Churn Prediction

The churn rate, also known as the rate of attrition, is the percentage of subscribers to a service who discontinue their subscriptions to that service within a given time period. For a company to expand its clientele, its growth rate, as measured by the number of new customers, must exceed its churn rate.

Attribute Name	Description
State	categorical, for the 50 states and the District of Columbia
VoiceMail Plan	dichotomous categorical, yes or no
Account length	integer-valued, how long account has been active
Number of voice mail messages	integer-valued
Area code	categorical
Total day minutes	continuous, minutes customer used service during the day
Phone number	essentially a surrogate for customer ID
Total day calls	integer-valued
International Plan	dichotomous categorical, yes or no
Total day charge	continuous, perhaps based on foregoing two variables
Total evening minutes	continuous, minutes customer used service during the evening.
Total night charge	continuous, perhaps based on foregoing two variables
Total evening calls	integer-valued
Total international minutes	continuous, minutes customer used service to make international calls.
Total evening charge	continuous, perhaps based on foregoing two variables
Total international calls	integer-valued
Total night minutes	continuous, minutes customer used service during the night
Total international charge	continuous, perhaps based on foregoing two variables
Total night calls	integer-valued
Number of calls to customer service	integer-valued
Churn	Label indicating if customer churned

```
#------------------------Package Requirements--------------------------------------------
#required packages: ggplot2, randomForest, RWeka, dplyr
installedPackages = installed.packages()
installedPackages = installedPackages[,1]
requiredPackages = as.matrix(c('ggplot2','randomForest','RWeka','dplyr'))
installPackages<-function(package){
  searchResult<- grep(paste(package,"$",sep = ""),installedPackages)
  #print(length(searchResult))
  if(length(searchResult) == 0){
    print (paste(package,"not installed"))
    print("Downloading and Installing the package")
    install.packages(package)
  }
}
loadPackages<-function(package){
  print (paste("Loading",package))
```

```
  require(package,character.only = TRUE)
}
installingPackages <- apply(requiredPackages, 1, installPackages)
loadingPackages <- apply(requiredPackages, 1, loadPackages)
```

```
## [1] "Loading ggplot2"

## Loading required package: ggplot2

## [1] "Loading randomForest"

## Loading required package: randomForest

## randomForest 4.6-12

## Type rfNews() to see new features/changes/bug fixes.

##
## Attaching package: 'randomForest'

## The following object is masked from 'package:ggplot2':
##
##     margin

## [1] "Loading RWeka"

## Loading required package: RWeka

## [1] "Loading dplyr"

## Loading required package: dplyr

##
## Attaching package: 'dplyr'

## The following object is masked from 'package:randomForest':
##
##     combine

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

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

```r
# Check for the Directory of the R language
getwd()
```

```
## [1] "C:/Users/shant/OneDrive/Documents/Fall 2016/Survey of Programming Languages/Churn-Prediction"
```

```r
#copy the churn_tel.csv to this location, view the files present in the directory
dir()
```

```
##  [1] "boxplots_CallsChargeMin.R" "catAttrExploration.R"
##  [3] "Churn-Prediction.Rproj"    "churn_tel.csv"
##  [5] "churnPrediction.html"      "churnPrediction.pdf"
##  [7] "churnPrediction.Rmd"       "contAttrExploration.R"
##  [9] "exploreData.R"             "firstforest.csv"
## [11] "installAndLoadPackages.R"  "j48decisionTree.R"
## [13] "loadData.R"                "project_spl.R"
## [15] "randomForestTest.R"        "README.md"
## [17] "scatterplot_ggally.R"      "tTest.R"
```

```r
#import the file in the above directory, then read it here
churn <- read.csv("churn_tel.csv")
# Compactly Display the Structure of churn dataset
str(churn)
```

```
## 'data.frame':    3333 obs. of  21 variables:
##  $ State         : Factor w/ 51 levels "AK","AL","AR",..: 17 36 32 36 37 2 20 25 19 50 ...
##  $ Account.Length: int  128 107 137 84 75 118 121 147 117 141 ...
##  $ Area.Code     : int  415 415 415 408 415 510 510 415 408 415 ...
##  $ Phone         : Factor w/ 3333 levels "327-1058","327-1319",..: 1927 1576 1118 1708 111 2254 1048
##  $ Int.l.Plan    : Factor w/ 2 levels "no","yes": 1 1 1 2 2 2 1 2 1 2 ...
##  $ VMail.Plan    : Factor w/ 2 levels "no","yes": 2 2 1 1 1 1 2 1 1 2 ...
##  $ VMail.Message : int  25 26 0 0 0 0 24 0 0 37 ...
##  $ Day.Mins      : num  265 162 243 299 167 ...
##  $ Day.Calls     : int  110 123 114 71 113 98 88 79 97 84 ...
##  $ Day.Charge    : num  45.1 27.5 41.4 50.9 28.3 ...
##  $ Eve.Mins      : num  197.4 195.5 121.2 61.9 148.3 ...
##  $ Eve.Calls     : int  99 103 110 88 122 101 108 94 80 111 ...
##  $ Eve.Charge    : num  16.78 16.62 10.3 5.26 12.61 ...
##  $ Night.Mins    : num  245 254 163 197 187 ...
##  $ Night.Calls   : int  91 103 104 89 121 118 118 96 90 97 ...
##  $ Night.Charge  : num  11.01 11.45 7.32 8.86 8.41 ...
##  $ Intl.Mins     : num  10 13.7 12.2 6.6 10.1 6.3 7.5 7.1 8.7 11.2 ...
##  $ Intl.Calls    : int  3 3 5 7 3 6 7 6 4 5 ...
##  $ Intl.Charge   : num  2.7 3.7 3.29 1.78 2.73 1.7 2.03 1.92 2.35 3.02 ...
##  $ CustServ.Calls: int  1 1 0 2 3 0 3 0 1 0 ...
##  $ Churn.        : Factor w/ 2 levels "False.","True.": 1 1 1 1 1 1 1 1 1 1 ...
```

```r
#Names of all the attributes in the data set
names(churn)
```

```
##  [1] "State"          "Account.Length" "Area.Code"      "Phone"
##  [5] "Int.l.Plan"     "VMail.Plan"     "VMail.Message"  "Day.Mins"
```

```
##  [9] "Day.Calls"      "Day.Charge"     "Eve.Mins"       "Eve.Calls"
## [13] "Eve.Charge"     "Night.Mins"     "Night.Calls"    "Night.Charge"
## [17] "Intl.Mins"      "Intl.Calls"     "Intl.Charge"    "CustServ.Calls"
## [21] "Churn."
```

```
#summary of the dataset
summary(churn)
```

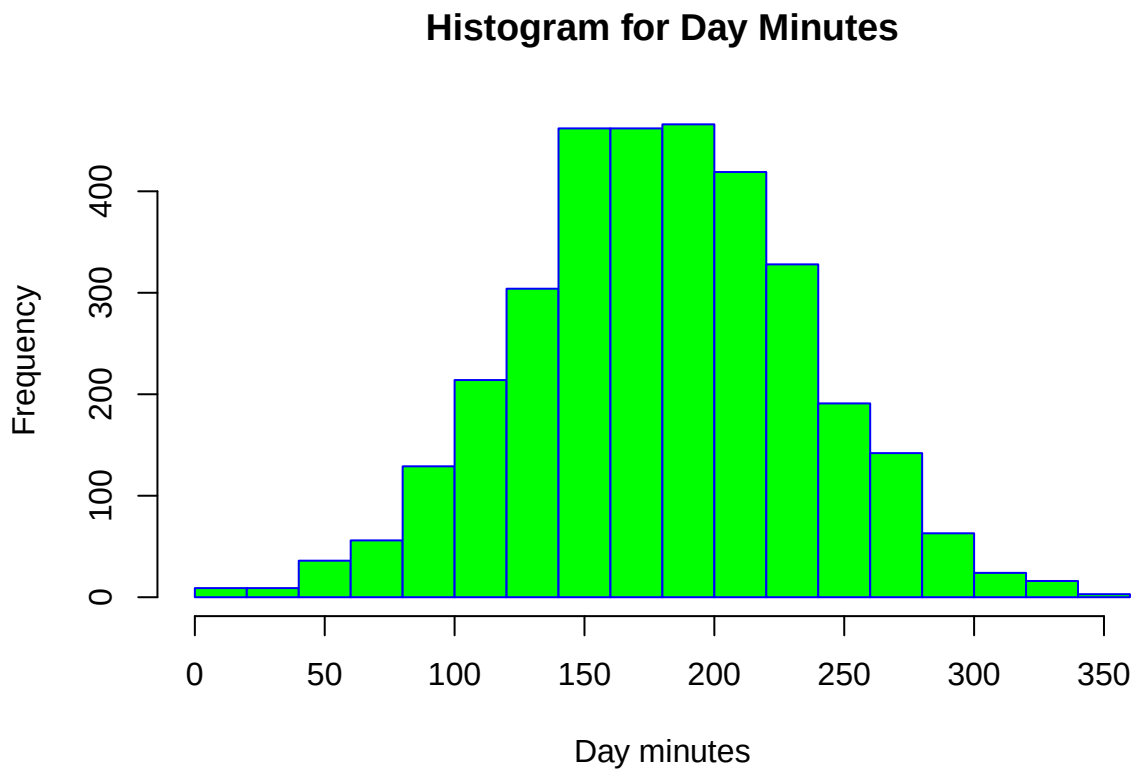
```
##      State      Account.Length    Area.Code          Phone      Int.l.Plan
##  WV     : 106   Min.   :  1.0   Min.   :408.0   327-1058:   1   no :3010
##  MN     :  84   1st Qu.: 74.0   1st Qu.:408.0   327-1319:   1   yes: 323
##  NY     :  83   Median :101.0   Median :415.0   327-3053:   1
##  AL     :  80   Mean   :101.1   Mean   :437.2   327-3587:   1
##  OH     :  78   3rd Qu.:127.0   3rd Qu.:510.0   327-3850:   1
##  OR     :  78   Max.   :243.0   Max.   :510.0   327-3954:   1
##  (Other):2824                                   (Other) :3327
##  VMail.Plan VMail.Message       Day.Mins       Day.Calls
##  no :2411   Min.   : 0.000   Min.   :  0.0   Min.   :  0.0
##  yes: 922   1st Qu.: 0.000   1st Qu.:143.7   1st Qu.: 87.0
##             Median : 0.000   Median :179.4   Median :101.0
##             Mean   : 8.099   Mean   :179.8   Mean   :100.4
##             3rd Qu.:20.000   3rd Qu.:216.4   3rd Qu.:114.0
##             Max.   :51.000   Max.   :350.8   Max.   :165.0
##
##    Day.Charge       Eve.Mins       Eve.Calls       Eve.Charge
##  Min.   : 0.00   Min.   :  0.0   Min.   :  0.0   Min.   : 0.00
##  1st Qu.:24.43   1st Qu.:166.6   1st Qu.: 87.0   1st Qu.:14.16
##  Median :30.50   Median :201.4   Median :100.0   Median :17.12
##  Mean   :30.56   Mean   :201.0   Mean   :100.1   Mean   :17.08
##  3rd Qu.:36.79   3rd Qu.:235.3   3rd Qu.:114.0   3rd Qu.:20.00
##  Max.   :59.64   Max.   :363.7   Max.   :170.0   Max.   :30.91
##
##    Night.Mins     Night.Calls     Night.Charge      Intl.Mins
##  Min.   : 23.2   Min.   : 33.0   Min.   : 1.040   Min.   : 0.00
##  1st Qu.:167.0   1st Qu.: 87.0   1st Qu.: 7.520   1st Qu.: 8.50
##  Median :201.2   Median :100.0   Median : 9.050   Median :10.30
##  Mean   :200.9   Mean   :100.1   Mean   : 9.039   Mean   :10.24
##  3rd Qu.:235.3   3rd Qu.:113.0   3rd Qu.:10.590   3rd Qu.:12.10
##  Max.   :395.0   Max.   :175.0   Max.   :17.770   Max.   :20.00
##
##    Intl.Calls      Intl.Charge    CustServ.Calls     Churn.
##  Min.   : 0.000   Min.   :0.000   Min.   :0.000   False.:2850
##  1st Qu.: 3.000   1st Qu.:2.300   1st Qu.:1.000   True. : 483
##  Median : 4.000   Median :2.780   Median :1.000
##  Mean   : 4.479   Mean   :2.765   Mean   :1.563
##  3rd Qu.: 6.000   3rd Qu.:3.270   3rd Qu.:2.000
##  Max.   :20.000   Max.   :5.400   Max.   :9.000
##
```

