

# MultipleRegression\_CustomerChurn.R

2020-04-02

```
library(ggplot2)
## Warning: package 'ggplot2' was built under R version 3.6.3
library(dplyr)
## Warning: package 'dplyr' was built under R version 3.6.3
##
## Attaching package: 'dplyr'
## The following objects are masked from 'package:stats':
##
##   filter, lag
## The following objects are masked from 'package:base':
##
##   intersect, setdiff, setequal, union
library(stringr)
library(data.table)
## Warning: package 'data.table' was built under R version 3.6.2
##
## Attaching package: 'data.table'
## The following objects are masked from 'package:dplyr':
##
##   between, first, last
library(grid)
library(gridExtra)
## Warning: package 'gridExtra' was built under R version 3.6.2
##
## Attaching package: 'gridExtra'
## The following object is masked from 'package:dplyr':
##
##   combine
library(corrplot)
## Warning: package 'corrplot' was built under R version 3.6.2
```

```
## corrplot 0.84 loaded

library(scales)
library(qqplotr)

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

##
## Attaching package: 'qqplotr'

## The following objects are masked from 'package:ggplot2':
##
##   stat_qq_line, StatQqLine

library(MASS)

##
## Attaching package: 'MASS'

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

library(DMwR)

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

## Loading required package: lattice

## Warning: package 'lattice' was built under R version 3.6.2

## Registered S3 method overwritten by 'xts':
##   method      from
##   as.zoo.xts zoo

## Registered S3 method overwritten by 'quantmod':
##   method      from
##   as.zoo.data.frame zoo

library(car)

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

## Loading required package: carData

##
## Attaching package: 'car'

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

library(e1071)
```

```

## Warning: package 'e1071' was built under R version 3.6.2
library(caret)
## Warning: package 'caret' was built under R version 3.6.3
library(caTools)
## Warning: package 'caTools' was built under R version 3.6.3
library(pROC)
## Warning: package 'pROC' was built under R version 3.6.3
## Type 'citation("pROC")' for a citation.
##
## Attaching package: 'pROC'
##
## The following objects are masked from 'package:stats':
##
##     cov, smooth, var
library(tidyverse)
## Warning: package 'tidyverse' was built under R version 3.6.3
## -- Attaching packages -----
## ----- tidyverse 1.3.0 -----
## v tibble 2.1.3      v purrr 0.3.3
## v tidyr 1.0.2      v forcats 0.4.0
## v readr 1.3.1
## Warning: package 'tidyr' was built under R version 3.6.2
## Warning: package 'readr' was built under R version 3.6.3
## Warning: package 'purrr' was built under R version 3.6.2
## Warning: package 'forcats' was built under R version 3.6.2
## -- Conflicts -----
## ----- tidyverse_conflicts() -----
## x data.table::between() masks dplyr::between()
## x readr::col_factor() masks scales::col_factor()
## x gridExtra::combine() masks dplyr::combine()
## x purrr::discard() masks scales::discard()
## x dplyr::filter() masks stats::filter()
## x data.table::first() masks dplyr::first()
## x dplyr::lag() masks stats::lag()
## x data.table::last() masks dplyr::last()
## x purrr::lift() masks caret::lift()
## x car::recode() masks dplyr::recode()

```

```

## x MASS::select()          masks dplyr::select()
## x purrr::some()           masks car::some()
## x qqplotr::stat_qq_line() masks ggplot2::stat_qq_line()
## x purrr::transpose()      masks data.table::transpose()

library(MVA)

## Warning: package 'MVA' was built under R version 3.6.2
## Loading required package: HSAUR2
## Warning: package 'HSAUR2' was built under R version 3.6.2
## Loading required package: tools

library(GGally)

## Warning: package 'GGally' was built under R version 3.6.3
## Registered S3 method overwritten by 'GGally':
##   method from
##   +.gg      ggplot2

##
## Attaching package: 'GGally'

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

library(gvlma)

##Importing Dataset and doing preliminary analysis

#Importing CSV file from drive on my local computer and viewing it

custc <- read.csv("C:/Users/admin/Desktop/MVA/PROJECT/TelEco_Customer_Churn.csv")
custc <- as.data.frame(custc)
View(custc)

#Checking the Dimension of the dataset

dim(custc)

## [1] 7043    21

#Viewing the first 4 rows of the dataset to get the overview of the dataset

head(custc,4)

##   customerID gender SeniorCitizen Partner Dependents tenure PhoneService
## 1 7590-VHVEG Female              0     Yes          No         1         No

```

```

## 2 5575-GNVDE    Male           0      No      No      34      Yes
## 3 3668-QPYBK    Male           0      No      No       2      Yes
## 4 7795-CFOCW    Male           0      No      No     45      No
##      MultipleLines InternetService OnlineSecurity OnlineBackup DeviceProtection
## 1 No phone service          DSL              No              Yes
## 2              No          DSL              Yes              No
## 3              No          DSL              Yes              Yes
## 4 No phone service          DSL              Yes              No
##      TechSupport StreamingTV StreamingMovies      Contract PaperlessBilling
## 1      No              No              No Month-to-month      Yes
## 2      No              No              No      One year      No
## 3      No              No              No Month-to-month      Yes
## 4      Yes              No              No      One year      No
##      PaymentMethod MonthlyCharges TotalCharges Churn
## 1      Electronic check      29.85      29.85      No
## 2      Mailed check      56.95      1889.50      No
## 3      Mailed check      53.85      108.15      Yes
## 4 Bank transfer (automatic)      42.30      1840.75      No

```

*#Gaining more insight about the kind of data stored in each column*

`summary(custc)`

```

##      customerID      gender      SeniorCitizen      Partner      Dependents
## 0002-ORFBO: 1 Female:3488 Min. :0.0000 No :3641 No :4933
## 0003-MKNFE: 1 Male :3555 1st Qu.:0.0000 Yes:3402 Yes:2110
## 0004-TLHLJ: 1 Median :0.0000
## 0011-IGKFF: 1 Mean :0.1621
## 0013-EXCHZ: 1 3rd Qu.:0.0000
## 0013-MHZWF: 1 Max. :1.0000
## (Other) :7037
##      tenure      PhoneService      MultipleLines      InternetService
## Min. : 0.00 No : 682 No :3390 DSL :2421
## 1st Qu.: 9.00 Yes:6361 No phone service: 682 Fiber optic:3096
## Median :29.00 Yes :2971 No :1526
## Mean :32.37
## 3rd Qu.:55.00
## Max. :72.00
##
##      OnlineSecurity      OnlineBackup
## No :3498 No :3088
## No internet service:1526 No internet service:1526
## Yes :2019 Yes :2429
##
##

```

```
##
##
##          DeviceProtection          TechSupport
## No          :3095      No          :3473
## No internet service:1526      No internet service:1526
## Yes         :2422      Yes         :2044
##
##
##
##          StreamingTV          StreamingMovies          Contract
## No          :2810      No          :2785      Month-to-month:3875
## No internet service:1526      No internet service:1526      One year      :1473
## Yes         :2707      Yes         :2732      Two year      :1695
##
##
##
##          PaperlessBilling          PaymentMethod          MonthlyCharges
## No :2872      Bank transfer (automatic):1544      Min.      : 18.25
## Yes:4171      Credit card (automatic) :1522      1st Qu.: 35.50
##          Electronic check          :2365      Median   : 70.35
##          Mailed check              :1612      Mean     : 64.76
##          :                          3rd Qu.: 89.85
##          :                          Max.     :118.75
##
##          TotalCharges          Churn
## Min.      : 18.8      No :5174
## 1st Qu.: 401.4      Yes:1869
## Median :1397.5
## Mean     :2283.3
## 3rd Qu.:3794.7
## Max.     :8684.8
## NA's      :11
```

`glimpse(custc)`

```
## Observations: 7,043
## Variables: 21
## $ customerID      <fct> 7590-VHVEG, 5575-GNVDE, 3668-QPYBK, 7795-CFOCW, 9
2...
## $ gender          <fct> Female, Male, Male, Male, Female, Female, Male, F
e...
## $ SeniorCitizen   <int> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
,...
## $ Partner         <fct> Yes, No, No, No, No, No, No, No, Yes, No, Yes, No
,...
## $ Dependents      <fct> No, No, No, No, No, No, Yes, No, No, Yes, Yes, No
,...
## $ tenure          <int> 1, 34, 2, 45, 2, 8, 22, 10, 28, 62, 13, 16, 58, 4
```

```

9...
## $ PhoneService      <fct> No, Yes, Yes, No, Yes, Yes, Yes, No, Yes, Yes, Ye
S...
## $ MultipleLines     <fct> No phone service, No, No, No phone service, No, Y
e...
## $ InternetService   <fct> DSL, DSL, DSL, DSL, Fiber optic, Fiber optic, Fib
e...
## $ OnlineSecurity    <fct> No, Yes, Yes, Yes, No, No, No, Yes, No, Yes, Yes,
...
## $ OnlineBackup      <fct> Yes, No, Yes, No, No, No, Yes, No, No, Yes, No, N
O...
## $ DeviceProtection  <fct> No, Yes, No, Yes, No, Yes, No, No, Yes, No, No, N
O...
## $ TechSupport       <fct> No, No, No, Yes, No, No, No, No, Yes, No, No, No
i...
## $ StreamingTV       <fct> No, No, No, No, No, Yes, Yes, No, Yes, No, No, No
...
## $ StreamingMovies   <fct> No, No, No, No, No, Yes, No, No, Yes, No, No, No
i...
## $ Contract          <fct> Month-to-month, One year, Month-to-month, One yea
r...
## $ PaperlessBilling  <fct> Yes, No, Yes, No, Yes, Yes, Yes, No, Yes, No, Yes
,...
## $ PaymentMethod     <fct> Electronic check, Mailed check, Mailed check, Ban
k...
## $ MonthlyCharges    <dbl> 29.85, 56.95, 53.85, 42.30, 70.70, 99.65, 89.10,
2...
## $ TotalCharges      <dbl> 29.85, 1889.50, 108.15, 1840.75, 151.65, 820.50,
1...
## $ Churn              <fct> No, No, Yes, No, Yes, Yes, No, No, Yes, No, No, N
O...

```

*#The above results give us an insight that TotalCharges and MonthlyCharges are numerical values*

*#SeniorCitizen and tenure are stored as numerical which need to be converted to categorical variables*

*## Performing Data Cleaning and Formatting*

*#Converting SeniorCitizen numerical variable into Categorical Variable*

```

custc$SeniorCitizen<-factor(custc$SeniorCitizen,levels = c(0,1),labels = c('
no','yes'))

```

*#Converting tenure values into ranges of 12 months*

```

custc <- mutate(custc,tenure_Range = tenure)
cut(custc$tenure_Range,6,labels = c('0-1 Years','1-2 Years','2-3 Years','4-5
Years','5-6 Years','6-7 Years'))

```

## [1] 0-1 Years 2-3 Years 0-1 Years 4-5 Years 0-1 Years 0-1 Years 1-2 Yea  
rs  
## [8] 0-1 Years 2-3 Years 6-7 Years 1-2 Years 1-2 Years 5-6 Years 5-6 Yea  
rs  
## [15] 2-3 Years 6-7 Years 5-6 Years 6-7 Years 0-1 Years 1-2 Years 0-1 Yea  
rs  
## [22] 0-1 Years 0-1 Years 5-6 Years 5-6 Years 2-3 Years 4-5 Years 0-1 Yea  
rs  
## [29] 6-7 Years 1-2 Years 6-7 Years 0-1 Years 2-3 Years 0-1 Years 0-1 Yea  
rs  
## [36] 6-7 Years 0-1 Years 4-5 Years 2-3 Years 0-1 Years 0-1 Years 6-7 Yea  
rs  
## [43] 1-2 Years 6-7 Years 1-2 Years 5-6 Years 0-1 Years 0-1 Years 5-6 Yea  
rs  
## [50] 6-7 Years 4-5 Years 1-2 Years 2-3 Years 0-1 Years 5-6 Years 1-2 Yea  
rs  
## [57] 6-7 Years 6-7 Years 2-3 Years 6-7 Years 4-5 Years 5-6 Years 6-7 Yea  
rs  
## [64] 1-2 Years 0-1 Years 0-1 Years 4-5 Years 2-3 Years 5-6 Years 0-1 Yea  
rs  
## [71] 0-1 Years 5-6 Years 6-7 Years 6-7 Years 0-1 Years 5-6 Years 4-5 Yea  
rs  
## [78] 0-1 Years 2-3 Years 4-5 Years 0-1 Years 0-1 Years 0-1 Years 4-5 Yea  
rs  
## [85] 5-6 Years 0-1 Years 2-3 Years 4-5 Years 4-5 Years 2-3 Years 2-3 Yea  
rs  
## [92] 0-1 Years 6-7 Years 6-7 Years 6-7 Years 0-1 Years 6-7 Years 0-1 Yea  
rs  
## [99] 5-6 Years 2-3 Years 0-1 Years 0-1 Years 4-5 Years 6-7 Years 6-7 Yea  
rs  
## [106] 0-1 Years 6-7 Years 2-3 Years 4-5 Years 6-7 Years 5-6 Years 5-6 Yea  
rs  
## [113] 4-5 Years 4-5 Years 6-7 Years 0-1 Years 2-3 Years 0-1 Years 4-5 Yea  
rs  
## [120] 2-3 Years 5-6 Years 0-1 Years 0-1 Years 0-1 Years 0-1 Years 2-3 Yea  
rs  
## [127] 2-3 Years 6-7 Years 0-1 Years 6-7 Years 1-2 Years 2-3 Years 6-7 Yea  
rs  
## [134] 0-1 Years 0-1 Years 4-5 Years 1-2 Years 6-7 Years 5-6 Years 0-1 Yea  
rs  
## [141] 6-7 Years 0-1 Years 6-7 Years 6-7 Years 6-7 Years 6-7 Years 0-1 Yea  
rs  
## [148] 0-1 Years 2-3 Years 1-2 Years 0-1 Years 0-1 Years 6-7 Years 6-7 Yea  
rs  
## [155] 0-1 Years 1-2 Years 1-2 Years 1-2 Years 1-2 Years 0-1 Years 1-2 Yea  
rs  
## [162] 1-2 Years 0-1 Years 5-6 Years 0-1 Years 6-7 Years 0-1 Years 6-7 Yea  
rsYears  
## [6994] 5-6 Years 4-5 Years 5-6 Years 4-5 Years 2-3 Years 1-2 Years 0-1 Yea  
rs



```

## [7001] 6-7 Years 0-1 Years 6-7 Years 2-3 Years 4-5 Years 1-2 Years 4-5 Years
## [7008] 6-7 Years 0-1 Years 1-2 Years 0-1 Years 0-1 Years 6-7 Years 4-5 Years
## [7015] 4-5 Years 2-3 Years 0-1 Years 5-6 Years 0-1 Years 4-5 Years 0-1 Years
## [7022] 0-1 Years 6-7 Years 6-7 Years 4-5 Years 1-2 Years 0-1 Years 1-2 Years
## [7029] 6-7 Years 0-1 Years 0-1 Years 5-6 Years 0-1 Years 4-5 Years 6-7 Years
## [7036] 1-2 Years 0-1 Years 6-7 Years 1-2 Years 6-7 Years 0-1 Years 0-1 Years
## [7043] 6-7 Years
## Levels: 0-1 Years 1-2 Years 2-3 Years 4-5 Years 5-6 Years 6-7 Years

custc$tenure_Range <- cut(custc$tenure_Range,6,labels = c('0-1 Years','1-2 Years',
'2-3 Years','4-5 Years','5-6 Years','6-7 Years'))

#Checking if there are any NULL values in any of the columns
table(is.na(custc))

##
## FALSE TRUE
## 154935 11

str_detect(custc,'NA')

## Warning in stri_detect_regex(string, pattern, negate = negate, opts_regex =
## opts(pattern)): argument is not an atomic vector; coercing

## [1] FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE
## [13] FALSE FALSE FALSE FALSE FALSE FALSE FALSE TRUE FALSE FALSE

setDT(custc)
custc[is.na(TotalCharges),NROW(TotalCharges)]

## [1] 11

#There are 11 rows out of 7043 rows that have null values.Hence removing these rows since they are only 0.15% of total so we can afford to drop them

custc <- custc[complete.cases(custc), ]
dim(custc)

## [1] 7032 22

#Replacing 'No Internet Service' values in OnlineSecurity,OnlineBackup Device Protection,TechSupport,StreamingTV and StreamingMovies columns with 'No'

custc$OnlineSecurity[custc$OnlineSecurity=='No internet service'] <- 'No'

