Code_All

Rizal Mujahiddan

5/24/2022

Analysis Data with R

Import Library

```
current_0 <- Sys.time()
library(tidyverse)
```

```
## -- Attaching packages --------------------------------------- tidyverse 1.3.1 --

## v ggplot2 3.3.6     v purrr   0.3.4
## v tibble  3.1.7     v dplyr   1.0.9
## v tidyr   1.2.0     v stringr 1.4.0
## v readr   2.1.2     v forcats 0.5.1

## -- Conflicts ------------------------------------------ tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```
library(dplyr)
library(rpart)
library(rpart.plot)
library(caret)
```

```
## Loading required package: lattice

##
## Attaching package: 'caret'

## The following object is masked from 'package:purrr':
##
##     lift
```

```
library(caTools)
library(earth)
```

```
## Loading required package: Formula
```

```
## Loading required package: plotmo

## Loading required package: plotrix

## Loading required package: TeachingDemos
```

```
library(mda)
```

```
## Loading required package: class

## Loaded mda 0.5-3
```

```
library(ROSE)
```

```
## Loaded ROSE 0.0-4
```

```
library(DataExplorer)
library(car)
```

```
## Loading required package: carData

##
## Attaching package: 'car'

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

## The following object is masked from 'package:purrr':
##
##     some
```

```
library(randomForest)
```

```
## randomForest 4.7-1.1

## Type rfNews() to see new features/changes/bug fixes.

##
## Attaching package: 'randomForest'

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

## The following object is masked from 'package:ggplot2':
##
##     margin
```

```
library(mlr)
```

```
## Loading required package: ParamHelpers
```

```
## Warning message: 'mlr' is in 'maintenance-only' mode since July 2019.
## Future development will only happen in 'mlr3'
## (<https://mlr3.mlr-org.com>). Due to the focus on 'mlr3' there might be
## uncaught bugs meanwhile in {mlr} - please consider switching.
```

```
##
## Attaching package: 'mlr'
```

```
## The following object is masked from 'package:caret':
##
##     train
```

Import data from csv

```
data <- read.csv("dataset.csv")
ukuran_data <- dim(data)
head_data <- head(data)
write.csv(head_data,"head_data.csv")
summary(data)
```

```
##   encounter_id      patient_id      hospital_id         age
##  Min.   :     1   Min.   :     1   Min.   :  2.0   Min.   :16.00
##  1st Qu.: 32852   1st Qu.: 32830   1st Qu.: 47.0   1st Qu.:52.00
##  Median : 65665   Median : 65413   Median :109.0   Median :65.00
##  Mean   : 65606   Mean   : 65537   Mean   :105.7   Mean   :62.31
##  3rd Qu.: 98342   3rd Qu.: 98298   3rd Qu.:161.0   3rd Qu.:75.00
##  Max.   :131051   Max.   :131051   Max.   :204.0   Max.   :89.00
##                                                    NA's   :4228
##       bmi        elective_surgery  ethnicity           gender
##  Min.   :14.85   Min.   :0.0000   Length:91713       Length:91713
##  1st Qu.:23.64   1st Qu.:0.0000   Class :character   Class :character
##  Median :27.66   Median :0.0000   Mode  :character   Mode  :character
##  Mean   :29.19   Mean   :0.1837
##  3rd Qu.:32.93   3rd Qu.:0.0000
##  Max.   :67.81   Max.   :1.0000
##  NA's   :3429
##      height      icu_admit_source       icu_id      icu_stay_type
##  Min.   :137.2   Length:91713       Min.   : 82.0   Length:91713
##  1st Qu.:162.5   Class :character   1st Qu.:369.0   Class :character
##  Median :170.1   Mode  :character   Median :504.0   Mode  :character
##  Mean   :169.6                      Mean   :508.4
##  3rd Qu.:177.8                      3rd Qu.:679.0
##  Max.   :195.6                      Max.   :927.0
##  NA's   :1334
##    icu_type         pre_icu_los_days        weight       apache_2_diagnosis
##  Length:91713       Min.   :-24.94722   Min.   : 38.60   Min.   :101.0
```

```
##  Class :character   1st Qu.:  0.03542   1st Qu.: 66.80   1st Qu.:113.0
##  Mode  :character   Median :  0.13889   Median : 80.30   Median :122.0
##                     Mean   :  0.83577   Mean   : 84.03   Mean   :185.4
##                     3rd Qu.:  0.40903   3rd Qu.: 97.10   3rd Qu.:301.0
##                     Max.   :159.09097   Max.   :186.00   Max.   :308.0
##                                         NA's   :2720     NA's   :1662
##  apache_3j_diagnosis apache_post_operative   arf_apache    gcs_eyes_apache
##  Min.   :   0.01     Min.   :0.0000        Min.   :0.000   Min.   :1.000
##  1st Qu.: 203.01     1st Qu.:0.0000        1st Qu.:0.000   1st Qu.:3.000
##  Median : 409.02     Median :0.0000        Median :0.000   Median :4.000
##  Mean   : 558.22     Mean   :0.2011        Mean   :0.028   Mean   :3.465
##  3rd Qu.: 703.03     3rd Qu.:0.0000        3rd Qu.:0.000   3rd Qu.:4.000
##  Max.   :2201.05     Max.   :1.0000        Max.   :1.000   Max.   :4.000
##  NA's   :1101                              NA's   :715     NA's   :1901
##  gcs_motor_apache gcs_unable_apache gcs_verbal_apache heart_rate_apache
##  Min.   :1.000    Min.   :0.0000    Min.   :1.000     Min.   : 30.00
##  1st Qu.:6.000    1st Qu.:0.0000    1st Qu.:4.000     1st Qu.: 86.00
##  Median :6.000    Median :0.0000    Median :5.000     Median :104.00
##  Mean   :5.471    Mean   :0.0095    Mean   :3.995     Mean   : 99.71
##  3rd Qu.:6.000    3rd Qu.:0.0000    3rd Qu.:5.000     3rd Qu.:120.00
##  Max.   :6.000    Max.   :1.0000    Max.   :5.000     Max.   :178.00
##  NA's   :1901     NA's   :1037      NA's   :1901      NA's   :878
##  intubated_apache   map_apache     resprate_apache  temp_apache
##  Min.   :0.0000   Min.   : 40.00   Min.   : 4.00   Min.   :32.10
##  1st Qu.:0.0000   1st Qu.: 54.00   1st Qu.:11.00   1st Qu.:36.20
##  Median :0.0000   Median : 67.00   Median :28.00   Median :36.50
##  Mean   :0.1512   Mean   : 88.02   Mean   :25.81   Mean   :36.41
##  3rd Qu.:0.0000   3rd Qu.:125.00   3rd Qu.:36.00   3rd Qu.:36.70
##  Max.   :1.0000   Max.   :200.00   Max.   :60.00   Max.   :39.70
##  NA's   :715      NA's   :994      NA's   :1234    NA's   :4108
##  ventilated_apache d1_diasbp_max    d1_diasbp_min   d1_diasbp_noninvasive_max
##  Min.   :0.0000    Min.   : 46.00   Min.   :13.00   Min.   : 46.00
##  1st Qu.:0.0000    1st Qu.: 75.00   1st Qu.:42.00   1st Qu.: 75.00
##  Median :0.0000    Median : 86.00   Median :50.00   Median : 87.00
##  Mean   :0.3257    Mean   : 88.49   Mean   :50.16   Mean   : 88.61
##  3rd Qu.:1.0000    3rd Qu.: 99.00   3rd Qu.:58.00   3rd Qu.: 99.00
##  Max.   :1.0000    Max.   :165.00   Max.   :90.00   Max.   :165.00
##  NA's   :715       NA's   :165      NA's   :165     NA's   :1040
##  d1_diasbp_noninvasive_min d1_heartrate_max d1_heartrate_min   d1_mbp_max
##  Min.   :13.00             Min.   : 58      Min.   :  0.00   Min.   : 60.0
##  1st Qu.:42.00             1st Qu.: 87      1st Qu.: 60.00   1st Qu.: 90.0
##  Median :50.00             Median :101      Median : 69.00   Median :102.0
##  Mean   :50.24             Mean   :103      Mean   : 70.32   Mean   :104.7
##  3rd Qu.:58.00             3rd Qu.:116      3rd Qu.: 81.00   3rd Qu.:116.0
##  Max.   :90.00             Max.   :177      Max.   :175.00   Max.   :184.0
##  NA's   :1040              NA's   :145      NA's   :145      NA's   :220
##    d1_mbp_min     d1_mbp_noninvasive_max d1_mbp_noninvasive_min d1_resprate_max
##  Min.   : 22.00   Min.   : 60.0          Min.   : 22.00         Min.   :14.00
##  1st Qu.: 55.00   1st Qu.: 90.0          1st Qu.: 55.00         1st Qu.:22.00
##  Median : 64.00   Median :102.0          Median : 64.00         Median :26.00
##  Mean   : 64.87   Mean   :104.6          Mean   : 64.94         Mean   :28.88
##  3rd Qu.: 75.00   3rd Qu.:116.0          3rd Qu.: 75.00         3rd Qu.:32.00
##  Max.   :112.00   Max.   :181.0          Max.   :112.00         Max.   :92.00
##  NA's   :220      NA's   :1479           NA's   :1479           NA's   :385
```

```
##  d1_resprate_min   d1_spo2_max      d1_spo2_min      d1_sysbp_max
##  Min.   :  0.00   Min.   :  0.00   Min.   :  0.00   Min.   : 90.0
##  1st Qu.: 10.00   1st Qu.: 99.00   1st Qu.: 89.00   1st Qu.:130.0
##  Median : 13.00   Median :100.00   Median : 92.00   Median :146.0
##  Mean   : 12.85   Mean   : 99.24   Mean   : 90.45   Mean   :148.3
##  3rd Qu.: 16.00   3rd Qu.:100.00   3rd Qu.: 95.00   3rd Qu.:164.0
##  Max.   :100.00   Max.   :100.00   Max.   :100.00   Max.   :232.0
##  NA's   :385      NA's   :333      NA's   :333      NA's   :159
##   d1_sysbp_min    d1_sysbp_noninvasive_max d1_sysbp_noninvasive_min
##  Min.   : 41.00   Min.   : 90.0            Min.   : 41.03
##  1st Qu.: 83.00   1st Qu.:130.0            1st Qu.: 84.00
##  Median : 96.00   Median :146.0            Median : 96.00
##  Mean   : 96.92   Mean   :148.2            Mean   : 96.99
##  3rd Qu.:110.00   3rd Qu.:164.0            3rd Qu.:110.00
##  Max.   :160.00   Max.   :232.0            Max.   :160.00
##  NA's   :159      NA's   :1027             NA's   :1027
##   d1_temp_max     d1_temp_min    h1_diasbp_max    h1_diasbp_min
##  Min.   :35.10   Min.   :31.89   Min.   : 37.00   Min.   : 22.00
##  1st Qu.:36.90   1st Qu.:36.10   1st Qu.: 62.00   1st Qu.: 52.00
##  Median :37.11   Median :36.40   Median : 74.00   Median : 62.00
##  Mean   :37.28   Mean   :36.27   Mean   : 75.36   Mean   : 62.84
##  3rd Qu.:37.60   3rd Qu.:36.66   3rd Qu.: 86.00   3rd Qu.: 73.00
##  Max.   :39.90   Max.   :37.80   Max.   :143.00   Max.   :113.00
##  NA's   :2324    NA's   :2324    NA's   :3619     NA's   :3619
##  h1_diasbp_noninvasive_max h1_diasbp_noninvasive_min h1_heartrate_max
##  Min.   : 37.00            Min.   : 22.00            Min.   : 46.00
##  1st Qu.: 63.00            1st Qu.: 52.00            1st Qu.: 77.00
##  Median : 74.00            Median : 62.00            Median : 90.00
##  Mean   : 75.81            Mean   : 63.27            Mean   : 92.23
##  3rd Qu.: 87.00            3rd Qu.: 74.00            3rd Qu.:106.00
##  Max.   :144.00            Max.   :114.00            Max.   :164.00
##  NA's   :7350              NA's   :7350              NA's   :2790
##  h1_heartrate_min   h1_mbp_max       h1_mbp_min    h1_mbp_noninvasive_max
##  Min.   : 36.00   Min.   : 49.00   Min.   : 32.0   Min.   : 49.00
##  1st Qu.: 69.00   1st Qu.: 77.00   1st Qu.: 66.0   1st Qu.: 77.00
##  Median : 82.00   Median : 90.00   Median : 78.0   Median : 90.00
##  Mean   : 83.66   Mean   : 91.61   Mean   : 79.4   Mean   : 91.59
##  3rd Qu.: 97.00   3rd Qu.:104.00   3rd Qu.: 92.0   3rd Qu.:104.00
##  Max.   :144.00   Max.   :165.00   Max.   :138.0   Max.   :163.00
##  NA's   :2790     NA's   :4639     NA's   :4639    NA's   :9084
##  h1_mbp_noninvasive_min h1_resprate_max h1_resprate_min   h1_spo2_max
##  Min.   : 32.00         Min.   :10.00   Min.   :  0.00   Min.   :  0.00
##  1st Qu.: 66.00         1st Qu.:18.00   1st Qu.: 14.00   1st Qu.: 97.00
##  Median : 79.00         Median :21.00   Median : 16.00   Median : 99.00
##  Mean   : 79.71         Mean   :22.63   Mean   : 17.21   Mean   : 98.05
##  3rd Qu.: 92.00         3rd Qu.:26.00   3rd Qu.: 20.00   3rd Qu.:100.00
##  Max.   :138.00         Max.   :59.00   Max.   :189.00   Max.   :100.00
##  NA's   :9084           NA's   :4357    NA's   :4357     NA's   :4185
##   h1_spo2_min      h1_sysbp_max    h1_sysbp_min   h1_sysbp_noninvasive_max
##  Min.   :  0.00   Min.   : 75.0   Min.   : 53.0   Min.   : 75.0
##  1st Qu.: 94.00   1st Qu.:113.0   1st Qu.: 98.0   1st Qu.:113.0
##  Median : 96.00   Median :131.0   Median :115.0   Median :130.0
##  Mean   : 95.17   Mean   :133.2   Mean   :116.4   Mean   :133.1
##  3rd Qu.: 99.00   3rd Qu.:150.0   3rd Qu.:134.0   3rd Qu.:150.0
```

```
##  Max.   :100.00   Max.   :223.0   Max.   :194.0   Max.   :223.0
##  NA's   :4185     NA's   :3611    NA's   :3611    NA's   :7341
##  h1_sysbp_noninvasive_min d1_glucose_max  d1_glucose_min  d1_potassium_max
##  Min.   : 53.0            Min.   : 73.0   Min.   : 33.0   Min.   :2.800
##  1st Qu.: 98.0            1st Qu.:117.0   1st Qu.: 91.0   1st Qu.:3.800
##  Median :115.0            Median :150.0   Median :107.0   Median :4.200
##  Mean   :116.5            Mean   :174.6   Mean   :114.4   Mean   :4.252
##  3rd Qu.:134.0            3rd Qu.:201.0   3rd Qu.:131.0   3rd Qu.:4.600
##  Max.   :195.0            Max.   :611.0   Max.   :288.0   Max.   :7.000
##  NA's   :7341             NA's   :5807    NA's   :5807    NA's   :9585
##  d1_potassium_min apache_4a_hospital_death_prob apache_4a_icu_death_prob
##  Min.   :2.400    Min.   :-1.000                Min.   :-1.000
##  1st Qu.:3.600    1st Qu.: 0.020                1st Qu.: 0.010
##  Median :3.900    Median : 0.050                Median : 0.020
##  Mean   :3.935    Mean   : 0.087                Mean   : 0.044
##  3rd Qu.:4.300    3rd Qu.: 0.130                3rd Qu.: 0.060
##  Max.   :5.800    Max.   : 0.990                Max.   : 0.970
##  NA's   :9585     NA's   :7947                  NA's   :7947
##       aids         cirrhosis      diabetes_mellitus hepatic_failure
##  Min.   :0e+00   Min.   :0.0000   Min.   :0.0000    Min.   :0.000
##  1st Qu.:0e+00   1st Qu.:0.0000   1st Qu.:0.0000    1st Qu.:0.000
##  Median :0e+00   Median :0.0000   Median :0.0000    Median :0.000
##  Mean   :9e-04   Mean   :0.0157   Mean   :0.2252    Mean   :0.013
##  3rd Qu.:0e+00   3rd Qu.:0.0000   3rd Qu.:0.0000    3rd Qu.:0.000
##  Max.   :1e+00   Max.   :1.0000   Max.   :1.0000    Max.   :1.000
##  NA's   :715     NA's   :715      NA's   :715       NA's   :715
##  immunosuppression    leukemia         lymphoma
##  Min.   :0.0000    Min.   :0.0000   Min.   :0.0000
##  1st Qu.:0.0000    1st Qu.:0.0000   1st Qu.:0.0000
##  Median :0.0000    Median :0.0000   Median :0.0000
##  Mean   :0.0262    Mean   :0.0071   Mean   :0.0041
##  3rd Qu.:0.0000    3rd Qu.:0.0000   3rd Qu.:0.0000
##  Max.   :1.0000    Max.   :1.0000   Max.   :1.0000
##  NA's   :715       NA's   :715      NA's   :715
##  solid_tumor_with_metastasis apache_3j_bodysystem apache_2_bodysystem
##  Min.   :0.0000              Length:91713         Length:91713
##  1st Qu.:0.0000              Class :character     Class :character
##  Median :0.0000              Mode  :character     Mode  :character
##  Mean   :0.0206
##  3rd Qu.:0.0000
##  Max.   :1.0000
##  NA's   :715
##     X           hospital_death
##  Mode:logical   Min.   :0.0000
##  NA's:91713     1st Qu.:0.0000
##                 Median :0.0000
##                 Mean   :0.0863
##                 3rd Qu.:0.0000
##                 Max.   :1.0000
##
```

