Assignment-7.R

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<u>GitHub Link</u>:

.R File: https://github.com/kunwangRU/Survival-Analysis-of-Patients-with-Heart-Failure/blob/master/Multiple%20Regression%20Analysis%20(Assignment%207).R

```
#Loading Packages
library(dplyr)

##
## Attaching package: 'dplyr'

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

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

library(GGally)

## Warning: package 'GGally' was built under R version 3.6.3

## Loading required package: ggplot2

## Warning: package 'ggplot2' was built under R version 3.6.3

## Registered S3 method overwritten by 'GGally':
##   method from
##   +.gg   ggplot2

##
## Attaching package: 'GGally'

## The following object is masked from 'package:dplyr':
##
##     nasa

library(car)

## Warning: package 'car' was built under R version 3.6.3

## Loading required package: carData
```

```
##
## Attaching package: 'car'

## The following object is masked from 'package:dplyr':
##
##     recode
```

```r
library(MASS)
```

```
##
## Attaching package: 'MASS'

## The following object is masked from 'package:dplyr':
##
##     select
```

```r
library(gvlma)
library(leaps)
```

```
## Warning: package 'leaps' was built under R version 3.6.3
```

```r
library(relaimpo)
```

```
## Warning: package 'relaimpo' was built under R version 3.6.3

## Loading required package: boot

##
## Attaching package: 'boot'

## The following object is masked from 'package:car':
##
##     logit

## Loading required package: survey

## Loading required package: grid

## Loading required package: Matrix

## Loading required package: survival

##
## Attaching package: 'survival'

## The following object is masked from 'package:boot':
##
##     aml

##
## Attaching package: 'survey'
```

```
## The following object is masked from 'package:graphics':
##
##       dotchart

## Loading required package: mitools

## This is the global version of package relaimpo.

## If you are a non-US user, a version with the interesting additional metric
pmvd is available

## from Ulrike Groempings web site at prof.beuth-hochschule.de/groemping.
```

```r
#Loading dataset
rawdata <- read.csv("C:/Users/wangk/Desktop/Rutgers/Rutgers Courseware/Fall 20
20/Multivariate Analysis/heart_failure_clinical_records_dataset.csv")
View(rawdata)

#Identifying different columns names
names(rawdata)
```

```
##  [1] "age"                     "anaemia"
##  [3] "creatinine_phosphokinase" "diabetes"
##  [5] "ejection_fraction"        "high_blood_pressure"
##  [7] "platelets"                "serum_creatinine"
##  [9] "serum_sodium"             "sex"
## [11] "smoking"                  "time"
## [13] "DEATH_EVENT"
```

```r
#Data Summary
str(rawdata)
```

```
## 'data.frame':    299 obs. of  13 variables:
##  $ age                     : num  75 55 65 50 65 90 75 60 65 80 ...
##  $ anaemia                 : int  0 0 0 1 1 1 1 1 0 1 ...
##  $ creatinine_phosphokinase: int  582 7861 146 111 160 47 246 315 157 123
...
##  $ diabetes                : int  0 0 0 0 1 0 0 1 0 0 ...
##  $ ejection_fraction       : int  20 38 20 20 20 40 15 60 65 35 ...
##  $ high_blood_pressure     : int  1 0 0 0 0 1 0 0 0 1 ...
##  $ platelets               : num  265000 263358 162000 210000 327000 ...
##  $ serum_creatinine        : num  1.9 1.1 1.3 1.9 2.7 2.1 1.2 1.1 1.5 9.4
...
##  $ serum_sodium            : int  130 136 129 137 116 132 137 131 138 133
...
##  $ sex                     : Factor w/ 2 levels "Female","male": 2 2 2 2 1
2 2 2 1 2 ...
##  $ smoking                 : int  0 0 1 0 0 1 0 1 0 1 0 1 ...
##  $ time                    : int  4 6 7 7 8 8 10 10 10 10 ...
##  $ DEATH_EVENT             : Factor w/ 2 levels "Death","No Death": 2 2 2
2 2 2 2 2 ...
```

```
summary(rawdata)

##       age           anaemia        creatinine_phosphokinase
##  Min.   :40.00   Min.   :0.0000   Min.   :  23.0
##  1st Qu.:51.00   1st Qu.:0.0000   1st Qu.: 116.5
##  Median :60.00   Median :0.0000   Median : 250.0
##  Mean   :60.83   Mean   :0.4314   Mean   : 581.8
##  3rd Qu.:70.00   3rd Qu.:1.0000   3rd Qu.: 582.0
##  Max.   :95.00   Max.   :1.0000   Max.   :7861.0
##     diabetes       ejection_fraction high_blood_pressure   platelets
##  Min.   :0.0000   Min.   :14.00     Min.   :0.0000      Min.   : 25100
##  1st Qu.:0.0000   1st Qu.:30.00     1st Qu.:0.0000      1st Qu.:212500
##  Median :0.0000   Median :38.00     Median :0.0000      Median :262000
##  Mean   :0.4181   Mean   :38.08     Mean   :0.3512      Mean   :263358
##  3rd Qu.:1.0000   3rd Qu.:45.00     3rd Qu.:1.0000      3rd Qu.:303500
##  Max.   :1.0000   Max.   :80.00     Max.   :1.0000      Max.   :850000
##  serum_creatinine serum_sodium        sex          smoking
##  Min.   :0.500    Min.   :113.0   Female:105   Min.   :0.0000
##  1st Qu.:0.900    1st Qu.:134.0   male  :194   1st Qu.:0.0000
##  Median :1.100    Median :137.0                Median :0.0000
##  Mean   :1.394    Mean   :136.6                Mean   :0.3211
##  3rd Qu.:1.400    3rd Qu.:140.0                3rd Qu.:1.0000
##  Max.   :9.400    Max.   :148.0                Max.   :1.0000
##       time          DEATH_EVENT
##  Min.   :  4.0   Death   :203
##  1st Qu.: 73.0   No Death: 96
##  Median :115.0
##  Mean   :130.3
##  3rd Qu.:203.0
##  Max.   :285.0

head(rawdata)

##   age anaemia creatinine_phosphokinase diabetes ejection_fraction
## 1  75       0                      582        0                20
## 2  55       0                     7861        0                38
## 3  65       0                      146        0                20
## 4  50       1                      111        0                20
## 5  65       1                      160        1                20
## 6  90       1                       47        0                40
##   high_blood_pressure platelets serum_creatinine serum_sodium    sex
## 1                   1    265000              1.9          130   male
## 2                   0    263358              1.1          136   male
## 3                   0    162000              1.3          129   male
## 4                   0    210000              1.9          137   male
## 5                   0    327000              2.7          116 Female
## 6                   1    204000              2.1          132   male
##   smoking time DEATH_EVENT
## 1       0    4    No Death
## 2       0    6    No Death
```

```
## 3        1     7    No Death
## 4        0     7    No Death
## 5        0     8    No Death
## 6        1     8    No Death
```

```
dim(rawdata)
```

```
## [1] 299  13
```

```
#Data Cleaning
```

```
#Checking for missing values
is.null(rawdata)
```

```
## [1] FALSE
```

```
##The "FALSE" output shows there is no missing data in the dataset.
```

```
#Transforming data (Converting 0,1's to meaningful form)
```

```
data <- rawdata %>%
  mutate(DEATH_EVENT=ifelse(DEATH_EVENT=="Death",0,1),
         sex=ifelse(sex=="male",1,0)
  ) %>%
  mutate_if(is.character, as.factor) %>%
  dplyr::select(age, anaemia, creatinine_phosphokinase, diabetes, ejection_fr
action, high_blood_pressure, platelets,serum_creatinine, serum_sodium, sex, s
moking, time, DEATH_EVENT)
```

```
View(data)
summary(data)
```

```
##       age            anaemia       creatinine_phosphokinase
## Min.   :40.00   Min.   :0.0000   Min.   :  23.0
## 1st Qu.:51.00   1st Qu.:0.0000   1st Qu.: 116.5
## Median :60.00   Median :0.0000   Median : 250.0
## Mean   :60.83   Mean   :0.4314   Mean   : 581.8
## 3rd Qu.:70.00   3rd Qu.:1.0000   3rd Qu.: 582.0
## Max.   :95.00   Max.   :1.0000   Max.   :7861.0
##    diabetes       ejection_fraction high_blood_pressure   platelets
## Min.   :0.0000   Min.   :14.00     Min.   :0.0000      Min.   : 25100
## 1st Qu.:0.0000   1st Qu.:30.00     1st Qu.:0.0000      1st Qu.:212500
## Median :0.0000   Median :38.00     Median :0.0000      Median :262000
## Mean   :0.4181   Mean   :38.08     Mean   :0.3512      Mean   :263358
## 3rd Qu.:1.0000   3rd Qu.:45.00     3rd Qu.:1.0000      3rd Qu.:303500
## Max.   :1.0000   Max.   :80.00     Max.   :1.0000      Max.   :850000
##  serum_creatinine serum_sodium        sex              smoking
## Min.   :0.500    Min.   :113.0    Min.   :0.0000   Min.   :0.0000
## 1st Qu.:0.900    1st Qu.:134.0    1st Qu.:0.0000   1st Qu.:0.0000
## Median :1.100    Median :137.0    Median :1.0000   Median :0.0000
## Mean   :1.394    Mean   :136.6    Mean   :0.6488   Mean   :0.3211
```

```
##   3rd Qu.:1.400     3rd Qu.:140.0   3rd Qu.:1.0000   3rd Qu.:1.0000
##   Max.   :9.400     Max.   :148.0   Max.   :1.0000   Max.   :1.0000
##        time          DEATH_EVENT
##   Min.   :  4.0   Min.   :0.0000
##   1st Qu.: 73.0   1st Qu.:0.0000
##   Median :115.0   Median :0.0000
##   Mean   :130.3   Mean   :0.3211
##   3rd Qu.:203.0   3rd Qu.:1.0000
##   Max.   :285.0   Max.   :1.0000
```

```r
dataset<-data
attach(dataset)

#Performing Multiple Regression on our dataset
fit <- lm(DEATH_EVENT~age+anaemia+creatinine_phosphokinase+diabetes+ejection_
fraction+high_blood_pressure+platelets+serum_creatinine+serum_sodium+sex+smok
ing+time, data=dataset)
#show the results
summary(fit)
```

```
##
## Call:
## lm(formula = DEATH_EVENT ~ age + anaemia + creatinine_phosphokinase +
##     diabetes + ejection_fraction + high_blood_pressure + platelets +
##     serum_creatinine + serum_sodium + sex + smoking + time, data = dataset
)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.80866 -0.28041 -0.04205  0.24742  0.96983
##
## Coefficients:
##                            Estimate Std. Error t value Pr(>|t|)
## (Intercept)               1.664e+00  6.954e-01   2.392  0.01738 *
## age                       5.767e-03  1.867e-03   3.088  0.00221 **
## anaemia                  -2.766e-03  4.438e-02  -0.062  0.95035
## creatinine_phosphokinase  3.427e-05  2.247e-05   1.525  0.12840
## diabetes                  1.928e-02  4.410e-02   0.437  0.66236
## ejection_fraction        -9.834e-03  1.844e-03  -5.333 1.96e-07 ***
## high_blood_pressure      -1.430e-02  4.565e-02  -0.313  0.75438
## platelets                -8.370e-08  2.208e-07  -0.379  0.70492
## serum_creatinine          8.527e-02  2.123e-02   4.017 7.54e-05 ***
## serum_sodium             -7.599e-03  5.024e-03  -1.513  0.13149
## sex                      -6.369e-02  5.108e-02  -1.247  0.21353
## smoking                  -5.733e-03  5.119e-02  -0.112  0.91091
## time                     -2.733e-03  2.903e-04  -9.415  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.3646 on 286 degrees of freedom
```

```
## Multiple R-squared:  0.4168, Adjusted R-squared:  0.3924
## F-statistic: 17.04 on 12 and 286 DF,  p-value: < 2.2e-16

#Summary has three sections
#Section1: How well does the model fit the data
#Based on Adjusted R-squared value (0.3924), our model can explain 39.24% of
variation in Death_Event(Survived or not survived)

#Section2: Is the hypothesis supported?
#Based on the p-value of each independent variable we found age, ejection_fra
ction, serum_creatinine and time have significant impact for predicting Death
_Event at significance level of 0.05
#Age has significantly positive impact on Death_Event which means elder patie
nts have higher chance of survival holding other independent variables consta
nt, which is against our hypothesis
#Ejection_fraction has significantly negative impact on Death_Event which mea
ns patients with lower ejection fraction have higher chance of survival holdi
ng other independent variables constant, which supports our hypothesis
#Serum_creatinine has significantly positive impact on Death_Event which mean
s patients with higher level of Serum_creatinine have a higher chance of surv
ival holding other independent variables constant, which is against our hypot
hesis
#Time has significantly negative impact on Death_Event which means patients w
ho have closer follow-up period have higher chance of survival holding other
independent variables constant
#For other independent variables, no significant impact is found for Death_Ev
ent

#Section3: How well does data fit the model
#Based on F-statistic and its p-value, since p-value is smaller than 0.05, we
can say our model has significant predictive power

#Plotting
ggpairs(data=dataset, title="Heart Disease")
```

Heart Disease
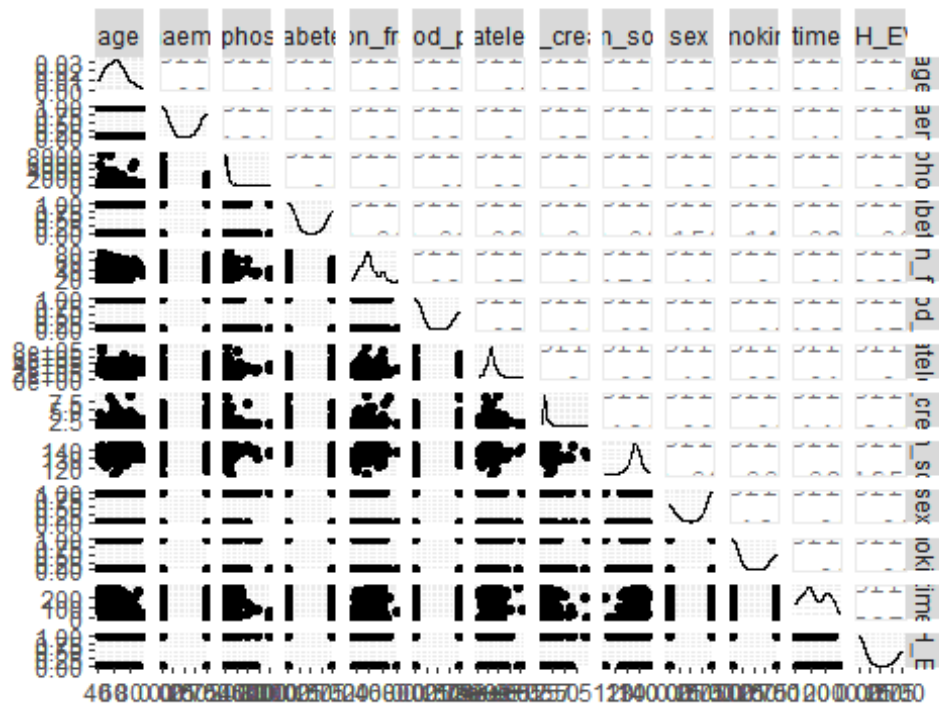

```
confint(fit,level=0.95)
```

```
##                                   2.5 %        97.5 %
## (Intercept)                2.948959e-01   3.032216e+00
## age                        2.091427e-03   9.441730e-03
## anaemia                   -9.012611e-02   8.459435e-02
## creatinine_phosphokinase  -9.964467e-06   7.849673e-05
## diabetes                  -6.751944e-02   1.060698e-01
## ejection_fraction         -1.346289e-02  -6.204407e-03
## high_blood_pressure       -1.041538e-01   7.556037e-02
## platelets                 -5.183239e-07   3.509178e-07
## serum_creatinine           4.348865e-02   1.270487e-01
## serum_sodium              -1.748777e-02   2.289480e-03
## sex                       -1.642331e-01   3.686234e-02
## smoking                   -1.064866e-01   9.502127e-02
## time                      -3.304154e-03  -2.161529e-03
```

```
# Predicted Values and residuals
fitted(fit)
```

```
##            1           2           3           4           5
##   0.982345979 0.834590601 0.875165092 0.776784161 1.163193304
##            6           7           8           9          10
##   0.841370721 0.913803559 0.410394682 0.434424722 1.429472461
##           11          12          13          14          15
##   0.926121014 0.663799435 0.606474040 0.502764204 0.604838745
##           16          17          18          19          20
```

```
##   0.629173000   0.682895433   0.792607354   0.769153879   0.630192236
##           21            22            23            24            25
##   0.780200331   0.773402126   0.566577875   0.288319276   0.878818105
##           26            27            28            29            30
##   0.698538512   0.759402673   0.546983047   0.952355824   0.805102397
##           31            32            33            34            35
##   0.835097173   0.794369743   0.627809164   0.627942594   0.417614891
##           36            37            38            39            40
##   0.871890118   0.611826468   0.550781656   0.808662158   0.730403477
##           41            42            43            44            45
##   0.837765771   0.628951296   0.520200951   0.491264131   0.364484181
##           46            47            48            49            50
##   0.562534674   0.643436728   0.446790685   1.107141235   0.572442107
##           51            52            53            54            55
##   0.654045296   0.669162036   0.885766132   0.497469251   0.695739523
##           56            57            58            59            60
##   0.854853814   0.668728846   0.401646128   0.576070700   0.724977161
##           61            62            63            64            65
##   0.714794341   0.573718264   0.423140250   0.319595316   0.021624082
##           66            67            68            69            70
##   0.843114846   0.665225354   0.585312682   0.649344672   0.657460408
##           71            72            73            74            75
##   0.229489442   0.439856881   0.806749766   0.364763841   0.677576180
##           76            77            78            79            80
##   0.529138249   0.235890962   0.287865358   0.491876123   0.318931556
##           81            82            83            84            85
##   0.558219619   0.338553347   0.766072787   0.463808473   0.545099101
##           86            87            88            89            90
##   0.150886122   0.382505900   0.152216225   0.235952998   0.438076133
##           91            92            93            94            95
##   0.372082705   0.384458142   0.149073345   0.579936570   0.360664236
##           96            97            98            99           100
##   0.100440253   0.581626482   0.283129189   0.573597849   0.428496351
##          101           102           103           104           105
##   0.496157505   0.395228869   0.589683553   0.484531208   0.353131352
##          106           107           108           109           110
##   0.575989106   0.307411584   0.364634222   0.433000167   0.258870084
##          111           112           113           114           115
##   0.326364752   0.380575682   0.510174815   0.273762431   0.449255407
##          116           117           118           119           120
##   0.382183619   0.171667430   0.489278466   0.193431807   0.661838202
##          121           122           123           124           125
##   0.183125936   0.453619127   0.379803580   0.422036882   0.589154377
##          126           127           128           129           130
##   0.229379076   0.713184116   0.149166604   0.364731016   0.469171071
##          131           132           133           134           135
##   0.055120875   0.768247285   0.290889329   0.051596736   0.620405915
##          136           137           138           139           140
##   0.404037020   0.195743460   0.636025647   0.443949643   0.338661854
##          141           142           143           144           145
```

```
##   0.470688815  0.277699395  0.440903385  0.293268672  0.535779129
##           146          147          148          149          150
##   0.253661872  0.305392393  0.149199576  0.564643334  0.374763454
##           151          152          153          154          155
##   0.483262620  0.053680466  0.150176108  0.333101661  0.375742253
##           156          157          158          159          160
##   0.461345806  0.353227423  0.347105819  0.368983263  0.155749500
##           161          162          163          164          165
##   0.305630225  0.177840477  0.243283767  0.351240957  0.324331129
##           166          167          168          169          170
##   0.496396718 -0.019149971  0.576528928  0.315644564  0.373091269
##           171          172          173          174          175
##   0.256621200  0.223216564 -0.025230846  0.289820175  0.249694372
##           176          177          178          179          180
##  -0.040013163  0.296176972  0.062646047 -0.029794303  0.117292801
##           181          182          183          184          185
##   0.184614055  0.334425228  0.381734292  0.381197201  0.263286356
##           186          187          188          189          190
##   0.269317891  0.030165627  0.432140051  0.192349525 -0.039902324
##           191          192          193          194          195
##   0.412205374  0.042596251  0.087298094  0.260747841  0.276426893
##           196          197          198          199          200
##   0.153970464  0.106209140  0.238641693  0.312688795  0.421154097
##           201          202          203          204          205
##   0.082619417 -0.203199663 -0.096124339  0.418186449  0.134390205
##           206          207          208          209          210
##   0.042045365 -0.031654779  0.240263319  0.189934820  0.187077883
##           211          212          213          214          215
##   0.348319411 -0.254248656  0.065651459  0.252722608  0.113568005
##           216          217          218          219          220
##   0.224967128  0.042084718  0.462223622  0.213771907  0.087845418
##           221          222          223          224          225
##   0.418710323 -0.089560837 -0.050000988  0.134748266  0.161876676
##           226          227          228          229          230
##   0.135504256  0.213655158  0.098152391  0.647379732  0.335542521
##           231          232          233          234          235
##   0.329206748  0.148401328 -0.068838898  0.027055455 -0.069551381
##           236          237          238          239          240
##  -0.013547732 -0.092337855  0.227329121  0.142594920 -0.066951840
##           241          242          243          244          245
##   0.161384581  0.190335108 -0.056687689  0.119465257  0.107810427
##           246          247          248          249          250
##   0.069797443  0.174308511  0.301331485 -0.101827332  0.113146471
##           251          252          253          254          255
##   0.096706771  0.050056203 -0.096129560  0.222952872 -0.266917056
##           256          257          258          259          260
##  -0.004312678  0.138717239 -0.050587985  0.026570140 -0.213260537
##           261          262          263          264          265
##  -0.091209278  0.035977880  0.234502267 -0.156152023 -0.011973678
##           266          267          268          269          270
```

```
## -0.127586535  0.212809281 -0.026613984 -0.090638893 -0.077639926
##          271          272          273          274          275
##  0.037462947 -0.023331908  0.087630358 -0.238644474  0.032522926
##          276          277          278          279          280
## -0.122717475  0.062014916  0.024605632  0.043904507 -0.003471040
##          281          282          283          284          285
##  0.070808910  0.133657649  0.193641479 -0.007012765 -0.215890150
##          286          287          288          289          290
## -0.088875925 -0.015130338 -0.225060398  0.037111917  0.067864297
##          291          292          293          294          295
## -0.301636861 -0.040458049 -0.169552332 -0.076298724 -0.158667692
##          296          297          298          299
## -0.047755325 -0.379408376 -0.158778882 -0.262307731
```

