HW6

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R Markdown

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When you click the **Knit** button a document will be generated that includes both content as well as the output of any embedded R code chunks within the document. You can embed an R code chunk like this:

```
#load the packages
library(readr)
library(readxl)
library(forecast)
```

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

```
library(tidyverse)
```

```
## ── Attaching packages ─────────────────────────────────────── tid
yverse 1.2.1 ──
```

```
## ✔ ggplot2 3.2.1     ✔ purrr   0.3.3
## ✔ tibble  2.1.3     ✔ dplyr   0.8.3
## ✔ tidyr   1.0.0     ✔ stringr 1.4.0
## ✔ ggplot2 3.2.1     ✔ forcats 0.4.0
```

```
## ── Conflicts ─────────────────────────────────────────── tidyverse
_conflicts() ──
## ✖ dplyr::filter() masks stats::filter()
## ✖ dplyr::lag()    masks stats::lag()
```

```
library(caret)
```

```
## Loading required package: lattice
```

```
##
## Attaching package: 'caret'
```

```
## The following object is masked from 'package:purrr':
##
##     lift
```

```
library(rpart)
library(caret)
library(e1071)
library(data.table)
```

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

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

```
## The following object is masked from 'package:purrr':
##
##     transpose
```

```
library(randomForest)
```

```
## randomForest 4.6-14
```

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

```
##
## Attaching package: 'randomForest'
```

```
## The following object is masked from 'package:dplyr':
##
##     combine
```

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

```
library(leaps)
library(MASS)
```

```
##
## Attaching package: 'MASS'
```

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

```
library(readr)
library(corrplot)
```

```
## corrplot 0.84 loaded
```

```
library(gridExtra)
```

```
##
## Attaching package: 'gridExtra'
```

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

```
## The following object is masked from 'package:dplyr':
##
##     combine
```

```
library(formattable)
```

```
##
## Attaching package: 'formattable'
```

```
## The following object is masked from 'package:MASS':
##
##     area
```

```
library(readr)
tele_Churn <- read_csv("~/Desktop/WA_Fn-UseC_-Telco-Customer-Churn.csv")
```

```
## Parsed with column specification:
## cols(
##   .default = col_character(),
##   SeniorCitizen = col_double(),
##   tenure = col_double(),
##   MonthlyCharges = col_double(),
##   TotalCharges = col_double()
## )
```

```
## See spec(...) for full column specifications.
```

```
#check the missing values
sapply(tele_Churn, function(x) sum(is.na(x)))
```

```
##       customerID           gender    SeniorCitizen          Partn
er
##                0                0                0
0
##       Dependents           tenure     PhoneService    MultipleLin
es
##                0                0                0
0
##  InternetService   OnlineSecurity     OnlineBackup DeviceProtecti
on
##                0                0                0
0
##      TechSupport      StreamingTV  StreamingMovies         Contra
ct
##                0                0                0
0
## PaperlessBilling    PaymentMethod   MonthlyCharges     TotalCharg
es
##                0                0                0
11
##            Churn
##                0
```

