Project

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1.Introduction

For an Auto Insurance company, predict the customer lifetime value (CLV). CLV is the total revenue the client will derive from their entire relationship with a customer. Because we don't know how long each customer relationship will be, we make a good estimate and state CLV as a periodic value

```
#Import data from Excel
library(readxl)
setwd("D:/Project/Insurance value")
df = read_excel("Insurance_Marketing-Customer-Value-Analysis.xlsx")
head(df)
```

```
## # A tibble: 6 x 24
##   Customer State `Customer Lifet~ Response Coverage Education
##   <chr>    <chr>            <dbl> <chr>    <chr>    <chr>
## 1 BU79786  Wash~            2764. No       Basic    Bachelor
## 2 QZ44356  Ariz~            6980. No       Extended Bachelor
## 3 AI49188  Neva~           12887. No       Premium  Bachelor
## 4 WW63253  Cali~            7646. No       Basic    Bachelor
## 5 HB64268  Wash~            2814. No       Basic    Bachelor
## 6 OC83172  Oreg~            8256. Yes      Basic    Bachelor
## # ... with 18 more variables: `Effective To Date` <dttm>,
## #   EmploymentStatus <chr>, Gender <chr>, Income <dbl>, `Location
## #   Code` <chr>, `Marital Status` <chr>, `Monthly Premium Auto` <dbl>,
## #   `Months Since Last Claim` <dbl>, `Months Since Policy
## #   Inception` <dbl>, `Number of Open Complaints` <dbl>, `Number of
## #   Policies` <dbl>, `Policy Type` <chr>, Policy <chr>, `Renew Offer
## #   Type` <chr>, `Sales Channel` <chr>, `Total Claim Amount` <dbl>,
## #   `Vehicle Class` <chr>, `Vehicle Size` <chr>
```