```
#Omit and row which has missing value(there are none), it returns 0 rows
churn[!complete.cases(churn),]
```

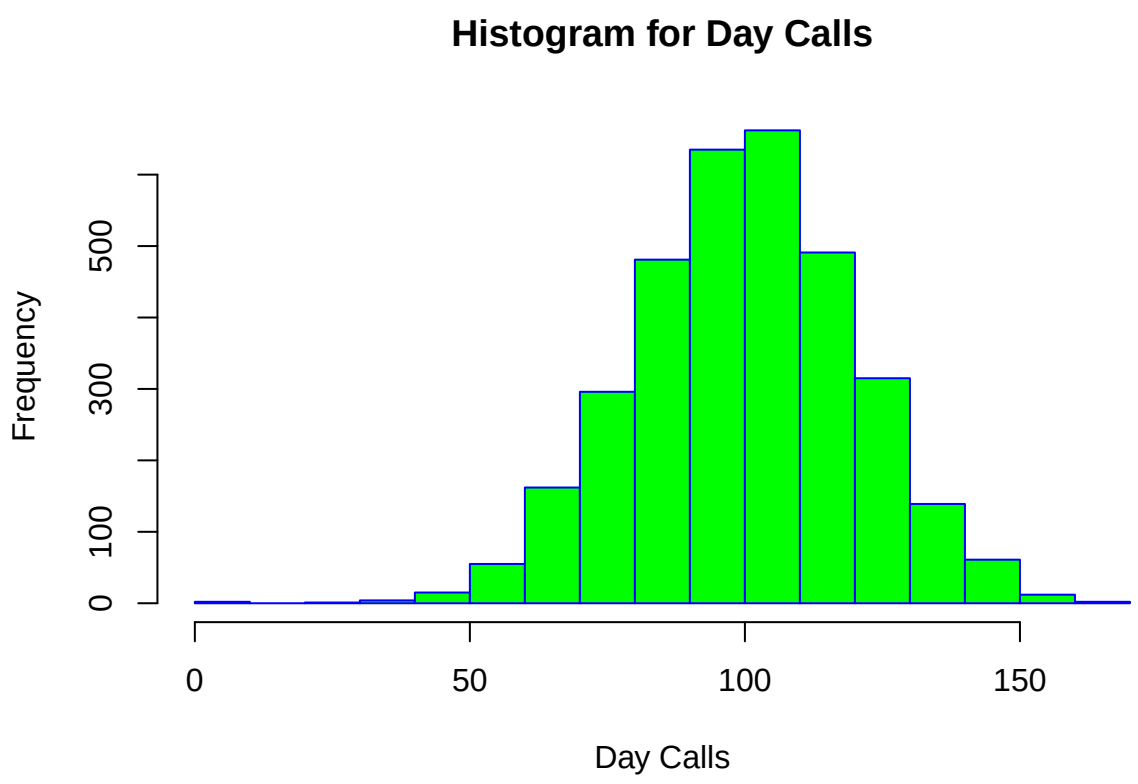
```
##  [1] State          Account.Length Area.Code      Phone
```

```
##  [5] Int.l.Plan     VMail.Plan     VMail.Message  Day.Mins
##  [9] Day.Calls      Day.Charge     Eve.Mins       Eve.Calls
## [13] Eve.Charge     Night.Mins     Night.Calls    Night.Charge
## [17] Intl.Mins      Intl.Calls     Intl.Charge    CustServ.Calls
## [21] Churn.
## <0 rows> (or 0-length row.names)
```

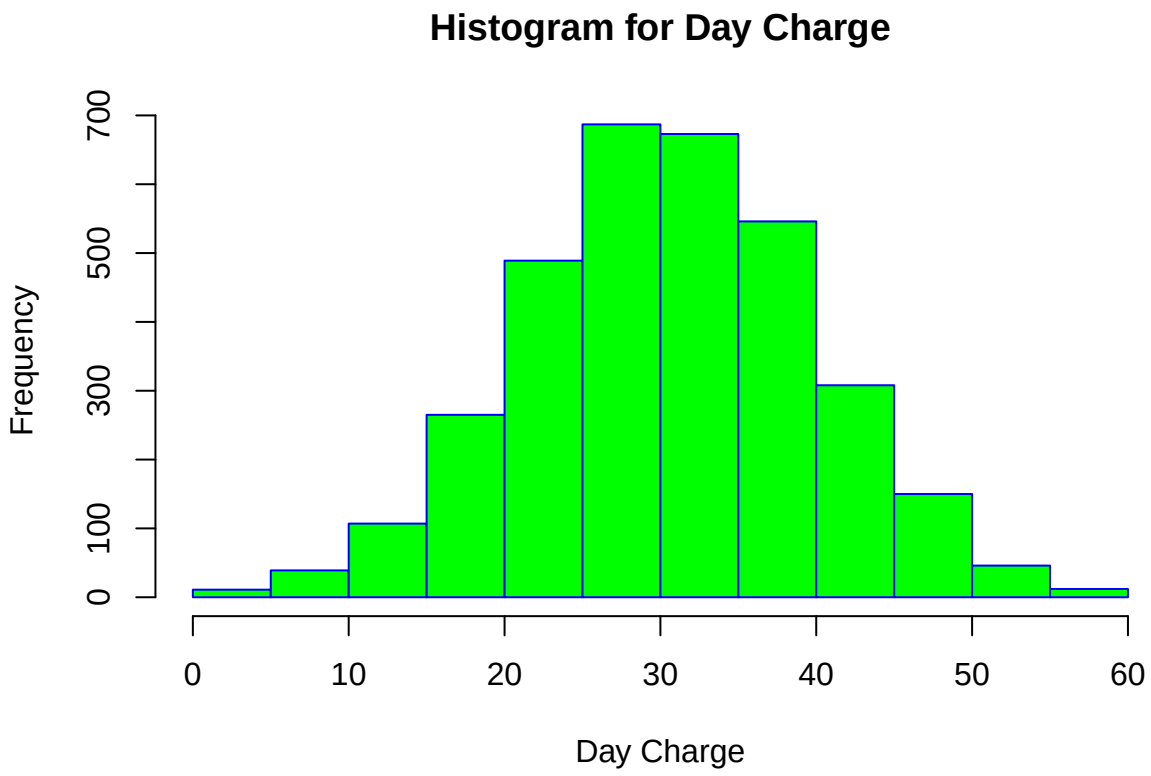
```r
#Histograms (run them one by one)

hist(
  churn$Day.Mins,
  border = "blue",
  col = "green",
  main = "Histogram for Day Minutes",
  xlab = "Day minutes"
)
```



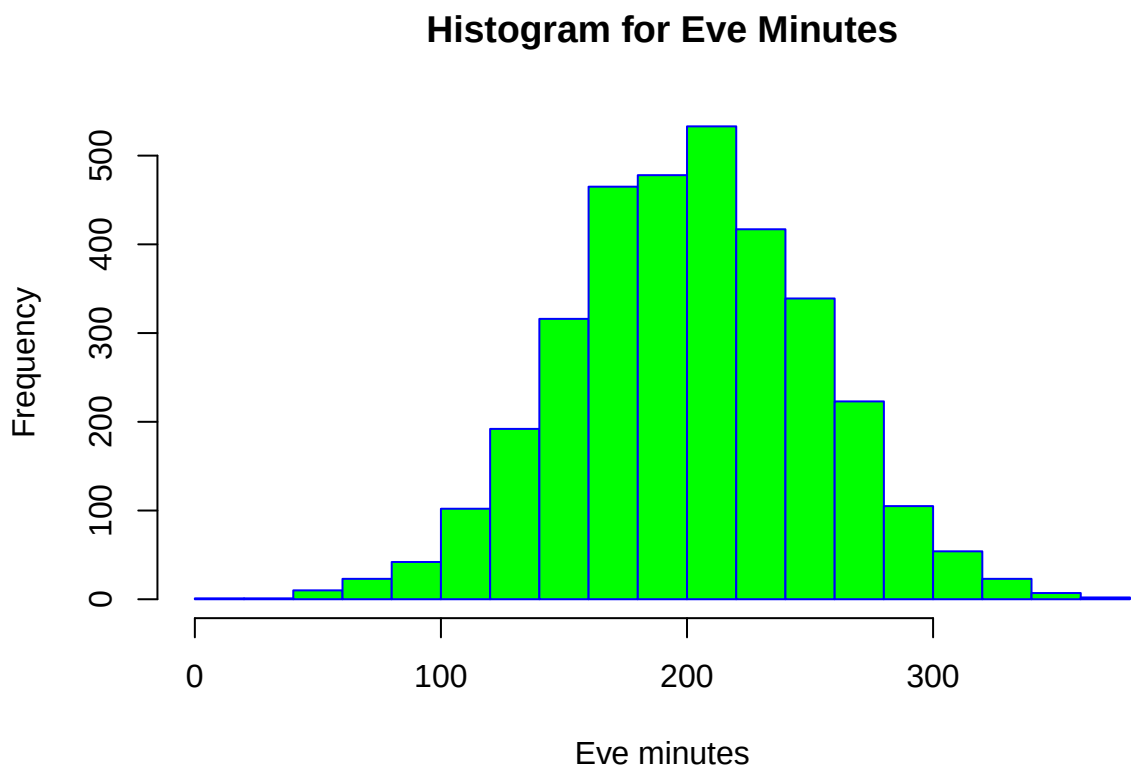

