

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
No
## 2              No          DSL              Yes          No
Yes
## 3              No          DSL              Yes          Yes
No
## 4 No phone service          DSL              Yes          No
Yes
##      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,
92...
## $ gender          <fct> Female, Male, Male, Male, Female, Female, Male,
Fe...
## $ 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, 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,
```

```

49...
## $ PhoneService      <fct> No, Yes, Yes, No, Yes, Yes, Yes, No, Yes, Yes,
Yes...
## $ MultipleLines     <fct> No phone service, No, No, No phone service, No,
Ye...
## $ InternetService   <fct> DSL, DSL, DSL, DSL, Fiber optic, Fiber optic,
Fibe...
## $ 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,
No...
## $ DeviceProtection <fct> No, Yes, No, Yes, No, Yes, No, No, Yes, No, No,
No...
## $ 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
year...
## $ PaperlessBilling  <fct> Yes, No, Yes, No, Yes, Yes, Yes, No, Yes, No,
Yes,...
## $ PaymentMethod     <fct> Electronic check, Mailed check, Mailed check,
Bank...
## $ 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,
No...

```

#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 Years
[8] 0-1 Years 2-3 Years 6-7 Years 1-2 Years 1-2 Years 5-6 Years 5-6 Years
[15] 2-3 Years 6-7 Years 5-6 Years 6-7 Years 0-1 Years 1-2 Years 0-1 Years
[22] 0-1 Years 0-1 Years 5-6 Years 5-6 Years 2-3 Years 4-5 Years 0-1 Years
[29] 6-7 Years 1-2 Years 6-7 Years 0-1 Years 2-3 Years 0-1 Years 0-1 Years
[36] 6-7 Years 0-1 Years 4-5 Years 2-3 Years 0-1 Years 0-1 Years 6-7 Years
[43] 1-2 Years 6-7 Years 1-2 Years 5-6 Years 0-1 Years 0-1 Years 5-6 Years
[50] 6-7 Years 4-5 Years 1-2 Years 2-3 Years 0-1 Years 5-6 Years 1-2 Years
[57] 6-7 Years 6-7 Years 2-3 Years 6-7 Years 4-5 Years 5-6 Years 6-7 Years
[64] 1-2 Years 0-1 Years 0-1 Years 4-5 Years 2-3 Years 5-6 Years 0-1 Years
[71] 0-1 Years 5-6 Years 6-7 Years 6-7 Years 0-1 Years 5-6 Years 4-5 Years
[78] 0-1 Years 2-3 Years 4-5 Years 0-1 Years 0-1 Years 0-1 Years 4-5 Years
[85] 5-6 Years 0-1 Years 2-3 Years 4-5 Years 4-5 Years 2-3 Years 2-3 Years
[92] 0-1 Years 6-7 Years 6-7 Years 6-7 Years 0-1 Years 6-7 Years 0-1 Years
[99] 5-6 Years 2-3 Years 0-1 Years 0-1 Years 4-5 Years 6-7 Years 6-7 Years
[106] 0-1 Years 6-7 Years 2-3 Years 4-5 Years 6-7 Years 5-6 Years 5-6 Years
[113] 4-5 Years 4-5 Years 6-7 Years 0-1 Years 2-3 Years 0-1 Years 4-5 Years
[120] 2-3 Years 5-6 Years 0-1 Years 0-1 Years 0-1 Years 0-1 Years 2-3 Years
[127] 2-3 Years 6-7 Years 0-1 Years 6-7 Years 1-2 Years 2-3 Years 6-7 Years
[134] 0-1 Years 0-1 Years 4-5 Years 1-2 Years 6-7 Years 5-6 Years 0-1 Years
[141] 6-7 Years 0-1 Years 6-7 Years 6-7 Years 6-7 Years 6-7 Years 0-1 Years
[148] 0-1 Years 2-3 Years 1-2 Years 0-1 Years 0-1 Years 6-7 Years 6-7 Years
[155] 0-1 Years 1-2 Years 1-2 Years 1-2 Years 1-2 Years 0-1 Years 1-2 Years
[162] 1-2 Years 0-1 Years 5-6 Years 0-1 Years 6-7 Years 0-1 Years 6-7 Years
[169] 5-6 Years 1-2 Years 4-5 Years 0-1 Years 1-2 Years 5-6 Years 2-3 Years