2. Visualisation Data

```
dim(df)
```

```
## [1] 9134   24
```

```
#Data contain 9134 rows and 24 columns
```

```r
# Check missing values
colSums(is.na(df))
```

```
##                      Customer                         State
##                             0                             0
##       Customer Lifetime Value                      Response
##                             0                             0
##                      Coverage                     Education
##                             0                             0
##             Effective To Date              EmploymentStatus
##                             0                             0
##                        Gender                        Income
##                             0                             0
##                 Location Code                Marital Status
##                             0                             0
##          Monthly Premium Auto       Months Since Last Claim
##                             0                             0
## Months Since Policy Inception     Number of Open Complaints
##                             0                             0
##            Number of Policies                   Policy Type
##                             0                             0
##                        Policy              Renew Offer Type
##                             0                             0
##                 Sales Channel            Total Claim Amount
##                             0                             0
##                 Vehicle Class                  Vehicle Size
##                             0                             0
```

```r
str(df)
```

```
## Classes 'tbl_df', 'tbl' and 'data.frame':    9134 obs. of  24 variables:
##  $ Customer                     : chr  "BU79786" "QZ44356" "AI49188"
"WW63253" ...
##  $ State                        : chr  "Washington" "Arizona" "Nevada"
"California" ...
##  $ Customer Lifetime Value      : num  2764 6980 12887 7646 2814 ...
##  $ Response                     : chr  "No" "No" "No" "No" ...
##  $ Coverage                     : chr  "Basic" "Extended" "Premium"
"Basic" ...
##  $ Education                    : chr  "Bachelor" "Bachelor" "Bachelor"
"Bachelor" ...
##  $ Effective To Date            : POSIXct, format: "2011-02-24" "2011-01-
31" ...
##  $ EmploymentStatus             : chr  "Employed" "Unemployed" "Employed"
"Unemployed" ...
##  $ Gender                       : chr  "F" "F" "F" "M" ...
##  $ Income                       : num  56274 0 48767 0 43836 ...
##  $ Location Code                : chr  "Suburban" "Suburban" "Suburban"
"Suburban" ...
##  $ Marital Status               : chr  "Married" "Single" "Married"
```

```
"Married" ...
##  $ Monthly Premium Auto         : num  69 94 108 106 73 69 67 101 71 93
...
##  $ Months Since Last Claim      : num  32 13 18 18 12 14 0 0 13 17 ...
##  $ Months Since Policy Inception: num  5 42 38 65 44 94 13 68 3 7 ...
##  $ Number of Open Complaints    : num  0 0 0 0 0 0 0 0 0 0 ...
##  $ Number of Policies           : num  1 8 2 7 1 2 9 4 2 8 ...
##  $ Policy Type                  : chr  "Corporate Auto" "Personal Auto"
"Personal Auto" "Corporate Auto" ...
##  $ Policy                       : chr  "Corporate L3" "Personal L3"
"Personal L3" "Corporate L2" ...
##  $ Renew Offer Type             : chr  "Offer1" "Offer3" "Offer1" "Offer1"
...
##  $ Sales Channel                : chr  "Agent" "Agent" "Agent" "Call
Center" ...
##  $ Total Claim Amount           : num  385 1131 566 530 138 ...
##  $ Vehicle Class                : chr  "Two-Door Car" "Four-Door Car"
"Two-Door Car" "SUV" ...
##  $ Vehicle Size                 : chr  "Medsize" "Medsize" "Medsize"
"Medsize" ...
```

```
summary(df)
```

```
##    Customer            State           Customer Lifetime Value
##  Length:9134        Length:9134        Min.   : 1898
##  Class :character   Class :character   1st Qu.: 3994
##  Mode  :character   Mode  :character   Median : 5780
##                                        Mean   : 8005
##                                        3rd Qu.: 8962
##                                        Max.   :83325
##    Response           Coverage          Education
##  Length:9134        Length:9134        Length:9134
##  Class :character   Class :character   Class :character
##  Mode  :character   Mode  :character   Mode  :character
##
##
##
##  Effective To Date             EmploymentStatus      Gender
##  Min.   :2011-01-01 00:00:00   Length:9134        Length:9134
##  1st Qu.:2011-01-15 00:00:00   Class :character   Class :character
##  Median :2011-01-29 00:00:00   Mode  :character   Mode  :character
##  Mean   :2011-01-29 20:06:21
##  3rd Qu.:2011-02-13 00:00:00
##  Max.   :2011-02-28 00:00:00
##      Income      Location Code      Marital Status
##  Min.   :    0   Length:9134        Length:9134
##  1st Qu.:    0   Class :character   Class :character
##  Median :33890   Mode  :character   Mode  :character
##  Mean   :37657
##  3rd Qu.:62320
```

```
##  Max.   :99981
##  Monthly Premium Auto Months Since Last Claim
##  Min.   : 61.00       Min.   : 0.0
##  1st Qu.: 68.00       1st Qu.: 6.0
##  Median : 83.00       Median :14.0
##  Mean   : 93.22       Mean   :15.1
##  3rd Qu.:109.00       3rd Qu.:23.0
##  Max.   :298.00       Max.   :35.0
##  Months Since Policy Inception Number of Open Complaints
##  Min.   : 0.00                 Min.   :0.0000
##  1st Qu.:24.00                 1st Qu.:0.0000
##  Median :48.00                 Median :0.0000
##  Mean   :48.06                 Mean   :0.3844
##  3rd Qu.:71.00                 3rd Qu.:0.0000
##  Max.   :99.00                 Max.   :5.0000
##  Number of Policies Policy Type          Policy
##  Min.   :1.000      Length:9134        Length:9134
##  1st Qu.:1.000      Class :character   Class :character
##  Median :2.000      Mode  :character   Mode  :character
##  Mean   :2.966
##  3rd Qu.:4.000
##  Max.   :9.000
##  Renew Offer Type   Sales Channel      Total Claim Amount
##  Length:9134        Length:9134        Min.   :   0.099
##  Class :character   Class :character   1st Qu.: 272.258
##  Mode  :character   Mode  :character   Median : 383.945
##                                        Mean   : 434.089
##                                        3rd Qu.: 547.515
##                                        Max.   :2893.240
##  Vehicle Class      Vehicle Size
##  Length:9134        Length:9134
##  Class :character   Class :character
##  Mode  :character   Mode  :character
##
##
##
```

2.1 Data manipulation

```
#state
unique(df$State)
```

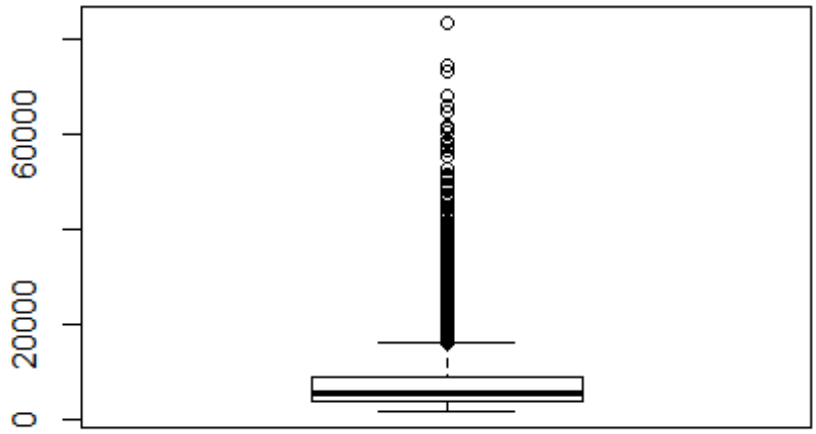
```
## [1] "Washington" "Arizona"    "Nevada"     "California" "Oregon"
```

```
table(df$State)
```