```r
hist(
  churn$Day.Calls,
  border = "blue",
  col = "green",
  main = "Histogram for Day Calls",
  xlab = "Day Calls"
)
```



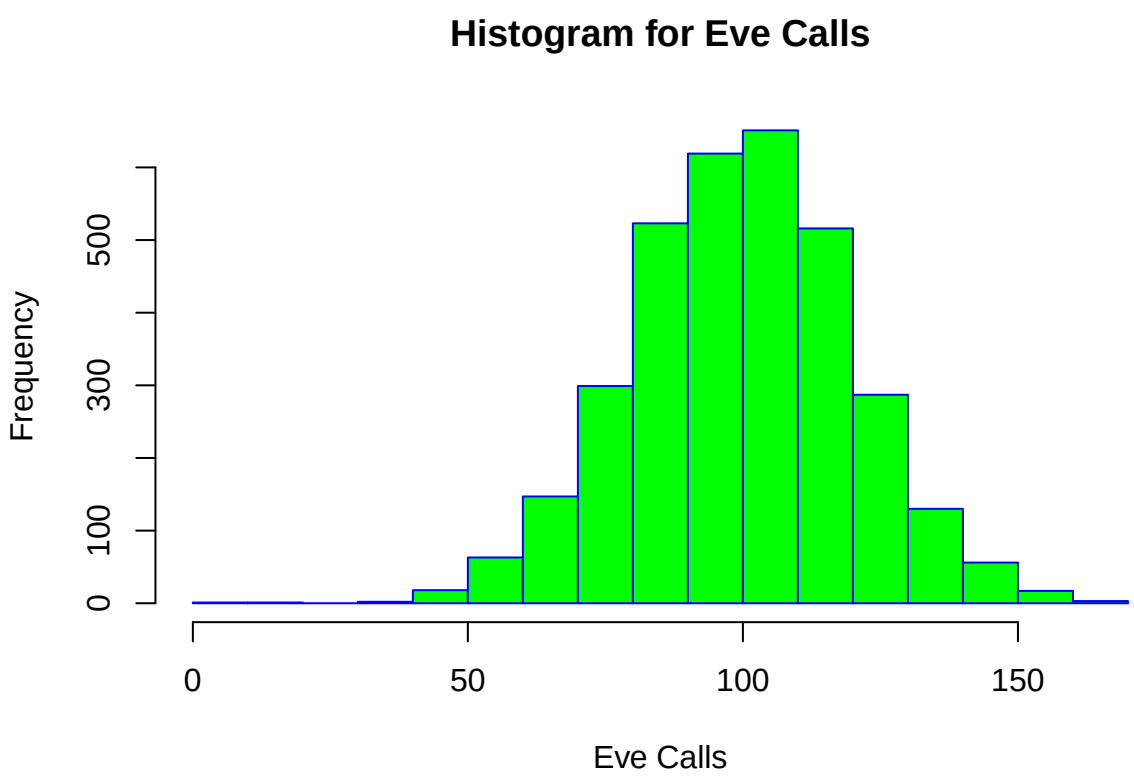

```
hist(
  churn$Day.Charge,
  border = "blue",
  col = "green",
  main = "Histogram for Day Charge",
  xlab = "Day Charge"
)
```



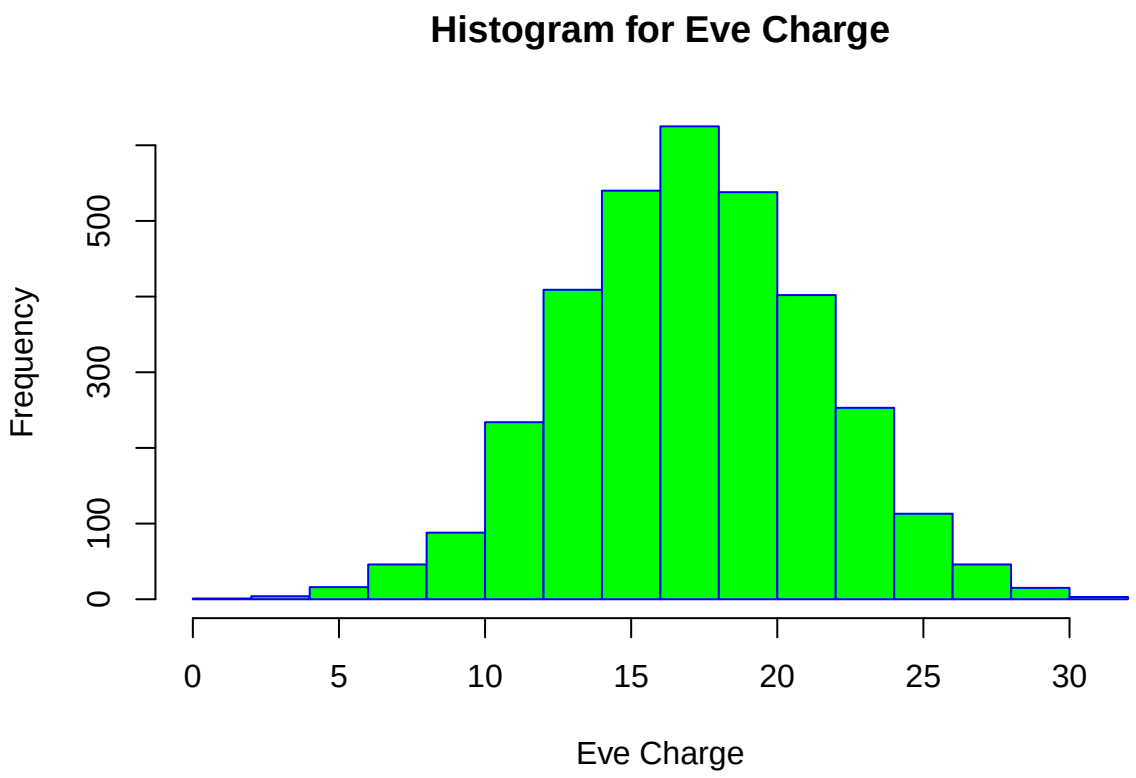

```
hist(
  churn$Eve.Mins,
  border = "blue",
  col = "green",
  main = "Histogram for Eve Minutes",
  xlab = "Eve minutes"
)
```



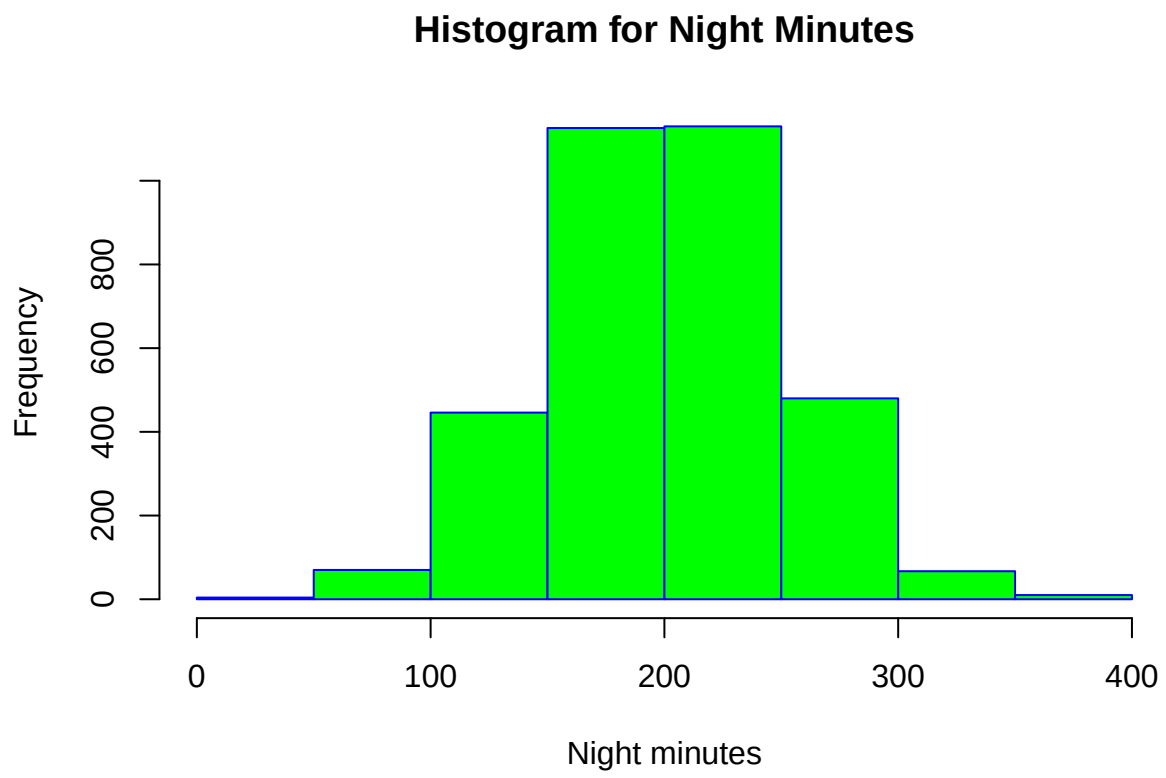

```
hist(
  churn$Eve.Calls,
  border = "blue",
  col = "green",
  main = "Histogram for Eve Calls",
  xlab = "Eve Calls"
)
```



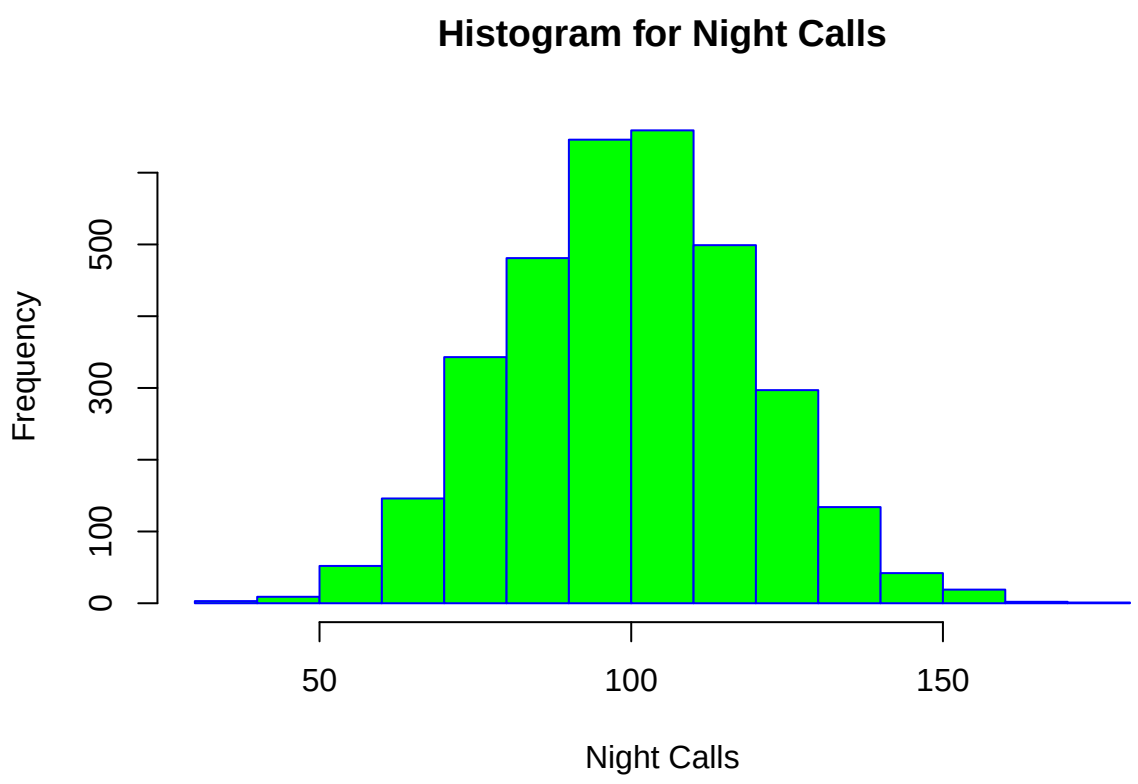

