(%)` 2.062e+02 6.620e+02 0.312 0.755485   
## `Jitter(Abs)` -6.586e+04 3.909e+04 -1.685 0.092340 .   
## `Jitter:RAP` 1.180e+05 1.105e+05 1.068 0.285758   
## `Jitter:PPQ5` -3.192e+02 7.024e+02 -0.454 0.649648   
## `Jitter:DDP` -3.896e+04 3.685e+04 -1.057 0.290556   
## Shimmer 3.834e+01 1.842e+02 0.208 0.835130   
## `Shimmer(dB)` 1.284e+01 1.434e+01 0.896 0.370725   
## `Shimmer:APQ3` 8.317e+04 1.109e+05 0.750 0.453470   
## `Shimmer:APQ5` 1.226e+02 1.751e+02 0.700 0.483846   
## `Shimmer:APQ11` -3.479e+01 8.247e+01 -0.422 0.673182   
## `Shimmer:DDA` -2.787e+04 3.697e+04 -0.754 0.451104   
## NHR -5.444e+01 1.778e+01 -3.062 0.002261 \*\*   
## HNR -6.924e-01 1.671e-01 -4.143 3.73e-05 \*\*\*  
## RPDE 1.839e+00 4.245e+00 0.433 0.664900   
## DFA -4.009e+01 5.652e+00 -7.093 2.54e-12 \*\*\*  
## PPE 1.114e+01 7.647e+00 1.457 0.145581   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 9.296 on 959 degrees of freedom  
## Multiple R-squared: 0.265, Adjusted R-squared: 0.2497   
## F-statistic: 17.29 on 20 and 959 DF, p-value: < 2.2e-16

## choose model  
predictors5 <- data5[, c(-4,-6,-7)]  
response5 <- data5$total\_UPDRS  
leapSet5 <- leaps(x = predictors5, y = response5, nbest = 3)  
leapSet5$which[which.min(leapSet5$Cp),]

## 1 2 3 4 5 6 7 8 9 A B C D   
## TRUE TRUE TRUE TRUE FALSE FALSE TRUE FALSE FALSE FALSE TRUE FALSE FALSE   
## E F G H I J K   
## FALSE TRUE TRUE TRUE FALSE TRUE FALSE

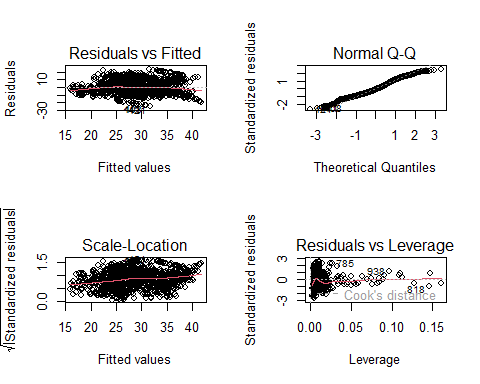
selectmod5 <- lm(total\_UPDRS ~ `subject#`+age+sex+test\_time+`Jitter:RAP`  
 +`Shimmer(dB)`+`Shimmer:DDA`+NHR+HNR+DFA, data5)  
anova(selectmod5, mod5)

## Analysis of Variance Table  
##   
## Model 1: total\_UPDRS ~ `subject#` + age + sex + test\_time + `Jitter:RAP` +   
## `Shimmer(dB)` + `Shimmer:DDA` + NHR + HNR + DFA  
## Model 2: total\_UPDRS ~ (`subject#` + age + sex + method + test\_time +   
## motor\_UPDRS + `Jitter(%)` + `Jitter(Abs)` + `Jitter:RAP` +   
## `Jitter:PPQ5` + `Jitter:DDP` + Shimmer + `Shimmer(dB)` +   
## `Shimmer:APQ3` + `Shimmer:APQ5` + `Shimmer:APQ11` + `Shimmer:DDA` +   
## NHR + HNR + RPDE + DFA + PPE) - method - motor\_UPDRS  
## Res.Df RSS Df Sum of Sq F Pr(>F)  
## 1 969 83453   
## 2 959 82880 10 573.02 0.663 0.7594

summary(selectmod5)

