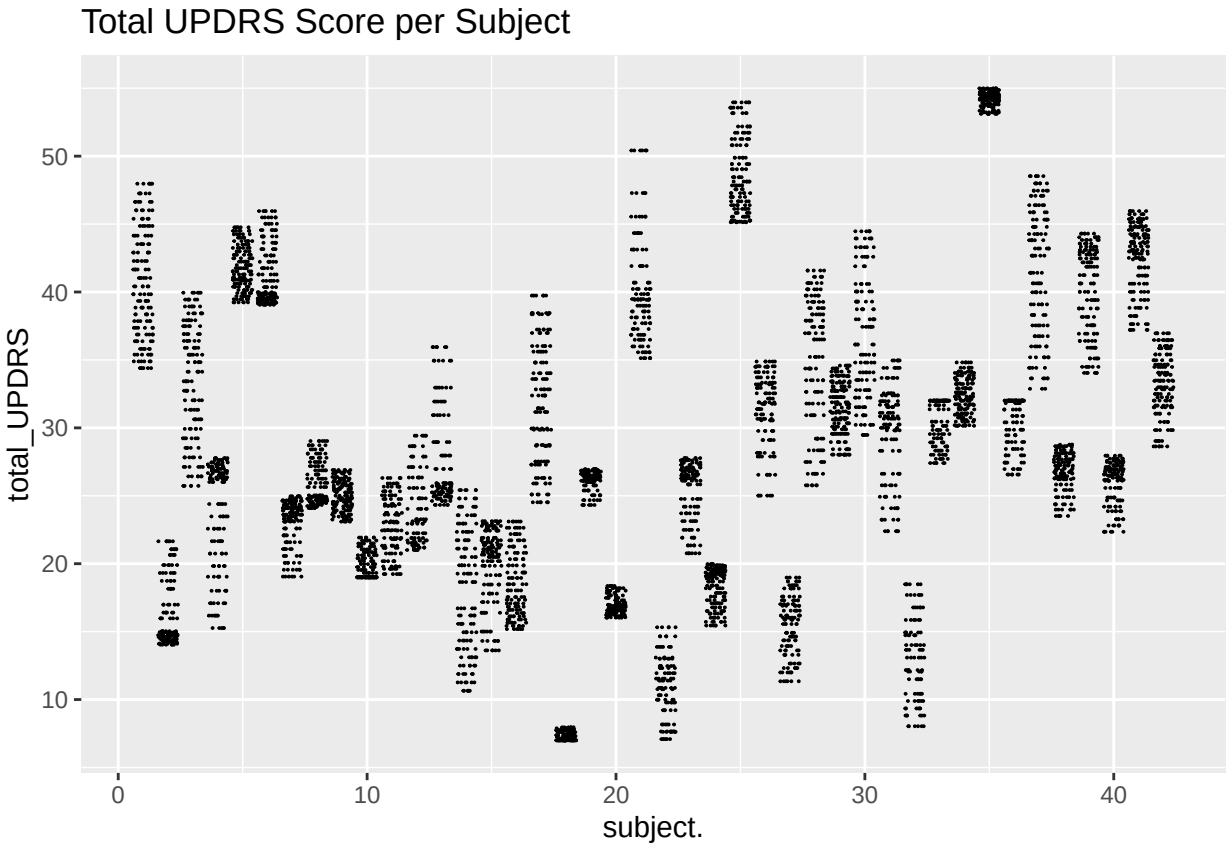
project_option2

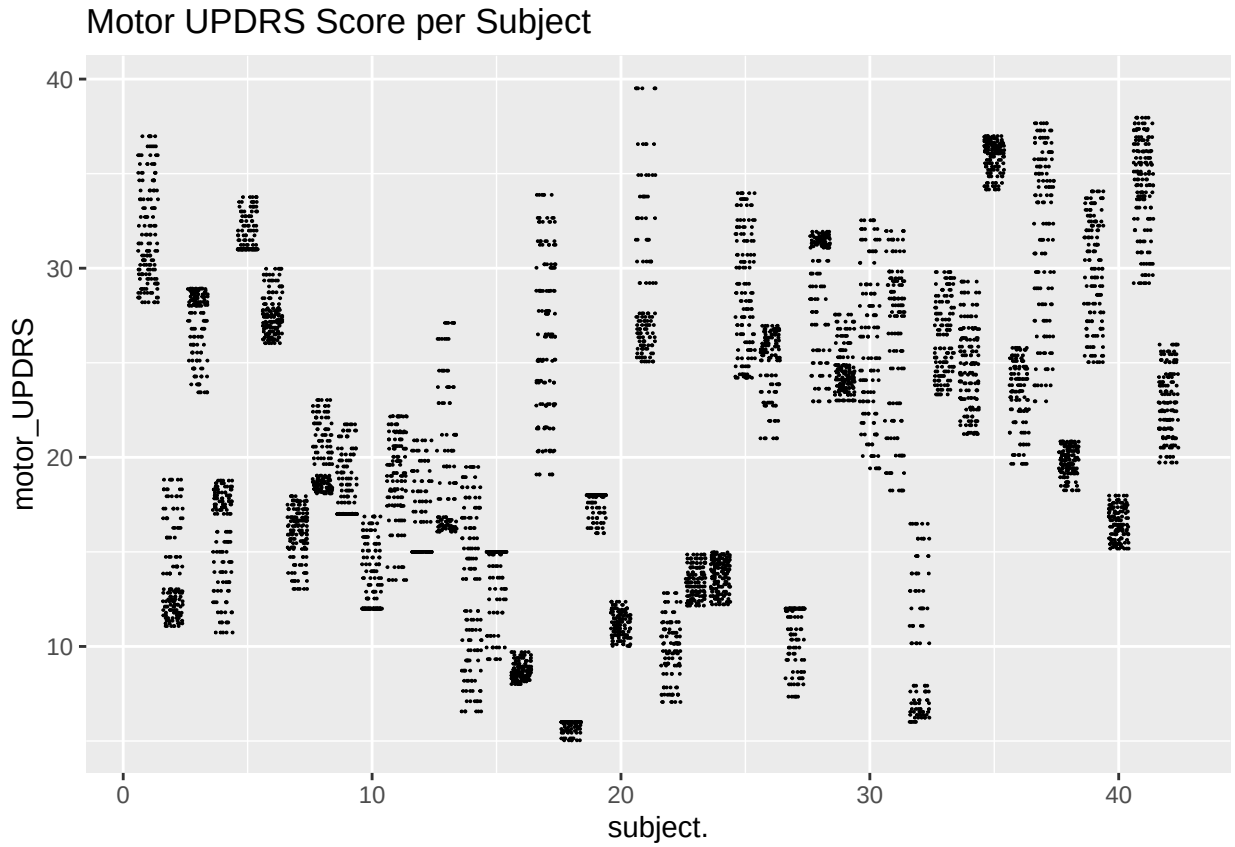
```
categorical_col = c(1,2,3)
full_data = read.csv("D:/R/data_467/data467_project/parkinsons_updrs.data")
data = full_data[-categorical_col]
for (i in 1:length(data)){
  data[,i] = scale(data[,i], center = TRUE, scale = TRUE)
}
subject_data = full_data
head(data)
```

```
##    test_time motor_UPDRS total_UPDRS   Jitter... Jitter.Abs. Jitter.RAP
## 1 -1.6319513   0.8491244   0.5027024  0.08289818  -0.2842180  0.3274246
## 2 -1.5005486   0.8796314   0.5490563 -0.56074568  -0.7566586 -0.5337008
## 3 -1.3692936   0.9101384   0.5953167 -0.23892375  -0.5393359 -0.3000125
## 4 -1.2576661   0.9359710   0.6346615 -0.15535673  -0.4851442 -0.3448294
## 5 -1.1080747   0.9706604   0.6874638 -0.49851492  -0.6638379 -0.6585480
## 6 -0.9769133   1.0011674   0.7337243 -0.46651053  -0.5871358 -0.5753165
##   Jitter.PPQ5 Jitter.DDP    Shimmer Shimmer.dB. Shimmer.APQ3 Shimmer.APQ5
## 1  -0.0286346  0.3284775 -0.3245661  -0.3516122   -0.2096910   -0.4233205
## 2  -0.4761714 -0.5347790 -0.5339707  -0.5731071   -0.5451114   -0.5655438
## 3  -0.3207395 -0.2989574 -0.6690579  -0.5644210   -0.7415288   -0.7023662
## 4  -0.1706673 -0.3448413 -0.4236559   0.0696623   -0.4605008   -0.4497248
## 5  -0.5297687 -0.6596258 -0.6582200  -0.5861362   -0.7830786   -0.6513579
## 6  -0.4520527 -0.5753275 -0.4553956  -0.4211008   -0.5360460   -0.4065177
##   Shimmer.APQ11 Shimmer.DDA         NHR          HNR        RPDE       DFA
## 1    -0.5434195  -0.2096865 -0.29869541 -0.009203976 -1.21396224 -1.478374
## 2    -0.5299101  -0.5451066 -0.35193510  1.282540523 -1.05502898 -1.247774
## 3    -0.6454902  -0.7415238 -0.19935262  0.318684263 -0.78479294 -1.540008
## 4    -0.3928152  -0.4607479 -0.07174823  0.644475136 -0.53644116 -1.062024
## 5    -0.4648651  -0.7833254 -0.34334103  1.036216523 -0.68913591 -1.297843
## 6    -0.2427112  -0.5357894 -0.37997892  0.295147154 -0.01963576 -1.139737
##          PPE
## 1 -0.6506028
## 2 -1.2184810
## 3 -0.1032714
## 4  1.2369692
## 5 -0.2839301
## 6 -0.2687386
```

```
#TOTAL UPDRS
ggplot(full_data, aes(subject., total_UPDRS)) +
  geom_jitter(size = 0.01)+
  ggtitle('Total UPDRS Score per Subject')
```




```
#MOTOR UPDRS
ggplot(full_data, aes(subject., motor_UPDRS)) +
  geom_jitter(size = 0.01)+
  ggtitle('Motor UPDRS Score per Subject')
```