residuals(fit)

```
##            1            2            3            4            5
##  0.017654021  0.165409399  0.124834908  0.223215839 -0.163193304
##            6            7            8            9           10
##  0.158629279  0.086196441  0.589605318  0.565575278 -0.429472461
##           11           12           13           14           15
##  0.073878986  0.336200565  0.393525960  0.497235796 -0.604838745
##           16           17           18           19           20
##  0.370827000  0.317104567  0.207392646  0.230846121  0.369807764
##           21           22           23           24           25
## -0.780200331  0.226597874  0.433422125 -0.288319276  0.121181895
##           26           27           28           29           30
##  0.301461488  0.240597327  0.453016953  0.047644176  0.194897603
##           31           32           33           34           35
##  0.164902827  0.205630257  0.372190836 -0.627942594  0.582385109
##           36           37           38           39           40
##  0.128109882  0.388173532  0.449218344 -0.808662158  0.269596523
##           41           42           43           44           45
##  0.162234229  0.371048704  0.479799049 -0.491264131  0.635515819
##           46           47           48           49           50
##  0.437465326  0.356563272  0.553209315 -0.107141235  0.427557893
##           51           52           53           54           55
##  0.345954704  0.330837964  0.114233868  0.502530749  0.304260477
##           56           57           58           59           60
##  0.145146186 -0.668728846 -0.401646128  0.423929300  0.275022839
##           61           62           63           64           65
##  0.285205659  0.426281736 -0.423140250  0.680404684 -0.021624082
##           66           67           68           69           70
##  0.156885154  0.334774646  0.414687318  0.350655328  0.342539592
##           71           72           73           74           75
## -0.229489442 -0.439856881  0.193250234 -0.364763841  0.322423820
##           76           77           78           79           80
##  0.470861751 -0.235890962 -0.287865358 -0.491876123 -0.318931556
##           81           82           83           84           85
## -0.558219619 -0.338553347  0.233927213 -0.463808473  0.454900899
```

```
##              86             87             88             89             90
## -0.150886122 -0.382505900 -0.152216225 -0.235952998 -0.438076133
##              91             92             93             94             95
## -0.372082705 -0.384458142 -0.149073345  0.420063430 -0.360664236
##              96             97             98             99            100
## -0.100440253 -0.581626482 -0.283129189 -0.573597849 -0.428496351
##             101            102            103            104            105
## -0.496157505 -0.395228869 -0.589683553 -0.484531208 -0.353131352
##             106            107            108            109            110
##  0.424010894 -0.307411584 -0.364634222 -0.433000167 -0.258870084
##             111            112            113            114            115
##  0.673635248 -0.380575682 -0.510174815  0.726237569 -0.449255407
##             116            117            118            119            120
## -0.382183619 -0.171667430 -0.489278466 -0.193431807  0.338161798
##             121            122            123            124            125
## -0.183125936 -0.453619127 -0.379803580 -0.422036882  0.410845623
##             126            127            128            129            130
## -0.229379076  0.286815884 -0.149166604 -0.364731016 -0.469171071
##             131            132            133            134            135
## -0.055120875 -0.768247285 -0.290889329 -0.051596736 -0.620405915
##             136            137            138            139            140
## -0.404037020 -0.195743460 -0.636025647 -0.443949643 -0.338661854
##             141            142            143            144            145
##  0.529311185 -0.277699395 -0.440903385 -0.293268672  0.464220871
##             146            147            148            149            150
## -0.253661872 -0.305392393 -0.149199576  0.435356666 -0.374763454
##             151            152            153            154            155
##  0.516737380 -0.053680466 -0.150176108 -0.333101661 -0.375742253
##             156            157            158            159            160
## -0.461345806 -0.353227423 -0.347105819 -0.368983263 -0.155749500
##             161            162            163            164            165
## -0.305630225 -0.177840477 -0.243283767  0.648759043  0.675668871
##             166            167            168            169            170
##  0.503603282  0.019149971  0.423471072 -0.315644564 -0.373091269
##             171            172            173            174            175
## -0.256621200 -0.223216564  0.025230846 -0.289820175 -0.249694372
##             176            177            178            179            180
##  0.040013163 -0.296176972 -0.062646047  0.029794303 -0.117292801
##             181            182            183            184            185
## -0.184614055  0.665574772  0.618265708  0.618802799  0.736713644
##             186            187            188            189            190
##  0.730682109  0.969834373  0.567859949 -0.192349525  0.039902324
##             191            192            193            194            195
## -0.412205374 -0.042596251 -0.087298094 -0.260747841  0.723573107
##             196            197            198            199            200
##  0.846029536 -0.106209140 -0.238641693 -0.312688795 -0.421154097
##             201            202            203            204            205
## -0.082619417  0.203199663  0.096124339 -0.418186449 -0.134390205
##             206            207            208            209            210
## -0.042045365  0.031654779 -0.240263319 -0.189934820 -0.187077883
```

```
##          211          212          213          214          215
## -0.348319411  0.254248656 -0.065651459  0.747277392 -0.113568005
##          216          217          218          219          220
## -0.224967128 -0.042084718  0.537776378 -0.213771907 -0.087845418
##          221          222          223          224          225
##  0.581289677  0.089560837  0.050000988 -0.134748266 -0.161876676
##          226          227          228          229          230
## -0.135504256 -0.213655158 -0.098152391 -0.647379732 -0.335542521
##          231          232          233          234          235
##  0.670793252 -0.148401328  0.068838898 -0.027055455  0.069551381
##          236          237          238          239          240
##  0.013547732  0.092337855 -0.227329121 -0.142594920  0.066951840
##          241          242          243          244          245
## -0.161384581 -0.190335108  0.056687689 -0.119465257 -0.107810427
##          246          247          248          249          250
## -0.069797443  0.825691489 -0.301331485  0.101827332 -0.113146471
##          251          252          253          254          255
## -0.096706771 -0.050056203  0.096129560 -0.222952872  0.266917056
##          256          257          258          259          260
##  0.004312678 -0.138717239  0.050587985 -0.026570140  0.213260537
##          261          262          263          264          265
##  0.091209278 -0.035977880  0.765497733  0.156152023  0.011973678
##          266          267          268          269          270
##  0.127586535  0.787190719  0.026613984  0.090638893  0.077639926
##          271          272          273          274          275
## -0.037462947  0.023331908 -0.087630358  0.238644474 -0.032522926
##          276          277          278          279          280
##  0.122717475 -0.062014916 -0.024605632 -0.043904507  0.003471040
##          281          282          283          284          285
## -0.070808910 -0.133657649 -0.193641479  0.007012765  0.215890150
##          286          287          288          289          290
##  0.088875925  0.015130338  0.225060398 -0.037111917 -0.067864297
##          291          292          293          294          295
##  0.301636861  0.040458049  0.169552332  0.076298724  0.158667692
##          296          297          298          299
##  0.047755325  0.379408376  0.158778882  0.262307731

#Anova Table
anova(fit)

## Analysis of Variance Table
##
## Response: DEATH_EVENT
##                          Df Sum Sq Mean Sq F value    Pr(>F)
## age                       1  4.196  4.1960 31.5729 4.557e-08 ***
## anaemia                   1  0.127  0.1268  0.9543   0.32946
## creatinine_phosphokinase  1  0.569  0.5695  4.2851   0.03934 *
## diabetes                  1  0.043  0.0433  0.3256   0.56869
## ejection_fraction         1  5.203  5.2030 39.1504 1.429e-09 ***
## high_blood_pressure       1  0.275  0.2746  2.0664   0.15167
```

```
## platelets               1  0.025  0.0254  0.1908   0.66255
## serum_creatinine        1  4.107  4.1070 30.9035 6.218e-08 ***
## serum_sodium            1  0.631  0.6310  4.7479  0.03015 *
## sex                     1  0.201  0.2015  1.5160  0.21923
## smoking                 1  0.009  0.0091  0.0687  0.79346
## time                    1 11.781 11.7810 88.6465 < 2.2e-16 ***
## Residuals             286 38.009  0.1329
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

#Based on p-values, age,creatinine_phosphokinase, ejection_fraction, serum_creatinine, serum_sodium and time variables have significant mean difference between Survived and Not survived patients at significance level of 0.05

#Covariance
vcov(fit)

```
##                               (Intercept)           age        anaemia
## (Intercept)                  4.835167e-01 -2.387576e-04  1.031142e-03
## age                         -2.387576e-04  3.486349e-06 -3.481328e-06
## anaemia                      1.031142e-03 -3.481328e-06  1.969917e-03
## creatinine_phosphokinase     6.020118e-07  3.020610e-09  1.897233e-07
## diabetes                    -4.506457e-03  6.465941e-06  3.018936e-05
## ejection_fraction            1.040950e-04 -2.810547e-07 -2.990373e-07
## high_blood_pressure          5.946787e-04 -4.984347e-06  3.682716e-05
## platelets                   -5.777669e-09  1.346060e-11  4.069839e-10
## serum_creatinine            -3.056697e-03 -4.760214e-06 -2.892930e-05
## serum_sodium                -3.394660e-03  2.213797e-07 -1.625557e-05
## sex                         -2.164976e-03 -6.846002e-06  1.064317e-04
## smoking                      5.404737e-05  1.297890e-06  1.859829e-04
## time                        -5.109123e-06  1.000600e-07  1.777094e-06
##                          creatinine_phosphokinase      diabetes
## (Intercept)                          6.020118e-07 -4.506457e-03
## age                                  3.020610e-09  6.465941e-06
## anaemia                              1.897233e-07  3.018936e-05
## creatinine_phosphokinase             5.049706e-10  9.079477e-09
## diabetes                             9.079477e-09  1.944492e-03
## ejection_fraction                    1.524811e-09  7.861101e-07
## high_blood_pressure                  7.027453e-08  4.179662e-05
## platelets                           -1.391402e-13 -8.264813e-10
## serum_creatinine                    -3.590277e-09  4.818313e-05
## serum_sodium                        -8.999146e-09  2.339215e-05
## sex                                 -8.814132e-08  2.029489e-04
## smoking                              6.852607e-08  2.202832e-04
## time                                 4.481005e-10 -8.136546e-08
##                          ejection_fraction high_blood_pressure
## (Intercept)                   1.040950e-04        5.946787e-04
## age                          -2.810547e-07       -4.984347e-06
## anaemia                      -2.990373e-07        3.682716e-05
## creatinine_phosphokinase      1.524811e-09        7.027453e-08
```

```
## diabetes                       7.861101e-07         4.179662e-05
## ejection_fraction              3.399792e-06         8.439954e-08
## high_blood_pressure            8.439954e-08         2.084132e-03
## platelets                     -2.108483e-11        -4.364144e-10
## serum_creatinine              -6.409676e-07         3.291456e-05
## serum_sodium                  -1.579505e-06        -1.101839e-05
## sex                            1.143668e-05         1.918222e-04
## smoking                        8.653958e-07         5.879382e-05
## time                          -2.335071e-08         2.535664e-06
##                                platelets serum_creatinine  serum_sodium
## (Intercept)                 -5.777669e-09    -3.056697e-03 -3.394660e-03
## age                          1.346060e-11    -4.760214e-06  2.213797e-07
## anaemia                      4.069839e-10    -2.892930e-05 -1.625557e-05
## creatinine_phosphokinase    -1.391402e-13    -3.590277e-09 -8.999146e-09
## diabetes                    -8.264813e-10     4.818313e-05  2.339215e-05
## ejection_fraction           -2.108483e-11    -6.409676e-07 -1.579505e-06
## high_blood_pressure         -4.364144e-10     3.291456e-05 -1.101839e-05
## platelets                    4.875751e-14     7.213667e-11 -5.444894e-11
## serum_creatinine             7.213667e-11     4.505652e-04  1.910521e-05
## serum_sodium                -5.444894e-11     1.910521e-05  2.524017e-05
## sex                          1.502167e-09     4.894986e-07  1.938850e-06
## smoking                     -1.113137e-09     3.552634e-05 -2.533983e-06
## time                         3.574473e-13     6.490395e-07 -1.036241e-07
##                                     sex        smoking          time
## (Intercept)                 -2.164976e-03  5.404737e-05 -5.109123e-06
## age                         -6.846002e-06  1.297890e-06  1.000600e-07
## anaemia                      1.064317e-04  1.859829e-04  1.777094e-06
## creatinine_phosphokinase    -8.814132e-08  6.852607e-08  4.481005e-10
## diabetes                     2.029489e-04  2.202832e-04 -8.136546e-08
## ejection_fraction            1.143668e-05  8.653958e-07 -2.335071e-08
## high_blood_pressure          1.918222e-04  5.879382e-05  2.535664e-06
## platelets                    1.502167e-09 -1.113137e-09  3.574473e-13
## serum_creatinine             4.894986e-07  3.552634e-05  6.490395e-07
## serum_sodium                 1.938850e-06 -2.533983e-06 -1.036241e-07
## sex                          2.609544e-03 -1.120641e-03  3.471694e-08
## smoking                     -1.120641e-03  2.620259e-03  5.899581e-07
## time                         3.471694e-08  5.899581e-07  8.424954e-08
```

#Correlation
cov2cor(vcov(fit))