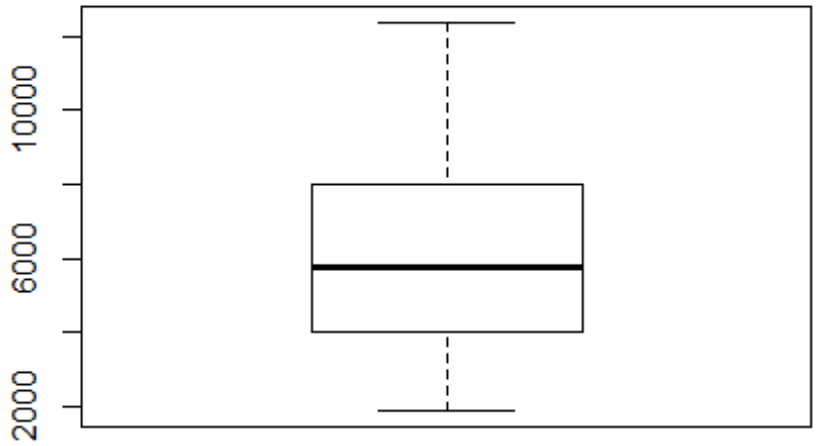
```
##
##    Arizona California     Nevada     Oregon Washington
##       1703       3150        882       2601        798
```

```
df$State = as.factor(df$State)
```

```r
#Customer Lifetime value
summary(df$`Customer Lifetime Value`)

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    1898    3994    5780    8005    8962   83325

boxplot(df$`Customer Lifetime Value`)
```




```r
df$`Customer Lifetime Value` = ifelse(df$`Customer Lifetime Value` >
15457,8005,
                                      df$`Customer Lifetime Value`)
summary(df$`Customer Lifetime Value`)

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    1898    3994    5780    6351    8005   15446

df$`Customer Lifetime Value` = ifelse(df$`Customer Lifetime Value` >
12367,6351,
                                      df$`Customer Lifetime Value`)
boxplot(df$`Customer Lifetime Value`)
```

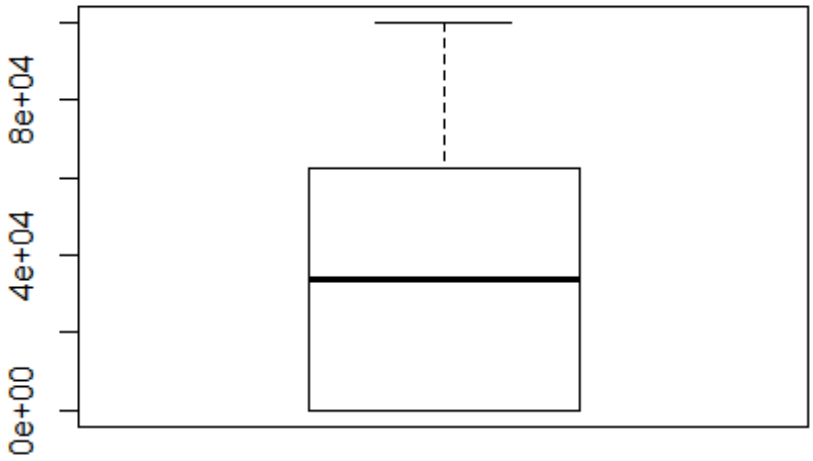



```
#Response
unique(df$Response)

## [1] "No"  "Yes"

df$Response = ifelse(df$Response == "Yes",1,0)

#Coverage
unique(df$Coverage)

## [1] "Basic"    "Extended" "Premium"

df$Coverage = as.factor(df$Coverage)

#Education
unique(df$Education)

## [1] "Bachelor"             "College"              "Master"
## [4] "High School or Below" "Doctor"

df$Education = factor(df$Education,
                      levels = c("High School or
Below","Bachelor","College","Master","Doctor"),
                      labels = c(0,1,1,1,2))
df$Education = as.numeric(df$Education)

For Schooling 0,
For Collage 1,
For Doctor 2
```