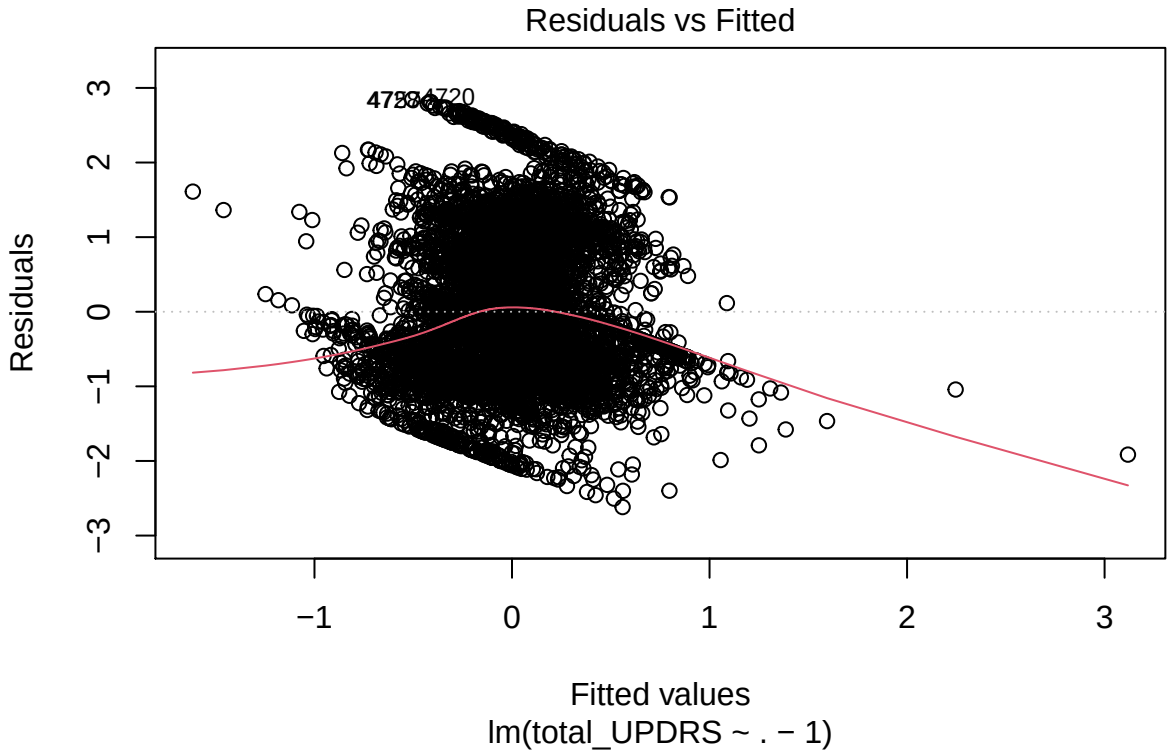


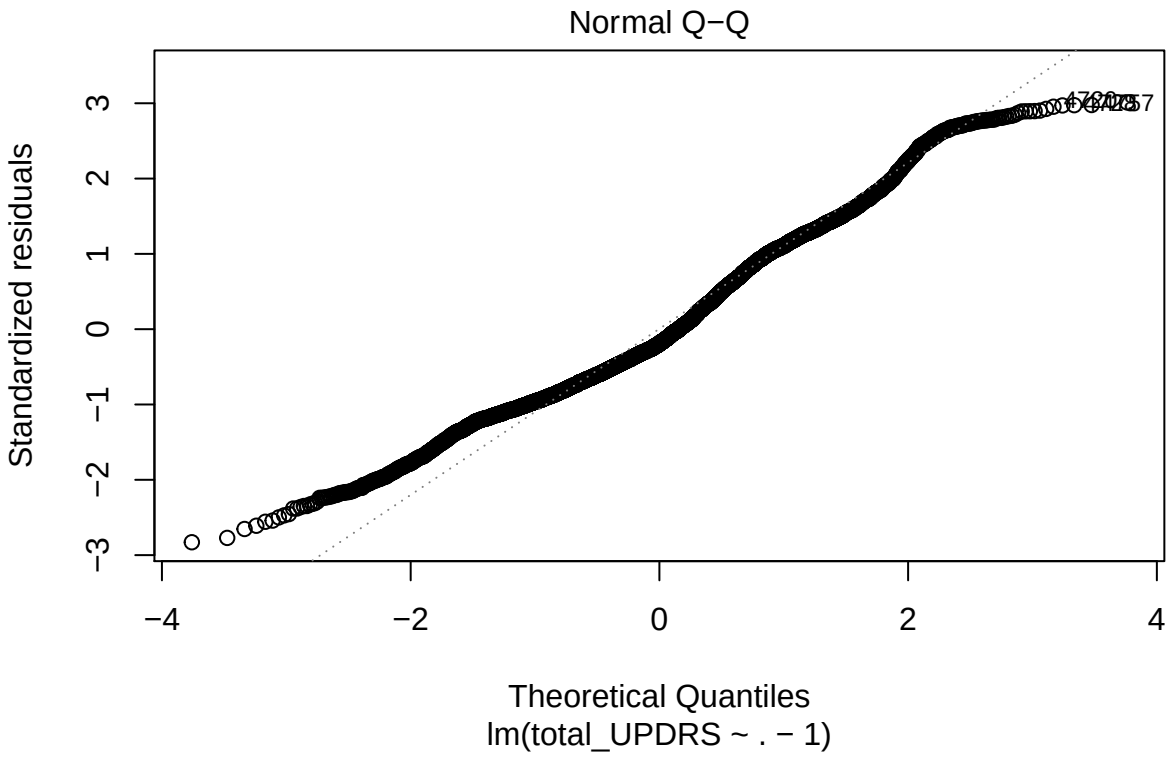

```
set.seed(7)

tot_df = data[-2] #Removing motor_UPDRS

#FULL MODEL
full_model = lm(total_UPDRS ~.-1, data = tot_df)
summary(full_model)
```

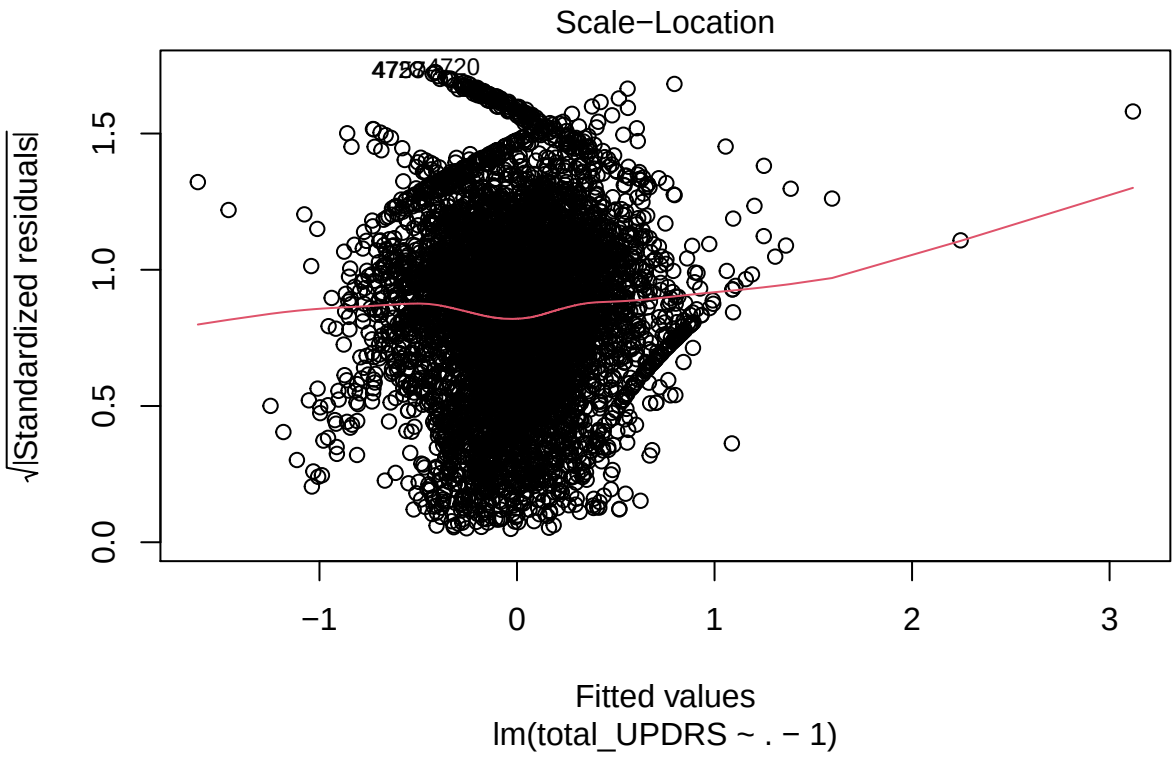
```
##
## Call:
## lm(formula = total_UPDRS ~ . - 1, data = tot_df)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -2.6178 -0.6973 -0.1820  0.7077  2.8463
##
## Coefficients:
##                Estimate Std. Error t value Pr(>|t|)
## test_time       0.08829    0.01240   7.121 1.20e-12 ***
## Jitter...       0.06863    0.11639   0.590 0.555426
## Jitter.Abs.    -0.10601    0.03220  -3.293 0.000999 ***
## Jitter.RAP    -13.80989   14.19452  -0.973 0.330642
## Jitter.PPQ5    -0.02475    0.06819  -0.363 0.716636
## Jitter.DDP     13.88979   14.19602   0.978 0.327903
## Shimmer         0.28441    0.16238   1.751 0.079917 .
```