```

## [176] 2-3 Years 1-2 Years 0-1 Years 1-2 Years 6-7 Years 0-1 Years 0-1
Years
## [183] 0-1 Years 2-3 Years 1-2 Years 0-1 Years 1-2 Years 0-1 Years 1-2 ##
[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
DeviceProtection,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
phone service'),labels = c(1,2,3))
custc$InternetService<-factor(custc$InternetService,levels = c('No','Fiber
optic','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
(automatic)',
'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",...:
5376 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",...:
5376 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 |
| ## | 1.985485 | 1.655493 | 1.678477 | 1.462609 | 2.048314 | 1.773511 | 1.885400 | 1.465507 |
| ## | 97 | 98 | 99 | 100 | 101 | 102 | 103 | 104 |

```
## 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
## 1.923469e-01 -5.937580e-01 -6.543384e-01 -9.302690e-02 -5.799656e-01
##          31          32          33          34          35
```



```
## 3.146974e-02 7.469439e-01 3.430424e-02 1.688491e-01 3.857017e-01
## 36 37 38 39 40
## -7.646371e-02 -4.264421e-01 3.298016e-01 -4.772256e-01 -3.316295e-01
## 41 42 43 44 45
```

```
## 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 | 2.689060e-05 | 1.850624e-06 | -6.362494e-06 | - |
| 1.441401e-06 | | | | |
| ## StreamingTV | -7.690445e-07 | 1.331065e-05 | 1.859493e-05 | |
| 1.917970e-07 | | | | |
| ## StreamingMovies | -8.601065e-09 | 1.599902e-05 | 1.630379e-05 | - |
| 2.348457e-06 | | | | |
| ## Contract | 9.941673e-06 | 4.457994e-06 | 1.460907e-05 | |
| 1.356267e-05 | | | | |
| ## PaperlessBilling | 2.160343e-06 | 1.275585e-06 | 1.030859e-05 | |
| 6.110666e-06 | | | | |
| ## PaymentMethod | 1.246129e-06 | 1.217583e-07 | 2.268381e-07 | - |
| 3.925489e-07 | | | | |
| ## MonthlyCharges | -5.724919e-07 | 7.342228e-07 | 5.395447e-07 | |
| 7.895166e-07 | | | | |
| ## TotalCharges | 6.723676e-09 | 1.338913e-08 | 1.137596e-08 | |
| 1.041821e-08 | | | | |
| ## | 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 | |
| TotalCharges | | | | |
| ## (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 09 | 5.524762e-06 | 3.226624e-07 | -6.076301e-07 | 1.028860e- |
| ## Partner 10 | 2.985978e-08 | -9.974055e-07 | 5.001210e-08 | 5.862567e- |
| ## Dependents 09 | 2.582901e-06 | 4.599891e-07 | -2.334312e-07 | -1.400690e- |
| ## tenure 09 | 1.619332e-07 | 4.332767e-07 | 7.015047e-08 | -2.559805e- |
| ## PhoneService 08 | 1.346655e-05 | -2.218533e-08 | 5.462805e-06 | 1.250002e- |
| ## MultipleLines 09 | 7.414882e-07 | 6.444628e-07 | -1.177836e-06 | -4.421621e- |
| ## InternetService 09 | 2.160343e-06 | 1.246129e-06 | -5.724919e-07 | 6.723676e- |
| ## OnlineBackup 08 | 1.275585e-06 | 1.217583e-07 | 7.342228e-07 | 1.338913e- |
| ## OnlineSecurity 08 | 1.030859e-05 | 2.268381e-07 | 5.395447e-07 | 1.137596e- |
| ## DeviceProtection 08 | 6.110666e-06 | -3.925489e-07 | 7.895166e-07 | 1.041821e- |
| ## TechSupport 08 | 4.468371e-06 | -2.622397e-07 | 4.171404e-07 | 1.071044e- |
| ## StreamingTV 09 | -1.485915e-06 | 1.250326e-06 | 1.694071e-06 | 6.810876e- |
| ## StreamingMovies 09 | 1.137417e-06 | 7.983254e-07 | 1.646184e-06 | 7.393941e- |
| ## Contract 09 | -7.238461e-06 | 7.276605e-07 | 8.133148e-07 | 3.944176e- |
| ## PaperlessBilling 10 | 1.004681e-04 | -1.007124e-06 | 6.816789e-07 | -8.912854e- |
| ## PaymentMethod 09 | -1.007124e-06 | 2.099732e-05 | 1.594187e-07 | -2.132492e- |
| ## MonthlyCharges 09 | 6.816789e-07 | 1.594187e-07 | 1.434099e-07 | -1.126434e- |
| ## TotalCharges 11 | -8.912854e-10 | -2.132492e-09 | -1.126434e-09 | 4.168302e- |

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 | |
| DeviceProtection | | | | |
| ## (Intercept) | -2.624262e-01 | -0.384342218 | -0.396364232 | - |
| 0.351694650 | | | | |
| ## gender | -1.651265e-02 | -0.016046567 | -0.022034448 | |
| 0.001529001 | | | | |
| ## SeniorCitizen | 2.634741e-02 | -0.010786334 | -0.054920899 | - |
| 0.017225288 | | | | |
| ## Partner | -6.375294e-03 | 0.002663074 | -0.005844429 | - |
| 0.014993269 | | | | |
| ## Dependents | -2.669489e-03 | -0.027193772 | -0.036950553 | |
| 0.001487305 | | | | |
| ## tenure | -3.043832e-02 | -0.018313490 | -0.035993236 | - |
| 0.042328976 | | | | |
| ## PhoneService | -2.965399e-01 | 0.129654634 | 0.096428916 | |
| 0.141608726 | | | | |
| ## MultipleLines | 3.913913e-02 | -0.068278207 | -0.081036697 | - |
| 0.069931717 | | | | |
| ## InternetService | 1.000000e+00 | 0.150655219 | 0.286504096 | |

| | | | | |
|---------------------|------------------|---------------|-----------------|--------------|
| 0.114886685 | | | | |
| ## OnlineBackup | 1.506552e-01 | 1.000000000 | 0.027387844 | |
| 0.050166960 | | | | |
| ## OnlineSecurity | 2.865041e-01 | 0.027387844 | 1.000000000 | |
| 0.036163867 | | | | |
| ## DeviceProtection | 1.148867e-01 | 0.050166960 | 0.036163867 | |
| 1.000000000 | | | | |
| ## TechSupport | 2.589950e-01 | 0.012938223 | -0.042637133 | - |
| 0.009829171 | | | | |
| ## StreamingTV | -7.079033e-03 | 0.088937971 | 0.119093125 | |
| 0.001249987 | | | | |
| ## StreamingMovies | -7.920208e-05 | 0.106940746 | 0.104458219 | - |
| 0.015311169 | | | | |
| ## Contract | 1.382114e-01 | 0.044987250 | 0.141311182 | |
| 0.133496839 | | | | |
| ## PaperlessBilling | 2.550880e-02 | 0.010933076 | 0.084690841 | |
| 0.051085452 | | | | |
| ## PaymentMethod | 3.218567e-02 | 0.002282778 | 0.004076479 | - |
| 0.007178515 | | | | |
| ## MonthlyCharges | -1.789210e-01 | 0.166565591 | 0.117324590 | |
| 0.174700623 | | | | |
| ## TotalCharges | 1.232562e-01 | 0.178163964 | 0.145097370 | |
| 0.135218601 | | | | |
| ## | 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 | |
| TotalCharges | | | | |
| ## (Intercept) | -0.2489715131 | -0.1769875922 | -0.632867955 | - |
| 0.093927200 | | | | |
| ## gender | -0.0095149757 | -0.0180726126 | 0.003771549 | - |
| 0.014249077 | | | | |

```

## SeniorCitizen      0.0422159960  0.0053931685  -0.122893017
0.012205460
## Partner            0.0002741999 -0.0200347772   0.012155706
0.008358011
## Dependents        0.0223527390  0.0087076837  -0.053469544 -
0.018819129
## tenure             0.0322525774  0.1887669642   0.369814198 -
0.791534549
## PhoneService       0.0462577826 -0.0001666964   0.496670750
0.066661263
## MultipleLines      0.0065416094  0.0124368473  -0.275036036 -
0.060561464
## InternetService    0.0255087997  0.0321856660  -0.178920961
0.123256160
## OnlineBackup       0.0109330759  0.0022827775   0.166565591
0.178163964
## OnlineSecurity     0.0846908407  0.0040764789   0.117324590
0.145097370
## DeviceProtection   0.0510854523 -0.0071785152   0.174700623
0.135218601
## TechSupport        0.0362780999 -0.0046572109   0.089640054
0.135001107
## StreamingTV        -0.0115297760  0.0212218090   0.347922814
0.082047320
## StreamingMovies    0.0088289399  0.0135550435   0.338214078
0.089104435
## Contract           -0.0848271864  0.0186530455   0.252273697
0.071759542
## PaperlessBilling   1.0000000000 -0.0219273902   0.179587522 -
0.013772828
## PaymentMethod      -0.0219273902  1.0000000000   0.091868757 -
0.072081851
## MonthlyCharges     0.1795875220  0.0918687568   1.000000000 -
0.460719561
## TotalCharges       -0.0137728282 -0.0720818510  -0.460719561
1.000000000