Handling Missing Value

Check Table frequency NA

```
# Check column if have NA's
kolom_NA <- data.frame(as.list(colSums(is.na(data))))
kolom_NA <- as.data.frame(t(kolom_NA))
kolom_NA <- data.frame(names = row.names(kolom_NA), kolom_NA)
rownames(kolom_NA) <- NULL
colnames(kolom_NA) <- c("Nama_Kolom","freq")

# pipelining https://raw.githubusercontent.com/rstudio/cheatsheets/main/data-transformation.pdf
kolom_NA <- kolom_NA %>%
              mutate(percen_freq = freq / ukuran_data[1] * 100) %>%
              filter(freq > 0)

kolom_NA
```

```
##                       Nama_Kolom  freq percen_freq
## 1                            age  4228   4.6100335
## 2                            bmi  3429   3.7388375
## 3                         height  1334   1.4545375
## 4                         weight  2720   2.9657737
## 5             apache_2_diagnosis  1662   1.8121749
## 6            apache_3j_diagnosis  1101   1.2004841
## 7                     arf_apache   715   0.7796059
## 8                gcs_eyes_apache  1901   2.0727705
## 9                gcs_motor_apache  1901   2.0727705
## 10              gcs_unable_apache  1037   1.1307012
## 11              gcs_verbal_apache  1901   2.0727705
## 12              heart_rate_apache   878   0.9573343
## 13               intubated_apache   715   0.7796059
## 14                    map_apache   994   1.0838158
## 15                resprate_apache  1234   1.3455017
## 16                    temp_apache  4108   4.4791905
## 17              ventilated_apache   715   0.7796059
## 18                  d1_diasbp_max   165   0.1799091
## 19                  d1_diasbp_min   165   0.1799091
## 20     d1_diasbp_noninvasive_max  1040   1.1339723
## 21     d1_diasbp_noninvasive_min  1040   1.1339723
## 22               d1_heartrate_max   145   0.1581019
## 23               d1_heartrate_min   145   0.1581019
## 24                    d1_mbp_max   220   0.2398788
## 25                    d1_mbp_min   220   0.2398788
## 26        d1_mbp_noninvasive_max  1479   1.6126394
## 27        d1_mbp_noninvasive_min  1479   1.6126394
## 28               d1_resprate_max   385   0.4197878
## 29               d1_resprate_min   385   0.4197878
## 30                   d1_spo2_max   333   0.3630892
## 31                   d1_spo2_min   333   0.3630892
## 32                  d1_sysbp_max   159   0.1733669
## 33                  d1_sysbp_min   159   0.1733669
## 34      d1_sysbp_noninvasive_max  1027   1.1197976
```

```
## 35      d1_sysbp_noninvasive_min  1027   1.1197976
## 36                   d1_temp_max  2324   2.5339919
## 37                   d1_temp_min  2324   2.5339919
## 38                 h1_diasbp_max  3619   3.9460055
## 39                 h1_diasbp_min  3619   3.9460055
## 40     h1_diasbp_noninvasive_max  7350   8.0141310
## 41     h1_diasbp_noninvasive_min  7350   8.0141310
## 42               h1_heartrate_max  2790   3.0420987
## 43               h1_heartrate_min  2790   3.0420987
## 44                     h1_mbp_max  4639   5.0581706
## 45                     h1_mbp_min  4639   5.0581706
## 46        h1_mbp_noninvasive_max  9084   9.9048117
## 47        h1_mbp_noninvasive_min  9084   9.9048117
## 48               h1_resprate_max  4357   4.7506897
## 49               h1_resprate_min  4357   4.7506897
## 50                   h1_spo2_max  4185   4.5631481
## 51                   h1_spo2_min  4185   4.5631481
## 52                  h1_sysbp_max  3611   3.9372826
## 53                  h1_sysbp_min  3611   3.9372826
## 54      h1_sysbp_noninvasive_max  7341   8.0043178
## 55      h1_sysbp_noninvasive_min  7341   8.0043178
## 56                d1_glucose_max  5807   6.3317087
## 57                d1_glucose_min  5807   6.3317087
## 58              d1_potassium_max  9585  10.4510811
## 59              d1_potassium_min  9585  10.4510811
## 60 apache_4a_hospital_death_prob  7947   8.6650747
## 61      apache_4a_icu_death_prob  7947   8.6650747
## 62                          aids   715   0.7796059
## 63                     cirrhosis   715   0.7796059
## 64             diabetes_mellitus   715   0.7796059
## 65               hepatic_failure   715   0.7796059
## 66             immunosuppression   715   0.7796059
## 67                      leukemia   715   0.7796059
## 68                      lymphoma   715   0.7796059
## 69   solid_tumor_with_metastasis   715   0.7796059
## 70                             X 91713 100.0000000
```

delete Column

reference for deleting attribute in columns with threshold 10%: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3701793/

```
kolom_delete <- kolom_NA %>% filter(percen_freq > 10)
kolom_NA <- kolom_NA %>%
              filter(percen_freq <= 10)
data <- data %>% select(-c(kolom_delete$Nama_Kolom))
```

Divide column by datatype with variable

```
# pembagian kolom NA berdasarkan tipe data
int_kat <- names(which(lapply(data[kolom_NA$Nama_Kolom],class) == "integer"))
```

```
flo_num <- names(which(lapply(data[kolom_NA$Nama_Kolom],class) == "numeric"))

kolom_NA_cat <- kolom_NA %>% filter(Nama_Kolom %in% int_kat) %>% select(Nama_Kolom)
kolom_NA_cat <- kolom_NA_cat$Nama_Kolom

kolom_NA_num <- kolom_NA %>% filter(Nama_Kolom %in% flo_num) %>% select(Nama_Kolom)
kolom_NA_num <- kolom_NA_num$Nama_Kolom
kolom_NA_num
```

```
##  [1] "bmi"                          "height"
##  [3] "weight"                       "apache_3j_diagnosis"
##  [5] "resprate_apache"              "temp_apache"
##  [7] "d1_sysbp_noninvasive_min"     "d1_temp_max"
##  [9] "d1_temp_min"                  "apache_4a_hospital_death_prob"
## [11] "apache_4a_icu_death_prob"
```

```
kolom_NA_cat
```

```
##  [1] "age"                          "apache_2_diagnosis"
##  [3] "arf_apache"                   "gcs_eyes_apache"
##  [5] "gcs_motor_apache"             "gcs_unable_apache"
##  [7] "gcs_verbal_apache"            "heart_rate_apache"
##  [9] "intubated_apache"             "map_apache"
## [11] "ventilated_apache"            "d1_diasbp_max"
## [13] "d1_diasbp_min"                "d1_diasbp_noninvasive_max"
## [15] "d1_diasbp_noninvasive_min"    "d1_heartrate_max"
## [17] "d1_heartrate_min"             "d1_mbp_max"
## [19] "d1_mbp_min"                   "d1_mbp_noninvasive_max"
## [21] "d1_mbp_noninvasive_min"       "d1_resprate_max"
## [23] "d1_resprate_min"              "d1_spo2_max"
## [25] "d1_spo2_min"                  "d1_sysbp_max"
## [27] "d1_sysbp_min"                 "d1_sysbp_noninvasive_max"
## [29] "h1_diasbp_max"                "h1_diasbp_min"
## [31] "h1_diasbp_noninvasive_max"    "h1_diasbp_noninvasive_min"
## [33] "h1_heartrate_max"             "h1_heartrate_min"
## [35] "h1_mbp_max"                   "h1_mbp_min"
## [37] "h1_mbp_noninvasive_max"       "h1_mbp_noninvasive_min"
## [39] "h1_resprate_max"              "h1_resprate_min"
## [41] "h1_spo2_max"                  "h1_spo2_min"
## [43] "h1_sysbp_max"                 "h1_sysbp_min"
## [45] "h1_sysbp_noninvasive_max"     "h1_sysbp_noninvasive_min"
## [47] "d1_glucose_max"               "d1_glucose_min"
## [49] "aids"                         "cirrhosis"
## [51] "diabetes_mellitus"            "hepatic_failure"
## [53] "immunosuppression"            "leukemia"
## [55] "lymphoma"                     "solid_tumor_with_metastasis"
```

median numeric imputation

```
for(kolomku in kolom_NA_num){
  data[[kolomku]][is.na(data[[kolomku]])] = median(data[[kolomku]],na.rm=T)
```

```
}

kolom_NA_cat_factor <- c()
kolom_NA_cat_int <- c()
for(kolom in kolom_NA_cat){
  banyak_unique <- length(unique(data[[kolom]]))
  if(banyak_unique > 10){
    kolom_NA_cat_int <- c(kolom_NA_cat_int,kolom)
  } else{
    kolom_NA_cat_factor <- c(kolom_NA_cat_factor,kolom)
  }
}
kolom_NA_cat_factor
```

```
##  [1] "arf_apache"                  "gcs_eyes_apache"
##  [3] "gcs_motor_apache"            "gcs_unable_apache"
##  [5] "gcs_verbal_apache"           "intubated_apache"
##  [7] "ventilated_apache"           "aids"
##  [9] "cirrhosis"                   "diabetes_mellitus"
## [11] "hepatic_failure"             "immunosuppression"
## [13] "leukemia"                    "lymphoma"
## [15] "solid_tumor_with_metastasis"
```

```
kolom_NA_cat_int
```

```
##  [1] "age"                         "apache_2_diagnosis"
##  [3] "heart_rate_apache"           "map_apache"
##  [5] "d1_diasbp_max"               "d1_diasbp_min"
##  [7] "d1_diasbp_noninvasive_max"   "d1_diasbp_noninvasive_min"
##  [9] "d1_heartrate_max"            "d1_heartrate_min"
## [11] "d1_mbp_max"                  "d1_mbp_min"
## [13] "d1_mbp_noninvasive_max"      "d1_mbp_noninvasive_min"
## [15] "d1_resprate_max"             "d1_resprate_min"
## [17] "d1_spo2_max"                 "d1_spo2_min"
## [19] "d1_sysbp_max"                "d1_sysbp_min"
## [21] "d1_sysbp_noninvasive_max"    "h1_diasbp_max"
## [23] "h1_diasbp_min"               "h1_diasbp_noninvasive_max"
## [25] "h1_diasbp_noninvasive_min"   "h1_heartrate_max"
## [27] "h1_heartrate_min"            "h1_mbp_max"
## [29] "h1_mbp_min"                  "h1_mbp_noninvasive_max"
## [31] "h1_mbp_noninvasive_min"      "h1_resprate_max"
## [33] "h1_resprate_min"             "h1_spo2_max"
## [35] "h1_spo2_min"                 "h1_sysbp_max"
## [37] "h1_sysbp_min"                "h1_sysbp_noninvasive_max"
## [39] "h1_sysbp_noninvasive_min"    "d1_glucose_max"
## [41] "d1_glucose_min"
```

median integer imputation

```
for(kolomku in kolom_NA_cat_int){
  data[[kolomku]][is.na(data[[kolomku]])] = median(data[[kolomku]],na.rm=T)
}
```

mode factor imputation

```
for(kolomku in kolom_NA_cat_factor){
  data[[kolomku]][is.na(data[[kolomku]])] = as.numeric(names(sort(-table(data[[kolomku]])))[1])
  data[[kolomku]] <- as.factor(data[[kolomku]])
}
```