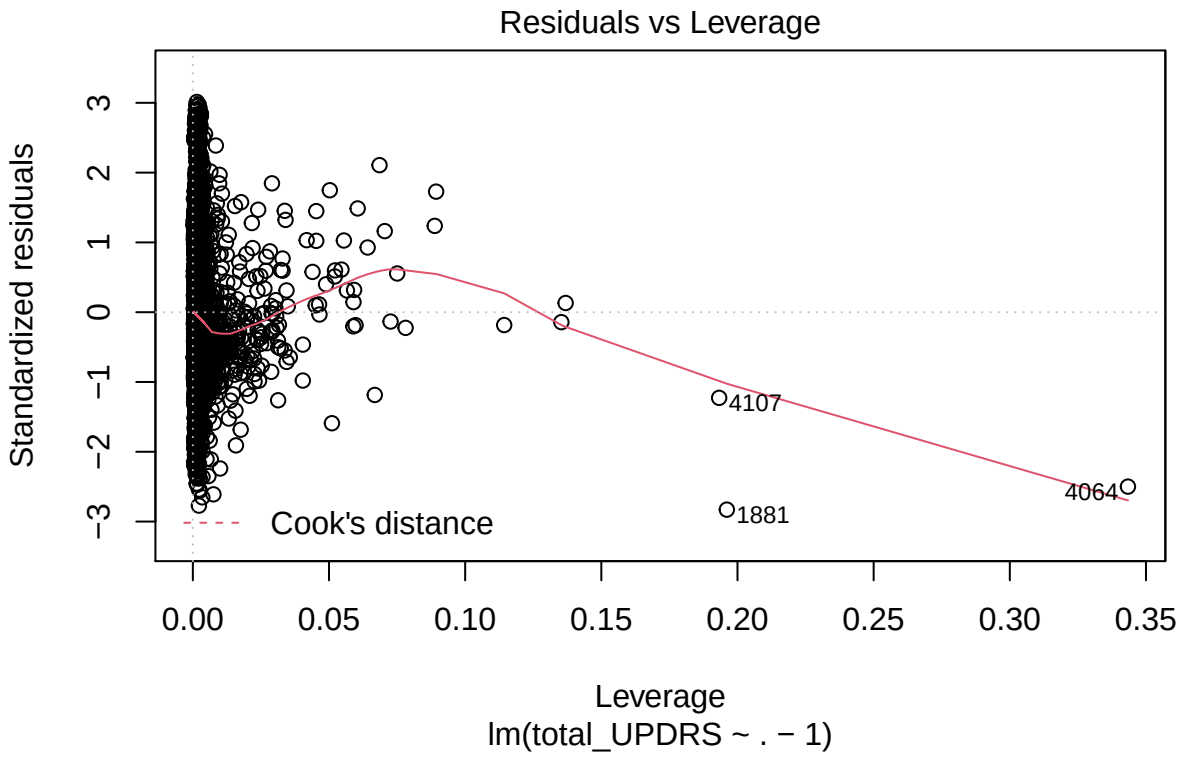
```
## Shimmer.dB.    -0.10831    0.10810  -1.002 0.316407
## Shimmer.APQ3  -25.52941   60.42833  -0.422 0.672694
## Shimmer.APQ5   -0.20346    0.08931  -2.278 0.022755 *
## Shimmer.APQ11   0.20057    0.04799   4.179 2.97e-05 ***
## Shimmer.DDA    25.32614   60.42825   0.419 0.675150
## NHR            -0.23069    0.03502  -6.587 4.87e-11 ***
## HNR            -0.24593    0.02859  -8.602  < 2e-16 ***
## RPDE            0.05478    0.01778   3.082 0.002068 **
## DFA            -0.27176    0.01561 -17.414  < 2e-16 ***
## PPE             0.17956    0.02588   6.937 4.43e-12 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.9456 on 5858 degrees of freedom
## Multiple R-squared:  0.1083, Adjusted R-squared:  0.1057
## F-statistic: 41.85 on 17 and 5858 DF,  p-value: < 2.2e-16
```

```
plot(full_model)
```

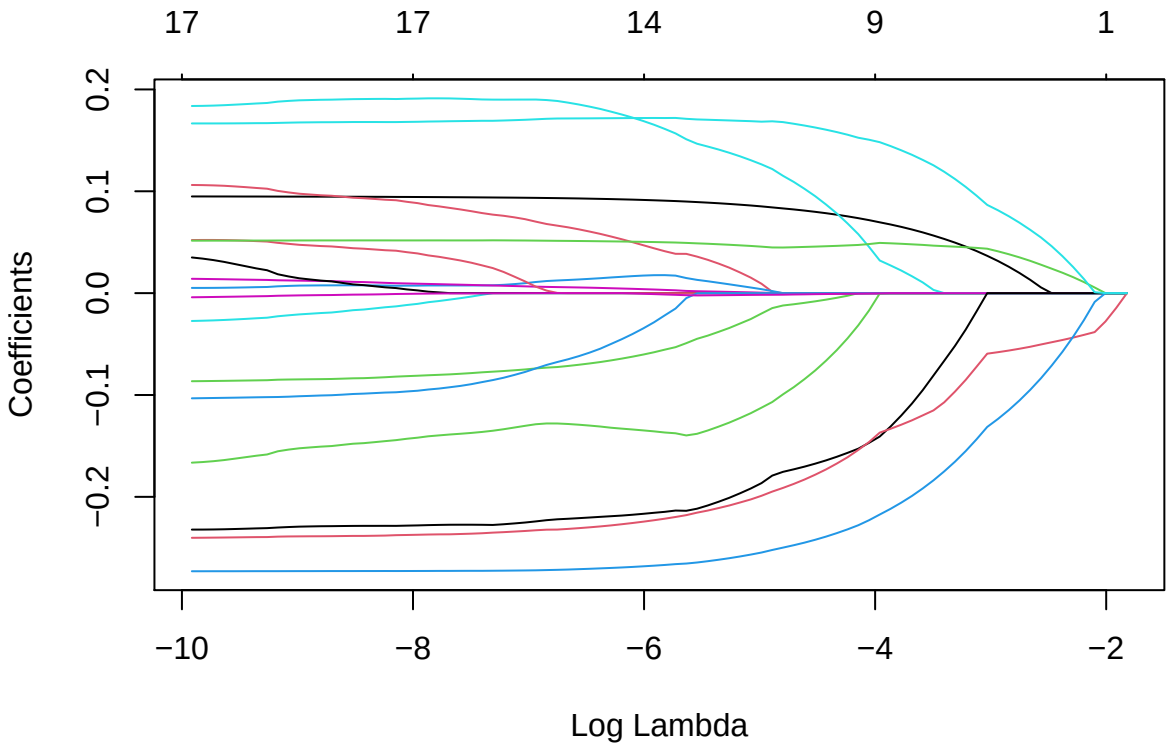



Normal Q−Q
Standardized residuals
−3
−2
−1
0
1
2
3
−4
−2
0
2
4
Theoretical Quantiles
lm(total_UPDRS ~ . − 1)

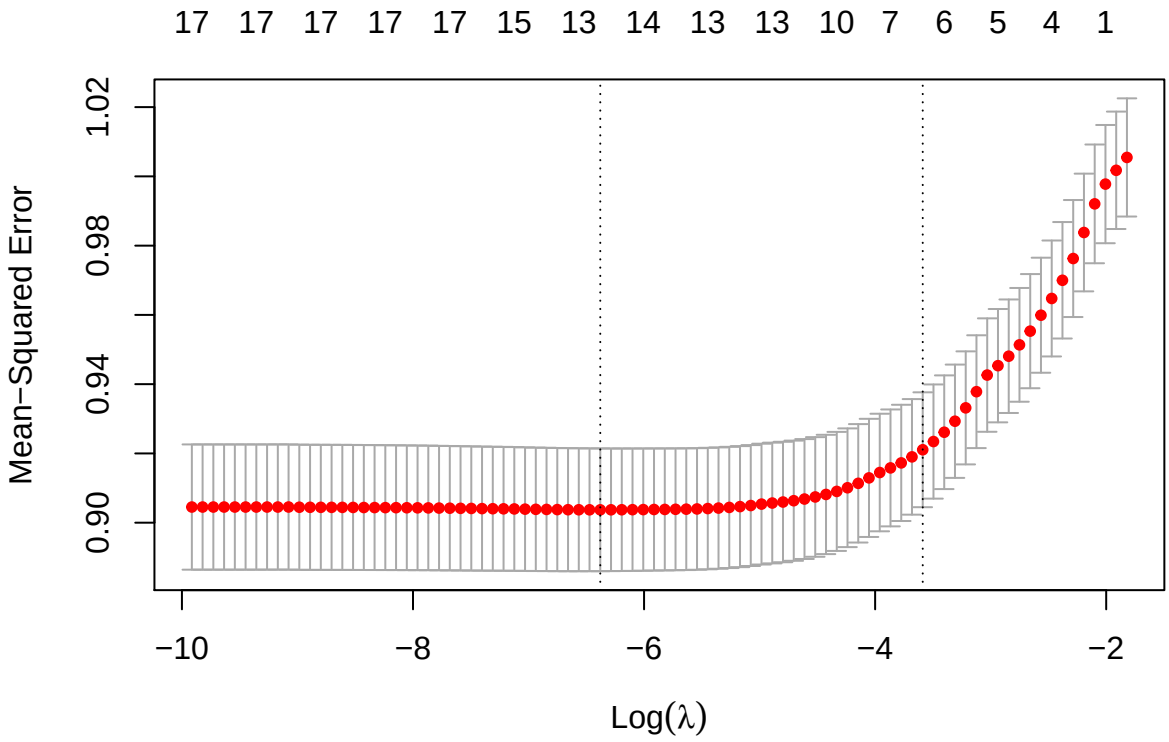

Scale−Location
√|Standardized residuals|
0.0
0.5
1.0
1.5
−1
0
1
2
3
Fitted values
lm(total_UPDRS ~ . − 1)