```

```

custc$OnlineBackup[custc$OnlineBackup=='No internet service'] <- 'No'
custc$DeviceProtection[custc$DeviceProtection=='No internet service'] <- 'No'
custc$TechSupport[custc$TechSupport=='No internet service'] <- 'No'
custc$StreamingTV[custc$StreamingTV=='No internet service'] <- 'No'
custc$StreamingMovies[custc$StreamingMovies=='No internet service'] <- 'No'

```

*#Deleting the unused levels from the factor variables*

```

custc$OnlineSecurity <- factor(custc$OnlineSecurity)
custc$OnlineBackup <- factor(custc$OnlineBackup)
custc$DeviceProtection <- factor(custc$DeviceProtection)
custc$TechSupport <- factor(custc$TechSupport)
custc$StreamingTV <- factor(custc$StreamingTV)

```

*#Converting Categorical Columns into numerical values*

```

custc$Partner<-ifelse(custc$Partner=='Yes', 1,2)
custc$Dependents<-ifelse(custc$Dependents=='Yes', 1,2)
custc$PhoneService<-ifelse(custc$PhoneService=='Yes', 1,2)
custc$OnlineBackup<-ifelse(custc$OnlineBackup=='Yes', 1,2)
custc$OnlineSecurity<-ifelse(custc$OnlineSecurity=='Yes', 1,2)
custc$DeviceProtection<-ifelse(custc$DeviceProtection=='Yes', 1,2)
custc$TechSupport<-ifelse(custc$TechSupport=='Yes', 1,2)
custc$StreamingTV<-ifelse(custc$StreamingTV=='Yes', 1,2)
custc$StreamingMovies<-ifelse(custc$StreamingMovies=='Yes', 1,2)
custc$PaperlessBilling<-ifelse(custc$PaperlessBilling=='Yes', 1,2)
custc$Churn<-ifelse(custc$Churn=='Yes', 1,2)

```

*#Converting Categorical Columns into numerical values*

```

custc$gender<-factor(custc$gender,levels = c('Female','Male'),labels = c(1,2)
)
custc$MultipleLines<-factor(custc$MultipleLines,levels = c('No','Yes','No pho
ne service'),labels = c(1,2,3))
custc$InternetService<-factor(custc$InternetService,levels = c('No','Fiber op
tic','DSL'),labels = c(1,2,3))
custc$Contract<-factor(custc$Contract,levels = c('Month-to-month','One year',
'Two year'),labels = c(1,2,3))
custc$PaymentMethod<-factor(custc$PaymentMethod,levels = c('Bank transfer (au
tomatic)',
'Credit
card (automatic)',
'Electronic check',
'Mailed
check'),labels = c(1,2,3,4))

```

*#Checking the dimension of the dataset again after performing above changes*

```

dim(custc)

```

```
## [1] 7032    22

str(custc)

## Classes 'data.table' and 'data.frame':  7032 obs. of  22 variables:
## $ customerID      : Factor w/ 7043 levels "0002-ORFBO","0003-MKNFE",...: 5
376 3963 2565 5536 6512 6552 1003 4771 5605 4535 ...
## $ gender          : Factor w/ 2 levels "1","2": 1 2 2 2 1 1 2 1 1 2 ...
## $ SeniorCitizen   : Factor w/ 2 levels "no","yes": 1 1 1 1 1 1 1 1 1 1 ..
.
## $ Partner         : num  1 2 2 2 2 2 2 2 1 2 ...
## $ Dependents      : num  2 2 2 2 2 2 1 2 2 1 ...
## $ tenure          : int  1 34 2 45 2 8 22 10 28 62 ...
## $ PhoneService    : num  2 1 1 2 1 1 1 2 1 1 ...
## $ MultipleLines   : Factor w/ 3 levels "1","2","3": 3 1 1 3 1 2 2 3 2 1 .
..
## $ InternetService : Factor w/ 3 levels "1","2","3": 3 3 3 3 2 2 2 3 2 3 .
..
## $ OnlineSecurity  : num  2 1 1 1 2 2 2 1 2 1 ...
## $ OnlineBackup    : num  1 2 1 2 2 2 1 2 2 1 ...
## $ DeviceProtection: num  2 1 2 1 2 1 2 2 1 2 ...
## $ TechSupport     : num  2 2 2 1 2 2 2 2 1 2 ...
## $ StreamingTV     : num  2 2 2 2 2 1 1 2 1 2 ...
## $ StreamingMovies : num  2 2 2 2 2 1 2 2 1 2 ...
## $ Contract        : Factor w/ 3 levels "1","2","3": 1 2 1 2 1 1 1 1 1 2 .
..
## $ PaperlessBilling: num  1 2 1 2 1 1 1 2 1 2 ...
## $ PaymentMethod   : Factor w/ 4 levels "1","2","3","4": 3 4 4 1 3 3 2 4 3
1 ...
## $ MonthlyCharges  : num  29.9 57 53.9 42.3 70.7 ...
## $ TotalCharges    : num  29.9 1889.5 108.2 1840.8 151.7 ...
## $ Churn            : num  2 2 1 2 1 1 2 2 1 2 ...
## $ tenure_Range    : Factor w/ 6 levels "0-1 Years","1-2 Years",...: 1 3 1
4 1 1 2 1 3 6 ...
## - attr(*, ".internal.selfref")=<externalptr>

##Converting factors into numeric columns
custc$gender<-as.numeric(custc$gender)
custc$SeniorCitizen<-as.numeric(custc$SeniorCitizen)
custc$tenure<-as.numeric(custc$tenure)
custc$MultipleLines<-as.numeric(custc$MultipleLines)
custc$InternetService<-as.numeric(custc$InternetService)
custc$Contract<-as.numeric(custc$Contract)
custc$PaymentMethod<-as.numeric(custc$PaymentMethod)

custc$Churn<-as.integer(custc$Churn)

str(custc)

## Classes 'data.table' and 'data.frame':  7032 obs. of  22 variables:
## $ customerID      : Factor w/ 7043 levels "0002-ORFBO","0003-MKNFE",...: 5
```

```

376 3963 2565 5536 6512 6552 1003 4771 5605 4535 ...
## $ gender      : num  1 2 2 2 1 1 2 1 1 2 ...
## $ SeniorCitizen : num  1 1 1 1 1 1 1 1 1 1 ...
## $ Partner      : num  1 2 2 2 2 2 2 2 1 2 ...
## $ Dependents   : num  2 2 2 2 2 2 1 2 2 1 ...
## $ tenure       : num  1 34 2 45 2 8 22 10 28 62 ...
## $ PhoneService  : num  2 1 1 2 1 1 1 2 1 1 ...
## $ MultipleLines : num  3 1 1 3 1 2 2 3 2 1 ...
## $ InternetService : num  3 3 3 3 2 2 2 3 2 3 ...
## $ OnlineSecurity : num  2 1 1 1 2 2 2 1 2 1 ...
## $ OnlineBackup  : num  1 2 1 2 2 2 1 2 2 1 ...
## $ DeviceProtection: num  2 1 2 1 2 1 2 2 1 2 ...
## $ TechSupport   : num  2 2 2 1 2 2 2 2 1 2 ...
## $ StreamingTV    : num  2 2 2 2 2 1 1 2 1 2 ...
## $ StreamingMovies : num  2 2 2 2 2 1 2 2 1 2 ...
## $ Contract       : num  1 2 1 2 1 1 1 1 1 2 ...
## $ PaperlessBilling: num  1 2 1 2 1 1 1 2 1 2 ...
## $ PaymentMethod  : num  3 4 4 1 3 3 2 4 3 1 ...
## $ MonthlyCharges : num  29.9 57 53.9 42.3 70.7 ...
## $ TotalCharges   : num  29.9 1889.5 108.2 1840.8 151.7 ...
## $ Churn          : int   2 2 1 2 1 1 2 2 1 2 ...
## $ tenure_Range   : Factor w/ 6 levels "0-1 Years", "1-2 Years",...: 1 3 1
4 1 1 2 1 3 6 ...
## - attr(*, ".internal.selfref")=<externalptr>

dim(custc)

## [1] 7032  22

#MULTIPLE Regression

##Performing regression taking all independent variables

fit <- lm(Churn~gender+SeniorCitizen+Partner+Dependents+tenure+PhoneService
+MultipleLines+InternetService+OnlineBackup+OnlineSecurity
+DeviceProtection+TechSupport+StreamingTV+StreamingMovies
+Contract+PaperlessBilling+PaymentMethod+MonthlyCharges
+TotalCharges, data=custc)

summary(fit)

##
## Call:
## lm(formula = Churn ~ gender + SeniorCitizen + Partner + Dependents +
##      tenure + PhoneService + MultipleLines + InternetService +
##      OnlineBackup + OnlineSecurity + DeviceProtection + TechSupport +
##      StreamingTV + StreamingMovies + Contract + PaperlessBilling +
##      PaymentMethod + MonthlyCharges + TotalCharges, data = custc)
##
## Residuals:

```

```
##      Min      1Q   Median      3Q      Max
## -1.16590 -0.29353  0.07249  0.26751  0.80298
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    2.714e+00  9.660e-02  28.098 < 2e-16 ***
## gender          3.950e-03  8.991e-03   0.439 0.660414
## SeniorCitizen  -5.014e-02  1.306e-02  -3.840 0.000124 ***
## Partner         1.714e-03  1.086e-02   0.158 0.874621
## Dependents     -2.389e-02  1.153e-02  -2.072 0.038282 *
## tenure         1.677e-03  5.009e-04   3.348 0.000818 ***
## PhoneService   -1.394e-01  2.904e-02  -4.799 1.63e-06 ***
## MultipleLines  -2.248e-02  1.131e-02  -1.987 0.046912 *
## InternetService 9.770e-03  8.449e-03   1.156 0.247568
## OnlineBackup   -5.578e-02  1.164e-02  -4.792 1.68e-06 ***
## OnlineSecurity -9.139e-02  1.214e-02  -7.526 5.88e-14 ***
## DeviceProtection -4.199e-02  1.193e-02  -3.518 0.000437 ***
## TechSupport    -9.267e-02  1.229e-02  -7.541 5.23e-14 ***
## StreamingTV    -1.756e-02  1.286e-02  -1.366 0.172065
## StreamingMovies -1.631e-02  1.285e-02  -1.269 0.204469
## Contract       4.278e-02  8.513e-03   5.025 5.16e-07 ***
## PaperlessBilling 5.032e-02  1.002e-02   5.020 5.28e-07 ***
## PaymentMethod  -7.811e-03  4.582e-03  -1.705 0.088325 .
## MonthlyCharges -7.487e-03  3.787e-04 -19.771 < 2e-16 ***
## TotalCharges   5.178e-05  6.456e-06   8.020 1.23e-15 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.3766 on 7012 degrees of freedom
## Multiple R-squared:  0.2752, Adjusted R-squared:  0.2733
## F-statistic: 140.1 on 19 and 7012 DF,  p-value: < 2.2e-16
```

**coefficients(fit)**

```
##      (Intercept)      gender  SeniorCitizen      Partner
##      2.714155e+00    3.950385e-03    -5.014032e-02    1.714374e-03
##      Dependents      tenure    PhoneService    MultipleLines
##      -2.388902e-02    1.677144e-03    -1.393886e-01    -2.247510e-02
##      InternetService  OnlineBackup  OnlineSecurity  DeviceProtection
##      9.770498e-03    -5.578451e-02    -9.139497e-02    -4.198796e-02
##      TechSupport     StreamingTV   StreamingMovies      Contract
##      -9.267124e-02    -1.756008e-02    -1.631069e-02    4.277958e-02
##      PaperlessBilling  PaymentMethod  MonthlyCharges    TotalCharges
##      5.032174e-02    -7.810663e-03    -7.487043e-03    5.178225e-05
```

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

```
##              2.5 %      97.5 %
## (Intercept)    2.524795e+00  2.903514e+00
## gender         -1.367509e-02  2.157586e-02
## SeniorCitizen  -7.573475e-02 -2.454588e-02
```

```
## Partner          -1.958311e-02  2.301186e-02
## Dependents       -4.648785e-02 -1.290193e-03
## tenure           6.952143e-04  2.659074e-03
## PhoneService     -1.963237e-01 -8.245341e-02
## MultipleLines    -4.464321e-02 -3.069874e-04
## InternetService  -6.792601e-03  2.633360e-02
## OnlineBackup     -7.860242e-02 -3.296659e-02
## OnlineSecurity   -1.152002e-01 -6.758976e-02
## DeviceProtection -6.538174e-02 -1.859419e-02
## TechSupport      -1.167600e-01 -6.858252e-02
## StreamingTV      -4.276481e-02  7.644647e-03
## StreamingMovies  -4.150602e-02  8.884647e-03
## Contract         2.609097e-02  5.946819e-02
## PaperlessBilling 3.067289e-02  6.997059e-02
## PaymentMethod    -1.679332e-02  1.171998e-03
## MonthlyCharges   -8.229400e-03 -6.744687e-03
## TotalCharges     3.912607e-05  6.443843e-05
```

*# Predicted Values*  
fitted(fit)

```
##      1      2      3      4      5      6      7      8
## 1.578780 1.880416 1.678410 1.937790 1.401416 1.282747 1.476809 1.688546
##      9     10     11     12     13     14     15     16
## 1.483933 2.077254 1.717267 1.959292 1.716204 1.614848 1.574554 2.055288
##     17     18     19     20     21     22     23     24
## 1.980638 1.946143 1.775126 1.491103 1.463953 1.903086 1.808091 1.977252
##     25     26     27     28     29     30     31     32
## 2.043183 1.807653 1.593758 1.654338 2.093027 1.579966 1.968530 1.253056
##     33     34     35     36     37     38     39     40
## 1.965696 1.831151 1.614298 2.076464 1.426442 1.670198 1.477226 1.331630
##     41     42     43     44     45     46     47     48
## 1.766935 2.038720 1.912051 2.059164 1.664647 1.565201 1.671200 1.344092
##     49     50     51     52     53     54     55     56
## 1.930623 2.104153 1.515463 1.465457 1.676756 1.351189 2.021071 1.291050
##     57     58     59     60     61     62     63     64
## 1.781483 1.805298 1.969694 1.881547 1.541334 1.699777 2.046809 1.809192
##     65     66     67     68     69     70     71     72
## 1.333968 1.565537 1.674989 1.870027 2.064647 1.513946 1.705424 1.965679
##     73     74     75     76     77     78     79     80
## 1.873543 2.010794 1.700504 1.747586 1.846266 1.770401 1.664160 1.904618
##     81     82     83     84     85     86     87     88
## 1.372681 1.611991 1.450257 1.676852 1.990957 1.317690 1.803056 2.064079
##     89     90     91     92     93     94     95     96
6896
## 1.615232 1.643396 1.712412 1.976699 1.786401 1.782334 1.591547 1.931483
##     6897    6898    6899    6900    6901    6902    6903    6904
## 1.676798 1.649010 1.670487 1.993734 2.034559 1.334527 1.891472 1.510341
##     6905    6906    6907    6908    6909    6910    6911    6912
## 1.799177 2.058996 1.948581 1.673141 1.690827 2.005464 1.688240 1.496480
```

```
##      6913      6914      6915      6916      6917      6918      6919      6920
## 1.951954 1.409535 1.896973 1.728266 1.773577 1.903812 1.908033 1.356768
##      6921      6922      6923      6924      6925      6926      6927      6928
## 1.864444 1.583137 1.407676 1.895694 1.891586 1.407213 1.700905 2.009210
##      6929      6930      6931      6932      6933      6934      6935      6936
## 1.725865 2.114009 1.964367 1.993545 1.699389 1.770688 1.900975 1.789723
##      6937      6938      6939      6940      6941      6942      6943      6944
## 1.771510 1.769628 1.782595 1.685640 1.993233 1.585919 1.329473 1.798847
##      6945      6946      6947      6948      6949      6950      6951      6952
## 1.639235 2.050839 1.493282 1.919836 1.558075 1.519134 1.469400 1.464793
##      6953      6954      6955      6956      6957      6958      6959      6960
## 1.356058 1.780822 1.837169 1.871832 1.409782 1.430057 1.805488 1.364806
##      6961      6962      6963      6964      6965      6966      6967      6968
## 1.416140 1.702152 1.755833 1.615627 1.893232 2.014458 1.712467 2.168399
##      6969      6970      6971      6972      6973      6974      6975      6976
## 1.637069 1.534363 1.647430 2.170494 1.696819 1.736629 1.879995 1.560184
##      6977      6978      6979      6980      6981      6982      6983      6984
## 1.553173 1.706614 1.709798 1.580936 1.334455 1.856192 1.569332 1.908360
##      6985      6986      6987      6988      6989      6990      6991      6992
## 2.063141 1.886823 1.557533 1.407343 1.633443 2.030948 1.619403 1.848911
##      6993      6994      6995      6996      6997      6998      6999      7000
## 1.762797 1.565764 1.932171 1.534199 2.004911 1.311136 1.474402 1.293335
##      7001      7002      7003      7004      7005      7006      7007      7008
## 1.729937 1.999070 1.590333 1.564067 1.506970 1.665706 2.045058 1.414233
##      7009      7010      7011      7012      7013      7014      7015      7016
## 1.995160 1.824648 1.696363 1.801091 1.643126 1.667171 1.469167 1.649988
##      7017      7018      7019      7020      7021      7022      7023      7024
## 1.678968 2.103267 1.419965 1.757233 1.921761 1.289334 1.610627 1.809769
##      7025      7026      7027      7028      7029      7030      7031      7032
## 1.476730 1.666917 2.046856 1.736280 1.830835 1.673316 1.306902 1.958708
```