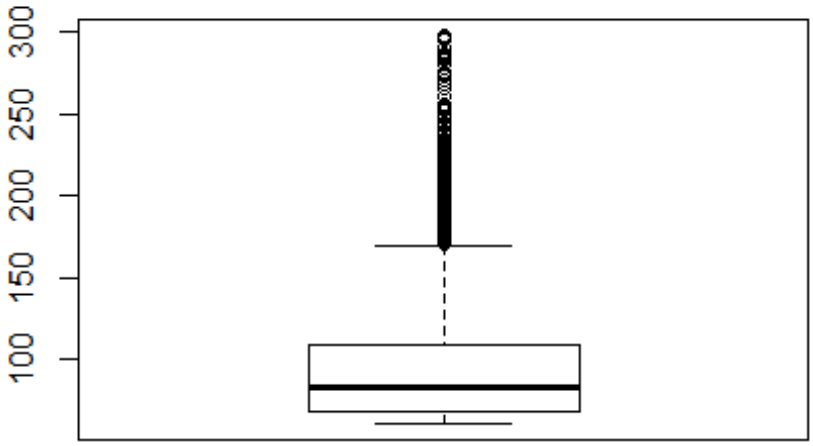
```r
#Effective TO Date
months = strftime(df$`Effective To Date`,"%m")
df$month = as.numeric(months)
days = strftime(df$`Effective To Date`,"%d")
df$day = as.numeric(days)
df$`Effective To Date` = NULL
```

Extrect months and days from date column

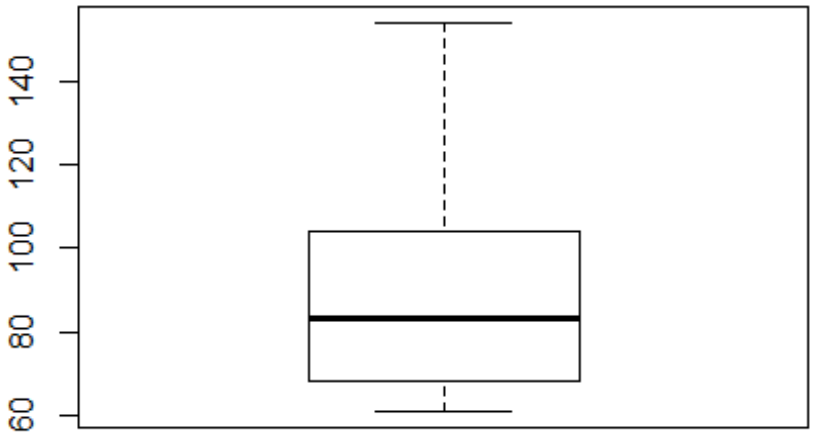
```r
#EmploymentStatus
unique(df$EmploymentStatus)

## [1] "Employed"      "Unemployed"    "Medical Leave" "Disabled"
## [5] "Retired"

df$EmploymentStatus = ifelse(df$EmploymentStatus == "Unemployed",0,1)

#Gender
unique(df$Gender)

## [1] "F" "M"

df$Gender  = ifelse(df$Gender == "M",1,0)

#INcome
summary(df$Income)

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##       0       0   33890   37657   62320   99981

boxplot(df$Income)
```




```
#Location code
unique(df$`Location Code`)

## [1] "Suburban" "Rural"    "Urban"

#Marital Status
df$`Marital Status` = ifelse(df$`Marital Status` == "Married",1,0)

#Monthly Premium
summary(df$`Monthly Premium Auto`)

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   61.00   68.00   83.00   93.22  109.00  298.00

boxplot(df$`Monthly Premium Auto`)
```



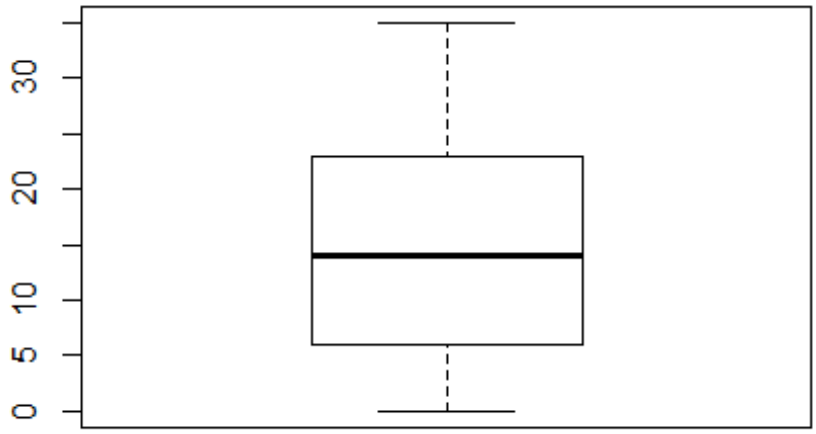

```
df$`Monthly Premium Auto` = ifelse(df$`Monthly Premium Auto` >
154,93,df$`Monthly Premium Auto`)
boxplot(df$`Monthly Premium Auto`)
```



```r
#months since last claim
summary(df$`Months Since Last Claim`)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     0.0     6.0    14.0    15.1    23.0    35.0
```