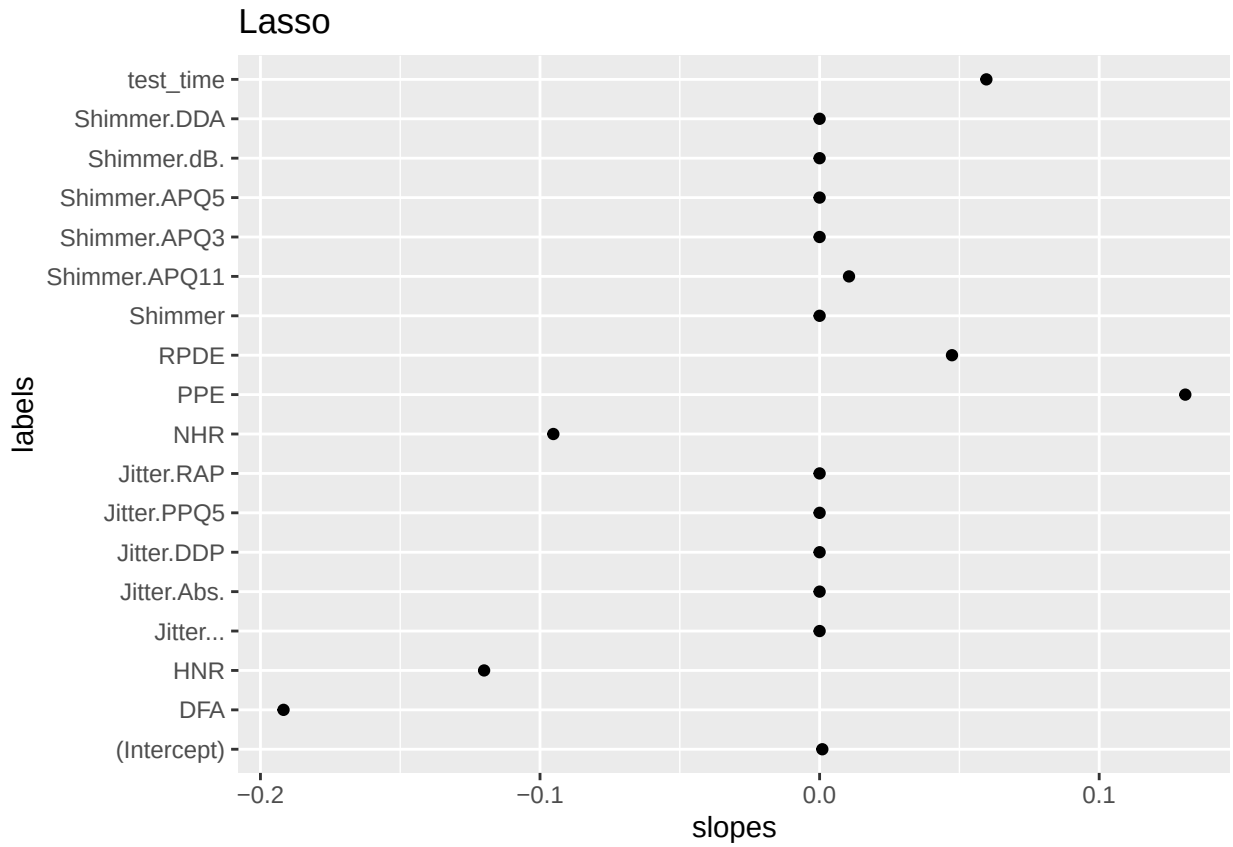

```
#CROSS VALIDATION
tot_split = initial_split(tot_df , prop = 0.7, strata = 'total_UPDRS')
tot_train = training(tot_split); tot_test = testing(tot_split)
tot_train_y = tot_train$total_UPDRS
tot_train_x = model.matrix(lm(total_UPDRS ~ .-1, data = tot_train))


# #RIDGE
# tot_ridge = glmnet(x = tot_train_x, y = tot_train_y, alpha = 0)
# plot(tot_ridge, xvar = 'lambda')
#
# tot_ridge_cv = cv.glmnet(x = tot_train_x, y = tot_train_y, alpha = 0)
# plot(tot_ridge_cv)
#
# ridge_coef = coef(tot_ridge, tot_ridge_cv$lambda.1se)
# ridge_coef_df = as.data.frame(as.matrix(ridge_coef))
# colnames(ridge_coef_df) = c('slopes')
# ridge_coef_df$labels = rownames(ridge_coef_df)
# ggplot(data = ridge_coef_df, mapping = aes(x = slopes, y = labels)) + geom_point()+ggtitle('Ridge')
# ridge_coef_df

#LASSO
tot_lasso = glmnet(x = tot_train_x, y = tot_train_y, alpha = 1)
plot(tot_lasso, xvar = 'lambda')
```




```
tot_lasso_cv = cv.glmnet(x = tot_train_x, y = tot_train_y, alpha = 1)
plot(tot_lasso_cv)
```




```
lasso_coef = coef(tot_lasso, tot_lasso_cv$lambda.1se)
lasso_coef_df = as.data.frame(as.matrix(lasso_coef))
colnames(lasso_coef_df) = c('slopes')
lasso_coef_df$labels = rownames(lasso_coef_df)
ggplot(data = lasso_coef_df, mapping = aes(x = slopes, y = labels)) + geom_point() +ggtitle('Lasso')
```




```
lasso_coef_df
```

