Loan_prediction_problem_v4.R

jas

Fri Sep 09 14:51:53 2016

```r
##clean all objects from memory
rm(list=ls())

#Running the packages#
library(dplyr)
```

```
## Warning: package 'dplyr' was built under R version 3.2.5

##
## Attaching package: 'dplyr'

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

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

```r
library(VIM)
```

```
## Warning: package 'VIM' was built under R version 3.2.5

## Loading required package: colorspace

## Warning: package 'colorspace' was built under R version 3.2.5

## Loading required package: grid

## Loading required package: data.table

## Warning: package 'data.table' was built under R version 3.2.5

##
## Attaching package: 'data.table'

## The following objects are masked from 'package:dplyr':
##
##     between, last

## VIM is ready to use.
##  Since version 4.0.0 the GUI is in its own package VIMGUI.
##
##            Please use the package to use the new (and old) GUI.
```

```
## Suggestions and bug-reports can be submitted at:
https://github.com/alexkowa/VIM/issues

##
## Attaching package: 'VIM'

## The following object is masked from 'package:datasets':
##
##     sleep

library(mice)

## Warning: package 'mice' was built under R version 3.2.5

## Loading required package: Rcpp

## Warning: package 'Rcpp' was built under R version 3.2.5

## mice 2.25 2015-11-09

library(ggplot2)

## Warning: package 'ggplot2' was built under R version 3.2.5

#Setting up the working drive#
getwd()

## [1] "D:/R/Analytics vidhya/Hackathon/Loan Prediction"

setwd("D:/R/Analytics vidhya/Hackathon/Loan Prediction")

#Checking what files are there in the working drive#
dir("D:/R/Analytics vidhya/Hackathon/Loan Prediction")

##  [1] "1st submission.csv"
##  [2] "2nd_submission.csv"
##  [3] "check.csv"
##  [4] "df.csv"
##  [5] "df1.csv"
##  [6] "df2.csv"
##  [7] "df4.csv"
##  [8] "impdata.csv"
##  [9] "Loan prediction problem v1.R"
## [10] "Loan prediction problem v2.5.R"
## [11] "Loan prediction problem v2.R"
## [12] "Loan prediction problem v3.R"
## [13] "Loan prediction problem v4.R"
## [14] "Loan prediction problem.R"
## [15] "Loan_prediction_problem_v4.R"
## [16] "Loan_prediction_problem_v4.spin.R"
## [17] "Loan_prediction_problem_v4.spin.Rmd"
## [18] "Log_Reg_Pred.csv"
## [19] "Logistic regression.R"
```

```
## [20] "Random Forest.R"
## [21] "test_home loan.csv"
## [22] "TestD.csv"
## [23] "train_home loan.csv"
## [24] "TrainD.csv"
## [25] "TrainD1.csv"
## [26] "XGBOOST.R"
```

```r
#Reading the train and test dataset#
train <- read.csv('train_home loan.csv',stringsAsFactors =
FALSE,na.strings=c("","NA"))
test <- read.csv('test_home loan.csv',stringsAsFactors =
FALSE,na.strings=c("","NA"))

#Checking train dataset#
str(train)
```

```
## 'data.frame':    614 obs. of  13 variables:
##  $ Loan_ID          : chr  "LP001002" "LP001003" "LP001005" "LP001006" ...
##  $ Gender           : chr  "Male" "Male" "Male" "Male" ...
##  $ Married          : chr  "No" "Yes" "Yes" "Yes" ...
##  $ Dependents       : chr  "0" "1" "0" "0" ...
##  $ Education        : chr  "Graduate" "Graduate" "Graduate" "Not Graduate"
...
##  $ Self_Employed    : chr  "No" "No" "Yes" "No" ...
##  $ ApplicantIncome  : int  5849 4583 3000 2583 6000 5417 2333 3036 4006
12841 ...
##  $ CoapplicantIncome: num  0 1508 0 2358 0 ...
##  $ LoanAmount       : int  NA 128 66 120 141 267 95 158 168 349 ...
##  $ Loan_Amount_Term : int  360 360 360 360 360 360 360 360 360 360 ...
##  $ Credit_History   : int  1 1 1 1 1 1 1 0 1 1 ...
##  $ Property_Area    : chr  "Urban" "Rural" "Urban" "Urban" ...
##  $ Loan_Status      : chr  "Y" "N" "Y" "Y" ...
```

```r
#Combining Test and Train dataset using tags for missing value imputations#
test$Loan_Status<- 2
test$Tag<- "test"
train$Tag<- "train"
train$Loan_Status <- ifelse(train$Loan_Status=="Y",1,0)
data<- rbind(train,test)

head(data)
```

```
##     Loan_ID Gender Married Dependents    Education Self_Employed
## 1 LP001002   Male      No          0     Graduate            No
## 2 LP001003   Male     Yes          1     Graduate            No
## 3 LP001005   Male     Yes          0     Graduate           Yes
## 4 LP001006   Male     Yes          0 Not Graduate            No
## 5 LP001008   Male      No          0     Graduate            No
## 6 LP001011   Male     Yes          2     Graduate           Yes
##   ApplicantIncome CoapplicantIncome LoanAmount Loan_Amount_Term
```

```
## 1               5849                    0          NA                 360
## 2               4583                 1508         128                 360
## 3               3000                    0          66                 360
## 4               2583                 2358         120                 360
## 5               6000                    0         141                 360
## 6               5417                 4196         267                 360
##    Credit_History Property_Area Loan_Status   Tag
## 1               1         Urban           1 train
## 2               1         Rural           0 train
## 3               1         Urban           1 train
## 4               1         Urban           1 train
## 5               1         Urban           1 train
## 6               1         Urban           1 train
```

```r
summary(data)
```

```
##     Loan_ID             Gender             Married
##  Length:981         Length:981         Length:981
##  Class :character   Class :character   Class :character
##  Mode  :character   Mode  :character   Mode  :character
##
##
##
##
##   Dependents          Education          Self_Employed        ApplicantIncome
##  Length:981         Length:981         Length:981         Min.   :     0
##  Class :character   Class :character   Class :character   1st Qu.: 2875
##  Mode  :character   Mode  :character   Mode  :character   Median : 3800
##                                                           Mean   : 5180
##                                                           3rd Qu.: 5516
##                                                           Max.   :81000
##
##  CoapplicantIncome   LoanAmount      Loan_Amount_Term Credit_History
##  Min.   :    0     Min.   :  9.0   Min.   :  6.0    Min.   :0.0000
##  1st Qu.:    0     1st Qu.:100.0   1st Qu.:360.0    1st Qu.:1.0000
##  Median : 1110     Median :126.0   Median :360.0    Median :1.0000
##  Mean   : 1602     Mean   :142.5   Mean   :342.2    Mean   :0.8359
##  3rd Qu.: 2365     3rd Qu.:162.0   3rd Qu.:360.0    3rd Qu.:1.0000
##  Max.   :41667     Max.   :700.0   Max.   :480.0    Max.   :1.0000
##                    NA's   :27      NA's   :20       NA's   :79
##  Property_Area        Loan_Status         Tag
##  Length:981         Min.   :0.000     Length:981
##  Class :character   1st Qu.:1.000     Class :character
##  Mode  :character   Median :1.000     Mode  :character
##                     Mean   :1.178
##                     3rd Qu.:2.000
##                     Max.   :2.000
##
```

```
#Converting characters to factors#
data$Gender <- as.factor(data$Gender)
data$Married <- as.factor(data$Married)
data$Education <- as.factor(data$Education)
data$Self_Employed <- as.factor(data$Self_Employed)
data$Property_Area <- as.factor(data$Property_Area)
data$Loan_Status <- as.factor(data$Loan_Status)
data$Dependents <- as.factor(data$Dependents)
str(data)

## 'data.frame':    981 obs. of  14 variables:
##  $ Loan_ID          : chr  "LP001002" "LP001003" "LP001005" "LP001006" ...
##  $ Gender           : Factor w/ 2 levels "Female","Male": 2 2 2 2 2 2 2 2
## 2 2 ...
##  $ Married          : Factor w/ 2 levels "No","Yes": 1 2 2 2 1 2 2 2 2 2
## ...
##  $ Dependents       : Factor w/ 4 levels "0","1","2","3+": 1 2 1 1 1 3 1 4
## 3 2 ...
##  $ Education        : Factor w/ 2 levels "Graduate","Not Graduate": 1 1 1
## 2 1 1 2 1 1 1 ...
##  $ Self_Employed    : Factor w/ 2 levels "No","Yes": 1 1 2 1 1 2 1 1 1 1
## ...
##  $ ApplicantIncome  : int  5849 4583 3000 2583 6000 5417 2333 3036 4006
## 12841 ...
##  $ CoapplicantIncome: num  0 1508 0 2358 0 ...
##  $ LoanAmount       : int  NA 128 66 120 141 267 95 158 168 349 ...
##  $ Loan_Amount_Term : int  360 360 360 360 360 360 360 360 360 360 ...
##  $ Credit_History   : int  1 1 1 1 1 1 1 0 1 1 ...
##  $ Property_Area    : Factor w/ 3 levels "Rural","Semiurban",..: 3 1 3 3 3
## 3 3 2 3 2 ...
##  $ Loan_Status      : Factor w/ 3 levels "0","1","2": 2 1 2 2 2 2 2 1 2 1
## ...
##  $ Tag              : chr  "train" "train" "train" "train" ...