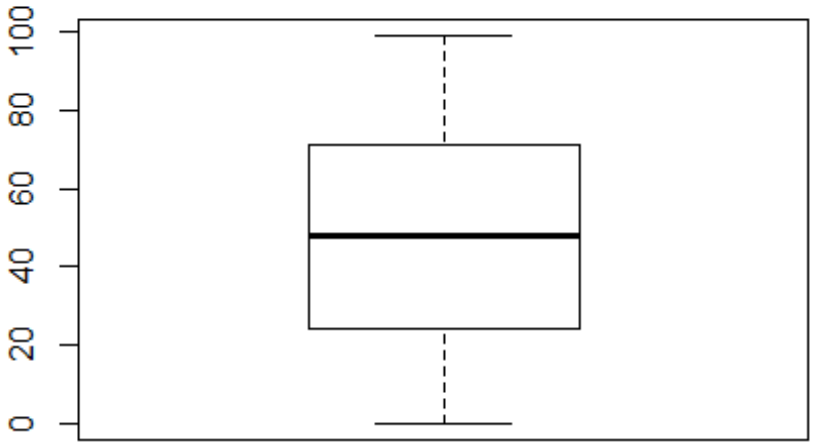
```r
boxplot(df$`Months Since Last Claim`)
```



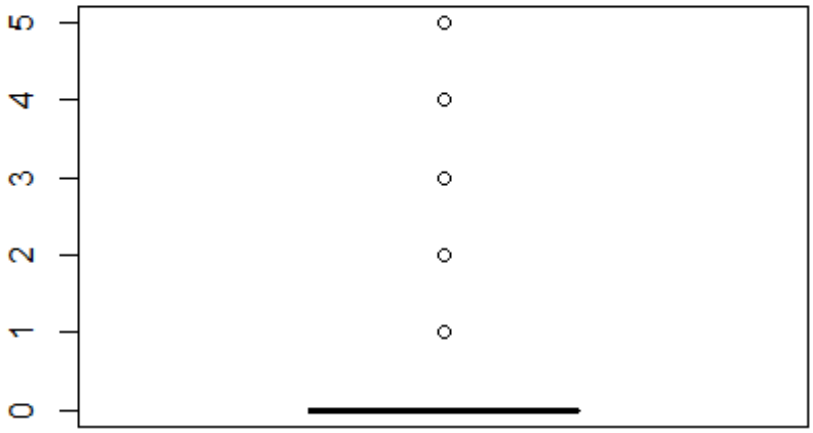

```r
#months since policy inception
summary(df$`Months Since Policy Inception`)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    0.00   24.00   48.00   48.06   71.00   99.00
```

```r
boxplot(df$`Months Since Policy Inception`)
```



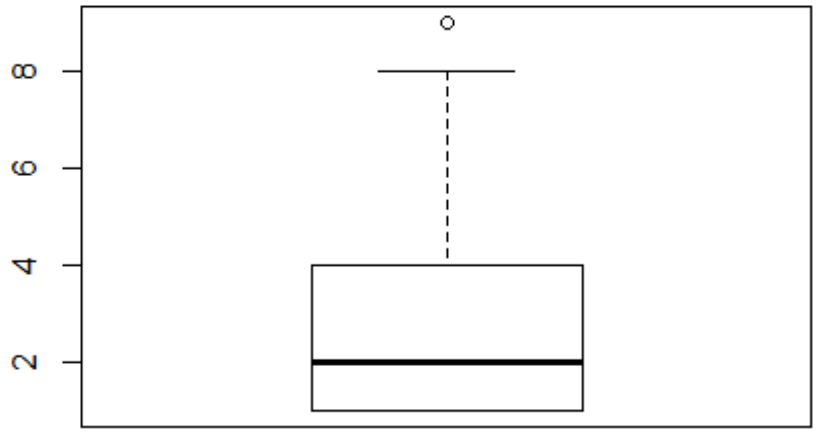

```
#number of open complaints
summary(df$`Number of Open Complaints`)

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  0.0000  0.0000  0.0000  0.3844  0.0000  5.0000

boxplot(df$`Number of Open Complaints`)
```