**residuals(fit)**

```
##      1      2      3      4      5
## 4.212205e-01 1.195841e-01 -6.784100e-01 6.221027e-02 -4.014162e-01
##      6      7      8      9     10
## -2.827473e-01 5.231914e-01 3.114542e-01 -4.839328e-01 -7.725445e-02
##     11     12     13     14     15
## 2.827325e-01 4.070819e-02 2.837956e-01 -6.148475e-01 4.254464e-01
##     16     17     18     19     20
## -5.528752e-02 1.936205e-02 5.385749e-02 -7.751256e-01 5.088968e-01
##     21     22     23     24     25
## -4.639526e-01 9.691352e-02 -8.080907e-01 2.274791e-02 -4.318281e-02
##     26     27     28     29     30
## 7030
## 3.330831e-01 -4.685621e-02 2.637199e-01 1.691649e-01 3.266835e-01
##      7031      7032
## -3.069020e-01 4.129215e-02
```



### #Anova Table

anova(fit)

## Analysis of Variance Table

##

## Response: Churn

##	Df	Sum Sq	Mean Sq	F value	Pr(>F)	
## gender	1	0.10	0.100	0.7064	0.40068	
## SeniorCitizen	1	31.09	31.092	219.2101	< 2.2e-16	***
## Partner	1	31.94	31.942	225.1981	< 2.2e-16	***
## Dependents	1	7.01	7.007	49.4036	2.280e-12	***
## tenure	1	143.41	143.413	1011.1025	< 2.2e-16	***
## PhoneService	1	0.22	0.224	1.5826	0.20843	
## MultipleLines	1	28.49	28.491	200.8684	< 2.2e-16	***
## InternetService	1	2.83	2.831	19.9589	8.037e-06	***
## OnlineBackup	1	0.09	0.092	0.6490	0.42049	
## OnlineSecurity	1	8.41	8.406	59.2631	1.569e-14	***
## DeviceProtection	1	1.29	1.286	9.0682	0.00261	**
## TechSupport	1	5.91	5.911	41.6721	1.151e-10	***
## StreamingTV	1	20.06	20.061	141.4371	< 2.2e-16	***
## StreamingMovies	1	8.13	8.128	57.3065	4.207e-14	***
## Contract	1	21.94	21.938	154.6714	< 2.2e-16	***
## PaperlessBilling	1	11.10	11.098	78.2460	< 2.2e-16	***
## PaymentMethod	1	0.00	0.001	0.0050	0.94340	
## MonthlyCharges	1	46.53	46.531	328.0532	< 2.2e-16	***
## TotalCharges	1	9.12	9.124	64.3284	1.225e-15	***
## Residuals	7012	994.57	0.142			
## ---						
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1						

vcov(fit)

##	(Intercept)	gender	SeniorCitizen	Partner
## (Intercept)	9.330979e-03	-1.043314e-04	-7.174709e-05	-1.196903e-04
## gender	-1.043314e-04	8.084175e-05	-1.918729e-07	-7.220319e-07
## SeniorCitizen	-7.174709e-05	-1.918729e-07	1.704688e-04	1.433912e-05
## Partner	-1.196903e-04	-7.220319e-07	1.433912e-05	1.180349e-04
## Dependents	-7.359280e-05	1.271971e-06	-2.827964e-05	-5.513827e-05
## tenure	-2.655198e-06	-1.438413e-08	-2.714253e-07	6.209264e-07
## PhoneService	-1.325468e-03	-1.919321e-06	-1.375776e-05	-4.739417e-06
## MultipleLines	2.621207e-04	7.127575e-07	-4.244851e-06	2.555923e-06
## InternetService	-2.141852e-04	-1.254449e-06	2.906557e-06	-5.852266e-07
## OnlineBackup	-4.321501e-04	-1.679395e-06	-1.639265e-06	3.367763e-07
## OnlineSecurity	-4.649507e-04	-2.405852e-06	-8.707809e-06	-7.710743e-07
## DeviceProtection	-4.054213e-04	1.640601e-07	-2.683899e-06	-1.943922e-06
## TechSupport	-3.973676e-04	-1.006999e-06	-1.372185e-05	2.804173e-06
## StreamingTV	-4.884500e-04	-4.046762e-07	-6.087791e-06	-1.093309e-06
## StreamingMovies	-4.996359e-04	-9.416645e-07	-2.726379e-06	-1.069560e-06
## Contract	-3.314475e-04	3.762276e-07	7.694614e-06	9.571979e-07
## PaperlessBilling	-2.410612e-04	-8.575108e-07	5.524762e-06	2.985978e-08



## PaymentMethod	-7.834087e-05	-7.445961e-07	3.226624e-07	-9.974055e-07
## MonthlyCharges	-2.315082e-05	1.284184e-08	-6.076301e-07	5.001210e-08
## TotalCharges	-5.857800e-08	-8.271498e-10	1.028860e-09	5.862567e-10
##	Dependents	tenure	PhoneService	MultipleLines
## (Intercept)	-7.359280e-05	-2.655198e-06	-1.325468e-03	2.621207e-04
## gender	1.271971e-06	-1.438413e-08	-1.919321e-06	7.127575e-07
## SeniorCitizen	-2.827964e-05	-2.714253e-07	-1.375776e-05	-4.244851e-06
## Partner	-5.513827e-05	6.209264e-07	-4.739417e-06	2.555923e-06
## Dependents	1.329003e-04	-8.259228e-08	-5.466097e-06	-8.899269e-07
## tenure	-8.259228e-08	2.509082e-07	3.599119e-07	-4.764958e-07
## PhoneService	-5.466097e-06	3.599119e-07	8.435583e-04	-2.398677e-04
## MultipleLines	-8.899269e-07	-4.764958e-07	-2.398677e-04	1.278825e-04
## InternetService	-2.600217e-07	-1.288240e-07	-7.277115e-05	3.739687e-06
## OnlineBackup	-3.649096e-06	-1.067779e-07	4.383273e-05	-8.987536e-06
## OnlineSecurity	-5.172883e-06	-2.189410e-07	3.401055e-05	-1.112849e-05
## DeviceProtection	2.046162e-07	-2.530302e-07	4.908229e-05	-9.437501e-06
## TechSupport	-2.548810e-06	-5.059799e-07	3.258670e-05	-1.156028e-05
## StreamingTV	-4.345735e-06	-2.065340e-07	7.783321e-05	-1.261980e-05
## StreamingMovies	1.805325e-07	-2.368224e-07	7.820319e-05	-1.163990e-05
## Contract	7.055507e-06	-1.650745e-06	2.682114e-05	-2.626768e-06
## PaperlessBilling	2.582901e-06	1.619332e-07	1.346655e-05	7.414882e-07
## PaymentMethod	4.599891e-07	4.332767e-07	-2.218533e-08	6.444628e-07
## MonthlyCharges	-2.334312e-07	7.015047e-08	5.462805e-06	-1.177836e-06
## TotalCharges	-1.400690e-09	-2.559805e-09	1.250002e-08	-4.421621e-09
##	InternetService	OnlineBackup	OnlineSecurity	DeviceProtection
## (Intercept)	-2.141852e-04	-4.321501e-04	-4.649507e-04	-4.054213e-04
## gender	-1.254449e-06	-1.679395e-06	-2.405852e-06	1.640601e-07
## SeniorCitizen	2.906557e-06	-1.639265e-06	-8.707809e-06	-2.683899e-06
## Partner	-5.852266e-07	3.367763e-07	-7.710743e-07	-1.943922e-06
## Dependents	-2.600217e-07	-3.649096e-06	-5.172883e-06	2.046162e-07
## tenure	-1.288240e-07	-1.067779e-07	-2.189410e-07	-2.530302e-07
## PhoneService	-7.277115e-05	4.383273e-05	3.401055e-05	4.908229e-05
## MultipleLines	3.739687e-06	-8.987536e-06	-1.112849e-05	-9.437501e-06
## InternetService	7.138995e-05	1.481684e-05	2.939667e-05	1.158418e-05
## OnlineBackup	1.481684e-05	1.354896e-04	3.871325e-06	6.968639e-06
## OnlineSecurity	2.939667e-05	3.871325e-06	1.474679e-04	5.240840e-06
## DeviceProtection	1.158418e-05	6.968639e-06	5.240840e-06	1.424146e-04

## TechSupport e-06	2.689060e-05	1.850624e-06	-6.362494e-06	-1.441401
## StreamingTV e-07	-7.690445e-07	1.331065e-05	1.859493e-05	1.917970
## StreamingMovies e-06	-8.601065e-09	1.599902e-05	1.630379e-05	-2.348457
## Contract e-05	9.941673e-06	4.457994e-06	1.460907e-05	1.356267
## PaperlessBilling e-06	2.160343e-06	1.275585e-06	1.030859e-05	6.110666
## PaymentMethod e-07	1.246129e-06	1.217583e-07	2.268381e-07	-3.925489
## MonthlyCharges e-07	-5.724919e-07	7.342228e-07	5.395447e-07	7.895166
## TotalCharges e-08	6.723676e-09	1.338913e-08	1.137596e-08	1.041821
##	TechSupport	StreamingTV	StreamingMovies	Contract
## (Intercept)	-3.973676e-04	-4.884500e-04	-4.996359e-04	-3.314475e-04
## gender	-1.006999e-06	-4.046762e-07	-9.416645e-07	3.762276e-07
## SeniorCitizen	-1.372185e-05	-6.087791e-06	-2.726379e-06	7.694614e-06
## Partner	2.804173e-06	-1.093309e-06	-1.069560e-06	9.571979e-07
## Dependents	-2.548810e-06	-4.345735e-06	1.805325e-07	7.055507e-06
## tenure	-5.059799e-07	-2.065340e-07	-2.368224e-07	-1.650745e-06
## PhoneService	3.258670e-05	7.783321e-05	7.820319e-05	2.682114e-05
## MultipleLines	-1.156028e-05	-1.261980e-05	-1.163990e-05	-2.626768e-06
## InternetService	2.689060e-05	-7.690445e-07	-8.601065e-09	9.941673e-06
## OnlineBackup	1.850624e-06	1.331065e-05	1.599902e-05	4.457994e-06
## OnlineSecurity	-6.362494e-06	1.859493e-05	1.630379e-05	1.460907e-05
## DeviceProtection	-1.441401e-06	1.917970e-07	-2.348457e-06	1.356267e-05
## TechSupport	1.510015e-04	3.442249e-06	3.950646e-06	2.371814e-05
## StreamingTV	3.442249e-06	1.653172e-04	-1.737778e-05	1.357233e-05
## StreamingMovies	3.950646e-06	-1.737778e-05	1.651940e-04	1.399133e-05
## Contract	2.371814e-05	1.357233e-05	1.399133e-05	7.247600e-05
## PaperlessBilling	4.468371e-06	-1.485915e-06	1.137417e-06	-7.238461e-06
## PaymentMethod	-2.622397e-07	1.250326e-06	7.983254e-07	7.276605e-07
## MonthlyCharges	4.171404e-07	1.694071e-06	1.646184e-06	8.133148e-07
## TotalCharges	1.071044e-08	6.810876e-09	7.393941e-09	3.944176e-09
##	PaperlessBilling	PaymentMethod	MonthlyCharges	TotalCharg es
## (Intercept)	-2.410612e-04	-7.834087e-05	-2.315082e-05	-5.857800e-08
## gender	-8.575108e-07	-7.445961e-07	1.284184e-08	-8.271498e-10
## SeniorCitizen	5.524762e-06	3.226624e-07	-6.076301e-07	1.028860e-09
## Partner	2.985978e-08	-9.974055e-07	5.001210e-08	5.862567e-10
## Dependents	2.582901e-06	4.599891e-07	-2.334312e-07	-1.400690e-09
## tenure	1.619332e-07	4.332767e-07	7.015047e-08	-2.559805e-

```

09
## PhoneService      1.346655e-05 -2.218533e-08  5.462805e-06  1.250002e-
08
## MultipleLines     7.414882e-07  6.444628e-07  -1.177836e-06 -4.421621e-
09
## InternetService   2.160343e-06  1.246129e-06  -5.724919e-07  6.723676e-
09
## OnlineBackup      1.275585e-06  1.217583e-07  7.342228e-07  1.338913e-
08
## OnlineSecurity    1.030859e-05  2.268381e-07  5.395447e-07  1.137596e-
08
## DeviceProtection  6.110666e-06  -3.925489e-07  7.895166e-07  1.041821e-
08
## TechSupport       4.468371e-06  -2.622397e-07  4.171404e-07  1.071044e-
08
## StreamingTV       -1.485915e-06  1.250326e-06  1.694071e-06  6.810876e-
09
## StreamingMovies   1.137417e-06  7.983254e-07  1.646184e-06  7.393941e-
09
## Contract          -7.238461e-06  7.276605e-07  8.133148e-07  3.944176e-
09
## PaperlessBilling  1.004681e-04  -1.007124e-06  6.816789e-07  -8.912854e-
10
## PaymentMethod     -1.007124e-06  2.099732e-05  1.594187e-07  -2.132492e-
09
## MonthlyCharges    6.816789e-07  1.594187e-07  1.434099e-07  -1.126434e-
09
## TotalCharges      -8.912854e-10  -2.132492e-09  -1.126434e-09  4.168302e-
11

```

**cov2cor(vcov(fit))**

```

##              (Intercept)      gender SeniorCitizen      Partner
## (Intercept)    1.00000000 -0.120124991 -0.056887682 -0.1140485821
## gender         -0.12012499  1.000000000 -0.001634456 -0.0073915108
## SeniorCitizen -0.05688768 -0.001634456  1.000000000  0.1010868537
## Partner        -0.11404858 -0.007391511  0.101086854  1.0000000000
## Dependents     -0.06608590  0.012271465 -0.187883457 -0.4402354054
## tenure         -0.05487517 -0.003193804 -0.041502129  0.1140978354
## PhoneService   -0.47244143 -0.007349743 -0.036280035 -0.0150197278
## MultipleLines   0.23995631  0.007010005 -0.028749773  0.0208035239
## InternetService -0.26242624 -0.016512650  0.026347409 -0.0063752938
## OnlineBackup    -0.38434222 -0.016046567 -0.010786334  0.0026630738
## OnlineSecurity  -0.39636423 -0.022034448 -0.054920899 -0.0058444292
## DeviceProtection -0.35169465  0.001529001 -0.017225288 -0.0149932688
## TechSupport     -0.33476364 -0.009114247 -0.085526315  0.0210043335
## StreamingTV     -0.39327608 -0.003500505 -0.036264217 -0.0078267000
## StreamingMovies -0.40243240 -0.008148567 -0.016246757 -0.0076595445
## Contract        -0.40304543  0.004915137  0.069225690  0.0103490223
## PaperlessBilling -0.24897151 -0.009514976  0.042215996  0.0002741999