```
##                            (Intercept)          age       anaemia
## (Intercept)                1.000000000 -0.18389332  0.033410956
## age                       -0.183893320  1.00000000 -0.042008336
## anaemia                    0.033410956 -0.04200834  1.000000000
## creatinine_phosphokinase   0.038527090  0.07199066  0.190223297
## diabetes                  -0.146969208  0.07853137  0.015425059
## ejection_fraction          0.081189133 -0.08163555 -0.003654056
## high_blood_pressure        0.018733288 -0.05847365  0.018175300
## platelets                 -0.037629302  0.03264813  0.041527186
```

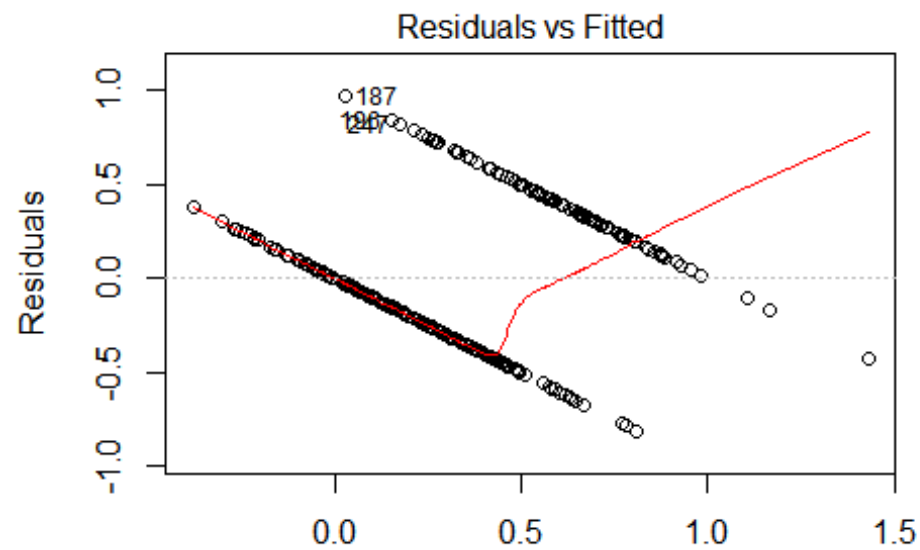```
serum_creatinine   -0.207094136 -0.12010532 -0.030706839
serum_sodium   -0.971727417 0.02359969 -0.072900788
sex   -0.060948785 -0.07177434 0.046942349
smoking   0.001518437 0.01357939 0.081860954
time   -0.025313772 0.18462528 0.137943944
creatinine_phosphokinase   diabetes
(Intercept)   0.038527090 -0.146969208
age   0.071990659 0.078531373
anaemia   0.190223297 0.015425059
creatinine_phosphokinase   1.000000000 0.009162726
diabetes   0.009162726 1.000000000
ejection_fraction   0.036800753 0.009668388
high_blood_pressure   0.068501851 0.020762298
platelets   -0.028041352 -0.084880742
serum_creatinine   -0.007526900 0.051476985
serum_sodium   -0.079711721 0.105589547
sex   -0.076782846 0.090095131
smoking   0.059573165 0.097590194
time   0.068700295 -0.006357015
ejection_fraction high_blood_pressure
(Intercept)   0.081189133   0.018733288
age   -0.081635546   -0.058473652
anaemia   -0.003654056   0.018175300
creatinine_phosphokinase   0.036800753   0.068501851
diabetes   0.009668388   0.020762298
ejection_fraction   1.000000000   0.001002654
high_blood_pressure   0.001002654   1.000000000
platelets   -0.051787285   -0.043292797
serum_creatinine   -0.016376878   0.033966171
serum_sodium   -0.170509524   -0.048040721
sex   0.121420391   0.082253393
smoking   0.009168883   0.025159205
time   -0.043630504   0.191357417
platelets serum_creatinine serum_sodium
(Intercept)   -0.037629302   -0.2070941364 -0.971727417
age   0.032648129   -0.1201053245 0.023599688
anaemia   0.041527186   -0.0307068386 -0.072900788
creatinine_phosphokinase   -0.028041352   -0.0075269004 -0.079711721
diabetes   -0.084880742   0.0514769849 0.105589547
ejection_fraction   -0.051787285   -0.0163768778 -0.170509524
high_blood_pressure   -0.043292797   0.0339661707 -0.048040721
platelets   1.000000000   0.0153906352 -0.049082040
serum_creatinine   0.015390635   1.0000000000 0.179154186
serum_sodium   -0.049082040   0.1791541856 1.000000000
sex   0.133172688   0.0004514299 0.007554673
smoking   -0.098481760   0.0326963688 -0.009853386
time   0.005577087   0.1053436951 -0.071060900
sex   smoking   time
(Intercept)   -0.0609487846 0.001518437 -0.025313772
age   -0.0717743414 0.013579394 0.184625277
```

```
## anaemia                     0.0469423486  0.081860954  0.137943944
## creatinine_phosphokinase -0.0767828455  0.059573165  0.068700295
## diabetes                    0.0900951311  0.097590194 -0.006357015
## ejection_fraction           0.1214203912  0.009168883 -0.043630504
## high_blood_pressure         0.0822533929  0.025159205  0.191357417
## platelets                   0.1331726879 -0.098481760  0.005577087
## serum_creatinine            0.0004514299  0.032696369  0.105343695
## serum_sodium                0.0075546735 -0.009853386 -0.071060900
## sex                         1.0000000000 -0.428560522  0.002341399
## smoking                    -0.4285605220  1.000000000  0.039706834
## time                        0.0023413988  0.039706834  1.000000000

#diagnostic plots
plot(fit)
```
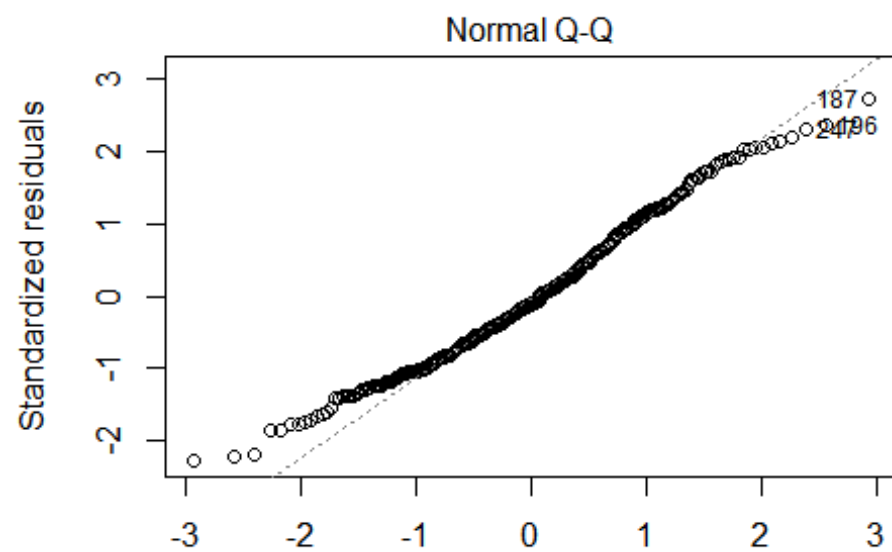
Residuals vs Fitted

Residuals

Fitted values

○ 187
○ 196
○ 247

EATH_EVENT ~ age + anaemia + creatinine_phosphokinase + diabet

Normal Q-Q

Standardized residuals

Theoretical Quantiles

187 ○
247 ○ 196

EATH_EVENT ~ age + anaemia + creatinine_phosphokinase + diabet

Scale-Location

√|Standardized residuals|

Fitted values
EATH_EVENT ~ age + anaemia + creatinine_phosphokinase + diabet

Residuals vs Leverage

Standardized residuals
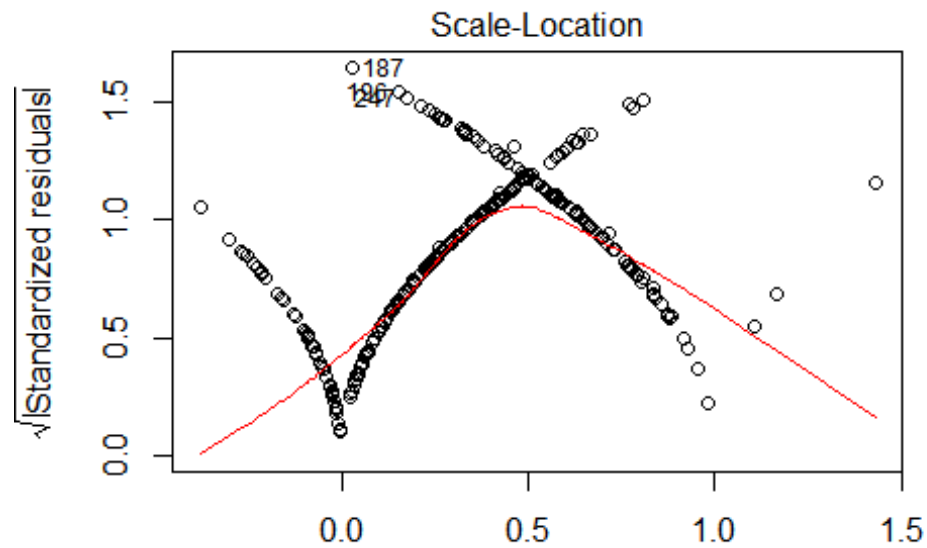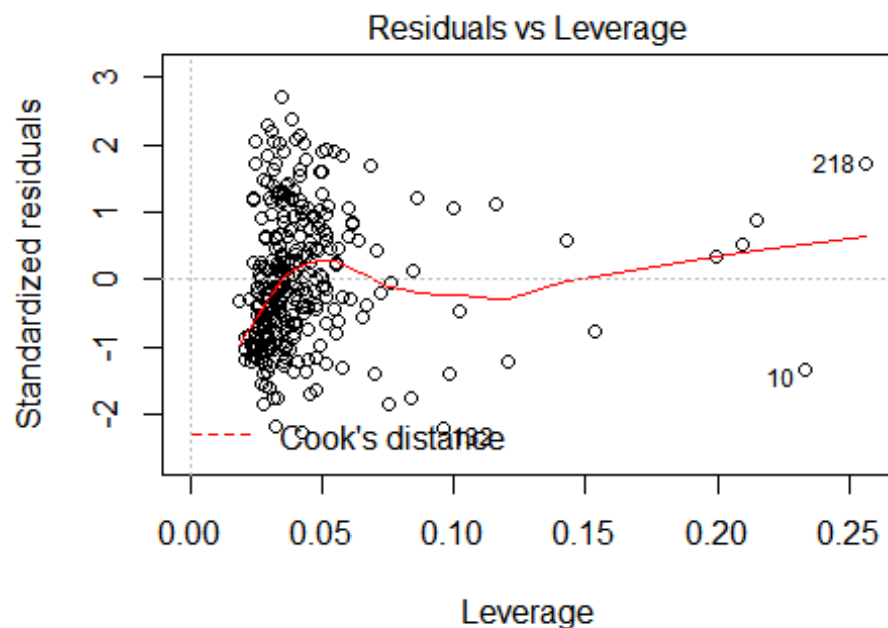
Leverage
EATH_EVENT ~ age + anaemia + creatinine_phosphokinase + diabet

```
# Checking the existence of Outliers
outlierTest(fit)
```

```
## No Studentized residuals with Bonferroni p < 0.05
## Largest |rstudent|:
##      rstudent unadjusted p-value Bonferroni p
## 187  2.73831          0.0065644           NA
```

#Since p-value is smaller than 0.05, we can say there are some outliers

#Plotting the data, to identify outliers
qqPlot(fit, main="QQ Plot")
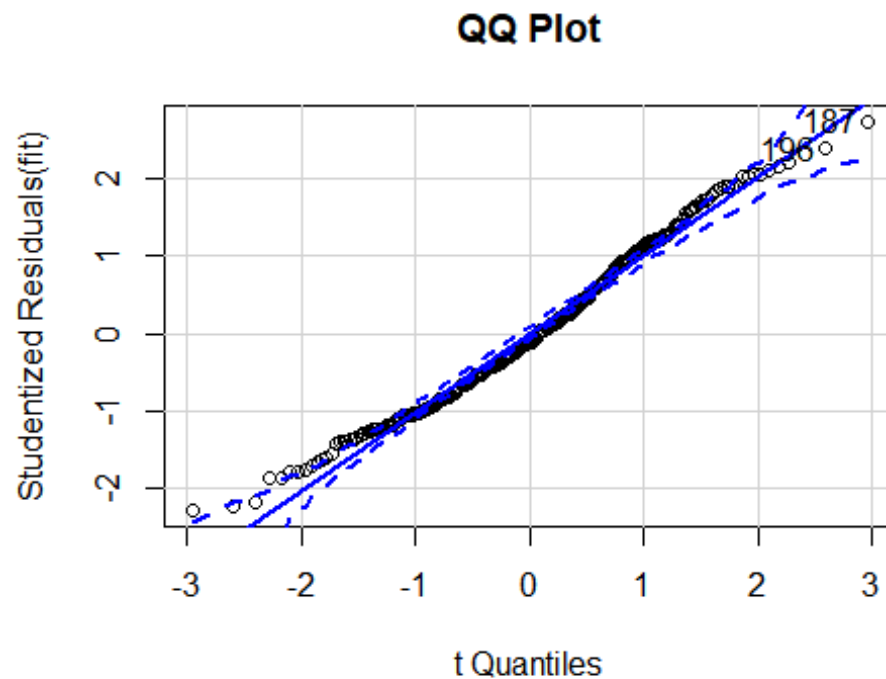
[1] 187 196

#Based on the plot, we can say record 187 and 196 are identified as outliers

#Leverage plots
leveragePlots(fit)

Leverage Plots
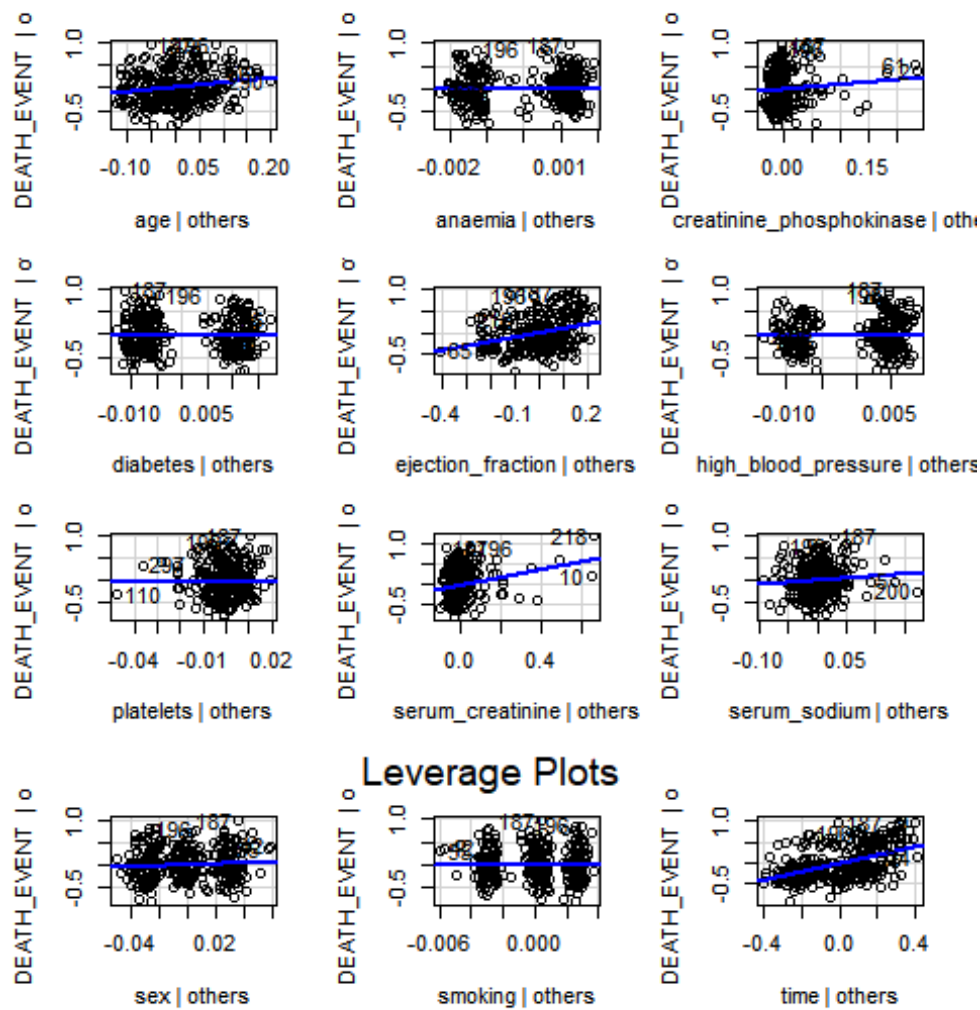
```
# added variable plots
avPlots(fit)
```

Added-Variable Plots
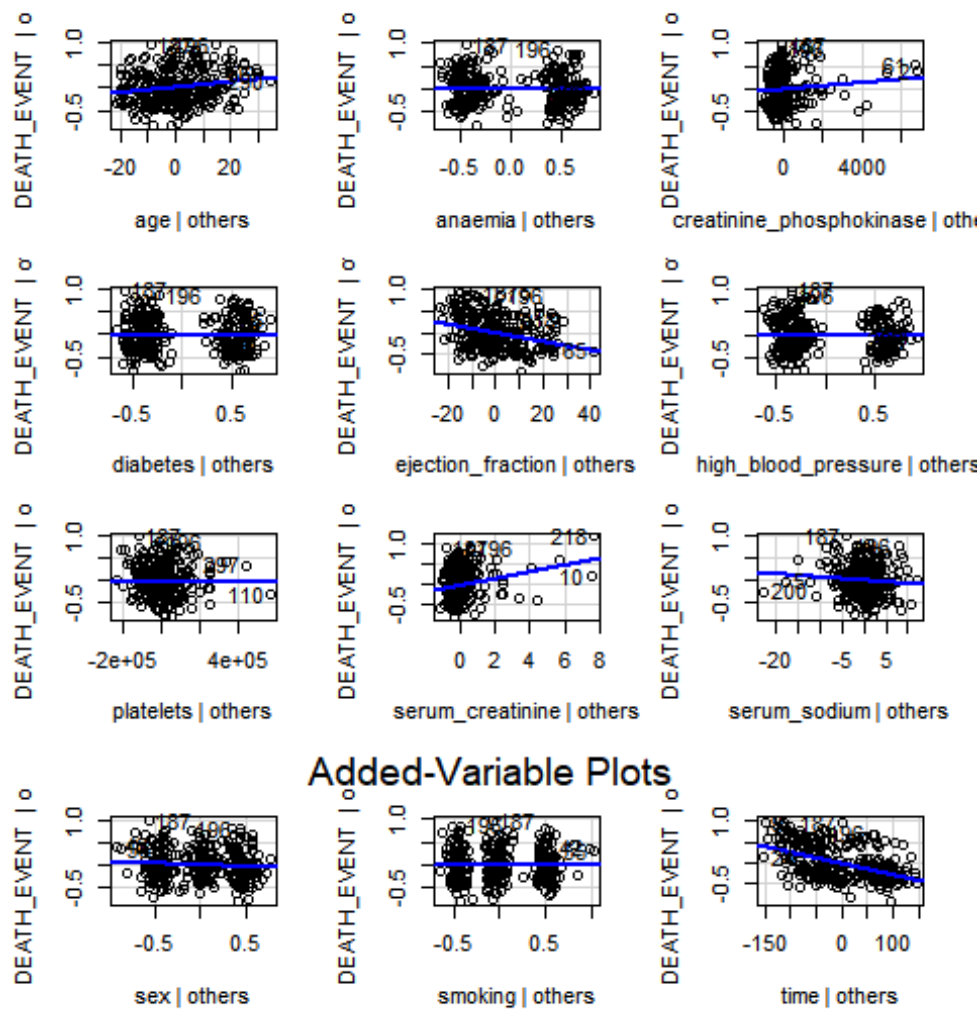
```r
# Cook's Distance plot
cutoff <- 4/((nrow(dataset)-length(fit$coefficients)-2))
plot(fit, which=4, cook.levels=cutoff)
```
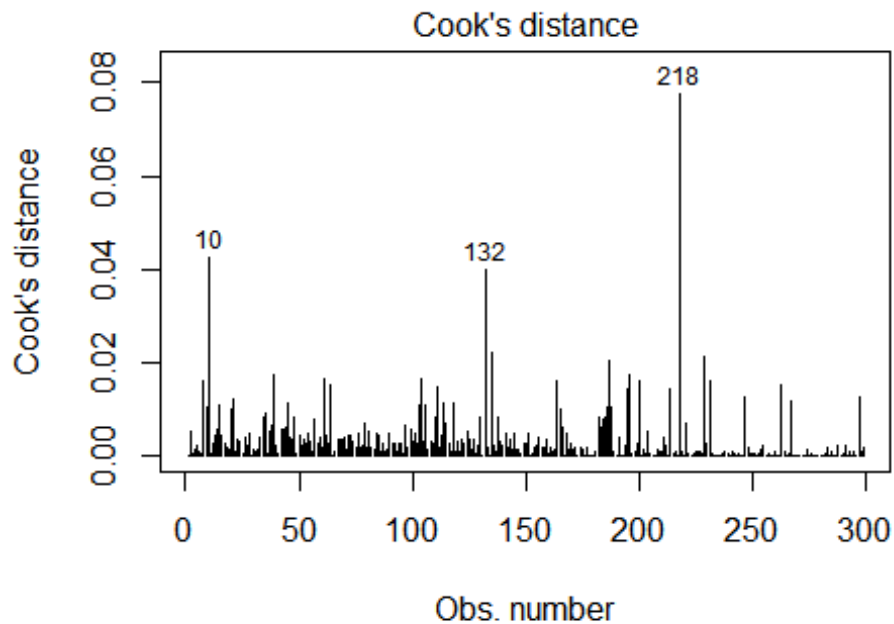
Cook's distance