#Missing values#
table(is.na(data))

##
## FALSE   TRUE
## 13501    233

colSums(is.na(data))

##           Loan_ID            Gender           Married         Dependents
##                 0                24                 3                 25
##         Education     Self_Employed   ApplicantIncome CoapplicantIncome
##                 0                55                 0                 0
##        LoanAmount  Loan_Amount_Term    Credit_History     Property_Area
##                27                20                79                 0
##       Loan_Status               Tag
##                 0                 0
```

```r
summary(data)
```
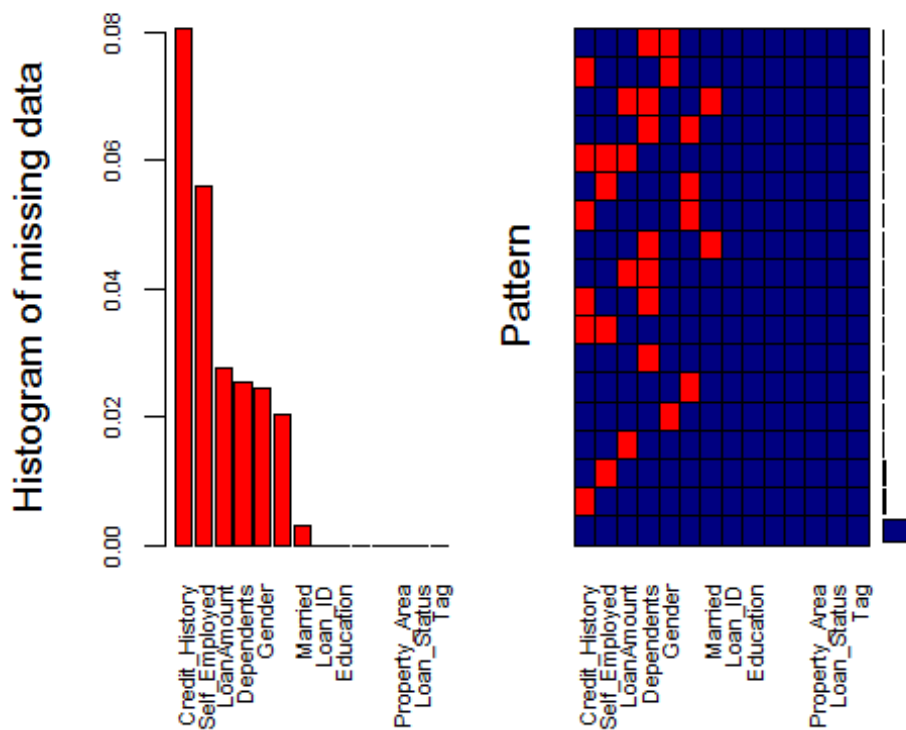
```
##     Loan_ID              Gender      Married    Dependents          Education
##   Length:981          Female:182    No  :347   0    :545   Graduate    :763
##   Class :character    Male  :775    Yes :631   1    :160   Not Graduate:218
##   Mode  :character    NA's  : 24    NA's:  3   2    :160
##                                                3+   : 91
##                                                NA's: 25
##
##
##   Self_Employed ApplicantIncome CoapplicantIncome    LoanAmount
##   No  :807      Min.   :    0   Min.   :    0      Min.   :  9.0
##   Yes :119      1st Qu.: 2875   1st Qu.:    0      1st Qu.:100.0
##   NA's: 55      Median : 3800   Median : 1110      Median :126.0
##                 Mean   : 5180   Mean   : 1602      Mean   :142.5
##                 3rd Qu.: 5516   3rd Qu.: 2365      3rd Qu.:162.0
##                 Max.   :81000   Max.   :41667      Max.   :700.0
##                                                    NA's   :27
##   Loan_Amount_Term Credit_History     Property_Area Loan_Status
##   Min.   :  6.0    Min.   :0.0000   Rural    :290   0:192
##   1st Qu.:360.0    1st Qu.:1.0000   Semiurban:349   1:422
##   Median :360.0    Median :1.0000   Urban    :342   2:367
##   Mean   :342.2    Mean   :0.8359
##   3rd Qu.:360.0    3rd Qu.:1.0000
##   Max.   :480.0    Max.   :1.0000
##   NA's   :20       NA's   :79
##       Tag
##   Length:981
##   Class :character
##   Mode  :character
##
##
##
##
```

```r
#Visual represenatation of missing data#
aggr_plot <- aggr(data, col=c('navyblue','red'), numbers=TRUE, sortVars=TRUE,
labels=names(data), cex.axis=.7, gap=3, ylab=c("Histogram of missing
data","Pattern"))
```

```
## Warning in plot.aggr(res, ...): not enough horizontal space to display
## frequencies
```

```
## 
##  Variables sorted by number of missings:
##           Variable        Count
##     Credit_History 0.080530071
##      Self_Employed 0.056065240
##         LoanAmount 0.027522936
##         Dependents 0.025484200
##             Gender 0.024464832
##   Loan_Amount_Term 0.020387360
##            Married 0.003058104
##            Loan_ID 0.000000000
##          Education 0.000000000
##    ApplicantIncome 0.000000000
##  CoapplicantIncome 0.000000000
##      Property_Area 0.000000000
##        Loan_Status 0.000000000
##                Tag 0.000000000
```

#Missing value imputation with MICE#
```
data1 <- mice(data =
data[,c("Gender","Married","Dependents","Education","Self_Employed","Loan_Amo
unt_Term","Credit_History","Property_Area","Tag")], m=7,maxit=100,seed = 500)

## 
##  iter imp variable
##   1   1  Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
```

```
##    1    2 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    1    3 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    1    4 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    1    5 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    1    6 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    1    7 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    2    1 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    2    2 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    2    3 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    2    4 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    2    5 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    2    6 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    2    7 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    3    1 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    3    2 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    3    3 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    3    4 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    3    5 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    3    6 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    3    7 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    4    1 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    4    2 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    4    3 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    4    4 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    4    5 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
```

```
##   4   6 Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   4   7 Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   5   1 Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   5   2 Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   5   3 Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   5   4 Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   5   5 Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   5   6 Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   5   7 Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   6   1 Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   6   2 Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   6   3 Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   6   4 Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   6   5 Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   6   6 Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   6   7 Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   7   1 Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   7   2 Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   7   3 Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   7   4 Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   7   5 Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   7   6 Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   7   7 Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   8   1 Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   8   2 Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
```

```
##   8   3 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   8   4 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   8   5 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   8   6 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   8   7 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   9   1 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   9   2 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   9   3 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   9   4 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   9   5 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   9   6 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   9   7 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##  10   1 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##  10   2 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##  10   3 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##  10   4 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##  10   5 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##  10   6 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##  10   7 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##  11   1 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##  11   2 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##  11   3 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##  11   4 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##  11   5 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##  11   6 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
```

```
## 11    7 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 12    1 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 12    2 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 12    3 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 12    4 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 12    5 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 12    6 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 12    7 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 13    1 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 13    2 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 13    3 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 13    4 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 13    5 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 13    6 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 13    7 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 14    1 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 14    2 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 14    3 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 14    4 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 14    5 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 14    6 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 14    7 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 15    1 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 15    2 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 15    3 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
```

```
##   15    4  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   15    5  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   15    6  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   15    7  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   16    1  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   16    2  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   16    3  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   16    4  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   16    5  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   16    6  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   16    7  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   17    1  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   17    2  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   17    3  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   17    4  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   17    5  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   17    6  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   17    7  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   18    1  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   18    2  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   18    3  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   18    4  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   18    5  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   18    6  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   18    7  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
```

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##   19    1  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   19    2  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   19    3  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   19    4  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   19    5  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   19    6  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   19    7  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   20    1  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   20    2  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   20    3  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   20    4  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   20    5  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   20    6  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   20    7  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   21    1  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   21    2  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   21    3  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   21    4  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   21    5  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   21    6  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   21    7  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   22    1  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   22    2  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   22    3  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   22    4  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
```

