India Credit Risk - FRA

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Problem Statement:

We are requested to create an India credit risk(default) model, using the data provided in the spreadsheet. Please use the logistic regression framework to develop the credit default model.

Setting the Working Directory

```
## [1] "D:/Great Lakes/Projects/Domain/FRA"

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

##    0    1
## 3298  243

## [1] 0.07368102
```

As per our data we have about 73% companies hasn't defaulted and 17% of companies has defaulted

Understanding the data

Structure of Data

```
## 'data.frame':    3541 obs. of  53 variables:
##  $ Num                         : num  1 2 3 4 5 6 7 8 9 10
...
##  $ Networth.Next.Year          : num  8890.6 394.3 92.2 2.7
109 ...
##  $ Total.assets                : num  17512.3 941 232.8 2.7
478.5 ...
##  $ Net.worth                   : num  7093.2 351.5 100.6 2.
7 107.6 ...
##  $ Total.income                : num  24965 1527 477 NA 158
0 ...
##  $ Change.in.stock             : num  235.8 42.7 -5.2 NA -1
7 ...
##  $ Total.expenses              : num  23658 1455 479 NA 155
8 ...
```

```
##  $ Profit.after.tax                        : num  1543.2 115.2 -6.6 NA
5.5 ...
##  $ PBDITA                                   : num  2860.2 283 5.8 NA 31
...
##  $ PBT                                      : num  2417.2 188.4 -6.6 NA
6.3 ...
##  $ Cash.profit                             : num  1872.8 158.6 0.3 NA 1
1.9 ...
##  $ PBDITA.as...of.total.income             : num  11.46 18.53 1.22 0 1.
96 ...
##  $ PBT.as...of.total.income                : num  9.68 12.33 -1.38 0 0.
4 ...
##  $ PAT.as...of.total.income                : num  6.18 7.54 -1.38 0 0.3
5 2.81 0 0.72 8.29 -2.88 ...
##  $ Cash.profit.as...of.total.income        : num  7.5 10.38 0.06 0 0.75
...
##  $ PAT.as...of.net.worth                   : num  23.78 38.08 -6.35 0 5
.25 ...
##  $ Sales                                   : num  24458 1504 476 NA 157
5 ...
##  $ Income.from.financial.services          : num  158 4 1.5 NA 3.9 6.4
NA NA 7.3 NA ...
##  $ Other.income                            : num  297.2 15.9 0.2 NA 0.9
...
##  $ Total.capital                           : num  423.8 115.5 81.4 0.5
6.2 ...
##  $ Reserves.and.funds                      : num  6822.8 257.8 19.2 2.2
161.8 ...
##  $ Deposits..accepted.by.commercial.banks. : logi  NA NA NA NA NA NA ..
.
##  $ Borrowings                              : num  14.9 272.5 35.4 NA 19
3.1 ...
##  $ Current.liabilities...provisions        : num  9965.9 210 96.8 NA 11
2.8 ...
##  $ Deferred.tax.liability                  : num  284.9 85.2 NA NA 4.6
...
##  $ Shareholders.funds                      : num  7093.2 351.5 100.6 2.
7 107.6 ...
##  $ Cumulative.retained.profits             : num  6263.3 247.4 32.4 2.2
82.7 ...
##  $ Capital.employed                        : num  7108.1 624 136 2.7 30
0.7 ...
##  $ TOL.TNW                                 : num  1.33 1.23 1.44 0 2.83
1.8 0.03 5.17 1.05 3.25 ...
##  $ Total.term.liabilities...tangible.net.worth: num  0 0.34 0.29 0 1.59 0.
37 0.03 0.94 0.3 0.54 ...
##  $ Contingent.liabilities...Net.worth....   : num  14.8 19.2 45.8 0 34.9
...
##  $ Contingent.liabilities                  : num  1049.7 67.6 46.1 NA 3
7.6 ...
```

```
##  $ Net.fixed.assets                        : num  1900.2 286.4 38.7 2.5
94.8 ...
##  $ Investments                             : num  1069.6 2.2 4.3 NA 7.4
...
##  $ Current.assets                          : num  13277.5 563.9 167.5 0
.2 349.7 ...
##  $ Net.working.capital                     : num  3588.5 203.5 59.6 0.2
215.8 ...
##  $ Quick.ratio..times.                     : num  1.18 0.95 1.11 NA 1.4
1 0.48 NA 0.54 0.59 0.39 ...
##  $ Current.ratio..times.                   : num  1.37 1.56 1.55 NA 2.5
4 1.27 NA 1.15 1.58 0.5 ...
##  $ Debt.to.equity.ratio..times.            : num  0 0.78 0.35 0 1.79 1.
09 0.32 2.31 0.94 3.13 ...
##  $ Cash.to.current.liabilities..times.     : num  0.43 0.06 0.21 NA 0 0
.11 NA 0.04 0.19 0 ...
##  $ Cash.to.average.cost.of.sales.per.day   : num  68.21 5.96 17.07 NA 0
...
##  $ Creditors.turnover                      : Factor w/ 1609 levels "0",
"0.01","0.02",..: 856 1585 1136 1 299 1279 1 804 274 NA ...
##  $ Debtors.turnover                        : Factor w/ 1641 levels "0",
"0.01","0.02",..: 904 1205 1146 1 1595 704 1 1189 1397 831 ...
##  $ Finished.goods.turnover                 : Factor w/ 2202 levels "-0.
09","0","0.07",..: 812 408 2117 NA 299 82 NA 476 1607 1468 ...
##  $ WIP.turnover                            : Factor w/ 1942 levels "-0.
18","0","0.02",..: 813 1684 15 NA 1716 1782 NA 220 1269 1541 ...
##  $ Raw.material.turnover                   : Factor w/ 1602 levels "-0.
1","-1","-2",..: 1400 229 NA 4 489 1066 4 1214 903 1155 ...
##  $ Shares.outstanding                      : Factor w/ 2371 levels "-21
47483647",..: 1357 160 2161 1666 1886 152 1592 2371 1221 1841 ...
##  $ Equity.face.value                       : Factor w/ 19 levels "-9999
98.9","1",..: 3 3 3 3 3 3 3 19 3 3 ...
##  $ EPS                                     : num  35.52 9.97 -0.5 0 7.9
1 ...
##  $ Adjusted.EPS                            : num  7.1 9.97 -0.5 0 7.91
...
##  $ Total.liabilities                       : num  17512.3 941 232.8 2.7
478.5 ...
##  $ PE.on.BSE                               : Factor w/ 1143 levels "-0.
07","-0.16",..: 694 1055 175 1143 1143 1143 1143 1143 352 42 ...
##  $ default                                 : num  0 0 0 0 0 0 0 0 1 .
..

## [1] 13548

##                                          Num
##                                           0
##                         Networth.Next.Year
##                                           0
##                                 Total.assets
```

```
##                                          0
##                                  Net.worth
##                                          0
##                               Total.income
##                                        198
##                            Change.in.stock
##                                        458
##                             Total.expenses
##                                        139
##                           Profit.after.tax
##                                        131
##                                     PBDITA
##                                        131
##                                        PBT
##                                        131
##                                Cash.profit
##                                        131
##                PBDITA.as...of.total.income
##                                         68
##                   PBT.as...of.total.income
##                                         68
##                   PAT.as...of.total.income
##                                         68
##           Cash.profit.as...of.total.income
##                                         68
##                        PAT.as...of.net.worth
##                                          0
##                                      Sales
##                                        259
##              Income.from.financial.services
##                                        935
##                               Other.income
##                                       1295
##                              Total.capital
##                                          4
##                          Reserves.and.funds
##                                         85
##   Deposits..accepted.by.commercial.banks.
##                                       3541
##                                 Borrowings
##                                        366
##           Current.liabilities...provisions
##                                         96
##                     Deferred.tax.liability
##                                       1140
##                         Shareholders.funds
##                                          0
##                 Cumulative.retained.profits
##                                         38
##                           Capital.employed
```

```
##                                            0
##                                      TOL.TNW
##                                            0
## Total.term.liabilities...tangible.net.worth
##                                            0
##          Contingent.liabilities...Net.worth....
##                                            0
##                       Contingent.liabilities
##                                         1188
##                             Net.fixed.assets
##                                          118
##                                  Investments
##                                         1435
##                               Current.assets
##                                           66
##                          Net.working.capital
##                                           32
##                          Quick.ratio..times.
##                                           93
##                        Current.ratio..times.
##                                           93
##                  Debt.to.equity.ratio..times.
##                                            0
##            Cash.to.current.liabilities..times.
##                                           93
##          Cash.to.average.cost.of.sales.per.day
##                                           85
##                           Creditors.turnover
##                                           47
##                             Debtors.turnover
##                                           42
##                       Finished.goods.turnover
##                                          454
##                                 WIP.turnover
##                                          354
##                         Raw.material.turnover
##                                           75
##                           Shares.outstanding
##                                            0
##                            Equity.face.value
##                                            0
##                                          EPS
##                                            0
##                                 Adjusted.EPS
##                                            0
##                            Total.liabilities
##                                            0
##                                    PE.on.BSE
##                                           23
```

```
##                             default
##                                0
##
##       Num          Networth.Next.Year  Total.assets        Net.worth
##  Min.   :   1   Min.   :-74265.6   Min.   :      0.1   Min.   :     0.0
##  1st Qu.: 886   1st Qu.:    31.7   1st Qu.:     91.3   1st Qu.:    31.3
##  Median :1773   Median :   116.3   Median :    309.7   Median :   102.3
##  Mean   :1772   Mean   :  1616.3   Mean   :   3443.4   Mean   :  1295.9
##  3rd Qu.:2658   3rd Qu.:   456.1   3rd Qu.:   1098.7   3rd Qu.:   377.3
##  Max.   :3545   Max.   :805773.4   Max.   :1176509.2   Max.   :613151.6
##
##   Total.income        Change.in.stock     Total.expenses
##  Min.   :      0.0   Min.   :-3029.40   Min.   :     -0.1
##  1st Qu.:    106.5   1st Qu.:   -1.80   1st Qu.:     95.8
##  Median :    444.9   Median :    1.60   Median :    407.7
##  Mean   :   4582.8   Mean   :   41.49   Mean   :   4262.9
##  3rd Qu.:   1440.9   3rd Qu.:   18.05   3rd Qu.:   1359.8
##  Max.   :2442828.2   Max.   :14185.50   Max.   :2366035.3
##  NA's   :198         NA's   :458        NA's   :139
##  Profit.after.tax       PBDITA             PBT
##  Min.   : -3908.30   Min.   :  -440.7   Min.   : -3894.80
##  1st Qu.:     0.50   1st Qu.:     6.9   1st Qu.:     0.70
##  Median :     8.80   Median :    35.4   Median :    12.40
##  Mean   :   277.36   Mean   :   578.1   Mean   :   383.81
##  3rd Qu.:    52.27   3rd Qu.:   150.2   3rd Qu.:    71.97
##  Max.   :119439.10   Max.   :208576.5   Max.   :145292.60
##  NA's   :131         NA's   :131        NA's   :131
##   Cash.profit        PBDITA.as...of.total.income PBT.as...of.total.income
##  Min.   : -2245.70   Min.   :-6400.000            Min.   :-21340.00
##  1st Qu.:     2.90   1st Qu.:    5.000            1st Qu.:     0.55
##  Median :    18.85   Median :    9.660            Median :     3.31
##  Mean   :   392.07   Mean   :    4.571            Mean   :   -17.28
##  3rd Qu.:    93.20   3rd Qu.:   16.390            3rd Qu.:     8.80
##  Max.   :176911.80   Max.   :  100.000            Max.   :   100.00
##  NA's   :131         NA's   :68                   NA's   :68
##  PAT.as...of.total.income Cash.profit.as...of.total.income
##  Min.   :-21340.00        Min.   :-15020.000
##  1st Qu.:     0.35        1st Qu.:     2.020
##  Median :     2.34        Median :     5.640
##  Mean   :   -19.20        Mean   :    -8.229
##  3rd Qu.:     6.34        3rd Qu.:    10.700
##  Max.   :   150.00        Max.   :   100.000
##  NA's   :68               NA's   :68
##  PAT.as...of.net.worth     Sales            Income.from.financial.services
##  Min.   :-748.72       Min.   :      0.1   Min.   :    0.00
##  1st Qu.:   0.00       1st Qu.:    112.7   1st Qu.:    0.40
##  Median :   7.92       Median :    453.1   Median :    1.80
##  Mean   :  10.27       Mean   :   4549.5   Mean   :   80.84
##  3rd Qu.:  20.19       3rd Qu.:   1433.5   3rd Qu.:    9.68
##  Max.   :2466.67       Max.   :2384984.4   Max.   :51938.20
```

```
##                        NA's   :259          NA's    :935
##    Other.income     Total.capital      Reserves.and.funds
##  Min.   :    0.00  Min.   :     0.1  Min.   : -6525.9
##  1st Qu.:    0.40  1st Qu.:    13.1  1st Qu.:     5.0
##  Median :    1.40  Median :    42.1  Median :    54.8
##  Mean   :   41.36  Mean   :   216.6  Mean   :  1163.8
##  3rd Qu.:    5.97  3rd Qu.:   100.3  3rd Qu.:   277.3
##  Max.   :42856.70  Max.   :78273.2  Max.   :625137.8
##  NA's   :1295      NA's   :4         NA's   :85
##  Deposits..accepted.by.commercial.banks.   Borrowings
##  Mode:logical                             Min.   :     0.10
##  NA's:3541                                1st Qu.:    23.95
##                                           Median :    99.20
##                                           Mean   :  1122.28
##                                           3rd Qu.:   352.60
##                                           Max.   :278257.30
##                                           NA's   :366
##  Current.liabilities...provisions Deferred.tax.liability
##  Min.   :     0.1                 Min.   :     0.1
##  1st Qu.:    17.8                 1st Qu.:     3.2
##  Median :    69.4                 Median :    13.4
##  Mean   :   940.6                 Mean   :   227.2
##  3rd Qu.:   261.7                 3rd Qu.:    50.0
##  Max.   :352240.3                 Max.   :72796.6
##  NA's   :96                       NA's   :1140
##  Shareholders.funds Cumulative.retained.profits Capital.employed
##  Min.   :     0.0  Min.   : -6534.3            Min.   :     0.0
##  1st Qu.:    32.0  1st Qu.:     1.1            1st Qu.:    60.8
##  Median :   105.6  Median :    37.1            Median :   214.7
##  Mean   :  1322.1  Mean   :   890.5            Mean   :  2328.3
##  3rd Qu.:   393.2  3rd Qu.:   202.3            3rd Qu.:   767.3
##  Max.   :613151.6  Max.   :390133.8            Max.   :891408.9
##                    NA's   :38
##     TOL.TNW         Total.term.liabilities...tangible.net.worth
##  Min.   :-350.480  Min.   :-325.600
##  1st Qu.:   0.600  1st Qu.:   0.050
##  Median :   1.430  Median :   0.340
##  Mean   :   3.994  Mean   :   1.844
##  3rd Qu.:   2.830  3rd Qu.:   1.000
##  Max.   : 473.000  Max.   : 456.000
##
##  Contingent.liabilities...Net.worth....  Contingent.liabilities
##  Min.   :    0.00                        Min.   :     0.1
##  1st Qu.:    0.00                        1st Qu.:     6.3
##  Median :    5.33                        Median :    38.0
##  Mean   :   53.94                        Mean   :   932.9
##  3rd Qu.:   30.76                        3rd Qu.:   192.7
##  Max.   :14704.27                        Max.   :559506.8
##                                          NA's   :1188
##  Net.fixed.assets     Investments        Current.assets
```

```
##  Min.    :      0.0   Min.    :      0.00   Min.    :      0.1
##  1st Qu.:      26.0   1st Qu.:      1.00   1st Qu.:      36.2
##  Median :      93.5   Median :      8.35   Median :     145.1
##  Mean   :    1189.7   Mean   :    694.73   Mean   :    1293.4
##  3rd Qu.:     344.9   3rd Qu.:     64.30   3rd Qu.:     502.2
##  Max.   :636604.6   Max.   :199978.60   Max.   :354815.2
##  NA's   :118         NA's   :1435         NA's   :66
##  Net.working.capital Quick.ratio..times. Current.ratio..times.
##  Min.   :-63839.0   Min.    :  0.000   Min.   :  0.00
##  1st Qu.:     -1.1   1st Qu.:  0.410   1st Qu.:  0.93
##  Median :     16.2   Median :  0.670   Median :  1.23
##  Mean   :    138.6   Mean    :  1.401   Mean   :  2.13
##  3rd Qu.:     84.2   3rd Qu.:  1.030   3rd Qu.:  1.71
##  Max.   : 85782.8   Max.    :341.000   Max.   :505.00
##  NA's   :32          NA's    :93         NA's   :93
##  Debt.to.equity.ratio..times. Cash.to.current.liabilities..times.
##  Min.    :  0.00              Min.    :  0.0000
##  1st Qu.:  0.22              1st Qu.:  0.0200
##  Median :  0.79              Median :  0.0700
##  Mean    :  2.78              Mean    :  0.4904
##  3rd Qu.:  1.75              3rd Qu.:  0.1900
##  Max.    :456.00              Max.    :165.0000
##                                NA's    :93
##  Cash.to.average.cost.of.sales.per.day Creditors.turnover Debtors.turnover
##  Min.    :      0.00                   NA      : 286       NA      : 286
##  1st Qu.:      2.79                   0       : 178       0       : 210
##  Median :      8.03                   4       :  11       4.9     :   9
##  Mean    :    158.44                   3.71    :   9       3.76    :   8
##  3rd Qu.:     21.79                   3.73    :   8       4.68    :   8
##  Max.    :128040.76                   (Other):3002       (Other):2978
##  NA's    :85                           NA's    :  47       NA's    :  42
##  Finished.goods.turnover  WIP.turnover   Raw.material.turnover
##  NA      : 286             NA      : 286  0       : 352
##  0       :   9             0       :  14  NA      : 286
##  12.61   :   5             8.17    :   7  2       :  11
##  5.58    :   5             1.79    :   6  2.55    :   8
##  7.18    :   5             11.87   :   5  2.57    :   7
##  (Other):2777             (Other):2869  (Other):2802
##  NA's    : 454             NA's    : 354  NA's    :  75
##  Shares.outstanding Equity.face.value      EPS
##  NA      : 692       10     :2413     Min.    :-843181.8
##  3e+06   :  35       NA     : 692     1st Qu.:      0.0
##  5e+06   :  21       100    : 251     Median :      1.4
##  50000   :  18       5      :  47     Mean    :   -220.3
##  2e+05   :  17       1      :  45     3rd Qu.:      9.6
##  1500000:  14       2      :  41     Max.    :  34522.5
##  (Other):2744       (Other):  52
##   Adjusted.EPS      Total.liabilities    PE.on.BSE       default
##  Min.   :-843181.8   Min.    :      0.1   NA      :2171   Min.   :0.00000
##  1st Qu.:      0.0   1st Qu.:      91.3   12.17   :   4   1st Qu.:0.00000
```

```
## Median :        1.2    Median :      309.7    15.05   :    4    Median :0.00000
## Mean   :     -221.5    Mean   :     3443.4    4.11    :    4    Mean   :0.06862
## 3rd Qu.:        7.5    3rd Qu.:     1098.7    7.93    :    4    3rd Qu.:0.00000
## Max.   :    34522.5    Max.   :  1176509.2    (Other):1331    Max.   :1.00000
##                                               NA's    :   23
```

