Aprendizagem Estatística em Altas Dimensões [MAE0501/MAE5904/IBI5904]

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Importando os dados / Limpando / Inspecionando

```
diabetes <- read_csv("C:\\Users\\Rodrigo Araujo\\Documents\\IME-USP\\Aprendizagem Estatística em Altas
## Parsed with column specification:
## cols(
##
    Pregnancies = col_double(),
##
    Glucose = col_double(),
    BloodPressure = col_double(),
##
    SkinThickness = col_double(),
    Insulin = col_double(),
##
    BMI = col_double(),
##
    DiabetesPedigreeFunction = col_double(),
##
    Age = col_double(),
##
    Outcome = col_double()
## )
#diabetes <- read.csv("diabetes.csv")</pre>
```

Tabela 1: Dados.

Pregnancies	Glucose	${\bf BloodPressure}$	SkinThickness	Insulin	BMI	${\bf Diabetes Pedigree Function}$	Age	Outcome
6	148	72	35	0	33,6	0,63	50	1
1	85	66	29	0	26,6	0,35	31	0
8	183	64	0	0	23,3	0,67	32	1
1	89	66	23	94	28,1	0,17	21	0
0	137	40	35	168	43,1	2,29	33	1
5	116	74	0	0	25,6	0,20	30	0

```
dim(diabetes)
```

```
Renomear coluna e ajustar níveis de categórica
```

[1] 768 9

head(diabetes) %>% kable(caption="Dados.")

```
diabetes[, 2:6][diabetes[, 2:6] == 0] <- NA
colnames(diabetes)[9] <- "diabetes"
diabetes$diabetes <- as.factor(diabetes$diabetes)
levels(diabetes$diabetes) <- c("No","Yes")</pre>
```

Visualização dos Dados

Estrutura dos Dados

```
str(diabetes)
## tibble [768 x 9] (S3: spec_tbl_df/tbl_df/tbl/data.frame)
## $ Pregnancies
                            : num [1:768] 6 1 8 1 0 5 3 10 2 8 ...
## $ Glucose
                            : num [1:768] 148 85 183 89 137 116 78 115 197 125 ...
## $ BloodPressure
                           : num [1:768] 72 66 64 66 40 74 50 NA 70 96 ...
                            : num [1:768] 35 29 NA 23 35 NA 32 NA 45 NA ...
## $ SkinThickness
                             : num [1:768] NA NA NA 94 168 NA 88 NA 543 NA ...
## $ Insulin
## $ BMI
                             : num [1:768] 33.6 26.6 23.3 28.1 43.1 25.6 31 35.3 30.5 NA ...
## $ DiabetesPedigreeFunction: num [1:768] 0.627 0.351 0.672 0.167 2.288 ...
## $ Age
                             : num [1:768] 50 31 32 21 33 30 26 29 53 54 ...
                             : Factor w/ 2 levels "No", "Yes": 2 1 2 1 2 1 2 1 2 2 ...
## $ diabetes
## - attr(*, "spec")=
##
    .. cols(
##
         Pregnancies = col_double(),
##
         Glucose = col_double(),
    . .
##
    .. BloodPressure = col_double(),
##
    .. SkinThickness = col_double(),
##
    .. Insulin = col_double(),
##
    .. BMI = col_double(),
##
    .. DiabetesPedigreeFunction = col_double(),
##
    .. Age = col_double(),
##
         Outcome = col_double()
    . .
##
    ..)
```

train / test

```
# para reprodução
set.seed(23)
nrows <- nrow(diabetes)
index <- sample(1:nrows, 0.7 * nrows) # shuffle and divide
# train <- diab
# 768 test data (100%)
train <- diabetes[index,] # 537 test data (70%)
test <- diabetes[-index,] # 231 test data (30%)</pre>
```

Proporção de diabetes (Benign / Malignant)

train

```
prop.table(table(train$diabetes))
```

```
##
## No Yes
## 0.6405959 0.3594041

test

prop.table(table(test$diabetes))

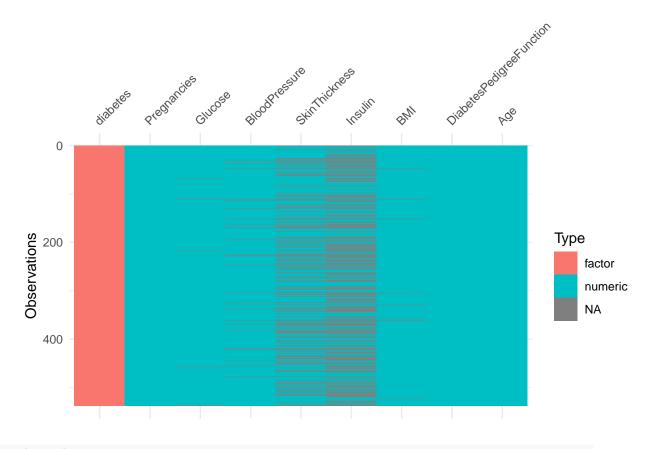
##
## No Yes
## 0.6753247 0.3246753
```

Analise dos Missings

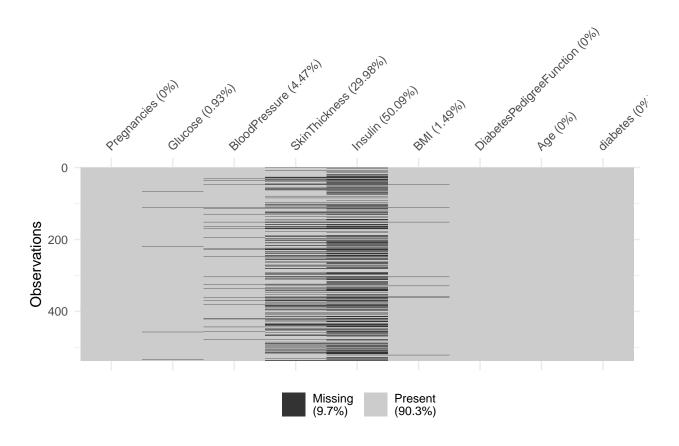
Descritiva inicial

```
summary(train)
```