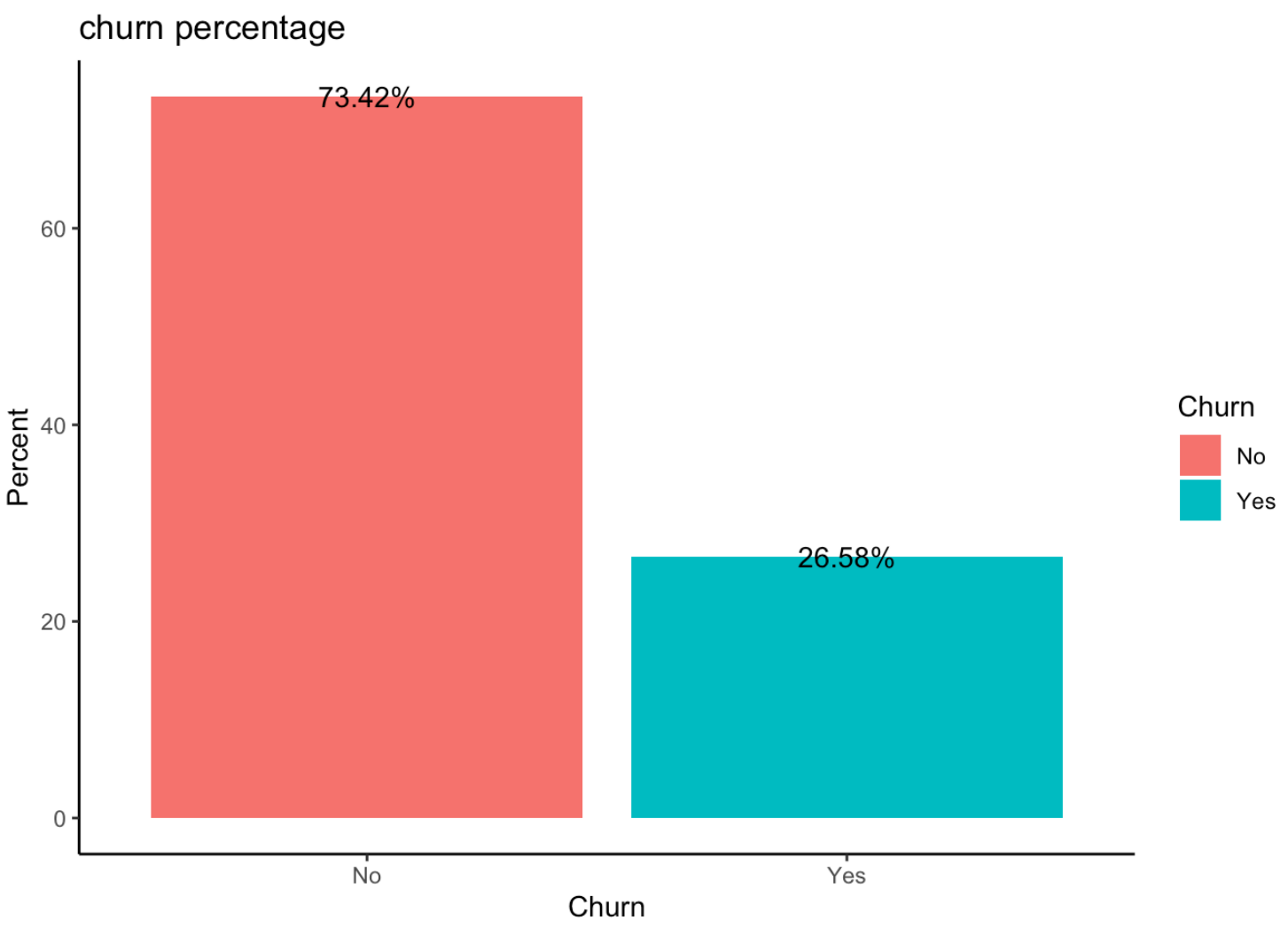
```
#drop the missing values
telechurn01 <-na.omit(tele_Churn)

#change the seniorCitizen column to factor
telechurn02 <- telechurn01%>%
  mutate(SeniorCitizen = as.factor(SeniorCitizen))
telechurn02$customerID <- NULL

head(telechurn02)
```

```
## # A tibble: 6 x 20
##   gender SeniorCitizen Partner Dependents tenure PhoneService Mul
tipleLines
##   <chr>  <fct>         <chr>   <chr>       <dbl> <chr>        <ch
r>
## 1 Female 0             Yes     No              1 No           No
phone ser…
## 2 Male   0             No      No             34 Yes          No
## 3 Male   0             No      No              2 Yes          No
## 4 Male   0             No      No             45 No           No
phone ser…
## 5 Female 0             No      No              2 Yes          No
## 6 Female 0             No      No              8 Yes          Yes
## # … with 13 more variables: InternetService <chr>, OnlineSecurity
<chr>,
## #   OnlineBackup <chr>, DeviceProtection <chr>, TechSupport <chr>
,
## #   StreamingTV <chr>, StreamingMovies <chr>, Contract <chr>,
## #   PaperlessBilling <chr>, PaymentMethod <chr>, MonthlyCharges <
dbl>,
## #   TotalCharges <dbl>, Churn <chr>
```