Inferences:

- We have 52 variables, with Net worth Next Year as dependent variable

- Then we have created a variable default based on Net worth Next Year variable

- The Data looks impure as we have lot of NA's (10007) which we need to clean.

Missing value Treatment

Since our dataset has lot of NA's we can't forward without cleaning the Missing Value Treatment.

The Variable **Deposits accepted by commercial banks** doesn't has any value. So it's safe to eliminate the variable both in Training and Validation dataset.

```
# removing Deposits (accepted by commercial banks) column as it is full of NA

## [1] 10007

## [1] 0

## [1] 1878

## [1] 0
```

Outlier Treatment using capping

For values that lie outside the 1.5 * IQR limits, we could cap it by replacing those observations outside the lower limit with the value of 25th %ile and those that lie above the upper limit, with the value of 75th %ile.

```
boxplot(rawdata.nona$Total.assets)
```

Box Plot Before Capping
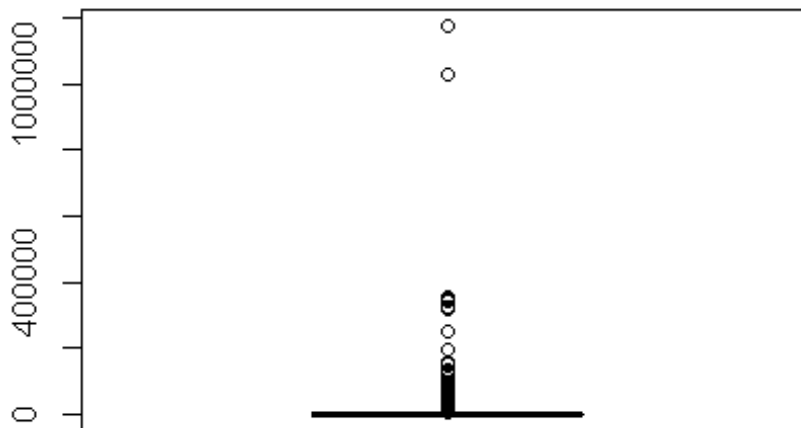

```r
fun <- function(x){
    quantiles <- quantile( x, c(.25, .75 ) )
    x[ x < quantiles[1] ] <- quantiles[1]
    x[ x > quantiles[2] ] <- quantiles[2]
    x
}
default <- rawdata.nona$default

for (i in 2:ncol(rawdata.nona)) {
rawdata.nona[,i] <- fun( rawdata.nona[,i] )
}

rawdata.nona$default <- default
summary(as.factor(rawdata.nona$default))

##    0    1
## 3298  243

boxplot(rawdata.nona$Total.assets)
```