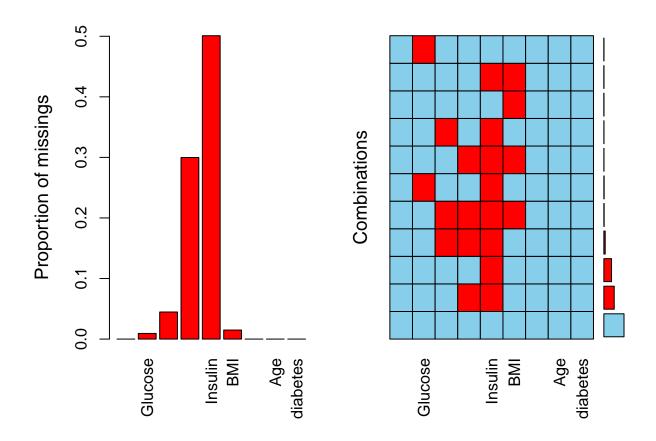
```
Pregnancies
                       Glucose
                                    BloodPressure
                                                     SkinThickness
                                    Min. : 24.00
## Min. : 0.000
                    Min. : 44.0
                                                     Min. : 7.00
   1st Qu.: 1.000
                    1st Qu.:100.0
                                    1st Qu.: 64.00
                                                     1st Qu.:22.75
## Median : 3.000
                    Median :117.0
                                    Median : 72.00
                                                     Median :30.00
## Mean : 3.903
                    Mean
                          :122.7
                                    Mean
                                         : 72.72
                                                     Mean
                                                          :29.68
   3rd Qu.: 6.000
                    3rd Qu.:143.2
                                    3rd Qu.: 80.00
                                                     3rd Qu.:37.00
##
##
   Max. :15.000
                    Max.
                          :199.0
                                    Max.
                                          :114.00
                                                     Max.
                                                            :63.00
##
                    NA's
                          :5
                                    NA's
                                           :24
                                                     NA's
##
      Insulin
                        BMI
                                   {\tt DiabetesPedigreeFunction}
                                                                 Age
##
   Min. : 14.0
                   Min.
                          :18.20
                                   Min.
                                         :0.078
                                                           Min.
                                                                   :21.00
   1st Qu.: 76.0
                   1st Qu.:27.60
                                   1st Qu.:0.238
                                                            1st Qu.:24.00
  Median :126.0
                   Median :32.40
                                   Median : 0.361
                                                           Median :29.00
                         :32.55
##
  Mean
         :157.1
                   Mean
                                   Mean
                                         :0.463
                                                           Mean
                                                                 :33.56
   3rd Qu.:190.2
                   3rd Qu.:36.80
                                   3rd Qu.:0.619
                                                            3rd Qu.:41.00
  Max.
          :846.0
                          :67.10
                                   Max. :2.420
                                                           Max. :72.00
                   Max.
  NA's
           :269
                   NA's
                          :8
##
  diabetes
##
  No :344
##
   Yes:193
##
##
##
##
##
vis_dat(train)
```



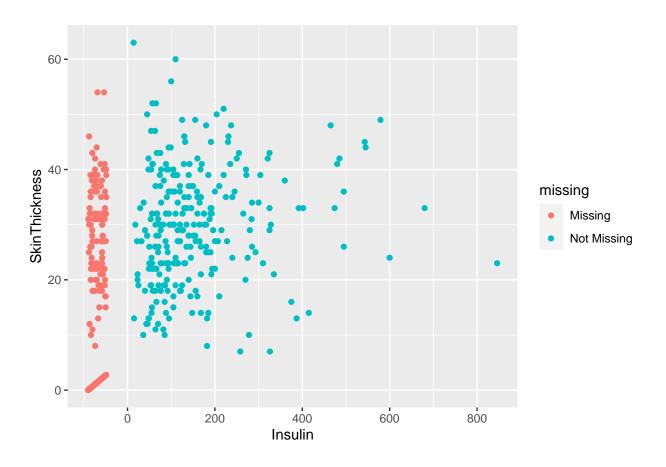
vis_miss(train)



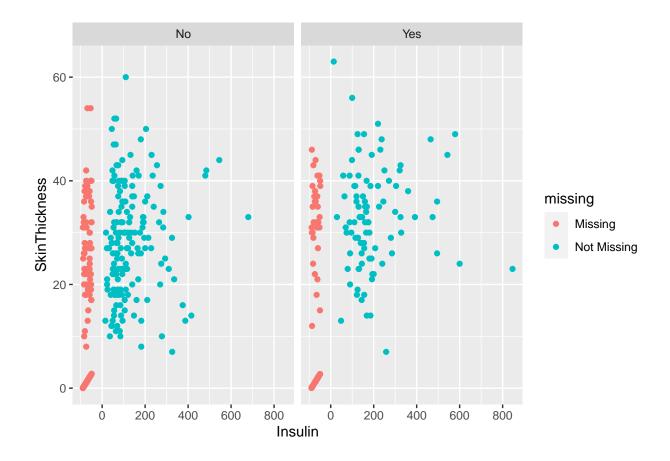
aggr(train) # Missings têm padrões?