##   
## Call:  
## lm(formula = total\_UPDRS ~ `subject#` + age + sex + test\_time +   
## `Jitter:RAP` + `Shimmer(dB)` + `Shimmer:DDA` + NHR + HNR +   
## DFA, data = data5)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -24.585 -6.752 -1.026 7.045 22.864   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 4.544e+01 6.122e+00 7.423 2.51e-13 \*\*\*  
## `subject#` 2.539e-01 2.647e-02 9.592 < 2e-16 \*\*\*  
## age 3.208e-01 3.523e-02 9.107 < 2e-16 \*\*\*  
## sex -4.490e+00 7.071e-01 -6.349 3.32e-10 \*\*\*  
## test\_time 1.839e-02 5.597e-03 3.285 0.00106 \*\*   
## `Jitter:RAP` 7.800e+02 2.771e+02 2.815 0.00498 \*\*   
## `Shimmer(dB)` 1.652e+01 7.488e+00 2.206 0.02761 \*   
## `Shimmer:DDA` -1.159e+02 3.734e+01 -3.105 0.00196 \*\*   
## NHR -5.748e+01 1.452e+01 -3.959 8.09e-05 \*\*\*  
## HNR -7.475e-01 1.324e-01 -5.648 2.14e-08 \*\*\*  
## DFA -4.096e+01 5.224e+00 -7.840 1.19e-14 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 9.28 on 969 degrees of freedom  
## Multiple R-squared: 0.26, Adjusted R-squared: 0.2523   
## F-statistic: 34.04 on 10 and 969 DF, p-value: < 2.2e-16

## diagnostics  
par(mfrow=c(2,2))  
plot(selectmod5)



## as.factor(sex)  
data5$sex <- as.factor(data5$sex)  
fselectmod5 <- aov(total\_UPDRS ~ `subject#`+age+sex+test\_time+`Jitter:RAP`  
 +`Shimmer(dB)`+`Shimmer:DDA`+NHR+HNR+DFA, data5)  
summary(fselectmod5)

## Df Sum Sq Mean Sq F value Pr(>F)   
## `subject#` 1 7412 7412 86.064 < 2e-16 \*\*\*  
## age 1 11352 11352 131.808 < 2e-16 \*\*\*  
## sex 1 3197 3197 37.121 1.60e-09 \*\*\*  
## test\_time 1 529 529 6.144 0.013354 \*   
## `Jitter:RAP` 1 180 180 2.088 0.148745   
## `Shimmer(dB)` 1 2 2 0.021 0.885964   
## `Shimmer:DDA` 1 217 217 2.524 0.112452   
## NHR 1 82 82 0.950 0.329932   
## HNR 1 1051 1051 12.205 0.000498 \*\*\*  
## DFA 1 5293 5293 61.463 1.19e-14 \*\*\*  
## Residuals 969 83453 86   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

## Fisher's LSD  
LSD.test(fselectmod5, "sex", group = F, console = T)

##   
## Study: fselectmod5 ~ "sex"  
##   
## LSD t Test for total\_UPDRS   
##   
## Mean Square Error: 86.12301   
##   
## sex, means and individual ( 95 %) CI  
##   
## total\_UPDRS std r LCL UCL Min Max  
## 0 29.71987 11.04093 666 29.01418 30.42555 7.0000 54.992  
## 1 27.44572 9.88753 314 26.41798 28.47347 7.0881 48.530  
##   
## Alpha: 0.05 ; DF Error: 969  
## Critical Value of t: 1.962415   
##   
## Comparison between treatments means  
##   
## difference pvalue signif. LCL UCL  
## 0 - 1 2.274143 4e-04 \*\*\* 1.027444 3.520842

### method 6

data6 <- data[method == 6,]  
mod6 = lm(total\_UPDRS ~ .- method - motor\_UPDRS, data = data6)  
summary(mod6)