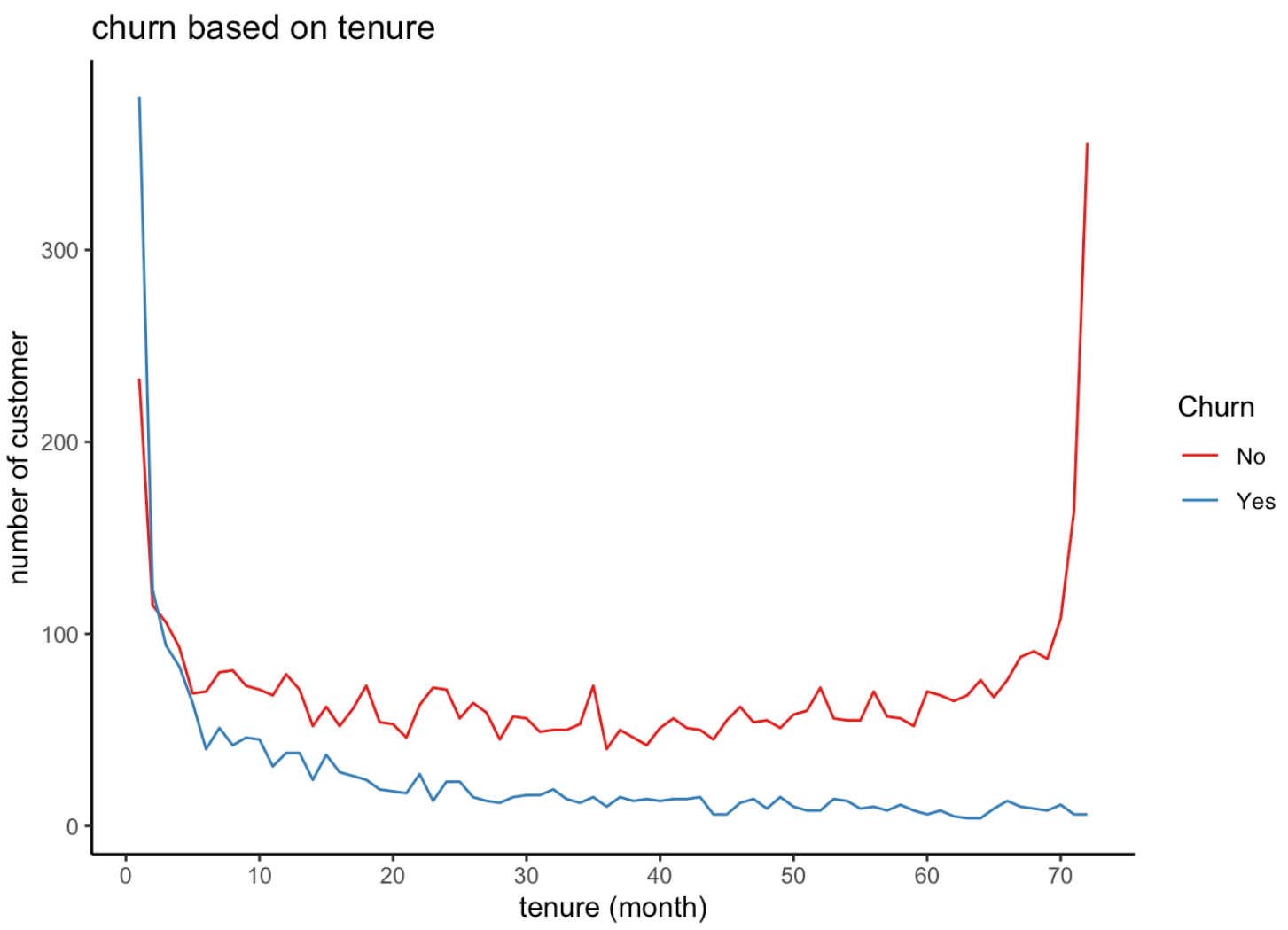
```
str(telechurn02)
```

```
## Classes 'tbl_df', 'tbl' and 'data.frame':    7032 obs. of  20 var
iables:
##  $ gender          : chr  "Female" "Male" "Male" "Male" ...
##  $ SeniorCitizen   : Factor w/ 2 levels "0","1": 1 1 1 1 1 1 1 1
1 1 ...
##  $ Partner         : chr  "Yes" "No" "No" "No" ...
##  $ Dependents      : chr  "No" "No" "No" "No" ...
##  $ tenure          : num  1 34 2 45 2 8 22 10 28 62 ...
##  $ PhoneService    : chr  "No" "Yes" "Yes" "No" ...
##  $ MultipleLines   : chr  "No phone service" "No" "No" "No phone
service" ...
##  $ InternetService : chr  "DSL" "DSL" "DSL" "DSL" ...
##  $ OnlineSecurity  : chr  "No" "Yes" "Yes" "Yes" ...
##  $ OnlineBackup    : chr  "Yes" "No" "Yes" "No" ...
##  $ DeviceProtection: chr  "No" "Yes" "No" "Yes" ...
##  $ TechSupport     : chr  "No" "No" "No" "Yes" ...
##  $ StreamingTV     : chr  "No" "No" "No" "No" ...
##  $ StreamingMovies : chr  "No" "No" "No" "No" ...
##  $ Contract        : chr  "Month-to-month" "One year" "Month-to-m
onth" "One year" ...
##  $ PaperlessBilling: chr  "Yes" "No" "Yes" "No" ...
##  $ PaymentMethod   : chr  "Electronic check" "Mailed check" "Mail
ed check" "Bank transfer (automatic)" ...
##  $ MonthlyCharges  : num  29.9 57 53.9 42.3 70.7 ...
##  $ TotalCharges    : num  29.9 1889.5 108.2 1840.8 151.7 ...
##  $ Churn           : chr  "No" "No" "Yes" "No" ...
```