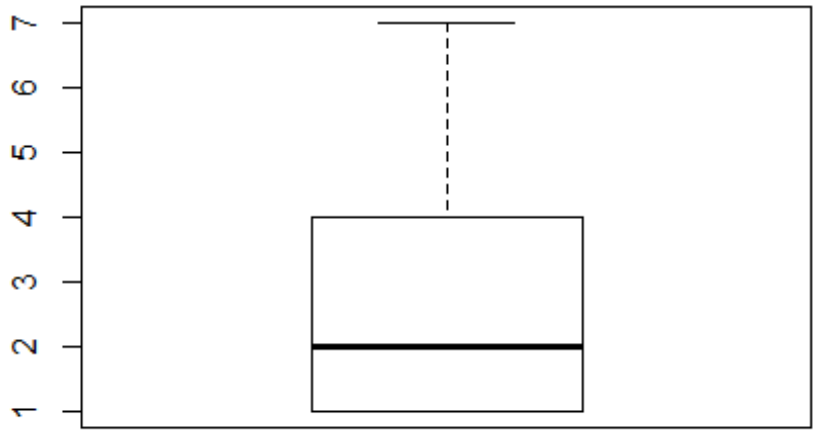

```
table(df$`Number of Open Complaints`)

##
##    0    1    2    3    4    5
## 7252 1011  374  292  149   56

df$`Number of Open Complaints` = NULL
```

This Variable is invariant

```
#number of policies
summary(df$`Number of Policies`)

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   1.000   1.000   2.000   2.966   4.000   9.000

boxplot(df$`Number of Policies`)
```




```r
df$`Number of Policies` = ifelse(df$`Number of Policies` > 7.5,7,df$`Number of Policies`)
boxplot(df$`Number of Policies`)
```



```r
#Policy Type
table(df$`Policy Type`)
```

```
##
## Corporate Auto  Personal Auto   Special Auto
##           1968           6788            378
```

```r
library(stringr)
#Policy
table(df$Policy)
```

```
##
## Corporate L1 Corporate L2 Corporate L3  Personal L1  Personal L2
##          359          595         1014         1240         2122
##  Personal L3   Special L1   Special L2   Special L3
##         3426           66          164          148
```

```r
df$Policy = str_sub(df$Policy,-1,-1)

#Renew offer type
table(df$`Renew Offer Type`)
```

```
##
## Offer1 Offer2 Offer3 Offer4
##   3752   2926   1432   1024
```

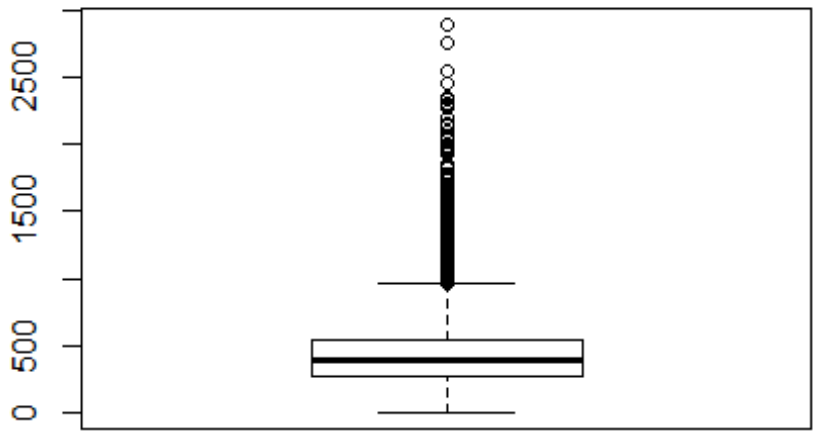
```r
df$`Renew Offer Type` = str_sub(df$`Renew Offer Type`,-1)

#Sales channel
table(df$`Sales Channel`)
```

```
##
##       Agent      Branch Call Center         Web
##        3477        2567        1765        1325
```

```r
#Total claim amount
summary(df$`Total Claim Amount`)
```

```
##     Min.  1st Qu.   Median     Mean  3rd Qu.     Max.
##    0.099  272.258  383.945  434.089  547.515 2893.240
```