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##    22    5  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    22    6  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    22    7  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    23    1  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    23    2  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    23    3  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    23    4  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    23    5  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    23    6  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    23    7  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    24    1  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    24    2  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    24    3  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    24    4  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    24    5  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    24    6  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    24    7  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    25    1  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    25    2  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    25    3  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    25    4  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    25    5  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    25    6  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    25    7  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    26    1  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
```

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## 26   2 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 26   3 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 26   4 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 26   5 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 26   6 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 26   7 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 27   1 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 27   2 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 27   3 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 27   4 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 27   5 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 27   6 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 27   7 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 28   1 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 28   2 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 28   3 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 28   4 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 28   5 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 28   6 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 28   7 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 29   1 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 29   2 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 29   3 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 29   4 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
## 29   5 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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##   29    6  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   29    7  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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Credit_History
##   30    2  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   30    3  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   30    4  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   30    5  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   30    6  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   30    7  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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Credit_History
##   31    2  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   31    3  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   31    4  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   31    5  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   31    6  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   31    7  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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Credit_History
##   32    2  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   32    3  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   32    4  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   32    5  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   32    6  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   32    7  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   33    1  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   33    2  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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##  33    3  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##  33    4  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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Credit_History
##  33    6  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##  33    7  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##  34    1  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##  34    2  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##  34    3  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##  34    4  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##  34    5  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##  34    6  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##  34    7  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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Credit_History
##  35    2  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##  35    3  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##  35    4  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##  35    5  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##  35    6  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##  35    7  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##  36    1  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##  36    2  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##  36    3  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##  36    4  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##  36    5  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##  36    6  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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##   36    7 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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Credit_History
##   37    2 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   37    3 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   37    4 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   37    5 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   37    6 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   37    7 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   38    1 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   38    2 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   38    3 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   38    4 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   38    5 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   38    6 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   38    7 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   39    1 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   39    2 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   39    3 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   39    4 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   39    5 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   39    6 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   39    7 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   40    1 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   40    2 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   40    3 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
```

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##    40    4   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    40    5   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    40    6   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    40    7   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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Credit_History
##    41    2   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    41    3   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    41    4   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    41    5   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    41    6   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    41    7   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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Credit_History
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Credit_History
##    42    3   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    42    4   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    42    5   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    42    6   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    42    7   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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Credit_History
##    43    2   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    43    3   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    43    4   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    43    5   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    43    6   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    43    7   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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##   44    1  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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Credit_History
##   44    3  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   44    4  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   44    5  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   44    6  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   44    7  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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Credit_History
##   45    2  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   45    3  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   45    4  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   45    5  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   45    6  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   45    7  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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Credit_History
##   46    2  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   46    3  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   46    4  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   46    5  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   46    6  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   46    7  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   47    1  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   47    2  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   47    3  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   47    4  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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##   47   5 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   47   6 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   47   7 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   48   1 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   48   2 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   48   3 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   48   4 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   48   5 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   48   6 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   48   7 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   49   1 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   49   2 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   49   3 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   49   4 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   49   5 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   49   6 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   49   7 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   50   1 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   50   2 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
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##   50   3 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   50   4 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   50   5 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   50   6 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   50   7 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   51   1 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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##   51    2  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   51    3  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   51    4  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   51    5  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   51    6  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   51    7  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   52    1  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   52    2  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   52    3  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   52    4  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   52    5  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   52    6  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   52    7  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
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##   53    2  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
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##   53    3  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
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##   53    4  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
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##   53    5  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   53    6  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
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##   53    7  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
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##   54    2  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   54    3  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   54    4  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   54    5  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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##    54    6  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    54    7  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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Credit_History
##    55    2  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    55    3  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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Credit_History
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Credit_History
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Credit_History
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##    56    5  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
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##    56    7  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
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##    57    5  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
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##    57    7  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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Credit_History
##    58    2  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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##   58    3 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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Credit_History
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Credit_History
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##   58    7 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
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##   59    2 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
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##   59    3 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
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##   59    4 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
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##   59    5 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
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##   59    6 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
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##   59    7 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
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##   60    2 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
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##   60    3 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
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##   60    4 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
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##   60    5 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
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##   60    6 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
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##   60    7 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
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##   61    3 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
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##   61    4 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   61    5 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   61    6 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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##    61    7  Gender    Married    Dependents    Self_Employed    Loan_Amount_Term
Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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##    62    6  Gender    Married    Dependents    Self_Employed    Loan_Amount_Term
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##    62    7  Gender    Married    Dependents    Self_Employed    Loan_Amount_Term
Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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##    63    7  Gender    Married    Dependents    Self_Employed    Loan_Amount_Term
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
##    65    3  Gender    Married    Dependents    Self_Employed    Loan_Amount_Term
Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
##   66    2   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   66    3   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   66    4   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
##   68    6   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   68    7   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
##   69    6 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   69    7 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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##   71    7 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
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Credit_History
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Credit_History
##   72    3 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   72    4 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
##   78    7  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
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##   79    2  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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Credit_History
##   79    4  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   79    5  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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Credit_History
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##   82   7  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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Credit_History
##   83   2  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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Credit_History
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Credit_History
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##    83    6 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    83    7 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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Credit_History
##    84    2 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
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##    84    3 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    84    4 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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Credit_History
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Credit_History
##    84    7 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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Credit_History
##    85    2 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    85    3 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
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##    85    4 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    85    5 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    85    6 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    85    7 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
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##    86    2 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
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##    86    3 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    86    4 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    86    5 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    86    6 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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Credit_History
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Credit_History
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Credit_History
##   87   3 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   87   4 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   87   5 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   87   6 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   87   7 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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Credit_History
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Credit_History
##   88   3 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   88   4 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   88   5 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   88   6 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   88   7 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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Credit_History
##   89   2 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   89   3 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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Credit_History
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Credit_History
##   89   7 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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Credit_History
##   90   2 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   90   3 Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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Credit_History
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Credit_History
##   90    7   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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Credit_History
##   91    2   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   91    3   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
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Credit_History
##   91    5   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   91    6   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   91    7   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   92    1   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   92    2   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   92    3   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   92    4   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   92    5   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   92    6   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   92    7   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   93    1   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   93    2   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   93    3   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   93    4   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   93    5   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   93    6   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##   93    7   Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
```

```
##    94    1  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    94    2  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    94    3  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    94    4  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    94    5  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    94    6  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    94    7  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    95    1  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    95    2  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    95    3  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    95    4  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    95    5  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    95    6  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    95    7  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    96    1  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    96    2  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    96    3  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    96    4  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    96    5  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    96    6  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    96    7  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    97    1  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    97    2  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    97    3  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
##    97    4  Gender   Married   Dependents   Self_Employed   Loan_Amount_Term
Credit_History
```

```
##   97    5  Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   97    6  Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   97    7  Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   98    1  Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   98    2  Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   98    3  Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   98    4  Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   98    5  Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   98    6  Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   98    7  Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   99    1  Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   99    2  Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   99    3  Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   99    4  Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   99    5  Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   99    6  Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   99    7  Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   100   1  Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   100   2  Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   100   3  Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   100   4  Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   100   5  Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   100   6  Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
##   100   7  Gender  Married  Dependents  Self_Employed  Loan_Amount_Term
Credit_History
```

```r
summary(data1)
```

```
## Multiply imputed data set
## Call:
## mice(data = data[, c("Gender", "Married", "Dependents", "Education",
## "Self_Employed", "Loan_Amount_Term", "Credit_History",
"Property_Area",
## "Tag")], m = 7, maxit = 100, seed = 500)
## Number of multiple imputations:  7
## Missing cells per column:
##          Gender          Married       Dependents        Education
##              24                3               25                0
##   Self_Employed Loan_Amount_Term   Credit_History    Property_Area
##              55               20               79                0
##             Tag
##               0
## Imputation methods:
##          Gender          Married       Dependents        Education
##        "logreg"         "logreg"        "polyreg"               ""
##   Self_Employed Loan_Amount_Term   Credit_History    Property_Area
##        "logreg"            "pmm"            "pmm"               ""
##             Tag
##              ""
## VisitSequence:
##          Gender          Married       Dependents    Self_Employed
##               1                2                3                5
## Loan_Amount_Term   Credit_History
##               6                7
## PredictorMatrix:
##                Gender Married Dependents Education Self_Employed
## Gender              0       1          1         1             1
## Married             1       0          1         1             1
## Dependents          1       1          0         1             1
## Education           0       0          0         0             0
## Self_Employed       1       1          1         1             0
## Loan_Amount_Term    1       1          1         1             1
## Credit_History      1       1          1         1             1
## Property_Area       0       0          0         0             0
## Tag                 0       0          0         0             0
##                Loan_Amount_Term Credit_History Property_Area Tag
## Gender                        1              1             1   0
## Married                       1              1             1   0
## Dependents                    1              1             1   0
## Education                     0              0             0   0
## Self_Employed                 1              1             1   0
## Loan_Amount_Term              0              1             1   0
## Credit_History                1              0             1   0
## Property_Area                 0              0             0   0
## Tag                           0              0             0   0
## Random generator seed value:  500
```