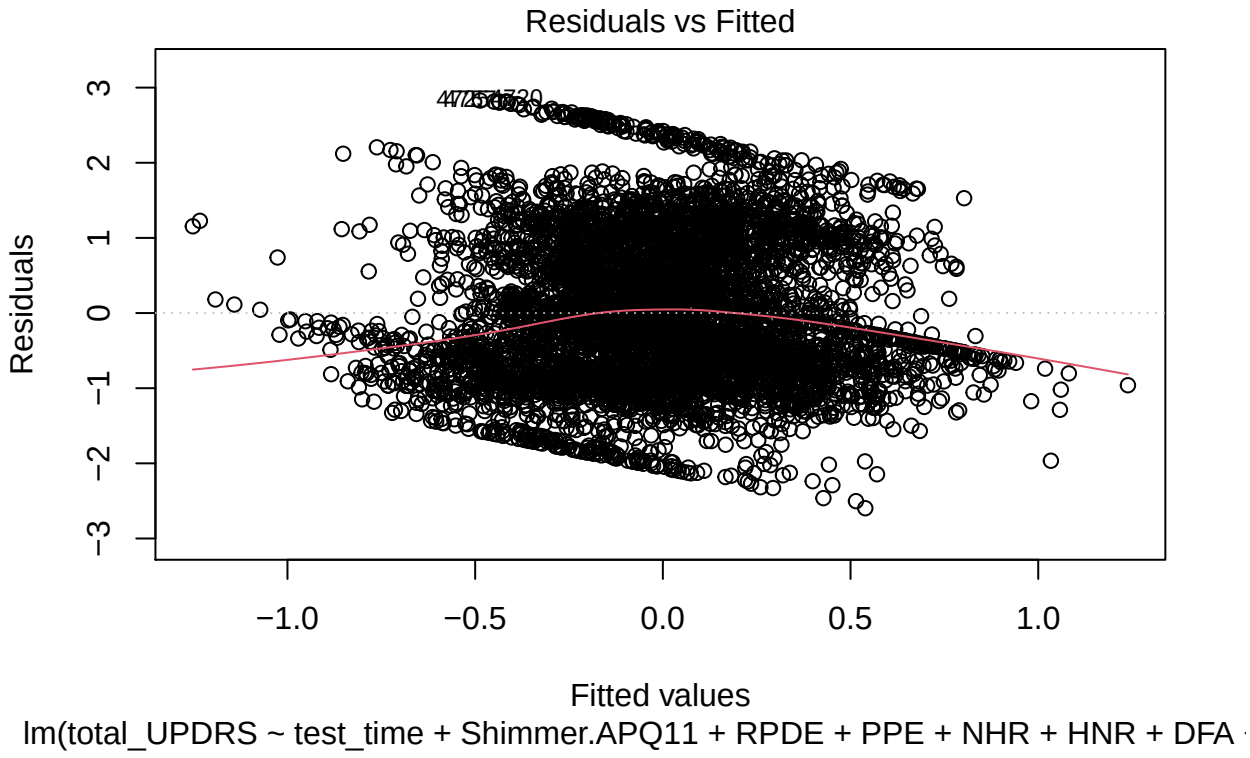
```
##                      slopes        labels
## (Intercept)    0.0009700013   (Intercept)
## test_time      0.0596532999     test_time
## Jitter...      0.0000000000     Jitter...
## Jitter.Abs.    0.0000000000   Jitter.Abs.
## Jitter.RAP     0.0000000000    Jitter.RAP
## Jitter.PPQ5    0.0000000000   Jitter.PPQ5
## Jitter.DDP     0.0000000000    Jitter.DDP
## Shimmer        0.0000000000       Shimmer
## Shimmer.dB.    0.0000000000   Shimmer.dB.
## Shimmer.APQ3   0.0000000000  Shimmer.APQ3
## Shimmer.APQ5   0.0000000000  Shimmer.APQ5
## Shimmer.APQ11  0.0105209293 Shimmer.APQ11
## Shimmer.DDA    0.0000000000   Shimmer.DDA
## NHR           -0.0952388334           NHR
## HNR           -0.1200046925           HNR
## RPDE           0.0473549429          RPDE
## DFA           -0.1917464936           DFA
## PPE            0.1308031817           PPE
```

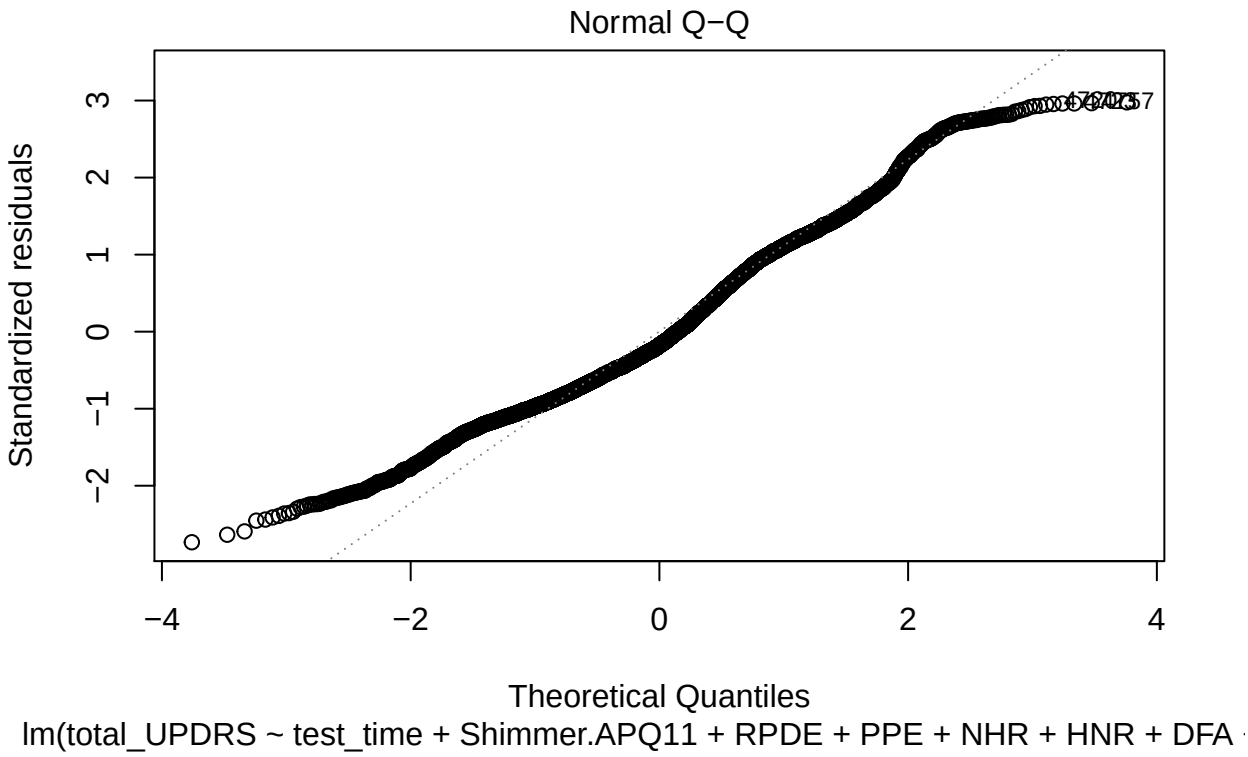
```
red_model = lm(total_UPDRS~ test_time+ Shimmer.APQ11 + RPDE + PPE + NHR + HNR + DFA -1, data = tot_df)
summary(red_model)
```