temp <- influence.measures(fit)
temp

## Influence measures of
## lm(formula = Churn ~ gender + SeniorCitizen + Partner + Dependents +
tenure + PhoneService + MultipleLines + InternetService + OnlineBackup +
OnlineSecurity + DeviceProtection + TechSupport + StreamingTV +
StreamingMovies + 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 |

```

## 3952 -1.42e-02 -2.28e-03 8.07e-03 2.50e-02 -1.17e-02 -3.08e-03 -5.72e-02
## 3953 -6.36e-03 -7.45e-04 -3.59e-03 -4.53e-03 -2.34e-03 8.65e-04 1.96e-02
## 3954 1.22e-02 -3.13e-03 1.57e-02 -5.92e-04 -1.02e-02 4.97e-04 5.44e-02
## 3955 6.63e-03 3.74e-03 -1.21e-02 1.27e-02 -6.72e-03 1.29e-02 5.94e-02
## 3956 1.41e-02 -4.97e-03 2.99e-03 -2.44e-03 -5.36e-03 5.75e-03 -3.78e-02
## 3957 1.27e-04 -6.65e-04 -1.96e-03 4.13e-04 -2.35e-03 5.77e-03 -1.28e-02
## 3958 1.05e-04 2.44e-04 5.06e-04 -4.23e-06 2.11e-04 5.96e-04 1.57e-03
## 3959 -3.02e-03 8.59e-03 -3.05e-03 1.10e-02 -4.89e-03 9.44e-03 4.97e-02
## 3960 5.98e-05 -4.37e-04 3.41e-04 6.60e-06 9.07e-05 -9.52e-04 -2.15e-03
## 3961 -4.40e-04 -4.29e-04 1.37e-03 2.64e-03 -1.04e-03 -5.07e-04 7.35e-03
## 3962 1.42e-04 -3.43e-05 -2.28e-03 3.36e-03 -2.87e-03 7.42e-03 -1.52e-02
## 3963 1.77e-02 8.97e-03 -1.33e-02 -1.77e-02 2.85e-02 1.27e-03 6.79e-02
## 3964 -4.16e-04 -1.12e-04 2.16e-04 -9.32e-05 -4.05e-06 -2.40e-05 9.55e-04
## 3965 4.77e-04 -5.98e-02 -1.76e-02 2.62e-02 2.23e-02 -1.35e-02 -1.19e-01
## 3966 1.10e-03 -7.00e-03 -4.73e-03 -6.67e-03 -2.48e-03 7.09e-05 2.13e-02
## 3967 -4.15e-03 -3.26e-03 -5.30e-03 -1.72e-03 -1.14e-03 -3.47e-03 2.54e-02
## 3968 -8.64e-03 6.91e-04 8.77e-03 1.11e-02 -6.05e-03 -4.42e-03 3.46e-02
## 3969 1.71e-02 -1.72e-03 3.09e-03 6.88e-03 -5.33e-03 2.35e-03 -4.49e-02
## 3970 -1.18e-02 -8.14e-03 1.80e-02 2.27e-03 1.21e-02 -3.43e-02 -8.08e-02
## 3971 8.76e-05 1.47e-03 -1.02e-03 -6.31e-05 6.87e-04 9.37e-04 5.47e-03
## 3972 -1.97e-02 4.41e-03 3.84e-02 2.24e-02 3.84e-02 -2.87e-02 8.93e-02
## 3973 2.97e-05 -1.73e-04 7.31e-04 4.10e-05 -2.04e-05 8.10e-04 -1.95e-03
## 3974 1.03e-02 8.95e-03 3.75e-03 -6.98e-03 -3.13e-03 1.52e-02 -5.30e-02
## 3975 -3.43e-02 8.21e-03 4.07e-02 4.38e-03 2.38e-02 -1.53e-02 9.66e-02
## 3976 1.77e-04 -1.59e-05 -1.30e-03 -4.08e-03 -1.67e-03 4.86e-03 -1.10e-02
## 3977 -1.14e-02 -1.04e-02 1.85e-02 3.97e-03 1.37e-02 -3.69e-02 -8.17e-02
## 3978 1.38e-04 2.59e-04 -2.05e-03 2.90e-03 -1.29e-03 5.50e-03 -1.23e-02
## 3979 -3.19e-04 -2.52e-03 -8.85e-03 -1.69e-02 -1.18e-02 -1.23e-03 4.91e-02
## 3980 -1.90e-03 -1.12e-03 -1.13e-03 -1.92e-03 -1.46e-03 -6.92e-04 -4.85e-03
## 3981 -1.28e-02 -5.35e-03 6.77e-03 -3.15e-03 -1.63e-02 2.30e-03 -3.92e-02
## 3982 2.06e-03 -8.07e-04 -1.47e-03 -3.20e-04 -1.82e-03 -8.73e-04 6.60e-03
## 3983 -2.53e-02 -4.05e-03 -1.31e-02 -3.53e-04 -7.59e-03 8.91e-03 6.67e-02
## 3984 -1.66e-02 1.34e-03 -6.78e-03 4.68e-03 2.54e-02 -1.51e-02 7.27e-02
## 3985 2.10e-02 6.29e-04 5.71e-03 -3.19e-03 -1.41e-02 2.46e-02 -6.21e-02
## 3986 1.41e-03 -1.47e-03 -2.01e-03 -3.32e-03 1.67e-03 -6.36e-04 -8.32e-03
## 3987 -5.21e-03 -3.74e-03 -5.61e-03 -6.13e-03 -2.08e-03 -7.94e-04 -2.91e-02
## 3988 8.97e-03 -1.50e-02 2.76e-03 2.64e-03 3.57e-03 -1.58e-02 -7.67e-02
## 3989 -1.97e-02 1.50e-02 1.68e-02 3.43e-02 -2.91e-02 -1.43e-03 -9.95e-02
## 3990 9.23e-05 3.19e-03 7.04e-04 1.60e-03 -1.74e-04 5.88e-04 5.49e-03
## 3991 -1.96e-03 1.84e-03 -1.14e-03 1.23e-04 7.39e-05 4.23e-06 6.40e-03
## 3992 3.54e-04 -4.09e-03 2.57e-03 3.64e-03 4.54e-06 -1.26e-03 1.10e-02
## 3993 -1.08e-02 -9.96e-03 6.47e-03 -8.17e-04 -1.34e-02 -5.37e-04 -4.16e-02
## 3994 -9.85e-03 -1.43e-02 -2.94e-03 1.10e-02 -7.98e-03 3.85e-03 6.96e-02
## 3995 -2.74e-04 1.42e-02 -4.77e-03 -9.63e-03 4.84e-03 7.54e-04 3.35e-02
## 3996 -7.92e-03 -1.78e-03 5.22e-03 4.14e-03 4.30e-03 -5.53e-04 -1.97e-02
## 3997 1.49e-05 5.66e-04 1.96e-04 5.11e-04 9.40e-05 -1.65e-04 1.34e-03
## 3998 -4.53e-03 -2.70e-03 6.28e-03 4.01e-03 2.75e-03 2.51e-03 -2.19e-02
## 3999 1.16e-02 1.26e-02 3.27e-02 -1.45e-02 5.67e-02 -2.76e-02 -9.76e-02
## cov.r cook.d hat inf
## 1 1.003 2.41e-04 0.00382