EATH_EVENT ~ age + anaemia + creatinine_phosphokinase + diabet

```
#Based on Cook's Distance plot, records 10, 132 and 218 have negative effect
on our regression model

# Influence Plot
influencePlot(fit, id.method="identify", main="Influence Plot", sub="Circle s
ize is proportial to Cook's Distance" )

## Warning in plot.window(...): "id.method" is not a graphical parameter

## Warning in plot.xy(xy, type, ...): "id.method" is not a graphical paramete
r

## Warning in axis(side = side, at = at, labels = labels, ...): "id.method" i
s
## not a graphical parameter

## Warning in axis(side = side, at = at, labels = labels, ...): "id.method" i
s
## not a graphical parameter

## Warning in box(...): "id.method" is not a graphical parameter

## Warning in title(...): "id.method" is not a graphical parameter

## Warning in plot.xy(xy.coords(x, y), type = type, ...): "id.method" is not
a
## graphical parameter
```

Influence Plot

Hat-Values
Circle size is proportial to Cook's Distance
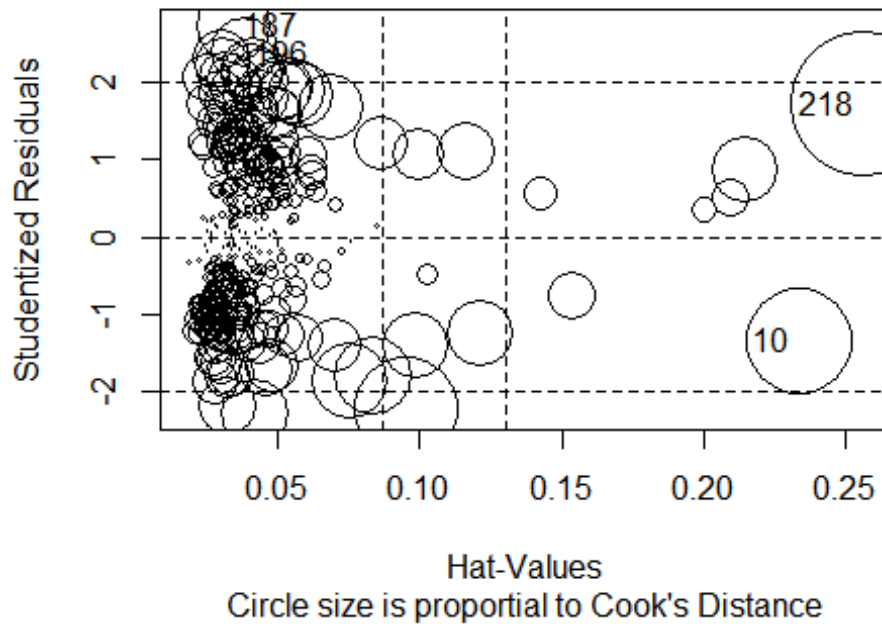
```
##         StudRes        Hat       CookD
## 10    -1.347257 0.23319463 0.04234040
## 187    2.738310 0.03469004 0.02026761
## 196    2.385849 0.03831717 0.01716472
## 218    1.716078 0.25603549 0.07743463
```

#Based on the plot, we can identify records 10,187,196,218 as outliers

```
# distribution of studentized residuals
sresid <- studres(fit)
hist(sresid, freq=FALSE,
     main="Distribution of Studentized Residuals")
xfit<-seq(min(sresid),max(sresid),length=40)
yfit<-dnorm(xfit)
lines(xfit, yfit)
```

Distribution of Studentized Residuals

Density vs sresid
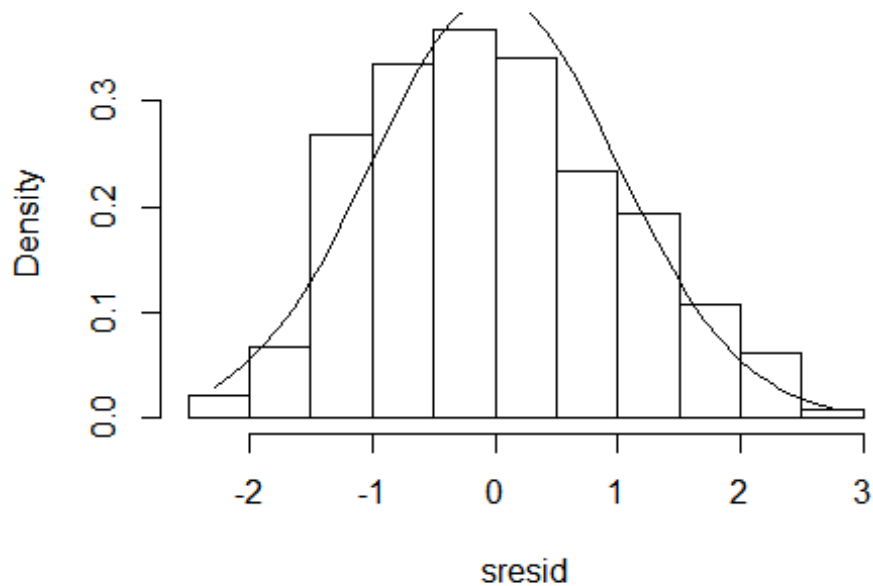
```
#Based on the plot, we can see the Studentized residuals are almost normally
distributed

#Non-constant Error Variance
# Evaluate homoscedasticity
# non-constant error variance test
ncvTest(fit)

## Non-constant Variance Score Test
## Variance formula: ~ fitted.values
## Chisquare = 17.61125, Df = 1, p = 2.7098e-05

#Based on the p-value, since it is smaller than 0.05, we have the problem of
heteroscedasticity

# plot studentized residuals vs. fitted values
spreadLevelPlot(fit)

## Warning in spreadLevelPlot.lm(fit):
## 48 negative fitted values removed
```

Spread-Level Plot for fit
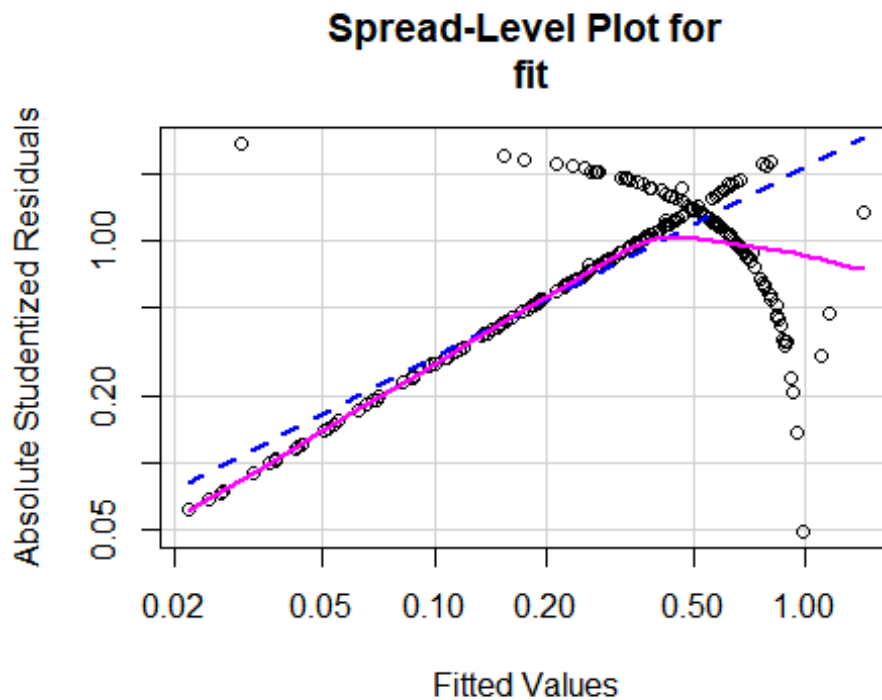

```
##
## Suggested power transformation:  0.1502631

#Multi-collinearity
# Evaluate Collinearity

# variance inflation factors(VIF)
vif(fit)

##                      age                    anaemia creatinine_phosphokinase
##                 1.106067                   1.087163                 1.066014
##                 diabetes          ejection_fraction       high_blood_pressure
##                 1.064324                   1.067758                 1.068377
##                platelets           serum_creatinine              serum_sodium
##                 1.045809                   1.081241                 1.101927
##                      sex                    smoking                      time
##                 1.337716                   1.285049                 1.138009

#Based on VIF values, we don't have a problem of multi-collinearity as they h
ave measure less than 5

#Using the cutoff value as 2 for checking multi-collinearity
sqrt(vif(fit)) > 2

##                      age                    anaemia creatinine_phosphokinase
##                    FALSE                      FALSE                     FALSE
##                 diabetes          ejection_fraction       high_blood_pressure
```

```
##                   FALSE                     FALSE                      FALSE
##               platelets         serum_creatinine              serum_sodium
##                   FALSE                     FALSE                      FALSE
##                     sex                   smoking                       time
##                   FALSE                     FALSE                      FALSE

#Again, we have no problem of multi-collinearity

#Nonlinearity
# component + residual plot
crPlots(fit)
```

Component + Residual Plots
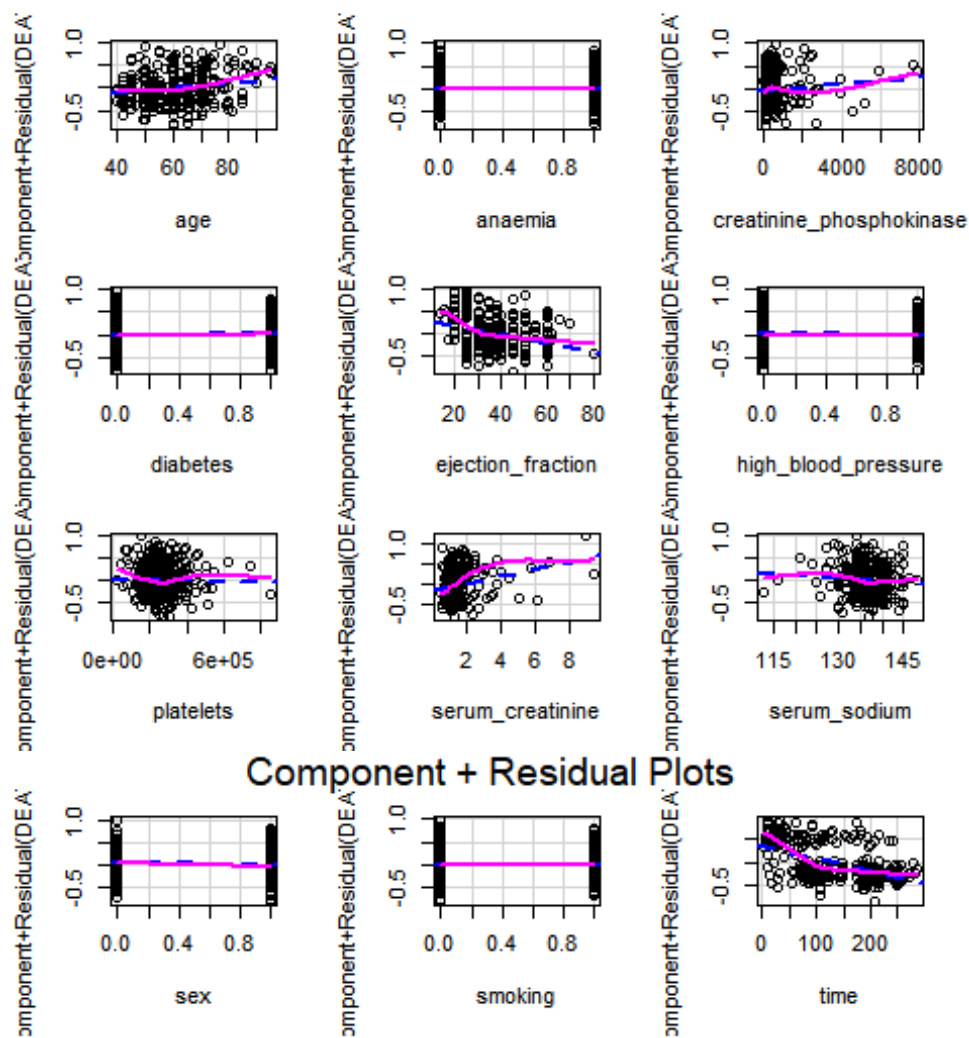
```
#Non-independence of Errors
# Test for Autocorrelated Errors
durbinWatsonTest(fit)
```

```
##  lag Autocorrelation D-W Statistic p-value
##    1       0.2102177      1.577746   0.002
##  Alternative hypothesis: rho != 0
```

#Since p-value is smaller than 0.05, we may have the problem of Autocorrelated errors

#Global test of model assumptions
gvmodel <- gvlma(fit)
summary(gvmodel)

```
##
## Call:
## lm(formula = DEATH_EVENT ~ age + anaemia + creatinine_phosphokinase +
##      diabetes + ejection_fraction + high_blood_pressure + platelets +
##      serum_creatinine + serum_sodium + sex + smoking + time, data = dataset
)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.80866 -0.28041 -0.04205  0.24742  0.96983
##
## Coefficients:
##                             Estimate Std. Error t value Pr(>|t|)
## (Intercept)                1.664e+00  6.954e-01    2.392  0.01738 *
## age                        5.767e-03  1.867e-03    3.088  0.00221 **
## anaemia                   -2.766e-03  4.438e-02   -0.062  0.95035
## creatinine_phosphokinase   3.427e-05  2.247e-05    1.525  0.12840
## diabetes                   1.928e-02  4.410e-02    0.437  0.66236
## ejection_fraction         -9.834e-03  1.844e-03   -5.333 1.96e-07 ***
## high_blood_pressure       -1.430e-02  4.565e-02   -0.313  0.75438
## platelets                 -8.370e-08  2.208e-07   -0.379  0.70492
## serum_creatinine           8.527e-02  2.123e-02    4.017 7.54e-05 ***
## serum_sodium              -7.599e-03  5.024e-03   -1.513  0.13149
## sex                       -6.369e-02  5.108e-02   -1.247  0.21353
## smoking                   -5.733e-03  5.119e-02   -0.112  0.91091
## time                      -2.733e-03  2.903e-04   -9.415  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.3646 on 286 degrees of freedom
## Multiple R-squared:  0.4168, Adjusted R-squared:  0.3924
## F-statistic: 17.04 on 12 and 286 DF,  p-value: < 2.2e-16
##
##
## ASSESSMENT OF THE LINEAR MODEL ASSUMPTIONS
## USING THE GLOBAL TEST ON 4 DEGREES-OF-FREEDOM:
## Level of Significance =  0.05
##
## Call:
```

```
##  gvlma(x = fit)
##
##                      Value    p-value                        Decision
## Global Stat          23.441 0.0001034 Assumptions NOT satisfied!
## Skewness              4.679 0.0305261 Assumptions NOT satisfied!
## Kurtosis              3.335 0.0678280    Assumptions acceptable.
## Link Function         5.410 0.0200201 Assumptions NOT satisfied!
## Heteroscedasticity  10.017 0.0015513 Assumptions NOT satisfied!
```

fit

```
##
## Call:
## lm(formula = DEATH_EVENT ~ age + anaemia + creatinine_phosphokinase +
##     diabetes + ejection_fraction + high_blood_pressure + platelets +
##     serum_creatinine + serum_sodium + sex + smoking + time, data = dataset
)
##
## Coefficients:
##             (Intercept)                          age
##               1.664e+00                    5.767e-03
##                 anaemia   creatinine_phosphokinase
##              -2.766e-03                    3.427e-05
##                diabetes          ejection_fraction
##               1.928e-02                   -9.834e-03
##     high_blood_pressure                    platelets
##              -1.430e-02                   -8.370e-08
##        serum_creatinine               serum_sodium
##               8.527e-02                   -7.599e-03
##                     sex                      smoking
##              -6.369e-02                   -5.733e-03
##                    time
##              -2.733e-03
```