Box Plot after Capping
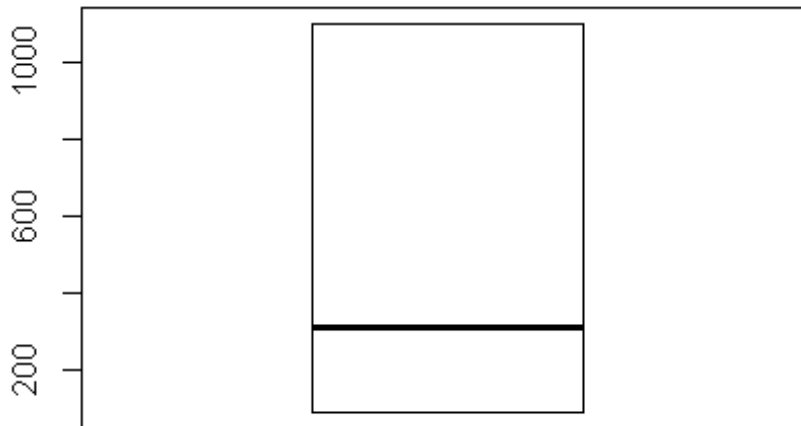

```
summary(rawdata.nona)

##       Num         Networth.Next.Year  Total.assets       Net.worth
##  Min.   :    1    Min.   : 31.7       Min.   :   91.3    Min.   : 31.3
##  1st Qu.: 886     1st Qu.: 31.7       1st Qu.:   91.3    1st Qu.: 31.3
##  Median :1773     Median :116.3       Median :  309.7    Median :102.3
##  Mean   :1772     Mean   :198.4       Mean   :  495.6    Mean   :167.6
##  3rd Qu.:2658     3rd Qu.:456.1       3rd Qu.: 1098.7    3rd Qu.:377.3
##  Max.   :3545     Max.   :456.1       Max.   : 1098.7    Max.   :377.3
##   Total.income     Change.in.stock  Total.expenses   Profit.after.tax
##  Min.   : 121.2    Min.   :-0.70    Min.   : 104.1   Min.   : 0.60
##  1st Qu.: 121.2    1st Qu.:-0.70    1st Qu.: 104.1   1st Qu.: 0.60
##  Median : 510.9    Median : 4.10    Median : 458.7   Median :10.00
##  Mean   : 827.0    Mean   :14.63    Mean   : 716.7   Mean   :24.28
##  3rd Qu.:1895.1    3rd Qu.:41.49    3rd Qu.:1618.9   3rd Qu.:64.20
##  Max.   :1895.1    Max.   :41.49    Max.   :1618.9   Max.   :64.20
##     PBDITA             PBT            Cash.profit
##  Min.   :   7.30   Min.   : 0.90    Min.   :   3.10
##  1st Qu.:   7.30   1st Qu.: 0.90    1st Qu.:   3.10
##  Median :  41.10   Median :14.20    Median :  21.80
##  Mean   :  75.72   Mean   :33.77    Mean   :  44.95
##  3rd Qu.: 184.20   3rd Qu.:89.50    3rd Qu.: 112.70
##  Max.   : 184.20   Max.   :89.50    Max.   : 112.70
##  PBDITA.as...of.total.income PBT.as...of.total.income
##  Min.   : 4.69               Min.   :0.420
```

```
##   1st Qu.: 4.69              1st Qu.:0.420
##   Median : 9.38              Median :3.170
##   Mean   :10.08              Mean    :4.052
##   3rd Qu.:16.15              3rd Qu.:8.630
##   Max.   :16.15              Max.    :8.630
##   PAT.as...of.total.income Cash.profit.as...of.total.income
##   Min.   :0.250             Min.    : 1.820
##   1st Qu.:0.250             1st Qu.: 1.820
##   Median :2.270             Median : 5.490
##   Mean   :2.906             Mean    : 5.937
##   3rd Qu.:6.250             3rd Qu.:10.560
##   Max.   :6.250             Max.    :10.560
##   PAT.as...of.net.worth      Sales          Income.from.financial.services
##   Min.   : 0.000          Min.    : 133.3   Min.    : 0.70
##   1st Qu.: 0.000          1st Qu.: 133.3    1st Qu.: 0.70
##   Median : 7.920          Median : 531.9    Median : 6.20
##   Mean   : 9.305          Mean    : 896.3   Mean    :30.81
##   3rd Qu.:20.190          3rd Qu.:2067.1    3rd Qu.:80.84
##   Max.   :20.190          Max.    :2067.1   Max.    :80.84
##    Other.income    Total.capital     Reserves.and.funds   Borrowings
##   Min.   : 0.80   Min.    : 13.10   Min.    :  5.8      Min.    : 29.7
##   1st Qu.: 0.80   1st Qu.: 13.10    1st Qu.:  5.8       1st Qu.: 29.7
##   Median : 8.00   Median : 42.20    Median : 58.9       Median :127.3
##   Mean   :19.49   Mean    : 51.36   Mean    :128.5      Mean    :270.9
##   3rd Qu.:41.36   3rd Qu.:100.50    3rd Qu.:331.0       3rd Qu.:682.0
##   Max.   :41.36   Max.    :100.50   Max.    :331.0      Max.    :682.0
##   Current.liabilities...provisions Deferred.tax.liability
##   Min.   : 18.7                     Min.    :  6.7
##   1st Qu.: 18.7                     1st Qu.:  6.7
##   Median : 74.2                     Median : 46.5
##   Mean   :129.6                     Mean    :105.4
##   3rd Qu.:299.6                     3rd Qu.:227.2
##   Max.   :299.6                     Max.    :227.2
##   Shareholders.funds Cumulative.retained.profits Capital.employed
##   Min.   : 32.0      Min.    :  1.30             Min.    : 60.8
##   1st Qu.: 32.0      1st Qu.:  1.30              1st Qu.: 60.8
##   Median :105.6      Median : 38.30             Median :214.7
##   Mean   :174.0      Mean    : 82.96            Mean    :342.9
##   3rd Qu.:393.2      3rd Qu.:214.60             3rd Qu.:767.3
##   Max.   :393.2      Max.    :214.60            Max.    :767.3
##     TOL.TNW        Total.term.liabilities...tangible.net.worth
##   Min.   :0.600   Min.    :0.0500
##   1st Qu.:0.600   1st Qu.:0.0500
##   Median :1.430   Median :0.3400
##   Mean   :1.616   Mean    :0.4656
##   3rd Qu.:2.830   3rd Qu.:1.0000
##   Max.   :2.830   Max.    :1.0000
##   Contingent.liabilities...Net.worth....  Contingent.liabilities
##   Min.   : 0.00                            Min.    : 16.0
##   1st Qu.: 0.00                            1st Qu.: 16.0
```

```
##  Median : 5.33                        Median :194.3
##  Mean   :11.98                        Mean   :433.9
##  3rd Qu.:30.76                        3rd Qu.:932.9
##  Max.   :30.76                        Max.   :932.9
##  Net.fixed.assets  Investments   Current.assets  Net.working.capital
##  Min.   : 27.3   Min.   :  4.6   Min.   : 37.2   Min.   :-1.00
##  1st Qu.: 27.3   1st Qu.:  4.6   1st Qu.: 37.2   1st Qu.:-1.00
##  Median :101.0   Median :188.9   Median :151.0   Median :16.70
##  Mean   :175.0   Mean   :342.0   Mean   :240.8   Mean   :33.99
##  3rd Qu.:401.1   3rd Qu.:694.7   3rd Qu.:541.5   3rd Qu.:87.70
##  Max.   :401.1   Max.   :694.7   Max.   :541.5   Max.   :87.70
##  Quick.ratio..times. Current.ratio..times. Debt.to.equity.ratio..times.
##  Min.   :0.4200      Min.   :0.940         Min.   :0.220
##  1st Qu.:0.4200      1st Qu.:0.940         1st Qu.:0.220
##  Median :0.6800      Median :1.240         Median :0.790
##  Mean   :0.7326      Mean   :1.316         Mean   :0.917
##  3rd Qu.:1.1000      3rd Qu.:1.770         3rd Qu.:1.750
##  Max.   :1.1000      Max.   :1.770         Max.   :1.750
##  Cash.to.current.liabilities..times. Cash.to.average.cost.of.sales.per.day
##  Min.   :0.0200                       Min.   : 2.89
##  1st Qu.:0.0200                       1st Qu.: 2.89
##  Median :0.0700                       Median : 8.37
##  Mean   :0.1001                       Mean   :11.86
##  3rd Qu.:0.2100                       3rd Qu.:24.82
##  Max.   :0.2100                       Max.   :24.82
##  Creditors.turnover Debtors.turnover Finished.goods.turnover
##  Min.   : 499.0     Min.   : 481.0   Min.   : 679
##  1st Qu.: 499.0     1st Qu.: 481.0   1st Qu.: 679
##  Median : 973.0     Median : 998.0   Median :1199
##  Mean   : 910.6     Mean   : 930.3   Mean   :1209
##  3rd Qu.:1280.0     3rd Qu.:1326.0   3rd Qu.:1743
##  Max.   :1280.0     Max.   :1326.0   Max.   :1743
##   WIP.turnover   Raw.material.turnover Shares.outstanding Equity.face.value
##  Min.   : 614   Min.   : 335.0        Min.   : 770       Min.   :3.000
##  1st Qu.: 614   1st Qu.: 335.0        1st Qu.: 770       1st Qu.:3.000
##  Median :1079   Median : 867.0        Median :1482       Median :3.000
##  Mean   :1098   Mean   : 833.9        Mean   :1482       Mean   :3.305
##  3rd Qu.:1563   3rd Qu.:1290.0        3rd Qu.:2204       3rd Qu.:4.000
##  Max.   :1563   Max.   :1290.0        Max.   :2204       Max.   :4.000
##      EPS           Adjusted.EPS   Total.liabilities  PE.on.BSE
##  Min.   :0.000   Min.   :0.000   Min.   :  91.3   Min.   : 782
##  1st Qu.:0.000   1st Qu.:0.000   1st Qu.:  91.3   1st Qu.: 782
##  Median :1.430   Median :1.180   Median : 309.7   Median :1143
##  Mean   :3.593   Mean   :2.824   Mean   : 495.6   Mean   :1028
##  3rd Qu.:9.620   3rd Qu.:7.480   3rd Qu.:1098.7   3rd Qu.:1143
##  Max.   :9.620   Max.   :7.480   Max.   :1098.7   Max.   :1143
##     default
##  Min.   :0.00000
##  1st Qu.:0.00000
##  Median :0.00000
```
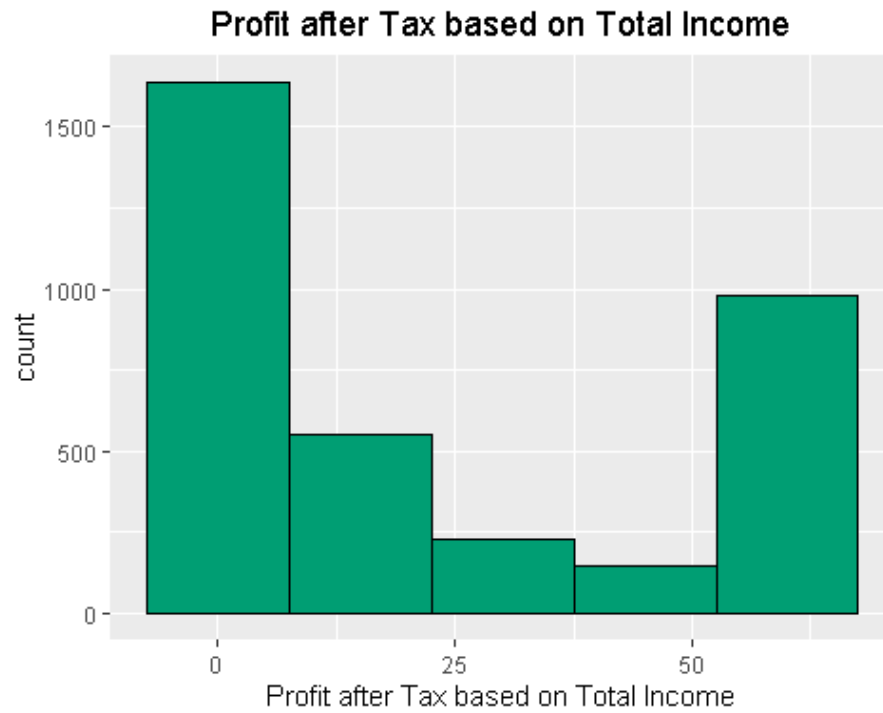
EDA

Univariate Analysis:

Profit after Tax based on Total Income

> ➤ We have around 1800 company's with low profit while only 1000 companies have Profit after tax on total income
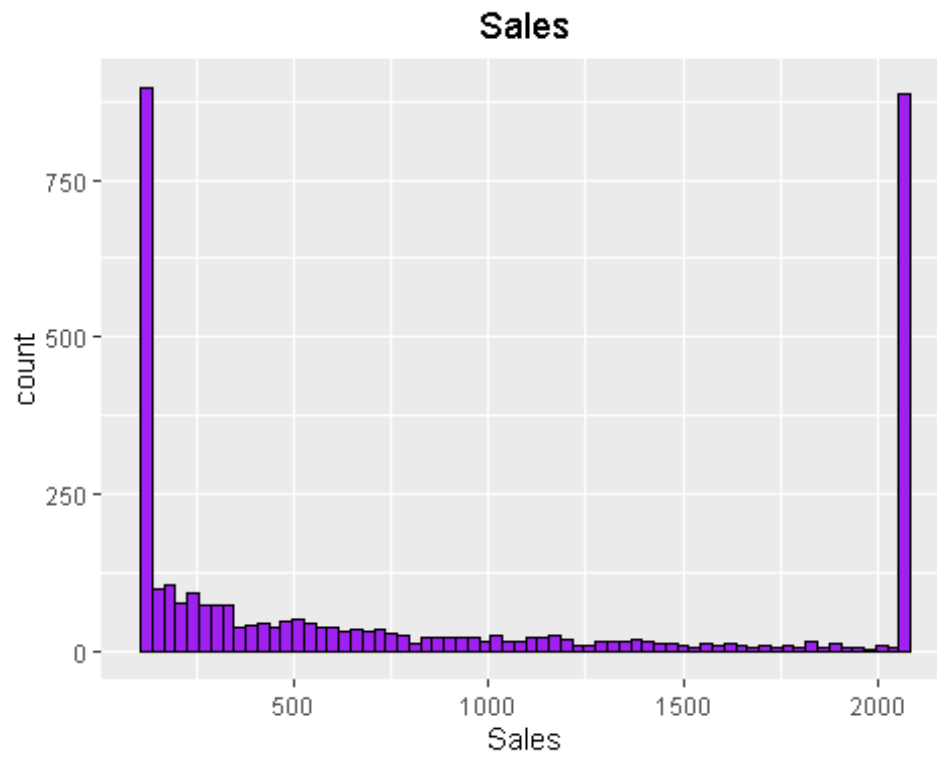
Sales

➢ The Sales chart shows that we have a dataset with two extreme companies one with less sales and the other with higher amount of the sale
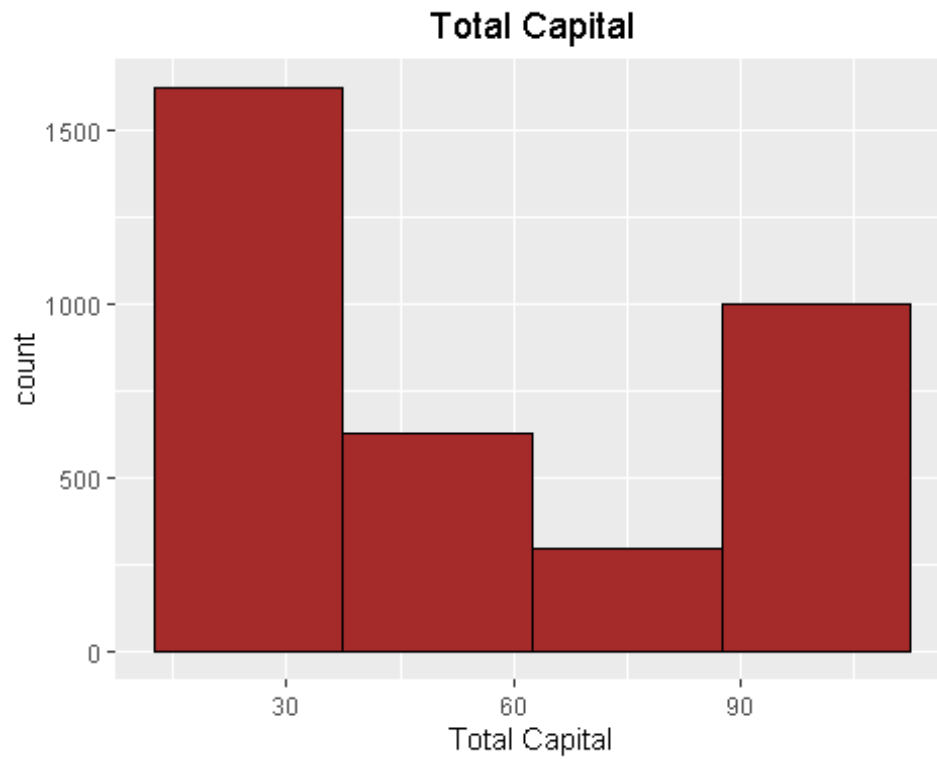
Total Capital

> ➢ The Total capital of the companies are varying from 30 lakhs to 90 lakhs, at the same time we have companies whose total capital ranges between 0- 30 lakhs. May be our dataset has lot of startup companies
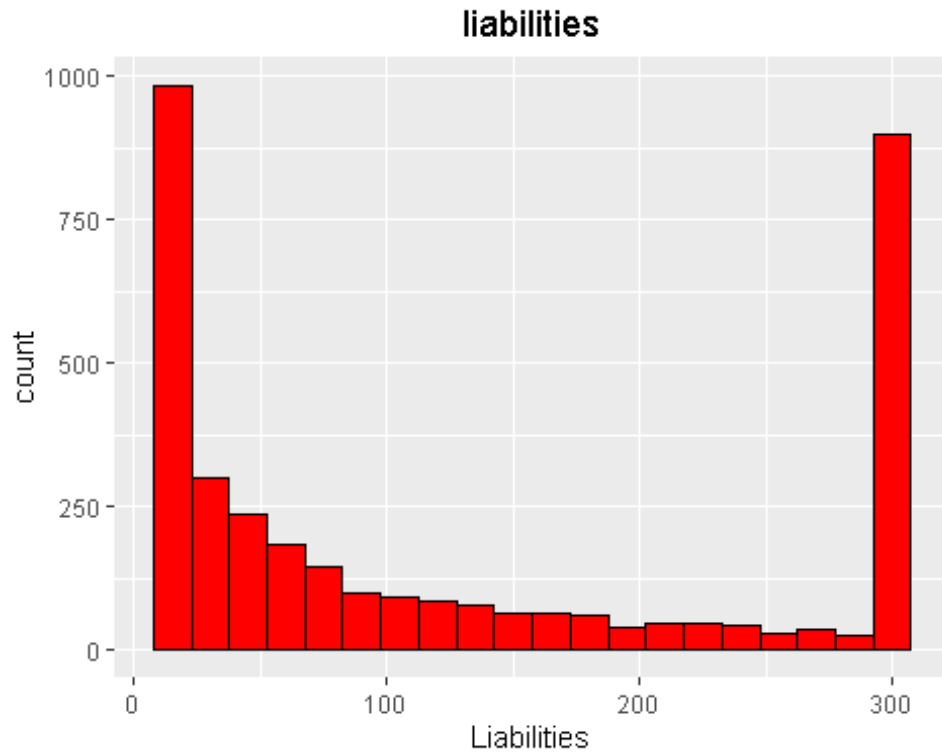
liabilities

➤ Similar to sales, liabilities and Borrowing companies graph also looks like the same

Borrowings
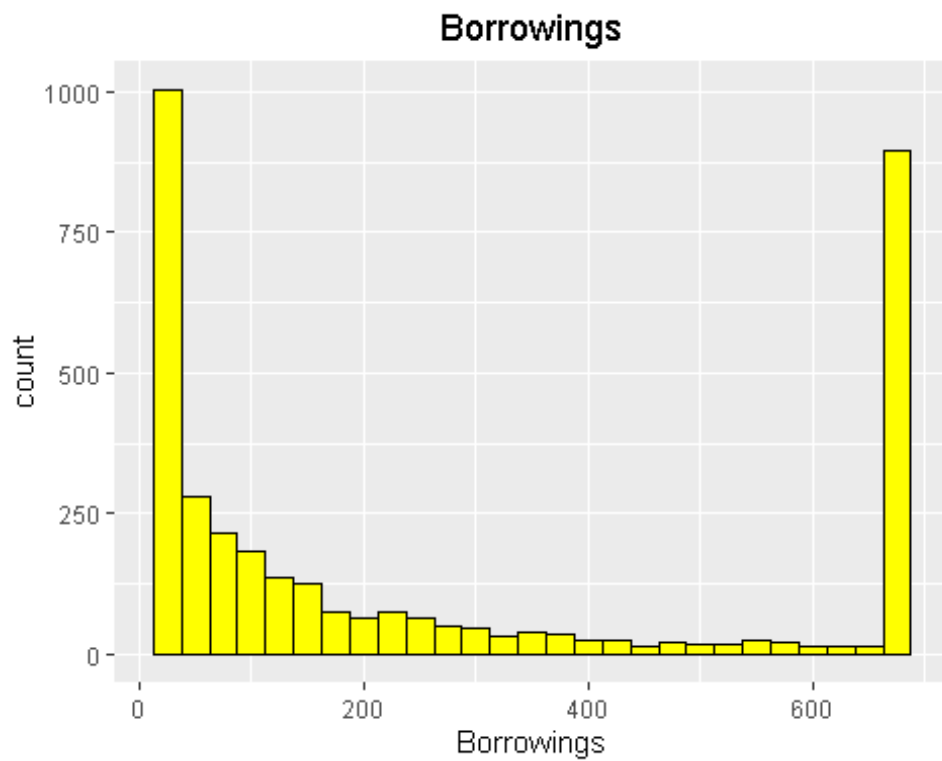
Bivariate Analysis

Default vs Borrowings
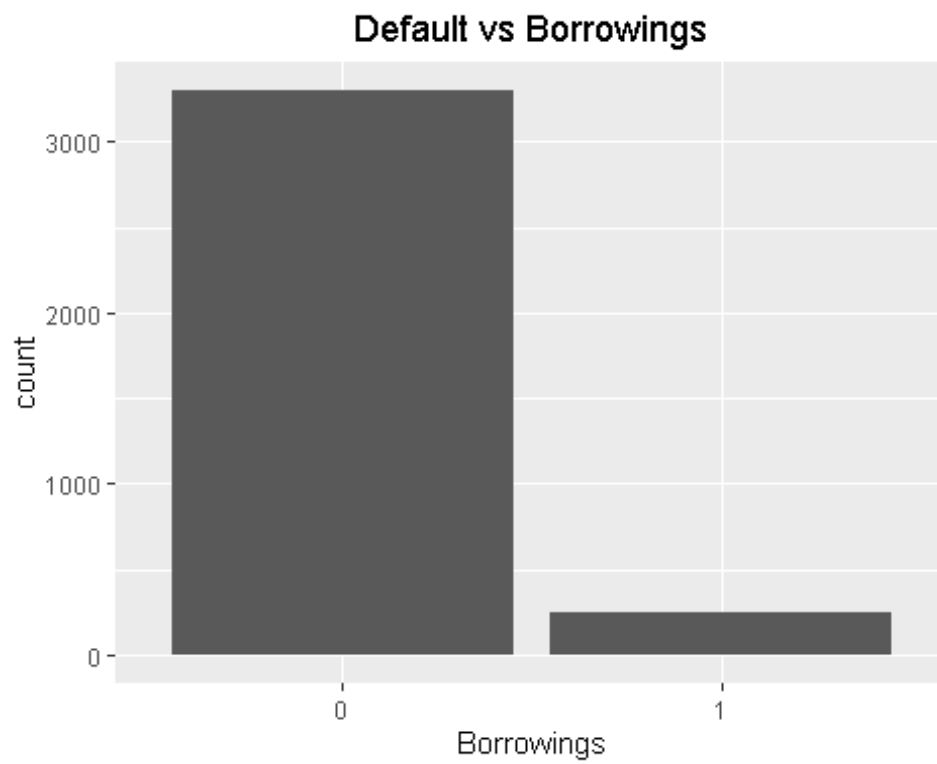
> ➤ It, seems like lot of companies who borrowed has defaulted
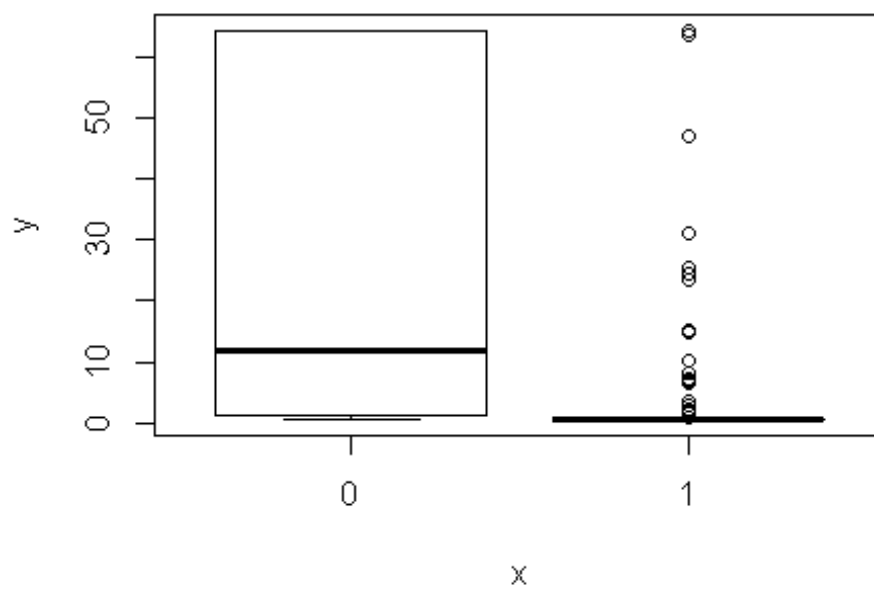
Removing Multicollinearity