```

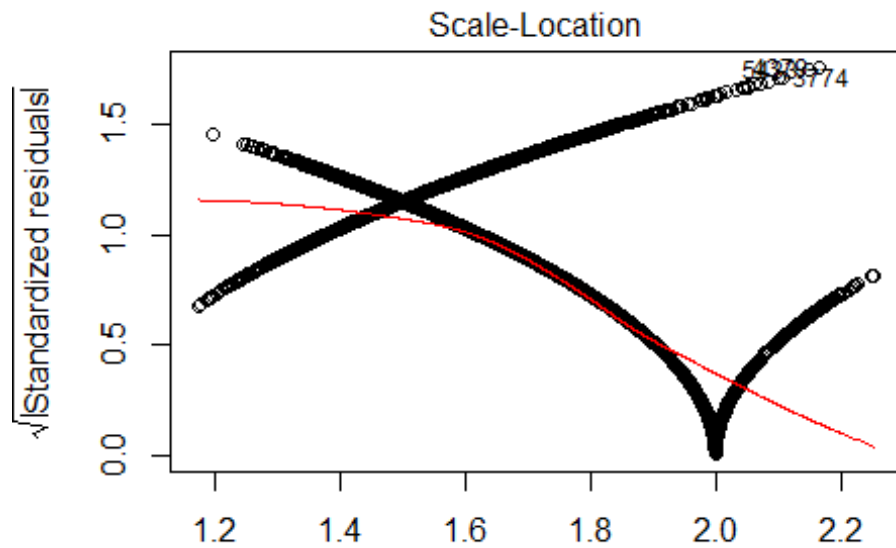

| | | | |
|-------|-------|----------|---------|
| ## 2 | 1.005 | 1.41e-05 | 0.00278 |
| ## 3 | 0.996 | 4.16e-04 | 0.00255 |
| ## 4 | 1.007 | 5.18e-06 | 0.00377 |
| ## 5 | 1.001 | 7.54e-05 | 0.00132 |
| ## 6 | 1.004 | 6.40e-05 | 0.00226 |
| ## 7 | 1.000 | 2.91e-04 | 0.00300 |
| ## 8 | 1.004 | 1.08e-04 | 0.00314 |
| ## 9 | 1.001 | 2.12e-04 | 0.00255 |
| ## 10 | 1.006 | 7.80e-06 | 0.00368 |
| ## 11 | 1.004 | 7.10e-05 | 0.00251 |
| ## 12 | 1.005 | 1.29e-06 | 0.00220 |
| ## 13 | 1.004 | 7.12e-05 | 0.00249 |
| ## 14 | 0.997 | 3.03e-04 | 0.00226 |
| ## 15 | 1.002 | 1.96e-04 | 0.00305 |
| ## 16 | 1.005 | 2.60e-06 | 0.00240 |
| ## 17 | 1.005 | 2.88e-07 | 0.00217 |
| ## 18 | 1.007 | 4.66e-06 | 0.00452 |
| ## 19 | 0.994 | 6.71e-04 | 0.00315 |
| ## 20 | 1.000 | 2.47e-04 | 0.00269 |
| ## 21 | 1.003 | 3.19e-04 | 0.00417 |
| ## 22 | 1.005 | 8.57e-06 | 0.00258 |
| ## 23 | 0.992 | 4.10e-04 | 0.00178 |
| ## 24 | 1.006 | 6.10e-07 | 0.00332 |
| ## 25 | 1.006 | 2.12e-06 | 0.00320 |
| ## 26 | 1.005 | 3.57e-05 | 0.00272 |
| ## 27 | 0.998 | 2.94e-04 | 0.00235 |
| ## 28 | 0.998 | 5.74e-04 | 0.00377 |
| ## 29 | 1.005 | 6.21e-06 | 0.00203 |
| ## 30 | 0.999 | 3.96e-04 | 0.00331 |
| ## 31 | 1.007 | 1.29e-06 | 0.00366 |
| ## 32 | 0.995 | 6.74e-04 | 0.00340 |
| ## 33 | 1.006 | 1.20e-06 | 0.00287 |
| ## 34 | 1.005 | 2.66e-05 | 0.00264 |
| ## 35 | 1.003 | 1.76e-04 | 0.00333 |
| ## 36 | 1.007 | 7.77e-06 | 0.00374 |
| ## 37 | 1.000 | 8.13e-05 | 0.00127 |
| ## 38 | 1.003 | 1.07e-04 | 0.00278 |
| ## 39 | 1.000 | 1.57e-04 | 0.00195 |
| ## 40 | 1.003 | 9.84e-05 | 0.00252 |
| ## 41 | 1.005 | 5.75e-05 | 0.00299 |
| ## 42 | 1.006 | 1.80e-06 | 0.00339 |
| ## 43 | 1.004 | 4.22e-06 | 0.00154 |
| ## 44 | 1.006 | 3.47e-06 | 0.00280 |
| ## 45 | 1.005 | 1.64e-04 | 0.00409 |
| ## 46 | 1.002 | 1.68e-04 | 0.00251 |
| ## 47 | 1.003 | 8.57e-05 | 0.00224 |
| ## 48 | 1.002 | 7.87e-05 | 0.00188 |
| ## 49 | 1.006 | 5.27e-06 | 0.00309 |
| ## 50 | 1.006 | 1.13e-05 | 0.00294 |
| ## 51 | 1.001 | 2.26e-04 | 0.00272 |

```
## 52    1.002 2.45e-04 0.00319
## 53    1.005 1.64e-04 0.00442
## 3952  1.001 1.64e-04 0.00223
## 3953  1.006 1.92e-05 0.00365
## 3954  1.003 1.48e-04 0.00291
## 3955  1.003 1.76e-04 0.00310
## 3956  1.004 7.15e-05 0.00269
## 3957  1.005 8.14e-06 0.00252
## 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
```