```r
#Check which method was used for missing data imputation#
data1$meth
```

```
##            Gender            Married        Dependents          Education
##           "logreg"           "logreg"          "polyreg"                 ""
##     Self_Employed Loan_Amount_Term    Credit_History      Property_Area
##           "logreg"              "pmm"             "pmm"                 ""
##               Tag
##                ""
```

```r
#Combining imputed data with the actual combined sheet#
data_imputed<- complete(data1,1)
imp_data<-
cbind(data,data_imputed$Gender,data_imputed$Married,data_imputed$Dependents,
data_imputed$Education,data_imputed$Self_Employed,data_imputed$Loan_Amount_Te
rm,data_imputed$Credit_History,data_imputed$Property_Area)
write.csv(imp_data,"impdata.csv",row.names = FALSE)

#Dropping earlier columns from Data#
names(imp_data)
```

```
##  [1] "Loan_ID"                     "Gender"
##  [3] "Married"                     "Dependents"
##  [5] "Education"                   "Self_Employed"
##  [7] "ApplicantIncome"             "CoapplicantIncome"
##  [9] "LoanAmount"                  "Loan_Amount_Term"
## [11] "Credit_History"             "Property_Area"
## [13] "Loan_Status"                 "Tag"
## [15] "data_imputed$Gender"         "data_imputed$Married"
## [17] "data_imputed$Dependents"     "data_imputed$Education"
## [19] "data_imputed$Self_Employed"  "data_imputed$Loan_Amount_Term"
## [21] "data_imputed$Credit_History" "data_imputed$Property_Area"
```

```r
df<- subset(imp_data, select= -
c(Gender,Married,Dependents,Education,Self_Employed,Loan_Amount_Term,Credit_H
istory,Property_Area))
summary(df)
```

```
##     Loan_ID          ApplicantIncome CoapplicantIncome   LoanAmount
##  Length:981         Min.   :     0   Min.   :     0     Min.   :  9.0
##  Class :character   1st Qu.: 2875    1st Qu.:     0     1st Qu.:100.0
##  Mode  :character   Median : 3800    Median : 1110      Median :126.0
##                     Mean   : 5180    Mean   : 1602      Mean   :142.5
##                     3rd Qu.: 5516    3rd Qu.: 2365      3rd Qu.:162.0
##                     Max.   :81000    Max.   :41667      Max.   :700.0
##                                                         NA's   :27
##  Loan_Status       Tag            data_imputed$Gender data_imputed$Married
##  0:192        Length:981          Female:188          No :348
##  1:422        Class :character    Male  :793          Yes:633
##  2:367        Mode  :character
##
```

```
## 
## 
## 
##  data_imputed$Dependents  data_imputed$Education
##  0 :551                    Graduate     :763
##  1 :167                    Not Graduate:218
##  2 :168
##  3+: 95
## 
## 
## 
##  data_imputed$Self_Employed data_imputed$Loan_Amount_Term
##  No :855                    Min.   :  6.0
##  Yes:126                    1st Qu.:360.0
##                             Median :360.0
##                             Mean   :342.1
##                             3rd Qu.:360.0
##                             Max.   :480.0
## 
##  data_imputed$Credit_History data_imputed$Property_Area
##  Min.   :0.0000              Rural    :290
##  1st Qu.:1.0000              Semiurban:349
##  Median :1.0000              Urban    :342
##  Mean   :0.8379
##  3rd Qu.:1.0000
##  Max.   :1.0000
## 
```

```r
write.csv(df,"df.csv",row.names = FALSE)
```

```r
#Checking for pending missing values and imputing loan amount missing values
with mean#
colSums(is.na(df))
```

```
##                      Loan_ID                 ApplicantIncome
##                            0                               0
##              CoapplicantIncome                    LoanAmount
##                            0                              27
##                  Loan_Status                             Tag
##                            0                               0
##          data_imputed$Gender          data_imputed$Married
##                            0                               0
##       data_imputed$Dependents        data_imputed$Education
##                            0                               0
##    data_imputed$Self_Employed data_imputed$Loan_Amount_Term
##                            0                               0
##    data_imputed$Credit_History    data_imputed$Property_Area
##                            0                               0
```

```r
df$LoanAmount[is.na(df$LoanAmount)]<- mean(df$LoanAmount, na.rm = TRUE)
summary(df$LoanAmount)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     9.0   101.0   128.0   142.5   160.0   700.0
```

```r
#Changing lable names for the imputed labels#
names(df)
```

```
##  [1] "Loan_ID"                   "ApplicantIncome"
##  [3] "CoapplicantIncome"         "LoanAmount"
##  [5] "Loan_Status"               "Tag"
##  [7] "data_imputed$Gender"       "data_imputed$Married"
##  [9] "data_imputed$Dependents"   "data_imputed$Education"
## [11] "data_imputed$Self_Employed" "data_imputed$Loan_Amount_Term"
## [13] "data_imputed$Credit_History" "data_imputed$Property_Area"
```

```r
names(df)[7:14]=
c("Gender","Married","Dependents","Education","Self_Employed","Loan_Amount_Te
rm","Credit_History","Property_Area")
names(df)
```

```
##  [1] "Loan_ID"           "ApplicantIncome"   "CoapplicantIncome"
##  [4] "LoanAmount"        "Loan_Status"       "Tag"
##  [7] "Gender"            "Married"           "Dependents"
## [10] "Education"         "Self_Employed"     "Loan_Amount_Term"
## [13] "Credit_History"    "Property_Area"
```

```r
#Feature engineering - Label encoding, one hot encoding, New features#
str(df)
```

```
## 'data.frame':    981 obs. of  14 variables:
##  $ Loan_ID          : chr  "LP001002" "LP001003" "LP001005" "LP001006" ...
##  $ ApplicantIncome  : int  5849 4583 3000 2583 6000 5417 2333 3036 4006
12841 ...
##  $ CoapplicantIncome: num  0 1508 0 2358 0 ...
##  $ LoanAmount       : num  143 128 66 120 141 ...
##  $ Loan_Status      : Factor w/ 3 levels "0","1","2": 2 1 2 2 2 2 2 1 2 1
...
##  $ Tag              : chr  "train" "train" "train" "train" ...
##  $ Gender           : Factor w/ 2 levels "Female","Male": 2 2 2 2 2 2 2 2
2 2 ...
##   ..- attr(*, "contrasts")= num [1:2, 1] 0 1
##   .. ..- attr(*, "dimnames")=List of 2
##   .. .. ..$ : chr  "Female" "Male"
##   .. .. ..$ : chr "2"
##  $ Married          : Factor w/ 2 levels "No","Yes": 1 2 2 2 1 2 2 2 2 2
...
##   ..- attr(*, "contrasts")= num [1:2, 1] 0 1
##   .. ..- attr(*, "dimnames")=List of 2
##   .. .. ..$ : chr  "No" "Yes"
```

```
##   .. .. ..$ : chr "2"
##  $ Dependents       : Factor w/ 4 levels "0","1","2","3+": 1 2 1 1 1 3 1 4
3 2 ...
##   ..- attr(*, "contrasts")= num [1:4, 1:3] 0 1 0 0 0 0 1 0 0 0 ...
##   .. ..- attr(*, "dimnames")=List of 2
##   .. .. ..$ : chr  "0" "1" "2" "3+"
##   .. .. ..$ : chr  "2" "3" "4"
##  $ Education        : Factor w/ 2 levels "Graduate","Not Graduate": 1 1 1
2 1 1 2 1 1 1 ...
##   ..- attr(*, "contrasts")= num [1:2, 1] 0 1
##   .. ..- attr(*, "dimnames")=List of 2
##   .. .. ..$ : chr  "Graduate" "Not Graduate"
##   .. .. ..$ : chr "2"
##  $ Self_Employed    : Factor w/ 2 levels "No","Yes": 1 1 2 1 1 2 1 1 1 1
...
##   ..- attr(*, "contrasts")= num [1:2, 1] 0 1
##   .. ..- attr(*, "dimnames")=List of 2
##   .. .. ..$ : chr  "No" "Yes"
##   .. .. ..$ : chr "2"
##  $ Loan_Amount_Term : int  360 360 360 360 360 360 360 360 360 360 ...
##  $ Credit_History   : int  1 1 1 1 1 1 1 0 1 1 ...
##  $ Property_Area    : Factor w/ 3 levels "Rural","Semiurban",..: 3 1 3 3 3
3 3 2 3 2 ...
##   ..- attr(*, "contrasts")= num [1:3, 1:2] 0 1 0 0 0 1
##   .. ..- attr(*, "dimnames")=List of 2
##   .. .. ..$ : chr  "Rural" "Semiurban" "Urban"
##   .. .. ..$ : chr  "2" "3"