summary(fit)

```
##
## Call:
## lm(formula = DEATH_EVENT ~ age + anaemia + creatinine_phosphokinase +
##     diabetes + ejection_fraction + high_blood_pressure + platelets +
##     serum_creatinine + serum_sodium + sex + smoking + time, data = dataset
)
##
## Residuals:
##      Min        1Q   Median        3Q      Max
## -0.80866 -0.28041 -0.04205   0.24742   0.96983
##
## Coefficients:
##                            Estimate Std. Error t value Pr(>|t|)
## (Intercept)                 1.664e+00  6.954e-01    2.392  0.01738 *
## age                         5.767e-03  1.867e-03    3.088  0.00221 **
```

```
## anaemia                    -2.766e-03  4.438e-02  -0.062  0.95035
## creatinine_phosphokinase   3.427e-05  2.247e-05   1.525  0.12840
## diabetes                    1.928e-02  4.410e-02   0.437  0.66236
## ejection_fraction          -9.834e-03  1.844e-03  -5.333 1.96e-07 ***
## high_blood_pressure        -1.430e-02  4.565e-02  -0.313  0.75438
## platelets                  -8.370e-08  2.208e-07  -0.379  0.70492
## serum_creatinine            8.527e-02  2.123e-02   4.017 7.54e-05 ***
## serum_sodium               -7.599e-03  5.024e-03  -1.513  0.13149
## sex                        -6.369e-02  5.108e-02  -1.247  0.21353
## smoking                    -5.733e-03  5.119e-02  -0.112  0.91091
## time                       -2.733e-03  2.903e-04  -9.415  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.3646 on 286 degrees of freedom
## Multiple R-squared:  0.4168, Adjusted R-squared:  0.3924
## F-statistic: 17.04 on 12 and 286 DF,  p-value: < 2.2e-16

fit1 <- fit
fit2 <- lm(DEATH_EVENT~age+creatinine_phosphokinase+diabetes+ejection_fractio
n+high_blood_pressure+platelets+serum_creatinine+serum_sodium+sex+smoking+tim
e, data=dataset)

# compare models
anova(fit1, fit2)

## Analysis of Variance Table
##
## Model 1: DEATH_EVENT ~ age + anaemia + creatinine_phosphokinase + diabetes
+
##     ejection_fraction + high_blood_pressure + platelets + serum_creatinine
+
##     serum_sodium + sex + smoking + time
## Model 2: DEATH_EVENT ~ age + creatinine_phosphokinase + diabetes + ejectio
n_fraction +
##     high_blood_pressure + platelets + serum_creatinine + serum_sodium +
##     sex + smoking + time
##   Res.Df    RSS Df    Sum of Sq      F Pr(>F)
## 1    286 38.009
## 2    287 38.010 -1 -0.00051611 0.0039 0.9504

step <- stepAIC(fit, direction="both")

## Start:  AIC=-590.72
## DEATH_EVENT ~ age + anaemia + creatinine_phosphokinase + diabetes +
##     ejection_fraction + high_blood_pressure + platelets + serum_creatinine
+
##     serum_sodium + sex + smoking + time
##
##                              Df Sum of Sq    RSS      AIC
## - anaemia                     1    0.0005 38.010 -592.72
```

```
## - smoking                         1     0.0017 38.011 -592.71
## - high_blood_pressure             1     0.0130 38.022 -592.62
## - platelets                       1     0.0191 38.028 -592.57
## - diabetes                        1     0.0254 38.034 -592.52
## - sex                             1     0.2066 38.216 -591.10
## <none>                                         38.009 -590.72
## - serum_sodium                    1     0.3041 38.313 -590.34
## - creatinine_phosphokinase        1     0.3090 38.318 -590.30
## - age                             1     1.2676 39.277 -582.91
## - serum_creatinine                1     2.1446 40.154 -576.31
## - ejection_fraction               1     3.7801 41.789 -564.37
## - time                            1    11.7810 49.790 -512.00
##
## Step:  AIC=-592.72
## DEATH_EVENT ~ age + creatinine_phosphokinase + diabetes + ejection_fractio
n +
##     high_blood_pressure + platelets + serum_creatinine + serum_sodium +
##     sex + smoking + time
##
##                                 Df Sum of Sq    RSS     AIC
## - smoking                        1     0.0015 38.011 -594.71
## - high_blood_pressure            1     0.0129 38.022 -594.62
## - platelets                      1     0.0189 38.028 -594.57
## - diabetes                       1     0.0255 38.035 -594.52
## - sex                            1     0.2060 38.216 -593.10
## <none>                                        38.010 -592.72
## - serum_sodium                   1     0.3075 38.317 -592.31
## - creatinine_phosphokinase       1     0.3256 38.335 -592.17
## + anaemia                        1     0.0005 38.009 -590.72
## - age                            1     1.2677 39.277 -584.91
## - serum_creatinine               1     2.1446 40.154 -578.31
## - ejection_fraction              1     3.7804 41.790 -566.37
## - time                           1    11.9876 49.997 -512.75
##
## Step:  AIC=-594.71
## DEATH_EVENT ~ age + creatinine_phosphokinase + diabetes + ejection_fractio
n +
##     high_blood_pressure + platelets + serum_creatinine + serum_sodium +
##     sex + time
##
##                                 Df Sum of Sq    RSS     AIC
## - high_blood_pressure            1     0.0127 38.024 -596.61
## - platelets                      1     0.0202 38.031 -596.55
## - diabetes                       1     0.0270 38.038 -596.50
## <none>                                        38.011 -594.71
## - sex                            1     0.2733 38.284 -594.57
## - serum_sodium                   1     0.3077 38.319 -594.30
## - creatinine_phosphokinase       1     0.3283 38.339 -594.14
## + smoking                        1     0.0015 38.010 -592.72
## + anaemia                        1     0.0004 38.011 -592.71
```

```
## - age                            1     1.2696 39.281 -586.88
## - serum_creatinine               1     2.1513 40.162 -580.25
## - ejection_fraction              1     3.7793 41.790 -568.37
## - time                           1    11.9897 50.001 -514.73
##
## Step:  AIC=-596.61
## DEATH_EVENT ~ age + creatinine_phosphokinase + diabetes + ejection_fractio
n +
##     platelets + serum_creatinine + serum_sodium + sex + time
##
##                              Df Sum of Sq    RSS     AIC
## - platelets                   1     0.0216 38.045 -598.44
## - diabetes                    1     0.0277 38.051 -598.39
## <none>                                     38.024 -596.61
## - sex                         1     0.2641 38.288 -596.54
## - serum_sodium                1     0.3143 38.338 -596.15
## - creatinine_phosphokinase    1     0.3382 38.362 -595.96
## + high_blood_pressure         1     0.0127 38.011 -594.71
## + smoking                     1     0.0013 38.022 -594.62
## + anaemia                     1     0.0003 38.023 -594.61
## - age                         1     1.2591 39.283 -588.87
## - serum_creatinine            1     2.1649 40.189 -582.05
## - ejection_fraction           1     3.7790 41.803 -570.28
## - time                        1    12.2858 50.310 -514.89
##
## Step:  AIC=-598.44
## DEATH_EVENT ~ age + creatinine_phosphokinase + diabetes + ejection_fractio
n +
##     serum_creatinine + serum_sodium + sex + time
##
##                              Df Sum of Sq    RSS     AIC
## - diabetes                    1     0.0242 38.070 -600.25
## - sex                         1     0.2516 38.297 -598.47
## <none>                                     38.045 -598.44
## - serum_sodium                1     0.3232 38.369 -597.91
## - creatinine_phosphokinase    1     0.3335 38.379 -597.83
## + platelets                   1     0.0216 38.024 -596.61
## + high_blood_pressure         1     0.0141 38.031 -596.55
## + smoking                     1     0.0026 38.043 -596.46
## + anaemia                     1     0.0001 38.045 -596.44
## - age                         1     1.2718 39.317 -590.61
## - serum_creatinine            1     2.1755 40.221 -583.81
## - ejection_fraction           1     3.8181 41.863 -571.84
## - time                        1    12.2760 50.321 -516.82
##
## Step:  AIC=-600.25
## DEATH_EVENT ~ age + creatinine_phosphokinase + ejection_fraction +
##     serum_creatinine + serum_sodium + sex + time
##
##                              Df Sum of Sq    RSS      AIC
```

```
## <none>                                      38.070 -600.25
## - sex                          1    0.2830 38.353 -600.03
## - creatinine_phosphokinase     1    0.3337 38.403 -599.64
## - serum_sodium                 1    0.3460 38.416 -599.54
## + diabetes                     1    0.0242 38.045 -598.44
## + platelets                    1    0.0182 38.051 -598.39
## + high_blood_pressure          1    0.0147 38.055 -598.36
## + smoking                      1    0.0042 38.065 -598.28
## + anaemia                      1    0.0001 38.069 -598.25
## - age                          1    1.2516 39.321 -592.58
## - serum_creatinine             1    2.1579 40.228 -585.76
## - ejection_fraction            1    3.8212 41.891 -573.65
## - time                         1   12.2628 50.332 -518.76
```

step$anova

```
## Stepwise Model Path
## Analysis of Deviance Table
##
## Initial Model:
## DEATH_EVENT ~ age + anaemia + creatinine_phosphokinase + diabetes +
##      ejection_fraction + high_blood_pressure + platelets + serum_creatinine
+
##      serum_sodium + sex + smoking + time
##
## Final Model:
## DEATH_EVENT ~ age + creatinine_phosphokinase + ejection_fraction +
##      serum_creatinine + serum_sodium + sex + time
##
##
##                         Step Df    Deviance Resid. Df Resid. Dev      AIC
## 1                                              286    38.00902 -590.7234
## 2               - anaemia  1 0.0005161064      287    38.00953 -592.7194
## 3               - smoking  1 0.0015286615      288    38.01106 -594.7073
## 4 - high_blood_pressure  1 0.0127406287      289    38.02380 -596.6071
## 5             - platelets  1 0.0216002449      290    38.04540 -598.4373
## 6              - diabetes  1 0.0242332485      291    38.06964 -600.2469
```

#Based on the output, we can say the final model has variables age, creatinine_phosphokinase, ejection_fraction, serum_creatinine, serum_sodium, sex, and time included