Selecting Feature (Deleting id) because dont dependending for evaluation.

```
data <- data %>% select(-c(encounter_id,patient_id,
                           hospital_id,icu_id))
```

Factorizing Dataset

```
kol_char <- names(which(lapply(data,class)=="character"))

for(kol in kol_char){
  mode_impute <- names(sort(-table(data[[kol]])))[1]
   data[[kol]] <- replace(data[[kol]],data[[kol]]=="",mode_impute)
   data[[kol]] <- as.factor(data[[kol]])
}
head(data)
```

```
##   age      bmi elective_surgery ethnicity gender height
## 1  68 22.73000               0 Caucasian      M  180.3
## 2  77 27.42000               0 Caucasian      F  160.0
## 3  25 31.95000               0 Caucasian      F  172.7
## 4  81 22.64000               1 Caucasian      F  165.1
## 5  19 27.65465               0 Caucasian      M  188.0
## 6  67 27.56000               0 Caucasian      M  190.5
##            icu_admit_source icu_stay_type     icu_type pre_icu_los_days weight
## 1                     Floor         admit        CTICU      0.541666667   73.9
## 2                     Floor         admit Med-Surg ICU      0.927777778   70.2
## 3      Accident & Emergency         admit Med-Surg ICU      0.000694444   95.3
## 4 Operating Room / Recovery         admit        CTICU      0.000694444   61.7
## 5      Accident & Emergency         admit Med-Surg ICU      0.073611111   80.3
## 6      Accident & Emergency         admit Med-Surg ICU      0.000694444  100.0
##   apache_2_diagnosis apache_3j_diagnosis apache_post_operative arf_apache
## 1                113              502.01                     0          0
## 2                108              203.01                     0          0
## 3                122              703.03                     0          0
## 4                203             1206.03                     1          0
## 5                119              601.01                     0          0
## 6                301              403.01                     0          0
##   gcs_eyes_apache gcs_motor_apache gcs_unable_apache gcs_verbal_apache
## 1               3                6                 0                 4
## 2               1                3                 0                 1
## 3               3                6                 0                 5
```

```
## 4               4               6                0               5
## 5               4               6                0               5
## 6               4               6                0               5
##   heart_rate_apache intubated_apache map_apache resprate_apache temp_apache
## 1               118               0         40             36        39.3
## 2               120               0         46             33        35.1
## 3               102               0         68             37        36.7
## 4               114               1         60              4        34.8
## 5                60               0        103             16        36.7
## 6               113               0        130             35        36.6
##   ventilated_apache d1_diasbp_max d1_diasbp_min d1_diasbp_noninvasive_max
## 1                 0           68           37                        68
## 2                 1           95           31                        95
## 3                 0           88           48                        88
## 4                 1           48           42                        48
## 5                 0           99           57                        99
## 6                 0          100           61                       100
##   d1_diasbp_noninvasive_min d1_heartrate_max d1_heartrate_min d1_mbp_max
## 1                        37              119              72         89
## 2                        31              118              72        120
## 3                        48               96              68        102
## 4                        42              116              92         84
## 5                        57               89              60        104
## 6                        61              113              83        127
##   d1_mbp_min d1_mbp_noninvasive_max d1_mbp_noninvasive_min d1_resprate_max
## 1         46                     89                     46              34
## 2         38                    120                     38              32
## 3         68                    102                     68              21
## 4         84                     84                     84              23
## 5         90                    104                     90              18
## 6         80                    127                     80              32
##   d1_resprate_min d1_spo2_max d1_spo2_min d1_sysbp_max d1_sysbp_min
## 1              10         100          74          131           73
## 2              12         100          70          159           67
## 3               8          98          91          148          105
## 4               7         100          95          158           84
## 5              16         100          96          147          120
## 6              10          97          91          173          107
##   d1_sysbp_noninvasive_max d1_sysbp_noninvasive_min d1_temp_max d1_temp_min
## 1                      131                       73        39.9        37.2
## 2                      159                       67        36.3        35.1
## 3                      148                      105        37.0        36.7
## 4                      158                       84        38.0        34.8
## 5                      147                      120        37.2        36.7
## 6                      173                      107        36.8        36.6
##   h1_diasbp_max h1_diasbp_min h1_diasbp_noninvasive_max
## 1            68            63                        68
## 2            61            48                        61
## 3            88            58                        88
## 4            62            44                        74
## 5            99            68                        99
## 6            89            89                        89
##   h1_diasbp_noninvasive_min h1_heartrate_max h1_heartrate_min h1_mbp_max
## 1                        63              119              108         86
```

```
## 2                       48              114              100         85
## 3                       58               96               78         91
## 4                       62              100               96         92
## 5                       68               89               76        104
## 6                       89               83               83        111
##   h1_mbp_min h1_mbp_noninvasive_max h1_mbp_noninvasive_min h1_resprate_max
## 1         85                    86                    85              26
## 2         57                    85                    57              31
## 3         83                    91                    83              20
## 4         71                    90                    79              12
## 5         92                   104                    92              21
## 6        111                   111                   111              12
##   h1_resprate_min h1_spo2_max h1_spo2_min h1_sysbp_max h1_sysbp_min
## 1              18         100          74          131          115
## 2              28          95          70           95           71
## 3              16          98          91          148          124
## 4              11         100          99          136          106
## 5              16         100         100          130          120
## 6              12          97          97          143          143
##   h1_sysbp_noninvasive_max h1_sysbp_noninvasive_min d1_glucose_max
## 1                      131                      115            168
## 2                       95                       71            145
## 3                      148                      124            150
## 4                      130                      115            185
## 5                      130                      120            150
## 6                      143                      143            156
##   d1_glucose_min apache_4a_hospital_death_prob apache_4a_icu_death_prob aids
## 1            109                         0.10                     0.05    0
## 2            128                         0.47                     0.29    0
## 3            107                         0.00                     0.00    0
## 4             88                         0.04                     0.03    0
## 5            107                         0.05                     0.02    0
## 6            125                         0.05                     0.02    0
##   cirrhosis diabetes_mellitus hepatic_failure immunosuppression leukemia
## 1         0                 1               0                 0        0
## 2         0                 1               0                 0        0
## 3         0                 0               0                 0        0
## 4         0                 0               0                 0        0
## 5         0                 0               0                 0        0
## 6         0                 1               0                 0        0
##   lymphoma solid_tumor_with_metastasis apache_3j_bodysystem apache_2_bodysystem
## 1        0                           0              Sepsis      Cardiovascular
## 2        0                           0         Respiratory         Respiratory
## 3        0                           0           Metabolic           Metabolic
## 4        0                           0       Cardiovascular      Cardiovascular
## 5        0                           0              Trauma              Trauma
## 6        0                           0         Neurological          Neurologic
##   hospital_death
## 1              0
## 2              0
## 3              0
## 4              0
## 5              0
## 6              0
```

```
data <- data %>%
mutate(hospital_death = case_when(hospital_death == 0 ~ 'Survived',
                                  hospital_death == 1 ~ 'Death'))
data$hospital_death <- factor(data$hospital_death,levels = c("Survived","Death"),labels = c("Survived",
str(data)
```

```
## 'data.frame':    91713 obs. of  78 variables:
##  $ age                           : int  68 77 25 81 19 67 59 70 45 50 ...
##  $ bmi                           : num  22.7 27.4 31.9 22.6 27.7 ...
##  $ elective_surgery              : int  0 0 0 1 0 0 0 0 0 0 ...
##  $ ethnicity                     : Factor w/ 6 levels "African American",..: 3 3 3 3 3 3 3 3 3 3 ...
##  $ gender                        : Factor w/ 2 levels "F","M": 2 1 1 1 2 2 1 2 2 2 ...
##  $ height                        : num  180 160 173 165 188 ...
##  $ icu_admit_source              : Factor w/ 5 levels "Accident & Emergency",..: 2 2 1 3 1 1 1 1 4 1
##  $ icu_stay_type                 : Factor w/ 3 levels "admit","readmit",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ icu_type                      : Factor w/ 8 levels "Cardiac ICU",..: 4 5 5 4 5 5 5 5 2 2 ...
##  $ pre_icu_los_days              : num  0.541667 0.927778 0.000694 0.000694 0.073611 ...
##  $ weight                        : num  73.9 70.2 95.3 61.7 80.3 ...
##  $ apache_2_diagnosis            : int  113 108 122 203 119 301 108 113 116 112 ...
##  $ apache_3j_diagnosis           : num  502 203 703 1206 601 ...
##  $ apache_post_operative         : int  0 0 0 1 0 0 0 0 0 0 ...
##  $ arf_apache                    : Factor w/ 2 levels "0","1": 1 1 1 1 1 1 1 1 1 1 ...
##  $ gcs_eyes_apache               : Factor w/ 4 levels "1","2","3","4": 3 1 3 4 4 4 4 4 4 4 ...
##  $ gcs_motor_apache              : Factor w/ 6 levels "1","2","3","4",..: 6 3 6 6 6 6 6 6 6 6 ...
##  $ gcs_unable_apache             : Factor w/ 2 levels "0","1": 1 1 1 1 1 1 1 1 1 1 ...
##  $ gcs_verbal_apache             : Factor w/ 5 levels "1","2","3","4",..: 4 1 5 5 5 5 5 5 5 5 ...
##  $ heart_rate_apache             : int  118 120 102 114 60 113 133 120 82 94 ...
##  $ intubated_apache              : Factor w/ 2 levels "0","1": 1 1 1 2 1 1 2 1 1 1 ...
##  $ map_apache                    : int  40 46 68 60 103 130 138 60 66 58 ...
##  $ resprate_apache               : num  36 33 37 4 16 35 53 28 14 46 ...
##  $ temp_apache                   : num  39.3 35.1 36.7 34.8 36.7 36.6 35 36.6 36.9 36.3 ...
##  $ ventilated_apache             : Factor w/ 2 levels "0","1": 1 2 1 2 1 1 2 2 2 1 ...
##  $ d1_diasbp_max                 : num  68 95 88 48 99 100 76 84 65 83 ...
##  $ d1_diasbp_min                 : num  37 31 48 42 57 61 68 46 59 48 ...
##  $ d1_diasbp_noninvasive_max     : int  68 95 88 48 99 100 76 84 65 83 ...
##  $ d1_diasbp_noninvasive_min     : int  37 31 48 42 57 61 68 46 59 48 ...
##  $ d1_heartrate_max              : num  119 118 96 116 89 113 112 118 82 96 ...
##  $ d1_heartrate_min              : num  72 72 68 92 60 83 70 86 82 57 ...
##  $ d1_mbp_max                    : int  89 120 102 84 104 127 117 114 93 101 ...
##  $ d1_mbp_min                    : int  46 38 68 84 90 80 97 60 71 59 ...
##  $ d1_mbp_noninvasive_max        : num  89 120 102 84 104 127 117 114 93 101 ...
##  $ d1_mbp_noninvasive_min        : num  46 38 68 84 90 80 97 60 71 59 ...
##  $ d1_resprate_max               : num  34 32 21 23 18 32 38 28 24 44 ...
##  $ d1_resprate_min               : num  10 12 8 7 16 10 16 12 19 14 ...
##  $ d1_spo2_max                   : num  100 100 98 100 100 97 100 100 97 100 ...
##  $ d1_spo2_min                   : num  74 70 91 95 96 91 87 92 97 96 ...
##  $ d1_sysbp_max                  : num  131 159 148 158 147 173 151 147 104 135 ...
##  $ d1_sysbp_min                  : num  73 67 105 84 120 107 133 71 98 78 ...
##  $ d1_sysbp_noninvasive_max      : num  131 159 148 158 147 173 151 147 104 135 ...
##  $ d1_sysbp_noninvasive_min      : num  73 67 105 84 120 107 133 71 98 78 ...
##  $ d1_temp_max                   : num  39.9 36.3 37 38 37.2 36.8 37.2 38.5 36.9 37.1 ...
##  $ d1_temp_min                   : num  37.2 35.1 36.7 34.8 36.7 36.6 35 36.6 36.9 36.4 ...
##  $ h1_diasbp_max                 : num  68 61 88 62 99 89 107 74 65 83 ...
```

```
##  $ h1_diasbp_min                : num  63 48 58 44 68 89 79 55 59 61 ...
##  $ h1_diasbp_noninvasive_max    : int  68 61 88 74 99 89 74 74 65 83 ...
##  $ h1_diasbp_noninvasive_min    : int  63 48 58 62 68 89 62 55 59 61 ...
##  $ h1_heartrate_max             : int  119 114 96 100 89 83 79 118 82 96 ...
##  $ h1_heartrate_min             : int  108 100 78 96 76 83 72 114 82 60 ...
##  $ h1_mbp_max                   : num  86 85 91 92 104 111 117 88 93 101 ...
##  $ h1_mbp_min                   : num  85 57 83 71 92 111 117 60 71 77 ...
##  $ h1_mbp_noninvasive_max       : int  86 85 91 90 104 111 117 88 93 101 ...
##  $ h1_mbp_noninvasive_min       : int  85 57 83 79 92 111 117 60 71 77 ...
##  $ h1_resprate_max              : num  26 31 20 12 21 12 18 28 24 29 ...
##  $ h1_resprate_min              : num  18 28 16 11 16 12 18 26 19 17 ...
##  $ h1_spo2_max                  : num  100 95 98 100 100 97 100 96 97 100 ...
##  $ h1_spo2_min                  : num  74 70 91 99 100 97 100 92 97 96 ...
##  $ h1_sysbp_max                 : num  131 95 148 136 130 143 191 119 104 135 ...
##  $ h1_sysbp_min                 : num  115 71 124 106 120 143 163 106 98 103 ...
##  $ h1_sysbp_noninvasive_max     : num  131 95 148 130 130 143 130 119 104 135 ...
##  $ h1_sysbp_noninvasive_min     : num  115 71 124 115 120 143 115 106 98 103 ...
##  $ d1_glucose_max               : num  168 145 150 185 150 156 197 129 365 134 ...
##  $ d1_glucose_min               : num  109 128 107 88 107 125 129 129 288 134 ...
##  $ apache_4a_hospital_death_prob: num  0.1 0.47 0 0.04 0.05 0.05 0.1 0.11 0.05 0.02 ...
##  $ apache_4a_icu_death_prob     : num  0.05 0.29 0 0.03 0.02 0.02 0.05 0.06 0.02 0.01 ...
##  $ aids                         : Factor w/ 2 levels "0","1": 1 1 1 1 1 1 1 1 1 1 ...
##  $ cirrhosis                    : Factor w/ 2 levels "0","1": 1 1 1 1 1 1 1 1 1 1 ...
##  $ diabetes_mellitus            : Factor w/ 2 levels "0","1": 2 2 1 1 1 2 2 1 1 1 ...
##  $ hepatic_failure              : Factor w/ 2 levels "0","1": 1 1 1 1 1 1 1 1 1 1 ...
##  $ immunosuppression            : Factor w/ 2 levels "0","1": 1 1 1 1 1 1 1 2 1 1 ...
##  $ leukemia                     : Factor w/ 2 levels "0","1": 1 1 1 1 1 1 1 1 1 1 ...
##  $ lymphoma                     : Factor w/ 2 levels "0","1": 1 1 1 1 1 1 1 1 1 1 ...
##  $ solid_tumor_with_metastasis  : Factor w/ 2 levels "0","1": 1 1 1 1 1 1 1 1 1 1 ...
##  $ apache_3j_bodysystem         : Factor w/ 11 levels "Cardiovascular",..: 10 9 6 1 11 8 9 10 1 1 ..
##  $ apache_2_bodysystem          : Factor w/ 10 levels "Cardiovascular",..: 1 7 4 1 8 5 7 1 1 1 ...
##  $ hospital_death               : Factor w/ 2 levels "Survived","Death": 1 1 1 1 1 1 1 1 2 1 ...
```