#Label Encoding#
df$Gender <- ifelse(df$Gender=="Male",1,0)
df$Married <- ifelse(df$Married=="Yes",1,0)
df$Self_Employed <- ifelse(df$Self_Employed=="Yes",1,0)
df$Education <- ifelse(df$Education=="Graduate",1,0)

#One hot Encoding#
library(dummies)

## dummies-1.5.6 provided by Decision Patterns

names(df)

##  [1] "Loan_ID"          "ApplicantIncome"   "CoapplicantIncome"
##  [4] "LoanAmount"       "Loan_Status"       "Tag"
##  [7] "Gender"           "Married"           "Dependents"
## [10] "Education"        "Self_Employed"     "Loan_Amount_Term"
## [13] "Credit_History"   "Property_Area"

df <- dummy.data.frame(df, names = c('Dependents', 'Property_Area',
sep='_'))
str(df)
```

```
## 'data.frame':    981 obs. of  19 variables:
##  $ Loan_ID             : chr  "LP001002" "LP001003" "LP001005"
"LP001006" ...
##  $ ApplicantIncome     : int  5849 4583 3000 2583 6000 5417 2333 3036
4006 12841 ...
##  $ CoapplicantIncome   : num  0 1508 0 2358 0 ...
##  $ LoanAmount          : num  143 128 66 120 141 ...
##  $ Loan_Status         : Factor w/ 3 levels "0","1","2": 2 1 2 2 2 2 2 1
2 1 ...
##  $ Tag                 : chr  "train" "train" "train" "train" ...
##  $ Gender              : num  1 1 1 1 1 1 1 1 1 1 ...
##  $ Married             : num  0 1 1 1 0 1 1 1 1 1 ...
##  $ Dependents0         : int  1 0 1 1 1 0 1 0 0 0 ...
##  $ Dependents1         : int  0 1 0 0 0 0 0 0 0 1 ...
##  $ Dependents2         : int  0 0 0 0 0 1 0 0 1 0 ...
##  $ Dependents3+        : int  0 0 0 0 0 0 0 1 0 0 ...
##  $ Education           : num  1 1 1 0 1 1 0 1 1 1 ...
##  $ Self_Employed       : num  0 0 1 0 0 1 0 0 0 0 ...
##  $ Loan_Amount_Term    : int  360 360 360 360 360 360 360 360 360 360
...
##  $ Credit_History      : int  1 1 1 1 1 1 1 0 1 1 ...
##  $ Property_AreaRural  : int  0 1 0 0 0 0 0 0 0 0 ...
##  $ Property_AreaSemiurban: int  0 0 0 0 0 0 0 1 0 1 ...
##  $ Property_AreaUrban  : int  1 0 1 1 1 1 1 0 1 0 ...
##  - attr(*, "dummies")=List of 2
##   ..$ Dependents   : int  9 10 11 12
##   ..$ Property_Area: int  17 18 19
```

```r
#Total income = Applicant+Co-applicant#, Debt ratio = loan amount/income#,
Loan amount term binning#
# Creating new features#
df$TotalIncome <- df$ApplicantIncome + df$CoapplicantIncome
df$ApplicantIncome_Zero <- ifelse(df$ApplicantIncome==0,1,0)
df$DebtRatio_Mainapplicant <- df$LoanAmount/df$ApplicantIncome
df$DebtRatio_TotalIncome <- df$LoanAmount/df$TotalIncome
df$CoappIncGApplinc <- ifelse(df$CoapplicantIncome-df$ApplicantIncome>0,1,0)

df$Loan_Amount_Term1 <- ifelse(df$Loan_Amount_Term< 13,"0-12
mnths",ifelse(df$Loan_Amount_Term<121,"12-120
mnths",ifelse(df$Loan_Amount_Term<241,"120-240
mnths",ifelse(df$Loan_Amount_Term<361,"240-360 mnths","360+ Mnths"))))
df <- dummy.data.frame(df, names = c('Loan_Amount_Term1',  sep='_'))
str(df)
```

```
## 'data.frame':    981 obs. of  29 variables:
##  $ Loan_ID              : chr  "LP001002" "LP001003" "LP001005"
"LP001006" ...
##  $ ApplicantIncome      : int  5849 4583 3000 2583 6000 5417 2333
3036 4006 12841 ...
##  $ CoapplicantIncome    : num  0 1508 0 2358 0 ...
```

```
##  $ LoanAmount                      : num   143 128 66 120 141 ...
##  $ Loan_Status                     : Factor w/ 3 levels "0","1","2": 2 1 2 2
2 2 2 1 2 1 ...
##  $ Tag                             : chr   "train" "train" "train" "train"
...
##  $ Gender                          : num   1 1 1 1 1 1 1 1 1 1 ...
##  $ Married                         : num   0 1 1 1 0 1 1 1 1 1 ...
##  $ Dependents0                     : int   1 0 1 1 1 0 1 0 0 0 ...
##  $ Dependents1                     : int   0 1 0 0 0 0 0 0 0 1 ...
##  $ Dependents2                     : int   0 0 0 0 0 1 0 0 1 0 ...
##  $ Dependents3+                    : int   0 0 0 0 0 0 0 1 0 0 ...
##  $ Education                       : num   1 1 1 0 1 1 0 1 1 1 ...
##  $ Self_Employed                   : num   0 0 1 0 0 1 0 0 0 0 ...
##  $ Loan_Amount_Term                : int   360 360 360 360 360 360 360 360
360 360 ...
##  $ Credit_History                  : int   1 1 1 1 1 1 1 0 1 1 ...
##  $ Property_AreaRural              : int   0 1 0 0 0 0 0 0 0 0 ...
##  $ Property_AreaSemiurban          : int   0 0 0 0 0 0 0 1 0 1 ...
##  $ Property_AreaUrban              : int   1 0 1 1 1 1 1 0 1 0 ...
##  $ TotalIncome                     : num   5849 6091 3000 4941 6000 ...
##  $ ApplicantIncome_Zero            : num   0 0 0 0 0 0 0 0 0 0 ...
##  $ DebtRatio_Mainapplicant         : num   0.0244 0.0279 0.022 0.0465 0.0235
...
##  $ DebtRatio_TotalIncome           : num   0.0244 0.021 0.022 0.0243 0.0235
...
##  $ CoappIncGApplinc                : num   0 0 0 0 0 0 0 0 0 0 ...
##  $ Loan_Amount_Term10-12 mnths     : int   0 0 0 0 0 0 0 0 0 0 ...
##  $ Loan_Amount_Term112-120 mnths   : int   0 0 0 0 0 0 0 0 0 0 ...
##  $ Loan_Amount_Term1120-240 mnths  : int   0 0 0 0 0 0 0 0 0 0 ...
##  $ Loan_Amount_Term1240-360 mnths  : int   1 1 1 1 1 1 1 1 1 1 ...
##  $ Loan_Amount_Term1360+ Mnths     : int   0 0 0 0 0 0 0 0 0 0 ...
##  - attr(*, "dummies")=List of 1
##    ..$ Loan_Amount_Term1: int   25 26 27 28 29

df$Gender_Married <- df$Gender*df$Married  #Male married increases your
chances of loan approval(74%)

#Generating interaction between married and dependents#
df$Married_Dep0 <- df$Married*df$Dependents0
df$Married_Dep1 <- df$Married*df$Dependents1
df$Married_Dep2 <- df$Married*df$Dependents2
df$Married_Dep3 <- df$Married*df$`Dependents3+`

#Treating outliers in Loan amount and Incomes by log transformation#
ggplot(data=df, aes(df$LoanAmount)) + geom_histogram()

## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```
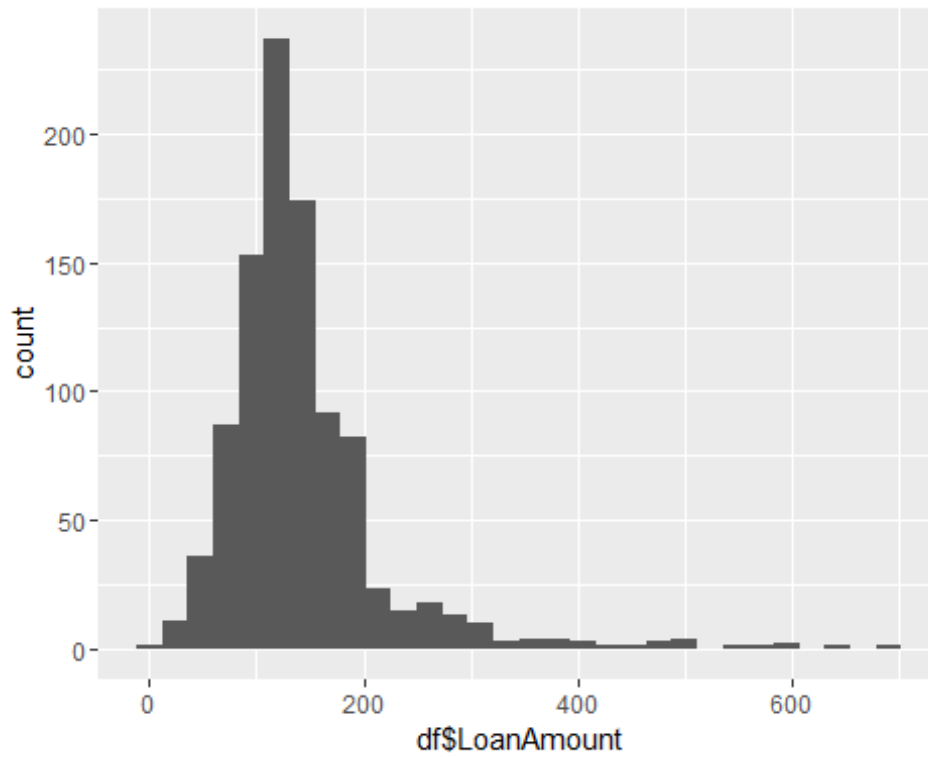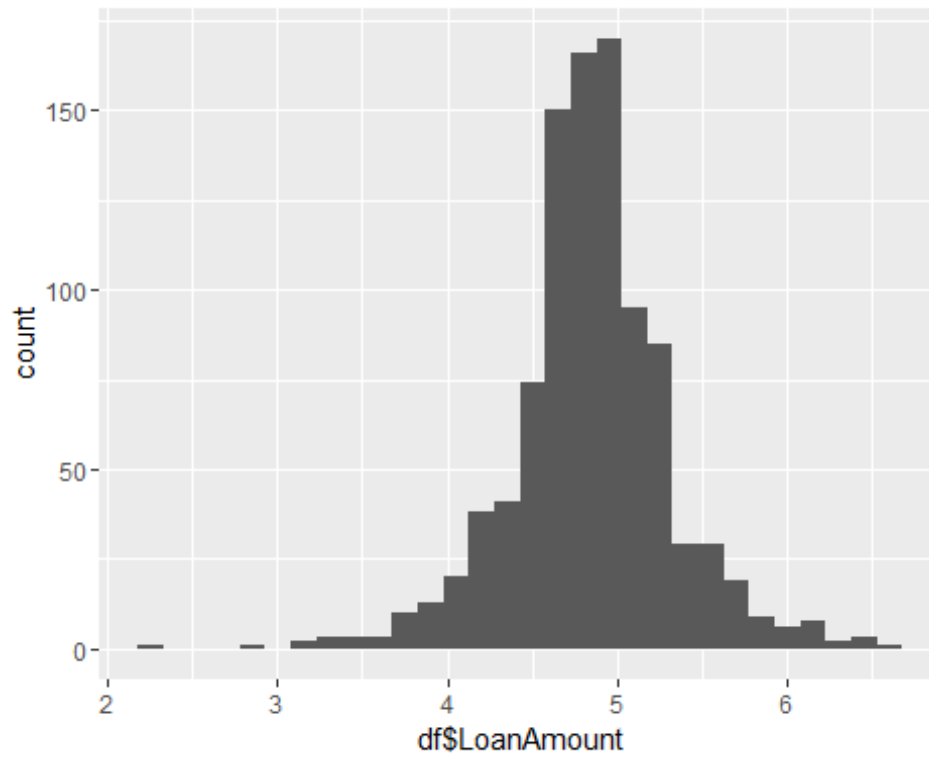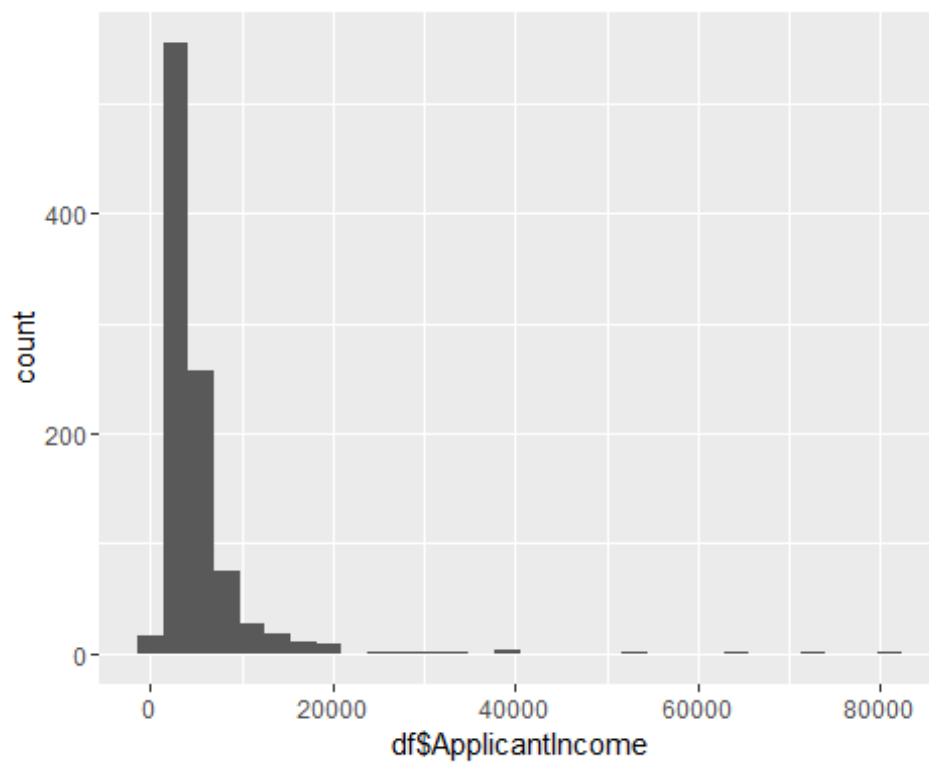
```
df$LoanAmount=log(df$LoanAmount)
ggplot(data=df, aes(df$LoanAmount)) + geom_histogram()

## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```
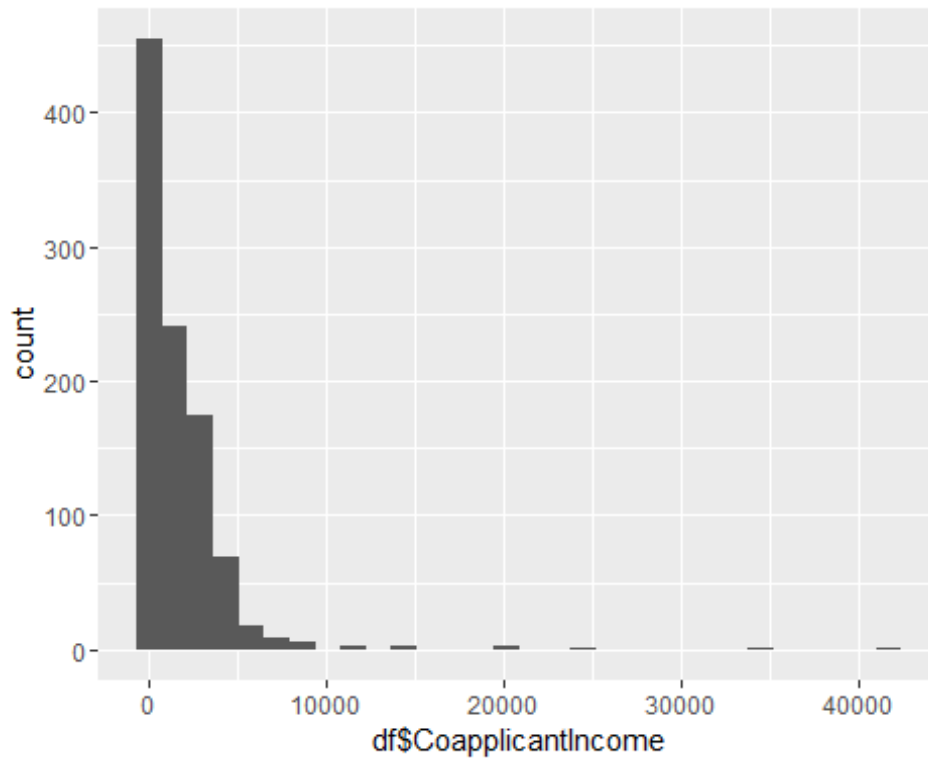
```
ggplot(data=df, aes(df$ApplicantIncome)) + geom_histogram()
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```
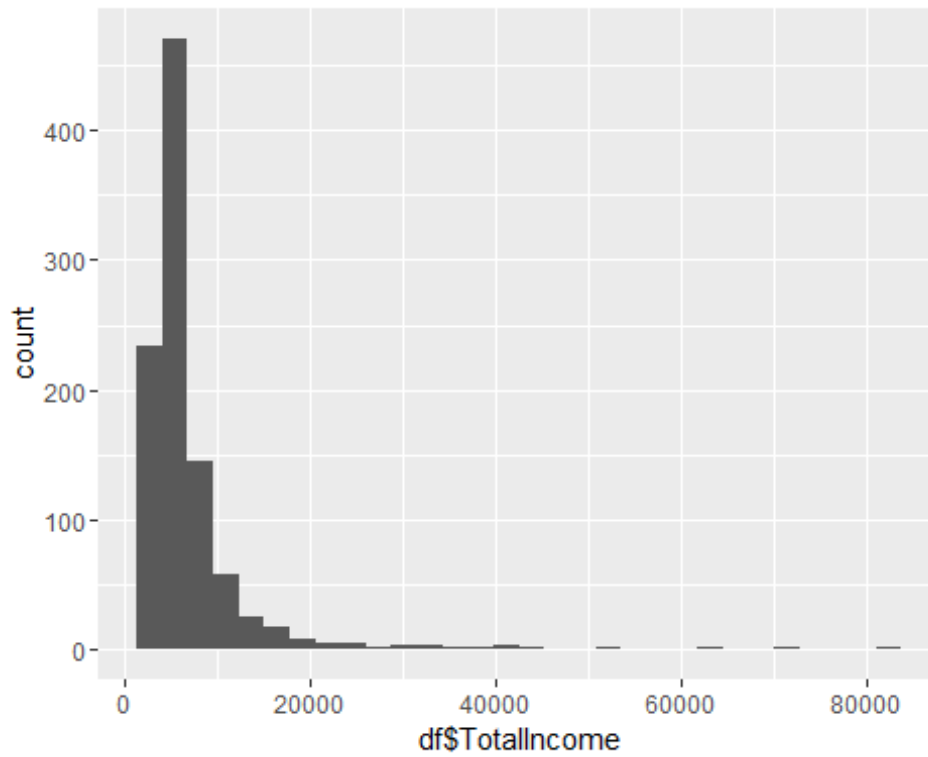
```
ggplot(data=df, aes(df$CoapplicantIncome)) + geom_histogram()
```
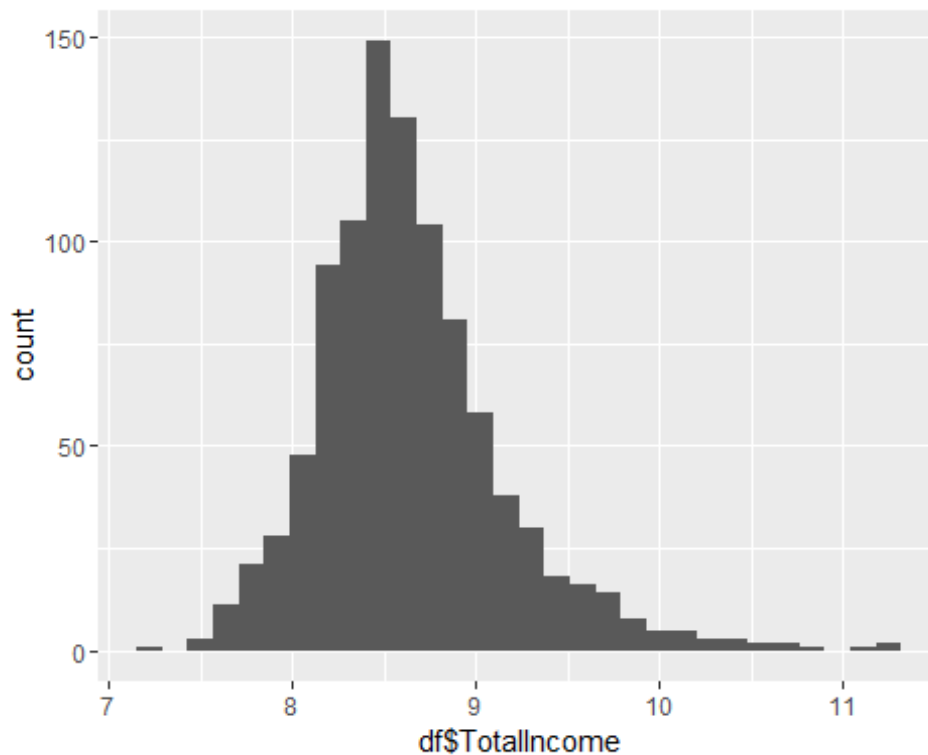## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.


```
ggplot(data=df, aes(df$TotalIncome)) + geom_histogram()
```
`stat_bin()` using `bins = 30`. Pick better value with `binwidth`.

```
df$TotalIncome=log(df$TotalIncome) #Transforming only the total income,
Keeping individual incomes intact#
ggplot(data=df, aes(df$TotalIncome)) + geom_histogram()

## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```