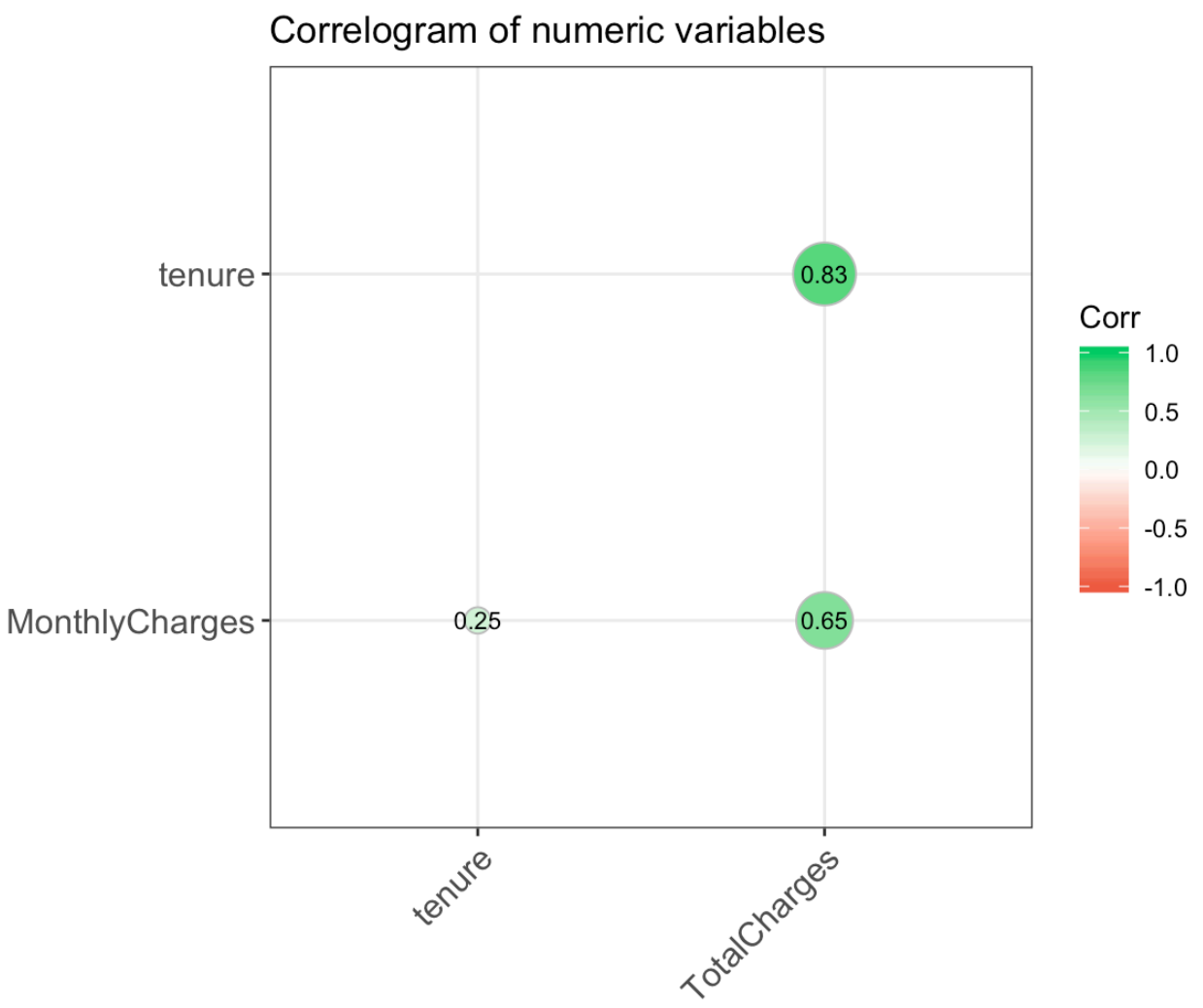
```
#Explortary
#Tele churn percentage
telechurn02 %>%
  group_by(Churn) %>%
  summarise(Number = n()) %>%
  mutate(Percent = prop.table(Number)*100) %>%
ggplot(aes(x=Churn, y=Percent)) +
  geom_col(aes(fill = Churn)) +
  labs(title = "churn percentage") +
  theme(plot.title = element_text(hjust = 0.5)) +
  geom_text(aes(label = sprintf("%.2f%%", Percent))) +
  scale_colour_brewer(palette = "Set1") + theme_classic()
```