```
hist(
  churn$Eve.Charge,
  border = "blue",
  col = "green",
  main = "Histogram for Eve Charge",
  xlab = "Eve Charge"
)
```



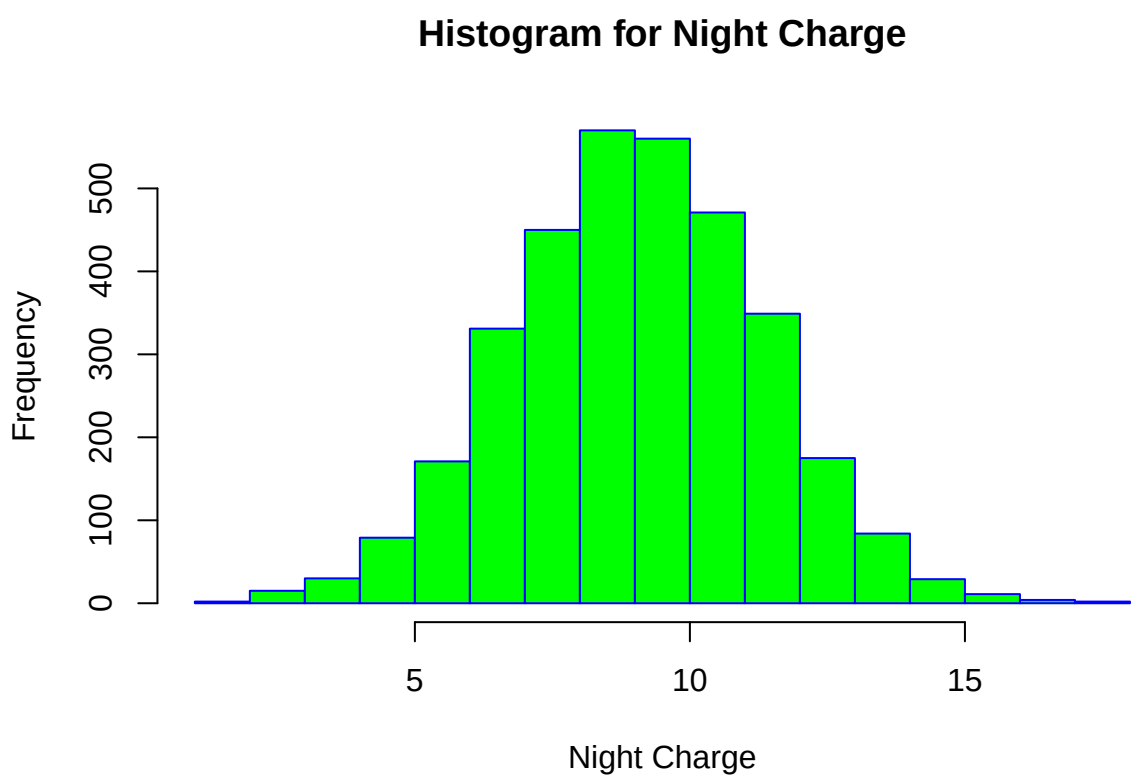

```
hist(
  churn$Night.Mins,
  border = "blue",
  col = "green",
  main = "Histogram for Night Minutes",
  xlab = "Night minutes"
)
```



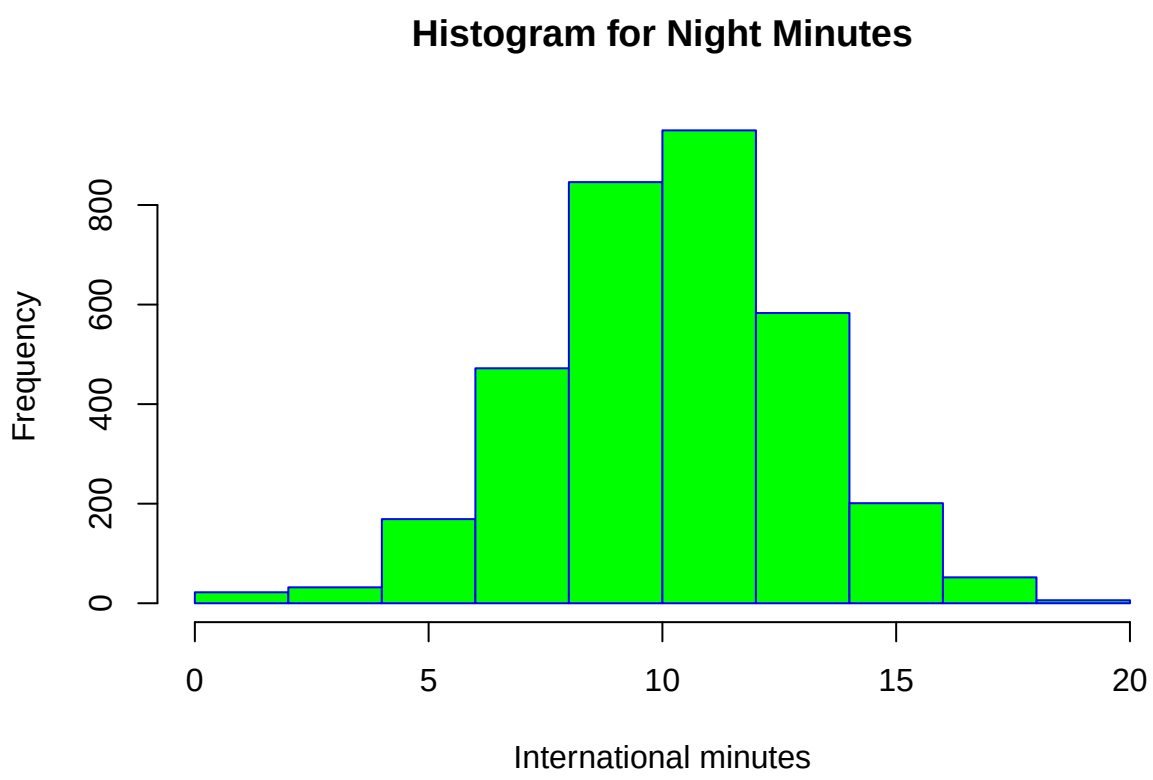

```
hist(
  churn$Night.Calls,
  border = "blue",
  col = "green",
  main = "Histogram for Night Calls",
  xlab = "Night Calls"
)
```



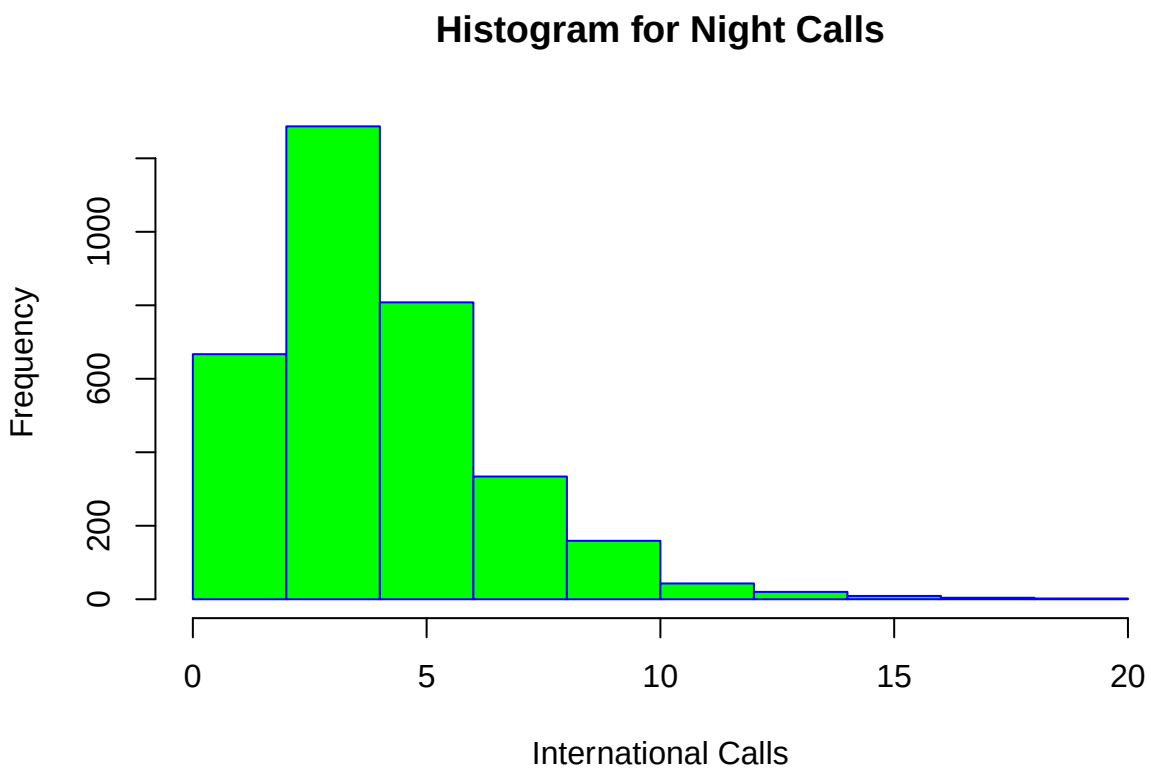

```
hist(
  churn$Night.Charge,
  border = "blue",
  col = "green",
  main = "Histogram for Night Charge",
  xlab = "Night Charge"
)
```



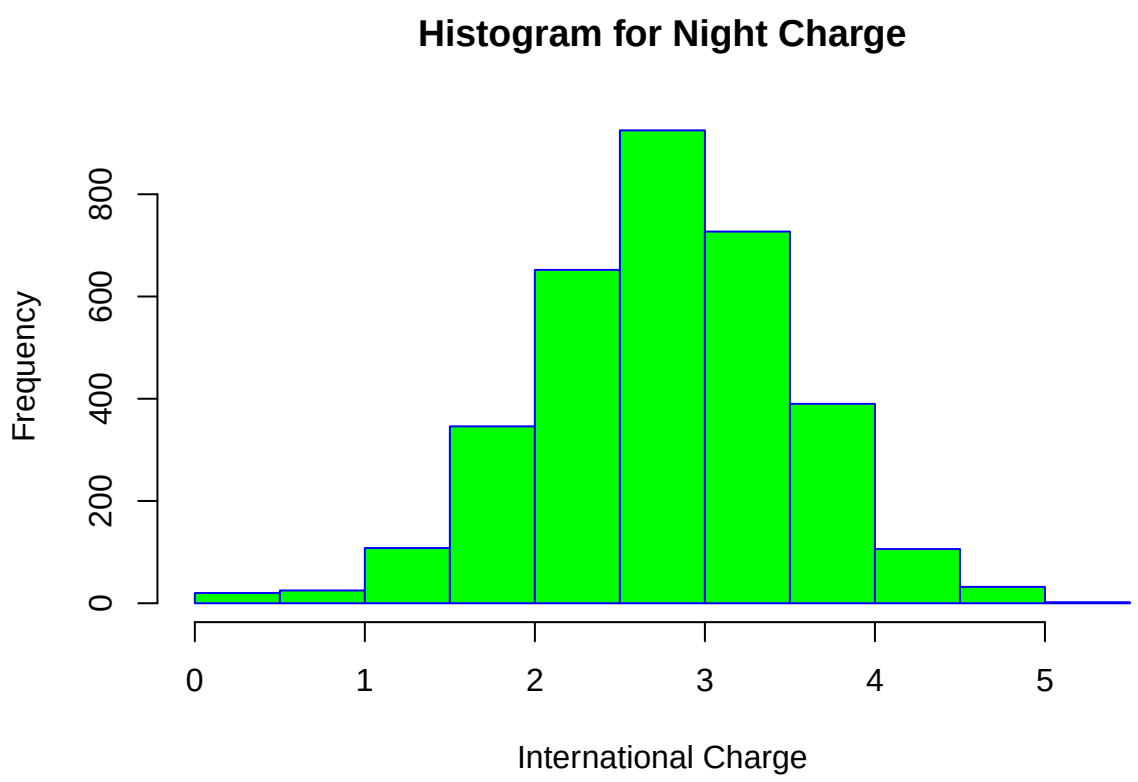