```

## PaymentMethod	-0.17698759	-0.018072613	0.005393169	-0.0200347772
## MonthlyCharges	-0.63286796	0.003771549	-0.122893017	0.0121557057
## TotalCharges	-0.09392720	-0.014249077	0.012205460	0.0083580106
##	Dependents	tenure	PhoneService	MultipleLines
## (Intercept)	-0.066085903	-0.054875174	-0.4724414252	0.239956313
## gender	0.012271465	-0.003193804	-0.0073497432	0.007010005
## SeniorCitizen	-0.187883457	-0.041502129	-0.0362800351	-0.028749773
## Partner	-0.440235405	0.114097835	-0.0150197278	0.020803524
## Dependents	1.000000000	-0.014302736	-0.0163251398	-0.006826307
## tenure	-0.014302736	1.000000000	0.0247389472	-0.084119387
## PhoneService	-0.016325140	0.024738947	1.000000000	-0.730312367
## MultipleLines	-0.006826307	-0.084119387	-0.7303123670	1.000000000
## InternetService	-0.002669489	-0.030438324	-0.2965399227	0.039139127
## OnlineBackup	-0.027193772	-0.018313490	0.1296546345	-0.068278207
## OnlineSecurity	-0.036950553	-0.035993236	0.0964289163	-0.081036697
## DeviceProtection	0.001487305	-0.042328976	0.1416087256	-0.069931717
## TechSupport	-0.017992189	-0.082202537	0.0913045053	-0.083190171
## StreamingTV	-0.029318470	-0.032068233	0.2084243111	-0.086793655
## StreamingMovies	0.001218416	-0.036784795	0.2094931462	-0.080084142
## Contract	0.071889960	-0.387102138	0.1084732349	-0.027284690
## PaperlessBilling	0.022352739	0.032252577	0.0462577826	0.006541609
## PaymentMethod	0.008707684	0.188766964	-0.0001666964	0.012436847
## MonthlyCharges	-0.053469544	0.369814198	0.4966707501	-0.275036036
## TotalCharges	-0.018819129	-0.791534549	0.0666612625	-0.060561464
##	InternetService	OnlineBackup	OnlineSecurity	DeviceProtect
ion				
## (Intercept)	-2.624262e-01	-0.384342218	-0.396364232	-0.351694
650				
## gender	-1.651265e-02	-0.016046567	-0.022034448	0.001529
001				
## SeniorCitizen	2.634741e-02	-0.010786334	-0.054920899	-0.017225
288				
## Partner	-6.375294e-03	0.002663074	-0.005844429	-0.014993
269				
## Dependents	-2.669489e-03	-0.027193772	-0.036950553	0.001487
305				
## tenure	-3.043832e-02	-0.018313490	-0.035993236	-0.042328
976				
## PhoneService	-2.965399e-01	0.129654634	0.096428916	0.141608
726				
## MultipleLines	3.913913e-02	-0.068278207	-0.081036697	-0.069931
717				
## InternetService	1.000000e+00	0.150655219	0.286504096	0.114886
685				
## OnlineBackup	1.506552e-01	1.000000000	0.027387844	0.050166
960				
## OnlineSecurity	2.865041e-01	0.027387844	1.000000000	0.036163
867				
## DeviceProtection	1.148867e-01	0.050166960	0.036163867	1.000000
000				

## TechSupport 171	2.589950e-01	0.012938223	-0.042637133	-0.009829
## StreamingTV 987	-7.079033e-03	0.088937971	0.119093125	0.001249
## StreamingMovies 169	-7.920208e-05	0.106940746	0.104458219	-0.015311
## Contract 839	1.382114e-01	0.044987250	0.141311182	0.133496
## PaperlessBilling 452	2.550880e-02	0.010933076	0.084690841	0.051085
## PaymentMethod 515	3.218567e-02	0.002282778	0.004076479	-0.007178
## MonthlyCharges 623	-1.789210e-01	0.166565591	0.117324590	0.174700
## TotalCharges 601	1.232562e-01	0.178163964	0.145097370	0.135218
##	TechSupport	StreamingTV	StreamingMovies	Contract
## (Intercept)	-0.334763642	-0.393276081	-4.024324e-01	-0.403045428
## gender	-0.009114247	-0.003500505	-8.148567e-03	0.004915137
## SeniorCitizen	-0.085526315	-0.036264217	-1.624676e-02	0.069225690
## Partner	0.021004333	-0.007826700	-7.659544e-03	0.010349022
## Dependents	-0.017992189	-0.029318470	1.218416e-03	0.071889960
## tenure	-0.082202537	-0.032068233	-3.678479e-02	-0.387102138
## PhoneService	0.091304505	0.208424311	2.094931e-01	0.108473235
## MultipleLines	-0.083190171	-0.086793655	-8.008414e-02	-0.027284690
## InternetService	0.258995028	-0.007079033	-7.920208e-05	0.138211394
## OnlineBackup	0.012938223	0.088937971	1.069407e-01	0.044987250
## OnlineSecurity	-0.042637133	0.119093125	1.044582e-01	0.141311182
## DeviceProtection	-0.009829171	0.001249987	-1.531117e-02	0.133496839
## TechSupport	1.000000000	0.021786765	2.501384e-02	0.226721613
## StreamingTV	0.021786765	1.000000000	-1.051570e-01	0.123993281
## StreamingMovies	0.025013845	-0.105157016	1.000000e+00	0.127868842
## Contract	0.226721613	0.123993281	1.278688e-01	1.000000000
## PaperlessBilling	0.036278100	-0.011529776	8.828940e-03	-0.084827186
## PaymentMethod	-0.004657211	0.021221809	1.355504e-02	0.018653045
## MonthlyCharges	0.089640054	0.347922814	3.382141e-01	0.252273697
## TotalCharges	0.135001107	0.082047320	8.910444e-02	0.071759542
##	PaperlessBilling	PaymentMethod	MonthlyCharges	TotalCharge s
## (Intercept)	-0.2489715131	-0.1769875922	-0.632867955	-0.09392720
## gender	-0.0095149757	-0.0180726126	0.003771549	-0.01424907
## SeniorCitizen	0.0422159960	0.0053931685	-0.122893017	0.01220546
## Partner	0.0002741999	-0.0200347772	0.012155706	0.00835801
## Dependents	0.0223527390	0.0087076837	-0.053469544	-0.01881912
## tenure	0.0322525774	0.1887669642	0.369814198	-0.79153454

```

9
## PhoneService      0.0462577826 -0.0001666964    0.496670750  0.06666126
3
## MultipleLines     0.0065416094  0.0124368473  -0.275036036 -0.06056146
4
## InternetService   0.0255087997  0.0321856660  -0.178920961  0.12325616
0
## OnlineBackup      0.0109330759  0.0022827775    0.166565591  0.17816396
4
## OnlineSecurity    0.0846908407  0.0040764789    0.117324590  0.14509737
0
## DeviceProtection  0.0510854523 -0.0071785152    0.174700623  0.13521860
1
## TechSupport       0.0362780999 -0.0046572109    0.089640054  0.13500110
7
## StreamingTV       -0.0115297760  0.0212218090    0.347922814  0.08204732
0
## StreamingMovies   0.0088289399  0.0135550435    0.338214078  0.08910443
5
## Contract          -0.0848271864  0.0186530455    0.252273697  0.07175954
2
## PaperlessBilling  1.0000000000 -0.0219273902    0.179587522 -0.01377282
8
## PaymentMethod     -0.0219273902  1.0000000000    0.091868757 -0.07208185
1
## MonthlyCharges    0.1795875220  0.0918687568    1.000000000 -0.46071956
1
## TotalCharges      -0.0137728282 -0.0720818510   -0.460719561  1.00000000
0

```

```

temp <- influence.measures(fit)
temp

```

```

## Influence measures of
##   lm(formula = Churn ~ gender + SeniorCitizen + Partner + Dependents +
tenure + PhoneService + MultipleLines + InternetService +      OnlineBackup +
OnlineSecurity + DeviceProtection + TechSupport +      StreamingTV + Streamin
gMovies + Contract + PaperlessBilling +      PaymentMethod + MonthlyCharges +
TotalCharges, data = custc) :
##

```

```

##          dfb.1_  dfb.gndr  dfb.SnrC  dfb.Prtn  dfb.Dpnd  dfb.tenr  dfb.PhnS
## 1    -2.03e-03 -1.34e-02 -1.12e-02 -2.90e-02  1.88e-02 -2.65e-02  1.89e-02
## 2    -4.60e-03  3.55e-03 -8.24e-04  2.91e-03  1.89e-03  2.50e-03 -7.70e-05
## 3    -1.66e-02 -2.24e-02  6.71e-03 -5.75e-03 -1.07e-02  8.29e-03  1.46e-02
## 4    -1.74e-03  1.97e-03 -5.51e-04  1.78e-03  8.49e-04  1.71e-03  3.82e-03
## 5     1.64e-02  1.29e-02  9.08e-03 -4.11e-03 -2.83e-03  2.32e-03 -1.53e-02
## 6    -7.70e-03  8.71e-03  8.13e-03 -5.15e-03 -1.11e-03 -6.52e-03  8.23e-03
## 7     3.38e-03  1.68e-02 -7.18e-03  3.03e-02 -3.91e-02  5.68e-03 -9.05e-03
## 8    -1.16e-02 -1.04e-02 -4.01e-03  3.72e-03  4.00e-03 -6.90e-03  1.58e-02
## 9    -2.08e-02  1.50e-02  1.57e-02  2.48e-02 -1.72e-02 -8.20e-03  9.92e-03

```

## 10	1.92e-03	-2.36e-03	-3.38e-04	-5.61e-03	5.17e-03	-3.27e-03	-6.37e-04
## 11	2.67e-03	8.69e-03	-9.30e-04	-7.84e-03	-9.75e-03	-1.00e-03	-3.15e-03
## 12	-3.66e-04	1.31e-03	7.68e-05	6.56e-04	9.97e-04	-2.55e-03	1.91e-04
## 13	-1.12e-02	8.46e-03	-9.79e-03	-1.01e-02	1.06e-02	-3.09e-03	4.24e-04
## 14	-1.83e-02	-1.97e-02	2.05e-02	-2.28e-02	-6.28e-05	-5.54e-03	1.13e-02
## 15	1.80e-02	1.43e-02	-7.58e-03	9.59e-03	2.85e-03	1.63e-02	1.17e-02
## 16	-5.80e-04	1.76e-03	3.61e-04	-3.01e-04	2.10e-03	2.73e-03	-4.31e-04
## 17	-2.77e-05	-6.52e-04	-1.41e-04	5.71e-04	3.35e-04	1.49e-03	1.19e-04
## 18	-2.59e-03	1.61e-03	-3.12e-04	4.58e-03	-3.98e-03	-1.96e-03	7.92e-04
## 19	-2.14e-02	2.59e-02	-1.79e-03	2.18e-02	2.84e-02	6.94e-03	9.64e-03
## 20	6.73e-03	-1.59e-02	-1.38e-02	1.07e-02	1.97e-03	1.39e-02	1.48e-02
## 21	3.95e-03	-1.41e-02	-3.36e-02	-9.05e-03	4.53e-03	2.01e-02	-1.51e-02
## 22	2.87e-03	3.21e-03	-9.67e-04	-6.04e-03	5.22e-03	-6.10e-03	-2.72e-05
## 23	-2.44e-02	-2.49e-02	3.60e-03	-6.00e-03	-1.39e-02	3.60e-02	7.29e-03
## 24	-4.00e-04	-7.19e-04	-3.98e-04	-9.53e-04	1.10e-03	-1.60e-05	-9.46e-04
## 25	-1.31e-03	-1.36e-03	-2.29e-05	5.48e-04	1.51e-03	-1.99e-03	1.38e-04
## 26	6.80e-03	-5.78e-03	-2.71e-03	4.38e-03	2.18e-03	3.62e-03	-2.37e-03
## 27	-7.01e-03	-1.83e-02	1.50e-02	4.41e-03	2.73e-02	-5.38e-03	6.43e-03
## 28	1.66e-02	-1.97e-02	5.50e-03	2.18e-02	2.27e-02	3.88e-02	-3.23e-02
## 29	-4.12e-03	-3.08e-03	1.59e-03	2.92e-03	-4.37e-03	1.10e-03	4.64e-03
## 30	-1.08e-02	2.00e-02	3.04e-04	-3.06e-02	4.21e-02	-1.11e-02	1.16e-02
## 31	-6.85e-04	-9.73e-04	2.12e-03	-7.15e-04	7.99e-04	-1.00e-03	3.81e-04
## 32	1.54e-02	2.52e-02	4.46e-02	-4.00e-02	1.71e-02	6.42e-03	1.39e-02
## 33	1.03e-03	-1.10e-03	2.43e-04	-7.11e-04	-1.02e-03	2.40e-04	-1.62e-04
## 34	8.00e-03	5.49e-03	-8.44e-04	1.58e-03	2.77e-03	-1.06e-02	-1.51e-03
## 35	-1.23e-02	1.18e-02	3.17e-02	7.25e-03	-1.87e-03	-1.79e-02	-5.53e-03
## 36	1.93e-03	2.42e-03	4.62e-04	-3.57e-04	2.73e-03	3.19e-03	-1.48e-03
## 37	2.05e-02	-1.33e-02	9.70e-03	-4.69e-03	-3.28e-03	9.93e-04	-1.58e-02
## 38	-1.17e-02	-1.13e-02	-9.00e-03	1.03e-02	3.05e-04	9.51e-03	1.51e-02
## 39	-1.10e-02	-1.53e-02	1.55e-02	-1.40e-02	-1.11e-03	-1.17e-02	9.90e-03
## 40	-1.33e-02	9.90e-03	9.55e-03	-6.89e-03	-1.07e-03	-3.11e-03	1.01e-02
## 41	-7.72e-03	6.97e-03	1.28e-04	-6.78e-03	-6.81e-03	-7.72e-03	-1.13e-03
## 42	-1.76e-04	1.24e-03	2.19e-04	-1.05e-04	1.25e-03	-6.33e-05	1.63e-03
## 43	1.93e-03	-2.93e-03	4.42e-04	-2.26e-03	-2.47e-03	-2.85e-03	3.39e-04
## 44	-1.92e-03	1.82e-03	4.02e-04	-2.40e-03	-9.35e-04	-3.61e-04	3.01e-03
## 45	2.92e-02	-9.48e-03	-5.97e-03	-2.05e-02	1.60e-02	2.01e-03	-2.41e-02
## 46	-1.46e-02	-1.46e-02	-1.43e-02	1.46e-02	-5.10e-04	1.53e-02	-2.34e-03
## 47	-6.34e-03	9.98e-03	-3.32e-03	2.57e-03	4.90e-03	-5.64e-03	-5.29e-03
## 48	7.53e-03	1.09e-02	7.78e-03	-3.88e-03	-2.86e-03	-2.49e-03	-1.11e-02
## 49	3.61e-04	2.28e-03	-4.49e-04	2.44e-03	1.07e-03	-8.08e-04	-3.52e-03
## 50	-7.62e-04	3.41e-03	-5.44e-05	-9.02e-05	3.58e-03	-2.26e-03	4.26e-03
## 51	-7.95e-03	-1.58e-02	2.96e-02	1.95e-02	-6.77e-03	9.41e-03	-6.00e-03
## 52	-2.18e-02	1.30e-02	1.07e-02	-8.97e-03	-4.16e-03	-1.26e-02	-1.12e-02
## 53	1.99e-02	-9.66e-03	2.41e-02	-1.49e-02	8.93e-03	8.16e-04	-2.27e-02
## 54	3.02e-04	1.04e-02	-1.98e-02	1.83e-02	-8.01e-03	5.63e-03	6.28e-03
## 55	-1.23e-03	6.66e-04	-1.92e-03	-1.09e-04	1.15e-03	-5.10e-04	1.70e-04
## 56	4.11e-03	-9.30e-03	-1.82e-02	-8.74e-03	3.84e-03	-3.79e-03	6.64e-03
## 57	-1.53e-03	-7.11e-03	-4.15e-03	4.60e-04	-9.60e-03	-3.94e-03	1.12e-03
## 58	2.33e-03	5.83e-03	1.47e-02	2.11e-03	-1.20e-02	-2.95e-03	-1.30e-03

```

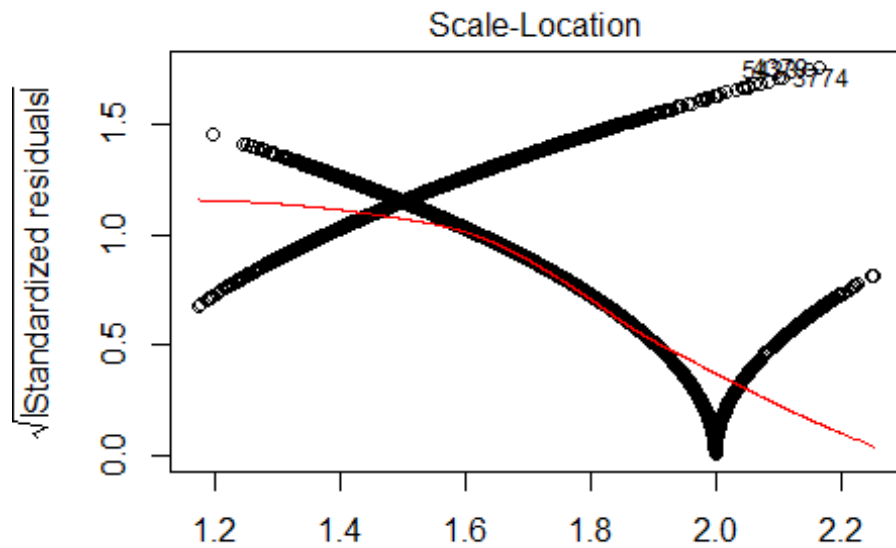
## 3958 1.006 1.23e-07 0.00297
## 3959 1.002 1.24e-04 0.00219
## 3960 1.006 2.32e-07 0.00299
## 3961 1.004 2.70e-06 0.00171
## 3962 1.006 1.16e-05 0.00303
## 3963 0.998 2.30e-04 0.00204
## 3964 1.006 4.56e-08 0.00290
## 3965 0.988 7.09e-04 0.00235 *
## 3966 1.005 2.26e-05 0.00298
## 3967 1.006 3.23e-05 0.00331
## 3968 1.005 5.99e-05 0.00352
## 3969 1.003 1.01e-04 0.00230
## 3970 0.999 3.27e-04 0.00281
## 3971 1.005 1.50e-06 0.00257
## 3972 0.997 3.98e-04 0.00257
## 3973 1.005 1.90e-07 0.00250
## 3974 1.001 1.40e-04 0.00202
## 3975 0.997 4.67e-04 0.00289
## 3976 1.007 6.00e-06 0.00392
## 3977 0.999 3.33e-04 0.00289
## 3978 1.005 7.52e-06 0.00262
## 3979 1.005 1.21e-04 0.00392
## 3980 1.007 1.17e-06 0.00385
## 3981 1.001 7.69e-05 0.00146
## 3982 1.006 2.18e-06 0.00271
## 3983 1.004 2.22e-04 0.00430
## 3984 0.996 2.64e-04 0.00179
## 3985 1.003 1.93e-04 0.00362
## 3986 1.007 3.47e-06 0.00369
## 3987 1.006 4.23e-05 0.00355
## 3988 0.998 2.94e-04 0.00235
## 3989 0.998 4.95e-04 0.00332
## 3990 1.005 1.51e-06 0.00185
## 3991 1.007 2.05e-06 0.00413
## 3992 1.006 6.04e-06 0.00317
## 3993 1.002 8.65e-05 0.00190
## 3994 0.999 2.42e-04 0.00226
## 3995 1.004 5.63e-05 0.00267
## 3996 1.005 1.94e-05 0.00259
## 3997 1.005 8.96e-08 0.00178
## 3998 1.005 2.39e-05 0.00284
## 3999 0.995 4.76e-04 0.00269
## [ reached 'max' / getOption("max.print") -- omitted 3033 rows ]

##Diagnostics Plots for visualization
plot(fit)

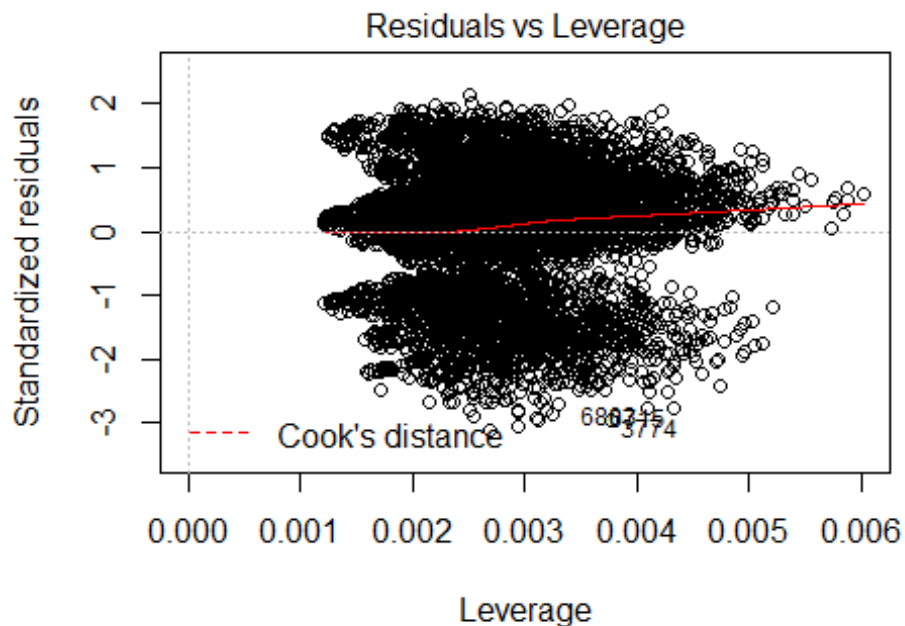
```