As a rule of thumb, a VIF value that exceeds 5 or 10 indicates a problematic amount of collinearity

We have a lot of variable which are collinear with each other, by using the vif function we eliminate the high collinear variables.

```
library(car)

## Loading required package: carData

vif.model <- glm(default~.,rawdata.nona,family = "binomial")

## Warning: glm.fit: algorithm did not converge

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

summary(vif.model)

##
## Call:
## glm(formula = default ~ ., family = "binomial", data = rawdata.nona)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -3.252    0.000    0.000    0.000    3.236
##
## Coefficients: (1 not defined because of singularities)
##                                      Estimate Std. Error z value
## (Intercept)                         1.204e+03  4.251e+03   0.283
## Num                                 2.230e-04  1.113e-04   2.003
## Networth.Next.Year                 -3.819e+01  1.341e+02  -0.285
## Total.assets                        5.949e-03  4.141e-03   1.437
## Net.worth                          -1.697e-02  2.990e-02  -0.568
## Total.income                       -2.482e-04  3.577e-04  -0.694
## Change.in.stock                     1.515e-02  7.854e-03   1.930
## Total.expenses                     -3.529e-04  6.777e-04  -0.521
## Profit.after.tax                   -1.867e-01  1.544e-01  -1.210
## PBDITA                              3.705e-03  2.130e-02   0.174
## PBT                                 2.088e-01  1.071e-01   1.949
## Cash.profit                        -6.196e-02  4.984e-02  -1.243
## PBDITA.as...of.total.income        -5.059e-02  5.113e-02  -0.989
## PBT.as...of.total.income            8.106e-02  1.765e-01   0.459
## PAT.as...of.total.income           -1.116e-01  2.494e-01  -0.447
## Cash.profit.as...of.total.income   -4.119e-02  7.908e-02  -0.521
## PAT.as...of.net.worth              -1.164e-01  3.072e-02  -3.790
## Sales                               2.073e-04  2.960e-04   0.701
## Income.from.financial.services     -8.582e-04  3.323e-03  -0.258
## Other.income                        5.885e-03  6.790e-03   0.867
## Total.capital                       2.274e-02  6.965e-03   3.265
```

```
## Reserves.and.funds                                    7.224e-04  2.077e-03   0.348
## Borrowings                                            1.648e-03  6.462e-04   2.550
## Current.liabilities...provisions                     -4.894e-04  1.854e-03  -0.264
## Deferred.tax.liability                                1.575e-03  1.265e-03   1.246
## Shareholders.funds                                    3.495e-02  2.909e-02   1.201
## Cumulative.retained.profits                          -3.899e-04  3.326e-03  -0.117
## Capital.employed                                     -7.233e-03  5.599e-03  -1.292
## TOL.TNW                                               8.588e-01  2.246e-01   3.824
## Total.term.liabilities...tangible.net.worth  3.085e-01  5.247e-01   0.588
## Contingent.liabilities...Net.worth....                2.679e-02  1.490e-02   1.798
## Contingent.liabilities                               -2.943e-04  4.289e-04  -0.686
## Net.fixed.assets                                      2.752e-03  1.083e-03   2.542
## Investments                                           3.758e-04  3.676e-04   1.022
## Current.assets                                       -1.165e-03  1.201e-03  -0.970
## Net.working.capital                                   2.624e-05  9.075e-03   0.003
## Quick.ratio..times.                                  -1.170e+00  7.038e-01  -1.663
## Current.ratio..times.                                -1.319e-01  5.686e-01  -0.232
## Debt.to.equity.ratio..times.                          7.106e-01  3.833e-01   1.854
## Cash.to.current.liabilities..times.                   1.915e+00  2.601e+00   0.736
## Cash.to.average.cost.of.sales.per.day                 1.648e-02  1.855e-02   0.889
## Creditors.turnover                                    5.417e-04  4.528e-04   1.196
## Debtors.turnover                                     -2.272e-04  4.741e-04  -0.479
## Finished.goods.turnover                              -2.298e-04  3.804e-04  -0.604
## WIP.turnover                                          6.997e-04  4.416e-04   1.584
## Raw.material.turnover                                -9.337e-05  3.711e-04  -0.252
## Shares.outstanding                                   -5.312e-05  2.662e-04  -0.200
## Equity.face.value                                    -5.668e-02  3.240e-01  -0.175
## EPS                                                   2.824e-01  2.419e-01   1.168
## Adjusted.EPS                                         -4.502e-01  2.961e-01  -1.521
## Total.liabilities                                            NA         NA      NA
## PE.on.BSE                                             5.696e-04  1.004e-03   0.567
##                                               Pr(>|z|)
## (Intercept)                                   0.776954
## Num                                           0.045128 *
## Networth.Next.Year                            0.775814
## Total.assets                                  0.150769
## Net.worth                                     0.570315
## Total.income                                  0.487791
## Change.in.stock                               0.053653 .
## Total.expenses                                0.602562
## Profit.after.tax                              0.226458
## PBDITA                                        0.861899
## PBT                                           0.051309 .
## Cash.profit                                   0.213807
## PBDITA.as...of.total.income                   0.322523
## PBT.as...of.total.income                      0.645996
## PAT.as...of.total.income                      0.654521
## Cash.profit.as...of.total.income              0.602421
## PAT.as...of.net.worth                         0.000151 ***
## Sales                                         0.483543
```

```
## Income.from.financial.services                      0.796221
## Other.income                                         0.386099
## Total.capital                                        0.001096 **
## Reserves.and.funds                                   0.727967
## Borrowings                                           0.010774 *
## Current.liabilities...provisions                     0.791823
## Deferred.tax.liability                               0.212882
## Shareholders.funds                                   0.229643
## Cumulative.retained.profits                          0.906691
## Capital.employed                                     0.196423
## TOL.TNW                                              0.000131 ***
## Total.term.liabilities...tangible.net.worth 0.556548
## Contingent.liabilities...Net.worth....               0.072206 .
## Contingent.liabilities                               0.492610
## Net.fixed.assets                                     0.011022 *
## Investments                                          0.306613
## Current.assets                                       0.332108
## Net.working.capital                                  0.997693
## Quick.ratio..times.                                  0.096306 .
## Current.ratio..times.                                0.816549
## Debt.to.equity.ratio..times.                         0.063783 .
## Cash.to.current.liabilities..times.                  0.461557
## Cash.to.average.cost.of.sales.per.day                0.374267
## Creditors.turnover                                   0.231531
## Debtors.turnover                                     0.631750
## Finished.goods.turnover                              0.545728
## WIP.turnover                                         0.113137
## Raw.material.turnover                                0.801358
## Shares.outstanding                                   0.841807
## Equity.face.value                                    0.861143
## EPS                                                  0.242928
## Adjusted.EPS                                         0.128376
## Total.liabilities                                          NA
## PE.on.BSE                                            0.570458
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 1770.97  on 3540  degrees of freedom
## Residual deviance:  567.58  on 3490  degrees of freedom
## AIC: 669.58
##
## Number of Fisher Scoring iterations: 25

rawdata.nona <- rawdata.nona[,-50]
vif.model1 <- glm(default~.,rawdata.nona,family = "binomial")
```

```
## Warning: glm.fit: algorithm did not converge

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

alias(vif.model)

## Model :
## default ~ Num + Networth.Next.Year + Total.assets + Net.worth +
##     Total.income + Change.in.stock + Total.expenses + Profit.after.tax +
##     PBDITA + PBT + Cash.profit + PBDITA.as...of.total.income +
##     PBT.as...of.total.income + PAT.as...of.total.income + Cash.profit.as..
.of.total.income +
##     PAT.as...of.net.worth + Sales + Income.from.financial.services +
##     Other.income + Total.capital + Reserves.and.funds + Borrowings +
##     Current.liabilities...provisions + Deferred.tax.liability +
##     Shareholders.funds + Cumulative.retained.profits + Capital.employed +
##     TOL.TNW + Total.term.liabilities...tangible.net.worth + Contingent.lia
bilities...Net.worth.... +
##     Contingent.liabilities + Net.fixed.assets + Investments +
##     Current.assets + Net.working.capital + Quick.ratio..times. +
##     Current.ratio..times. + Debt.to.equity.ratio..times. + Cash.to.current
.liabilities..times. +
##     Cash.to.average.cost.of.sales.per.day + Creditors.turnover +
##     Debtors.turnover + Finished.goods.turnover + WIP.turnover +
##     Raw.material.turnover + Shares.outstanding + Equity.face.value +
##     EPS + Adjusted.EPS + Total.liabilities + PE.on.BSE
##
## Complete :
##                     (Intercept) Num Networth.Next.Year Total.assets
## Total.liabilities 0           0   0                   1
##                     Net.worth Total.income Change.in.stock Total.expenses
## Total.liabilities 0         0            0               0
##                     Profit.after.tax PBDITA PBT Cash.profit
## Total.liabilities 0                0      0   0
##                     PBDITA.as...of.total.income PBT.as...of.total.income
## Total.liabilities 0                           0
##                     PAT.as...of.total.income
## Total.liabilities 0
##                     Cash.profit.as...of.total.income PAT.as...of.net.worth
## Total.liabilities 0                                0
##                     Sales Income.from.financial.services Other.income
## Total.liabilities 0     0                              0
##                     Total.capital Reserves.and.funds Borrowings
## Total.liabilities 0             0                  0
##                     Current.liabilities...provisions Deferred.tax.liability
## Total.liabilities 0                                0
##                     Shareholders.funds Cumulative.retained.profits
## Total.liabilities 0                  0
##                     Capital.employed TOL.TNW
## Total.liabilities 0                0
```

```
##                      Total.term.liabilities...tangible.net.worth
## Total.liabilities 0
##                      Contingent.liabilities...Net.worth....
## Total.liabilities 0
##                      Contingent.liabilities Net.fixed.assets Investments
## Total.liabilities 0                                       0              0
##                      Current.assets Net.working.capital Quick.ratio..times.
## Total.liabilities 0                 0                                    0
##                      Current.ratio..times. Debt.to.equity.ratio..times.
## Total.liabilities 0                        0
##                      Cash.to.current.liabilities..times.
## Total.liabilities 0
##                      Cash.to.average.cost.of.sales.per.day Creditors.turnover
## Total.liabilities 0                                                         0
##                      Debtors.turnover Finished.goods.turnover WIP.turnover
## Total.liabilities 0                   0                                   0
##                      Raw.material.turnover Shares.outstanding
## Total.liabilities 0                        0
##                      Equity.face.value EPS Adjusted.EPS PE.on.BSE
## Total.liabilities 0                    0   0            0
```