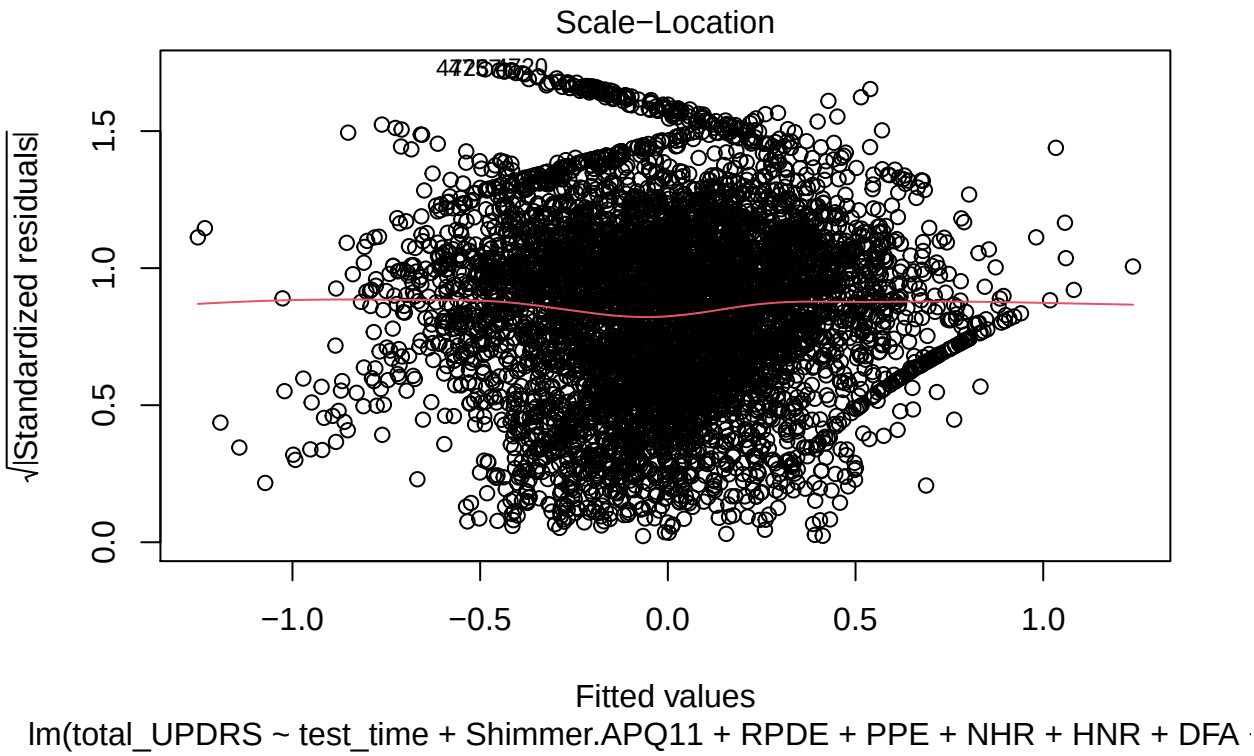
```
##
```

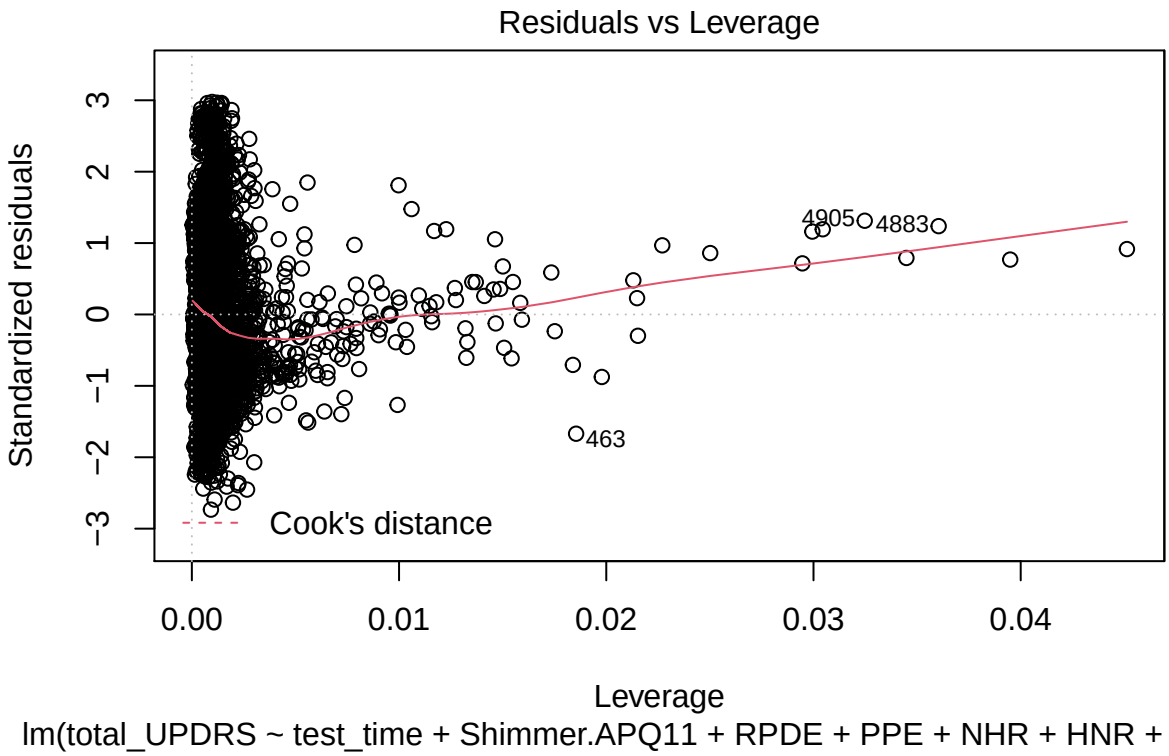
```
## Call:
## lm(formula = total_UPDRS ~ test_time + Shimmer.APQ11 + RPDE +
##     PPE + NHR + HNR + DFA - 1, data = tot_df)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -2.5971 -0.7127 -0.1682  0.7171  2.8278
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## test_time      0.08513    0.01243   6.848 8.24e-12 ***
## Shimmer.APQ11  0.05281    0.02152   2.454 0.014156 *
## RPDE           0.05668    0.01676   3.382 0.000725 ***
## PPE            0.19601    0.02053   9.547  < 2e-16 ***
## NHR           -0.23690    0.01981 -11.959  < 2e-16 ***
## HNR           -0.17864    0.02678  -6.670 2.79e-11 ***
## DFA           -0.26997    0.01451 -18.601  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.9505 on 5868 degrees of freedom
## Multiple R-squared:  0.09745,    Adjusted R-squared:  0.09638
## F-statistic: 90.51 on 7 and 5868 DF,  p-value: < 2.2e-16
```

```
plot(red_model)
```




Normal Q−Q
Standardized residuals
−2
−1
0
1
2
3
−4
−2
0
2
4
Theoretical Quantiles
lm(total_UPDRS ~ test_time + Shimmer.APQ11 + RPDE + PPE + NHR + HNR + DFA


Scale−Location
√|Standardized residuals|
0.0
0.5
1.0
1.5
−1.0
−0.5
0.0
0.5
1.0
Fitted values
lm(total_UPDRS ~ test_time + Shimmer.APQ11 + RPDE + PPE + NHR + HNR + DFA




```
anova1 = anova(red_model, full_model)
anova1
```

```
## Analysis of Variance Table
##
## Model 1: total_UPDRS ~ test_time + Shimmer.APQ11 + RPDE + PPE + NHR +
##     HNR + DFA - 1
## Model 2: total_UPDRS ~ (test_time + 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) - 1
##   Res.Df    RSS Df Sum of Sq      F    Pr(>F)
## 1   5868 5301.6
## 2   5858 5237.9 10    63.642 7.1176 3.113e-11 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
qf(0.95, anova1$Df[2], anova1$Res.Df[1])
```

```
## [1] 1.832312
```

```
dt(2.454,5686)
```

```
## [1] 0.01966379
```