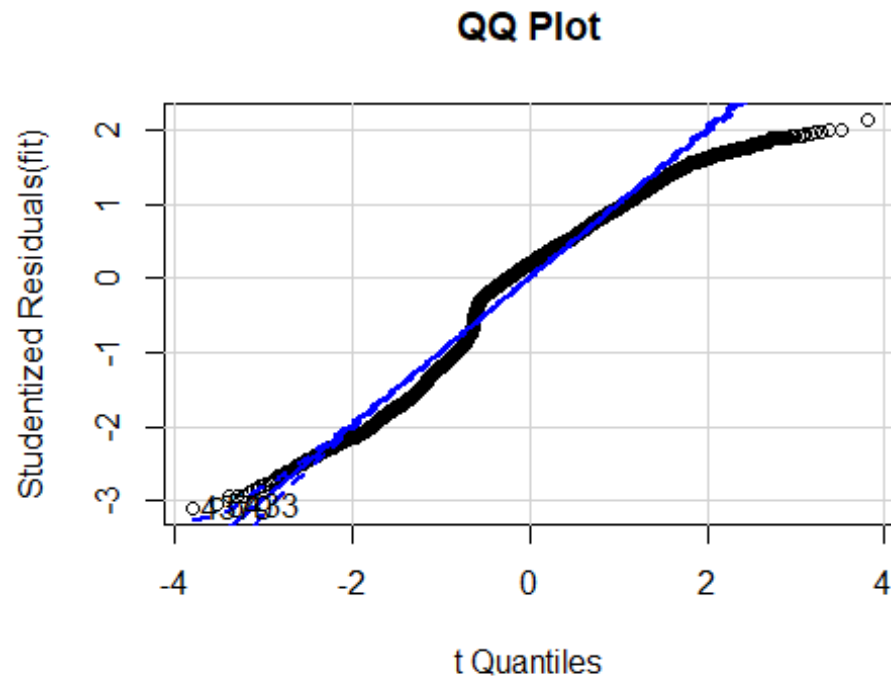
Churn ~ gender + SeniorCitizen + Partner + Dependents + tenure + Ph



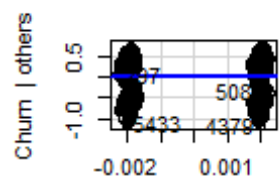
Churn ~ gender + SeniorCitizen + Partner + Dependents + tenure + Ph

*#Finding Outliers and plotting scatterplot for visual analysis*  
`outlierTest(fit)`

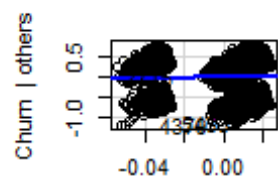
```
## No Studentized residuals with Bonferroni p < 0.05
## Largest |rstudent|:
##      rstudent unadjusted p-value Bonferroni p
## 4379 -3.101834          0.0019309          NA
qqPlot(fit, main="QQ Plot")
```



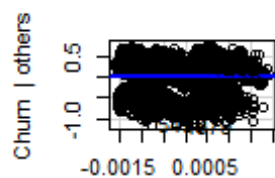
```
## [1] 4379 5433
#Plotting Leverage plots
leveragePlots(fit)
```



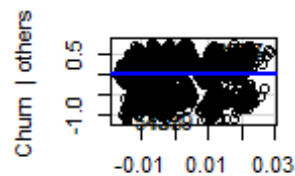
gender | others



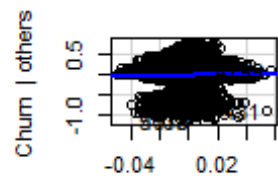
SeniorCitizen | others



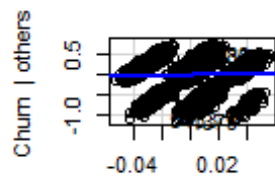
Partner | others



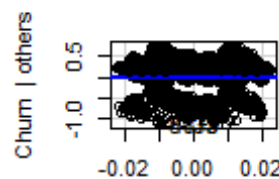
Dependents | others



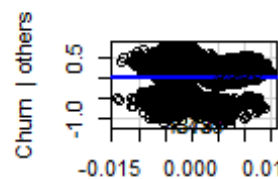
tenure | others



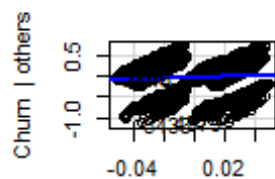
PhoneService | others



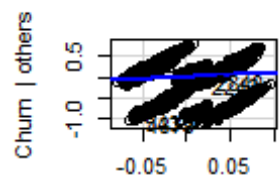
MultipleLines | others



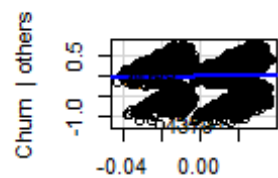
InternetService | others



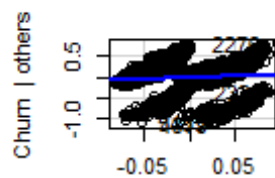
OnlineBackup | others



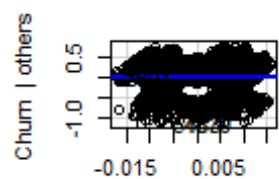
OnlineSecurity | others



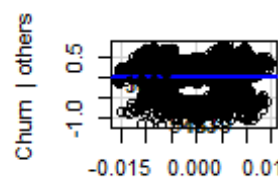
DeviceProtection | others



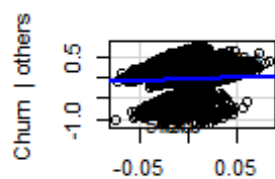
TechSupport | others



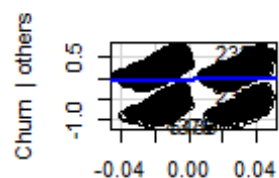
StreamingTV | others



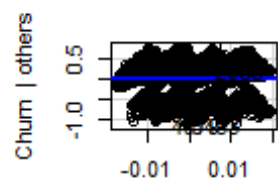
StreamingMovies | others



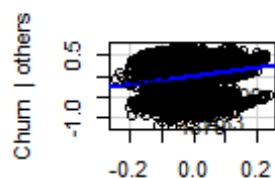
Contract | others



PaperlessBilling | others

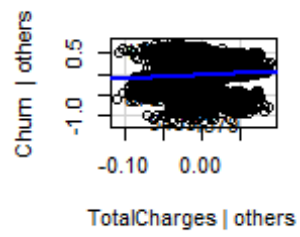


PaymentMethod | others



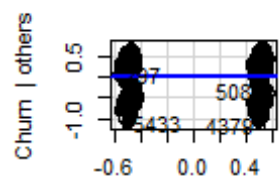
MonthlyCharges | others

## Leverage Plots

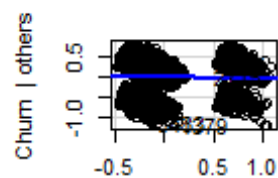


*# Plotting variable plots for Influential Observations*

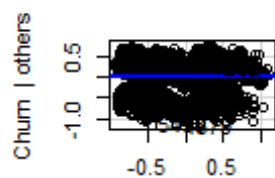
**avPlots**(fit)