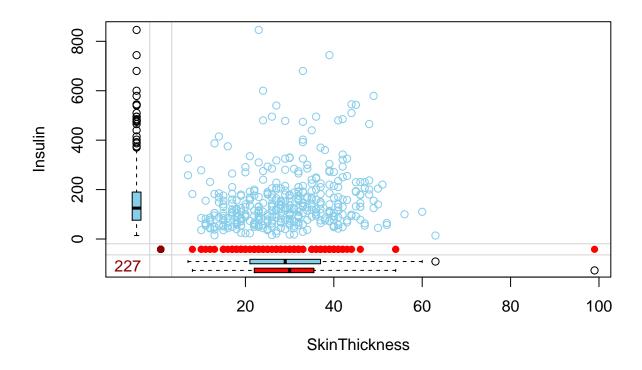
ggplot(train, aes(x = Insulin, y = SkinThickness)) + # Padrão de missing entre 2 vars com mais missings
geom_miss_point()



ggplot(train, aes(x = Insulin, y = SkinThickness)) + # Padrão de missing entre 2 vars com mais missings
geom_miss_point() + facet_wrap(~ diabetes)



marginplot(diabetes[c(4,5)])



Possibilidades de imputação

```
library(mice)
## Warning: package 'mice' was built under R version 4.0.3
## Attaching package: 'mice'
## The following objects are masked from 'package:base':
##
##
       cbind, rbind
imputacao_train <- mice(data = train , m = 5, maxit = 50, meth = 'pmm', seed = 25)</pre>
##
##
    iter imp variable
         1 Glucose BloodPressure
                                   SkinThickness Insulin BMI
##
##
         2 Glucose BloodPressure
                                   SkinThickness
                                                  Insulin BMI
         3 Glucose BloodPressure SkinThickness Insulin BMI
##
```

```
##
                                       SkinThickness
                                                        Insulin
     1
             Glucose
                       BloodPressure
         5
##
             Glucose
                       BloodPressure
                                       SkinThickness
                                                        Insulin
                                                                  BMT
     1
##
     2
         1
             Glucose
                       BloodPressure
                                       SkinThickness
                                                        Insulin
                                                                  BMI
     2
                                                        Insulin
##
         2
             Glucose
                       BloodPressure
                                       SkinThickness
                                                                  BMT
##
     2
         3
             Glucose
                       BloodPressure
                                       SkinThickness
                                                        Insulin
                                                                  BMT
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     2
         4
             Glucose
                       BloodPressure
                                       SkinThickness
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##
     2
         5
             Glucose
                       BloodPressure
                                       SkinThickness
                                                        Insulin
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##
     3
         1
             Glucose
                       BloodPressure
                                       SkinThickness
                                                        Insulin
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             Glucose
                       BloodPressure
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             Glucose
                       BloodPressure
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                                                        Insulin
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                       BloodPressure
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                        BloodPressure
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                        BloodPressure
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                        BloodPressure
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##
     22
                        BloodPressure
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              Glucose
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##
     23
                        BloodPressure
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```
##
     23
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              Glucose
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                        BloodPressure
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              Glucose
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     23
              Glucose
                        BloodPressure
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              Glucose
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              Glucose
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              Glucose
                        BloodPressure
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           5
              Glucose
                        BloodPressure
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              Glucose
                        BloodPressure
                                        SkinThickness
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              Glucose
                        BloodPressure
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                                        SkinThickness
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                                                                   BMI
##
     25
           4
                                                         Insulin
              Glucose
                        BloodPressure
                                        SkinThickness
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           5
              Glucose
                        BloodPressure
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                                                         Insulin
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     26
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              Glucose
                        BloodPressure
                                        SkinThickness
                                                         Insulin
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              Glucose
                        BloodPressure
                                        SkinThickness
                                                         Insulin
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                        BloodPressure
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                        BloodPressure
                                        SkinThickness
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                        BloodPressure
                                        SkinThickness
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     26
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              Glucose
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              Glucose
                        BloodPressure
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              Glucose
                        BloodPressure
                                        SkinThickness
                                                         Insulin
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              Glucose
                        BloodPressure
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                                                         Insulin
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                                                         Insulin
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              Glucose
                        BloodPressure
                                        SkinThickness
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                        BloodPressure
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                        BloodPressure
                                        SkinThickness
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                        BloodPressure
                                        SkinThickness
                                                         Insulin
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                        BloodPressure
                                        SkinThickness
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     29
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                                        SkinThickness
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              Glucose
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                        BloodPressure
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              Glucose
                        BloodPressure
                                        SkinThickness
                                                         Insulin
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                                        SkinThickness
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                        BloodPressure
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              Glucose
                                        SkinThickness
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              Glucose
                        BloodPressure
                                        SkinThickness
                                                         Insulin
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                        BloodPressure
                                        SkinThickness
                                                         Insulin
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                        BloodPressure
                                        SkinThickness
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              Glucose
                        BloodPressure
                                        SkinThickness
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                        BloodPressure
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                                        SkinThickness
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                                                         Insulin
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                        BloodPressure
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                                                         Insulin
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                                                         Insulin
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                                                         Insulin
              Glucose
                        BloodPressure
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              Glucose
                        BloodPressure
                                        SkinThickness
                                                         Insulin
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     33
                        BloodPressure
                                        SkinThickness
                                                         Insulin
           4
              Glucose
                                                                   BMI
##
     33
                        BloodPressure
                                        SkinThickness
              Glucose
                                                         Insulin
```