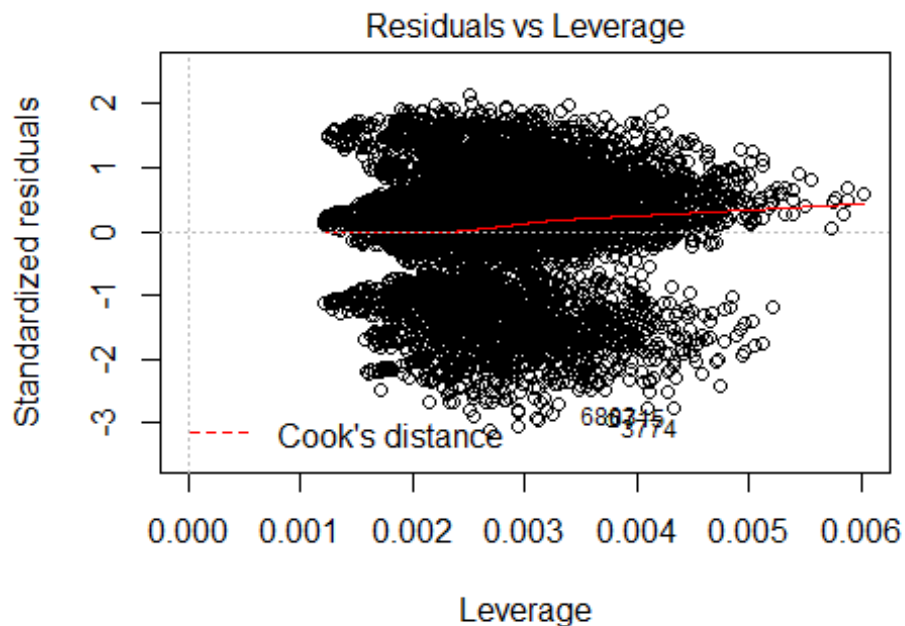
*

```
## 3999 0.995 4.76e-04 0.00269
## [ reached 'max' / getOption("max.print") -- omitted 3033 rows ]

##Diagnostics Plots for visualization
plot(fit)
```

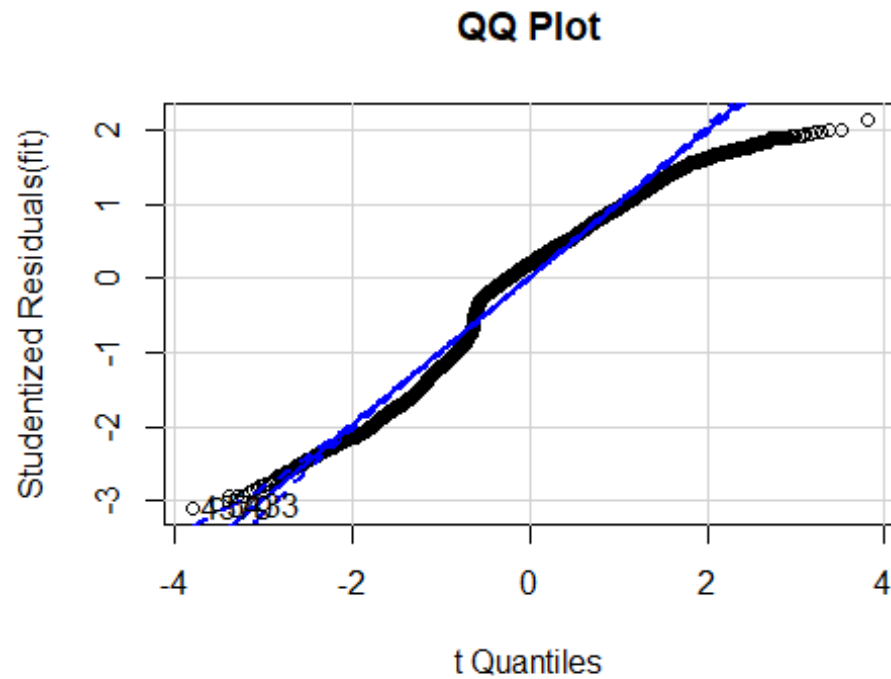
Churn ~ gender + SeniorCitizen + Partner + Dependents + tenure + Ph



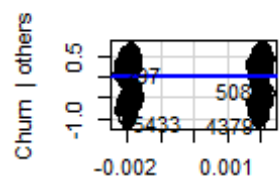
Churn ~ gender + SeniorCitizen + Partner + Dependents + tenure + Ph

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

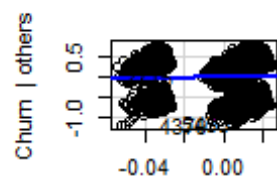
```
## No Studentized residuals with Bonferroni p < 0.05
## Largest |rstudent|:
##      rstudent unadjusted p-value Bonferroni p
## 4379 -3.101834          0.0019309          NA
qqPlot(fit, main="QQ Plot")
```



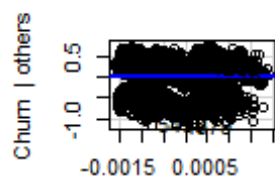
```
## [1] 4379 5433
#Plotting Leverage plots
leveragePlots(fit)
```