feature engineering

averaging dataset

```
data$d1_diasbp <- (data$d1_diasbp_min +
                     data$d1_diasbp_max)/2
data$d1_diasbp_noninvasive <- (data$d1_diasbp_noninvasive_min +
                                 data$d1_diasbp_noninvasive_max)/2
data$d1_heartrate <- (data$d1_heartrate_min +
                    data$d1_heartrate_max) / 2
data$d1_mbp <- (data$d1_mbp_max + data$d1_mbp_min)/2
data$d1_mbp_noninvasive <- (data$d1_mbp_noninvasive_max +
                              data$d1_mbp_noninvasive_min)/2
data$d1_glucose <- (data$d1_glucose_max + data$d1_glucose_min)/2
data$d1_resprate <- (data$d1_resprate_min + data$d1_resprate_max)/2
data$d1_sysbp <- (data$d1_sysbp_min + data$d1_sysbp_max)/2
data$d1_sysbp_noninvasive <- (data$d1_sysbp_noninvasive_max +
                                data$d1_sysbp_noninvasive_min)/2
data$d1_temp <- (data$d1_temp_min + data$d1_temp_max)/2
```

```
data$h1_diasbp <- (data$h1_diasbp_max + data$h1_diasbp_min)/2
data$h1_diasbp_noninvasive <- (data$h1_diasbp_noninvasive_min +
                                 data$h1_diasbp_noninvasive_max)/2
data$h1_heartrate <- (data$h1_heartrate_min  + data$h1_heartrate_max)/2
data$h1_mbp <- (data$h1_mbp_max + data$h1_mbp_min)/2
data$h1_mbp_noninvasive <- (data$h1_mbp_noninvasive_max +
                              data$h1_mbp_noninvasive_min)/2
data$h1_resprate <- (data$h1_resprate_min + data$h1_resprate_max)
data$h1_spo2 <- (data$h1_spo2_min + data$h1_spo2_max)/2
data$h1_sysbp <- (data$h1_sysbp_max + data$h1_sysbp_min)/2
data$h1_sysbp_noninvasive <- (data$h1_sysbp_noninvasive_max +
                                data$h1_diasbp_noninvasive_min)/2


data <- data %>% select(-c(d1_diasbp_min,d1_diasbp_max,
                           d1_diasbp_noninvasive_max,
                           d1_diasbp_noninvasive_min,
                           d1_glucose_max,d1_glucose_min,
                           d1_heartrate_max,d1_heartrate_min,
                           d1_mbp_max,d1_mbp_min,
                           d1_mbp_noninvasive_max,
                           d1_mbp_min,d1_resprate_min,
                           d1_resprate_max,
                           d1_spo2_max,d1_spo2_min,
                           d1_sysbp_max,d1_sysbp_min,
                           d1_sysbp_max,d1_sysbp_min,
                           d1_sysbp_noninvasive_max,
                           d1_sysbp_noninvasive_min,
                           d1_temp_max,d1_temp_min, h1_diasbp_max,
                           h1_diasbp_min,h1_diasbp_noninvasive_max,
                           h1_diasbp_noninvasive_min,
                           h1_heartrate_max,h1_heartrate_min,
                           h1_mbp_min,h1_mbp_max,h1_mbp_noninvasive_max,
                           h1_mbp_noninvasive_min,
                           h1_resprate_max,h1_resprate_min,
                           h1_spo2_max,h1_spo2_min,
                           h1_sysbp_max,h1_sysbp_min,
                           h1_sysbp_noninvasive_min,
                           h1_sysbp_noninvasive_max))
names(data)
```

```
##  [1] "age"                          "bmi"
##  [3] "elective_surgery"             "ethnicity"
##  [5] "gender"                       "height"
##  [7] "icu_admit_source"             "icu_stay_type"
##  [9] "icu_type"                     "pre_icu_los_days"
## [11] "weight"                       "apache_2_diagnosis"
## [13] "apache_3j_diagnosis"          "apache_post_operative"
## [15] "arf_apache"                   "gcs_eyes_apache"
## [17] "gcs_motor_apache"             "gcs_unable_apache"
## [19] "gcs_verbal_apache"            "heart_rate_apache"
## [21] "intubated_apache"             "map_apache"
## [23] "resprate_apache"              "temp_apache"
```

```
## [25] "ventilated_apache"             "d1_mbp_noninvasive_min"
## [27] "apache_4a_hospital_death_prob" "apache_4a_icu_death_prob"
## [29] "aids"                          "cirrhosis"
## [31] "diabetes_mellitus"             "hepatic_failure"
## [33] "immunosuppression"             "leukemia"
## [35] "lymphoma"                      "solid_tumor_with_metastasis"
## [37] "apache_3j_bodysystem"          "apache_2_bodysystem"
## [39] "hospital_death"                "d1_diasbp"
## [41] "d1_diasbp_noninvasive"         "d1_heartrate"
## [43] "d1_mbp"                        "d1_mbp_noninvasive"
## [45] "d1_glucose"                    "d1_resprate"
## [47] "d1_sysbp"                      "d1_sysbp_noninvasive"
## [49] "d1_temp"                       "h1_diasbp"
## [51] "h1_diasbp_noninvasive"         "h1_heartrate"
## [53] "h1_mbp"                        "h1_mbp_noninvasive"
## [55] "h1_resprate"                   "h1_spo2"
## [57] "h1_sysbp"                      "h1_sysbp_noninvasive"
```