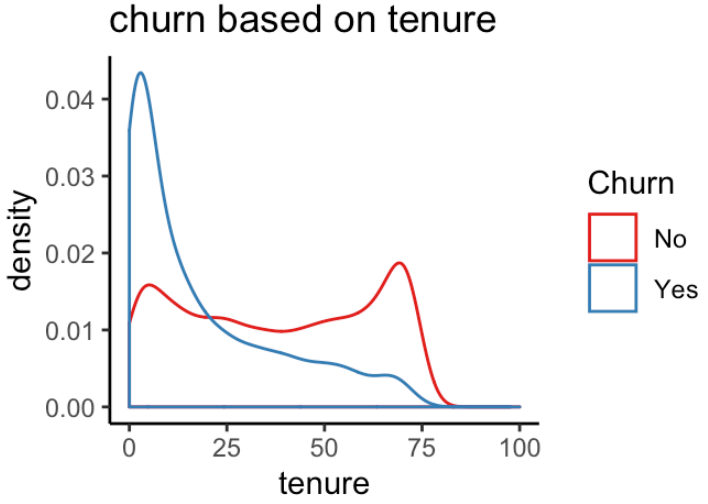

```
#Customer Behaviors based on Churn and Not Churn
#1 Churn is based on the tenure
 telechurn02%>%
  group_by(tenure, Churn) %>%
  summarise(Number = n()) %>%
  ggplot(aes(x=tenure, y=Number)) +
  geom_line(aes(col = Churn)) +
  labs(x = "tenure (month)",
       y = "number of customer",
       title = "churn based on tenure") +
  scale_x_continuous(breaks = seq(0, 100, 10)) +
  scale_colour_brewer(palette = "Set1") + theme_classic()
```