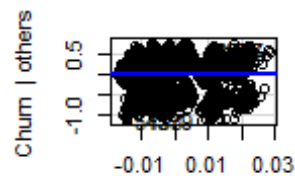
gender | others



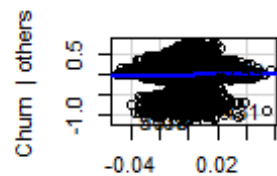
SeniorCitizen | others



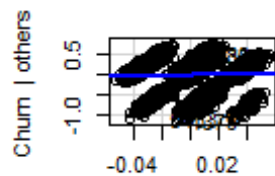
Partner | others



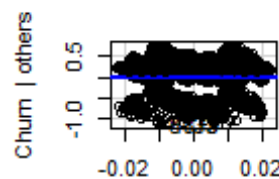
Dependents | others



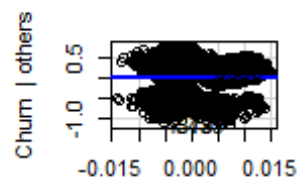
tenure | others



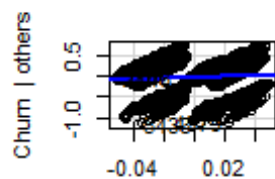
PhoneService | others



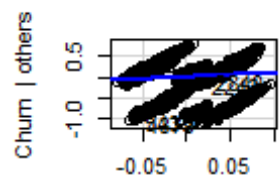
MultipleLines | others



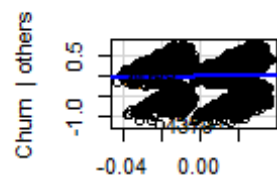
InternetService | others



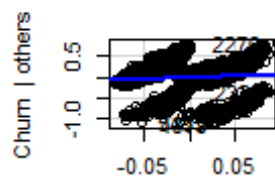
OnlineBackup | others



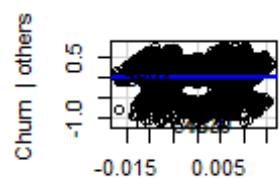
OnlineSecurity | others



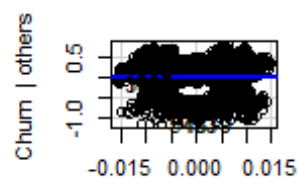
DeviceProtection | others



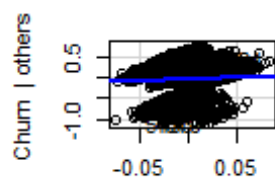
TechSupport | others



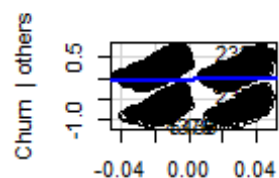
StreamingTV | others



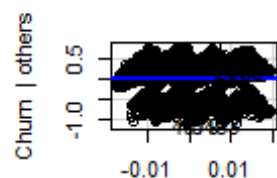
StreamingMovies | others



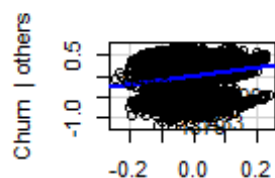
Contract | others



PaperlessBilling | others

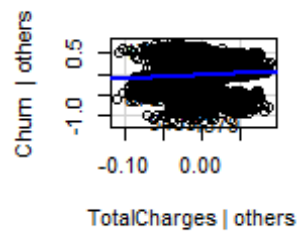


PaymentMethod | others



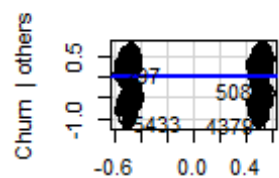
MonthlyCharges | others

Leverage Plots

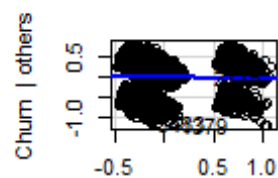


Plotting variable plots for Influential Observations

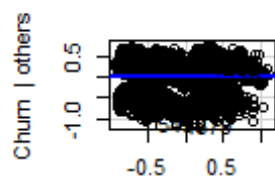
avPlots(fit)