Delete Multicollinearity

singularities

```
model_logit <- glm(hospital_death ~ .,family=binomial,data=data)
summary(model_logit)
```

```
##
## Call:
## glm(formula = hospital_death ~ ., family = binomial, data = data)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -2.6246  -0.3656  -0.2248  -0.1353   3.5881
##
## Coefficients: (6 not defined because of singularities)
##                                                Estimate Std. Error z value
## (Intercept)                                   1.295e+01  9.317e-01  13.901
## age                                           2.447e-02  1.076e-03  22.735
## bmi                                          -2.323e-04  7.140e-03  -0.033
## elective_surgery                             -6.882e-01  9.434e-02  -7.295
## ethnicityAsian                                2.722e-02  1.358e-01   0.201
## ethnicityCaucasian                            5.955e-02  4.864e-02   1.224
## ethnicityHispanic                             1.173e-01  8.029e-02   1.461
## ethnicityNative American                      9.157e-02  1.549e-01   0.591
## ethnicityOther/Unknown                        3.449e-02  8.041e-02   0.429
## genderM                                       8.122e-02  3.782e-02   2.147
## height                                        1.282e-03  3.146e-03   0.408
## icu_admit_sourceFloor                         1.667e-01  3.636e-02   4.584
## icu_admit_sourceOperating Room / Recovery -3.510e-01  1.010e-01  -3.475
## icu_admit_sourceOther Hospital                4.246e-01  7.359e-02   5.770
## icu_admit_sourceOther ICU                     1.289e+00  1.266e-01  10.183
## icu_stay_typereadmit                          2.300e-01  1.832e-01   1.255
## icu_stay_typetransfer                        -2.968e-01  5.889e-02  -5.039
```

```
## icu_typeCCU-CTICU                          -1.218e-01  7.687e-02  -1.585
## icu_typeCSICU                              -4.809e-01  9.624e-02  -4.997
## icu_typeCTICU                              -1.335e-01  9.771e-02  -1.366
## icu_typeMed-Surg ICU                       -1.742e-01  6.030e-02  -2.889
## icu_typeMICU                               -7.728e-02  7.068e-02  -1.093
## icu_typeNeuro ICU                           2.799e-02  7.925e-02   0.353
## icu_typeSICU                               -3.293e-02  8.356e-02  -0.394
## pre_icu_los_days                            3.329e-02  4.356e-03   7.641
## weight                                     -2.016e-03  2.563e-03  -0.787
## apache_2_diagnosis                         -1.362e-04  2.180e-04  -0.625
## apache_3j_diagnosis                         3.202e-03  3.765e-04   8.505
## apache_post_operative                      -3.298e+00  4.238e-01  -7.782
## arf_apache1                                 3.657e-01  7.265e-02   5.034
## gcs_eyes_apache2                           -3.063e-01  6.598e-02  -4.641
## gcs_eyes_apache3                           -3.881e-01  7.004e-02  -5.541
## gcs_eyes_apache4                           -4.396e-01  7.440e-02  -5.908
## gcs_motor_apache2                           2.241e-01  1.469e-01   1.526
## gcs_motor_apache3                           2.124e-02  1.209e-01   0.176
## gcs_motor_apache4                          -4.804e-01  6.538e-02  -7.347
## gcs_motor_apache5                          -5.723e-01  7.013e-02  -8.160
## gcs_motor_apache6                          -7.572e-01  8.019e-02  -9.443
## gcs_unable_apache1                          9.200e-01  1.013e-01   9.086
## gcs_verbal_apache2                          3.147e-01  8.243e-02   3.818
## gcs_verbal_apache3                          1.043e-03  7.393e-02   0.014
## gcs_verbal_apache4                          2.312e-01  6.258e-02   3.694
## gcs_verbal_apache5                         -1.261e-01  6.320e-02  -1.995
## heart_rate_apache                           1.944e-03  7.113e-04   2.733
## intubated_apache1                           1.253e-02  3.843e-02   0.326
## map_apache                                  1.254e-03  3.659e-04   3.426
## resprate_apache                             7.753e-03  1.257e-03   6.166
## temp_apache                                -5.689e-02  2.027e-02  -2.806
## ventilated_apache1                          8.658e-01  3.810e-02  22.726
## d1_mbp_noninvasive_min                     -2.295e-02  1.285e-03 -17.862
## apache_4a_hospital_death_prob               9.991e-01  1.352e-01   7.392
## apache_4a_icu_death_prob                    3.535e-01  1.485e-01   2.380
## aids1                                       3.868e-01  3.853e-01   1.004
## cirrhosis1                                  4.263e-01  1.047e-01   4.072
## diabetes_mellitus1                         -2.274e-01  3.679e-02  -6.180
## hepatic_failure1                            4.060e-01  1.127e-01   3.603
## immunosuppression1                          3.021e-01  7.225e-02   4.181
## leukemia1                                   3.407e-01  1.240e-01   2.748
## lymphoma1                                   2.861e-01  1.632e-01   1.753
## solid_tumor_with_metastasis1                7.528e-01  7.641e-02   9.853
## apache_3j_bodysystemGastrointestinal       -6.454e-01  9.071e-02  -7.115
## apache_3j_bodysystemGenitourinary          -1.077e+01  6.318e+01  -0.170
## apache_3j_bodysystemGynecological          -1.166e+01  6.318e+01  -0.185
## apache_3j_bodysystemHematological          -1.949e+00  3.025e-01  -6.443
## apache_3j_bodysystemMetabolic              -3.179e+00  2.445e-01 -13.004
## apache_3j_bodysystemMusculoskeletal/Skin   -7.014e-01  3.597e-01  -1.950
## apache_3j_bodysystemNeurological           -7.963e-01  1.210e-01  -6.584
## apache_3j_bodysystemRespiratory            -4.038e-01  5.592e-02  -7.220
## apache_3j_bodysystemSepsis                 -1.197e+00  1.496e-01  -7.998
## apache_3j_bodysystemTrauma                 -1.511e+00  1.924e-01  -7.851
## apache_2_bodysystemGastrointestinal                NA         NA      NA
```

```
## apache_2_bodysystemHaematologic                    NA         NA      NA
## apache_2_bodysystemMetabolic                       NA         NA      NA
## apache_2_bodysystemNeurologic                      NA         NA      NA
## apache_2_bodysystemRenal/Genitourinary      8.289e+00  6.318e+01   0.131
## apache_2_bodysystemRespiratory                     NA         NA      NA
## apache_2_bodysystemTrauma                          NA         NA      NA
## apache_2_bodysystemUndefined diagnoses     -1.426e+00  1.770e-01  -8.055
## apache_2_bodysystemUndefined Diagnoses     -2.520e+00  3.803e-01  -6.628
## d1_diasbp                                  -2.918e-02  1.011e-02  -2.887
## d1_diasbp_noninvasive                       2.123e-02  1.024e-02   2.073
## d1_heartrate                                1.139e-02  1.456e-03   7.820
## d1_mbp                                     -4.896e-03  6.528e-03  -0.750
## d1_mbp_noninvasive                          1.175e-02  6.778e-03   1.733
## d1_glucose                                  2.117e-03  2.695e-04   7.857
## d1_resprate                                 1.216e-02  2.996e-03   4.058
## d1_sysbp                                   -1.632e-02  8.040e-03  -2.030
## d1_sysbp_noninvasive                        6.473e-03  8.068e-03   0.802
## d1_temp                                    -3.314e-01  3.021e-02 -10.971
## h1_diasbp                                   5.582e-03  5.003e-03   1.116
## h1_diasbp_noninvasive                      -2.883e-05  5.389e-03  -0.005
## h1_heartrate                               -1.132e-03  1.078e-03  -1.050
## h1_mbp                                     -3.872e-03  4.834e-03  -0.801
## h1_mbp_noninvasive                         -6.318e-03  4.853e-03  -1.302
## h1_resprate                                 9.915e-03  1.378e-03   7.198
## h1_spo2                                    -2.255e-02  2.497e-03  -9.033
## h1_sysbp                                   -5.225e-04  2.043e-03  -0.256
## h1_sysbp_noninvasive                        2.212e-03  3.347e-03   0.661
##                                            Pr(>|z|)
## (Intercept)                                 < 2e-16 ***
## age                                         < 2e-16 ***
## bmi                                        0.974053
## elective_surgery                           2.98e-13 ***
## ethnicityAsian                             0.841081
## ethnicityCaucasian                         0.220838
## ethnicityHispanic                          0.143890
## ethnicityNative American                   0.554532
## ethnicityOther/Unknown                     0.667923
## genderM                                    0.031759 *
## height                                     0.683608
## icu_admit_sourceFloor                      4.57e-06 ***
## icu_admit_sourceOperating Room / Recovery 0.000511 ***
## icu_admit_sourceOther Hospital             7.93e-09 ***
## icu_admit_sourceOther ICU                   < 2e-16 ***
## icu_stay_typereadmit                       0.209345
## icu_stay_typetransfer                      4.68e-07 ***
## icu_typeCCU-CTICU                          0.113037
## icu_typeCSICU                              5.81e-07 ***
## icu_typeCTICU                              0.171952
## icu_typeMed-Surg ICU                       0.003861 **
## icu_typeMICU                               0.274224
## icu_typeNeuro ICU                          0.723917
## icu_typeSICU                               0.693502
## pre_icu_los_days                           2.16e-14 ***
## weight                                     0.431456
```

```
## apache_2_diagnosis                          0.532262
## apache_3j_diagnosis                          < 2e-16 ***
## apache_post_operative                       7.14e-15 ***
## arf_apache1                                 4.81e-07 ***
## gcs_eyes_apache2                            3.46e-06 ***
## gcs_eyes_apache3                            3.00e-08 ***
## gcs_eyes_apache4                            3.46e-09 ***
## gcs_motor_apache2                           0.127041
## gcs_motor_apache3                           0.860543
## gcs_motor_apache4                           2.03e-13 ***
## gcs_motor_apache5                           3.36e-16 ***
## gcs_motor_apache6                            < 2e-16 ***
## gcs_unable_apache1                           < 2e-16 ***
## gcs_verbal_apache2                          0.000134 ***
## gcs_verbal_apache3                          0.988749
## gcs_verbal_apache4                          0.000221 ***
## gcs_verbal_apache5                          0.046074 *
## heart_rate_apache                           0.006273 **
## intubated_apache1                           0.744467
## map_apache                                  0.000612 ***
## resprate_apache                             7.01e-10 ***
## temp_apache                                 0.005015 **
## ventilated_apache1                           < 2e-16 ***
## d1_mbp_noninvasive_min                       < 2e-16 ***
## apache_4a_hospital_death_prob               1.44e-13 ***
## apache_4a_icu_death_prob                    0.017316 *
## aids1                                       0.315349
## cirrhosis1                                  4.66e-05 ***
## diabetes_mellitus1                          6.40e-10 ***
## hepatic_failure1                            0.000315 ***
## immunosuppression1                          2.90e-05 ***
## leukemia1                                   0.006002 **
## lymphoma1                                   0.079522 .
## solid_tumor_with_metastasis1                 < 2e-16 ***
## apache_3j_bodysystemGastrointestinal        1.12e-12 ***
## apache_3j_bodysystemGenitourinary           0.864702
## apache_3j_bodysystemGynecological           0.853569
## apache_3j_bodysystemHematological           1.17e-10 ***
## apache_3j_bodysystemMetabolic                < 2e-16 ***
## apache_3j_bodysystemMusculoskeletal/Skin    0.051190 .
## apache_3j_bodysystemNeurological            4.59e-11 ***
## apache_3j_bodysystemRespiratory             5.19e-13 ***
## apache_3j_bodysystemSepsis                  1.26e-15 ***
## apache_3j_bodysystemTrauma                  4.13e-15 ***
## apache_2_bodysystemGastrointestinal               NA
## apache_2_bodysystemHaematologic                   NA
## apache_2_bodysystemMetabolic                      NA
## apache_2_bodysystemNeurologic                     NA
## apache_2_bodysystemRenal/Genitourinary      0.895620
## apache_2_bodysystemRespiratory                    NA
## apache_2_bodysystemTrauma                         NA
## apache_2_bodysystemUndefined diagnoses      7.95e-16 ***
## apache_2_bodysystemUndefined Diagnoses      3.40e-11 ***
## d1_diasbp                                   0.003887 **
```

```
## d1_diasbp_noninvasive                    0.038132 *
## d1_heartrate                             5.28e-15 ***
## d1_mbp                                   0.453262
## d1_mbp_noninvasive                       0.083056 .
## d1_glucose                               3.94e-15 ***
## d1_resprate                              4.94e-05 ***
## d1_sysbp                                 0.042369 *
## d1_sysbp_noninvasive                     0.422388
## d1_temp                                   < 2e-16 ***
## h1_diasbp                                0.264452
## h1_diasbp_noninvasive                    0.995732
## h1_heartrate                             0.293619
## h1_mbp                                   0.423143
## h1_mbp_noninvasive                       0.192945
## h1_resprate                              6.13e-13 ***
## h1_spo2                                   < 2e-16 ***
## h1_sysbp                                 0.798175
## h1_sysbp_noninvasive                     0.508757
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 53908  on 91712  degrees of freedom
## Residual deviance: 38628  on 91621  degrees of freedom
## AIC: 38812
##
## Number of Fisher Scoring iterations: 11
```

ada attribute yang bernilai NA dikarenakan ada suatu Singularitas, atau kemungkinan ada suatu Multicollinearity

Dikarenakan adanya singularitas, maka ada Multicolinnearity

```
data <- data %>% select(-c(apache_2_bodysystem))
model_logit <- glm(hospital_death ~ .,family=binomial,data=data)
summary(model_logit)
```

```
##
## Call:
## glm(formula = hospital_death ~ ., family = binomial, data = data)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -2.6217  -0.3663  -0.2267  -0.1376   3.5943
##
## Coefficients:
##                                      Estimate Std. Error z value
## (Intercept)                        13.2044509  0.9317495  14.172
## age                                 0.0243373  0.0010769  22.598
## bmi                                 0.0003327  0.0071374   0.047
## elective_surgery                   -0.7477388  0.0937334  -7.977
```

```
## ethnicityAsian                                0.0246090  0.1356087   0.181
## ethnicityCaucasian                            0.0564878  0.0486330   1.162
## ethnicityHispanic                             0.1167822  0.0802230   1.456
## ethnicityNative American                      0.0896774  0.1548415   0.579
## ethnicityOther/Unknown                        0.0303726  0.0803523   0.378
## genderM                                       0.0739105  0.0378289   1.954
## height                                        0.0013751  0.0031460   0.437
## icu_admit_sourceFloor                         0.1709878  0.0363851   4.699
## icu_admit_sourceOperating Room / Recovery -0.3423652  0.1012424  -3.382
## icu_admit_sourceOther Hospital                0.4299846  0.0736350   5.839
## icu_admit_sourceOther ICU                     1.3870554  0.1259131  11.016
## icu_stay_typereadmit                          0.2650091  0.1828207   1.450
## icu_stay_typetransfer                        -0.2913183  0.0587669  -4.957
## icu_typeCCU-CTICU                            -0.1328844  0.0768388  -1.729
## icu_typeCSICU                                -0.5148517  0.0960569  -5.360
## icu_typeCTICU                                -0.1927730  0.0973279  -1.981
## icu_typeMed-Surg ICU                         -0.1737967  0.0603245  -2.881
## icu_typeMICU                                 -0.0784274  0.0707182  -1.109
## icu_typeNeuro ICU                             0.0297931  0.0793354   0.376
## icu_typeSICU                                 -0.0429090  0.0835262  -0.514
## pre_icu_los_days                              0.0328321  0.0043686   7.515
## weight                                       -0.0022352  0.0025624  -0.872
## apache_2_diagnosis                           -0.0005280  0.0002161  -2.443
## apache_3j_diagnosis                           0.0026771  0.0003682   7.271
## apache_post_operative                        -2.7715716  0.4125770  -6.718
## arf_apache1                                   0.3708484  0.0726017   5.108
## gcs_eyes_apache2                             -0.3011241  0.0660114  -4.562
## gcs_eyes_apache3                             -0.3859150  0.0700414  -5.510
## gcs_eyes_apache4                             -0.4343039  0.0743959  -5.838
## gcs_motor_apache2                             0.2387984  0.1470905   1.623
## gcs_motor_apache3                             0.0333695  0.1209099   0.276
## gcs_motor_apache4                            -0.4650679  0.0653510  -7.116
## gcs_motor_apache5                            -0.5531070  0.0701040  -7.890
## gcs_motor_apache6                            -0.7409417  0.0801029  -9.250
## gcs_unable_apache1                            0.9158402  0.1010952   9.059
## gcs_verbal_apache2                            0.3085180  0.0824544   3.742
## gcs_verbal_apache3                            0.0034636  0.0738690   0.047
## gcs_verbal_apache4                            0.2324079  0.0625426   3.716
## gcs_verbal_apache5                           -0.1162570  0.0630917  -1.843
## heart_rate_apache                             0.0018961  0.0007115   2.665
## intubated_apache1                             0.0009896  0.0383582   0.026
## map_apache                                    0.0012865  0.0003651   3.523
## resprate_apache                               0.0076883  0.0012554   6.124
## temp_apache                                  -0.0509630  0.0202678  -2.514
## ventilated_apache1                            0.8464675  0.0380977  22.218
## d1_mbp_noninvasive_min                       -0.0231848  0.0012848 -18.045
## apache_4a_hospital_death_prob                 1.0829532  0.1360271   7.961
## apache_4a_icu_death_prob                      0.3286380  0.1494344   2.199
## aids1                                         0.3928768  0.3849558   1.021
## cirrhosis1                                    0.4273153  0.1046700   4.082
## diabetes_mellitus1                           -0.2395560  0.0366886  -6.529
## hepatic_failure1                              0.3994222  0.1126018   3.547
## immunosuppression1                            0.3058148  0.0723017   4.230
## leukemia1                                     0.3347209  0.1240654   2.698
```

```
## lymphoma1                                      0.2849948  0.1632175   1.746
## solid_tumor_with_metastasis1                   0.7562412  0.0765511   9.879
## apache_3j_bodysystemGastrointestinal          -0.4662466  0.0893951  -5.216
## apache_3j_bodysystemGenitourinary             -1.9870340  0.2978638  -6.671
## apache_3j_bodysystemGynecological             -2.8734089  0.7672454  -3.745
## apache_3j_bodysystemHematological             -1.5059689  0.2967752  -5.074
## apache_3j_bodysystemMetabolic                 -2.8167111  0.2392724 -11.772
## apache_3j_bodysystemMusculoskeletal/Skin      -1.9894162  0.3455704  -5.757
## apache_3j_bodysystemNeurological              -0.5796708  0.1184559  -4.894
## apache_3j_bodysystemRespiratory               -0.3196892  0.0555153  -5.759
## apache_3j_bodysystemSepsis                    -0.9804454  0.1467636  -6.680
## apache_3j_bodysystemTrauma                    -1.2227654  0.1894552  -6.454
## d1_diasbp                                     -0.0291667  0.0100884  -2.891
## d1_diasbp_noninvasive                          0.0209703  0.0102222   2.051
## d1_heartrate                                   0.0113617  0.0014571   7.798
## d1_mbp                                        -0.0047922  0.0065151  -0.736
## d1_mbp_noninvasive                             0.0119046  0.0067673   1.759
## d1_glucose                                     0.0021970  0.0002695   8.153
## d1_resprate                                    0.0116968  0.0029964   3.904
## d1_sysbp                                      -0.0168286  0.0080933  -2.079
## d1_sysbp_noninvasive                           0.0071075  0.0081221   0.875
## d1_temp                                       -0.3421224  0.0302051 -11.327
## h1_diasbp                                      0.0071055  0.0049590   1.433
## h1_diasbp_noninvasive                         -0.0013949  0.0053507  -0.261
## h1_heartrate                                  -0.0010860  0.0010781  -1.007
## h1_mbp                                        -0.0029331  0.0047865  -0.613
## h1_mbp_noninvasive                            -0.0073600  0.0048064  -1.531
## h1_resprate                                    0.0102127  0.0013767   7.418
## h1_spo2                                       -0.0229028  0.0024881  -9.205
## h1_sysbp                                      -0.0005036  0.0020410  -0.247
## h1_sysbp_noninvasive                           0.0022868  0.0033455   0.684
##                                               Pr(>|z|)
## (Intercept)                                    < 2e-16 ***
## age                                            < 2e-16 ***
## bmi                                           0.962818
## elective_surgery                              1.50e-15 ***
## ethnicityAsian                                0.855998
## ethnicityCaucasian                            0.245434
## ethnicityHispanic                             0.145470
## ethnicityNative American                      0.562484
## ethnicityOther/Unknown                        0.705436
## genderM                                       0.050724 .
## height                                        0.662043
## icu_admit_sourceFloor                         2.61e-06 ***
## icu_admit_sourceOperating Room / Recovery     0.000721 ***
## icu_admit_sourceOther Hospital                5.24e-09 ***
## icu_admit_sourceOther ICU                      < 2e-16 ***
## icu_stay_typereadmit                          0.147182
## icu_stay_typetransfer                         7.15e-07 ***
## icu_typeCCU-CTICU                             0.083739 .
## icu_typeCSICU                                 8.33e-08 ***
## icu_typeCTICU                                 0.047630 *
## icu_typeMed-Surg ICU                          0.003964 **
## icu_typeMICU                                  0.267425
```

```
## icu_typeNeuro ICU                            0.707264
## icu_typeSICU                                 0.607448
## pre_icu_los_days                             5.67e-14 ***
## weight                                       0.383037
## apache_2_diagnosis                           0.014546 *
## apache_3j_diagnosis                          3.57e-13 ***
## apache_post_operative                        1.85e-11 ***
## arf_apache1                                  3.26e-07 ***
## gcs_eyes_apache2                             5.07e-06 ***
## gcs_eyes_apache3                             3.59e-08 ***
## gcs_eyes_apache4                             5.29e-09 ***
## gcs_motor_apache2                            0.104487
## gcs_motor_apache3                            0.782559
## gcs_motor_apache4                            1.11e-12 ***
## gcs_motor_apache5                            3.03e-15 ***
## gcs_motor_apache6                             < 2e-16 ***
## gcs_unable_apache1                            < 2e-16 ***
## gcs_verbal_apache2                           0.000183 ***
## gcs_verbal_apache3                           0.962602
## gcs_verbal_apache4                           0.000202 ***
## gcs_verbal_apache5                           0.065378 .
## heart_rate_apache                            0.007704 **
## intubated_apache1                            0.979418
## map_apache                                   0.000426 ***
## resprate_apache                              9.11e-10 ***
## temp_apache                                  0.011921 *
## ventilated_apache1                            < 2e-16 ***
## d1_mbp_noninvasive_min                        < 2e-16 ***
## apache_4a_hospital_death_prob                1.70e-15 ***
## apache_4a_icu_death_prob                     0.027863 *
## aids1                                        0.307455
## cirrhosis1                                   4.46e-05 ***
## diabetes_mellitus1                           6.60e-11 ***
## hepatic_failure1                             0.000389 ***
## immunosuppression1                           2.34e-05 ***
## leukemia1                                    0.006977 **
## lymphoma1                                    0.080793 .
## solid_tumor_with_metastasis1                  < 2e-16 ***
## apache_3j_bodysystemGastrointestinal         1.83e-07 ***
## apache_3j_bodysystemGenitourinary            2.54e-11 ***
## apache_3j_bodysystemGynecological            0.000180 ***
## apache_3j_bodysystemHematological            3.89e-07 ***
## apache_3j_bodysystemMetabolic                 < 2e-16 ***
## apache_3j_bodysystemMusculoskeletal/Skin     8.57e-09 ***
## apache_3j_bodysystemNeurological             9.90e-07 ***
## apache_3j_bodysystemRespiratory              8.48e-09 ***
## apache_3j_bodysystemSepsis                   2.38e-11 ***
## apache_3j_bodysystemTrauma                   1.09e-10 ***
## d1_diasbp                                    0.003839 **
## d1_diasbp_noninvasive                        0.040223 *
## d1_heartrate                                 6.31e-15 ***
## d1_mbp                                       0.461999
## d1_mbp_noninvasive                           0.078554 .
## d1_glucose                                   3.54e-16 ***
```

```
## d1_resprate                                 9.48e-05 ***
## d1_sysbp                                    0.037587 *
## d1_sysbp_noninvasive                        0.381529
## d1_temp                                      < 2e-16 ***
## h1_diasbp                                   0.151904
## h1_diasbp_noninvasive                       0.794333
## h1_heartrate                                0.313780
## h1_mbp                                      0.540019
## h1_mbp_noninvasive                          0.125699
## h1_resprate                                 1.19e-13 ***
## h1_spo2                                      < 2e-16 ***
## h1_sysbp                                    0.805120
## h1_sysbp_noninvasive                        0.494256
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 53908  on 91712  degrees of freedom
## Residual deviance: 38733  on 91624  degrees of freedom
## AIC: 38911
##
## Number of Fisher Scoring iterations: 7
```