leaps<-**regsubsets**(DEATH_EVENT~age+anaemia+creatinine_phosphokinase+diabetes+ejection_fraction+high_blood_pressure+platelets+serum_creatinine+serum_sodium+sex+smoking+time, data=dataset,nbest=10)
summary(leaps)

```
## Subset selection object
## Call: regsubsets.formula(DEATH_EVENT ~ age + anaemia + creatinine_phosphokinase +
##      diabetes + ejection_fraction + high_blood_pressure + platelets +
```

```
##      serum_creatinine + serum_sodium + sex + smoking + time, data = dataset
,
##      nbest = 10)
## 12 Variables  (and intercept)
##                            Forced in Forced out
## age                          FALSE      FALSE
## anaemia                      FALSE      FALSE
## creatinine_phosphokinase     FALSE      FALSE
## diabetes                     FALSE      FALSE
## ejection_fraction            FALSE      FALSE
## high_blood_pressure          FALSE      FALSE
## platelets                    FALSE      FALSE
## serum_creatinine             FALSE      FALSE
## serum_sodium                 FALSE      FALSE
## sex                          FALSE      FALSE
## smoking                      FALSE      FALSE
## time                         FALSE      FALSE
## 10 subsets of each size up to 8
## Selection Algorithm: exhaustive
##           age anaemia creatinine_phosphokinase diabetes ejection_fraction
## 1  ( 1 )  " " " "      " "                       " "      " "
## 1  ( 2 )  " " " "      " "                       " "      " "
## 1  ( 3 )  " " " "      " "                       " "      "*"
## 1  ( 4 )  "*" " "      " "                       " "      " "
## 1  ( 5 )  " " " "      " "                       " "      " "
## 1  ( 6 )  " " " "      " "                       " "      " "
## 1  ( 7 )  " " "*"      " "                       " "      " "
## 1  ( 8 )  " " " "      "*"                       " "      " "
## 1  ( 9 )  " " " "      " "                       " "      " "
## 1  ( 10 ) " " " "      " "                       " "      " "
## 2  ( 1 )  " " " "      " "                       " "      "*"
## 2  ( 2 )  " " " "      " "                       " "      " "
## 2  ( 3 )  " " " "      " "                       " "      " "
## 2  ( 4 )  "*" " "      " "                       " "      " "
## 2  ( 5 )  " " " "      "*"                       " "      " "
## 2  ( 6 )  " " " "      " "                       " "      " "
## 2  ( 7 )  " " " "      " "                       " "      " "
## 2  ( 8 )  " " " "      " "                       " "      " "
## 2  ( 9 )  " " " "      " "                       "*"      " "
## 2  ( 10 ) " " " "      " "                       " "      " "
## 3  ( 1 )  " " " "      " "                       " "      "*"
## 3  ( 2 )  "*" " "      " "                       " "      "*"
## 3  ( 3 )  " " " "      " "                       " "      "*"
## 3  ( 4 )  " " " "      " "                       " "      "*"
## 3  ( 5 )  " " " "      "*"                       " "      "*"
## 3  ( 6 )  " " " "      " "                       " "      "*"
## 3  ( 7 )  " " " "      " "                       " "      "*"
## 3  ( 8 )  " " " "      " "                       " "      "*"
## 3  ( 9 )  " " " "      " "                       "*"      "*"
## 3  ( 10 ) " " "*"      " "                       " "      "*"
```

```
## 4  ( 1  ) "*" " "    " "            " "    "*"
## 4  ( 2  ) " " " "    " "            " "    "*"
## 4  ( 3  ) " " " "    "*"            " "    "*"
## 4  ( 4  ) " " " "    " "            " "    "*"
## 4  ( 5  ) " " " "    " "            " "    "*"
## 4  ( 6  ) " " " "    " "            "*"    "*"
## 4  ( 7  ) " " " "    " "            " "    "*"
## 4  ( 8  ) " " " "    " "            " "    "*"
## 4  ( 9  ) " " "*"    " "            " "    "*"
## 4  ( 10 ) "*" " "    " "            " "    "*"
## 5  ( 1  ) "*" " "    " "            " "    "*"
## 5  ( 2  ) "*" " "    "*"            " "    "*"
## 5  ( 3  ) "*" " "    " "            " "    "*"
## 5  ( 4  ) "*" " "    " "            " "    "*"
## 5  ( 5  ) "*" " "    " "            "*"    "*"
## 5  ( 6  ) "*" " "    " "            " "    "*"
## 5  ( 7  ) "*" "*"    " "            " "    "*"
## 5  ( 8  ) "*" " "    " "            " "    "*"
## 5  ( 9  ) " " " "    "*"            " "    "*"
## 5  ( 10 ) " " " "    " "            " "    "*"
## 6  ( 1  ) "*" " "    "*"            " "    "*"
## 6  ( 2  ) "*" " "    " "            " "    "*"
## 6  ( 3  ) "*" " "    "*"            " "    "*"
## 6  ( 4  ) "*" " "    " "            " "    "*"
## 6  ( 5  ) "*" " "    " "            "*"    "*"
## 6  ( 6  ) "*" " "    "*"            " "    "*"
## 6  ( 7  ) "*" " "    "*"            "*"    "*"
## 6  ( 8  ) "*" " "    " "            " "    "*"
## 6  ( 9  ) "*" "*"    " "            " "    "*"
## 6  ( 10 ) "*" " "    " "            " "    "*"
## 7  ( 1  ) "*" " "    "*"            " "    "*"
## 7  ( 2  ) "*" " "    "*"            " "    "*"
## 7  ( 3  ) "*" " "    "*"            "*"    "*"
## 7  ( 4  ) "*" " "    "*"            " "    "*"
## 7  ( 5  ) "*" " "    "*"            " "    "*"
## 7  ( 6  ) "*" "*"    "*"            " "    "*"
## 7  ( 7  ) "*" " "    "*"            "*"    "*"
## 7  ( 8  ) "*" " "    " "            " "    "*"
## 7  ( 9  ) "*" " "    " "            "*"    "*"
## 7  ( 10 ) "*" "*"    " "            " "    "*"
## 8  ( 1  ) "*" " "    "*"            "*"    "*"
## 8  ( 2  ) "*" " "    "*"            " "    "*"
## 8  ( 3  ) "*" " "    "*"            " "    "*"
## 8  ( 4  ) "*" " "    "*"            " "    "*"
## 8  ( 5  ) "*" "*"    "*"            " "    "*"
## 8  ( 6  ) "*" " "    "*"            "*"    "*"
## 8  ( 7  ) "*" " "    "*"            " "    "*"
## 8  ( 8  ) "*" " "    "*"            " "    "*"
## 8  ( 9  ) "*" "*"    "*"            " "    "*"
## 8  ( 10 ) "*" " "    "*"            "*"    "*"
```

```
##           high_blood_pressure platelets serum_creatinine serum_sodium sex
## 1  ( 1 )  " "                 " "       " "              " "          " "
## 1  ( 2 )  " "                 " "       "*"              " "          " "
## 1  ( 3 )  " "                 " "       " "              " "          " "
## 1  ( 4 )  " "                 " "       " "              " "          " "
## 1  ( 5 )  " "                 " "       " "              "*"          " "
## 1  ( 6 )  "*"                 " "       " "              " "          " "
## 1  ( 7 )  " "                 " "       " "              " "          " "
## 1  ( 8 )  " "                 " "       " "              " "          " "
## 1  ( 9 )  " "                 "*"       " "              " "          " "
## 1  ( 10 ) " "                 " "       " "              " "          " "
## 2  ( 1 )  " "                 " "       " "              " "          " "
## 2  ( 2 )  " "                 " "       "*"              " "          " "
## 2  ( 3 )  " "                 " "       " "              "*"          " "
## 2  ( 4 )  " "                 " "       " "              " "          " "
## 2  ( 5 )  " "                 " "       " "              " "          " "
## 2  ( 6 )  " "                 "*"       " "              " "          " "
## 2  ( 7 )  " "                 " "       " "              " "          " "
## 2  ( 8 )  "*"                 " "       " "              " "          " "
## 2  ( 9 )  " "                 " "       " "              " "          " "
## 2  ( 10 ) " "                 " "       " "              " "          "*"
## 3  ( 1 )  " "                 " "       "*"              " "          " "
## 3  ( 2 )  " "                 " "       " "              " "          " "
## 3  ( 3 )  " "                 " "       " "              "*"          " "
## 3  ( 4 )  " "                 " "       " "              " "          "*"
## 3  ( 5 )  " "                 " "       " "              " "          " "
## 3  ( 6 )  " "                 " "       " "              " "          " "
## 3  ( 7 )  " "                 "*"       " "              " "          " "
## 3  ( 8 )  "*"                 " "       " "              " "          " "
## 3  ( 9 )  " "                 " "       " "              " "          " "
## 3  ( 10 ) " "                 " "       " "              " "          " "
## 4  ( 1 )  " "                 " "       "*"              " "          " "
## 4  ( 2 )  " "                 " "       "*"              "*"          " "
## 4  ( 3 )  " "                 " "       "*"              " "          " "
## 4  ( 4 )  " "                 " "       "*"              " "          "*"
## 4  ( 5 )  " "                 " "       "*"              " "          " "
## 4  ( 6 )  " "                 " "       "*"              " "          " "
## 4  ( 7 )  " "                 "*"       "*"              " "          " "
## 4  ( 8 )  "*"                 " "       "*"              " "          " "
## 4  ( 9 )  " "                 " "       "*"              " "          " "
## 4  ( 10 ) " "                 " "       " "              "*"          " "
## 5  ( 1 )  " "                 " "       "*"              "*"          " "
## 5  ( 2 )  " "                 " "       "*"              " "          " "
## 5  ( 3 )  " "                 " "       "*"              " "          "*"
## 5  ( 4 )  " "                 " "       "*"              " "          " "
## 5  ( 5 )  " "                 " "       "*"              " "          " "
## 5  ( 6 )  "*"                 " "       "*"              " "          " "
## 5  ( 7 )  " "                 " "       "*"              " "          " "
## 5  ( 8 )  " "                 "*"       "*"              " "          " "
## 5  ( 9 )  " "                 " "       "*"              "*"          " "
```

```
## 5  ( 10 ) " "                " "    "*"    "*"    "*"
## 6  ( 1 )  " "                " "    "*"    "*"    " "
## 6  ( 2 )  " "                " "    "*"    "*"    "*"
## 6  ( 3 )  " "                " "    "*"    " "    "*"
## 6  ( 4 )  " "                " "    "*"    "*"    " "
## 6  ( 5 )  " "                " "    "*"    "*"    " "
## 6  ( 6 )  " "                " "    "*"    " "    " "
## 6  ( 7 )  " "                " "    "*"    " "    " "
## 6  ( 8 )  "*"                " "    "*"    "*"    " "
## 6  ( 9 )  " "                " "    "*"    "*"    " "
## 6  ( 10 ) " "                "*"    "*"    "*"    " "
## 7  ( 1 )  " "                " "    "*"    "*"    "*"
## 7  ( 2 )  " "                " "    "*"    "*"    " "
## 7  ( 3 )  " "                " "    "*"    "*"    " "
## 7  ( 4 )  " "                "*"    "*"    "*"    " "
## 7  ( 5 )  "*"                " "    "*"    "*"    " "
## 7  ( 6 )  " "                " "    "*"    "*"    " "
## 7  ( 7 )  " "                " "    "*"    " "    "*"
## 7  ( 8 )  "*"                " "    "*"    "*"    "*"
## 7  ( 9 )  " "                " "    "*"    "*"    "*"
## 7  ( 10 ) " "                " "    "*"    "*"    "*"
## 8  ( 1 )  " "                " "    "*"    "*"    "*"
## 8  ( 2 )  " "                "*"    "*"    "*"    "*"
## 8  ( 3 )  "*"                " "    "*"    "*"    "*"
## 8  ( 4 )  " "                " "    "*"    "*"    "*"
## 8  ( 5 )  " "                " "    "*"    "*"    "*"
## 8  ( 6 )  " "                " "    "*"    "*"    " "
## 8  ( 7 )  "*"                " "    "*"    "*"    " "
## 8  ( 8 )  " "                "*"    "*"    "*"    " "
## 8  ( 9 )  " "                " "    "*"    "*"    " "
## 8  ( 10 ) " "                "*"    "*"    "*"    " "
##           smoking time
## 1  ( 1 )  " "     "*"
## 1  ( 2 )  " "     " "
## 1  ( 3 )  " "     " "
## 1  ( 4 )  " "     " "
## 1  ( 5 )  " "     " "
## 1  ( 6 )  " "     " "
## 1  ( 7 )  " "     " "
## 1  ( 8 )  " "     " "
## 1  ( 9 )  " "     " "
## 1  ( 10 ) "*"     " "
## 2  ( 1 )  " "     "*"
## 2  ( 2 )  " "     "*"
## 2  ( 3 )  " "     "*"
## 2  ( 4 )  " "     "*"
## 2  ( 5 )  " "     "*"
## 2  ( 6 )  " "     "*"
## 2  ( 7 )  "*"     "*"
## 2  ( 8 )  " "     "*"
```

```
## 2  ( 9 )   " "      "*"
## 2  ( 10 )  " "      "*"
## 3  ( 1 )   " "      "*"
## 3  ( 2 )   " "      "*"
## 3  ( 3 )   " "      "*"
## 3  ( 4 )   " "      "*"
## 3  ( 5 )   " "      "*"
## 3  ( 6 )   "*"      "*"
## 3  ( 7 )   " "      "*"
## 3  ( 8 )   " "      "*"
## 3  ( 9 )   " "      "*"
## 3  ( 10 )  " "      "*"
## 4  ( 1 )   " "      "*"
## 4  ( 2 )   " "      "*"
## 4  ( 3 )   " "      "*"
## 4  ( 4 )   " "      "*"
## 4  ( 5 )   "*"      "*"
## 4  ( 6 )   " "      "*"
## 4  ( 7 )   " "      "*"
## 4  ( 8 )   " "      "*"
## 4  ( 9 )   " "      "*"
## 4  ( 10 )  " "      "*"
## 5  ( 1 )   " "      "*"
## 5  ( 2 )   " "      "*"
## 5  ( 3 )   " "      "*"
## 5  ( 4 )   "*"      "*"
## 5  ( 5 )   " "      "*"
## 5  ( 6 )   " "      "*"
## 5  ( 7 )   " "      "*"
## 5  ( 8 )   " "      "*"
## 5  ( 9 )   " "      "*"
## 5  ( 10 )  " "      "*"
## 6  ( 1 )   " "      "*"
## 6  ( 2 )   " "      "*"
## 6  ( 3 )   " "      "*"
## 6  ( 4 )   "*"      "*"
## 6  ( 5 )   " "      "*"
## 6  ( 6 )   "*"      "*"
## 6  ( 7 )   " "      "*"
## 6  ( 8 )   " "      "*"
## 6  ( 9 )   " "      "*"
## 6  ( 10 )  " "      "*"
## 7  ( 1 )   " "      "*"
## 7  ( 2 )   "*"      "*"
## 7  ( 3 )   " "      "*"
## 7  ( 4 )   " "      "*"
## 7  ( 5 )   " "      "*"
## 7  ( 6 )   " "      "*"
## 7  ( 7 )   " "      "*"
## 7  ( 8 )   " "      "*"
```

```
## 7  ( 9 )    " "        "*"
## 7  ( 10 )  " "        "*"
## 8  ( 1 )    " "        "*"
## 8  ( 2 )    " "        "*"
## 8  ( 3 )    " "        "*"
## 8  ( 4 )    "*"       "*"
## 8  ( 5 )    " "        "*"
## 8  ( 6 )    "*"       "*"
## 8  ( 7 )    "*"       "*"
## 8  ( 8 )    "*"       "*"
## 8  ( 9 )    "*"       "*"
## 8  ( 10 )  " "        "*"
```

```r
plot(leaps)
```



```r
plot(leaps,scale="r2")
```

```
coef(leaps,1:5)

## [[1]]
##   (Intercept)            time
##   0.734682508 -0.003175261
##
## [[2]]
##      (Intercept) serum_creatinine
##        0.1356370        0.1330339
##
## [[3]]
##      (Intercept) ejection_fraction
##       0.72529879       -0.01061424
##
## [[4]]
##   (Intercept)              age
## -0.285802141  0.009975892
##
## [[5]]
##   (Intercept) serum_sodium
##    3.14775088  -0.02068927

# Calculate Relative Importance for Each Predictor
calc.relimp(fit,type=c("lmg","last","first","pratt"),rela=TRUE)
```

```
## Warning in rev(variances[[p]]) - variances[[p + 1]]: Recycling array of le
ngth 1 in vector-array arithmetic is deprecated.
##   Use c() or as.vector() instead.

## Response variable: DEATH_EVENT
## Total response variance: 0.2187156
## Analysis based on 299 observations
##
## 12 Regressors:
## age anaemia creatinine_phosphokinase diabetes ejection_fraction high_blood
_pressure platelets serum_creatinine serum_sodium sex smoking time
## Proportion of variance explained by model: 41.68%
## Metrics are normalized to sum to 100% (rela=TRUE).
##
## Relative importance metrics:
##
##                                     lmg          last         first
## age                       0.0937640906 6.385122e-02 1.157589e-01
## anaemia                   0.0049359382 2.599695e-05 7.896800e-03
## creatinine_phosphokinase 0.0125437999 1.556567e-02 7.075237e-03
## diabetes                  0.0007300819 1.279073e-03 6.787492e-06
## ejection_fraction         0.1546141562 1.904061e-01 1.297295e-01
## high_blood_pressure       0.0075585019 6.565266e-04 1.132195e-02
## platelets                 0.0024364830 9.619330e-04 4.341764e-03
## serum_creatinine          0.1332438538 1.080252e-01 1.557149e-01
## serum_sodium              0.0450742068 1.531584e-02 6.851592e-02
## sex                       0.0037103743 1.040443e-02 3.350075e-05
## smoking                   0.0006537701 8.395941e-05 2.865178e-04
## time                      0.5407347433 5.934241e-01 4.993182e-01
##                                    pratt
## age                        8.927702e-02
## anaemia                   -4.664673e-04
## creatinine_phosphokinase  1.069850e-02
## diabetes                  -9.491313e-05
## ejection_fraction          1.603553e-01
## high_blood_pressure       -2.782506e-03
## platelets                  2.063568e-03
## serum_creatinine           1.331607e-01
## serum_sodium               3.357606e-02
## sex                        6.742258e-04
## smoking                    1.736031e-04
## time                       5.733650e-01
##
## Average coefficients for different model sizes:
##
##                                     1X          2Xs           3Xs
## age                       9.975892e-03 9.462064e-03 8.977711e-03
## anaemia                   6.247150e-02 5.514393e-02 4.817298e-02
## creatinine_phosphokinase 3.023443e-05 3.219618e-05 3.377364e-05
## diabetes                 -1.839080e-03 1.852069e-03 5.053665e-03
```

```
## ejection_fraction            -1.061424e-02 -1.051875e-02 -1.042816e-02
## high_blood_pressure           7.761414e-02  6.808268e-02  5.881738e-02
## platelets                    -2.349673e-07 -2.098009e-07 -1.874021e-07
## serum_creatinine              1.330339e-01  1.272750e-01  1.218126e-01
## serum_sodium                 -2.068927e-02 -1.935134e-02 -1.804686e-02
## sex                          -4.221895e-03 -9.949780e-03 -1.572026e-02
## smoking                      -1.262315e-02 -1.395430e-02 -1.479149e-02
## time                         -3.175261e-03 -3.130357e-03 -3.086429e-03
##                                        4Xs           5Xs           6Xs
## age                           8.521826e-03  8.093342e-03  7.691150e-03
## anaemia                       4.153323e-02  3.519809e-02  2.914068e-02
## creatinine_phosphokinase      3.499096e-05  3.587129e-05  3.643648e-05
## diabetes                      7.805559e-03  1.015224e-02  1.214099e-02
## ejection_fraction            -1.034251e-02 -1.026181e-02 -1.018604e-02
## high_blood_pressure           4.980484e-02  4.103297e-02  3.249124e-02
## platelets                    -1.676213e-07 -1.502952e-07 -1.352535e-07
## serum_creatinine              1.166433e-01  1.117631e-01  1.071670e-01
## serum_sodium                 -1.677454e-02 -1.553311e-02 -1.432131e-02
## sex                          -2.148608e-02 -2.720690e-02 -3.284851e-02
## smoking                      -1.517259e-02 -1.513369e-02 -1.470899e-02
## time                         -3.043468e-03 -3.001463e-03 -2.960402e-03
##                                        7Xs           8Xs           9Xs
## age                           7.314121e-03  6.961114e-03  6.630990e-03
## anaemia                       2.333448e-02  1.775395e-02  1.237494e-02
## creatinine_phosphokinase      3.670700e-05  3.670195e-05  3.643914e-05
## diabetes                      1.382052e-02  1.523994e-02  1.644800e-02
## ejection_fraction            -1.011517e-02 -1.004918e-02 -9.988049e-03
## high_blood_pressure           2.417079e-02  1.606453e-02  8.167160e-03
## platelets                    -1.223244e-07 -1.113386e-07 -1.021331e-07
## serum_creatinine              1.028500e-01  9.880674e-02  9.503197e-02
## serum_sodium                 -1.313789e-02 -1.198155e-02 -1.085094e-02
## sex                          -3.838194e-02 -4.378275e-02 -4.903016e-02
## smoking                      -1.393084e-02 -1.282964e-02 -1.143382e-02
## time                         -2.920273e-03 -2.881058e-03 -2.842736e-03
##                                       10Xs          11Xs          12Xs
## age                           6.322613e-03  6.034851e-03  5.766578e-03
## anaemia                       7.175118e-03  2.134180e-03 -2.765880e-03
## creatinine_phosphokinase      3.593524e-05  3.520594e-05  3.426613e-05
## diabetes                      1.749252e-02  1.842000e-02  1.927520e-02
## ejection_fraction            -9.931758e-03 -9.880295e-03 -9.833650e-03
## high_blood_pressure           4.752014e-04 -7.012907e-03 -1.429674e-02
## platelets                    -9.455323e-08 -8.845434e-08 -8.370305e-08
## serum_creatinine              9.152060e-02  8.826772e-02  8.526866e-02
## serum_sodium                 -9.744662e-03 -8.661238e-03 -7.599145e-03
## sex                          -5.410641e-02 -5.899606e-02 -6.368536e-02
## smoking                      -9.769796e-03 -7.861942e-03 -5.732644e-03
## time                         -2.805281e-03 -2.768663e-03 -2.732842e-03
```

```
# Bootstrap Measures of Relative Importance (100 samples)
boot <- boot.relimp(fit, b = 100, type = c("lmg","last", "first", "pratt"), r
ank = TRUE, diff = TRUE, rela = TRUE)

## Warning in rev(variances[[p]]) - variances[[p + 1]]: Recycling array of le
ngth 1 in vector-array arithmetic is deprecated.
##   Use c() or as.vector() instead.

booteval.relimp(boot)

## Warning in rev(variances[[p]]) - variances[[p + 1]]: Recycling array of le
ngth 1 in vector-array arithmetic is deprecated.
##   Use c() or as.vector() instead.

## Response variable: DEATH_EVENT
## Total response variance: 0.2187156
## Analysis based on 299 observations
##
## 12 Regressors:
## age anaemia creatinine_phosphokinase diabetes ejection_fraction high_blood
_pressure platelets serum_creatinine serum_sodium sex smoking time
## Proportion of variance explained by model: 41.68%
## Metrics are normalized to sum to 100% (rela=TRUE).
##
## Relative importance metrics:
##
##                                    lmg          last         first
## age                       0.0937640906 6.385122e-02 1.157589e-01
## anaemia                   0.0049359382 2.599695e-05 7.896800e-03
## creatinine_phosphokinase  0.0125437999 1.556567e-02 7.075237e-03
## diabetes                  0.0007300819 1.279073e-03 6.787492e-06
## ejection_fraction         0.1546141562 1.904061e-01 1.297295e-01
## high_blood_pressure       0.0075585019 6.565266e-04 1.132195e-02
## platelets                 0.0024364830 9.619330e-04 4.341764e-03
## serum_creatinine          0.1332438538 1.080252e-01 1.557149e-01
## serum_sodium              0.0450742068 1.531584e-02 6.851592e-02
## sex                       0.0037103743 1.040443e-02 3.350075e-05
## smoking                   0.0006537701 8.395941e-05 2.865178e-04
## time                      0.5407347433 5.934241e-01 4.993182e-01
##                                  pratt
## age                       8.927702e-02
## anaemia                  -4.664673e-04
## creatinine_phosphokinase  1.069850e-02
## diabetes                 -9.491313e-05
## ejection_fraction         1.603553e-01
## high_blood_pressure      -2.782506e-03
## platelets                 2.063568e-03
## serum_creatinine          1.331607e-01
## serum_sodium              3.357606e-02
## sex                       6.742258e-04
## smoking                   1.736031e-04
```

```
## time                        5.733650e-01
##
## Average coefficients for different model sizes:
##
##                                    1X           2Xs           3Xs
## age                       9.975892e-03  9.462064e-03  8.977711e-03
## anaemia                   6.247150e-02  5.514393e-02  4.817298e-02
## creatinine_phosphokinase  3.023443e-05  3.219618e-05  3.377364e-05
## diabetes                 -1.839080e-03  1.852069e-03  5.053665e-03
## ejection_fraction        -1.061424e-02 -1.051875e-02 -1.042816e-02
## high_blood_pressure       7.761414e-02  6.808268e-02  5.881738e-02
## platelets                -2.349673e-07 -2.098009e-07 -1.874021e-07
## serum_creatinine          1.330339e-01  1.272750e-01  1.218126e-01
## serum_sodium             -2.068927e-02 -1.935134e-02 -1.804686e-02
## sex                      -4.221895e-03 -9.949780e-03 -1.572026e-02
## smoking                  -1.262315e-02 -1.395430e-02 -1.479149e-02
## time                     -3.175261e-03 -3.130357e-03 -3.086429e-03
##                                    4Xs           5Xs           6Xs
## age                       8.521826e-03  8.093342e-03  7.691150e-03
## anaemia                   4.153323e-02  3.519809e-02  2.914068e-02
## creatinine_phosphokinase  3.499096e-05  3.587129e-05  3.643648e-05
## diabetes                  7.805559e-03  1.015224e-02  1.214099e-02
## ejection_fraction        -1.034251e-02 -1.026181e-02 -1.018604e-02
## high_blood_pressure       4.980484e-02  4.103297e-02  3.249124e-02
## platelets                -1.676213e-07 -1.502952e-07 -1.352535e-07
## serum_creatinine          1.166433e-01  1.117631e-01  1.071670e-01
## serum_sodium             -1.677454e-02 -1.553311e-02 -1.432131e-02
## sex                      -2.148608e-02 -2.720690e-02 -3.284851e-02
## smoking                  -1.517259e-02 -1.513369e-02 -1.470899e-02
## time                     -3.043468e-03 -3.001463e-03 -2.960402e-03
##                                    7Xs           8Xs           9Xs
## age                       7.314121e-03  6.961114e-03  6.630990e-03
## anaemia                   2.333448e-02  1.775395e-02  1.237494e-02
## creatinine_phosphokinase  3.670700e-05  3.670195e-05  3.643914e-05
## diabetes                  1.382052e-02  1.523994e-02  1.644800e-02
## ejection_fraction        -1.011517e-02 -1.004918e-02 -9.988049e-03
## high_blood_pressure       2.417079e-02  1.606453e-02  8.167160e-03
## platelets                -1.223244e-07 -1.113386e-07 -1.021331e-07
## serum_creatinine          1.028500e-01  9.880674e-02  9.503197e-02
## serum_sodium             -1.313789e-02 -1.198155e-02 -1.085094e-02
## sex                      -3.838194e-02 -4.378275e-02 -4.903016e-02
## smoking                  -1.393084e-02 -1.282964e-02 -1.143382e-02
## time                     -2.920273e-03 -2.881058e-03 -2.842736e-03
##                                   10Xs          11Xs          12Xs
## age                       6.322613e-03  6.034851e-03  5.766578e-03
## anaemia                   7.175118e-03  2.134180e-03 -2.765880e-03
## creatinine_phosphokinase  3.593524e-05  3.520594e-05  3.426613e-05
## diabetes                  1.749252e-02  1.842000e-02  1.927520e-02
## ejection_fraction        -9.931758e-03 -9.880295e-03 -9.833650e-03
## high_blood_pressure       4.752014e-04 -7.012907e-03 -1.429674e-02
```

```
## platelets                   -9.455323e-08 -8.845434e-08 -8.370305e-08
## serum_creatinine             9.152060e-02  8.826772e-02  8.526866e-02
## serum_sodium                -9.744662e-03 -8.661238e-03 -7.599145e-03
## sex                         -5.410641e-02 -5.899606e-02 -6.368536e-02
## smoking                     -9.769796e-03 -7.861942e-03 -5.732644e-03
## time                        -2.805281e-03 -2.768663e-03 -2.732842e-03
##
##
##  Confidence interval information ( 100 bootstrap replicates, bty= perc ):
## Relative Contributions with confidence intervals:
##
##                                                      Lower   Upper
##                              percentage 0.95         0.95    0.95
## age.lmg                          0.0938   _BCDEF_____  0.0233  0.1672
## anaemia.lmg                      0.0049   ____EFGHIJKL  0.0010  0.0347
## creatinine_phosphokinase.lmg     0.0125   ____EFGHIJKL  0.0006  0.0551
## diabetes.lmg                     0.0007   _____FGHIJKL  0.0005  0.0360
## ejection_fraction.lmg            0.1546   _BCDE_____  0.0458  0.2785
## high_blood_pressure.lmg          0.0076   ____EFGHIJKL  0.0016  0.0509
## platelets.lmg                    0.0024   _____FGHIJKL  0.0006  0.0371
## serum_creatinine.lmg             0.1332   _BCDE_____  0.0312  0.2646
## serum_sodium.lmg                 0.0451   __CDEFGH____  0.0062  0.1361
## sex.lmg                          0.0037   ____EFGHIJKL  0.0008  0.0494
## smoking.lmg                      0.0007   _____FGHIJKL  0.0008  0.0210
## time.lmg                         0.5407   A_____  0.3617  0.6406
##
## age.last                         0.0639   _BCDEFG_____  0.0144  0.1544
## anaemia.last                     0.0000   ____EFGHIJKL  0.0000  0.0323
## creatinine_phosphokinase.last    0.0156   ___DEFGHIJKL  0.0000  0.0696
## diabetes.last                    0.0013   ____EFGHIJKL  0.0000  0.0433
## ejection_fraction.last           0.1904   _BCD_____  0.0673  0.3438
## high_blood_pressure.last         0.0007   ___DEFGHIJKL  0.0000  0.0377
## platelets.last                   0.0010   ____EFGHIJKL  0.0000  0.0343
## serum_creatinine.last            0.1080   _BCDEFG_____  0.0043  0.2668
## serum_sodium.last                0.0153   __CDEFGHIJKL  0.0000  0.0834
## sex.last                         0.0104   ___DEFGHIJKL  0.0000  0.0858
## smoking.last                     0.0001   _____FGHIJKL  0.0000  0.0206
## time.last                        0.5934   A_____  0.3789  0.7347
##
## age.first                        0.1158   _BCDEF_____  0.0275  0.1995
## anaemia.first                    0.0079   _____FGHIJKL  0.0000  0.0425
## creatinine_phosphokinase.first   0.0071   ____EFGHIJKL  0.0000  0.0467
## diabetes.first                   0.0000   _____FGHIJKL  0.0000  0.0419
## ejection_fraction.first          0.1297   _BCDE_____  0.0256  0.2456
## high_blood_pressure.first        0.0113   ____EFGHIJKL  0.0000  0.0747
## platelets.first                  0.0043   _____FGHIJKL  0.0000  0.0419
## serum_creatinine.first           0.1557   _BCDE_____  0.0573  0.2821
## serum_sodium.first               0.0685   _BCDEFGH____  0.0116  0.1710
## sex.first                        0.0000   ____EFGHIJKL  0.0000  0.0379
## smoking.first                    0.0003   _____GHIJKL  0.0000  0.0336
```

```
## time.first                              0.4993    A_____   0.3362  0.5863
##
## age.pratt                               0.0893    _BCDEFG_____   0.0214  0.1729
## anaemia.pratt                          -0.0005    ____EFGHIJKL  -0.0087  0.0328
## creatinine_phosphokinase.pratt         0.0107    ____EFGHIJKL  -0.0030  0.0528
## diabetes.pratt                         -0.0001    ____EFGHIJKL  -0.0027  0.0375
## ejection_fraction.pratt                 0.1604    _BCDE_____   0.0430  0.2953
## high_blood_pressure.pratt              -0.0028    ____EFGHIJKL  -0.0131  0.0305
## platelets.pratt                         0.0021    ____EFGHIJKL  -0.0047  0.0340
## serum_creatinine.pratt                  0.1332    _BCDE_____   0.0200  0.2721
## serum_sodium.pratt                      0.0336    __CDEFGHIJK_  -0.0060  0.1234
## sex.pratt                               0.0007    ___DEFGHIJKL  -0.0079  0.0567
## smoking.pratt                           0.0002    _____FGHIJKL  -0.0073  0.0199
## time.pratt                              0.5734    A_____   0.3824  0.6838
##
## Letters indicate the ranks covered by bootstrap CIs.
## (Rank bootstrap confidence intervals always obtained by percentile method)
## CAUTION: Bootstrap confidence intervals can be somewhat liberal.
##
##
##   Differences between Relative Contributions:
##
##                                                                     Lower
Upper
##                                                          difference 0.95 0.95
## age-anaemia.lmg                                            0.0888    *   0.0027
## age-creatinine_phosphokinase.lmg                           0.0812       -0.0129
## age-diabetes.lmg                                           0.0930    *   0.0160
## age-ejection_fraction.lmg                                 -0.0609       -0.2175
## age-high_blood_pressure.lmg                                0.0862    *   0.0061
## age-platelets.lmg                                          0.0913    *   0.0134
## age-serum_creatinine.lmg                                  -0.0395       -0.1977
## age-serum_sodium.lmg                                       0.0487       -0.0765
## age-sex.lmg                                                0.0901    *   0.0159
## age-smoking.lmg                                            0.0931    *   0.0142
## age-time.lmg                                              -0.4470    *  -0.5961
## anaemia-creatinine_phosphokinase.lmg                      -0.0076       -0.0494
## anaemia-diabetes.lmg                                       0.0042       -0.0306
## anaemia-ejection_fraction.lmg                             -0.1497    *  -0.2618
## anaemia-high_blood_pressure.lmg                           -0.0026       -0.0387
## anaemia-platelets.lmg                                      0.0025       -0.0354
## anaemia-serum_creatinine.lmg                              -0.1283    *  -0.2572
## anaemia-serum_sodium.lmg                                  -0.0401       -0.1332
## anaemia-sex.lmg                                            0.0012       -0.0473
## anaemia-smoking.lmg                                        0.0043       -0.0145
## anaemia-time.lmg                                          -0.5358    *  -0.6258
## creatinine_phosphokinase-diabetes.lmg                      0.0118       -0.0256
## creatinine_phosphokinase-ejection_fraction.lmg            -0.1421    *  -0.2612
## creatinine_phosphokinase-high_blood_pressure.lmg          0.0050       -0.0411
## creatinine_phosphokinase-platelets.lmg                    0.0101       -0.0253
```

```
## creatinine_phosphokinase-serum_creatinine.lmg    -0.1207     *   -0.2361
## creatinine_phosphokinase-serum_sodium.lmg        -0.0325         -0.1229
## creatinine_phosphokinase-sex.lmg                  0.0088         -0.0450
## creatinine_phosphokinase-smoking.lmg              0.0119         -0.0143
## creatinine_phosphokinase-time.lmg                -0.5282     *   -0.6279
## diabetes-ejection_fraction.lmg                   -0.1539     *   -0.2744
## diabetes-high_blood_pressure.lmg                 -0.0068         -0.0422
## diabetes-platelets.lmg                           -0.0017         -0.0303
## diabetes-serum_creatinine.lmg                    -0.1325     *   -0.2605
## diabetes-serum_sodium.lmg                        -0.0443     *   -0.1339
## diabetes-sex.lmg                                 -0.0030         -0.0459
## diabetes-smoking.lmg                              0.0001         -0.0194
## diabetes-time.lmg                                -0.5400     *   -0.6348
## ejection_fraction-high_blood_pressure.lmg         0.1471     *    0.0303
## ejection_fraction-platelets.lmg                   0.1522     *    0.0384
## ejection_fraction-serum_creatinine.lmg            0.0214         -0.1459
## ejection_fraction-serum_sodium.lmg                0.1095         -0.0382
## ejection_fraction-sex.lmg                         0.1509     *    0.0110
## ejection_fraction-smoking.lmg                     0.1540     *    0.0394
## ejection_fraction-time.lmg                       -0.3861     *   -0.5593
## high_blood_pressure-platelets.lmg                 0.0051         -0.0322
## high_blood_pressure-serum_creatinine.lmg         -0.1257     *   -0.2599
## high_blood_pressure-serum_sodium.lmg             -0.0375         -0.1253
## high_blood_pressure-sex.lmg                       0.0038         -0.0414
## high_blood_pressure-smoking.lmg                   0.0069         -0.0151
## high_blood_pressure-time.lmg                     -0.5332     *   -0.6334
## platelets-serum_creatinine.lmg                   -0.1308     *   -0.2607
## platelets-serum_sodium.lmg                       -0.0426         -0.1334
## platelets-sex.lmg                                -0.0013         -0.0455
## platelets-smoking.lmg                             0.0018         -0.0177
## platelets-time.lmg                               -0.5383     *   -0.6316
## serum_creatinine-serum_sodium.lmg                 0.0882         -0.0458
## serum_creatinine-sex.lmg                          0.1295     *    0.0277
## serum_creatinine-smoking.lmg                      0.1326     *    0.0270
## serum_creatinine-time.lmg                        -0.4075     *   -0.5944
## serum_sodium-sex.lmg                              0.0414         -0.0067
## serum_sodium-smoking.lmg                          0.0444     *    0.0005
## serum_sodium-time.lmg                            -0.4957     *   -0.5997
## sex-smoking.lmg                                   0.0031         -0.0170
## sex-time.lmg                                     -0.5370     *   -0.6331
## smoking-time.lmg                                 -0.5401     *   -0.6319
##
## age-anaemia.last                                  0.0638         -0.0084
## age-creatinine_phosphokinase.last                 0.0483         -0.0380
## age-diabetes.last                                 0.0626     *    0.0004
## age-ejection_fraction.last                       -0.1266         -0.2977
## age-high_blood_pressure.last                      0.0632         -0.0113
## age-platelets.last                                0.0629     *    0.0003
## age-serum_creatinine.last                        -0.0442         -0.2104
## age-serum_sodium.last                             0.0485         -0.0486
```