vif(vif.model1)

```
##                                        Num
##                                   1.126513
##                      Networth.Next.Year
##                                   1.001380
##                            Total.assets
##                                  19.326881
##                               Net.worth
##                                  20.825500
##                            Total.income
##                                   6.067352
##                         Change.in.stock
##                                   2.158212
##                          Total.expenses
##                                  12.335687
##                         Profit.after.tax
##                                1099.769018
##                                   PBDITA
##                                 160.465428
##                                      PBT
##                                1022.779027
##                             Cash.profit
##                                 337.469211
##             PBDITA.as...of.total.income
##                                   3.231757
##                PBT.as...of.total.income
##                                  10.321746
##                PAT.as...of.total.income
```

```
##                                       9.881261
##              Cash.profit.as...of.total.income
##                                       3.587372
##                          PAT.as...of.net.worth
##                                       1.942955
##                                          Sales
##                                       5.666134
##              Income.from.financial.services
##                                       1.432340
##                                   Other.income
##                                       1.400320
##                                  Total.capital
##                                       2.126382
##                             Reserves.and.funds
##                                       3.659707
##                                     Borrowings
##                                       2.540444
##              Current.liabilities...provisions
##                                       2.579234
##                         Deferred.tax.liability
##                                       1.449164
##                             Shareholders.funds
##                                      21.920888
##                    Cumulative.retained.profits
##                                       2.508490
##                               Capital.employed
##                                      17.460386
##                                        TOL.TNW
##                                       3.888636
## Total.term.liabilities...tangible.net.worth
##                                       4.452760
##        Contingent.liabilities...Net.worth....
##                                       2.866696
##                         Contingent.liabilities
##                                       3.039446
##                               Net.fixed.assets
##                                       1.953995
##                                    Investments
##                                       1.206145
##                                 Current.assets
##                                       2.392271
##                            Net.working.capital
##                                       2.477440
##                            Quick.ratio..times.
##                                       3.677401
##                          Current.ratio..times.
##                                       3.683540
##                  Debt.to.equity.ratio..times.
##                                       5.950012
##           Cash.to.current.liabilities..times.
```

```
##                                               4.117944
##           Cash.to.average.cost.of.sales.per.day
##                                               2.835987
##                              Creditors.turnover
##                                               2.113278
##                                Debtors.turnover
##                                               2.584530
##                         Finished.goods.turnover
##                                               1.945163
##                                    WIP.turnover
##                                               2.094396
##                           Raw.material.turnover
##                                               2.122013
##                              Shares.outstanding
##                                               1.944265
##                              Equity.face.value
##                                               2.336104
##                                             EPS
##                                              10.856029
##                                    Adjusted.EPS
##                                              10.946138
##                                       PE.on.BSE
##                                               1.636551
```

```
names(rawdata.nona)
```

```
##  [1] "Num"
##  [2] "Networth.Next.Year"
##  [3] "Total.assets"
##  [4] "Net.worth"
##  [5] "Total.income"
##  [6] "Change.in.stock"
##  [7] "Total.expenses"
##  [8] "Profit.after.tax"
##  [9] "PBDITA"
## [10] "PBT"
## [11] "Cash.profit"
## [12] "PBDITA.as...of.total.income"
## [13] "PBT.as...of.total.income"
## [14] "PAT.as...of.total.income"
## [15] "Cash.profit.as...of.total.income"
## [16] "PAT.as...of.net.worth"
## [17] "Sales"
## [18] "Income.from.financial.services"
## [19] "Other.income"
## [20] "Total.capital"
## [21] "Reserves.and.funds"
## [22] "Borrowings"
## [23] "Current.liabilities...provisions"
## [24] "Deferred.tax.liability"
```

```
## [25] "Shareholders.funds"
## [26] "Cumulative.retained.profits"
## [27] "Capital.employed"
## [28] "TOL.TNW"
## [29] "Total.term.liabilities...tangible.net.worth"
## [30] "Contingent.liabilities...Net.worth...."
## [31] "Contingent.liabilities"
## [32] "Net.fixed.assets"
## [33] "Investments"
## [34] "Current.assets"
## [35] "Net.working.capital"
## [36] "Quick.ratio..times."
## [37] "Current.ratio..times."
## [38] "Debt.to.equity.ratio..times."
## [39] "Cash.to.current.liabilities..times."
## [40] "Cash.to.average.cost.of.sales.per.day"
## [41] "Creditors.turnover"
## [42] "Debtors.turnover"
## [43] "Finished.goods.turnover"
## [44] "WIP.turnover"
## [45] "Raw.material.turnover"
## [46] "Shares.outstanding"
## [47] "Equity.face.value"
## [48] "EPS"
## [49] "Adjusted.EPS"
## [50] "PE.on.BSE"
## [51] "default"
```

```r
rawdata.nona <- rawdata.nona[,-c(48,49)]
vif.model2 <- glm(default~.,rawdata.nona,family = "binomial")
```

```
## Warning: glm.fit: algorithm did not converge
```

```
## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred
```

```r
vif(vif.model2)
```

```
##                                 Num
##                            1.122015
##                  Networth.Next.Year
##                            1.001268
##                        Total.assets
##                           19.786094
##                           Net.worth
##                           21.255840
##                        Total.income
##                            6.082286
##                     Change.in.stock
##                            2.142470
##                      Total.expenses
##                           12.278930
```

```
##                           Profit.after.tax
##                                 1084.157455
##                                      PBDITA
##                                  151.914156
##                                         PBT
##                                 1009.281071
##                                 Cash.profit
##                                  309.695327
##                 PBDITA.as...of.total.income
##                                    3.175359
##                    PBT.as...of.total.income
##                                   10.216457
##                    PAT.as...of.total.income
##                                    9.735594
##            Cash.profit.as...of.total.income
##                                    3.547761
##                       PAT.as...of.net.worth
##                                    1.764784
##                                       Sales
##                                    5.681594
##                Income.from.financial.services
##                                    1.432816
##                                Other.income
##                                    1.407377
##                               Total.capital
##                                    2.060177
##                           Reserves.and.funds
##                                    3.672400
##                                  Borrowings
##                                    2.545463
##                Current.liabilities...provisions
##                                    2.580170
##                     Deferred.tax.liability
##                                    1.450929
##                          Shareholders.funds
##                                   22.283580
##                  Cumulative.retained.profits
##                                    2.519933
##                             Capital.employed
##                                   17.745434
##                                     TOL.TNW
##                                    3.868913
## Total.term.liabilities...tangible.net.worth
##                                    4.475854
##        Contingent.liabilities...Net.worth....
##                                    2.898749
##                       Contingent.liabilities
##                                    3.064733
##                            Net.fixed.assets
##                                    1.950164
```

```
##                               Investments
##                                 1.202464
##                             Current.assets
##                                 2.403315
##                        Net.working.capital
##                                 2.523832
##                       Quick.ratio..times.
##                                 3.672211
##                     Current.ratio..times.
##                                 3.697583
##              Debt.to.equity.ratio..times.
##                                 5.969298
##        Cash.to.current.liabilities..times.
##                                 4.114950
##      Cash.to.average.cost.of.sales.per.day
##                                 2.833243
##                         Creditors.turnover
##                                 2.114019
##                           Debtors.turnover
##                                 2.570621
##                    Finished.goods.turnover
##                                 1.950076
##                               WIP.turnover
##                                 2.080885
##                       Raw.material.turnover
##                                 2.129501
##                         Shares.outstanding
##                                 1.847882
##                         Equity.face.value
##                                 2.268754
##                                  PE.on.BSE
##                                 1.618421

rawdata.nona <- rawdata.nona[,-c(5)]
vif.model3 <- glm(default~.,rawdata.nona,family = "binomial")

## Warning: glm.fit: algorithm did not converge

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

vif(vif.model3)

##                                        Num
##                                 1.122236
##                         Networth.Next.Year
##                                 1.001241
##                               Total.assets
##                                19.911550
##                                  Net.worth
##                                21.325910
##                            Change.in.stock
```

```
##                                          2.127808
##                                   Total.expenses
##                                         12.473925
##                                 Profit.after.tax
##                                       1079.580029
##                                            PBDITA
##                                        149.220545
##                                               PBT
##                                       1001.870192
##                                       Cash.profit
##                                        298.961898
##                 PBDITA.as...of.total.income
##                                          3.104570
##                    PBT.as...of.total.income
##                                         10.143852
##                    PAT.as...of.total.income
##                                          9.631116
##             Cash.profit.as...of.total.income
##                                          3.545271
##                       PAT.as...of.net.worth
##                                          1.753502
##                                             Sales
##                                          3.375143
##             Income.from.financial.services
##                                          1.425425
##                                      Other.income
##                                          1.380640
##                                     Total.capital
##                                          2.051948
##                             Reserves.and.funds
##                                          3.661169
##                                        Borrowings
##                                          2.521540
##           Current.liabilities...provisions
##                                          2.560351
##                      Deferred.tax.liability
##                                          1.450549
##                           Shareholders.funds
##                                         22.381565
##              Cumulative.retained.profits
##                                          2.509645
##                              Capital.employed
##                                         17.812136
##                                           TOL.TNW
##                                          3.854330
## Total.term.liabilities...tangible.net.worth
##                                          4.458524
##        Contingent.liabilities...Net.worth....
##                                          2.911183
##                         Contingent.liabilities
```

```
##                                             3.059842
##                          Net.fixed.assets
##                                             1.942022
##                                Investments
##                                             1.200481
##                             Current.assets
##                                             2.396667
##                        Net.working.capital
##                                             2.518491
##                         Quick.ratio..times.
##                                             3.669285
##                       Current.ratio..times.
##                                             3.685922
##                Debt.to.equity.ratio..times.
##                                             5.936962
##           Cash.to.current.liabilities..times.
##                                             4.112268
##           Cash.to.average.cost.of.sales.per.day
##                                             2.846045
##                          Creditors.turnover
##                                             2.105634
##                            Debtors.turnover
##                                             2.564673
##                     Finished.goods.turnover
##                                             1.944502
##                                WIP.turnover
##                                             2.074347
##                       Raw.material.turnover
##                                             2.125956
##                          Shares.outstanding
##                                             1.843116
##                           Equity.face.value
##                                             2.269778
##                                   PE.on.BSE
##                                             1.608306
```

```r
rawdata.nona <- rawdata.nona[,-c(3,26)]
vif.model3 <- glm(default~.,rawdata.nona,family = "binomial")
```

```
## Warning: glm.fit: algorithm did not converge
```

```
## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred
```

```r
vif(vif.model3)
```

```
##                                          Num
##                                     1.111016
##                            Networth.Next.Year
##                                     1.001449
##                                    Net.worth
##                                    19.685652
```

```
##                            Change.in.stock
##                                   2.133665
##                             Total.expenses
##                                  11.343724
##                            Profit.after.tax
##                                1102.563939
##                                      PBDITA
##                                 129.289227
##                                         PBT
##                                1032.381973
##                                 Cash.profit
##                                  294.768974
##              PBDITA.as...of.total.income
##                                    3.158434
##                 PBT.as...of.total.income
##                                   10.213255
##                 PAT.as...of.total.income
##                                    9.733032
##          Cash.profit.as...of.total.income
##                                    3.628562
##                   PAT.as...of.net.worth
##                                    1.806712
##                                        Sales
##                                    3.357218
##            Income.from.financial.services
##                                    1.409960
##                                 Other.income
##                                    1.369304
##                               Total.capital
##                                    1.961644
##                          Reserves.and.funds
##                                    3.624146
##                                   Borrowings
##                                    2.272747
##          Current.liabilities...provisions
##                                    2.065778
##                     Deferred.tax.liability
##                                    1.434008
##                          Shareholders.funds
##                                   20.942328
##              Cumulative.retained.profits
##                                    2.486563
##                                     TOL.TNW
##                                    3.827124
## Total.term.liabilities...tangible.net.worth
##                                    4.473188
##       Contingent.liabilities...Net.worth....
##                                    2.952297
##                       Contingent.liabilities
##                                    3.118699
```

```
##                                     Net.fixed.assets
##                                             1.930537
##                                          Investments
##                                             1.196148
##                                       Current.assets
##                                             2.333260
##                                  Net.working.capital
##                                             2.430576
##                                 Quick.ratio..times.
##                                             3.672833
##                               Current.ratio..times.
##                                             3.700881
##                          Debt.to.equity.ratio..times.
##                                             5.819336
##                    Cash.to.current.liabilities..times.
##                                             4.062605
##                     Cash.to.average.cost.of.sales.per.day
##                                             2.793980
##                                    Creditors.turnover
##                                             2.092374
##                                      Debtors.turnover
##                                             2.569497
##                               Finished.goods.turnover
##                                             1.941282
##                                          WIP.turnover
##                                             2.061132
##                                 Raw.material.turnover
##                                             2.111441
##                                   Shares.outstanding
##                                             1.823562
##                                     Equity.face.value
##                                             2.245024
##                                             PE.on.BSE
##                                             1.600827

rawdata.nona <- rawdata.nona[,-c(3,5,6)]