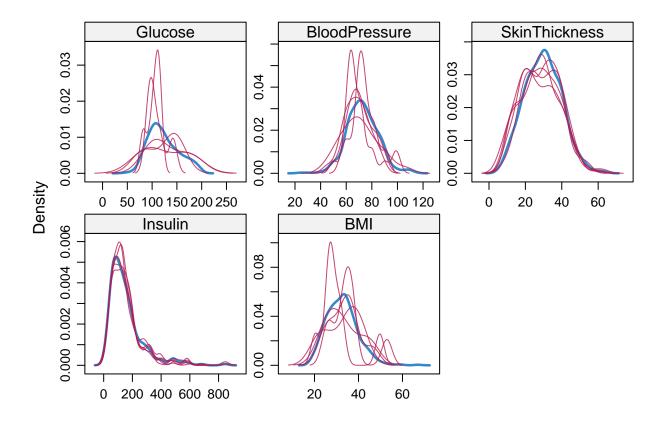
```
##
     34
                                                         Insulin
           1
              Glucose
                        BloodPressure
                                        SkinThickness
##
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              Glucose
                        BloodPressure
                                        SkinThickness
                                                         Insulin
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                        BloodPressure
                                        SkinThickness
                                                         Insulin
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                        BloodPressure
                                        SkinThickness
                                                         Insulin
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              Glucose
                        BloodPressure
                                        SkinThickness
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                        BloodPressure
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                                                         Insulin
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                        BloodPressure
                                        SkinThickness
                                                         Insulin
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              Glucose
                        BloodPressure
                                        SkinThickness
                                                         Insulin
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                        BloodPressure
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                                                         Insulin
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              Glucose
                        BloodPressure
                                        SkinThickness
                                                         Insulin
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     36
              Glucose
                        BloodPressure
                                        SkinThickness
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              Glucose
                        BloodPressure
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     36
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              Glucose
                        BloodPressure
                                        SkinThickness
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     36
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              Glucose
                        BloodPressure
                                        SkinThickness
                                                         Insulin
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     36
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              Glucose
                        BloodPressure
                                        SkinThickness
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              Glucose
                        BloodPressure
                                        SkinThickness
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     37
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              Glucose
                        BloodPressure
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                                                         Insulin
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                                        SkinThickness
                                                         Insulin
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                        BloodPressure
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              Glucose
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                                                         Insulin
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     38
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              Glucose
                        BloodPressure
                                        SkinThickness
                                                         Insulin
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     38
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              Glucose
                        BloodPressure
                                        SkinThickness
                                                         Insulin
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                        BloodPressure
                                        SkinThickness
                                                         Insulin
              Glucose
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              Glucose
                        BloodPressure
                                        SkinThickness
                                                         Insulin
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              Glucose
                        BloodPressure
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              Glucose
                        BloodPressure
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                        BloodPressure
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                        BloodPressure
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                        BloodPressure
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                        BloodPressure
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              Glucose
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              Glucose
                        BloodPressure
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              Glucose
                        BloodPressure
                                        SkinThickness
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     41
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              Glucose
                        BloodPressure
                                        SkinThickness
                                                         Insulin
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     41
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              Glucose
                        BloodPressure
                                        SkinThickness
                                                         Insulin
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     41
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              Glucose
                        BloodPressure
                                        SkinThickness
                                                                  BMT
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     41
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              Glucose
                        BloodPressure
                                        SkinThickness
##
     41
           5
                        BloodPressure
                                                         Insulin
              Glucose
                                        SkinThickness
                                                                  BMI
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     42
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              Glucose
                        BloodPressure
                                        SkinThickness
                                                         Insulin
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     42
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              Glucose
                        BloodPressure
                                        SkinThickness
                                                         Insulin
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     42
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              Glucose
                        BloodPressure
                                        SkinThickness
                                                         Insulin
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     42
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              Glucose
                        BloodPressure
                                        SkinThickness
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     42
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              Glucose
                        BloodPressure
                                        SkinThickness
                                                         Insulin
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     43
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              Glucose
                        BloodPressure
                                        SkinThickness
                                                         Insulin
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                        BloodPressure
                                        SkinThickness
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     43
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              Glucose
                        BloodPressure
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                                                         Insulin
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              Glucose
                        BloodPressure
                                        SkinThickness
                                                         Insulin
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     43
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                        BloodPressure
                                        SkinThickness
                                                         Insulin
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     44
                        BloodPressure
                                        SkinThickness
                                                         Insulin
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              Glucose
                        BloodPressure
                                        SkinThickness
                                                         Insulin
                                                                   BMI
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     44
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                        BloodPressure
                                        SkinThickness
                                                         Insulin
              Glucose
                                                                  BMI
##
     44
                        BloodPressure
                                        SkinThickness
              Glucose
                                                         Insulin
```

```
##
     44
             Glucose
                      BloodPressure
                                      SkinThickness
                                                      Insulin
##
     45
                      BloodPressure
                                      SkinThickness
                                                      Insulin
                                                                BMT
          1
             Glucose
                                      SkinThickness
##
     45
             Glucose
                      BloodPressure
                                                      Insulin
                                                                BMI
##
     45
             Glucose
                      BloodPressure
                                      SkinThickness
                                                      Insulin
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     45
             Glucose
                      BloodPressure
                                      SkinThickness
                                                      Insulin
     45
             Glucose
                      BloodPressure
                                      SkinThickness
                                                      Insulin
##
                      BloodPressure
                                      SkinThickness
                                                      Insulin
##
     46
             Glucose
##
     46
          2
             Glucose
                      BloodPressure
                                      SkinThickness
                                                      Insulin
                                                                BMT
##
     46
          3
             Glucose
                      BloodPressure
                                      SkinThickness
                                                      Insulin
##
     46
             Glucose
                      BloodPressure
                                      SkinThickness
                                                      Insulin
                                                                BMI
##
     46
             Glucose
                      BloodPressure
                                      SkinThickness
                                                      Insulin
                                                                BMI
##
     47
             Glucose
                      BloodPressure
                                      SkinThickness
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             Glucose
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                                      SkinThickness
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##
     47
             Glucose
                      BloodPressure
                                                      Insulin
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##
     47
             Glucose
                      BloodPressure
                                      SkinThickness
                                                      Insulin
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          5
             Glucose
                      BloodPressure
                                      SkinThickness
                                                      Insulin
                                                                BMI
##
     48
                                                      Insulin
          1
             Glucose
                      BloodPressure
                                      SkinThickness
##
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                      BloodPressure
                                      SkinThickness
                                                      Insulin
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             Glucose
                      BloodPressure
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                                                      Insulin
     48
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     48
             Glucose
                      BloodPressure
                                      SkinThickness
                                                      Insulin
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     48
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             Glucose
                      BloodPressure
                                      SkinThickness
                                                      Insulin
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                      BloodPressure
                                      SkinThickness
                                                      Insulin
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             Glucose
                      BloodPressure
                                      SkinThickness
                                                      Insulin
     49
          2
                                                                BMT
             Glucose
                      BloodPressure
                                      SkinThickness
                                                      Insulin
##
     49
     49
##
             Glucose
                      BloodPressure
                                      SkinThickness
                                                      Insulin
##
     49
             Glucose
                      BloodPressure SkinThickness
                                                      Insulin
##
     50
             Glucose
                      BloodPressure
                                      SkinThickness
                                                      Insulin
          1
                                                                BMI
                                                      Insulin
##
     50
             Glucose
                      BloodPressure
                                      SkinThickness
##
     50
          3
             Glucose
                      BloodPressure
                                      SkinThickness
                                                      Insulin
                                                                BMI
##
     50
          4
             Glucose
                      BloodPressure
                                      SkinThickness
                                                      Insulin
                                                                BMI
##
     50
             Glucose
                      BloodPressure
                                      SkinThickness
                                                      Insulin
                                                                BMI
```