##   
## Call:  
## lm(formula = total\_UPDRS ~ . - method - motor\_UPDRS, data = data6)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -24.5122 -6.8771 -0.9534 6.6090 22.8721   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 3.329e+01 8.042e+00 4.140 3.78e-05 \*\*\*  
## `subject#` 2.456e-01 2.727e-02 9.008 < 2e-16 \*\*\*  
## age 3.301e-01 3.624e-02 9.108 < 2e-16 \*\*\*  
## sex -5.658e+00 8.679e-01 -6.519 1.14e-10 \*\*\*  
## test\_time 1.727e-02 5.607e-03 3.079 0.00213 \*\*   
## `Jitter(%)` -4.004e+02 6.832e+02 -0.586 0.55794   
## `Jitter(Abs)` -1.086e+05 4.236e+04 -2.563 0.01052 \*   
## `Jitter:RAP` -1.454e+05 1.086e+05 -1.339 0.18095   
## `Jitter:PPQ5` -1.238e+03 7.159e+02 -1.730 0.08404 .   
## `Jitter:DDP` 4.951e+04 3.619e+04 1.368 0.17171   
## Shimmer 2.185e+02 1.396e+02 1.566 0.11779   
## `Shimmer(dB)` -1.317e+01 1.196e+01 -1.102 0.27081   
## `Shimmer:APQ3` 1.474e+05 1.143e+05 1.289 0.19772   
## `Shimmer:APQ5` 1.523e+02 1.644e+02 0.926 0.35450   
## `Shimmer:APQ11` -1.100e+01 7.170e+01 -0.153 0.87807   
## `Shimmer:DDA` -4.927e+04 3.811e+04 -1.293 0.19641   
## NHR -2.942e+01 1.962e+01 -1.500 0.13403   
## HNR -5.694e-01 1.781e-01 -3.198 0.00143 \*\*   
## RPDE 4.584e+00 4.368e+00 1.050 0.29420   
## DFA -3.294e+01 5.783e+00 -5.695 1.64e-08 \*\*\*  
## PPE 1.862e+01 7.442e+00 2.502 0.01252 \*   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 9.293 on 959 degrees of freedom  
## Multiple R-squared: 0.2591, Adjusted R-squared: 0.2436   
## F-statistic: 16.77 on 20 and 959 DF, p-value: < 2.2e-16

## choose model  
predictors6 <- data6[, c(-4,-6,-7)]  
response6 <- data6$total\_UPDRS  
leapSet6 <- leaps(x = predictors6, y = response6, nbest = 3)  
leapSet6$which[which.min(leapSet6$Cp),]

## 1 2 3 4 5 6 7 8 9 A B C D   
## TRUE TRUE TRUE TRUE FALSE TRUE FALSE TRUE TRUE FALSE FALSE FALSE FALSE   
## E F G H I J K   
## FALSE TRUE FALSE TRUE FALSE TRUE TRUE

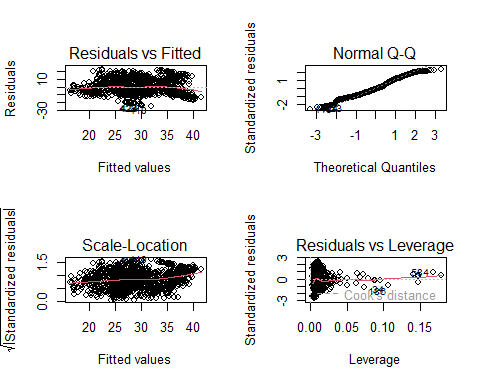
selectmod6 <- lm(total\_UPDRS ~ `subject#`+age+sex+test\_time+`Jitter(Abs)`  
 +`Jitter:PPQ5`+`Jitter:DDP`+`Shimmer:DDA`+HNR+DFA+PPE, data6)  
anova(selectmod6, mod6)

## Analysis of Variance Table  
##   
## Model 1: total\_UPDRS ~ `subject#` + age + sex + test\_time + `Jitter(Abs)` +   
## `Jitter:PPQ5` + `Jitter:DDP` + `Shimmer:DDA` + HNR + DFA +   
## PPE  
## Model 2: total\_UPDRS ~ (`subject#` + age + sex + method + test\_time +   
## motor\_UPDRS + `Jitter(%)` + `Jitter(Abs)` + `Jitter:RAP` +   
## `Jitter:PPQ5` + `Jitter:DDP` + Shimmer + `Shimmer(dB)` +   
## `Shimmer:APQ3` + `Shimmer:APQ5` + `Shimmer:APQ11` + `Shimmer:DDA` +   
## NHR + HNR + RPDE + DFA + PPE) - method - motor\_UPDRS  
## Res.Df RSS Df Sum of Sq F Pr(>F)  
## 1 968 83771   
## 2 959 82819 9 951.86 1.2247 0.2758

summary(selectmod6)