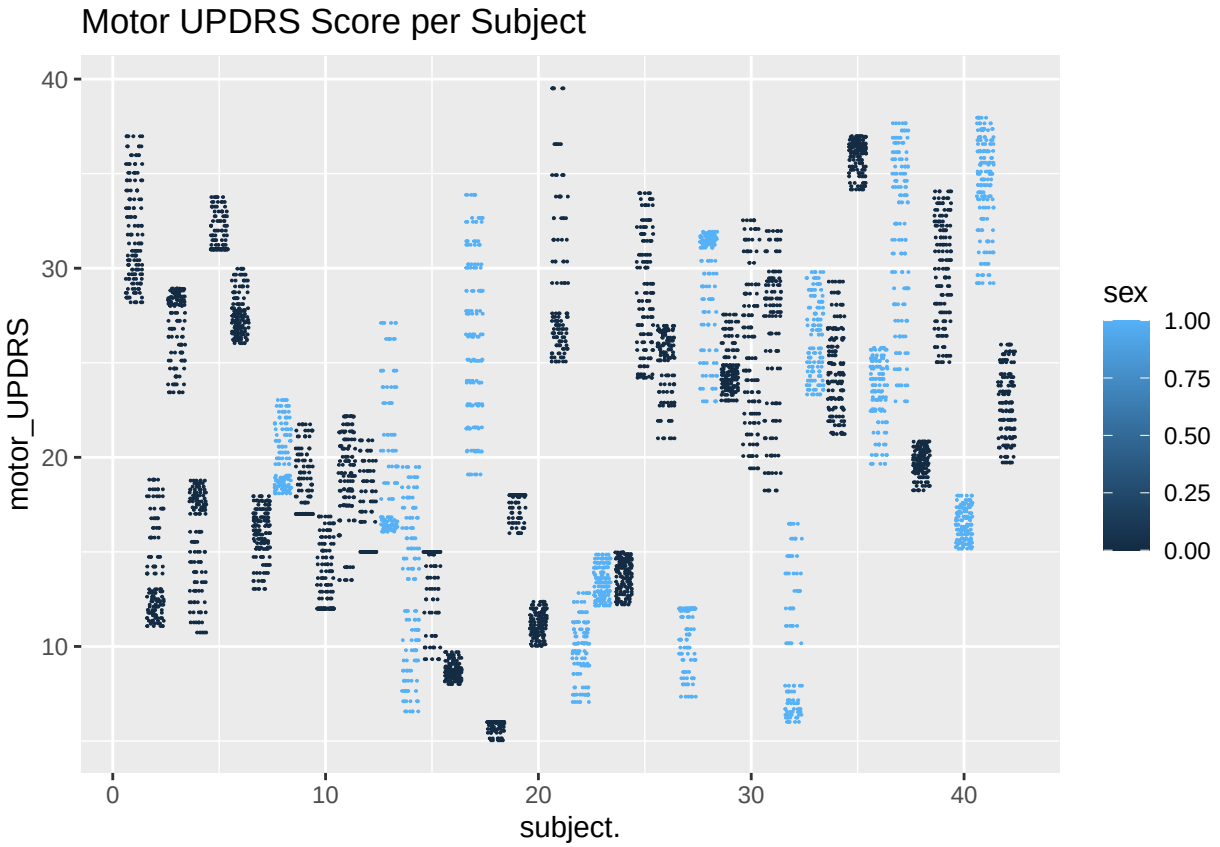
```r
grouped_subject = subject_data %>%
  group_by(subject.)

head(grouped_subject)
```

```
## # A tibble: 6 x 22
## # Groups:   subject. [1]
##   subject.   age   sex test_time motor_UPDRS total_UPDRS Jitter... Jitter.Abs.
##      <int> <int> <int>     <dbl>       <dbl>       <dbl>     <dbl>       <dbl>
## 1        1    72     0      5.64        28.2        34.4   0.00662   0.0000338
## 2        1    72     0     12.7         28.4        34.9   0.003     0.0000168
## 3        1    72     0     19.7         28.7        35.4   0.00481   0.0000246
## 4        1    72     0     25.6         28.9        35.8   0.00528   0.0000266
## 5        1    72     0     33.6         29.2        36.4   0.00335   0.0000201
## 6        1    72     0     40.7         29.4        36.9   0.00353   0.0000229
## # ... with 14 more variables: Jitter.RAP <dbl>, Jitter.PPQ5 <dbl>,
## #   Jitter.DDP <dbl>, Shimmer <dbl>, Shimmer.dB. <dbl>, Shimmer.APQ3 <dbl>,
## #   Shimmer.APQ5 <dbl>, Shimmer.APQ11 <dbl>, Shimmer.DDA <dbl>, NHR <dbl>,
## #   HNR <dbl>, RPDE <dbl>, DFA <dbl>, PPE <dbl>
```

```r
gs_lmer = lmer(formula = total_UPDRS ~ sex + (1 | subject.), data = grouped_subject)
summary(gs_lmer)
```

```
## Linear mixed model fit by REML ['lmerMod']
## Formula: total_UPDRS ~ sex + (1 | subject.)
##    Data: grouped_subject
##
## REML criterion at convergence: 28948.8
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.2925 -0.5928  0.0396  0.5703  3.7142
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  subject. (Intercept) 110.064  10.491
##  Residual               7.666   2.769
## Number of obs: 5875, groups:  subject., 42
##
## Fixed effects:
##             Estimate Std. Error t value
## (Intercept)   29.431      1.983   14.84
## sex           -2.679      3.435   -0.78
##
## Correlation of Fixed Effects:
##     (Intr)
## sex -0.577
```

```r
ggplot(grouped_subject, aes(subject., motor_UPDRS, color = sex)) +
  geom_jitter(size = 0.01)+
  ggtitle('Motor UPDRS Score per Subject')
```




```
gs_lm = lm(total_UPDRS ~ sex, data = grouped_subject)
gs_me = lmer(total_UPDRS ~ (1 | subject.), data = grouped_subject)
anova(gs_lmer, gs_me)
```

```
## refitting model(s) with ML (instead of REML)

## Data: grouped_subject
## Models:
## gs_me: total_UPDRS ~ (1 | subject.)
## gs_lmer: total_UPDRS ~ sex + (1 | subject.)
##         npar   AIC   BIC logLik deviance Chisq Df Pr(>Chisq)
## gs_me      3 28963 28983 -14478    28957
## gs_lmer    4 28964 28991 -14478    28956 0.634  1     0.4259
```

```
anova(gs_lmer, gs_lm)
```

```
## refitting model(s) with ML (instead of REML)

## Data: grouped_subject
## Models:
## gs_lm: total_UPDRS ~ sex
## gs_lmer: total_UPDRS ~ sex + (1 | subject.)
##         npar   AIC   BIC logLik deviance Chisq Df Pr(>Chisq)
## gs_lm      3 44473 44493 -22234    44467
```

```
## gs_lmer    4 28964 28991 -14478    28956 15511  1  < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```