```
hist(
  churn$Intl.Mins,
  border = "blue",
  col = "green",
  main = "Histogram for Night Minutes",
  xlab = "International minutes"
)
```



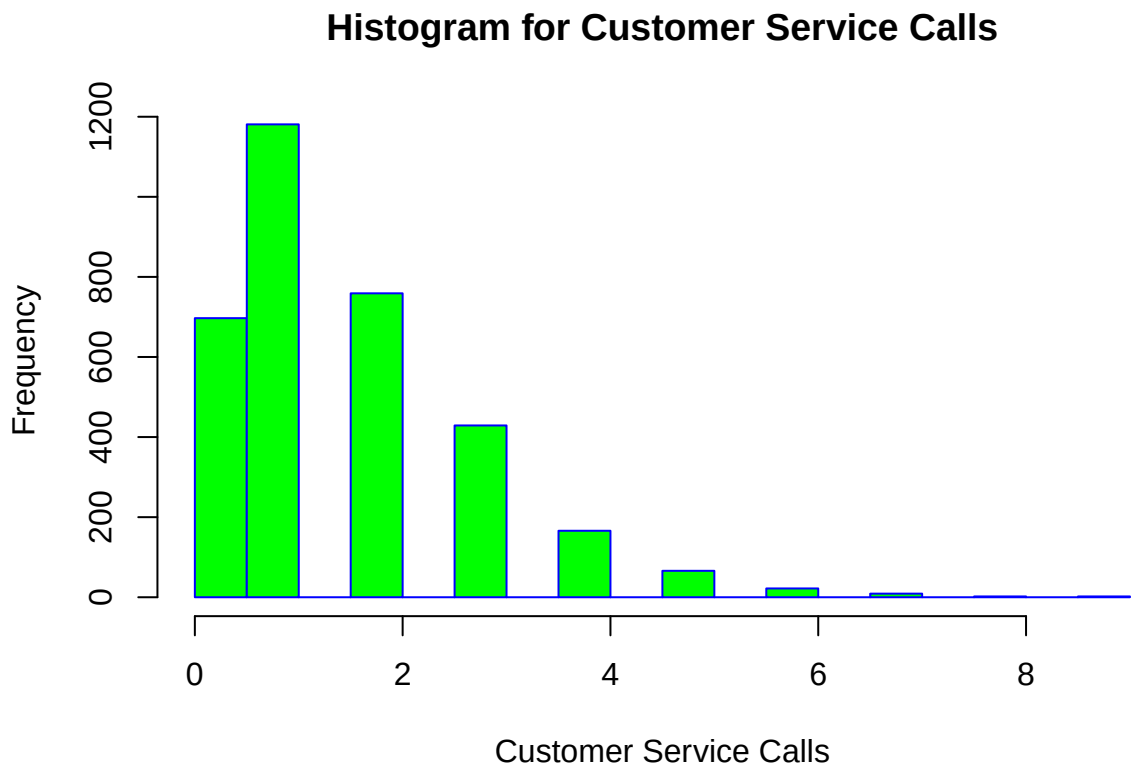

```
hist(
  churn$Intl.Calls,
  border = "blue",
  col = "green",
  main = "Histogram for Night Calls",
  xlab = "International Calls"
)
```



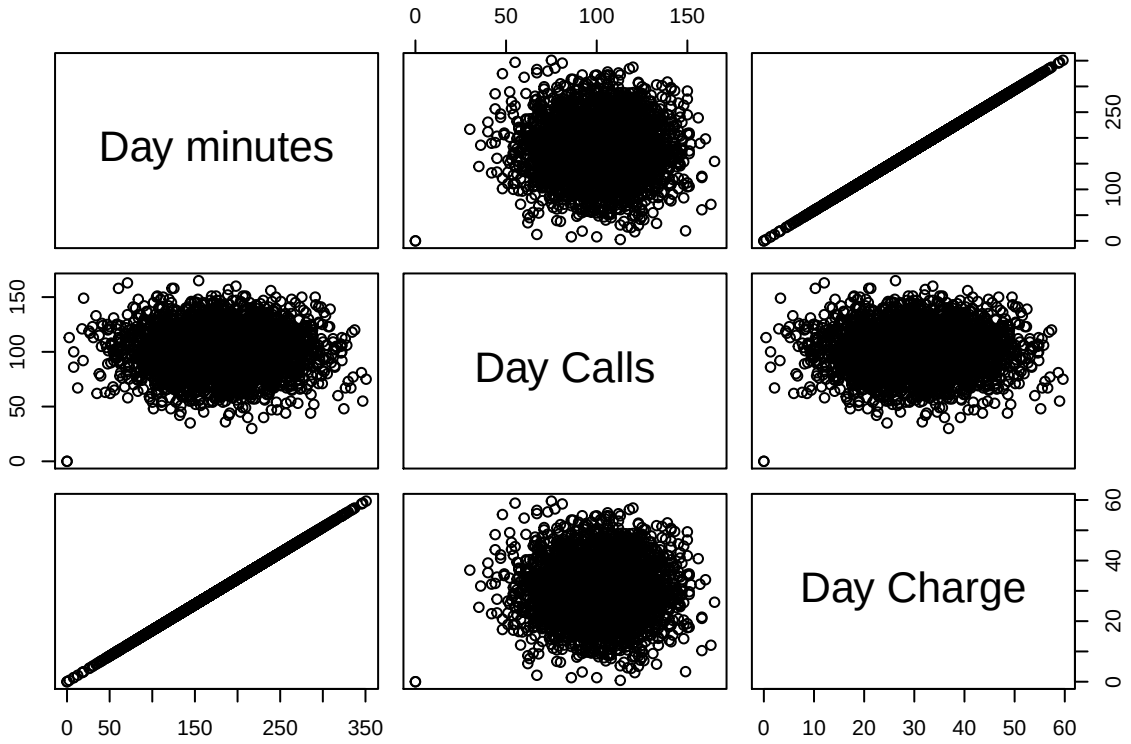

```
hist(
  churn$Intl.Charge,
  border = "blue",
  col = "green",
  main = "Histogram for Night Charge",
  xlab = "International Charge"
)
```



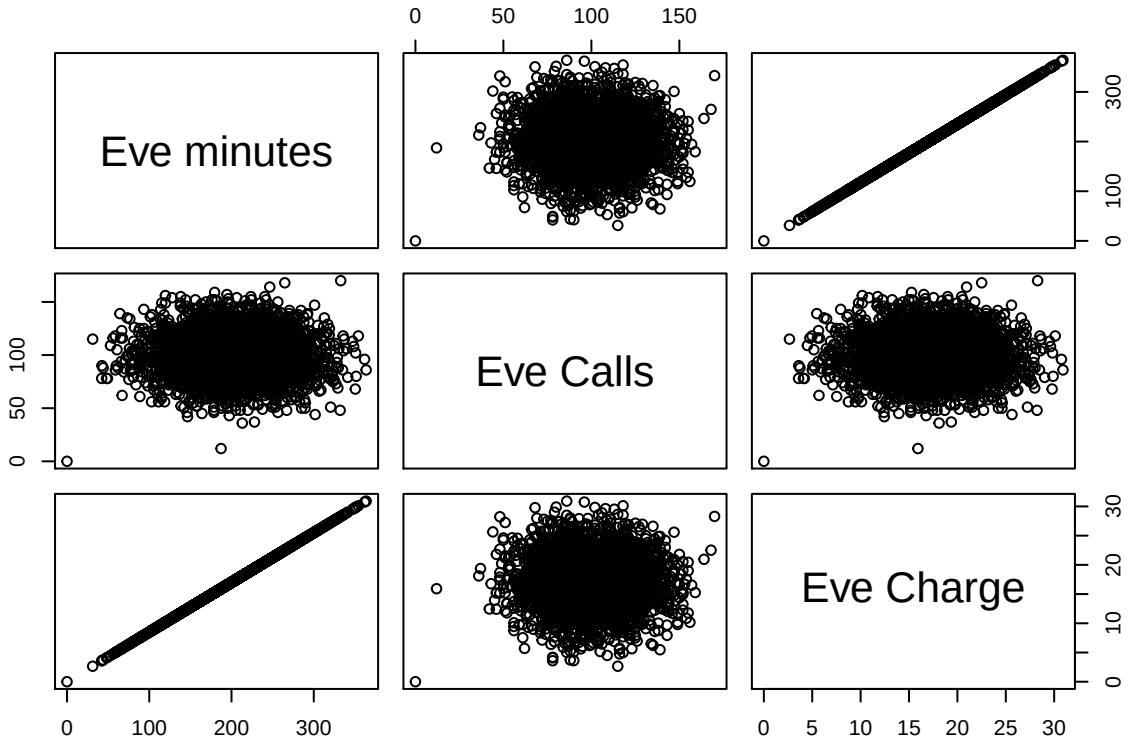