```
## age-sex.last                                              0.0534        -0.0036
## age-smoking.last                                          0.0638    *    0.0038
## age-time.last                                            -0.5296    *   -0.7074
## anaemia-creatinine_phosphokinase.last                    -0.0155        -0.0576
## anaemia-diabetes.last                                    -0.0013        -0.0398
## anaemia-ejection_fraction.last                           -0.1904    *   -0.3384
## anaemia-high_blood_pressure.last                         -0.0006        -0.0356
## anaemia-platelets.last                                   -0.0009        -0.0326
## anaemia-serum_creatinine.last                            -0.1080    *   -0.2649
## anaemia-serum_sodium.last                                -0.0153        -0.0807
## anaemia-sex.last                                         -0.0104        -0.0810
## anaemia-smoking.last                                     -0.0001        -0.0177
## anaemia-time.last                                        -0.5934    *   -0.7309
## creatinine_phosphokinase-diabetes.last                   0.0143        -0.0285
## creatinine_phosphokinase-ejection_fraction.last         -0.1748    *   -0.3316
## creatinine_phosphokinase-high_blood_pressure.last        0.0149        -0.0208
## creatinine_phosphokinase-platelets.last                  0.0146        -0.0256
## creatinine_phosphokinase-serum_creatinine.last          -0.0925        -0.2428
## creatinine_phosphokinase-serum_sodium.last               0.0002        -0.0648
## creatinine_phosphokinase-sex.last                        0.0052        -0.0842
## creatinine_phosphokinase-smoking.last                    0.0155        -0.0192
## creatinine_phosphokinase-time.last                      -0.5779    *   -0.7175
## diabetes-ejection_fraction.last                         -0.1891    *   -0.3416
## diabetes-high_blood_pressure.last                        0.0006        -0.0294
## diabetes-platelets.last                                  0.0003        -0.0295
## diabetes-serum_creatinine.last                          -0.1067        -0.2595
## diabetes-serum_sodium.last                              -0.0140        -0.0797
## diabetes-sex.last                                       -0.0091        -0.0817
## diabetes-smoking.last                                    0.0012        -0.0195
## diabetes-time.last                                      -0.5921    *   -0.7257
## ejection_fraction-high_blood_pressure.last               0.1897    *    0.0542
## ejection_fraction-platelets.last                         0.1894    *    0.0656
## ejection_fraction-serum_creatinine.last                  0.0824        -0.1140
## ejection_fraction-serum_sodium.last                      0.1751    *    0.0309
## ejection_fraction-sex.last                               0.1800    *    0.0209
## ejection_fraction-smoking.last                           0.1903    *    0.0611
## ejection_fraction-time.last                             -0.4030    *   -0.6069
## high_blood_pressure-platelets.last                      -0.0003        -0.0303
## high_blood_pressure-serum_creatinine.last               -0.1074        -0.2591
## high_blood_pressure-serum_sodium.last                   -0.0147        -0.0812
## high_blood_pressure-sex.last                            -0.0097        -0.0692
## high_blood_pressure-smoking.last                         0.0006        -0.0166
## high_blood_pressure-time.last                           -0.5928    *   -0.7335
## platelets-serum_creatinine.last                         -0.1071        -0.2636
## platelets-serum_sodium.last                             -0.0144        -0.0797
## platelets-sex.last                                      -0.0094        -0.0763
## platelets-smoking.last                                   0.0009        -0.0177
## platelets-time.last                                     -0.5925    *   -0.7306
## serum_creatinine-serum_sodium.last                       0.0927        -0.0587
## serum_creatinine-sex.last                                0.0976        -0.0039
```

```
## serum_creatinine-smoking.last                                  0.1079          -0.0010
## serum_creatinine-time.last                                     -0.4854     *   -0.6986
## serum_sodium-sex.last                                           0.0049          -0.0443
## serum_sodium-smoking.last                                       0.0152          -0.0174
## serum_sodium-time.last                                         -0.5781     *   -0.7172
## sex-smoking.last                                                0.0103          -0.0170
## sex-time.last                                                  -0.5830     *   -0.7273
## smoking-time.last                                              -0.5933     *   -0.7274
##
## age-anaemia.first                                               0.1079     *    0.0143
## age-creatinine_phosphokinase.first                              0.1087     *    0.0076
## age-diabetes.first                                              0.1158     *    0.0257
## age-ejection_fraction.first                                    -0.0140         -0.1926
## age-high_blood_pressure.first                                   0.1044     *    0.0031
## age-platelets.first                                             0.1114     *    0.0125
## age-serum_creatinine.first                                     -0.0400         -0.1972
## age-serum_sodium.first                                          0.0472         -0.1055
## age-sex.first                                                   0.1157     *    0.0217
## age-smoking.first                                               0.1155     *    0.0215
## age-time.first                                                 -0.3836     *   -0.5235
## anaemia-creatinine_phosphokinase.first                          0.0008         -0.0421
## anaemia-diabetes.first                                          0.0079         -0.0291
## anaemia-ejection_fraction.first                                -0.1218     *   -0.2349
## anaemia-high_blood_pressure.first                              -0.0034         -0.0647
## anaemia-platelets.first                                         0.0036         -0.0411
## anaemia-serum_creatinine.first                                 -0.1478     *   -0.2678
## anaemia-serum_sodium.first                                     -0.0606         -0.1655
## anaemia-sex.first                                               0.0079         -0.0289
## anaemia-smoking.first                                           0.0076         -0.0209
## anaemia-time.first                                             -0.4914     *   -0.5705
## creatinine_phosphokinase-diabetes.first                         0.0071         -0.0360
## creatinine_phosphokinase-ejection_fraction.first              -0.1227     *   -0.2346
## creatinine_phosphokinase-high_blood_pressure.first -0.0042                    -0.0727
## creatinine_phosphokinase-platelets.first                        0.0027         -0.0320
## creatinine_phosphokinase-serum_creatinine.first               -0.1486     *   -0.2660
## creatinine_phosphokinase-serum_sodium.first                   -0.0614         -0.1600
## creatinine_phosphokinase-sex.first                             0.0070         -0.0296
## creatinine_phosphokinase-smoking.first                         0.0068         -0.0286
## creatinine_phosphokinase-time.first                           -0.4922     *   -0.5755
## diabetes-ejection_fraction.first                              -0.1297     *   -0.2413
## diabetes-high_blood_pressure.first                            -0.0113         -0.0729
## diabetes-platelets.first                                      -0.0043         -0.0392
## diabetes-serum_creatinine.first                               -0.1557     *   -0.2778
## diabetes-serum_sodium.first                                   -0.0685     *   -0.1689
## diabetes-sex.first                                             0.0000         -0.0296
## diabetes-smoking.first                                        -0.0003         -0.0247
## diabetes-time.first                                           -0.4993     *   -0.5858
## ejection_fraction-high_blood_pressure.first                    0.1184     *    0.0041
## ejection_fraction-platelets.first                              0.1254     *    0.0147
## ejection_fraction-serum_creatinine.first                      -0.0260         -0.1891
```

```
## ejection_fraction-serum_sodium.first                          0.0612          -0.0756
## ejection_fraction-sex.first                                   0.1297      *    0.0059
## ejection_fraction-smoking.first                               0.1294      *    0.0237
## ejection_fraction-time.first                                 -0.3696      *   -0.5277
## high_blood_pressure-platelets.first                           0.0070          -0.0417
## high_blood_pressure-serum_creatinine.first                   -0.1444      *   -0.2724
## high_blood_pressure-serum_sodium.first                       -0.0572          -0.1576
## high_blood_pressure-sex.first                                 0.0113          -0.0348
## high_blood_pressure-smoking.first                             0.0110          -0.0199
## high_blood_pressure-time.first                               -0.4880      *   -0.5778
## platelets-serum_creatinine.first                             -0.1514      *   -0.2772
## platelets-serum_sodium.first                                 -0.0642      *   -0.1669
## platelets-sex.first                                           0.0043          -0.0375
## platelets-smoking.first                                       0.0041          -0.0309
## platelets-time.first                                         -0.4950      *   -0.5823
## serum_creatinine-serum_sodium.first                           0.0872          -0.0295
## serum_creatinine-sex.first                                    0.1557      *    0.0527
## serum_creatinine-smoking.first                                0.1554      *    0.0493
## serum_creatinine-time.first                                  -0.3436      *   -0.5058
## serum_sodium-sex.first                                        0.0685      *    0.0050
## serum_sodium-smoking.first                                    0.0682      *    0.0072
## serum_sodium-time.first                                      -0.4308      *   -0.5336
## sex-smoking.first                                            -0.0003          -0.0204
## sex-time.first                                               -0.4993      *   -0.5800
## smoking-time.first                                           -0.4990      *   -0.5849
##
## age-anaemia.pratt                                             0.0897          -0.0002
## age-creatinine_phosphokinase.pratt                            0.0786          -0.0134
## age-diabetes.pratt                                            0.0894      *    0.0147
## age-ejection_fraction.pratt                                  -0.0711          -0.2348
## age-high_blood_pressure.pratt                                 0.0921      *    0.0156
## age-platelets.pratt                                           0.0872      *    0.0120
## age-serum_creatinine.pratt                                   -0.0439          -0.2078
## age-serum_sodium.pratt                                        0.0557          -0.0694
## age-sex.pratt                                                 0.0886      *    0.0138
## age-smoking.pratt                                             0.0891      *    0.0131
## age-time.pratt                                               -0.4841      *   -0.6438
## anaemia-creatinine_phosphokinase.pratt                       -0.0112          -0.0517
## anaemia-diabetes.pratt                                       -0.0004          -0.0423
## anaemia-ejection_fraction.pratt                              -0.1608      *   -0.2850
## anaemia-high_blood_pressure.pratt                             0.0023          -0.0283
## anaemia-platelets.pratt                                      -0.0025          -0.0365
## anaemia-serum_creatinine.pratt                               -0.1336      *   -0.2699
## anaemia-serum_sodium.pratt                                   -0.0340          -0.1239
## anaemia-sex.pratt                                            -0.0011          -0.0590
## anaemia-smoking.pratt                                        -0.0006          -0.0171
## anaemia-time.pratt                                           -0.5738      *   -0.6791
## creatinine_phosphokinase-diabetes.pratt                       0.0108          -0.0278
## creatinine_phosphokinase-ejection_fraction.pratt             -0.1497      *   -0.2846
## creatinine_phosphokinase-high_blood_pressure.pratt            0.0135          -0.0250
```

```
## creatinine_phosphokinase-platelets.pratt                 0.0086          -0.0244
## creatinine_phosphokinase-serum_creatinine.pratt         -0.1225     *   -0.2475
## creatinine_phosphokinase-serum_sodium.pratt             -0.0229          -0.1104
## creatinine_phosphokinase-sex.pratt                       0.0100          -0.0545
## creatinine_phosphokinase-smoking.pratt                   0.0105          -0.0152
## creatinine_phosphokinase-time.pratt                     -0.5627     *   -0.6756
## diabetes-ejection_fraction.pratt                        -0.1605     *   -0.2934
## diabetes-high_blood_pressure.pratt                       0.0027          -0.0247
## diabetes-platelets.pratt                                -0.0022          -0.0302
## diabetes-serum_creatinine.pratt                         -0.1333     *   -0.2694
## diabetes-serum_sodium.pratt                             -0.0337          -0.1227
## diabetes-sex.pratt                                      -0.0008          -0.0522
## diabetes-smoking.pratt                                  -0.0003          -0.0211
## diabetes-time.pratt                                     -0.5735     *   -0.6809
## ejection_fraction-high_blood_pressure.pratt              0.1631     *    0.0451
## ejection_fraction-platelets.pratt                        0.1583     *    0.0439
## ejection_fraction-serum_creatinine.pratt                 0.0272          -0.1515
## ejection_fraction-serum_sodium.pratt                     0.1268          -0.0279
## ejection_fraction-sex.pratt                              0.1597     *    0.0075
## ejection_fraction-smoking.pratt                          0.1602     *    0.0443
## ejection_fraction-time.pratt                            -0.4130     *   -0.6061
## high_blood_pressure-platelets.pratt                     -0.0048          -0.0334
## high_blood_pressure-serum_creatinine.pratt              -0.1359     *   -0.2764
## high_blood_pressure-serum_sodium.pratt                  -0.0364          -0.1173
## high_blood_pressure-sex.pratt                           -0.0035          -0.0581
## high_blood_pressure-smoking.pratt                       -0.0030          -0.0284
## high_blood_pressure-time.pratt                          -0.5761     *   -0.6826
## platelets-serum_creatinine.pratt                        -0.1311     *   -0.2690
## platelets-serum_sodium.pratt                            -0.0315          -0.1232
## platelets-sex.pratt                                      0.0014          -0.0544
## platelets-smoking.pratt                                  0.0019          -0.0182
## platelets-time.pratt                                    -0.5713     *   -0.6777
## serum_creatinine-serum_sodium.pratt                      0.0996          -0.0570
## serum_creatinine-sex.pratt                               0.1325     *    0.0152
## serum_creatinine-smoking.pratt                           0.1330     *    0.0129
## serum_creatinine-time.pratt                             -0.4402     *   -0.6507
## serum_sodium-sex.pratt                                   0.0329          -0.0264
## serum_sodium-smoking.pratt                               0.0334          -0.0133
## serum_sodium-time.pratt                                 -0.5398     *   -0.6636
## sex-smoking.pratt                                        0.0005          -0.0235
## sex-time.pratt                                          -0.5727     *   -0.6797
## smoking-time.pratt                                      -0.5732     *   -0.6751
##                                                          0.95
## age-anaemia.lmg                                          0.1615
## age-creatinine_phosphokinase.lmg                         0.1595
## age-diabetes.lmg                                         0.1605
## age-ejection_fraction.lmg                                0.0885
## age-high_blood_pressure.lmg                              0.1592
## age-platelets.lmg                                        0.1562
## age-serum_creatinine.lmg                                 0.0845
```

```
## age-serum_sodium.lmg                                  0.1342
## age-sex.lmg                                           0.1585
## age-smoking.lmg                                       0.1633
## age-time.lmg                                         -0.2148
## anaemia-creatinine_phosphokinase.lmg                  0.0241
## anaemia-diabetes.lmg                                  0.0298
## anaemia-ejection_fraction.lmg                        -0.0370
## anaemia-high_blood_pressure.lmg                       0.0283
## anaemia-platelets.lmg                                 0.0319
## anaemia-serum_creatinine.lmg                         -0.0221
## anaemia-serum_sodium.lmg                              0.0046
## anaemia-sex.lmg                                       0.0287
## anaemia-smoking.lmg                                   0.0298
## anaemia-time.lmg                                     -0.3422
## creatinine_phosphokinase-diabetes.lmg                 0.0487
## creatinine_phosphokinase-ejection_fraction.lmg       -0.0339
## creatinine_phosphokinase-high_blood_pressure.lmg      0.0453
## creatinine_phosphokinase-platelets.lmg                0.0532
## creatinine_phosphokinase-serum_creatinine.lmg        -0.0225
## creatinine_phosphokinase-serum_sodium.lmg             0.0206
## creatinine_phosphokinase-sex.lmg                      0.0489
## creatinine_phosphokinase-smoking.lmg                  0.0526
## creatinine_phosphokinase-time.lmg                    -0.3389
## diabetes-ejection_fraction.lmg                       -0.0436
## diabetes-high_blood_pressure.lmg                      0.0219
## diabetes-platelets.lmg                                0.0218
## diabetes-serum_creatinine.lmg                        -0.0226
## diabetes-serum_sodium.lmg                            -0.0004
## diabetes-sex.lmg                                      0.0233
## diabetes-smoking.lmg                                  0.0270
## diabetes-time.lmg                                    -0.3465
## ejection_fraction-high_blood_pressure.lmg             0.2577
## ejection_fraction-platelets.lmg                       0.2744
## ejection_fraction-serum_creatinine.lmg                0.2096
## ejection_fraction-serum_sodium.lmg                    0.2543
## ejection_fraction-sex.lmg                             0.2709
## ejection_fraction-smoking.lmg                         0.2759
## ejection_fraction-time.lmg                           -0.1238
## high_blood_pressure-platelets.lmg                     0.0490
## high_blood_pressure-serum_creatinine.lmg             -0.0091
## high_blood_pressure-serum_sodium.lmg                  0.0152
## high_blood_pressure-sex.lmg                           0.0480
## high_blood_pressure-smoking.lmg                       0.0484
## high_blood_pressure-time.lmg                         -0.3528
## platelets-serum_creatinine.lmg                       -0.0258
## platelets-serum_sodium.lmg                            0.0035
## platelets-sex.lmg                                     0.0273
## platelets-smoking.lmg                                 0.0279
## platelets-time.lmg                                   -0.3416
## serum_creatinine-serum_sodium.lmg                     0.2320
```

```
## serum_creatinine-sex.lmg                                    0.2606
## serum_creatinine-smoking.lmg                                0.2587
## serum_creatinine-time.lmg                                  -0.1437
## serum_sodium-sex.lmg                                        0.1215
## serum_sodium-smoking.lmg                                    0.1280
## serum_sodium-time.lmg                                      -0.2168
## sex-smoking.lmg                                             0.0452
## sex-time.lmg                                               -0.3452
## smoking-time.lmg                                           -0.3592
##
## age-anaemia.last                                           0.1485
## age-creatinine_phosphokinase.last                          0.1374
## age-diabetes.last                                          0.1386
## age-ejection_fraction.last                                 0.0308
## age-high_blood_pressure.last                               0.1502
## age-platelets.last                                         0.1531
## age-serum_creatinine.last                                  0.1201
## age-serum_sodium.last                                      0.1347
## age-sex.last                                               0.1489
## age-smoking.last                                           0.1543
## age-time.last                                             -0.2437
## anaemia-creatinine_phosphokinase.last                      0.0177
## anaemia-diabetes.last                                      0.0207
## anaemia-ejection_fraction.last                            -0.0600
## anaemia-high_blood_pressure.last                           0.0262
## anaemia-platelets.last                                     0.0314
## anaemia-serum_creatinine.last                             -0.0038
## anaemia-serum_sodium.last                                  0.0165
## anaemia-sex.last                                           0.0271
## anaemia-smoking.last                                       0.0298
## anaemia-time.last                                         -0.3708
## creatinine_phosphokinase-diabetes.last                     0.0536
## creatinine_phosphokinase-ejection_fraction.last           -0.0466
## creatinine_phosphokinase-high_blood_pressure.last          0.0644
## creatinine_phosphokinase-platelets.last                    0.0570
## creatinine_phosphokinase-serum_creatinine.last             0.0071
## creatinine_phosphokinase-serum_sodium.last                 0.0500
## creatinine_phosphokinase-sex.last                          0.0526
## creatinine_phosphokinase-smoking.last                      0.0643
## creatinine_phosphokinase-time.last                        -0.3583
## diabetes-ejection_fraction.last                           -0.0493
## diabetes-high_blood_pressure.last                          0.0342
## diabetes-platelets.last                                    0.0405
## diabetes-serum_creatinine.last                             0.0017
## diabetes-serum_sodium.last                                 0.0237
## diabetes-sex.last                                          0.0286
## diabetes-smoking.last                                      0.0413
## diabetes-time.last                                        -0.3665
## ejection_fraction-high_blood_pressure.last                 0.3378
## ejection_fraction-platelets.last                           0.3392
```

```
## ejection_fraction-serum_creatinine.last                    0.3118
## ejection_fraction-serum_sodium.last                        0.3367
## ejection_fraction-sex.last                                 0.3404
## ejection_fraction-smoking.last                             0.3427
## ejection_fraction-time.last                               -0.0676
## high_blood_pressure-platelets.last                         0.0377
## high_blood_pressure-serum_creatinine.last                  0.0018
## high_blood_pressure-serum_sodium.last                      0.0258
## high_blood_pressure-sex.last                               0.0209
## high_blood_pressure-smoking.last                           0.0309
## high_blood_pressure-time.last                             -0.3684
## platelets-serum_creatinine.last                            0.0018
## platelets-serum_sodium.last                                0.0267
## platelets-sex.last                                         0.0267
## platelets-smoking.last                                     0.0260
## platelets-time.last                                       -0.3625
## serum_creatinine-serum_sodium.last                         0.2573
## serum_creatinine-sex.last                                  0.2495
## serum_creatinine-smoking.last                              0.2587
## serum_creatinine-time.last                                -0.1569
## serum_sodium-sex.last                                      0.0699
## serum_sodium-smoking.last                                  0.0752
## serum_sodium-time.last                                    -0.2971
## sex-smoking.last                                           0.0761
## sex-time.last                                             -0.3512
## smoking-time.last                                         -0.3708
##
## age-anaemia.first                                          0.1944
## age-creatinine_phosphokinase.first                         0.1944
## age-diabetes.first                                         0.1971
## age-ejection_fraction.first                                0.1371
## age-high_blood_pressure.first                              0.1926
## age-platelets.first                                        0.1938
## age-serum_creatinine.first                                 0.0736
## age-serum_sodium.first                                     0.1539
## age-sex.first                                              0.1974
## age-smoking.first                                          0.1969
## age-time.first                                            -0.1711
## anaemia-creatinine_phosphokinase.first                     0.0381
## anaemia-diabetes.first                                     0.0407
## anaemia-ejection_fraction.first                           -0.0166
## anaemia-high_blood_pressure.first                          0.0396
## anaemia-platelets.first                                    0.0404
## anaemia-serum_creatinine.first                            -0.0429
## anaemia-serum_sodium.first                                 0.0038
## anaemia-sex.first                                          0.0413
## anaemia-smoking.first                                      0.0402
## anaemia-time.first                                        -0.3206
## creatinine_phosphokinase-diabetes.first                    0.0444
## creatinine_phosphokinase-ejection_fraction.first          -0.0178
```

```
## creatinine_phosphokinase-high_blood_pressure.first    0.0409
## creatinine_phosphokinase-platelets.first              0.0419
## creatinine_phosphokinase-serum_creatinine.first      -0.0554
## creatinine_phosphokinase-serum_sodium.first           0.0198
## creatinine_phosphokinase-sex.first                    0.0433
## creatinine_phosphokinase-smoking.first                0.0411
## creatinine_phosphokinase-time.first                  -0.3296
## diabetes-ejection_fraction.first                     -0.0238
## diabetes-high_blood_pressure.first                    0.0274
## diabetes-platelets.first                              0.0320
## diabetes-serum_creatinine.first                      -0.0439
## diabetes-serum_sodium.first                          -0.0015
## diabetes-sex.first                                    0.0274
## diabetes-smoking.first                                0.0343
## diabetes-time.first                                  -0.3223
## ejection_fraction-high_blood_pressure.first           0.2428
## ejection_fraction-platelets.first                     0.2373
## ejection_fraction-serum_creatinine.first              0.1327
## ejection_fraction-serum_sodium.first                  0.1927
## ejection_fraction-sex.first                           0.2338
## ejection_fraction-smoking.first                       0.2440
## ejection_fraction-time.first                         -0.1551
## high_blood_pressure-platelets.first                   0.0739
## high_blood_pressure-serum_creatinine.first           -0.0225
## high_blood_pressure-serum_sodium.first                0.0213
## high_blood_pressure-sex.first                         0.0725
## high_blood_pressure-smoking.first                     0.0725
## high_blood_pressure-time.first                       -0.3218
## platelets-serum_creatinine.first                     -0.0526
## platelets-serum_sodium.first                         -0.0005
## platelets-sex.first                                   0.0382
## platelets-smoking.first                               0.0379
## platelets-time.first                                 -0.3144
## serum_creatinine-serum_sodium.first                   0.2530
## serum_creatinine-sex.first                            0.2790
## serum_creatinine-smoking.first                        0.2772
## serum_creatinine-time.first                          -0.1129
## serum_sodium-sex.first                                0.1516
## serum_sodium-smoking.first                            0.1598
## serum_sodium-time.first                              -0.1775
## sex-smoking.first                                     0.0359
## sex-time.first                                       -0.3228
## smoking-time.first                                   -0.3335
##
## age-anaemia.pratt                                     0.1659
## age-creatinine_phosphokinase.pratt                    0.1620
## age-diabetes.pratt                                    0.1699
## age-ejection_fraction.pratt                           0.0839
## age-high_blood_pressure.pratt                         0.1673
## age-platelets.pratt                                   0.1664
```

```
## age-serum_creatinine.pratt                                    0.0993
## age-serum_sodium.pratt                                         0.1505
## age-sex.pratt                                                  0.1719
## age-smoking.pratt                                              0.1757
## age-time.pratt                                                -0.2246
## anaemia-creatinine_phosphokinase.pratt                         0.0294
## anaemia-diabetes.pratt                                         0.0291
## anaemia-ejection_fraction.pratt                               -0.0470
## anaemia-high_blood_pressure.pratt                              0.0320
## anaemia-platelets.pratt                                        0.0342
## anaemia-serum_creatinine.pratt                                -0.0178
## anaemia-serum_sodium.pratt                                     0.0202
## anaemia-sex.pratt                                              0.0291
## anaemia-smoking.pratt                                          0.0278
## anaemia-time.pratt                                            -0.3654
## creatinine_phosphokinase-diabetes.pratt                        0.0488
## creatinine_phosphokinase-ejection_fraction.pratt             -0.0364
## creatinine_phosphokinase-high_blood_pressure.pratt            0.0541
## creatinine_phosphokinase-platelets.pratt                      0.0514
## creatinine_phosphokinase-serum_creatinine.pratt              -0.0096
## creatinine_phosphokinase-serum_sodium.pratt                   0.0283
## creatinine_phosphokinase-sex.pratt                            0.0549
## creatinine_phosphokinase-smoking.pratt                        0.0538
## creatinine_phosphokinase-time.pratt                          -0.3637
## diabetes-ejection_fraction.pratt                             -0.0416
## diabetes-high_blood_pressure.pratt                            0.0339
## diabetes-platelets.pratt                                      0.0229
## diabetes-serum_creatinine.pratt                              -0.0155
## diabetes-serum_sodium.pratt                                   0.0104
## diabetes-sex.pratt                                            0.0277
## diabetes-smoking.pratt                                        0.0382
## diabetes-time.pratt                                          -0.3733
## ejection_fraction-high_blood_pressure.pratt                   0.2845
## ejection_fraction-platelets.pratt                             0.2966
## ejection_fraction-serum_creatinine.pratt                      0.2347
## ejection_fraction-serum_sodium.pratt                          0.2901
## ejection_fraction-sex.pratt                                   0.2959
## ejection_fraction-smoking.pratt                               0.2983
## ejection_fraction-time.pratt                                 -0.1261
## high_blood_pressure-platelets.pratt                           0.0283
## high_blood_pressure-serum_creatinine.pratt                   -0.0124
## high_blood_pressure-serum_sodium.pratt                        0.0156
## high_blood_pressure-sex.pratt                                 0.0300
## high_blood_pressure-smoking.pratt                             0.0305
## high_blood_pressure-time.pratt                               -0.3739
## platelets-serum_creatinine.pratt                             -0.0177
## platelets-serum_sodium.pratt                                  0.0140
## platelets-sex.pratt                                           0.0367
## platelets-smoking.pratt                                       0.0284
## platelets-time.pratt                                         -0.3666
```

```
## serum_creatinine-serum_sodium.pratt                    0.2547
## serum_creatinine-sex.pratt                             0.2708
## serum_creatinine-smoking.pratt                         0.2672
## serum_creatinine-time.pratt                           -0.1569
## serum_sodium-sex.pratt                                 0.1233
## serum_sodium-smoking.pratt                             0.1241
## serum_sodium-time.pratt                               -0.2495
## sex-smoking.pratt                                      0.0611
## sex-time.pratt                                        -0.3705
## smoking-time.pratt                                    -0.3763
##
## * indicates that CI for difference does not include 0.
## CAUTION: Bootstrap confidence intervals can be somewhat liberal.

plot(booteval.relimp(boot,sort=TRUE))

## Warning in rev(variances[[p]]) - variances[[p + 1]]: Recycling array of le
ngth 1 in vector-array arithmetic is deprecated.
##    Use c() or as.vector() instead.
```