summary(imputacao_train)

```
## Class: mids
   Number of multiple imputations: 5
   Imputation methods:
##
                 Pregnancies
                                                 Glucose
                                                                      BloodPressure
##
                                                    "pmm"
                                                                                "pmm"
##
               SkinThickness
                                                  Insulin
                                                                                 BMI
                        "pmm"
                                                    "pmm"
                                                                               "pmm"
## DiabetesPedigreeFunction
                                                                            diabetes
                                                      Age
##
##
  PredictorMatrix:
##
                  Pregnancies Glucose BloodPressure SkinThickness Insulin BMI
  Pregnancies
##
                             0
                                                                              1
                                                                                   1
                                      1
                                                      1
                                                                     1
   Glucose
                             1
                                      0
                                                      1
                                                                     1
                                                                              1
                                                                                   1
   BloodPressure
                             1
                                                      0
                                                                              1
                                                                                   1
                                      1
                                                                     1
## SkinThickness
                             1
                                                                     0
                                                                              1
                                      1
                                                      1
                                                                                   1
## Insulin
                             1
                                      1
                                                      1
                                                                     1
                                                                              0
                                                                                   1
##
  BMI
                              1
                                      1
                                                      1
##
                  DiabetesPedigreeFunction Age diabetes
## Pregnancies
                                            1
                                                1
```

```
## Glucose
                                            1
## BloodPressure
                                                 1
                                                           1
                                                           1
## SkinThickness
## Insulin
                                                           1
                                                 1
                                            1
## BMI
imputado_train_1 <- complete(imputacao_train, 1)</pre>
imputado_train_2 <- complete(imputacao_train, 2)</pre>
imputado_train_3 <- complete(imputacao_train, 3)</pre>
imputado_train_4 <- complete(imputacao_train, 4)</pre>
imputado_train_5 <- complete(imputacao_train, 5)</pre>
library(lattice)
densityplot(imputacao_train)
```