Dihapus Atribut yang bernilai VIF lebih dari 5%

```
data <- data %>% select(-c(d1_sysbp_noninvasive,apache_3j_diagnosis,
                           d1_diasbp_noninvasive,d1_mbp_noninvasive,
                           h1_mbp_noninvasive,h1_diasbp_noninvasive))
model_logit <- glm(hospital_death ~ .,family=binomial,data=data)
summary(model_logit)
```

```
##
## Call:
## glm(formula = hospital_death ~ ., family = binomial, data = data)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -2.6203  -0.3667  -0.2277  -0.1391   3.7398
##
## Coefficients:
##                                        Estimate Std. Error z value
## (Intercept)                          13.3981163  0.9316307  14.381
## age                                   0.0241325  0.0010728  22.495
## bmi                                   0.0003668  0.0071219   0.052
## elective_surgery                     -0.7580741  0.0925732  -8.189
## ethnicityAsian                        0.0160493  0.1354371   0.118
## ethnicityCaucasian                    0.0540729  0.0486152   1.112
## ethnicityHispanic                     0.1125326  0.0801777   1.404
## ethnicityNative American              0.0930028  0.1547638   0.601
## ethnicityOther/Unknown                0.0289549  0.0803077   0.361
## genderM                               0.0738126  0.0378101   1.952
```

```
## height                                        0.0014122  0.0031407   0.450
## icu_admit_sourceFloor                         0.1702969  0.0363767   4.681
## icu_admit_sourceOperating Room / Recovery -0.3412431  0.1010300  -3.378
## icu_admit_sourceOther Hospital                0.4273718  0.0735508   5.811
## icu_admit_sourceOther ICU                     1.6716167  0.1190664  14.039
## icu_stay_typereadmit                          0.2814729  0.1828237   1.540
## icu_stay_typetransfer                        -0.2538450  0.0579494  -4.380
## icu_typeCCU-CTICU                            -0.1340366  0.0767460  -1.746
## icu_typeCSICU                                -0.4981572  0.0959095  -5.194
## icu_typeCTICU                                -0.1710235  0.0970516  -1.762
## icu_typeMed-Surg ICU                         -0.1681338  0.0602101  -2.792
## icu_typeMICU                                 -0.0757945  0.0706353  -1.073
## icu_typeNeuro ICU                             0.0431562  0.0792429   0.545
## icu_typeSICU                                 -0.0381199  0.0833585  -0.457
## pre_icu_los_days                              0.0322615  0.0043788   7.368
## weight                                       -0.0022286  0.0025567  -0.872
## apache_2_diagnosis                           -0.0004867  0.0002148  -2.266
## apache_post_operative                         0.1191797  0.1151114   1.035
## arf_apache1                                   0.3639008  0.0725025   5.019
## gcs_eyes_apache2                             -0.3006715  0.0660096  -4.555
## gcs_eyes_apache3                             -0.3867796  0.0700390  -5.522
## gcs_eyes_apache4                             -0.4331509  0.0743632  -5.825
## gcs_motor_apache2                             0.2374621  0.1471861   1.613
## gcs_motor_apache3                             0.0437038  0.1209618   0.361
## gcs_motor_apache4                            -0.4593810  0.0653612  -7.028
## gcs_motor_apache5                            -0.5464054  0.0701557  -7.788
## gcs_motor_apache6                            -0.7369319  0.0801229  -9.198
## gcs_unable_apache1                            0.8991899  0.1010340   8.900
## gcs_verbal_apache2                            0.3107158  0.0824005   3.771
## gcs_verbal_apache3                            0.0032354  0.0738672   0.044
## gcs_verbal_apache4                            0.2335764  0.0625116   3.737
## gcs_verbal_apache5                           -0.1036367  0.0630306  -1.644
## heart_rate_apache                             0.0019380  0.0007118   2.723
## intubated_apache1                            -0.0010243  0.0383681  -0.027
## map_apache                                    0.0012651  0.0003642   3.473
## resprate_apache                               0.0076805  0.0012527   6.131
## temp_apache                                  -0.0486872  0.0202894  -2.400
## ventilated_apache1                            0.8343804  0.0379863  21.965
## d1_mbp_noninvasive_min                       -0.0226566  0.0012675 -17.876
## apache_4a_hospital_death_prob                 1.0959254  0.1356675   8.078
## apache_4a_icu_death_prob                      0.3352212  0.1491987   2.247
## aids1                                         0.3964544  0.3846255   1.031
## cirrhosis1                                    0.4154687  0.1044862   3.976
## diabetes_mellitus1                           -0.2480992  0.0366322  -6.773
## hepatic_failure1                              0.3992688  0.1122835   3.556
## immunosuppression1                            0.3034573  0.0721981   4.203
## leukemia1                                     0.3233097  0.1239723   2.608
## lymphoma1                                     0.2813025  0.1630453   1.725
## solid_tumor_with_metastasis1                  0.7458724  0.0763744   9.766
## apache_3j_bodysystemGastrointestinal          0.0504322  0.0554181   0.910
## apache_3j_bodysystemGenitourinary             0.0212062  0.1057222   0.201
## apache_3j_bodysystemGynecological            -1.2579784  0.7336437  -1.715
## apache_3j_bodysystemHematological             0.3180563  0.1589497   2.001
## apache_3j_bodysystemMetabolic                -1.2491257  0.1043241 -11.974
```

```
## apache_3j_bodysystemMusculoskeletal/Skin   0.2089520  0.1549879   1.348
## apache_3j_bodysystemNeurological           0.1803356  0.0567796   3.176
## apache_3j_bodysystemRespiratory           -0.0783944  0.0449349  -1.745
## apache_3j_bodysystemSepsis                 0.0446141  0.0438163   1.018
## apache_3j_bodysystemTrauma                 0.0300445  0.0801309   0.375
## d1_diasbp                                 -0.0078234  0.0024293  -3.220
## d1_heartrate                               0.0113233  0.0014577   7.768
## d1_mbp                                     0.0056063  0.0026926   2.082
## d1_glucose                                 0.0022149  0.0002694   8.223
## d1_resprate                                0.0115243  0.0029980   3.844
## d1_sysbp                                  -0.0095729  0.0014873  -6.436
## d1_temp                                   -0.3407017  0.0302804 -11.252
## h1_diasbp                                  0.0052778  0.0025246   2.091
## h1_heartrate                              -0.0011068  0.0010766  -1.028
## h1_mbp                                    -0.0092862  0.0023455  -3.959
## h1_resprate                                0.0101250  0.0013760   7.358
## h1_spo2                                   -0.0228517  0.0024842  -9.199
## h1_sysbp                                  -0.0004683  0.0018680  -0.251
## h1_sysbp_noninvasive                       0.0020242  0.0028708   0.705
##                                           Pr(>|z|)
## (Intercept)                                < 2e-16 ***
## age                                        < 2e-16 ***
## bmi                                       0.958921
## elective_surgery                          2.64e-16 ***
## ethnicityAsian                            0.905672
## ethnicityCaucasian                        0.266025
## ethnicityHispanic                         0.160456
## ethnicityNative American                  0.547884
## ethnicityOther/Unknown                    0.718436
## genderM                                   0.050915 .
## height                                    0.652965
## icu_admit_sourceFloor                     2.85e-06 ***
## icu_admit_sourceOperating Room / Recovery 0.000731 ***
## icu_admit_sourceOther Hospital            6.23e-09 ***
## icu_admit_sourceOther ICU                  < 2e-16 ***
## icu_stay_typereadmit                      0.123661
## icu_stay_typetransfer                     1.18e-05 ***
## icu_typeCCU-CTICU                         0.080725 .
## icu_typeCSICU                             2.06e-07 ***
## icu_typeCTICU                             0.078037 .
## icu_typeMed-Surg ICU                      0.005231 **
## icu_typeMICU                              0.283253
## icu_typeNeuro ICU                         0.586024
## icu_typeSICU                              0.647455
## pre_icu_los_days                          1.74e-13 ***
## weight                                    0.383381
## apache_2_diagnosis                        0.023437 *
## apache_post_operative                     0.300509
## arf_apache1                               5.19e-07 ***
## gcs_eyes_apache2                          5.24e-06 ***
## gcs_eyes_apache3                          3.34e-08 ***
## gcs_eyes_apache4                          5.72e-09 ***
## gcs_motor_apache2                         0.106670
## gcs_motor_apache3                         0.717873
```

```
## gcs_motor_apache4                          2.09e-12 ***
## gcs_motor_apache5                          6.78e-15 ***
## gcs_motor_apache6                           < 2e-16 ***
## gcs_unable_apache1                          < 2e-16 ***
## gcs_verbal_apache2                         0.000163 ***
## gcs_verbal_apache3                         0.965063
## gcs_verbal_apache4                         0.000187 ***
## gcs_verbal_apache5                         0.100129
## heart_rate_apache                          0.006478 **
## intubated_apache1                          0.978702
## map_apache                                 0.000514 ***
## resprate_apache                            8.72e-10 ***
## temp_apache                                0.016411 *
## ventilated_apache1                          < 2e-16 ***
## d1_mbp_noninvasive_min                      < 2e-16 ***
## apache_4a_hospital_death_prob              6.58e-16 ***
## apache_4a_icu_death_prob                   0.024652 *
## aids1                                      0.302656
## cirrhosis1                                 7.00e-05 ***
## diabetes_mellitus1                         1.26e-11 ***
## hepatic_failure1                           0.000377 ***
## immunosuppression1                         2.63e-05 ***
## leukemia1                                  0.009109 **
## lymphoma1                                  0.084473 .
## solid_tumor_with_metastasis1                < 2e-16 ***
## apache_3j_bodysystemGastrointestinal       0.362806
## apache_3j_bodysystemGenitourinary          0.841024
## apache_3j_bodysystemGynecological          0.086400 .
## apache_3j_bodysystemHematological          0.045394 *
## apache_3j_bodysystemMetabolic               < 2e-16 ***
## apache_3j_bodysystemMusculoskeletal/Skin   0.177600
## apache_3j_bodysystemNeurological           0.001493 **
## apache_3j_bodysystemRespiratory            0.081051 .
## apache_3j_bodysystemSepsis                 0.308580
## apache_3j_bodysystemTrauma                 0.707703
## d1_diasbp                                  0.001280 **
## d1_heartrate                               7.98e-15 ***
## d1_mbp                                     0.037332 *
## d1_glucose                                  < 2e-16 ***
## d1_resprate                                0.000121 ***
## d1_sysbp                                   1.22e-10 ***
## d1_temp                                     < 2e-16 ***
## h1_diasbp                                  0.036571 *
## h1_heartrate                               0.303930
## h1_mbp                                     7.52e-05 ***
## h1_resprate                                1.87e-13 ***
## h1_spo2                                     < 2e-16 ***
## h1_sysbp                                   0.802070
## h1_sysbp_noninvasive                       0.480758
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
```

```
##     Null deviance: 53908  on 91712  degrees of freedom
## Residual deviance: 38800  on 91630  degrees of freedom
## AIC: 38966
##
## Number of Fisher Scoring iterations: 7
```

```
df_vif <- vif(model_logit)
df_vif <- as.data.frame(df_vif)

colnames(df_vif) <- c("GVIF","Df","VIF")
df_vif_fil <- df_vif %>% filter(VIF>=5)
df_vif <- df_vif %>% arrange(VIF)
df_vif
```

```
##                                 GVIF Df      VIF
## aids                        1.008823  1 1.004402
## lymphoma                    1.018196  1 1.009057
## ethnicity                   1.193287  5 1.017828
## leukemia                    1.046124  1 1.022802
## arf_apache                  1.052674  1 1.025999
## h1_spo2                     1.054743  1 1.027007
## icu_type                    1.855363  7 1.045138
## icu_stay_type               1.255271  2 1.058484
## apache_3j_bodysystem        3.917740 10 1.070660
## solid_tumor_with_metastasis 1.148545  1 1.071702
## gcs_unable_apache           1.153381  1 1.073956
## immunosuppression           1.180378  1 1.086452
## diabetes_mellitus           1.196329  1 1.093768
## d1_glucose                  1.205784  1 1.098082
## pre_icu_los_days            1.239007  1 1.113107
## age                         1.296938  1 1.138832
## map_apache                  1.466491  1 1.210988
## gcs_motor_apache            7.879418  5 1.229276
## cirrhosis                   1.526697  1 1.235596
## hepatic_failure             1.532908  1 1.238106
## gcs_verbal_apache           5.829909  4 1.246544
## intubated_apache            1.605045  1 1.266904
## apache_2_diagnosis          1.675275  1 1.294324
## icu_admit_source            8.397254  4 1.304720
## h1_resprate                 1.881266  1 1.371593
## d1_mbp_noninvasive_min      1.888473  1 1.374217
## resprate_apache             1.912001  1 1.382751
## ventilated_apache           1.914615  1 1.383696
## gender                      1.937537  1 1.391954
## gcs_eyes_apache             7.568812  3 1.401214
## d1_resprate                 2.176024  1 1.475135
## temp_apache                 2.740330  1 1.655394
## heart_rate_apache           2.745408  1 1.656927
## d1_temp                     2.774842  1 1.665786
## h1_heartrate                2.835997  1 1.684042
## elective_surgery            3.618180  1 1.902152
## d1_heartrate                3.691996  1 1.921457
## d1_sysbp                    3.949325  1 1.987291
## d1_diasbp                   4.973844  1 2.230212
```

```
## height                          6.192468  1 2.488467
## apache_4a_icu_death_prob        6.582243  1 2.565588
## apache_4a_hospital_death_prob   7.047798  1 2.654769
## apache_post_operative           7.132021  1 2.670584
## d1_mbp                          7.583670  1 2.753846
## h1_diasbp                       8.397735  1 2.897885
## h1_mbp                          9.399459  1 3.065854
## h1_sysbp                       11.528199  1 3.395320
## h1_sysbp_noninvasive           15.617315  1 3.951875
## bmi                            18.243810  1 4.271277
## weight                         21.303482  1 4.615570
```