Relative importances for DEATH_EVENT
with 95% bootstrap confidence intervals
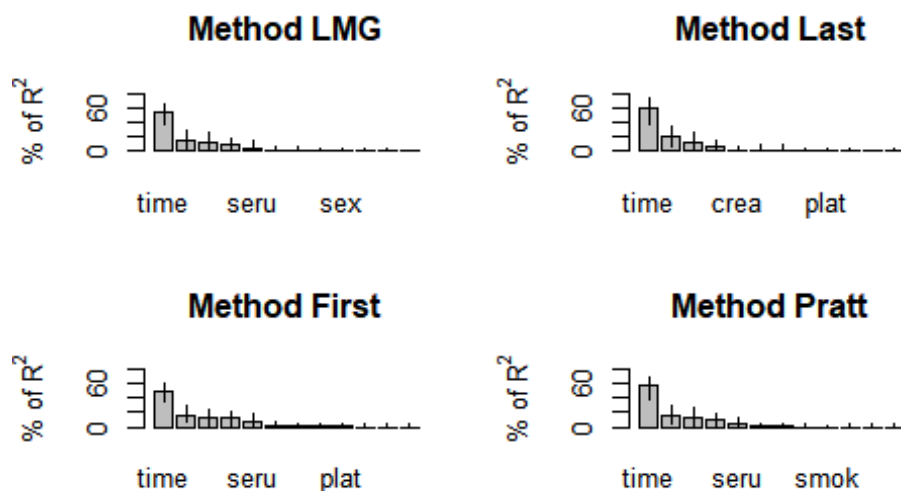
$R^2 = 41.68\%$, metrics are normalized to sum 100%.

```
summary(fit)

##
## Call:
## lm(formula = DEATH_EVENT ~ age + anaemia + creatinine_phosphokinase +
##       diabetes + ejection_fraction + high_blood_pressure + platelets +
##       serum_creatinine + serum_sodium + sex + smoking + time, data = dataset
```

```
)
##
## Residuals:
##     Min       1Q    Median       3Q      Max
## -0.80866 -0.28041 -0.04205  0.24742  0.96983
##
## Coefficients:
##                            Estimate Std. Error t value Pr(>|t|)
## (Intercept)               1.664e+00  6.954e-01   2.392  0.01738 *
## age                       5.767e-03  1.867e-03   3.088  0.00221 **
## anaemia                  -2.766e-03  4.438e-02  -0.062  0.95035
## creatinine_phosphokinase  3.427e-05  2.247e-05   1.525  0.12840
## diabetes                  1.928e-02  4.410e-02   0.437  0.66236
## ejection_fraction        -9.834e-03  1.844e-03  -5.333 1.96e-07 ***
## high_blood_pressure      -1.430e-02  4.565e-02  -0.313  0.75438
## platelets                -8.370e-08  2.208e-07  -0.379  0.70492
## serum_creatinine          8.527e-02  2.123e-02   4.017 7.54e-05 ***
## serum_sodium             -7.599e-03  5.024e-03  -1.513  0.13149
## sex                      -6.369e-02  5.108e-02  -1.247  0.21353
## smoking                  -5.733e-03  5.119e-02  -0.112  0.91091
## time                     -2.733e-03  2.903e-04  -9.415  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.3646 on 286 degrees of freedom
## Multiple R-squared:  0.4168, Adjusted R-squared:  0.3924
## F-statistic: 17.04 on 12 and 286 DF,  p-value: < 2.2e-16
```