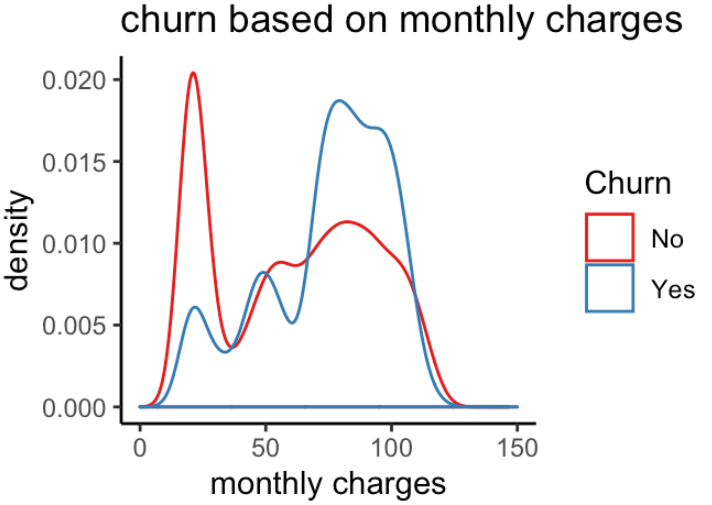


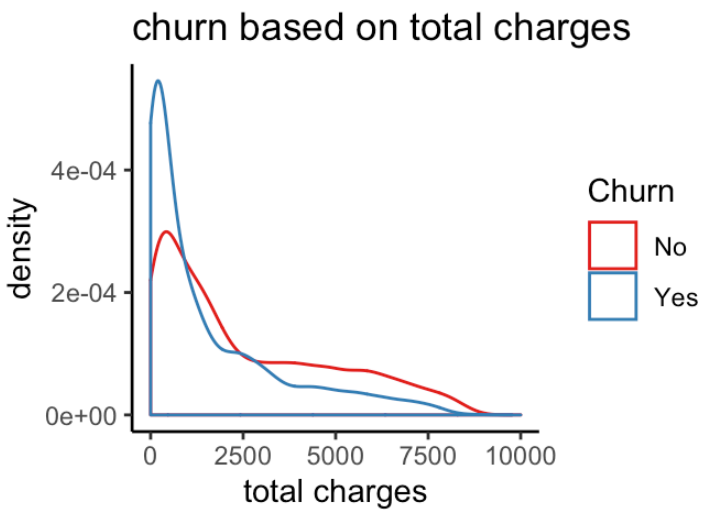

```
#Correlation between numeric variables
library(ggcorrplot)
numeric_var <- sapply(telechurn02, is.numeric)
matrix <- cor(telechurn02[,numeric_var])
ggcorrplot(matrix, hc.order = TRUE,
           type = "lower",
           lab = TRUE,
           lab_size = 3,
           method="circle",
           colors = c("tomato2", "white", "springgreen3"),
           title="Correlogram of numeric variables",
           ggtheme=theme_bw)
```


Correlogram of numeric variables
tenure
MonthlyCharges
0.83
0.25
0.65
tenure
TotalCharges
Corr
1.0
0.5
0.0
-0.5
-1.0

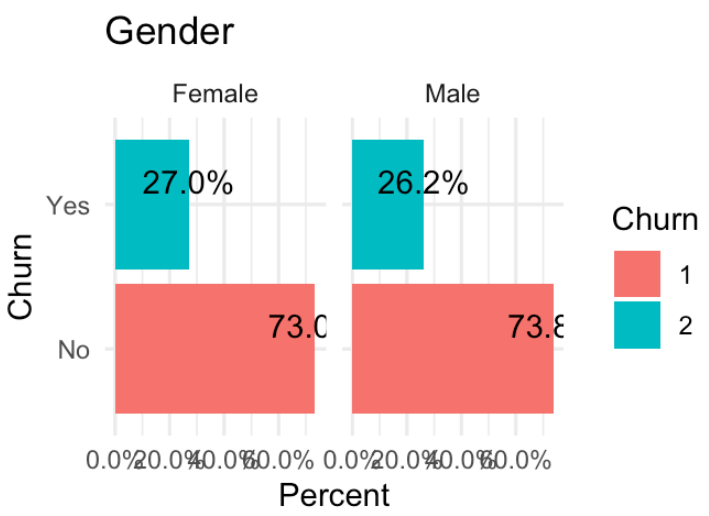
```
#Density plots for numerical variables
#1.Tenure
 a1 <-
  ggplot(telechurn02,aes(x=tenure)) +
  geom_density(aes(col = Churn))+
  labs(x = "tenure",
       y = "density",
       title = "churn based on tenure") +
  scale_colour_brewer(palette = "Set1") + theme_classic()+
  xlim(0,100)

#2.Monthly charges
 a2 <-
  ggplot(telechurn02,aes(x=MonthlyCharges)) +
  geom_density(aes(col = Churn)) +
  labs(x = "monthly charges",
       y = "density",
       title = "churn based on monthly charges") +
  scale_colour_brewer(palette = "Set1") + theme_classic()+
  xlim(0,150)

#3 Total charges
 a3 <-
  ggplot(telechurn02,aes(x=TotalCharges)) +
  geom_density(aes(col = Churn)) +
  labs(x = "total charges",
       y = "density",
       title = "churn based on total charges") +
  scale_colour_brewer(palette = "Set1") + theme_classic()+
  xlim(0,10000)

 grid.arrange(a1,a2,a3,nrow=2)
```