```
#dropping variables which are not required#
#Loan amount term#
df <- select(df,-c(Loan_Amount_Term))
names(df)

##  [1] "Loan_ID"                    "ApplicantIncome"
##  [3] "CoapplicantIncome"          "LoanAmount"
##  [5] "Loan_Status"                "Tag"
##  [7] "Gender"                     "Married"
##  [9] "Dependents0"                "Dependents1"
## [11] "Dependents2"                "Dependents3+"
## [13] "Education"                  "Self_Employed"
## [15] "Credit_History"             "Property_AreaRural"
## [17] "Property_AreaSemiurban"     "Property_AreaUrban"
## [19] "TotalIncome"                "ApplicantIncome_Zero"
## [21] "DebtRatio_Mainapplicant"    "DebtRatio_TotalIncome"
## [23] "CoappIncGApplinc"           "Loan_Amount_Term10-12 mnths"
## [25] "Loan_Amount_Term112-120 mnths" "Loan_Amount_Term1120-240 mnths"
## [27] "Loan_Amount_Term1240-360 mnths" "Loan_Amount_Term1360+ Mnths"
## [29] "Gender_Married"             "Married_Dep0"
## [31] "Married_Dep1"               "Married_Dep2"
## [33] "Married_Dep3"

str(df)

## 'data.frame':    981 obs. of  33 variables:
##  $ Loan_ID                  : chr  "LP001002" "LP001003" "LP001005"
```