Check data after Feature Selection

```
summary(data)
```

```
##       age              bmi         elective_surgery            ethnicity
##  Min.   :16.00   Min.   :14.84   Min.   :0.0000   African American: 9547
##  1st Qu.:53.00   1st Qu.:23.79   1st Qu.:0.0000   Asian           : 1129
##  Median :65.00   Median :27.65   Median :0.0000   Caucasian       :72079
##  Mean   :62.43   Mean   :29.13   Mean   :0.1837   Hispanic        : 3796
##  3rd Qu.:75.00   3rd Qu.:32.65   3rd Qu.:0.0000   Native American :  788
##  Max.   :89.00   Max.   :67.81   Max.   :1.0000   Other/Unknown   : 4374
##
##  gender        height                       icu_admit_source  icu_stay_type
##  F:42219   Min.   :137.2   Accident & Emergency     :54172   admit   :86183
##  M:49494   1st Qu.:162.6   Floor                    :15611   readmit :  560
##            Median :170.1   Operating Room / Recovery:18713   transfer: 4970
##            Mean   :169.6   Other Hospital           : 2358
##            3rd Qu.:177.8   Other ICU                :  859
##            Max.   :195.6
##
##          icu_type     pre_icu_los_days        weight       apache_2_diagnosis
##  Med-Surg ICU:50586   Min.   :-24.94722   Min.   : 38.60   Min.   :101.0
##  MICU        : 7695   1st Qu.:  0.03542   1st Qu.: 67.30   1st Qu.:113.0
##  Neuro ICU   : 7675   Median :  0.13889   Median : 80.30   Median :122.0
##  CCU-CTICU   : 7156   Mean   :  0.83577   Mean   : 83.92   Mean   :184.3
##  SICU        : 5209   3rd Qu.:  0.40903   3rd Qu.: 96.30   3rd Qu.:301.0
##  Cardiac ICU : 4776   Max.   :159.09097   Max.   :186.00   Max.   :308.0
##  (Other)     : 8616
##  apache_post_operative arf_apache gcs_eyes_apache gcs_motor_apache
##  Min.   :0.0000        0:89167    1: 8274         1: 5543
##  1st Qu.:0.0000        1: 2546    2: 4680         2:  309
##  Median :0.0000                   3:13863         3:  524
##  Mean   :0.2011                   4:64896         4: 4494
##  3rd Qu.:0.0000                                   5: 7982
##  Max.   :1.0000                                   6:72861
##
##  gcs_unable_apache gcs_verbal_apache heart_rate_apache intubated_apache
##  0:90849           1:16741           Min.   : 30.00    0:77952
##  1:  864           2: 1940           1st Qu.: 87.00    1:13761
##                    3: 3275           Median :104.00
```

```
##                   4:10947           Mean   : 99.75
##                   5:58810           3rd Qu.:120.00
##                                     Max.   :178.00
##
##    map_apache     resprate_apache  temp_apache    ventilated_apache
##  Min.   : 40.00   Min.   : 4.00   Min.   :32.10   0:62073
##  1st Qu.: 54.00   1st Qu.:11.00   1st Qu.:36.20   1:29640
##  Median : 67.00   Median :28.00   Median :36.50
##  Mean   : 87.79   Mean   :25.84   Mean   :36.42
##  3rd Qu.:124.00   3rd Qu.:36.00   3rd Qu.:36.70
##  Max.   :200.00   Max.   :60.00   Max.   :39.70
##
##  d1_mbp_noninvasive_min apache_4a_hospital_death_prob apache_4a_icu_death_prob
##  Min.   : 22.00         Min.   :-1.0000               Min.   :-1.00000
##  1st Qu.: 55.00         1st Qu.: 0.0200               1st Qu.: 0.01000
##  Median : 64.00         Median : 0.0500               Median : 0.02000
##  Mean   : 64.93         Mean   : 0.0836               Mean   : 0.04188
##  3rd Qu.: 74.00         3rd Qu.: 0.1200               3rd Qu.: 0.06000
##  Max.   :112.00         Max.   : 0.9900               Max.   : 0.97000
##
##  aids      cirrhosis diabetes_mellitus hepatic_failure immunosuppression
##  0:91635   0:90285   0:71221           0:90531         0:89332
##  1:   78   1: 1428   1:20492           1: 1182         1: 2381
##
##
##
##
##
##  leukemia  lymphoma  solid_tumor_with_metastasis       apache_3j_bodysystem
##  0:91070   0:91337   0:89835                     Cardiovascular  :31661
##  1:  643   1:  376   1: 1878                     Neurological    :11896
##                                                  Sepsis          :11740
##                                                  Respiratory     :11609
##                                                  Gastrointestinal: 9026
##                                                  Metabolic       : 7650
##                                                  (Other)         : 8131
##   hospital_death    d1_diasbp       d1_heartrate        d1_mbp
##  Survived:83798   Min.   : 29.50   Min.   : 29.00   Min.   : 41.00
##  Death   : 7915   1st Qu.: 60.50   1st Qu.: 74.50   1st Qu.: 74.50
##                   Median : 68.50   Median : 85.50   Median : 83.50
##                   Mean   : 69.32   Mean   : 86.66   Mean   : 84.76
##                   3rd Qu.: 77.00   3rd Qu.: 97.50   3rd Qu.: 94.00
##                   Max.   :127.50   Max.   :175.00   Max.   :148.00
##
##    d1_glucose     d1_resprate       d1_sysbp        d1_temp
##  Min.   : 53.0   Min.   : 7.00   Min.   : 65.5   Min.   :33.49
##  1st Qu.:109.5   1st Qu.:17.00   1st Qu.:109.0   1st Qu.:36.55
##  Median :128.5   Median :19.50   Median :121.0   Median :36.76
##  Mean   :143.5   Mean   :20.86   Mean   :122.6   Mean   :36.78
##  3rd Qu.:161.0   3rd Qu.:23.00   3rd Qu.:135.0   3rd Qu.:37.05
##  Max.   :449.5   Max.   :96.00   Max.   :196.0   Max.   :38.85
##
##    h1_diasbp       h1_heartrate        h1_mbp        h1_resprate
##  Min.   : 29.50   Min.   : 41.00   Min.   : 40.50   Min.   : 10.00
```

```
##  1st Qu.: 58.50   1st Qu.: 73.50   1st Qu.: 73.00   1st Qu.: 32.00
##  Median : 68.00   Median : 86.00   Median : 84.00   Median : 37.00
##  Mean   : 69.05   Mean   : 87.89   Mean   : 85.43   Mean   : 39.71
##  3rd Qu.: 78.50   3rd Qu.:100.00   3rd Qu.: 96.00   3rd Qu.: 45.00
##  Max.   :128.00   Max.   :154.00   Max.   :151.50   Max.   :248.00
##
##     h1_spo2          h1_sysbp     h1_sysbp_noninvasive
##  Min.   :  0.00   Min.   : 64.0   Min.   : 48.50
##  1st Qu.: 95.50   1st Qu.:107.0   1st Qu.: 85.50
##  Median : 97.50   Median :123.0   Median : 96.00
##  Mean   : 96.65   Mean   :124.7   Mean   : 97.99
##  3rd Qu.: 99.00   3rd Qu.:140.0   3rd Qu.:109.00
##  Max.   :100.00   Max.   :208.5   Max.   :168.50
##
```

Balancing Class

```
N_min <- min(unname(table(data$hospital_death)))
data <- ovun.sample(hospital_death ~ ., data=data,N=2*N_min ,seed=1234)$data
```

Splitting Data

```
set.seed(1234)
ind <- sample(2, nrow(data), replace = T, prob = c(0.8, 0.2))
trainData <- data[ind == 1,]
testData <- data[ind == 2,]
```