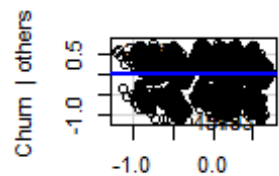
gender | others



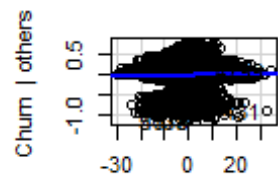
SeniorCitizen | others



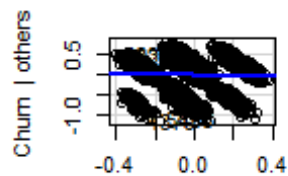
Partner | others



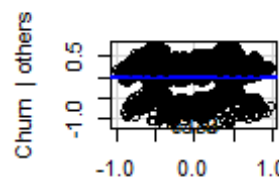
Dependents | others



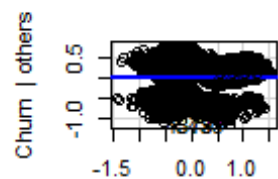
tenure | others



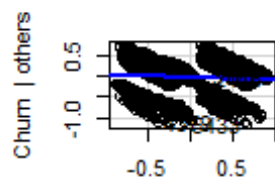
PhoneService | others



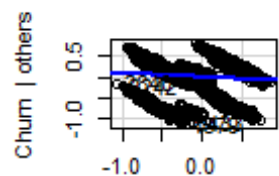
MultipleLines | others



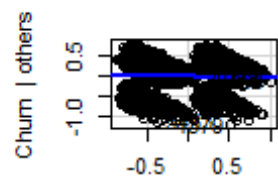
InternetService | others



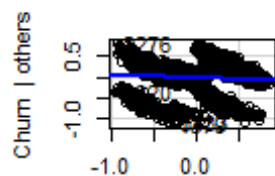
OnlineBackup | others



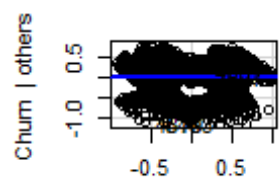
OnlineSecurity | others



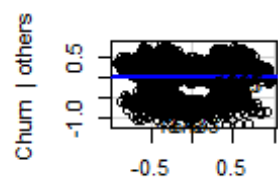
DeviceProtection | others



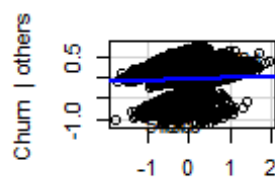
TechSupport | others



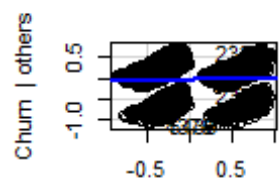
StreamingTV | others



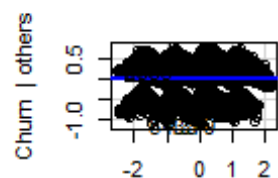
StreamingMovies | others



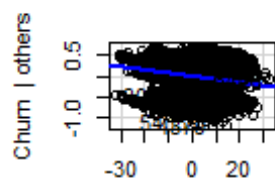
Contract | others



PaperlessBilling | others

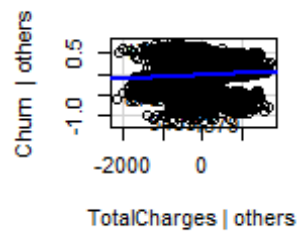


PaymentMethod | others

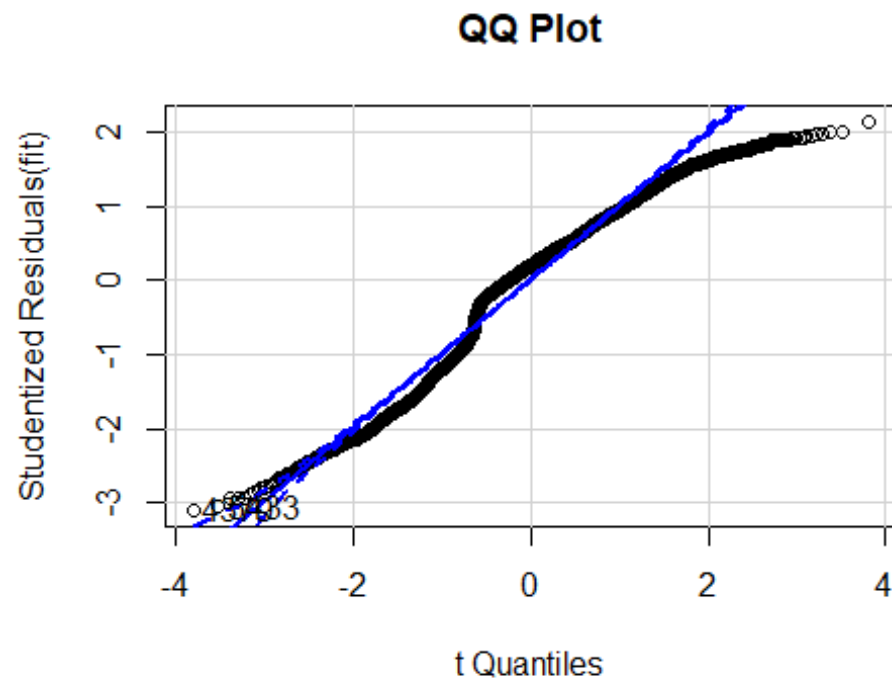


MonthlyCharges | others

## Added-Variable Plots

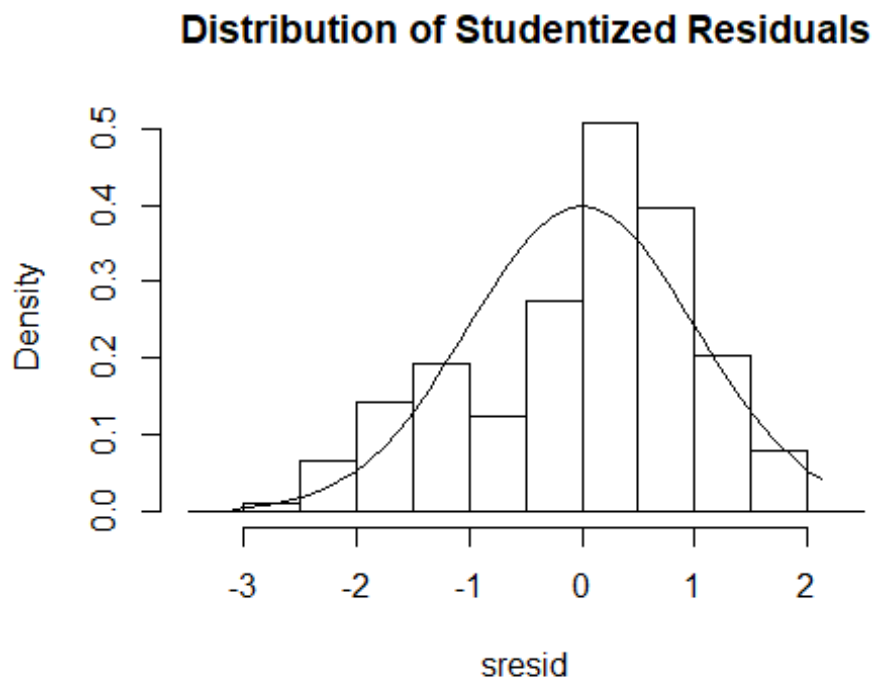


```
# Normality of Residuals and qqplot for studentized resid  
qqPlot(fit, main="QQ Plot")
```



```
## [1] 4379 5433

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

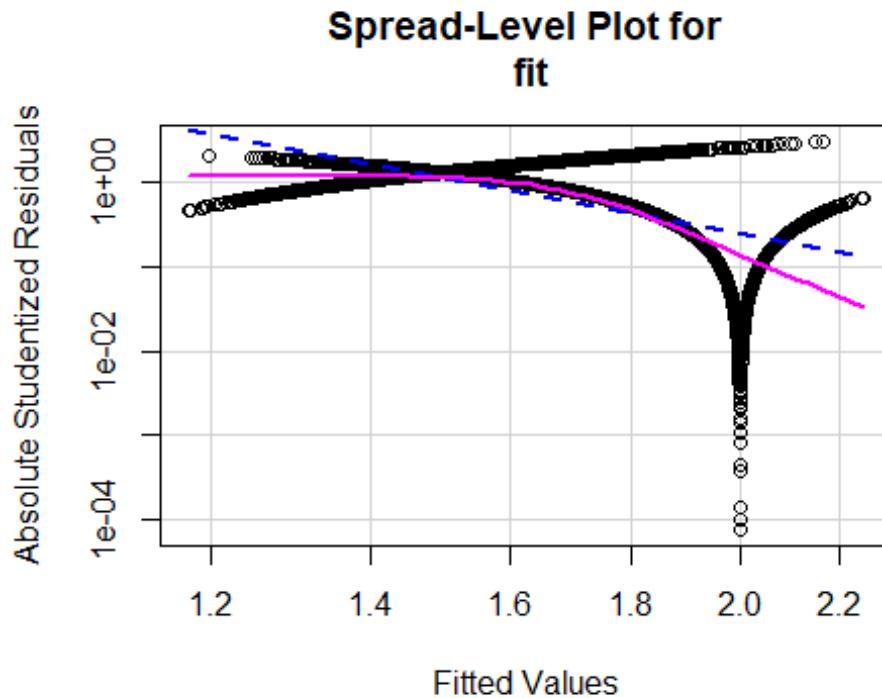


```
#Non-constant Error Variance
#Evaluating homoscedasticity
#Non-constant error variance test
ncvTest(fit)

## Non-constant Variance Score Test
## Variance formula: ~ fitted.values
## Chisquare = 914.0037, Df = 1, p = < 2.22e-16

#Plotting studentized residuals v/s. fitted values
spreadLevelPlot(fit)
```





```
##
## Suggested power transformation: 6.282503

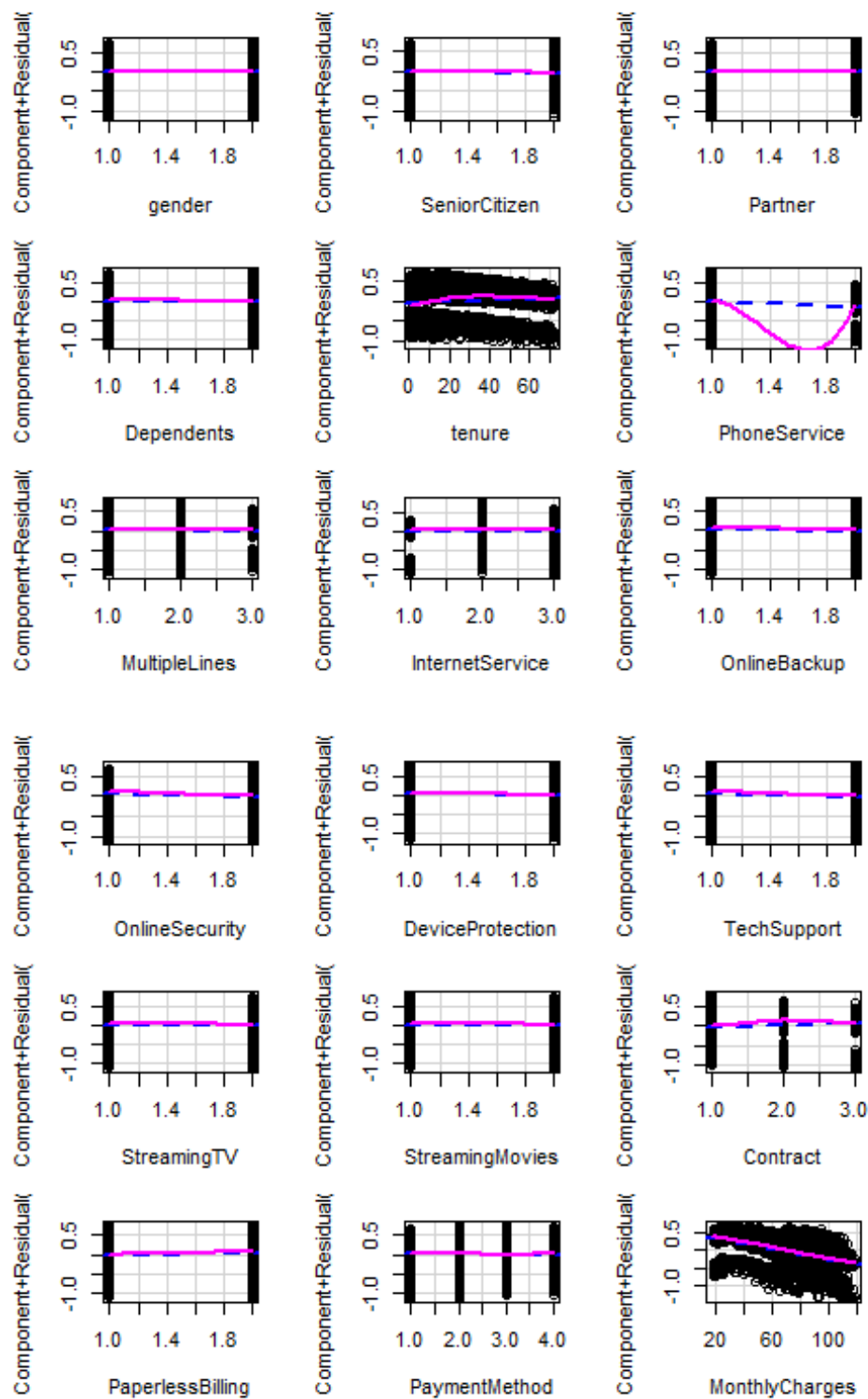
#Multi-collinearity
# Evaluate Collinearity
vif(fit) # variance inflation factors
```

##	gender	SeniorCitizen	Partner	Dependents
##	1.001896	1.149619	1.461181	1.379675
##	tenure	PhoneService	MultipleLines	InternetService
##	7.493307	3.653103	2.726882	1.923602
##	OnlineBackup	OnlineSecurity	DeviceProtection	TechSupport
##	1.517621	1.494666	1.593000	1.541748
##	StreamingTV	StreamingMovies	Contract	PaperlessBilling
##	1.939452	1.945417	2.492521	1.202420
##	PaymentMethod	MonthlyCharges	TotalCharges	
##	1.186114	6.434736	10.616907	

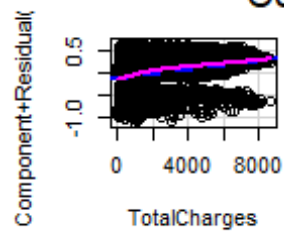
```
sqrt(vif(fit)) > 2
```

##	gender	SeniorCitizen	Partner	Dependents
##	FALSE	FALSE	FALSE	FALSE
##	tenure	PhoneService	MultipleLines	InternetService
##	TRUE	FALSE	FALSE	FALSE
##	OnlineBackup	OnlineSecurity	DeviceProtection	TechSupport
##	FALSE	FALSE	FALSE	FALSE
##	StreamingTV	StreamingMovies	Contract	PaperlessBilling

```
##           FALSE           FALSE           FALSE           FALSE
## PaymentMethod MonthlyCharges TotalCharges
##           FALSE           TRUE           TRUE
#Nonlinearity
# component + residual plot
crPlots(fit)
```



## Component + Residual Plots



*#Global test of model assumptions*

*##In the below steps we are performing regressions using all independent variable and we keep*

*##on eliminating the ones which are not significant in the next regression until we see*

*##constant values for R2*

```
gvmodel <- gvlma(fit)
summary(gvmodel)
```

```
##
```

```
## Call:
```

```
## lm(formula = Churn ~ gender + SeniorCitizen + Partner + Dependents +
##      tenure + PhoneService + MultipleLines + InternetService +
##      OnlineBackup + OnlineSecurity + DeviceProtection + TechSupport +
##      StreamingTV + StreamingMovies + Contract + PaperlessBilling +
##      PaymentMethod + MonthlyCharges + TotalCharges, data = custc)
```

```
##
```

```
## Residuals:
```

```
##      Min      1Q   Median      3Q      Max
## -1.16590 -0.29353  0.07249  0.26751  0.80298
```

```
##
```

```
## Coefficients:
```

```
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  2.714e+00  9.660e-02  28.098  < 2e-16 ***
## gender       3.950e-03  8.991e-03   0.439  0.660414
```

```

## SeniorCitizen    -5.014e-02  1.306e-02  -3.840 0.000124 ***
## Partner          1.714e-03  1.086e-02   0.158 0.874621
## Dependents       -2.389e-02  1.153e-02  -2.072 0.038282 *
## tenure           1.677e-03  5.009e-04   3.348 0.000818 ***
## PhoneService     -1.394e-01  2.904e-02  -4.799 1.63e-06 ***
## MultipleLines    -2.248e-02  1.131e-02  -1.987 0.046912 *
## InternetService   9.770e-03  8.449e-03   1.156 0.247568
## OnlineBackup     -5.578e-02  1.164e-02  -4.792 1.68e-06 ***
## OnlineSecurity   -9.139e-02  1.214e-02  -7.526 5.88e-14 ***
## DeviceProtection -4.199e-02  1.193e-02  -3.518 0.000437 ***
## TechSupport      -9.267e-02  1.229e-02  -7.541 5.23e-14 ***
## StreamingTV      -1.756e-02  1.286e-02  -1.366 0.172065
## StreamingMovies  -1.631e-02  1.285e-02  -1.269 0.204469
## Contract          4.278e-02  8.513e-03   5.025 5.16e-07 ***
## PaperlessBilling  5.032e-02  1.002e-02   5.020 5.28e-07 ***
## PaymentMethod    -7.811e-03  4.582e-03  -1.705 0.088325 .
## MonthlyCharges   -7.487e-03  3.787e-04 -19.771 < 2e-16 ***
## TotalCharges      5.178e-05  6.456e-06   8.020 1.23e-15 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.3766 on 7012 degrees of freedom
## Multiple R-squared:  0.2752, Adjusted R-squared:  0.2733
## F-statistic: 140.1 on 19 and 7012 DF,  p-value: < 2.2e-16
##
##
## ASSESSMENT OF THE LINEAR MODEL ASSUMPTIONS
## USING THE GLOBAL TEST ON 4 DEGREES-OF-FREEDOM:
## Level of Significance = 0.05
##
## Call:
## gvlma(x = fit)
##
##              Value    p-value              Decision
## Global Stat      664.671 0.000e+00 Assumptions NOT satisfied!
## Skewness         366.591 0.000e+00 Assumptions NOT satisfied!
## Kurtosis         51.526 7.064e-13 Assumptions NOT satisfied!
## Link Function    244.686 0.000e+00 Assumptions NOT satisfied!
## Heteroscedasticity 1.867 1.718e-01 Assumptions acceptable.

fit

##
## Call:
## lm(formula = Churn ~ gender + SeniorCitizen + Partner + Dependents +
##     tenure + PhoneService + MultipleLines + InternetService +
##     OnlineBackup + OnlineSecurity + DeviceProtection + TechSupport +
##     StreamingTV + StreamingMovies + Contract + PaperlessBilling +
##     PaymentMethod + MonthlyCharges + TotalCharges, data = custc)
##

```