train\$Glucose <- apply(cbind(imputado_train_1\$Glucose, imputado_train_2\$Glucose, imputado_train_3\$Gluco
train\$BloodPressure <- apply(cbind(imputado_train_1\$BloodPressure, imputado_train_2\$BloodPressure, impu
train\$SkinThickness <- apply(cbind(imputado_train_1\$SkinThickness, imputado_train_2\$SkinThickness, impu
train\$Insulin <- apply(cbind(imputado_train_1\$Insulin, imputado_train_2\$Insulin, imputado_train_3\$Insul
train\$BMI <- apply(cbind(imputado_train_1\$BMI, imputado_train_2\$BMI, imputado_train_3\$BMI, imputado_tra

```
##
    iter imp variable
##
##
     1
         1 BloodPressure
                           SkinThickness
                                           Insulin BMI
                                                    BMI
##
     1
            BloodPressure
                            SkinThickness
                                           Insulin
##
            BloodPressure
                            SkinThickness
                                           Insulin BMI
     1
##
     1
         4
            BloodPressure
                            SkinThickness
                                           Insulin
                                                    BMI
##
     1
         5
            BloodPressure
                            SkinThickness
                                           Insulin
                                                    BMI
##
     2
            BloodPressure
                            SkinThickness
                                           Insulin
                                                    BMI
##
     2
         2
            BloodPressure
                                           Insulin
                            SkinThickness
                                                    BMI
##
     2
         3
            BloodPressure
                            SkinThickness
                                           Insulin
                                                    BMI
     2
##
         4
            BloodPressure
                            SkinThickness
                                           Insulin
                                                    BMI
##
     2
            BloodPressure
                            SkinThickness
                                           Insulin BMI
            BloodPressure
                                           Insulin
##
     3
                            SkinThickness
                                                    BMI
         1
##
     3
            BloodPressure
                            SkinThickness
                                           Insulin
                                                    BMI
            {\tt BloodPressure}
##
     3
                            SkinThickness
                                           Insulin
         3
                                                    BMT
     3
            BloodPressure
                            SkinThickness
                                           Insulin
##
##
     3
         5
            BloodPressure
                            SkinThickness
                                           Insulin
                                                    BMT
                                           Insulin
##
     4
         1
            BloodPressure
                            SkinThickness
##
     4
         2
            BloodPressure
                                           Insulin BMI
                            SkinThickness
##
     4
         3
            BloodPressure
                           SkinThickness
                                           Insulin BMI
                                           Insulin
##
     4
         4
            BloodPressure
                            SkinThickness
                                                    BMT
##
     4
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            BloodPressure
                            SkinThickness
                                           Insulin
                                                    BMI
     5
                                           Insulin BMI
##
         1
            BloodPressure
                            SkinThickness
##
     5
         2
            BloodPressure
                            SkinThickness
                                           Insulin
                                                    RMT
##
     5
         3
            BloodPressure
                            SkinThickness
                                           Insulin
                                                    BMI
##
     5
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            BloodPressure
                                           Insulin
                            SkinThickness
                                                    BMI
##
     5
            BloodPressure
                            SkinThickness
                                           Insulin
##
     6
            BloodPressure
                           SkinThickness
                                           Insulin BMI
         1
##
     6
            BloodPressure
                            SkinThickness
                                           Insulin
                                                    BMI
##
     6
         3
            BloodPressure
                            SkinThickness
                                           Insulin
                                                    BMT
##
            BloodPressure
                            SkinThickness
                                           Insulin
     6
         4
##
         5
            BloodPressure
                            SkinThickness
                                           Insulin
     6
                                                    BMT
##
     7
         1
            BloodPressure
                            SkinThickness
                                           Insulin
                                                    BMI
                                           Insulin BMI
##
     7
         2
            BloodPressure
                            SkinThickness
##
     7
            BloodPressure
                           SkinThickness
                                           Insulin BMI
     7
            BloodPressure
                                           Insulin
##
                            SkinThickness
                                                    BMT
##
     7
         5
            BloodPressure
                            SkinThickness
                                           Insulin
                                                    BMI
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     8
         1
            BloodPressure
                            SkinThickness
                                           Insulin BMI
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            BloodPressure
                            SkinThickness
                                           Insulin BMI
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     8
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            BloodPressure
                            SkinThickness
                                                    BMI
##
     8
         4
            BloodPressure
                            SkinThickness
                                           Insulin
                                                    BMI
##
     8
            BloodPressure
                            SkinThickness
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            BloodPressure
                                           Insulin
     9
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                           SkinThickness
                                                    RMT
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     9
         2
            BloodPressure
                            SkinThickness
                                            Insulin
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##
     9
         3
            BloodPressure
                            SkinThickness
                                           Insulin
                                                    BMI
     9
            BloodPressure
                            SkinThickness
                                           Insulin
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##
                                           Insulin
##
     9
            BloodPressure
                           SkinThickness
                                                    RMT
##
     10
            BloodPressure
                             SkinThickness
                                            Insulin
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     10
             BloodPressure SkinThickness
                                            Insulin
##
     10
             BloodPressure SkinThickness
                                            Insulin
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     10
             BloodPressure SkinThickness Insulin
                                                     BMT
```

```
##
     10
                              SkinThickness
                                               Insulin
           5
              BloodPressure
##
     11
           1
              BloodPressure
                              SkinThickness
                                               Insulin
                                                         BMT
              {\tt BloodPressure}
                              SkinThickness
##
     11
                                               Insulin
                                                         BMI
##
                              SkinThickness
                                               Insulin
     11
           3
              BloodPressure
                                                         BMT
##
     11
           4
              BloodPressure
                              SkinThickness
                                               Insulin
                                                         BMT
                                               Insulin
##
           5
              BloodPressure
                              SkinThickness
                                                         BMT
     11
##
     12
           1
              BloodPressure
                              SkinThickness
                                               Insulin
                                                         BMT
##
     12
           2
              BloodPressure
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     43
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                                             Insulin
```

summary(imputacao_test)

```
## Class: mids
  Number of multiple imputations: 5
   Imputation methods:
##
                 Pregnancies
                                                Glucose
                                                                    BloodPressure
##
                                                                             "pmm"
##
               SkinThickness
                                                Insulin
                                                                               BMI
##
                                                  "pmm"
                                                                             "mmmg"
  DiabetesPedigreeFunction
##
                                                    Age
                                                                          diabetes
##
##
  PredictorMatrix:
##
                  Pregnancies Glucose BloodPressure SkinThickness Insulin BMI
```