vif.model3 <- glm(default~.,rawdata.nona,family = "binomial")

## Warning: glm.fit: algorithm did not converge

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

vif(vif.model3)

##                                                   Num
##                                             1.107125
##                                   Networth.Next.Year
##                                             1.001337
##                                      Change.in.stock
##                                             2.102624
##                                               PBDITA
```

```
##                                          113.679381
##                                                  PBT
##                                          190.268167
##                                          Cash.profit
##                                          301.097359
##                    PBDITA.as...of.total.income
##                                            3.143999
##                       PBT.as...of.total.income
##                                           10.093314
##                       PAT.as...of.total.income
##                                            9.206192
##              Cash.profit.as...of.total.income
##                                            3.642558
##                          PAT.as...of.net.worth
##                                            1.755358
##                                                Sales
##                                            3.021931
##                Income.from.financial.services
##                                            1.398348
##                                        Other.income
##                                            1.350653
##                                        Total.capital
##                                            1.855268
##                             Reserves.and.funds
##                                            3.643404
##                                           Borrowings
##                                            2.274559
##              Current.liabilities...provisions
##                                            2.059354
##                         Deferred.tax.liability
##                                            1.408287
##                             Shareholders.funds
##                                            1.308310
##                    Cumulative.retained.profits
##                                            2.478529
##                                              TOL.TNW
##                                            3.763376
## Total.term.liabilities...tangible.net.worth
##                                            4.368769
##         Contingent.liabilities...Net.worth....
##                                            2.930978
##                         Contingent.liabilities
##                                            3.096343
##                               Net.fixed.assets
##                                            1.915671
##                                          Investments
##                                            1.189021
##                                       Current.assets
##                                            2.329616
##                            Net.working.capital
```

```
##                                         2.408354
##                      Quick.ratio..times.
##                                         3.657889
##                    Current.ratio..times.
##                                         3.674054
##            Debt.to.equity.ratio..times.
##                                         5.650067
##      Cash.to.current.liabilities..times.
##                                         4.026254
##      Cash.to.average.cost.of.sales.per.day
##                                         2.767205
##                         Creditors.turnover
##                                         2.058178
##                          Debtors.turnover
##                                         2.538025
##                   Finished.goods.turnover
##                                         1.932727
##                             WIP.turnover
##                                         2.047828
##                    Raw.material.turnover
##                                         2.076156
##                       Shares.outstanding
##                                         1.800264
##                       Equity.face.value
##                                         2.216094
##                                 PE.on.BSE
##                                         1.575755
```

```r
rawdata.nona <- rawdata.nona[,-c(4,18,20)]
vif.model3 <- glm(default~.,rawdata.nona,family = "binomial")
```

```
## Warning: glm.fit: algorithm did not converge
```

```
## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred
```

```r
vif(vif.model3)
```

```
##                                              Num
##                                         1.094735
##                            Networth.Next.Year
##                                         1.001165
##                               Change.in.stock
##                                         2.060402
##                                           PBT
##                                        82.148730
##                                  Cash.profit
##                                        80.975124
##               PBDITA.as...of.total.income
##                                         3.149440
##                  PBT.as...of.total.income
##                                        10.002630
```

```
##                       PAT.as...of.total.income
##                                       9.253179
##               Cash.profit.as...of.total.income
##                                       3.435015
##                            PAT.as...of.net.worth
##                                       1.628003
##                                          Sales
##                                       3.005466
##               Income.from.financial.services
##                                       1.404709
##                                   Other.income
##                                       1.348790
##                                  Total.capital
##                                       1.773015
##                             Reserves.and.funds
##                                       3.464326
##                                      Borrowings
##                                       2.202864
##                         Deferred.tax.liability
##                                       1.385955
##                     Cumulative.retained.profits
##                                       2.354229
##                                        TOL.TNW
##                                       3.886303
## Total.term.liabilities...tangible.net.worth
##                                       4.299330
##         Contingent.liabilities...Net.worth....
##                                       2.742915
##                         Contingent.liabilities
##                                       2.910638
##                                Net.fixed.assets
##                                       1.840375
##                                     Investments
##                                       1.170725
##                                   Current.assets
##                                       2.484641
##                             Net.working.capital
##                                       2.655911
##                            Quick.ratio..times.
##                                       3.586590
##                          Current.ratio..times.
##                                       3.695947
##                   Debt.to.equity.ratio..times.
##                                       5.497952
##         Cash.to.current.liabilities..times.
##                                       3.850733
##         Cash.to.average.cost.of.sales.per.day
##                                       2.622549
##                               Creditors.turnover
##                                       1.998875
```

```
##                              Debtors.turnover
##                                     2.405121
##                         Finished.goods.turnover
##                                     1.889773
##                                  WIP.turnover
##                                     1.978928
##                           Raw.material.turnover
##                                     1.997248
##                             Shares.outstanding
##                                     1.784814
##                             Equity.face.value
##                                     2.188607
##                                     PE.on.BSE
##                                     1.605315
```

```r
rawdata.nona <- rawdata.nona[,-c(2,4,5)]
vif.model3 <- glm(default~.,rawdata.nona,family = "binomial")
vif(vif.model3)
```

```
##                                          Num
##                                     1.095651
##                              Change.in.stock
##                                     1.628019
##                    PBDITA.as...of.total.income
##                                     2.615169
##                       PBT.as...of.total.income
##                                    10.079659
##                       PAT.as...of.total.income
##                                     9.166929
##               Cash.profit.as...of.total.income
##                                     2.808063
##                         PAT.as...of.net.worth
##                                     1.430275
##                                        Sales
##                                     2.389571
##              Income.from.financial.services
##                                     1.433397
##                                 Other.income
##                                     1.294573
##                                Total.capital
##                                     2.199270
##                            Reserves.and.funds
##                                     2.283645
##                                   Borrowings
##                                     2.183195
##                        Deferred.tax.liability
##                                     1.320858
##                    Cumulative.retained.profits
##                                     2.020722
##                                      TOL.TNW
```

```
##                                             3.403948
## Total.term.liabilities...tangible.net.worth
##                                             3.466740
##       Contingent.liabilities...Net.worth....
##                                             2.012210
##                         Contingent.liabilities
##                                             1.855700
##                              Net.fixed.assets
##                                             2.272450
##                                   Investments
##                                             1.148138
##                                 Current.assets
##                                             2.730338
##                            Net.working.capital
##                                             1.841480
##                            Quick.ratio..times.
##                                             3.091495
##                          Current.ratio..times.
##                                             3.645072
##                  Debt.to.equity.ratio..times.
##                                             4.645635
##          Cash.to.current.liabilities..times.
##                                             3.148511
##        Cash.to.average.cost.of.sales.per.day
##                                             2.359867
##                            Creditors.turnover
##                                             1.707719
##                             Debtors.turnover
##                                             1.765758
##                       Finished.goods.turnover
##                                             1.638749
##                                  WIP.turnover
##                                             1.703147
##                         Raw.material.turnover
##                                             1.762291
##                           Shares.outstanding
##                                             1.510788
##                            Equity.face.value
##                                             1.830557
##                                     PE.on.BSE
##                                             1.463607

rawdata.nona <- rawdata.nona[,-c(4,5,12,14,15,20)]
vif.model3 <- glm(default~.,rawdata.nona,family = "binomial")
vif(vif.model3)

##                                           Num
##                                             1.076465
##                              Change.in.stock
##                                             1.592936
```

```
##                        PBDITA.as...of.total.income
##                                           2.449524
##              Cash.profit.as...of.total.income
##                                           2.478509
##                           PAT.as...of.net.worth
##                                           1.217857
##                                              Sales
##                                           2.056499
##             Income.from.financial.services
##                                           1.407824
##                                       Other.income
##                                           1.268730
##                                      Total.capital
##                                           2.003926
##                                         Borrowings
##                                           1.950809
##                                            TOL.TNW
##                                           3.365151
## Total.term.liabilities...tangible.net.worth
##                                           3.475202
##        Contingent.liabilities...Net.worth....
##                                           1.953546
##                         Contingent.liabilities
##                                           1.784975
##                                        Investments
##                                           1.128611
##                                      Current.assets
##                                           2.823333
##                           Net.working.capital
##                                           1.751051
##                             Quick.ratio..times.
##                                           3.031121
##                           Current.ratio..times.
##                                           3.618046
##                   Debt.to.equity.ratio..times.
##                                           4.670298
##          Cash.to.current.liabilities..times.
##                                           3.126662
##        Cash.to.average.cost.of.sales.per.day
##                                           2.396083
##                                 Creditors.turnover
##                                           1.659291
##                                  Debtors.turnover
##                                           1.695284
##                         Finished.goods.turnover
##                                           1.592570
##                                        WIP.turnover
##                                           1.658726
##                           Raw.material.turnover
##                                           1.690561
```

```
##                        Shares.outstanding
##                                  1.481561
##                         Equity.face.value
##                                  1.808682
##                                  PE.on.BSE
##                                  1.447735

rawdata.nona <- rawdata.nona[,-c(6,8,18)]
vif.model3 <- glm(default~.,rawdata.nona,family = "binomial")
vif(vif.model3)

##                                        Num
##                                   1.076940
##                           Change.in.stock
##                                   1.423412
##           PBDITA.as...of.total.income
##                                   2.409431
##        Cash.profit.as...of.total.income
##                                   2.472849
##                      PAT.as...of.net.worth
##                                   1.212893
##         Income.from.financial.services
##                                   1.341803
##                            Total.capital
##                                   1.989291
##                               Borrowings
##                                   1.888997
##                                   TOL.TNW
##                                   3.360237
## Total.term.liabilities...tangible.net.worth
##                                   3.416328
##     Contingent.liabilities...Net.worth....
##                                   1.913978
##                   Contingent.liabilities
##                                   1.754452
##                              Investments
##                                   1.124830
##                           Current.assets
##                                   2.623687
##                      Net.working.capital
##                                   1.749193
##                    Current.ratio..times.
##                                   2.200379
##           Debt.to.equity.ratio..times.
##                                   4.677923
##      Cash.to.current.liabilities..times.
##                                   2.966684
##      Cash.to.average.cost.of.sales.per.day
##                                   2.364898
##                        Creditors.turnover
```

```
##                                     1.653703
##                        Debtors.turnover
##                                     1.685481
##               Finished.goods.turnover
##                                     1.568282
##                          WIP.turnover
##                                     1.646544
##                  Raw.material.turnover
##                                     1.679570
##                     Shares.outstanding
##                                     1.471889
##                     Equity.face.value
##                                     1.797968
##                               PE.on.BSE
##                                     1.443409
```

```r
rawdata.nona <- rawdata.nona[,-c(9,10,16,18)]
vif.model3 <- glm(default~.,rawdata.nona,family = "binomial")
vif(vif.model3)
```

```
##                                         Num
##                                     1.066966
##                        Change.in.stock
##                                     1.430225
##           PBDITA.as...of.total.income
##                                     2.278902
##       Cash.profit.as...of.total.income
##                                     2.363941
##               PAT.as...of.net.worth
##                                     1.211885
##       Income.from.financial.services
##                                     1.337007
##                          Total.capital
##                                     1.827693
##                             Borrowings
##                                     1.888408
## Contingent.liabilities...Net.worth....
##                                     1.862434
##               Contingent.liabilities
##                                     1.692883
##                            Investments
##                                     1.105629
##                          Current.assets
##                                     2.384820
##               Net.working.capital
##                                     1.179719
##         Debt.to.equity.ratio..times.
##                                     1.401037
##   Cash.to.average.cost.of.sales.per.day
##                                     1.273919
```

```
##                       Creditors.turnover
##                              1.608483
##                       Debtors.turnover
##                              1.665273
##                  Finished.goods.turnover
##                              1.562722
##                       WIP.turnover
##                              1.644364
##                  Raw.material.turnover
##                              1.686859
##                     Shares.outstanding
##                              1.493677
##                      Equity.face.value
##                              1.828710
##                              PE.on.BSE
##                              1.445459
```

```
validation_data.nona1 <- validation_data.nona[,c(1,2,6,12,15,16,18,20,22,30,3
1,33,34,35,38,40,41,42,43,44,45,46,47,51)]
```