```
hist(
  churn$CustServ.Calls,
  border = "blue",
  col = "green",
  main = "Histogram for Customer Service Calls",
  xlab = "Customer Service Calls"
)
```



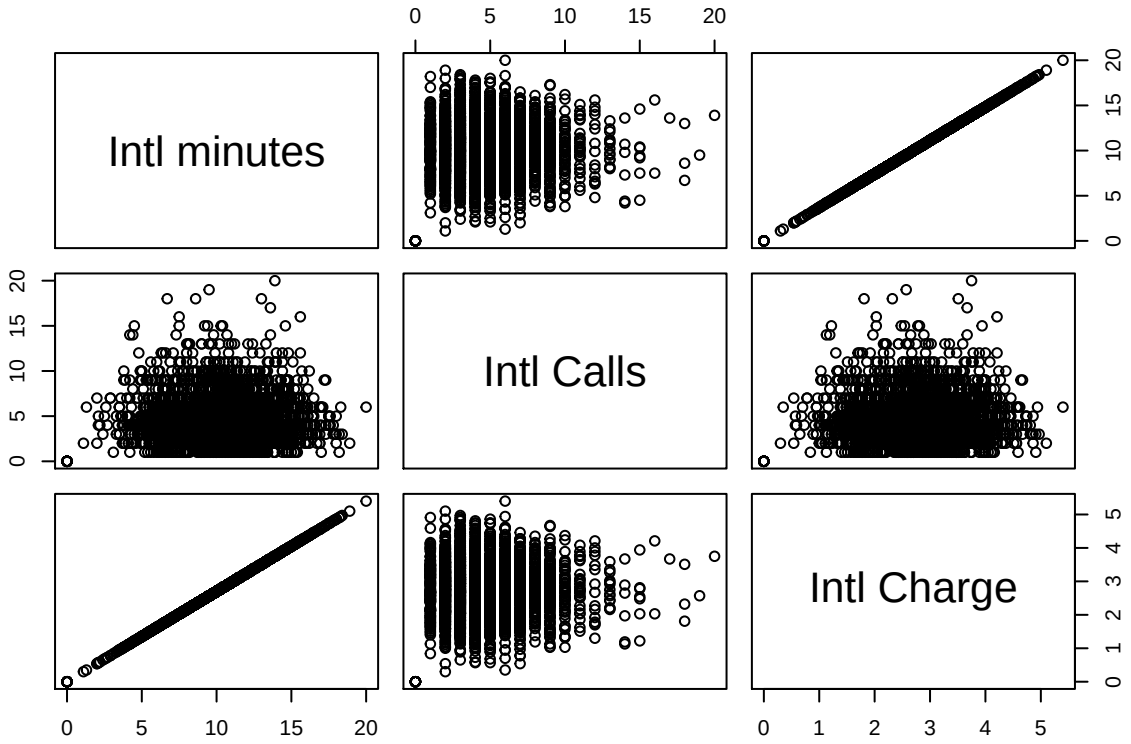

```
#scatter plot amongst the seemingly similar variables(continuous)

churnScatter1 <- churn[, c("Day.Mins", "Day.Calls", "Day.Charge")]
colnames(churnScatter1) <-
  c("Day minutes", "Day Calls", "Day Charge")
plot(churnScatter1)
```



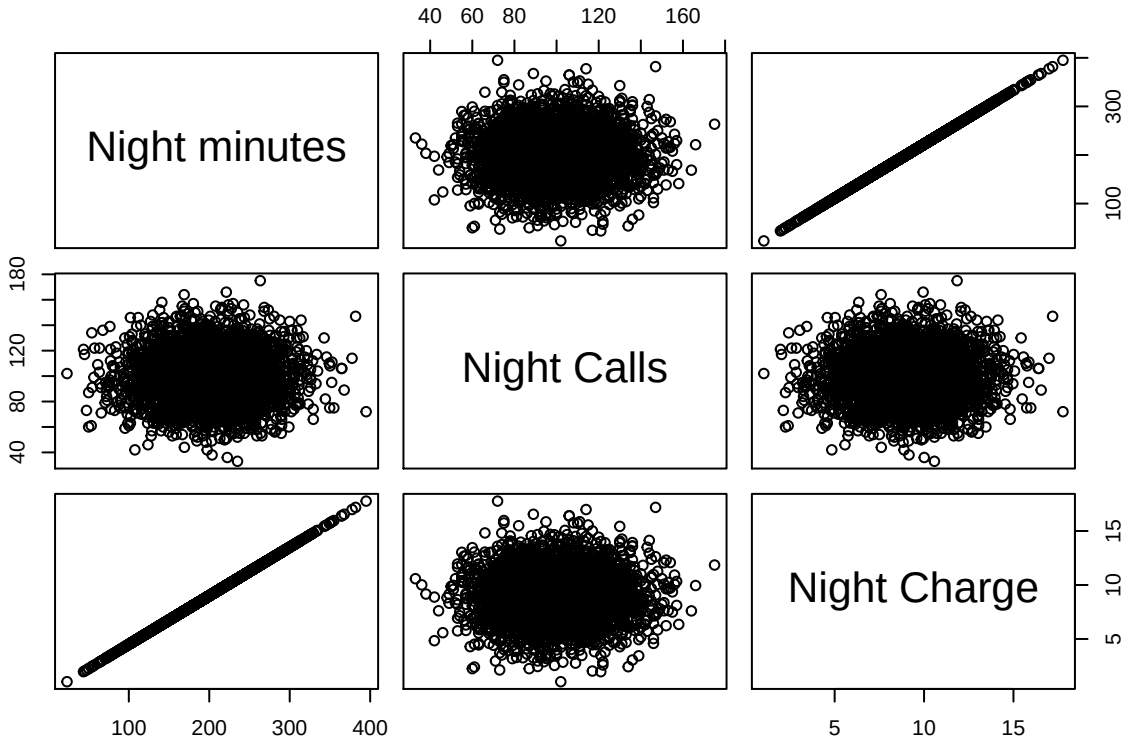

```
churnScatter2 <- churn[, c("Eve.Mins", "Eve.Calls", "Eve.Charge")]
colnames(churnScatter2) <-
  c("Eve minutes", "Eve Calls", "Eve Charge")
plot(churnScatter2)
```




```
churnScatter3 <-
  churn[, c("Intl.Mins", "Intl.Calls", "Intl.Charge")]
colnames(churnScatter3) <-
  c("Intl minutes", "Intl Calls", "Intl Charge")
plot(churnScatter3)
```




```
churnScatter4 <-
  churn[, c("Night.Mins", "Night.Calls", "Night.Charge")]
colnames(churnScatter4) <-
  c("Night minutes", "Night Calls", "Night Charge")
plot(churnScatter4)
```




```
#Correlation matrix (description in the document)
#On the basis of corelation we eliminate 4 variables, since there were a linear
#function of other 4 variables


cor(churnScatter1[sapply(churnScatter1, is.numeric)])
```

```
##             Day minutes   Day Calls  Day Charge
## Day minutes 1.000000000 0.006750414 0.999999952
## Day Calls   0.006750414 1.000000000 0.006752962
## Day Charge  0.999999952 0.006752962 1.000000000
```

```
cor(churnScatter2[sapply(churnScatter2, is.numeric)])
```

```
##             Eve minutes   Eve Calls  Eve Charge
## Eve minutes  1.00000000 -0.01143011  0.99999978
## Eve Calls   -0.01143011  1.00000000 -0.01142289
## Eve Charge   0.99999978 -0.01142289  1.00000000
```

```
cor(churnScatter3[sapply(churnScatter2, is.numeric)])
```

```
##              Intl minutes Intl Calls Intl Charge
## Intl minutes   1.00000000 0.03230388  0.99999274
## Intl Calls     0.03230388 1.00000000  0.03237215
## Intl Charge    0.99999274 0.03237215  1.00000000
```

```
cor(churnScatter4[sapply(churnScatter2, is.numeric)])
```

```
##                Night minutes Night Calls Night Charge
## Night minutes    1.00000000  0.01120386   0.99999921
## Night Calls      0.01120386  1.00000000   0.01118782
## Night Charge     0.99999921  0.01118782   1.00000000
```

```
#---------------------Graphical Evidence to retain ------------------------------
#---------------------above variables(Customer Service Call)---------------------
#Customer Service Calls vs Churn

ggplot() +
  geom_bar(data = churn,
           aes(
             x = factor(churn$CustServ.Calls),
             fill = factor(churn$Churn)
           ),
           position = "fill") +
  scale_x_discrete("Customer Service Calls") +
  scale_y_continuous("Percent") +
  guides(fill = guide_legend(title = "Churn")) +
  scale_fill_manual(values = c("green", "red"))
```

```r
#Conclusion: Customer Service Calls is predictive of churn

#If the p-value is greater than .1, it will not be predictive of churn

t.test(churn$Intl.Calls ~ churn$Churn)
```

```
##
##  Welch Two Sample t-test
##
## data:  churn$Intl.Calls by churn$Churn
## t = 2.9604, df = 640.64, p-value = 0.003186
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  0.1243807 0.6144620
## sample estimates:
## mean in group False.  mean in group True.
##             4.532982             4.163561
```

```r
#Retain International Calls

t.test(churn$Day.Calls ~ churn$Churn)
```

```
##
##  Welch Two Sample t-test
##
## data:  churn$Day.Calls by churn$Churn
## t = -1.0024, df = 627.17, p-value = 0.3165
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -3.113677  1.009186
## sample estimates:
## mean in group False.  mean in group True.
##             100.2832             101.3354
```

```r
#Eliminate Day Calls Calls

t.test(churn$Night.Calls ~ churn$Churn)
```

```
##
##  Welch Two Sample t-test
##
## data:  churn$Night.Calls by churn$Churn
## t = -0.34882, df = 647.95, p-value = 0.7273
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -2.262875  1.580194
## sample estimates:
## mean in group False.  mean in group True.
##             100.0582             100.3996
```

```r
#Eliminate Night Calls

t.test(churn$Eve.Calls ~ churn$Churn)
```

```
##
##  Welch Two Sample t-test
##
## data:  churn$Eve.Calls by churn$Churn
## t = -0.53739, df = 660.41, p-value = 0.5912
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -2.431568  1.386607
## sample estimates:
## mean in group False.  mean in group True.
##             100.0386             100.5611
```

```r
#Eliminate Eve Calls

t.test(churn$Day.Mins ~ churn$Churn)
```

```
##
##  Welch Two Sample t-test
##
## data:  churn$Day.Mins by churn$Churn
## t = -9.6846, df = 571.51, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -38.17516 -25.30148
## sample estimates:
## mean in group False.  mean in group True.
##             175.1758             206.9141
```

```r
#Retain Day Minutes

t.test(churn$Eve.Mins ~ churn$Churn)
```

```
##
##  Welch Two Sample t-test
##
## data:  churn$Eve.Mins by churn$Churn
## t = -5.2724, df = 645.99, p-value = 1.839e-07
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -18.345214  -8.388479
## sample estimates:
## mean in group False.  mean in group True.
##             199.0433             212.4101
```

```r
#retain Eve minutes

t.test(churn$Night.Mins ~ churn$Churn)
```

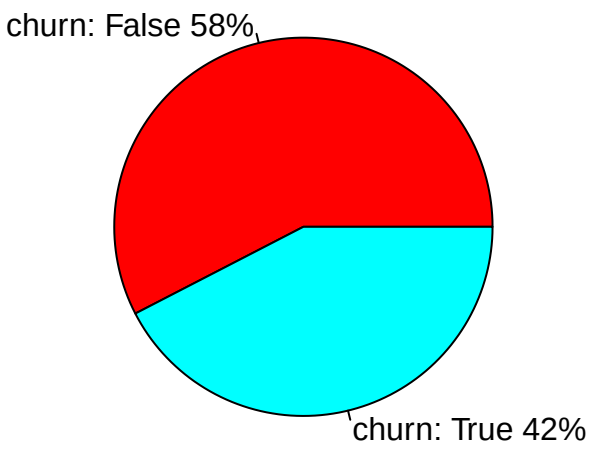
```
##
##  Welch Two Sample t-test
##
## data:  churn$Night.Mins by churn$Churn
## t = -2.1709, df = 688.58, p-value = 0.03028
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -9.7097014 -0.4872667
## sample estimates:
## mean in group False.  mean in group True.
##             200.1332             205.2317
```