```
 "LP001006" ...
 ##  $ ApplicantIncome          : int   5849 4583 3000 2583 6000 5417 2333
 3036 4006 12841 ...
 ##  $ CoapplicantIncome        : num   0 1508 0 2358 0 ...
 ##  $ LoanAmount               : num   4.96 4.85 4.19 4.79 4.95 ...
 ##  $ Loan_Status              : Factor w/ 3 levels "0","1","2": 2 1 2 2
 2 2 2 1 2 1 ...
 ##  $ Tag                      : chr   "train" "train" "train" "train"
 ...
 ##  $ Gender                   : num   1 1 1 1 1 1 1 1 1 1 ...
 ##  $ Married                  : num   0 1 1 1 0 1 1 1 1 1 ...
 ##  $ Dependents0              : int   1 0 1 1 1 0 1 0 0 0 ...
 ##  $ Dependents1              : int   0 1 0 0 0 0 0 0 0 1 ...
 ##  $ Dependents2              : int   0 0 0 0 0 1 0 0 1 0 ...
 ##  $ Dependents3+             : int   0 0 0 0 0 0 0 1 0 0 ...
 ##  $ Education                : num   1 1 1 0 1 1 0 1 1 1 ...
 ##  $ Self_Employed            : num   0 0 1 0 0 1 0 0 0 0 ...
 ##  $ Credit_History           : int   1 1 1 1 1 1 1 0 1 1 ...
 ##  $ Property_AreaRural       : int   0 1 0 0 0 0 0 0 0 0 ...
 ##  $ Property_AreaSemiurban   : int   0 0 0 0 0 0 0 1 0 1 ...
 ##  $ Property_AreaUrban       : int   1 0 1 1 1 1 1 0 1 0 ...
 ##  $ TotalIncome              : num   8.67 8.71 8.01 8.51 8.7 ...
 ##  $ ApplicantIncome_Zero     : num   0 0 0 0 0 0 0 0 0 0 ...
 ##  $ DebtRatio_Mainapplicant  : num   0.0244 0.0279 0.022 0.0465 0.0235
 ...
 ##  $ DebtRatio_TotalIncome    : num   0.0244 0.021 0.022 0.0243 0.0235
 ...
 ##  $ CoappIncGApplinc         : num   0 0 0 0 0 0 0 0 0 0 ...
 ##  $ Loan_Amount_Term10-12 mnths   : int   0 0 0 0 0 0 0 0 0 0 ...
 ##  $ Loan_Amount_Term112-120 mnths : int   0 0 0 0 0 0 0 0 0 0 ...
 ##  $ Loan_Amount_Term1120-240 mnths: int   0 0 0 0 0 0 0 0 0 0 ...
 ##  $ Loan_Amount_Term1240-360 mnths: int   1 1 1 1 1 1 1 1 1 1 ...
 ##  $ Loan_Amount_Term1360+ Mnths   : int   0 0 0 0 0 0 0 0 0 0 ...
 ##  $ Gender_Married           : num   0 1 1 1 0 1 1 1 1 1 ...
 ##  $ Married_Dep0             : num   0 0 1 1 0 0 1 0 0 0 ...
 ##  $ Married_Dep1             : num   0 1 0 0 0 0 0 0 0 1 ...
 ##  $ Married_Dep2             : num   0 0 0 0 0 1 0 0 1 0 ...
 ##  $ Married_Dep3             : num   0 0 0 0 0 0 0 1 0 0 ...
 ##  - attr(*, "dummies")=List of 1
 ##   ..$ Loan_Amount_Term1: int   25 26 27 28 29

 #####Changing the data type######
 df$Loan_Status <- as.factor(df$Loan_Status)
 df$Gender <- as.factor(df$Gender)
 df$Married <- as.factor(df$Married)
 df$Dependents0 <- as.factor(df$Dependents0)
 df$Dependents1 <- as.factor(df$Dependents1)
 df$Dependents2 <- as.factor(df$Dependents2)
 df$`Dependents3+`<- as.factor(df$`Dependents3+`)
 df$Education <- as.factor(df$Education)
```

```r
df$Self_Employed <- as.factor(df$Self_Employed)
df$Credit_History <- as.factor(df$Credit_History)
df$Property_AreaRural <- as.factor(df$Property_AreaRural)
df$Property_AreaSemiurban <- as.factor(df$Property_AreaSemiurban)
df$Property_AreaUrban <- as.factor(df$Property_AreaUrban)
df$ApplicantIncome_Zero <- as.factor(df$ApplicantIncome_Zero)
df$CoappIncGApplinc <- as.factor(df$CoappIncGApplinc)
df$`Loan_Amount_Term10-12 mnths`<- as.factor(df$`Loan_Amount_Term10-12
mnths`)
df$`Loan_Amount_Term1360+ Mnths`<- as.factor(df$`Loan_Amount_Term1360+
Mnths`)
df$`Loan_Amount_Term112-120 mnths`<- as.factor(df$`Loan_Amount_Term112-120
mnths`)
df$`Loan_Amount_Term1120-240 mnths`<- as.factor(df$`Loan_Amount_Term1120-240
mnths`)
df$`Loan_Amount_Term1240-360 mnths`<- as.factor(df$`Loan_Amount_Term1240-360
mnths`)
df$Gender_Married <- as.factor(df$Gender_Married)
df$Married_Dep0 <- as.factor(df$Married_Dep0)
df$Married_Dep1 <- as.factor(df$Married_Dep1)
df$Married_Dep2 <- as.factor(df$Married_Dep2)
df$Married_Dep3 <- as.factor(df$Married_Dep3)
str(df)

## 'data.frame':    981 obs. of  33 variables:
##  $ Loan_ID                  : chr  "LP001002" "LP001003" "LP001005"
"LP001006" ...
##  $ ApplicantIncome          : int  5849 4583 3000 2583 6000 5417 2333
3036 4006 12841 ...
##  $ CoapplicantIncome        : num  0 1508 0 2358 0 ...
##  $ LoanAmount               : num  4.96 4.85 4.19 4.79 4.95 ...
##  $ Loan_Status              : Factor w/ 3 levels "0","1","2": 2 1 2 2
2 2 2 1 2 1 ...
##  $ Tag                      : chr  "train" "train" "train" "train"
...
##  $ Gender                   : Factor w/ 2 levels "0","1": 2 2 2 2 2 2
2 2 2 2 ...
##  $ Married                  : Factor w/ 2 levels "0","1": 1 2 2 2 1 2
2 2 2 2 ...
##  $ Dependents0              : Factor w/ 2 levels "0","1": 2 1 2 2 2 1
2 1 1 1 ...
##  $ Dependents1              : Factor w/ 2 levels "0","1": 1 2 1 1 1 1
1 1 1 2 ...
##  $ Dependents2              : Factor w/ 2 levels "0","1": 1 1 1 1 1 2
1 1 2 1 ...
##  $ Dependents3+             : Factor w/ 2 levels "0","1": 1 1 1 1 1 1
1 2 1 1 ...
##  $ Education                : Factor w/ 2 levels "0","1": 2 2 2 1 2 2
1 2 2 2 ...
##  $ Self_Employed            : Factor w/ 2 levels "0","1": 1 1 2 1 1 2
```

```
1 1 1 1 ...
##  $ Credit_History            : Factor w/ 2 levels "0","1": 2 2 2 2 2 2
2 1 2 2 ...
##  $ Property_AreaRural        : Factor w/ 2 levels "0","1": 1 2 1 1 1 1
1 1 1 1 ...
##  $ Property_AreaSemiurban    : Factor w/ 2 levels "0","1": 1 1 1 1 1 1
1 2 1 2 ...
##  $ Property_AreaUrban        : Factor w/ 2 levels "0","1": 2 1 2 2 2 2
2 1 2 1 ...
##  $ TotalIncome               : num  8.67 8.71 8.01 8.51 8.7 ...
##  $ ApplicantIncome_Zero      : Factor w/ 2 levels "0","1": 1 1 1 1 1 1
1 1 1 1 ...
##  $ DebtRatio_Mainapplicant   : num  0.0244 0.0279 0.022 0.0465 0.0235
...
##  $ DebtRatio_TotalIncome     : num  0.0244 0.021 0.022 0.0243 0.0235
...
##  $ CoappIncGApplinc          : Factor w/ 2 levels "0","1": 1 1 1 1 1 1
1 1 1 1 ...
##  $ Loan_Amount_Term10-12 mnths  : Factor w/ 2 levels "0","1": 1 1 1 1 1 1 1
1 1 1 1 ...
##  $ Loan_Amount_Term112-120 mnths : Factor w/ 2 levels "0","1": 1 1 1 1 1 1
1 1 1 1 ...
##  $ Loan_Amount_Term1120-240 mnths: Factor w/ 2 levels "0","1": 1 1 1 1 1 1
1 1 1 1 ...
##  $ Loan_Amount_Term1240-360 mnths: Factor w/ 2 levels "0","1": 2 2 2 2 2 2
2 2 2 2 ...
##  $ Loan_Amount_Term1360+ Mnths  : Factor w/ 2 levels "0","1": 1 1 1 1 1 1 1
1 1 1 1 ...
##  $ Gender_Married            : Factor w/ 2 levels "0","1": 1 2 2 2 1 2
2 2 2 2 ...
##  $ Married_Dep0              : Factor w/ 2 levels "0","1": 1 1 2 2 1 1
2 1 1 1 ...
##  $ Married_Dep1              : Factor w/ 2 levels "0","1": 1 2 1 1 1 1
1 1 1 2 ...
##  $ Married_Dep2              : Factor w/ 2 levels "0","1": 1 1 1 1 1 2
1 1 2 1 ...
##  $ Married_Dep3              : Factor w/ 2 levels "0","1": 1 1 1 1 1 1
1 2 1 1 ...
##  - attr(*, "dummies")=List of 1
##   ..$ Loan_Amount_Term1: int  25 26 27 28 29

#Splitting Train and test data-set#
Train <- df[df$Tag=="train",]
Test  <- df[df$Tag=="test",]
Train$Tag <- NULL
Test$Tag  <- NULL
Test$Loan_Status  <- NULL
Train$Loan_Status <- factor(Train$Loan_Status) ## This is done to remove
original factor levels which are retained even after manipulation##
```

```r
write.csv(Train,"TrainD.csv",row.names=FALSE)
write.csv(Test,"TestD.csv",row.names=FALSE)
```