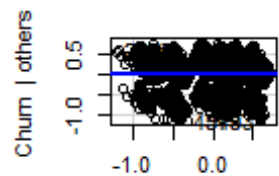
gender | others



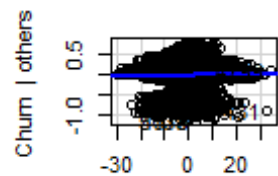
SeniorCitizen | others



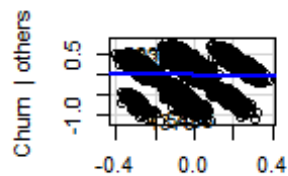
Partner | others



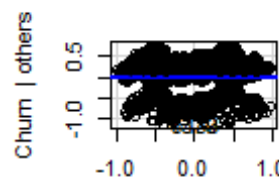
Dependents | others



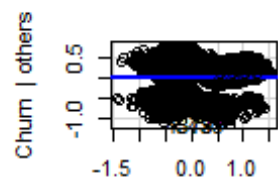
tenure | others



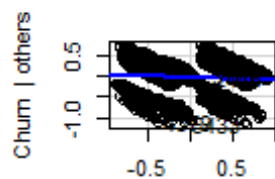
PhoneService | others



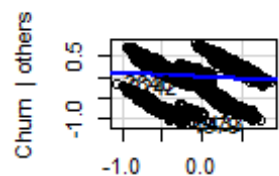
MultipleLines | others



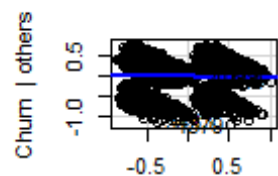
InternetService | others



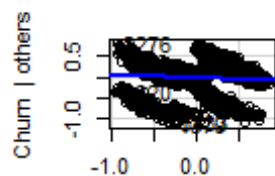
OnlineBackup | others



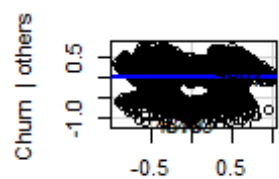
OnlineSecurity | others



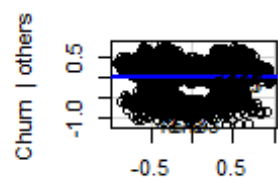
DeviceProtection | others



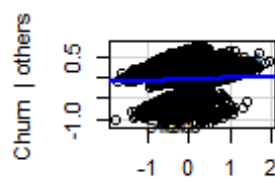
TechSupport | others



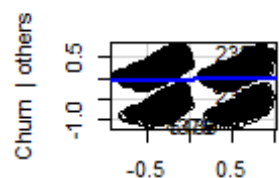
StreamingTV | others



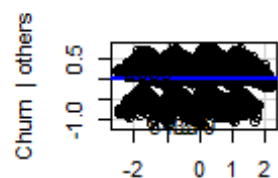
StreamingMovies | others



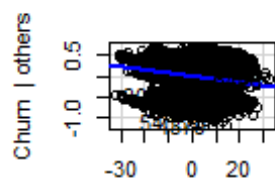
Contract | others



PaperlessBilling | others

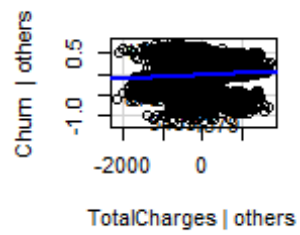


PaymentMethod | others

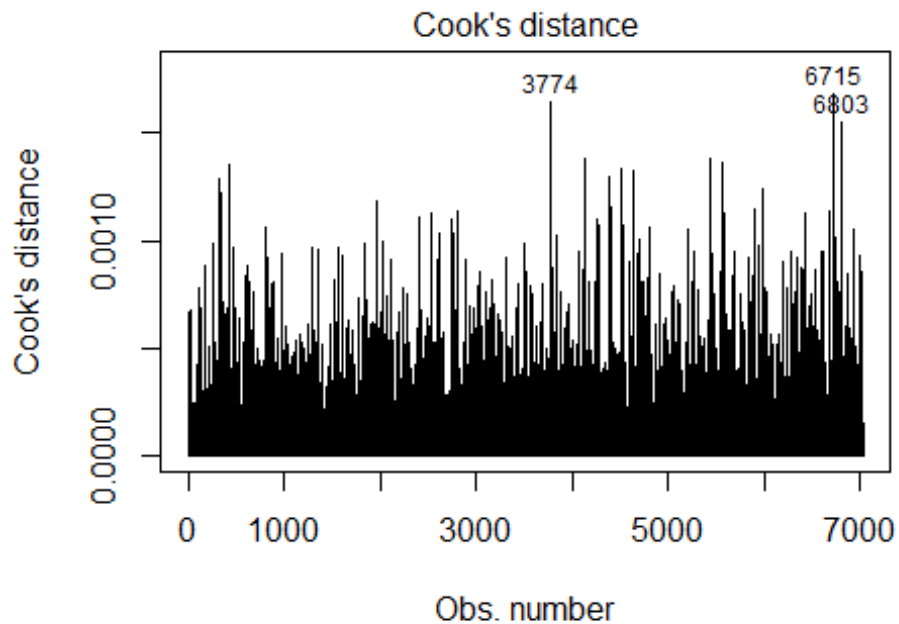


MonthlyCharges | others

Added-Variable Plots

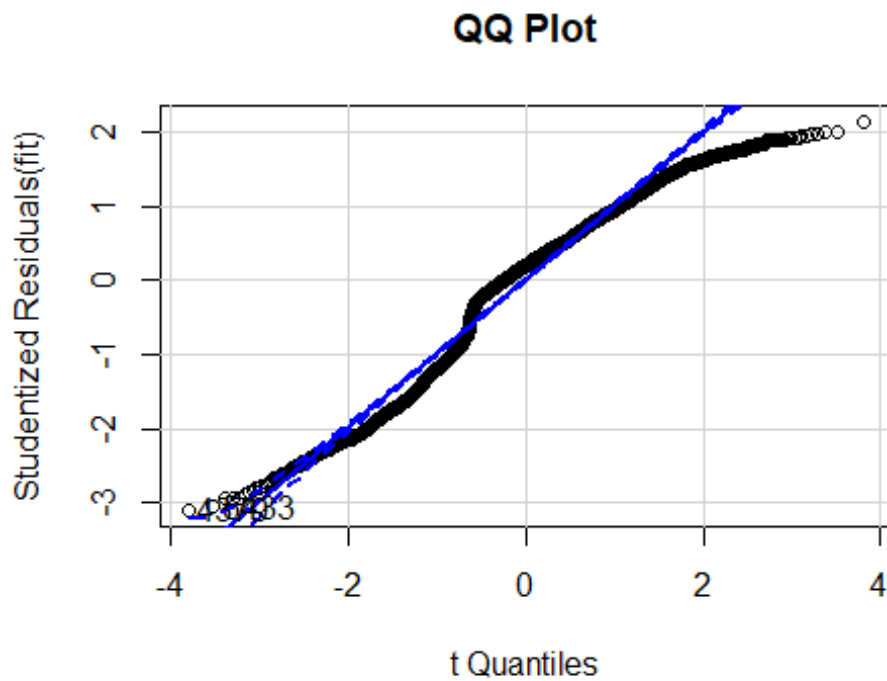


```
# Cook's D plot  
# identify D values > 4/(n-k-1)  
cutoff <- 4/((nrow(custc)-length(fit$coefficients)-2))  
plot(fit, which=4, cook.levels=cutoff)
```



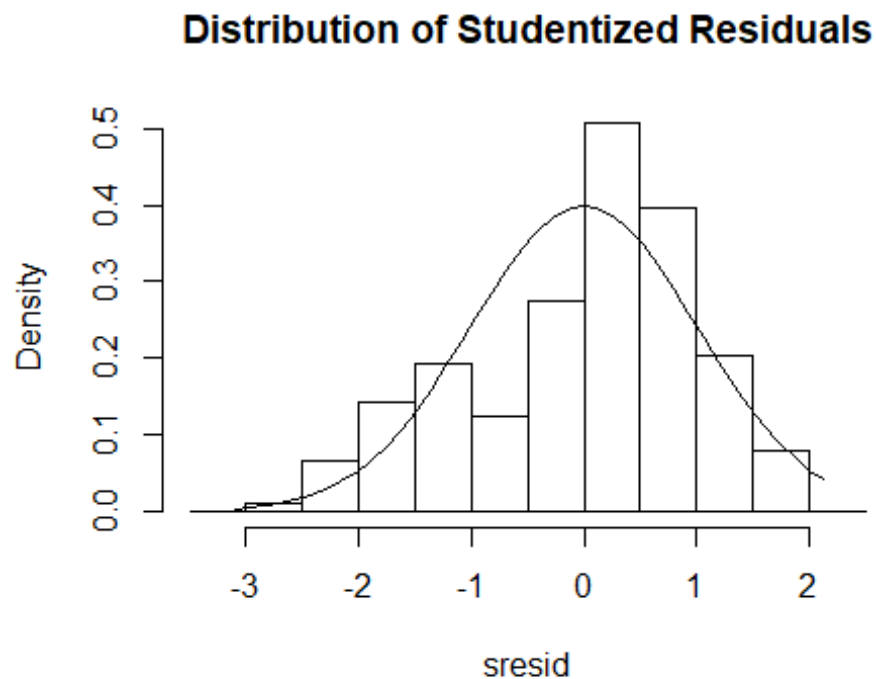
Churn ~ gender + SeniorCitizen + Partner + Dependents + tenure + Ph