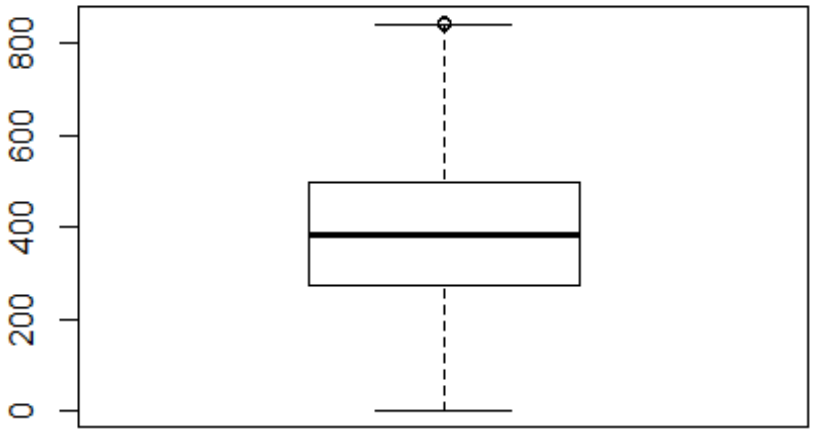
```r
boxplot(df$`Total Claim Amount`)
```




```
length(which(df$`Total Claim Amount` > 434 + (547.51-272.258)*1.5))
```

```
## [1] 693
```

```
df$`Total Claim Amount` = ifelse(df$`Total Claim Amount` > 847,434,df$`Total Claim Amount`)
boxplot(df$`Total Claim Amount`)
```




```
#Vehicle Class
table(df$`Vehicle Class`)

##
## Four-Door Car    Luxury Car    Luxury SUV    Sports Car           SUV
##          4621           163           184           484          1796
##  Two-Door Car
##          1886

df$`Vehicle Class` = factor(df$`Vehicle Class`,
                            levels = c("Luxury Car","Luxury SUV","Sports
Car","Four-Door Car","SUV","Two-Door Car"),
                            labels = c(3,3,3,2,2,1))
df$`Vehicle Class` = as.numeric(df$`Vehicle Class`)

#Vehicle size
table(df$`Vehicle Size`)

##
##   Large Medsize   Small
##     946    6424    1764

df$`Vehicle Size` = factor(df$`Vehicle Size`,
                           levels = c("Large","Medsize","Small"),
                           c(3,2,1))
df$`Vehicle Size` = as.numeric(df$`Vehicle Size`)
```

3. Modelling

```
df$`Number of Policies` = log(df$`Number of Policies`)
df$`Customer Lifetime Value` = log(df$`Customer Lifetime Value`)
df$`Monthly Premium Auto` = log(df$`Monthly Premium Auto`)
```

Dividing data into test and train

```
library(caTools)
set.seed(123)
split = sample.split(df$`Customer Lifetime Value`,SplitRatio = 0.8)
train = subset(df,split == TRUE)
test = subset(df,split == F)

#model 1
regg = lm(formula =  `Customer Lifetime Value` ~ . ,
          data = train[-1])
summary(regg)

##
## Call:
## lm(formula = `Customer Lifetime Value` ~ ., data = train[-1])
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -0.5815 -0.2397 -0.1211  0.1536  1.0873
##
## Coefficients:
##                                 Estimate Std. Error t value Pr(>|t|)
## (Intercept)                    5.553e+00  1.101e-01  50.457  < 2e-16 ***
## StateCalifornia                1.239e-02  1.077e-02   1.150  0.25001
## StateNevada                    1.007e-02  1.481e-02   0.680  0.49629
## StateOregon                    2.019e-02  1.115e-02   1.810  0.07034 .
## StateWashington               -1.130e-02  1.535e-02  -0.736  0.46164
## Response                       2.514e-03  1.130e-02   0.222  0.82402
## CoverageExtended               2.466e-02  9.488e-03   2.599  0.00937 **
## CoveragePremium                9.689e-02  1.464e-02   6.619 3.88e-11 ***
## Education                     -1.608e-02  7.403e-03  -2.172  0.02990 *
## EmploymentStatus               6.093e-02  1.279e-02   4.765 1.92e-06 ***
## Gender                        -4.562e-03  7.517e-03  -0.607  0.54395
## Income                         4.895e-07  1.901e-07   2.575  0.01005 *
## `Location Code`Suburban       -2.664e-02  1.694e-02  -1.573  0.11587
## `Location Code`Urban          -1.353e-02  1.485e-02  -0.911  0.36235
## `Marital Status`               1.279e-02  8.072e-03   1.584  0.11322
## `Monthly Premium Auto`         6.528e-01  2.317e-02  28.171  < 2e-16 ***
## `Months Since Last Claim`     -3.160e-04  3.722e-04  -0.849  0.39592
## `Months Since Policy Inception` 6.167e-05  1.348e-04   0.457  0.64737
## `Number of Policies`           3.486e-01  5.333e-03  65.366  < 2e-16 ***
## `Policy Type`Personal Auto     3.808e-03  9.117e-03   0.418  0.67623
## `Policy Type`Special Auto      2.768e-02  2.035e-02   1.360  0.17377
## Policy2                       -1.363e-02  1.101e-02  -1.238  0.21570
```

```
## Policy3                          -8.253e-03  1.019e-02  -0.810  0.41784
## `Renew Offer Type`2              -4.885e-02  9.276e-03  -5.267 1.43e-07 ***
## `Renew Offer Type`3              -2.535e-02  1.137e-02  -2.229  0.02587 *
## `Renew Offer Type`4              -2.705e-02  1.320e-02  -2.050  0.04042 *
## `Sales Channel`Branch            -1.150e-03  9.345e-03  -0.123  0.90204
## `Sales Channel`Call Center       -1.697e-03  1.048e-02  -0.162  0.87134
## `Sales Channel`Web               -1.243e-02  1.172e-02  -1.060  0.28909
## `Total Claim Amount`              5.516e-05  3.789e-05   1.456  0.14552
## `Vehicle Class`                  -6.231e-02  7.573e-03  -8.228 2.23e-16 ***
## `Vehicle Size`                    5.376e-03  7.036e-03   0.764  0.44489
## month                            -1.843e-02  7.529e-03  -2.448  0.01440 *
## day                              -7.784e-04  4.344e-04  -1.792  0.07321 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.3184 on 7273 degrees of freedom
## Multiple R-squared:  0.4932, Adjusted R-squared:  0.4909
## F-statistic: 214.5 on 33 and 7273 DF,  p-value: < 2.2e-16

#R-squared 0.491 and 0.03009
```