```
#retain Night minutes

t.test(churn$CustServ.Calls ~ churn$Churn)
```

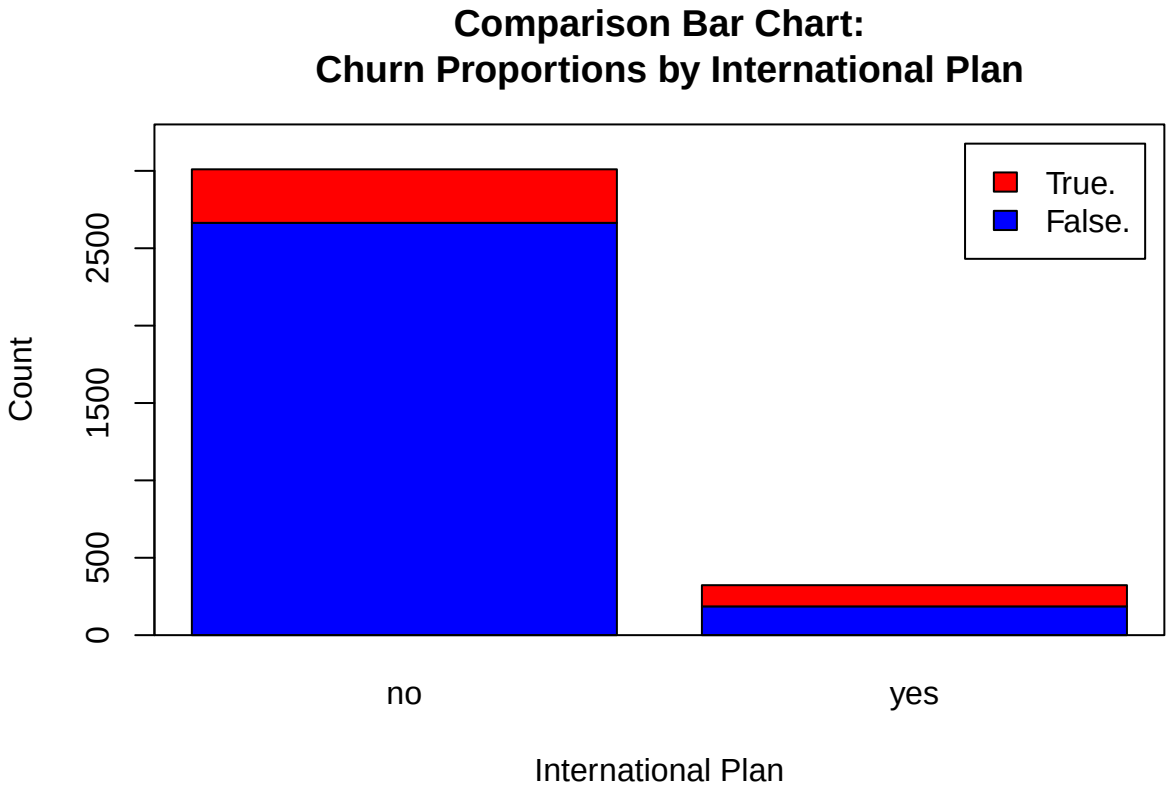
```
##
##  Welch Two Sample t-test
##
## data:  churn$CustServ.Calls by churn$Churn
## t = -8.9551, df = 548.17, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.9510789 -0.6088993
## sample estimates:
## mean in group False.  mean in group True.
##             1.449825             2.229814
```

```
#retain Customer Service Calls

#conclusion: Retain Intl Calls, Eve minutes, Nigh, Eve, Day Minutes
#, Customer Service Calls
```

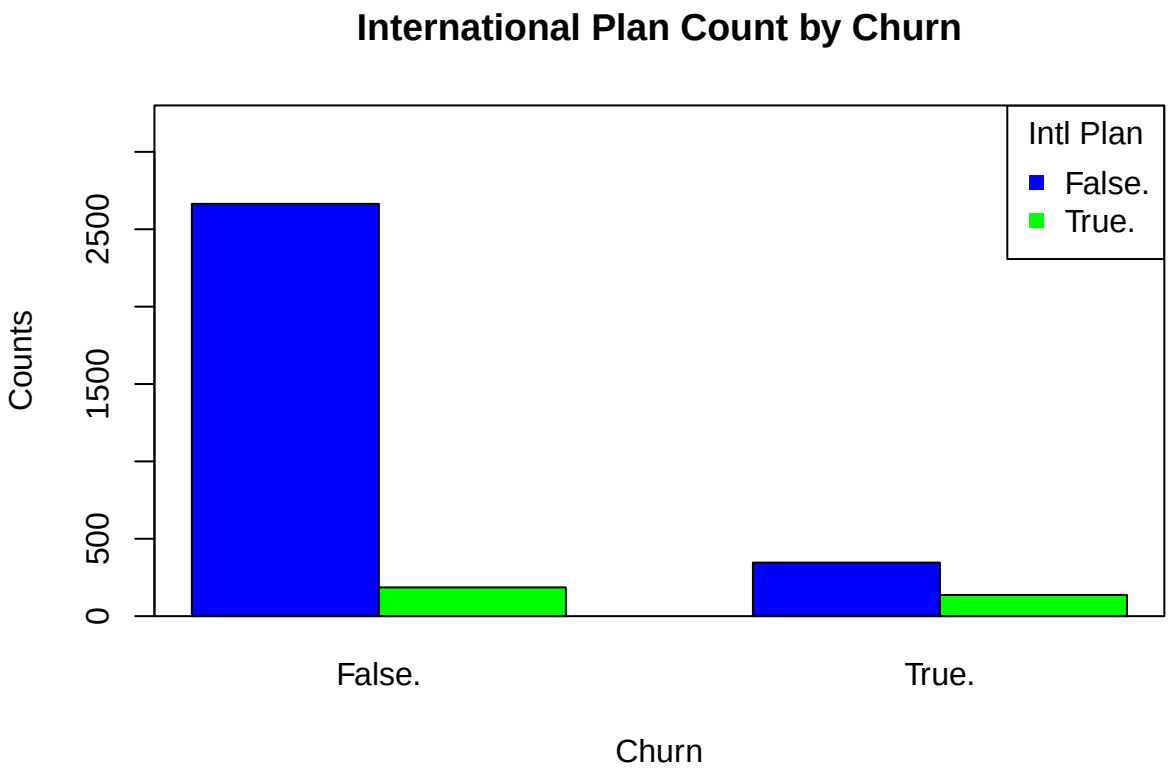
```
#Intl Plan

#table for counts of Churn and International Plan
countsIntlPlan <- table(churn$Churn,
                        churn$Int.l.Plan,
                        dnn = c("Churn", "International Plan"))


#Pie chart wich shows that people who have international plan may churn
slices <- c(countsIntlPlan[1, 2] , countsIntlPlan[2, 2])
lbls <- c("churn: False", "churn: True")
pct <- round(slices / sum(slices) * 100)
lbls <- paste(lbls, pct) # add percents to labels
lbls <- paste(lbls, "%", sep = "") # ad % to labels
pie(slices,
    labels = lbls,
    col = rainbow(length(lbls)),
    main = "People Having International Plan")
```




```r
#Overlayed bar chart
barplot(
  countsIntlPlan,
  legend = rownames(countsIntlPlan),
  col = c("blue", "red"),
  ylim = c(0, 3300),
  ylab = "Count",
  xlab = "International Plan",
  main = "Comparison Bar Chart:
  Churn Proportions by International Plan"
)
box(which = "plot",
    lty = "solid",
    col = "black")
```




```
#Clustered Bar Chart of Churn and Intl Plan with legend
barplot(
  t(countsIntlPlan),
  col = c("blue", "green"),
  ylim = c(0, 3300),
  ylab = "Counts",
  xlab = "Churn",
  main = "International Plan Count by Churn",
  beside = TRUE
)
legend(
  "topright",
  c(rownames(countsIntlPlan)),
  col = c("blue", "green"),
  pch = 15,
  title = "Intl Plan"
)
box(which = "plot",
    lty = "solid",
    col = "black")
```



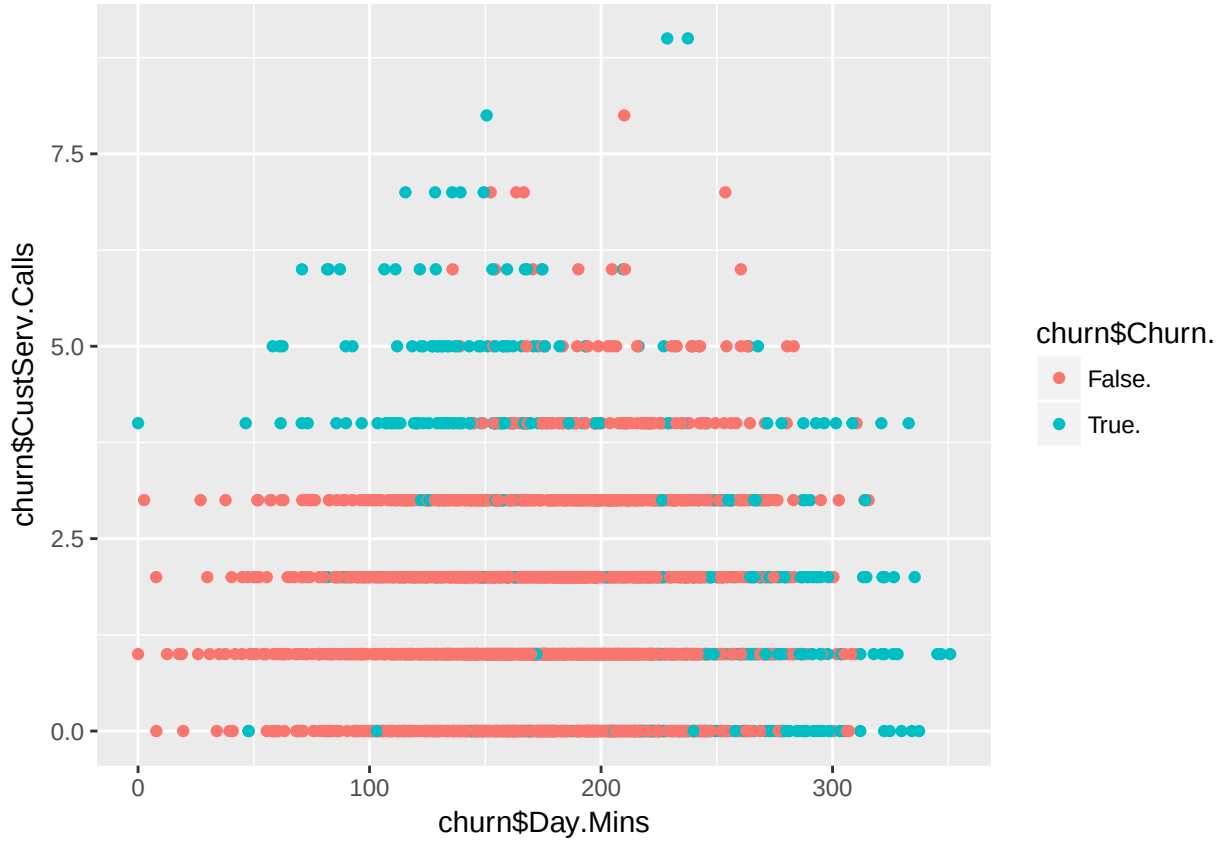