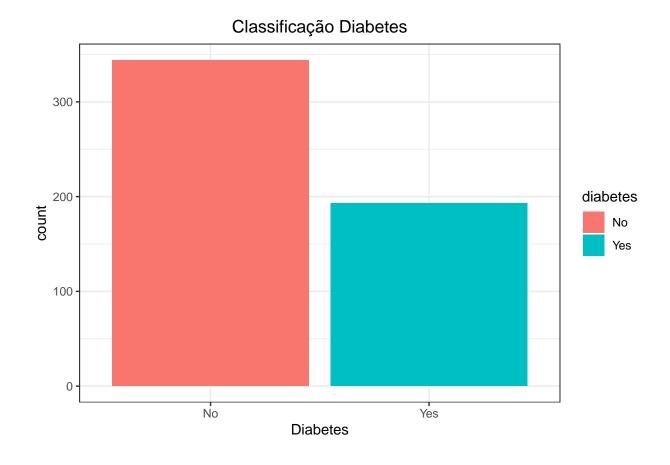
```
## Pregnancies
                            0
                                                    1
                                                                   1
                                                                           1
## Glucose
                            1
                                                    1
                                                                   1
                                                                           1
                                                                               1
                                                    0
## BloodPressure
                            1
                                                                  1
                                                                           1
                                                                               1
## SkinThickness
                                                                   0
                            1
                                     1
                                                    1
                                                                           1
                                                                              1
## Insulin
                            1
                                     1
                                                    1
                                                                   1
                                                                           0
                                                                               1
## BMI
                                     1
                                                    1
                                                                   1
                                                                           1
                                                                               0
                            1
                 DiabetesPedigreeFunction Age diabetes
## Pregnancies
                                          1
                                              1
## Glucose
                                          1
                                              1
## BloodPressure
                                          1
                                             1
                                                        1
## SkinThickness
                                          1
                                                        1
## Insulin
                                             1
                                                        1
                                          1
## BMI
imputado_test_1 <- complete(imputacao_test, 1)</pre>
imputado_test_2 <- complete(imputacao_test, 2)</pre>
imputado_test_3 <- complete(imputacao_test, 3)</pre>
imputado_test_4 <- complete(imputacao_test, 4)</pre>
imputado_test_5 <- complete(imputacao_test, 5)</pre>
```

```
test$Glucose <- apply(cbind(imputado_test_1$Glucose, imputado_test_2$Glucose, imputado_test_3$Glucose, test$BloodPressure <- apply(cbind(imputado_test_1$BloodPressure, imputado_test_2$BloodPressure, imputado test$SkinThickness <- apply(cbind(imputado_test_1$SkinThickness, imputado_test_2$SkinThickness, imputado test$Insulin <- apply(cbind(imputado_test_1$Insulin, imputado_test_2$Insulin, imputado_test_3$Insulin, test$BMI <- apply(cbind(imputado_test_1$BMI, imputado_test_2$BMI, imputado_test_3$BMI, imputado_test_4$
```

Análise Descritiva

Distribuição da variável Diabetes

```
ggplot(train, aes(diabetes, fill = diabetes)) +
  geom_bar() +
  theme_bw() +
  labs(title = "Classificação Diabetes", x = "Diabetes") +
  theme(plot.title = element_text(hjust = 0.5))
```



Correlação entre cada variável

```
library(PerformanceAnalytics)

## Loading required package: xts

## Loading required package: zoo
```

```
## Loading required package: zoo

## ## Attaching package: 'zoo'

## The following objects are masked from 'package:base':

## as.Date, as.Date.numeric

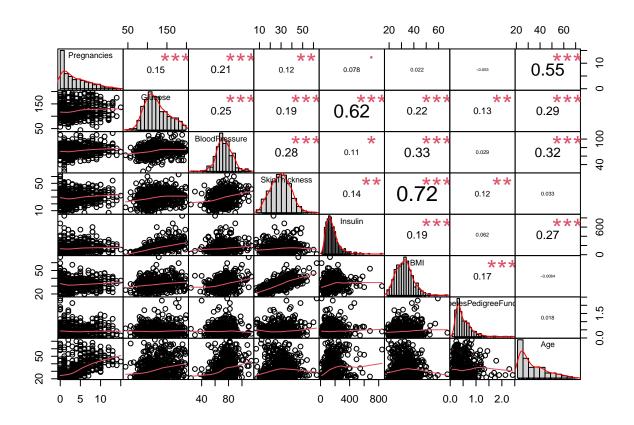
## ## Attaching package: 'xts'

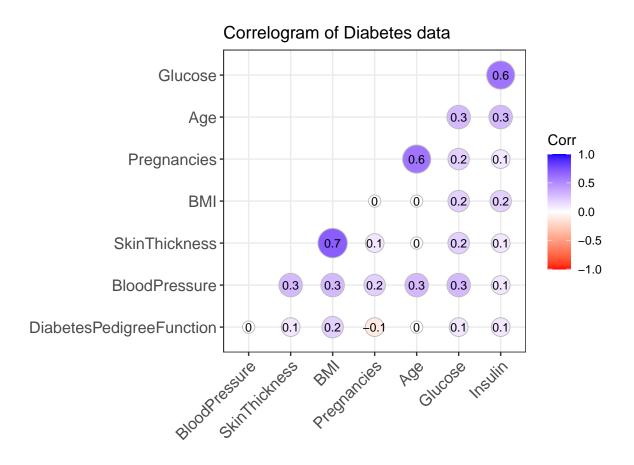
## The following objects are masked from 'package:dplyr':

## ## first, last
```

```
##
## Attaching package: 'PerformanceAnalytics'
## The following object is masked from 'package:graphics':
##
## legend
```

chart.Correlation(train[,-9], histogram=TRUE, col="grey10", pch=1, main="Correlação entre ás variáveis