##   
## Call:  
## lm(formula = total\_UPDRS ~ `subject#` + age + sex + test\_time +   
## `Jitter(Abs)` + `Jitter:PPQ5` + `Jitter:DDP` + `Shimmer:DDA` +   
## HNR + DFA + PPE, data = data6)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -24.490 -6.808 -1.198 6.968 21.967   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 3.440e+01 6.329e+00 5.435 6.92e-08 \*\*\*  
## `subject#` 2.536e-01 2.656e-02 9.549 < 2e-16 \*\*\*  
## age 3.411e-01 3.457e-02 9.866 < 2e-16 \*\*\*  
## sex -6.035e+00 8.049e-01 -7.498 1.46e-13 \*\*\*  
## test\_time 1.609e-02 5.574e-03 2.886 0.003983 \*\*   
## `Jitter(Abs)` -1.106e+05 3.340e+04 -3.313 0.000959 \*\*\*  
## `Jitter:PPQ5` -1.103e+03 4.286e+02 -2.574 0.010196 \*   
## `Jitter:DDP` 7.116e+02 1.918e+02 3.710 0.000219 \*\*\*  
## `Shimmer:DDA` -3.990e+01 1.608e+01 -2.482 0.013250 \*   
## HNR -6.298e-01 1.585e-01 -3.972 7.64e-05 \*\*\*  
## DFA -2.855e+01 4.951e+00 -5.767 1.09e-08 \*\*\*  
## PPE 1.503e+01 6.822e+00 2.202 0.027866 \*   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 9.303 on 968 degrees of freedom  
## Multiple R-squared: 0.2506, Adjusted R-squared: 0.2421   
## F-statistic: 29.42 on 11 and 968 DF, p-value: < 2.2e-16

## diagnostics  
par(mfrow=c(2,2))  
plot(selectmod6)



## as.factor(sex)  
data6$sex <- as.factor(data6$sex)  
fselectmod6 <- aov(total\_UPDRS ~ `subject#`+age+sex+test\_time+`Jitter(Abs)`  
 +`Jitter:PPQ5`+`Jitter:DDP`+`Shimmer:DDA`+HNR+DFA+PPE, data6)  
summary(fselectmod6)

## Df Sum Sq Mean Sq F value Pr(>F)   
## `subject#` 1 6928 6928 80.061 < 2e-16 \*\*\*  
## age 1 11230 11230 129.768 < 2e-16 \*\*\*  
## sex 1 3083 3083 35.628 3.35e-09 \*\*\*  
## test\_time 1 574 574 6.637 0.0101 \*   
## `Jitter(Abs)` 1 4 4 0.052 0.8205   
## `Jitter:PPQ5` 1 247 247 2.859 0.0912 .   
## `Jitter:DDP` 1 927 927 10.709 0.0011 \*\*   
## `Shimmer:DDA` 1 94 94 1.083 0.2983   
## HNR 1 1817 1817 20.998 5.20e-06 \*\*\*  
## DFA 1 2684 2684 31.020 3.31e-08 \*\*\*  
## PPE 1 420 420 4.851 0.0279 \*   
## Residuals 968 83771 87   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

## Fisher's LSD  
LSD.test(fselectmod6, "sex", group = F, console = T)

##   
## Study: fselectmod6 ~ "sex"  
##   
## LSD t Test for total\_UPDRS   
##   
## Mean Square Error: 86.54019   
##   
## sex, means and individual ( 95 %) CI  
##   
## total\_UPDRS std r LCL UCL Min Max  
## 0 29.82291 11.012309 670 29.11763 30.52820 7.0000 54.992  
## 1 27.58212 9.785149 310 26.54527 28.61898 7.0881 48.530  
##   
## Alpha: 0.05 ; DF Error: 968  
## Critical Value of t: 1.962418   
##   
## Comparison between treatments means  
##   
## difference pvalue signif. LCL UCL  
## 0 - 1 2.24079 5e-04 \*\*\* 0.9867964 3.494783