```
#Vmail Plan
#weak evidence, but still vmail plan may be predictive
#'cause we can see int row.margin[2,1] and row.margin[2,2]
#that the people who dont have the vmail plan and will churn % = 84
#have vmail and will churn % = 16

countsVmailPlan <- table(churn$Churn, churn$VMail.Plan,
                         dnn = c("Churn", "Vmail Plan"))


row.margin <- round(prop.table(countsVmailPlan, margin = 1), 4)*100
row.margin
```

```
##          Vmail Plan
## Churn         no   yes
##   False. 70.46 29.54
##   True.  83.44 16.56
```

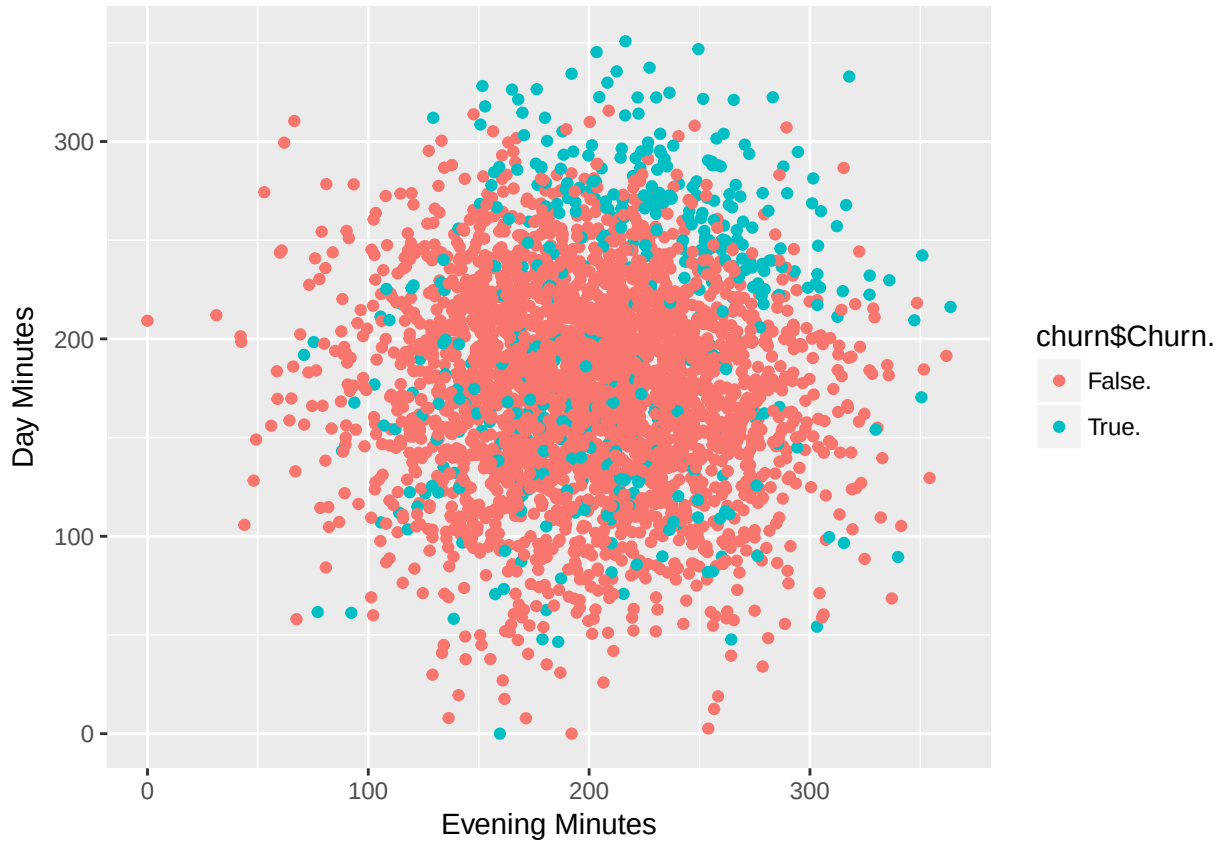
```
#Vmail message's histogram gives us a spike
#For the analysis we say that If Voice Mail Messages > 0 then VoiceMailMessages_Flag = 1;
#otherwise VoiceMailMessages_Flag = 0
#it reveals that it is similar to the vmal plan, hence we can eliminate vmail message

churn$flag[churn$VMail.Message>0] <- 1
churn$flag[churn$VMail.Message<=0] <- 0
table(churn$flag,churn$Churn)
```

```
##
##     False. True.
##   0   2008   403
##   1    842    80
```

```
#-----------------Multivariate relationships--------------------------------------

#cust serv calls vs day calls
#Conclusion: hiher the
qplot(churn$Day.Mins,
      churn$CustServ.Calls,
      data = churn,
      colour = churn$Churn.)
```




```
#Day min Vs Eve min
#conclusion: Higher the day min and evening min, more the churn
qplot(churn$Eve.Mins,churn$Day.Mins,
      data = churn,
      colour = churn$Churn., xlab = "Evening Minutes",
      ylab= "Day Minutes")
```




```
#creates a new file firstforest to test against the test data
#-------------------------------------------------------------------------------

#churn <- read.csv("churn_tel.csv")
churnTrain <- churn[800:3300, ]
churnTest <- churn[1:500, ]


fit <-
  randomForest(
    as.factor(Churn.) ~ Int.l.Plan + VMail.Plan + CustServ.Calls + Day.Mins +
      Eve.Mins + VMail.Message + Night.Mins + Intl.Mins + Intl.Calls,
    data = churnTrain,
    importance = TRUE,
    ntree = 500,
    nodesize = 3
  )
Prediction <- predict(fit, churnTest)
print(nrow(churnTest))
```

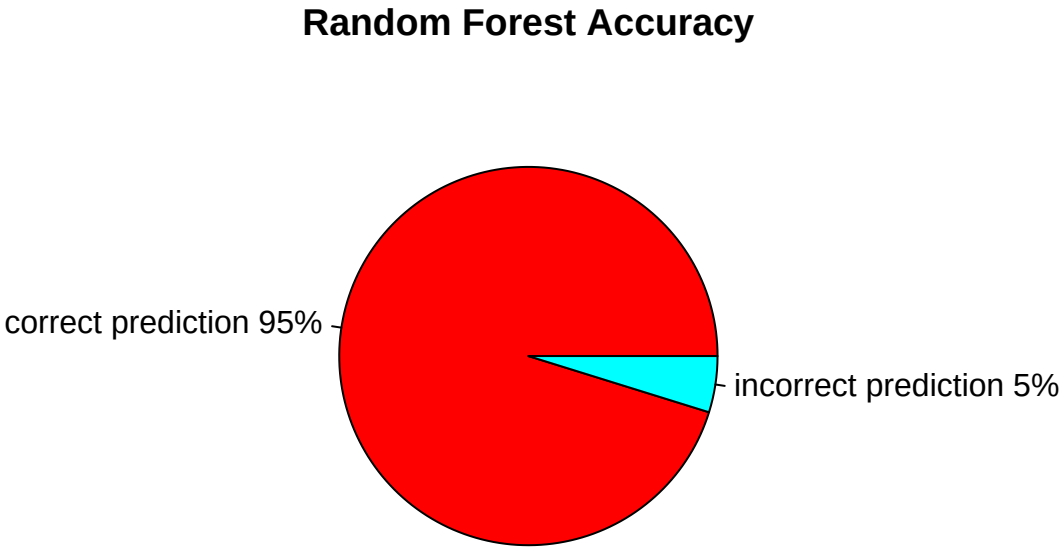
```
## [1] 500
```

```
submit <- data.frame(id = churnTest$Phone, Churn = Prediction)
write.csv(submit, file = "firstforest.csv", row.names = FALSE)
fr <- read.csv("firstforest.csv")
```

```r
count <- table(churnTest$Churn, fr$Churn)
count
```

```
##
##          False. True.
##   False.    427     5
##   True.      19    49
```

```r
#Accuracy of Random Forest(using pie chart)


slices <- c(count[1, 1] + count[2, 2], count[1, 2] + count[2, 1])
lbls <-  c("correct prediction", "incorrect prediction")
pct <- round(slices / sum(slices) * 100)
lbls <- paste(lbls, pct) # add percents to labels
lbls <- paste(lbls, "%", sep = "") # ad % to labels
pie(slices,
    labels = lbls,
    col = rainbow(length(lbls)),
    main = "Random Forest Accuracy")
```

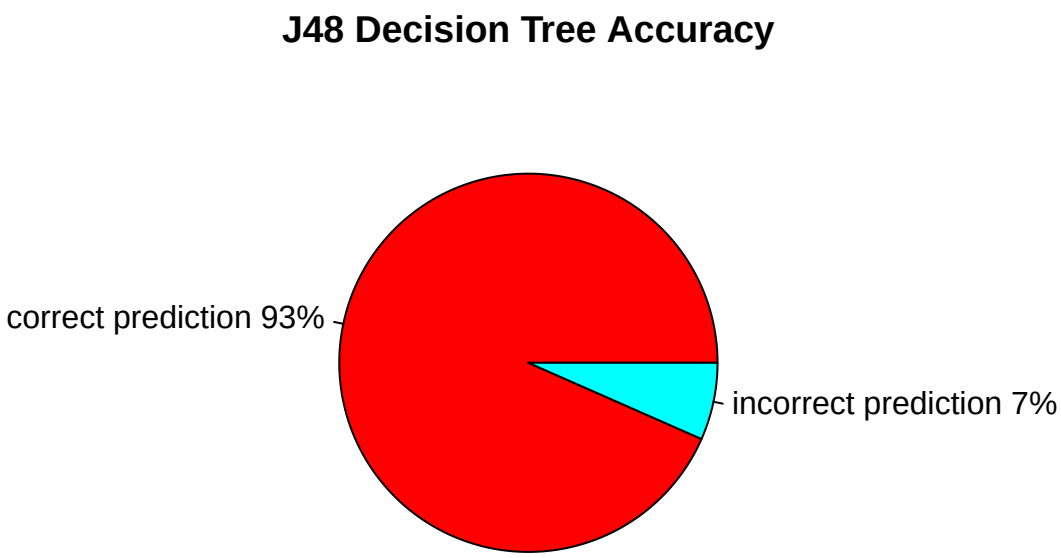



```r
#creates a new file decisionTree to test against the test data
#-------------------------------------------------------------------------------
```

```r
#churn <- read.csv("churn_tel.csv")
churnTrain2 <- churn[800:3300, ]
churnTest2 <- churn[1:500, ]


decisionTree <- J48(`Churn.` ~ ., data = churnTrain2)
prediction_tree <- predict(decisionTree,  churnTest2)
count2 <- table(churnTest2$Churn, prediction_tree)
count2
```

```
##         prediction_tree
##          False. True.
##   False.    418    14
##   True.      19    49
```

```r
#Accuracy of J48(using pie chart)


slices <-
  c(count2[1, 1] + count2[2, 2], count2[1, 2] + count2[2, 1])
lbls <- c("correct prediction", "incorrect prediction")
pct <- round(slices / sum(slices) * 100)
lbls <- paste(lbls, pct) # add percents to labels
lbls <- paste(lbls, "%", sep = "") # ad % to labels
pie(slices,
    labels = lbls,
    col = rainbow(length(lbls)),
    main = "J48 Decision Tree Accuracy")
```


J48 Decision Tree Accuracy
correct prediction 93%
incorrect prediction 7%