```
## Coefficients:
##      (Intercept)          gender      SeniorCitizen          Partner
##      2.714e+00      3.950e-03      -5.014e-02      1.714e-03
##      Dependents          tenure      PhoneService      MultipleLines
##      -2.389e-02      1.677e-03      -1.394e-01      -2.248e-02
##      InternetService      OnlineBackup      OnlineSecurity      DeviceProtection
##      9.770e-03      -5.578e-02      -9.139e-02      -4.199e-02
##      TechSupport      StreamingTV      StreamingMovies      Contract
##      -9.267e-02      -1.756e-02      -1.631e-02      4.278e-02
##      PaperlessBilling      PaymentMethod      MonthlyCharges      TotalCharges
##      5.032e-02      -7.811e-03      -7.487e-03      5.178e-05
```

```
summary(fit)
```

```
##
## Call:
## lm(formula = Churn ~ gender + SeniorCitizen + Partner + Dependents +
##      tenure + PhoneService + MultipleLines + InternetService +
##      OnlineBackup + OnlineSecurity + DeviceProtection + TechSupport +
##      StreamingTV + StreamingMovies + Contract + PaperlessBilling +
##      PaymentMethod + MonthlyCharges + TotalCharges, data = custc)
##
```

```
## Residuals:
```

```
##      Min        1Q      Median        3Q        Max
## -1.16590 -0.29353  0.07249  0.26751  0.80298
##
```

```
## Coefficients:
```

```
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  2.714e+00  9.660e-02  28.098 < 2e-16 ***
## gender       3.950e-03  8.991e-03   0.439 0.660414
## SeniorCitizen -5.014e-02  1.306e-02  -3.840 0.000124 ***
## Partner      1.714e-03  1.086e-02   0.158 0.874621
## Dependents   -2.389e-02  1.153e-02  -2.072 0.038282 *
## tenure       1.677e-03  5.009e-04   3.348 0.000818 ***
## PhoneService -1.394e-01  2.904e-02  -4.799 1.63e-06 ***
## MultipleLines -2.248e-02  1.131e-02  -1.987 0.046912 *
## InternetService 9.770e-03  8.449e-03   1.156 0.247568
## OnlineBackup  -5.578e-02  1.164e-02  -4.792 1.68e-06 ***
## OnlineSecurity -9.139e-02  1.214e-02  -7.526 5.88e-14 ***
## DeviceProtection -4.199e-02  1.193e-02  -3.518 0.000437 ***
## TechSupport   -9.267e-02  1.229e-02  -7.541 5.23e-14 ***
## StreamingTV   -1.756e-02  1.286e-02  -1.366 0.172065
## StreamingMovies -1.631e-02  1.285e-02  -1.269 0.204469
## Contract      4.278e-02  8.513e-03   5.025 5.16e-07 ***
## PaperlessBilling 5.032e-02  1.002e-02   5.020 5.28e-07 ***
## PaymentMethod -7.811e-03  4.582e-03  -1.705 0.088325 .
## MonthlyCharges -7.487e-03  3.787e-04 -19.771 < 2e-16 ***
## TotalCharges  5.178e-05  6.456e-06   8.020 1.23e-15 ***
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
##
## Residual standard error: 0.3766 on 7012 degrees of freedom
## Multiple R-squared:  0.2752, Adjusted R-squared:  0.2733
## F-statistic: 140.1 on 19 and 7012 DF,  p-value: < 2.2e-16

fit1<-fit
fit2<- lm(Churn~gender+SeniorCitizen+Partner+Dependents+tenure+PhoneService
+MultipleLines+InternetService+OnlineBackup+OnlineSecurity
+DeviceProtection+TechSupport+StreamingTV+StreamingMovies
+Contract+PaperlessBilling+MonthlyCharges
+TotalCharges, data=custc)
summary(fit2)

##
## Call:
## lm(formula = Churn ~ gender + SeniorCitizen + Partner + Dependents +
##      tenure + PhoneService + MultipleLines + InternetService +
##      OnlineBackup + OnlineSecurity + DeviceProtection + TechSupport +
##      StreamingTV + StreamingMovies + Contract + PaperlessBilling +
##      MonthlyCharges + TotalCharges, data = custc)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.15675 -0.29405  0.07269  0.26618  0.80173
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   2.685e+00  9.508e-02  28.238 < 2e-16 ***
## gender         3.673e-03  8.991e-03   0.409 0.682870
## SeniorCitizen -5.002e-02  1.306e-02  -3.831 0.000129 ***
## Partner        1.343e-03  1.086e-02   0.124 0.901592
## Dependents    -2.372e-02  1.153e-02  -2.057 0.039706 *
## tenure         1.838e-03  4.920e-04   3.737 0.000188 ***
## PhoneService  -1.394e-01  2.905e-02  -4.799 1.63e-06 ***
## MultipleLines  -2.224e-02  1.131e-02  -1.966 0.049322 *
## InternetService 1.023e-02  8.446e-03   1.212 0.225669
## OnlineBackup   -5.574e-02  1.164e-02  -4.788 1.72e-06 ***
## OnlineSecurity -9.131e-02  1.215e-02  -7.518 6.24e-14 ***
## DeviceProtection -4.213e-02  1.194e-02  -3.530 0.000418 ***
## TechSupport    -9.277e-02  1.229e-02  -7.548 4.96e-14 ***
## StreamingTV    -1.709e-02  1.286e-02  -1.330 0.183666
## StreamingMovies -1.601e-02  1.285e-02  -1.246 0.212850
## Contract        4.305e-02  8.513e-03   5.057 4.37e-07 ***
## PaperlessBilling 4.995e-02  1.002e-02   4.984 6.39e-07 ***
## MonthlyCharges -7.428e-03  3.771e-04 -19.695 < 2e-16 ***
## TotalCharges    5.099e-05  6.440e-06   7.917 2.81e-15 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.3767 on 7013 degrees of freedom
```

```
## Multiple R-squared:  0.2749, Adjusted R-squared:  0.2731
## F-statistic: 147.7 on 18 and 7013 DF,  p-value: < 2.2e-16

fit3<- lm(Churn~gender+SeniorCitizen+Partner+Dependents+tenure+PhoneService
          +MultipleLines+InternetService+OnlineBackup+OnlineSecurity
          +DeviceProtection+TechSupport+StreamingTV+
          Contract+PaperlessBilling+MonthlyCharges
          +TotalCharges, data=custc)
summary(fit3)

##
## Call:
## lm(formula = Churn ~ gender + SeniorCitizen + Partner + Dependents +
##      tenure + PhoneService + MultipleLines + InternetService +
##      OnlineBackup + OnlineSecurity + DeviceProtection + TechSupport +
##      StreamingTV + Contract + PaperlessBilling + MonthlyCharges +
##      TotalCharges, data = custc)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.16051 -0.29141  0.07225  0.26624  0.80783
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    2.637e+00  8.688e-02  30.351 < 2e-16 ***
## gender          3.585e-03  8.991e-03   0.399 0.690116
## SeniorCitizen  -5.029e-02  1.306e-02  -3.851 0.000119 ***
## Partner         1.243e-03  1.086e-02   0.114 0.908887
## Dependents     -2.370e-02  1.153e-02  -2.056 0.039846 *
## tenure         1.814e-03  4.916e-04   3.690 0.000226 ***
## PhoneService   -1.318e-01  2.840e-02  -4.641 3.54e-06 ***
## MultipleLines  -2.337e-02  1.127e-02  -2.073 0.038233 *
## InternetService 1.023e-02  8.446e-03   1.211 0.225933
## OnlineBackup   -5.419e-02  1.158e-02  -4.681 2.90e-06 ***
## OnlineSecurity -8.973e-02  1.208e-02  -7.428 1.23e-13 ***
## DeviceProtection -4.236e-02  1.193e-02  -3.549 0.000388 ***
## TechSupport    -9.238e-02  1.229e-02  -7.519 6.19e-14 ***
## StreamingTV    -1.878e-02  1.279e-02  -1.469 0.141814
## Contract       4.440e-02  8.444e-03   5.259 1.49e-07 ***
## PaperlessBilling 5.006e-02  1.002e-02   4.995 6.03e-07 ***
## MonthlyCharges -7.269e-03  3.549e-04 -20.481 < 2e-16 ***
## TotalCharges   5.171e-05  6.414e-06   8.062 8.73e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.3767 on 7014 degrees of freedom
## Multiple R-squared:  0.2748, Adjusted R-squared:  0.273
## F-statistic: 156.3 on 17 and 7014 DF,  p-value: < 2.2e-16
```



```

fit4<- lm(Churn~gender+SeniorCitizen+Partner+Dependents+tenure+PhoneService
          +MultipleLines+InternetService+OnlineBackup+OnlineSecurity
          +DeviceProtection+TechSupport+Contract+PaperlessBilling+MonthlyCharges
          +TotalCharges, data=custc)
summary(fit4)

##
## Call:
## lm(formula = Churn ~ gender + SeniorCitizen + Partner + Dependents +
##      tenure + PhoneService + MultipleLines + InternetService +
##      OnlineBackup + OnlineSecurity + DeviceProtection + TechSupport +
##      Contract + PaperlessBilling + MonthlyCharges + TotalCharges,
##      data = custc)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.16571 -0.28928  0.07148  0.26612  0.81598
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   2.575e+00  7.608e-02  33.847 < 2e-16 ***
## gender         3.532e-03  8.992e-03   0.393 0.694445
## SeniorCitizen -5.102e-02  1.305e-02  -3.910 9.31e-05 ***
## Partner        1.112e-03  1.086e-02   0.102 0.918482
## Dependents    -2.420e-02  1.153e-02  -2.100 0.035773 *
## tenure         1.784e-03  4.912e-04   3.632 0.000284 ***
## PhoneService  -1.219e-01  2.760e-02  -4.418 1.01e-05 ***
## MultipleLines -2.496e-02  1.122e-02  -2.225 0.026143 *
## InternetService 1.013e-02  8.447e-03   1.199 0.230417
## OnlineBackup   -5.247e-02  1.152e-02  -4.556 5.31e-06 ***
## OnlineSecurity -8.740e-02  1.198e-02  -7.298 3.24e-13 ***
## DeviceProtection -4.236e-02  1.194e-02  -3.550 0.000388 ***
## TechSupport    -9.194e-02  1.228e-02  -7.485 8.05e-14 ***
## Contract        4.613e-02  8.362e-03   5.516 3.59e-08 ***
## PaperlessBilling 4.991e-02  1.002e-02   4.980 6.51e-07 ***
## MonthlyCharges -7.055e-03  3.238e-04 -21.788 < 2e-16 ***
## TotalCharges    5.260e-05  6.386e-06   8.237 < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.3767 on 7015 degrees of freedom
## Multiple R-squared:  0.2745, Adjusted R-squared:  0.2729
## F-statistic: 165.9 on 16 and 7015 DF, p-value: < 2.2e-16

fit5<- lm(Churn~gender+SeniorCitizen+Partner+Dependents+tenure+PhoneService
          +MultipleLines+InternetService+OnlineSecurity
          +DeviceProtection+TechSupport+Contract+PaperlessBilling+MonthlyCharges
          +TotalCharges, data=custc)
summary(fit5)

```

```

      +TotalCharges, data=custc)
summary(fit5)

##
## Call:
## lm(formula = Churn ~ gender + SeniorCitizen + Partner + Dependents +
##      tenure + PhoneService + MultipleLines + InternetService +
##      OnlineSecurity + DeviceProtection + TechSupport + Contract +
##      PaperlessBilling + MonthlyCharges + TotalCharges, data = custc)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.19592 -0.29079  0.07252  0.26750  0.80480
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   2.443e+00  7.042e-02  34.691 < 2e-16 ***
## gender         2.921e-03  9.003e-03   0.324 0.745619
## SeniorCitizen  -5.133e-02  1.307e-02  -3.929 8.62e-05 ***
## Partner        1.329e-03  1.088e-02   0.122 0.902810
## Dependents     -2.550e-02  1.154e-02  -2.210 0.027160 *
## tenure         1.760e-03  4.919e-04   3.578 0.000349 ***
## PhoneService   -1.107e-01  2.753e-02  -4.022 5.84e-05 ***
## MultipleLines   -2.757e-02  1.122e-02  -2.457 0.014049 *
## InternetService 1.603e-02  8.359e-03   1.917 0.055260 .
## OnlineSecurity  -8.723e-02  1.199e-02  -7.274 3.88e-13 ***
## DeviceProtection -3.951e-02  1.194e-02  -3.311 0.000935 ***
## TechSupport     -9.150e-02  1.230e-02  -7.439 1.14e-13 ***
## Contract        4.681e-02  8.373e-03   5.591 2.34e-08 ***
## PaperlessBilling 5.042e-02  1.004e-02   5.024 5.19e-07 ***
## MonthlyCharges  -6.895e-03  3.223e-04 -21.391 < 2e-16 ***
## TotalCharges    5.734e-05  6.310e-06   9.087 < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.3772 on 7016 degrees of freedom
## Multiple R-squared:  0.2724, Adjusted R-squared:  0.2708
## F-statistic: 175.1 on 15 and 7016 DF, p-value: < 2.2e-16

fit6<- lm(Churn~gender+SeniorCitizen+Partner+Dependents+tenure+PhoneService
      +MultipleLines+OnlineSecurity
      +DeviceProtection+TechSupport+Contract+PaperlessBilling+MonthlyCharges
      +TotalCharges, data=custc)
summary(fit6)

##
## Call:
## lm(formula = Churn ~ gender + SeniorCitizen + Partner + Dependents +
##      tenure + PhoneService + MultipleLines + OnlineSecurity +

```

```
##      DeviceProtection + TechSupport + Contract + PaperlessBilling +
##      MonthlyCharges + TotalCharges, data = custc)
##
## Residuals:
##      Min        1Q      Median        3Q        Max
## -1.18559 -0.29352  0.07063  0.26881  0.80231
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   2.483e+00  6.723e-02  36.936 < 2e-16 ***
## gender         3.160e-03  9.004e-03   0.351 0.725623
## SeniorCitizen -5.201e-02  1.306e-02  -3.981 6.93e-05 ***
## Partner        1.465e-03  1.088e-02   0.135 0.892890
## Dependents    -2.551e-02  1.154e-02  -2.210 0.027110 *
## tenure         1.794e-03  4.916e-04   3.649 0.000265 ***
## PhoneService  -9.332e-02  2.600e-02  -3.590 0.000333 ***
## MultipleLines  -2.857e-02  1.121e-02  -2.548 0.010842 *
## OnlineSecurity -9.400e-02  1.146e-02  -8.202 2.80e-16 ***
## DeviceProtection -4.200e-02  1.187e-02  -3.539 0.000404 ***
## TechSupport   -9.767e-02  1.187e-02  -8.225 2.31e-16 ***
## Contract       4.456e-02  8.292e-03   5.374 7.95e-08 ***
## PaperlessBilling 4.994e-02  1.003e-02   4.977 6.61e-07 ***
## MonthlyCharges -6.753e-03  3.138e-04 -21.522 < 2e-16 ***
## TotalCharges   5.606e-05  6.276e-06   8.933 < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.3773 on 7017 degrees of freedom
## Multiple R-squared:  0.272, Adjusted R-squared:  0.2706
## F-statistic: 187.3 on 14 and 7017 DF,  p-value: < 2.2e-16

fit7<- lm(Churn~SeniorCitizen+Dependents+tenure+PhoneService
          +MultipleLines+OnlineSecurity
          +DeviceProtection+TechSupport+Contract+PaperlessBilling+MonthlyCharges
          +TotalCharges, data=custc)
summary(fit7)

##
## Call:
## lm(formula = Churn ~ SeniorCitizen + Dependents + tenure + PhoneService +
##      MultipleLines + OnlineSecurity + DeviceProtection + TechSupport +
##      Contract + PaperlessBilling + MonthlyCharges + TotalCharges,
##      data = custc)
##
## Residuals:
##      Min        1Q      Median        3Q        Max
## -1.18779 -0.29342  0.07041  0.26863  0.80440
##
## Coefficients:
```