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



```
## [1] 4379 5433

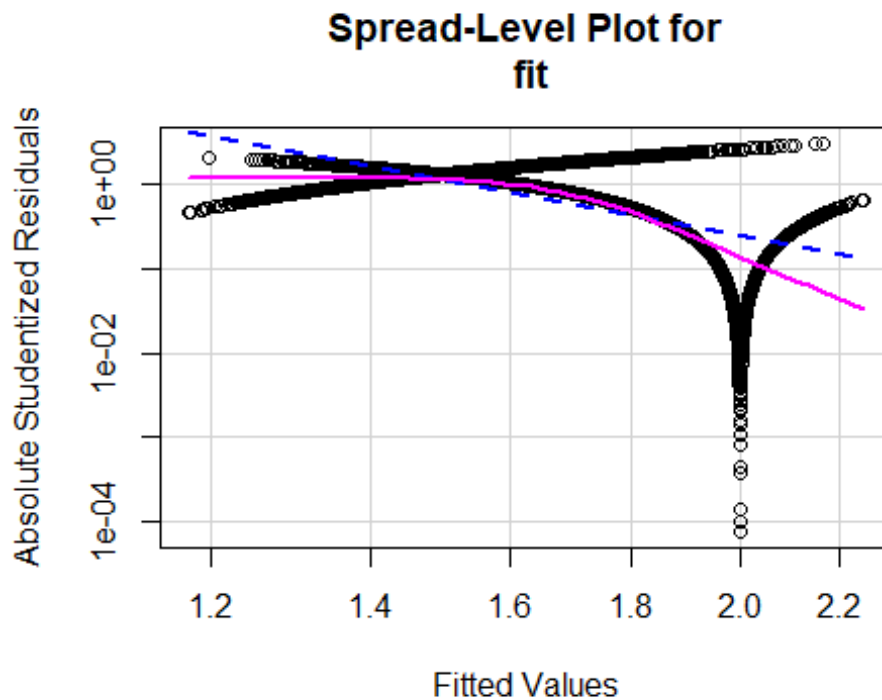
#Distribution of studentized residuals
sresid <- studres(fit)
hist(sresid, freq=FALSE,
     main="Distribution of Studentized Residuals")
xfit<-seq(min(sresid),max(sresid),length=40)
yfit<-dnorm(xfit)
lines(xfit, yfit)
```



```
#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

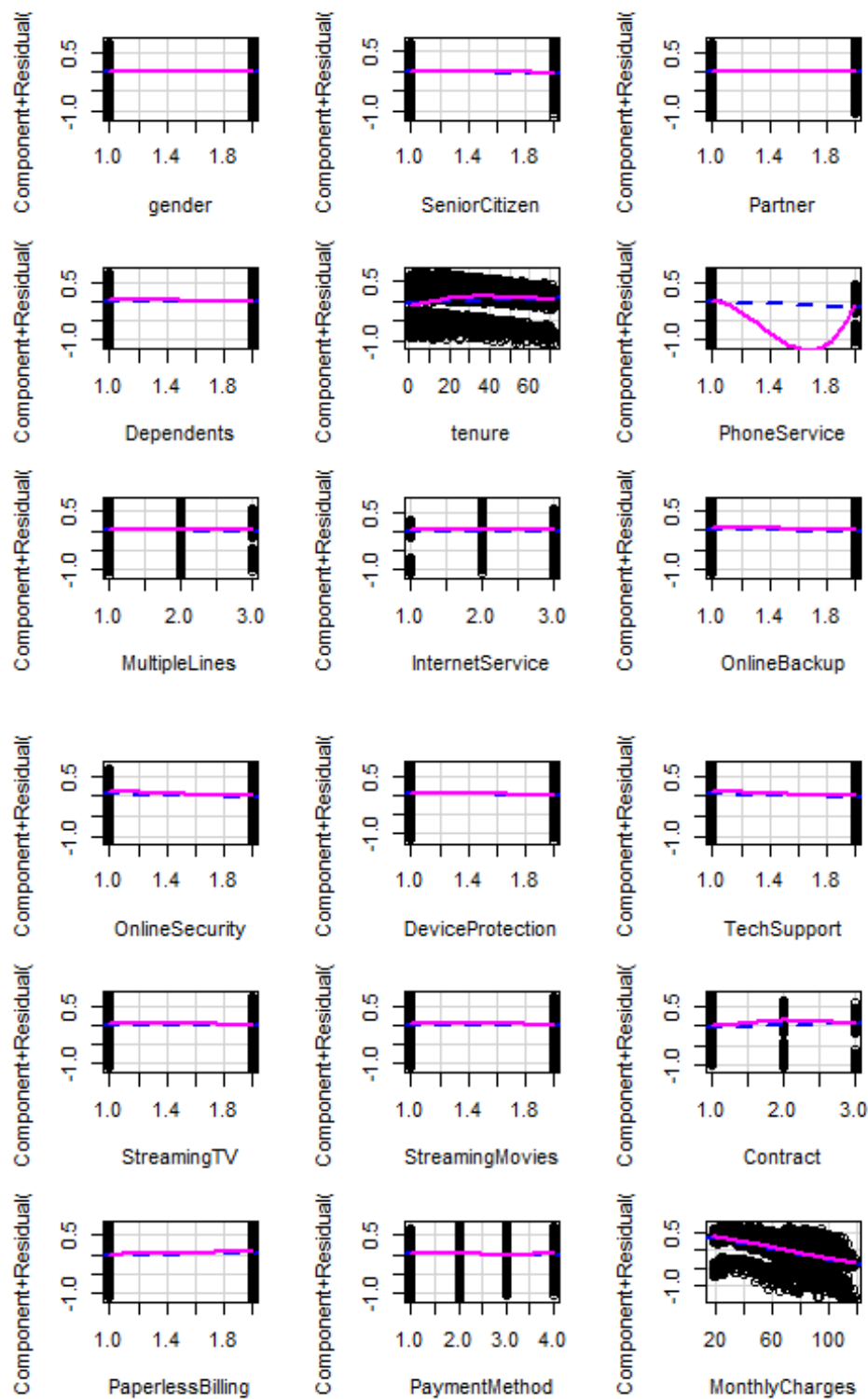
#Multi-collinearity
# Evaluate Collinearity
vif(fit) # variance inflation factors
```

| | | | | |
|----|---------------|-----------------|------------------|------------------|
| ## | 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 | |

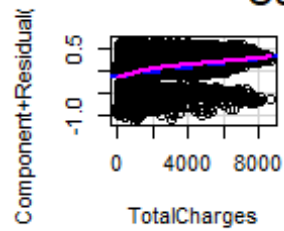
```
sqrt(vif(fit)) > 2
```

| | | | | |
|----|--------------|-----------------|------------------|------------------|
| ## | 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



#Non-independence of Errors

Test for Autocorrelated Errors

`durbinWatsonTest(fit)`

```
## lag Autocorrelation D-W Statistic p-value
```

```
## 1 -0.001775994 2.003372 0.92
```

```
## Alternative hypothesis: rho != 0
```

#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)

##
## 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
PaperlessBilling, not using OnlineSecurity
##and TechSupport, having contract of 2 years, MonthlyCharges and
TotalCharges being 100 &1000 respectively
##there is a likelihood of this customer churning

```