Modelagem

SVM

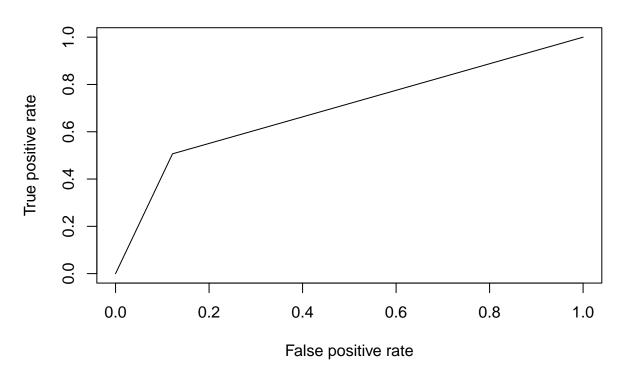
```
##
## Attaching package: 'caret'
## The following object is masked from 'package:vegan':
## tolerance
## The following objects are masked from 'package:MLmetrics':
##
## MAE, RMSE
## The following object is masked from 'package:survival':
##
## cluster
```

```
## The following object is masked from 'package:purrr':
##
##
       lift
library(e1071)
## Attaching package: 'e1071'
## The following objects are masked from 'package:PerformanceAnalytics':
##
##
       kurtosis, skewness
## The following object is masked from 'package:Hmisc':
##
       impute
set.seed(123)
linear.tune <- e1071::tune.svm(diabetes ~.,</pre>
                                 data = train,
                                 kernel = 'linear',
                                 cost = c(0.001, 0.01, 0.1, 1, 5, 10))
summary(linear.tune)
##
## Parameter tuning of 'svm':
## - sampling method: 10-fold cross validation
##
## - best parameters:
## cost
## 0.01
## - best performance: 0.2254018
##
## - Detailed performance results:
              error dispersion
      cost
## 1 1e-03 0.3591894 0.07461689
## 2 1e-02 0.2254018 0.05260323
## 3 1e-01 0.2291405 0.05587773
## 4 1e+00 0.2272886 0.05437335
## 5 5e+00 0.2366177 0.05092700
## 6 1e+01 0.2366177 0.05092700
        Matriz de Confusão
svm.real <- test$diabetes</pre>
best.linear <- linear.tune$best.model</pre>
```

```
## Confusion Matrix and Statistics
##
##
             Reference
## Prediction No Yes
          No 137 37
##
          Yes 19 38
##
##
                  Accuracy : 0.7576
##
                    95% CI : (0.697, 0.8114)
##
       No Information Rate: 0.6753
##
       P-Value [Acc > NIR] : 0.003953
##
##
                     Kappa : 0.4104
##
##
##
   Mcnemar's Test P-Value: 0.023103
##
##
               Sensitivity: 0.5067
##
               Specificity: 0.8782
##
            Pos Pred Value: 0.6667
            Neg Pred Value: 0.7874
##
##
                Prevalence: 0.3247
##
            Detection Rate: 0.1645
##
      Detection Prevalence: 0.2468
##
         Balanced Accuracy: 0.6924
##
##
          'Positive' Class : Yes
##
```

Curva ROC

ROC curve



RandomForest

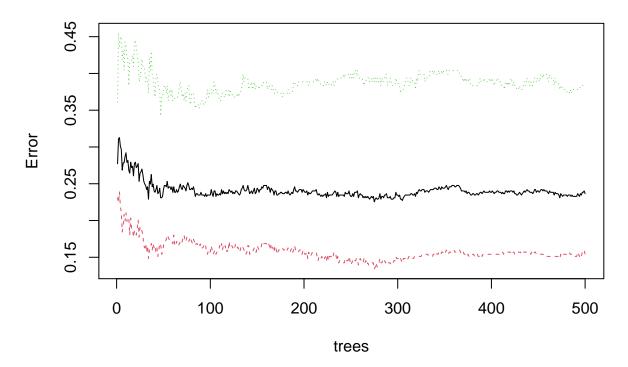
```
library(randomForest)

## randomForest 4.6-14

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

```
##
## Attaching package: 'randomForest'
## The following object is masked from 'package:psych':
##
##
       outlier
## The following object is masked from 'package:dplyr':
##
##
       combine
## The following object is masked from 'package:ggplot2':
##
##
       margin
learn_rf <- randomForest(diabetes~., data=train, ntree=500, proximity=T, importance=T)</pre>
pre_rf
         <- predict(learn_rf, test[,-9])
         <- confusionMatrix(pre_rf, test$diabetes)</pre>
cm_rf
cm_rf
## Confusion Matrix and Statistics
##
##
             Reference
## Prediction No Yes
          No 130 32
##
          Yes 26 43
##
##
                  Accuracy: 0.7489
##
                    95% CI: (0.6878, 0.8035)
       No Information Rate: 0.6753
##
##
       P-Value [Acc > NIR] : 0.009121
##
##
                     Kappa: 0.4153
##
   Mcnemar's Test P-Value: 0.511482
##
##
##
               Sensitivity: 0.8333
               Specificity: 0.5733
##
            Pos Pred Value : 0.8025
##
            Neg Pred Value: 0.6232
##
##
                Prevalence: 0.6753
##
            Detection Rate: 0.5628
      Detection Prevalence : 0.7013
##
##
         Balanced Accuracy: 0.7033
##
##
          'Positive' Class : No
##
```

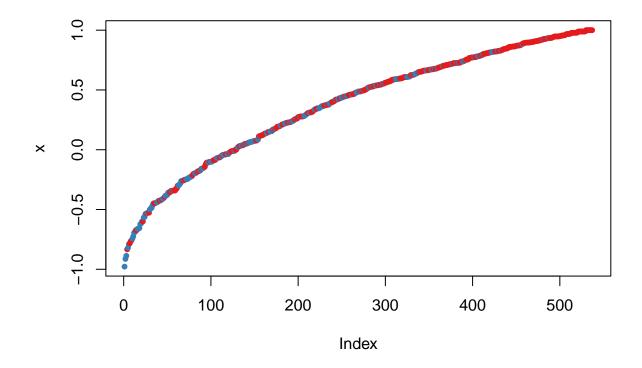
Random Forest (Error Rate vs. Number of Trees)



Prediction Plot

```
plot(margin(learn_rf,test$diabetes))
```

Warning in RColorBrewer::brewer.pal(nlevs, "Set1"): minimal value for n is 3, returning requested pa



Variance Importance Plot

varImpPlot(learn_rf)

learn_rf