Logistic Regression

Since we have removed Multi Collinearity we can now work on the logistic regression,

Initially we tried to build a model on all the available non collinear variable, then based on the significance level we cut short the variables and ended with the following variables

1. `Cash.to.average.cost.of.sales.per.day`

2. `Debt.to.equity.ratio..times. 3.`

3. `Net.working.capital`

4. `PAT.as...of.net.worth`

5. `Cash.profit.as...of.total.income`

6. `Current.assets`

7. `Investments`

8. `Borrowings`

9. `rawdata.nona$Contingent.liabilities...`

10. `Net.worth....`

```
##
## Call:
## glm(formula = default ~ ., family = "binomial", data = rawdata.nona)
##
```

```
## Deviance Residuals:
##     Min      1Q   Median      3Q      Max
## -1.6727  -0.2826  -0.1144  -0.0431   3.6622
##
## Coefficients:
##                                       Estimate Std. Error z value
## (Intercept)                          -3.532e+00  8.328e-01  -4.241
## Num                                   2.042e-04  7.865e-05   2.596
## Change.in.stock                       1.363e-02  4.894e-03   2.785
## PBDITA.as...of.total.income          -1.925e-03  3.244e-02  -0.059
## Cash.profit.as...of.total.income     -1.856e-01  5.107e-02  -3.635
## PAT.as...of.net.worth                -1.614e-01  2.096e-02  -7.700
## Income.from.financial.services        3.409e-03  2.318e-03   1.471
## Total.capital                         2.726e-03  3.043e-03   0.896
## Borrowings                            8.845e-04  3.980e-04   2.222
## Contingent.liabilities...Net.worth....  2.093e-02  7.802e-03   2.683
## Contingent.liabilities               -2.380e-04  2.324e-04  -1.024
## Investments                           8.118e-04  2.527e-04   3.213
## Current.assets                       -2.153e-03  6.677e-04  -3.225
## Net.working.capital                  -1.659e-02  3.515e-03  -4.721
## Debt.to.equity.ratio..times.          1.590e+00  1.518e-01  10.471
## Cash.to.average.cost.of.sales.per.day  4.944e-03  9.480e-03   0.521
## Creditors.turnover                   -2.092e-05  2.965e-04  -0.071
## Debtors.turnover                     -3.191e-04  2.785e-04  -1.146
## Finished.goods.turnover               2.523e-04  2.371e-04   1.064
## WIP.turnover                          2.250e-05  2.741e-04   0.082
## Raw.material.turnover                -1.824e-04  2.451e-04  -0.744
## Shares.outstanding                    1.514e-04  1.634e-04   0.927
## Equity.face.value                     3.789e-02  2.158e-01   0.176
## PE.on.BSE                            -5.010e-04  5.933e-04  -0.844
##                                      Pr(>|z|)
## (Intercept)                          2.22e-05 ***
## Num                                  0.009437 **
## Change.in.stock                      0.005353 **
## PBDITA.as...of.total.income          0.952688
## Cash.profit.as...of.total.income     0.000278 ***
## PAT.as...of.net.worth                1.36e-14 ***
## Income.from.financial.services       0.141292
## Total.capital                        0.370292
## Borrowings                           0.026251 *
## Contingent.liabilities...Net.worth.... 0.007298 **
## Contingent.liabilities               0.305822
## Investments                          0.001314 **
## Current.assets                       0.001261 **
## Net.working.capital                  2.35e-06 ***
## Debt.to.equity.ratio..times.          < 2e-16 ***
## Cash.to.average.cost.of.sales.per.day 0.602023
## Creditors.turnover                   0.943758
## Debtors.turnover                     0.251841
## Finished.goods.turnover              0.287243
```

```
## WIP.turnover                                       0.934572
## Raw.material.turnover                              0.456787
## Shares.outstanding                                 0.354185
## Equity.face.value                                  0.860633
## PE.on.BSE                                          0.398442
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##      Null deviance: 1771.0  on 3540  degrees of freedom
## Residual deviance: 1127.5  on 3517  degrees of freedom
## AIC: 1175.5
##
## Number of Fisher Scoring iterations: 8


##
## Call:
## glm(formula = default ~ rawdata.nona$Cash.to.average.cost.of.sales.per.day
+
##     Debt.to.equity.ratio..times. + Net.working.capital + PAT.as...of.net.w
orth +
##     Cash.profit.as...of.total.income + Current.assets + Investments +
##     Borrowings + rawdata.nona$Contingent.liabilities...Net.worth....,
##     family = "binomial", data = rawdata.nona)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -1.7811  -0.2952  -0.1154  -0.0436   3.7181
##
## Coefficients:
##                                                     Estimate Std. Error
## (Intercept)                                       -3.2380949  0.2896582
## rawdata.nona$Cash.to.average.cost.of.sales.per.day  0.0175998  0.0088549
## Debt.to.equity.ratio..times.                        1.4953207  0.1435441
## Net.working.capital                                -0.0187999  0.0034982
## PAT.as...of.net.worth                              -0.1658691  0.0205942
## Cash.profit.as...of.total.income                   -0.1953172  0.0351770
## Current.assets                                     -0.0016369  0.0006288
## Investments                                         0.0009679  0.0002412
## Borrowings                                          0.0010806  0.0003810
## rawdata.nona$Contingent.liabilities...Net.worth....  0.0220515  0.0062589
##                                                     z value Pr(>|z|)
## (Intercept)                                         -11.179  < 2e-16 ***
## rawdata.nona$Cash.to.average.cost.of.sales.per.day    1.988 0.046860 *
## Debt.to.equity.ratio..times.                         10.417  < 2e-16 ***
## Net.working.capital                                  -5.374 7.69e-08 ***
## PAT.as...of.net.worth                                -8.054 8.00e-16 ***
## Cash.profit.as...of.total.income                     -5.552 2.82e-08 ***
## Current.assets                                       -2.603 0.009237 **
```

```
## Investments                                          4.013 5.99e-05 ***
## Borrowings                                           2.836 0.004563 **
## rawdata.nona$Contingent.liabilities...Net.worth....  3.523 0.000426 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 1771.0  on 3540  degrees of freedom
## Residual deviance: 1158.9  on 3531  degrees of freedom
## AIC: 1178.9
##
## Number of Fisher Scoring iterations: 8
```

Coefficients and it's sign:

1. **Logit (score) = -3.532e+00**

2. Cash.to.average.cost.of.sales.per.day - 0.0175998

3. Debt.to.equity.ratio..times. - 1.4953207

4. Net.working.capital - −0.0187999

5. PAT.as...of.net.worth - −0.1658691

6. Cash.profit.as...of.total.income - −0.1953172

7. Current.assets - −0.0016369

8. Investments - 0.0009679

9. Borrowings - 0.0010806

10.   rawdata.nona$Contingent.liabilities... - 0.0220515

Based on the above coefficients we get the following equation

Logit(PD) = -3.532 – 0.0175998(Cash to avg cost of sales perday)
-1.4953207(Debt to equity ratio) – 0.0187999(Net working capital
) – 0.1658691(PAT as net worth) – 0.1953172 (cash profit as tota
l income) – 0.0016369(current assests) +0.0009679 (investments)
+ 0.0010806 (Borrowings) – 0.0220515 (Contingent Liabilities)
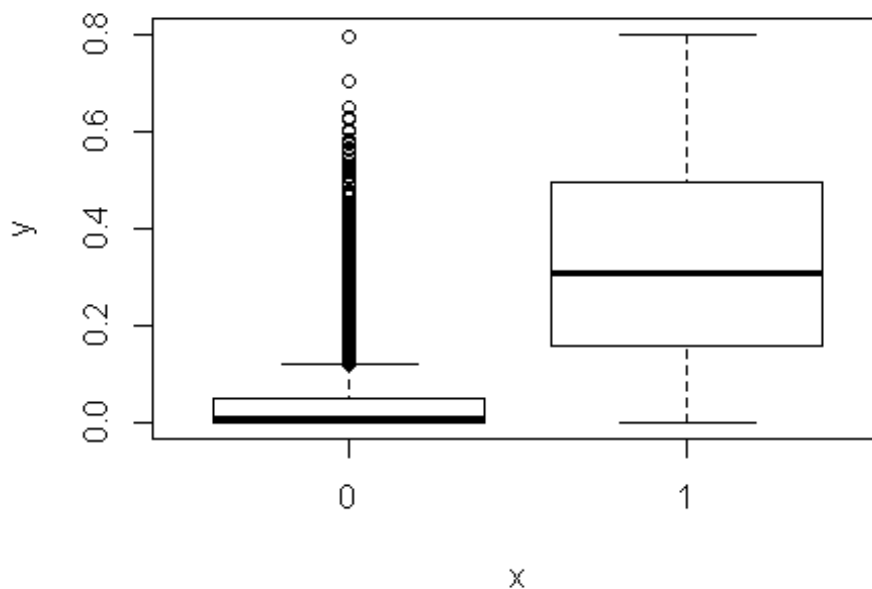
Model Prediction

From the above plot's it's safe to set the threshold above 0.19 for Defaulters

```
Default_prediction = ifelse(Default_model1$fitted.values>0.12,1,0)
summary(as.factor(Default_prediction))

##    0    1
## 2898  643

Result <- table(as.factor(Default_model1$y),Default_prediction)
Result

##    Default_prediction
##       0    1
##   0 2845  453
##   1   53  190

# Accuracy
accuracy <- round(sum(diag(Result))/sum(Result),2)
accuracy

## [1] 0.86

# Sensitivity
sensitivity <- round(2845/(2845+453),2)
sensitivity
```

```
## [1] 0.86

# Specificity
specificity <-round(190/(53+190),2)
specificity

## [1] 0.78
```

Unfortunately, Couldn't go beyond this due to the following issue (Performance Measures on Validation Dataset, sort the data in descending order)

- **Error in model.frame.default(Terms, newdata, na.action = na.action, xlev = object$xlevels) : variable lengths differ**

- **I Have checked for missing values and I have done variable correction but still couldn't get past this error. Can you Please help me on this ?**