Remove Variables one-by-one to show p -value

```
#model2
regg = lm(formula =  `Customer Lifetime Value` ~ . ,
          data = train[-c(1,2,4,6,8,9,10,11,13,14,16,17,18,19,20,22,23,24)])
summary(regg)

##
## Call:
## lm(formula = `Customer Lifetime Value` ~ ., data = train[-c(1,
##     2, 4, 6, 8, 9, 10, 11, 13, 14, 16, 17, 18, 19, 20, 22, 23,
##     24)])
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -0.6106 -0.2406 -0.1232  0.1574  1.0833
##
## Coefficients:
##                          Estimate Std. Error t value Pr(>|t|)
## (Intercept)              5.364405   0.094636  56.685  < 2e-16 ***
## CoverageExtended         0.021742   0.009470   2.296   0.0217 *
## CoveragePremium          0.098941   0.014624   6.766 1.43e-11 ***
## EmploymentStatus         0.082378   0.008559   9.624  < 2e-16 ***
## `Monthly Premium Auto`   0.679752   0.019960  34.056  < 2e-16 ***
## `Number of Policies`     0.351984   0.005282  66.641  < 2e-16 ***
## `Vehicle Class`         -0.062766   0.007571  -8.290  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.3192 on 7300 degrees of freedom
```

```
## Multiple R-squared:  0.4888, Adjusted R-squared:  0.4884
## F-statistic:  1163 on 6 and 7300 DF,  p-value: < 2.2e-16

#R-squared 0.4888 and mape 0.03016

#Get the pridiction of fitted value
pred = predict(regg,newdata = test[-1])
test$pred = pred
Error = test$`Customer Lifetime Value` - test$pred

#Calculating MAPE
(sum((abs(test$`Customer Lifetime Value`-test$pred))/test$`Customer Lifetime
Value`))/nrow(test)

## [1] 0.03013484
```

Checking of Assumption

```
Residuals should be uncorrelated ##Autocorrelation
Null H0: residuals from a linear regression are uncorrelated. Value should be
close to 2.
Less than 1 and greater than 3 -> concern
Should get a high p value

library(car)

## Loading required package: carData

dwt(regg)

##  lag Autocorrelation D-W Statistic p-value
##    1    -0.005318895       2.01047   0.604
##  Alternative hypothesis: rho != 0

#Checking multicollinearity
vif(regg) # should be within 2. If it is greater than 10 then serious problem

##                            GVIF Df GVIF^(1/(2*Df))
## Coverage                1.443216  2        1.096056
## EmploymentStatus        1.000601  1        1.000301
## `Monthly Premium Auto` 1.628558  1        1.276150
## `Number of Policies`   1.000908  1        1.000454
## `Vehicle Class`        1.174774  1        1.083870
```

Heteroscedasticity

```
# Breusch-Pagan test
library(lmtest)

## Loading required package: zoo

##
## Attaching package: 'zoo'
```

```
## The following objects are masked from 'package:base':
##
##     as.Date, as.Date.numeric
```

```
bptest(regg)  # Null hypothesis -> error is homogenious (p value should be
more than 0.05)
```

```
##
##  studentized Breusch-Pagan test
##
## data:  regg
## BP = 810.54, df = 6, p-value < 2.2e-16
```

Normality testing Null hypothesis is data is normal.

```
resids = regg$residuals

library(nortest)
ad.test(resids)
```

```
##
##  Anderson-Darling normality test
##
## data:  resids
## A = 372.55, p-value < 2.2e-16
```

Anderson-Darling test for normality P- value is > 0.05