```
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    2.489e+00  6.480e-02  38.418 < 2e-16 ***
## SeniorCitizen -5.218e-02  1.300e-02  -4.016 5.99e-05 ***
## Dependents    -2.486e-02  1.036e-02  -2.400 0.016420 *
## tenure        1.786e-03  4.881e-04   3.660 0.000254 ***
## PhoneService  -9.319e-02  2.599e-02  -3.586 0.000338 ***
## MultipleLines -2.863e-02  1.121e-02  -2.554 0.010660 *
## OnlineSecurity -9.393e-02  1.146e-02  -8.197 2.90e-16 ***
## DeviceProtection -4.199e-02  1.186e-02  -3.539 0.000404 ***
## TechSupport   -9.768e-02  1.187e-02  -8.230 < 2e-16 ***
## Contract      4.452e-02  8.289e-03   5.370 8.11e-08 ***
## PaperlessBilling 4.998e-02  1.003e-02   4.981 6.47e-07 ***
## MonthlyCharges -6.755e-03  3.136e-04 -21.538 < 2e-16 ***
## TotalCharges   5.608e-05  6.274e-06   8.938 < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.3773 on 7019 degrees of freedom
## Multiple R-squared:  0.272, Adjusted R-squared:  0.2708
## F-statistic: 218.5 on 12 and 7019 DF, p-value: < 2.2e-16

fit7<- lm(Churn~SeniorCitizen+Dependents+tenure+PhoneService+OnlineSecurity
          +DeviceProtection+TechSupport+Contract+PaperlessBilling+MonthlyCharges
          +TotalCharges, data=custc)
summary(fit7)

##
## Call:
## lm(formula = Churn ~ SeniorCitizen + Dependents + tenure + PhoneService +
##      OnlineSecurity + DeviceProtection + TechSupport + Contract +
##      PaperlessBilling + MonthlyCharges + TotalCharges, data = custc)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.20248 -0.29768  0.07117  0.26882  0.79270
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    2.531e+00  6.274e-02  40.339 < 2e-16 ***
## SeniorCitizen  -5.345e-02  1.299e-02  -4.114 3.93e-05 ***
## Dependents    -2.492e-02  1.036e-02  -2.405 0.016190 *
## tenure        1.663e-03  4.859e-04   3.424 0.000621 ***
## PhoneService  -1.437e-01  1.688e-02  -8.511 < 2e-16 ***
## OnlineSecurity -9.623e-02  1.143e-02  -8.421 < 2e-16 ***
## DeviceProtection -4.425e-02  1.184e-02  -3.738 0.000187 ***
## TechSupport   -1.006e-01  1.182e-02  -8.508 < 2e-16 ***
## Contract      4.430e-02  8.292e-03   5.342 9.46e-08 ***
## PaperlessBilling 5.013e-02  1.004e-02   4.995 6.02e-07 ***
## MonthlyCharges -6.950e-03  3.044e-04 -22.836 < 2e-16 ***
```

```

## TotalCharges      5.541e-05  6.271e-06   8.835  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.3774 on 7020 degrees of freedom
## Multiple R-squared:  0.2713, Adjusted R-squared:  0.2702
## F-statistic: 237.6 on 11 and 7020 DF,  p-value: < 2.2e-16

fit8<- lm(Churn~SeniorCitizen+tenure+PhoneService+OnlineSecurity
          +DeviceProtection+TechSupport+Contract+PaperlessBilling+MonthlyCharges
          +TotalCharges, data=custc)
summary(fit8)

##
## Call:
## lm(formula = Churn ~ SeniorCitizen + tenure + PhoneService +
##      OnlineSecurity + DeviceProtection + TechSupport + Contract +
##      PaperlessBilling + MonthlyCharges + TotalCharges, data = custc)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.21609 -0.29808  0.07179  0.27000  0.79348
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   2.495e+00  6.099e-02  40.917  < 2e-16 ***
## SeniorCitizen -5.853e-02  1.282e-02  -4.564  5.10e-06 ***
## tenure        1.709e-03  4.857e-04   3.519  0.000435 ***
## PhoneService  -1.448e-01  1.688e-02  -8.581  < 2e-16 ***
## OnlineSecurity -9.735e-02  1.142e-02  -8.523  < 2e-16 ***
## DeviceProtection -4.437e-02  1.184e-02  -3.748  0.000180 ***
## TechSupport    -1.008e-01  1.182e-02  -8.526  < 2e-16 ***
## Contract       4.617e-02  8.258e-03   5.591  2.34e-08 ***
## PaperlessBilling 5.074e-02  1.004e-02   5.055  4.40e-07 ***
## MonthlyCharges -6.984e-03  3.041e-04 -22.965  < 2e-16 ***
## TotalCharges    5.527e-05  6.273e-06   8.811  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.3775 on 7021 degrees of freedom
## Multiple R-squared:  0.2707, Adjusted R-squared:  0.2697
## F-statistic: 260.6 on 10 and 7021 DF,  p-value: < 2.2e-16

fit9<- lm(Churn~tenure+MonthlyCharges+TotalCharges, data=custc)
summary(fit9)

##
## Call:
## lm(formula = Churn ~ tenure + MonthlyCharges + TotalCharges,
##      data = custc)

```

```
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.05221 -0.31778  0.09134  0.25874  0.80134
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   1.931e+00  1.795e-02  107.57 < 2e-16 ***
## tenure        2.774e-03  4.570e-04    6.07 1.34e-09 ***
## MonthlyCharges -7.083e-03  2.770e-04  -25.57 < 2e-16 ***
## TotalCharges   7.528e-05  6.318e-06   11.91 < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.3891 on 7028 degrees of freedom
## Multiple R-squared:  0.2247, Adjusted R-squared:  0.2243
## F-statistic: 678.8 on 3 and 7028 DF,  p-value: < 2.2e-16

##By running the above regression we notice that independent variables Like SeniorCitizen,tenure,PhoneService,OnlineSecurity
##DeviceProtection,TechSupportContract,PaperlessBilling,MonthlyCharges and TotalCharges could be factors
##that cause person to churn

#Comparing model
anova(fit1,fit8)

## Analysis of Variance Table
##
## Model 1: Churn ~ gender + SeniorCitizen + Partner + Dependents + tenure +
##      PhoneService + MultipleLines + InternetService + OnlineBackup +
##      OnlineSecurity + DeviceProtection + TechSupport + StreamingTV +
##      StreamingMovies + Contract + PaperlessBilling + PaymentMethod +
##      MonthlyCharges + TotalCharges
## Model 2: Churn ~ SeniorCitizen + tenure + PhoneService + OnlineSecurity +
##      DeviceProtection + TechSupport + Contract + PaperlessBilling +
##      MonthlyCharges + TotalCharges
##   Res.Df    RSS Df Sum of Sq    F    Pr(>F)
## 1     7012  994.57
## 2     7021 1000.75  -9    -6.1797 4.8409 1.778e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

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

## Start:  AIC=-13714
## Churn ~ gender + SeniorCitizen + Partner + Dependents + tenure +
##      PhoneService + MultipleLines + InternetService + OnlineBackup +
##      OnlineSecurity + DeviceProtection + TechSupport + StreamingTV +
##      StreamingMovies + Contract + PaperlessBilling + PaymentMethod +
##      MonthlyCharges + TotalCharges
```

```

##
##           Df Sum of Sq      RSS      AIC
## - Partner      1      0.004  994.57 -13716
## - gender        1      0.027  994.60 -13716
## - InternetService  1      0.190  994.76 -13715
## - StreamingMovies  1      0.228  994.80 -13714
## - StreamingTV     1      0.265  994.84 -13714
## <none>                                994.57 -13714
## - PaymentMethod   1      0.412  994.98 -13713
## - MultipleLines    1      0.560  995.13 -13712
## - Dependents       1      0.609  995.18 -13712
## - tenure           1      1.590  996.16 -13705
## - DeviceProtection  1      1.756  996.33 -13704
## - SeniorCitizen    1      2.092  996.66 -13701
## - OnlineBackup     1      3.258  997.83 -13693
## - PhoneService     1      3.267  997.84 -13693
## - PaperlessBilling  1      3.575  998.15 -13691
## - Contract         1      3.582  998.15 -13691
## - OnlineSecurity    1      8.034 1002.60 -13659
## - TechSupport       1      8.067 1002.64 -13659
## - TotalCharges      1      9.124 1003.69 -13652
## - MonthlyCharges    1     55.442 1050.01 -13334
##
## Step:  AIC=-13715.97
## Churn ~ gender + SeniorCitizen + Dependents + tenure + PhoneService +
##       MultipleLines + InternetService + OnlineBackup + OnlineSecurity +
##       DeviceProtection + TechSupport + StreamingTV + StreamingMovies +
##       Contract + PaperlessBilling + PaymentMethod + MonthlyCharges +
##       TotalCharges
##
##           Df Sum of Sq      RSS      AIC
## - gender      1      0.028  994.60 -13718
## - InternetService  1      0.190  994.76 -13717
## - StreamingMovies  1      0.228  994.80 -13716
## - StreamingTV     1      0.264  994.84 -13716
## <none>                                994.57 -13716
## - PaymentMethod   1      0.411  994.98 -13715
## - MultipleLines    1      0.562  995.14 -13714
## + Partner          1      0.004  994.57 -13714
## - Dependents       1      0.706  995.28 -13713
## - tenure           1      1.594  996.17 -13707
## - DeviceProtection  1      1.754  996.33 -13706
## - SeniorCitizen    1      2.131  996.71 -13703
## - OnlineBackup     1      3.258  997.83 -13695
## - PhoneService     1      3.264  997.84 -13695
## - PaperlessBilling  1      3.575  998.15 -13693
## - Contract         1      3.580  998.15 -13693
## - OnlineSecurity    1      8.032 1002.61 -13661
## - TechSupport       1      8.077 1002.65 -13661
## - TotalCharges      1      9.122 1003.70 -13654

```

```

## - MonthlyCharges    1    55.460 1050.03 -13336
##
## Step:  AIC=-13717.78
## Churn ~ SeniorCitizen + Dependents + tenure + PhoneService +
##      MultipleLines + InternetService + OnlineBackup + OnlineSecurity +
##      DeviceProtection + TechSupport + StreamingTV + StreamingMovies +
##      Contract + PaperlessBilling + PaymentMethod + MonthlyCharges +
##      TotalCharges
##
##
##      Df Sum of Sq    RSS    AIC
## - InternetService    1      0.192  994.79 -13718
## - StreamingMovies    1      0.227  994.83 -13718
## - StreamingTV        1      0.263  994.87 -13718
## <none>                994.60 -13718
## - PaymentMethod      1      0.407  995.01 -13717
## + gender              1      0.028  994.57 -13716
## + Partner             1      0.004  994.60 -13716
## - MultipleLines       1      0.564  995.17 -13716
## - Dependents          1      0.709  995.31 -13715
## - tenure              1      1.595  996.20 -13708
## - DeviceProtection    1      1.755  996.36 -13707
## - SeniorCitizen       1      2.131  996.73 -13705
## - OnlineBackup        1      3.250  997.85 -13697
## - PhoneService        1      3.260  997.86 -13697
## - Contract            1      3.577  998.18 -13694
## - PaperlessBilling    1      3.581  998.18 -13694
## - OnlineSecurity      1      8.016 1002.62 -13663
## - TechSupport         1      8.070 1002.67 -13663
## - TotalCharges        1      9.138 1003.74 -13656
## - MonthlyCharges     1     55.471 1050.07 -13338
##
## Step:  AIC=-13718.42
## Churn ~ SeniorCitizen + Dependents + tenure + PhoneService +
##      MultipleLines + OnlineBackup + OnlineSecurity + DeviceProtection +
##      TechSupport + StreamingTV + StreamingMovies + Contract +
##      PaperlessBilling + PaymentMethod + MonthlyCharges + TotalCharges
##
##
##      Df Sum of Sq    RSS    AIC
## - StreamingMovies    1      0.227  995.02 -13719
## - StreamingTV        1      0.260  995.05 -13719
## <none>                994.79 -13718
## + InternetService    1      0.192  994.60 -13718
## - PaymentMethod      1      0.425  995.22 -13717
## + gender              1      0.030  994.76 -13717
## + Partner             1      0.004  994.79 -13716
## - MultipleLines       1      0.591  995.39 -13716
## - Dependents          1      0.704  995.50 -13715
## - tenure              1      1.630  996.42 -13709
## - DeviceProtection    1      1.916  996.71 -13707
## - SeniorCitizen       1      2.167  996.96 -13705

```



```

## - PhoneService      1      3.078  997.87 -13699
## - Contract          1      3.416  998.21 -13696
## - PaperlessBilling  1      3.542  998.34 -13695
## - OnlineBackup      1      3.573  998.37 -13695
## - TotalCharges      1      8.950 1003.74 -13657
## - TechSupport       1      9.356 1004.15 -13655
## - OnlineSecurity    1      9.522 1004.32 -13653
## - MonthlyCharges   1     56.102 1050.90 -13335
##
## Step:  AIC=-13718.82
## Churn ~ SeniorCitizen + Dependents + tenure + PhoneService +
##      MultipleLines + OnlineBackup + OnlineSecurity + DeviceProtection +
##      TechSupport + StreamingTV + Contract + PaperlessBilling +
##      PaymentMethod + MonthlyCharges + TotalCharges
##
##              Df Sum of Sq      RSS      AIC
## <none>                995.02 -13719
## - StreamingTV         1      0.317  995.34 -13719
## + StreamingMovies     1      0.227  994.79 -13718
## + InternetService     1      0.192  994.83 -13718
## - PaymentMethod       1      0.417  995.44 -13718
## + gender              1      0.029  994.99 -13717
## + Partner             1      0.004  995.02 -13717
## - MultipleLines       1      0.656  995.68 -13716
## - Dependents          1      0.706  995.73 -13716
## - tenure              1      1.588  996.61 -13710
## - DeviceProtection    1      1.937  996.96 -13707
## - SeniorCitizen       1      2.189  997.21 -13705
## - PhoneService        1      2.860  997.88 -13701
## - OnlineBackup        1      3.421  998.44 -13697
## - PaperlessBilling    1      3.558  998.58 -13696
## - Contract            1      3.709  998.73 -13695
## - TotalCharges        1      9.282 1004.30 -13656
## - TechSupport         1      9.287 1004.31 -13656
## - OnlineSecurity      1      9.316 1004.34 -13655
## - MonthlyCharges      1     60.876 1055.90 -13303

```

step\$anova

```

## Stepwise Model Path
## Analysis of Deviance Table
##
## Initial Model:
## Churn ~ gender + SeniorCitizen + Partner + Dependents + tenure +
##      PhoneService + MultipleLines + InternetService + OnlineBackup +
##      OnlineSecurity + DeviceProtection + TechSupport + StreamingTV +
##      StreamingMovies + Contract + PaperlessBilling + PaymentMethod +
##      MonthlyCharges + TotalCharges
##
## Final Model:

```

```
## Churn ~ SeniorCitizen + Dependents + tenure + PhoneService +
##      MultipleLines + OnlineBackup + OnlineSecurity + DeviceProtection +
##      TechSupport + StreamingTV + Contract + PaperlessBilling +
##      PaymentMethod + MonthlyCharges + TotalCharges
##
##
##          Step Df      Deviance Resid. Df Resid. Dev      AIC
## 1
## 2      - Partner  1 0.003531785      7013   994.5741 -13715.97
## 3      - gender  1 0.027527274      7014   994.6016 -13717.78
## 4 - InternetService  1 0.192459783      7015   994.7941 -13718.42
## 5 - StreamingMovies  1 0.226610422      7016   995.0207 -13718.82

predict.lm(fit8, data.frame(SeniorCitizen = 0,tenure =20,PhoneService = 1,OnlineSecurity = 2,
                             DeviceProtection = 1,TechSupport = 2,Contract = 3
                             ,PaperlessBilling = 1,
                             MonthlyCharges = 100,TotalCharges=1000) )

##          1
## 1.490098

##By running the above prediction model using values like the user not being
senior citizen,tenure
##being 20 months, Leveraging Phoneservice,DeviceProtection and PaperLessBill
ing, not using OnlineSecurity
##and TechSupport, having contract of 2 years, MonthlyCharges and TotalCharge
s being 100 &1000 respectively
##there is a likelihood of this customer churning
```