Train Data

```
head(trainData,5)
```

```
##   age      bmi elective_surgery        ethnicity gender height
## 1  72 27.99383                0        Caucasian      M  180.0
## 2  73 27.95332                1        Caucasian      F  163.8
## 3  68 37.25027                0 African American      F  172.7
## 4  80 26.83518                0        Caucasian      F  152.0
## 6  49 24.13270                0        Caucasian      M  175.3
##            icu_admit_source icu_stay_type     icu_type pre_icu_los_days weight
## 1      Accident & Emergency         admit         MICU      0.165972222  90.70
## 2 Operating Room / Recovery         admit Med-Surg ICU      0.215277778  75.00
## 3      Accident & Emergency         admit    CCU-CTICU      0.000694444 111.10
## 4      Accident & Emergency         admit Med-Surg ICU      0.223611111  62.00
## 6      Accident & Emergency         admit    CCU-CTICU      0.004166667  74.16
##   apache_2_diagnosis apache_post_operative arf_apache gcs_eyes_apache
## 1                113                     0          0               3
## 2                208                     1          0               1
## 3                113                     0          0               4
```

```
## 4               112                    0         0              4
## 6               113                    0         0              4
##   gcs_motor_apache gcs_unable_apache gcs_verbal_apache heart_rate_apache
## 1                5                 0                1               97
## 2                5                 0                1               85
## 3                6                 0                5              106
## 4                6                 0                5               96
## 6                6                 0                5              115
##   intubated_apache map_apache resprate_apache temp_apache ventilated_apache
## 1                0         48             14        36.8                 1
## 2                1        130              5        36.6                 1
## 3                0        118              4        36.9                 0
## 4                0        127             41        37.0                 0
## 6                0        150             35        37.1                 0
##   d1_mbp_noninvasive_min apache_4a_hospital_death_prob apache_4a_icu_death_prob
## 1                     50                         0.14                    0.07
## 2                     55                         0.29                    0.21
## 3                     82                         0.04                    0.02
## 4                     85                         0.07                    0.03
## 6                     71                         0.06                    0.04
##   aids cirrhosis diabetes_mellitus hepatic_failure immunosuppression leukemia
## 1    0         0                 1               0                 0        0
## 2    0         0                 0               0                 0        0
## 3    0         0                 1               0                 0        0
## 4    0         0                 1               0                 0        0
## 6    0         0                 0               0                 0        0
##   lymphoma solid_tumor_with_metastasis apache_3j_bodysystem hospital_death
## 1        0                           0              Sepsis       Survived
## 2        0                           0              Trauma       Survived
## 3        0                           0              Sepsis       Survived
## 4        0                           0       Cardiovascular       Survived
## 6        0                           0              Sepsis       Survived
##   d1_diasbp d1_heartrate d1_mbp d1_glucose d1_resprate d1_sysbp d1_temp
## 1      61.5         90.5   74.5      255.5        22.0    117.0   37.40
## 2      65.0         70.0   75.0      138.5        14.0    117.5   36.75
## 3      72.0         93.0  100.0      163.5        22.0    148.5   37.35
## 4      59.0         65.5   93.5      215.0        22.5    117.0   37.00
## 6      79.5        104.0   90.5      129.0        27.0    130.5   37.30
##   h1_diasbp h1_heartrate h1_mbp h1_resprate h1_spo2 h1_sysbp
## 1      49.0         91.0   66.5          43    98.5    103.0
## 2      83.0         84.0   95.0          46   100.0    151.0
## 3      81.0         97.0   98.5          47    98.5    163.0
## 4      71.0         90.0  102.5          44    99.0    146.5
## 6      84.5        109.5   95.5          67    95.5    133.0
##   h1_sysbp_noninvasive
## 1                 79.0
## 2                117.0
## 3                125.0
## 4                113.5
## 6                110.5
```

Test Data

```
head(testData ,5)
```

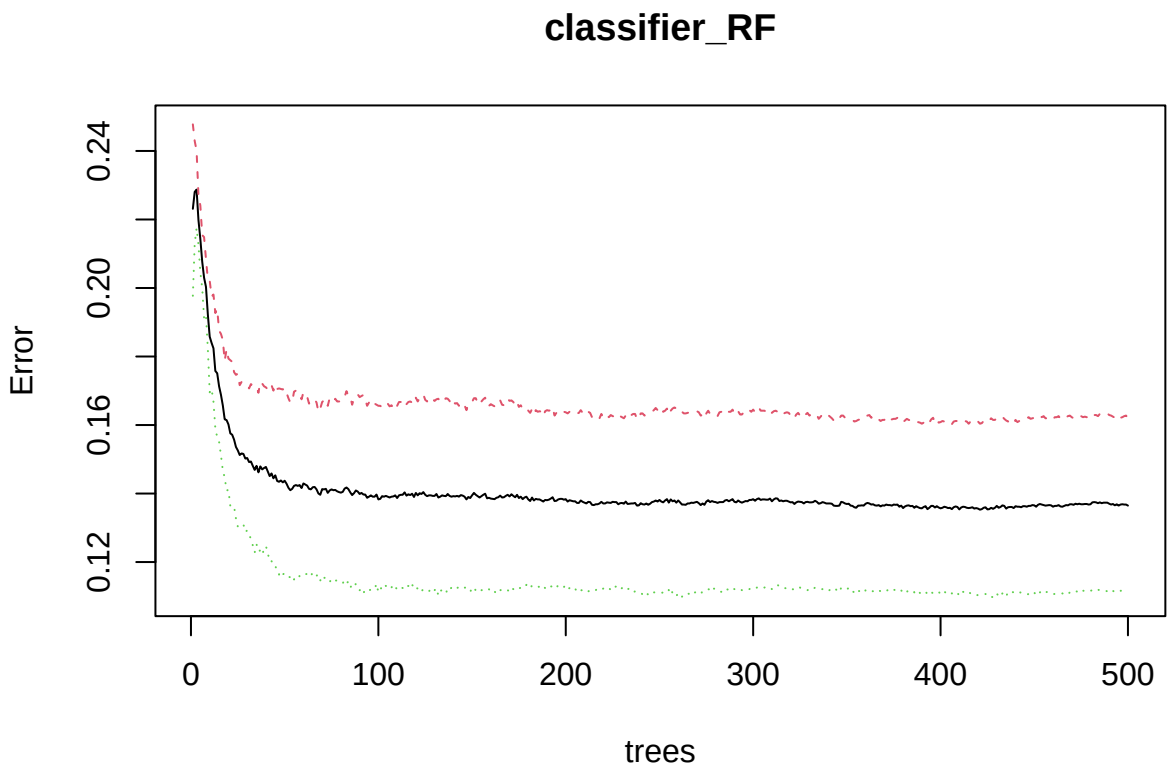
```
##    age      bmi elective_surgery       ethnicity gender height
## 5   66 40.14757                0       Caucasian      M  192.0
## 14  45 26.92346                0 Native American      M  172.7
## 16  67 27.65465                1       Caucasian      M  182.9
## 26  86 19.54726                1       Caucasian      F  152.4
## 28  83 27.86858                1       Caucasian      M  170.8
##             icu_admit_source icu_stay_type     icu_type pre_icu_los_days weight
## 5                      Floor         admit Med-Surg ICU        0.7194444  148.0
## 14                     Floor         admit Med-Surg ICU        5.7590278   80.3
## 16 Operating Room / Recovery         admit Med-Surg ICU        0.3194444   80.3
## 26 Operating Room / Recovery         admit         SICU        0.2638889   45.4
## 28 Operating Room / Recovery         admit        CSICU        2.3291667   81.3
##    apache_2_diagnosis apache_post_operative arf_apache gcs_eyes_apache
## 5                 302                     0          0               4
## 14                105                     0          1               3
## 16                302                     1          0               4
## 26                308                     1          0               4
## 28                302                     1          0               4
##    gcs_motor_apache gcs_unable_apache gcs_verbal_apache heart_rate_apache
## 5                 5                 0                 1              113
## 14                5                 0                 4              100
## 16                6                 0                 5              113
## 26                6                 0                 5              118
## 28                6                 0                 5               60
##    intubated_apache map_apache resprate_apache temp_apache ventilated_apache
## 5                 1        132              30        36.1                 1
## 14                0         55              27        36.0                 1
## 16                0        110              16        36.7                 0
## 26                0        117              37        36.4                 0
## 28                0         52              26        36.3                 0
##    d1_mbp_noninvasive_min apache_4a_hospital_death_prob
## 5                      63                         0.52
## 14                     55                         0.08
## 16                     88                         0.05
## 26                     88                         0.02
## 28                     52                         0.06
##    apache_4a_icu_death_prob aids cirrhosis diabetes_mellitus hepatic_failure
## 5                      0.32    0         0                 0              0
## 14                     0.05    0         0                 1              0
## 16                     0.02    0         0                 0              0
## 26                     0.01    0         0                 0              0
## 28                     0.02    0         0                 0              0
##    immunosuppression leukemia lymphoma solid_tumor_with_metastasis
## 5                  0        1        0                           0
## 14                 0        0        0                           0
## 16                 0        0        0                           0
## 26                 0        0        0                           0
## 28                 0        0        0                           0
##    apache_3j_bodysystem hospital_death d1_diasbp d1_heartrate d1_mbp d1_glucose
```

```
## 5        Cardiovascular       Survived      86.0         88.5   93.5      176.5
## 14          Respiratory       Survived      73.5         85.0   78.0      100.5
## 16       Cardiovascular       Survived      77.0         92.5   99.0      128.5
## 26 Musculoskeletal/Skin       Survived      70.0         89.5   96.0      136.0
## 28       Cardiovascular       Survived      61.5         61.5   72.0      106.0
##    d1_resprate d1_sysbp d1_temp h1_diasbp h1_heartrate h1_mbp h1_resprate
## 5         19.0    120.5   36.60      90.5        104.0   98.0          37
## 14        20.5     99.0   36.85      60.0         96.0   64.0          37
## 16        16.0    137.5   37.00      84.5         87.5  109.5          32
## 26        21.5    131.5   36.65      81.0        103.0  104.0          48
## 28        20.5    115.5   36.65      53.0         60.0   69.0          42
##    h1_spo2 h1_sysbp h1_sysbp_noninvasive
## 5     94.5    120.0                98.0
## 14    94.0     79.5                69.5
## 16    94.0    147.0               118.0
## 26    95.0    145.0               113.0
## 28    98.0    119.0                82.5
```

Model Evaluation

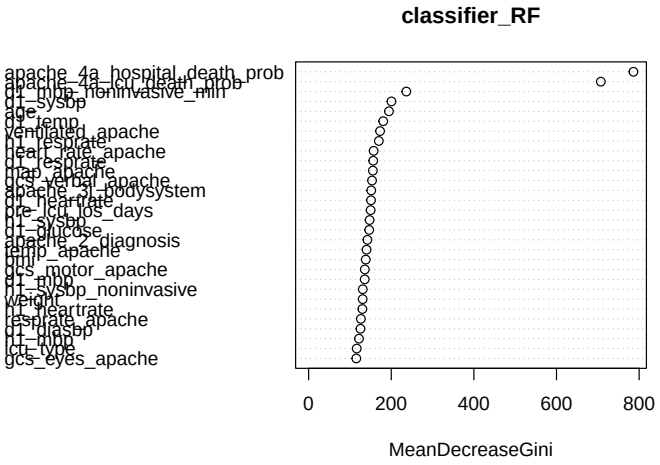
Training and Ploting error

```
trainData_x <- trainData %>% select(-c(hospital_death))
trainData_y <- trainData$hospital_death

classifier_RF = randomForest(x = trainData_x,y = trainData_y)

#classifier_RF = train(x = trainData_x,y = trainData_y)
plot(classifier_RF)
```



Plotting Variable Importance

```
varImpPlot(classifier_RF)
```



Predict & Evaluation

```
testData_x <- testData %>% select(-c(hospital_death))
testData_y <- testData %>% select(c(hospital_death))
testData_y <- testData_y$hospital_death

predict_y <- predict(classifier_RF,testData_x)
predict_y <- as.vector(predict_y)
predict_y <- factor(predict_y,levels = c("Survived","Death"))

# predict_y
confusionMatrix(predict_y,testData_y)
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction Survived Death
##   Survived     1310   176
##   Death         256  1426
##
##                Accuracy : 0.8636
##                  95% CI : (0.8512, 0.8754)
##     No Information Rate : 0.5057
##     P-Value [Acc > NIR] : < 2.2e-16
##
##                   Kappa : 0.7271
##
##  Mcnemar's Test P-Value : 0.0001442
##
##             Sensitivity : 0.8365
##             Specificity : 0.8901
##          Pos Pred Value : 0.8816
##          Neg Pred Value : 0.8478
##              Prevalence : 0.4943
##          Detection Rate : 0.4135
##    Detection Prevalence : 0.4691
##       Balanced Accuracy : 0.8633
##
##        'Positive' Class : Survived
##
```

Tune Hyperparameter

```
ntreeku     <- c()
mtryku      <- c()
accuracyku  <- c()
for(ntr in c(100,200,500,1000)){
  for(mt in c(7)){
    trainData_x <- trainData %>% select(-c(hospital_death))
    trainData_y <- trainData$hospital_death
```

```
    classifier_RF = randomForest(x = trainData_x,y = trainData_y,
                                 ntree=ntr,mtry = mt)
    testData_x <- testData %>% select(-c(hospital_death))
    testData_y <- testData %>% select(c(hospital_death))
    testData_y <- testData_y$hospital_death

    predict_y <- predict(classifier_RF,testData_x)
    predict_y <- as.vector(predict_y)
    predict_y <- factor(predict_y,levels = c("Survived","Death"))

    # predict_y
    acc <- confusionMatrix(predict_y,testData_y)$table
    acc_c <- (acc[1,1] + acc[2,2])/sum(acc)
    mtryku <- c(mtryku,mt)
    accuracyku <- c(accuracyku,acc_c)
    ntreeku <- c(ntreeku,ntr)
  }
}
```

```
# mtry Number of variables randomly sampled as candidates at each split. Note that the default values a
table_hyper <- data.frame(ntreeku,mtryku,accuracyku)
table_hyper
```

```
##   ntreeku mtryku accuracyku
## 1     100      7  0.8636364
## 2     200      7  0.8655303
## 3     500      7  0.8661616
## 4    1000      7  0.8655303
```

```
    trainData_x <- trainData %>% select(-c(hospital_death))
    trainData_y <- trainData$hospital_death

    classifier_RF = randomForest(x = trainData_x,y = trainData_y,
                                 ntree=500,mtry = 7)
    testData_x <- testData %>% select(-c(hospital_death))
    testData_y <- testData %>% select(c(hospital_death))
    testData_y <- testData_y$hospital_death

    predict_y <- predict(classifier_RF,testData_x)
    predict_y <- as.vector(predict_y)
    predict_y <- factor(predict_y,levels = c("Survived","Death"))

    # predict_y
confusionMatrix(predict_y,testData_y)
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction Survived Death
##   Survived     1314   176
##   Death         252  1426
##
```

```
##                Accuracy : 0.8649
##                  95% CI : (0.8525, 0.8766)
##     No Information Rate : 0.5057
##     P-Value [Acc > NIR] : < 2.2e-16
##
##                   Kappa : 0.7296
##
##  Mcnemar's Test P-Value : 0.0002887
##
##             Sensitivity : 0.8391
##             Specificity : 0.8901
##          Pos Pred Value : 0.8819
##          Neg Pred Value : 0.8498
##              Prevalence : 0.4943
##          Detection Rate : 0.4148
##    Detection Prevalence : 0.4703
##       Balanced Accuracy : 0.8646
##
##        'Positive' Class : Survived
##
```

Time Limit

```
current_2 <- Sys.time()
deltatime_rpart <- current_2 - current_0
print("Time Modelling :")
```

```
## [1] "Time Modelling :"
```

```
print(deltatime_rpart)
```

```
## Time difference of 4.877591 mins
```