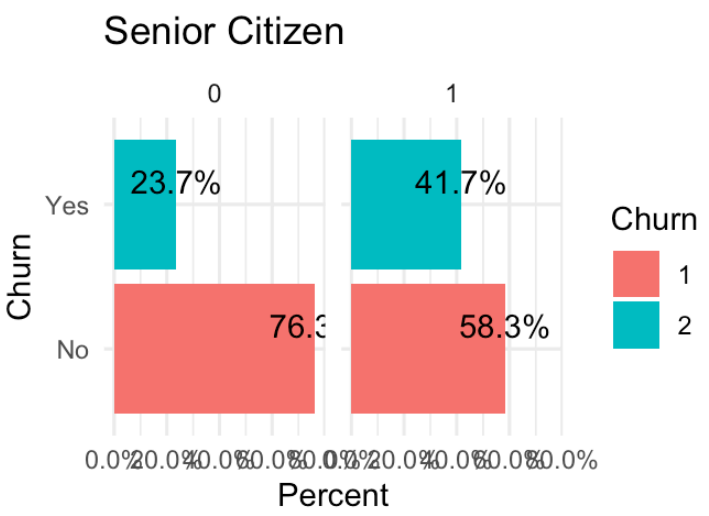

churn based on tenure
density
0.04
0.03
0.02
0.01
0.00
0
25
50
75
100
tenure
Churn
No
Yes

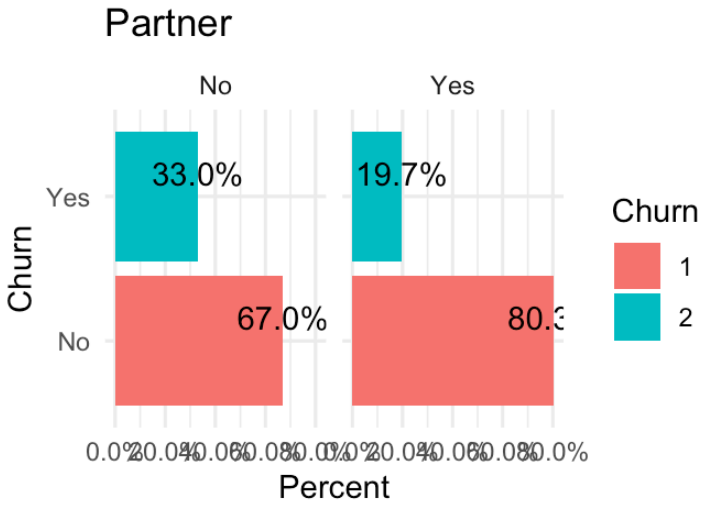

churn based on monthly charges
density
0.020
0.015
0.010
0.005
0.000
0
50
100
150
monthly charges
Churn
No
Yes


churn based on total charges
density
4e-04
2e-04
0e+00
0
2500
5000
7500
10000
total charges
Churn
No
Yes

```
#Different customer chracteristics
p1 <- ggplot(data=telechurn02, aes(x=Churn, group = gender)) +
          geom_bar(aes(y = ..prop.., fill = factor(..x..)), stat="co
unt") +
          geom_text(aes( label = scales::percent(..prop..),
                    y= ..prop.. ), stat= "count", vjust = -.5) +
    labs(y = "Percent", fill="Churn") +
    labs(title = "Gender")+
    facet_grid(~gender) +
    scale_y_continuous(labels = scales::percent)+
    coord_flip() + theme_minimal()

#1 is the senior citizen; 0 is not the senior citizen
p2 <- ggplot(data=telechurn02, aes(x=Churn, group =SeniorCitizen)) +
          geom_bar(aes(y = ..prop.., fill = factor(..x..)), stat="co
unt") +
          geom_text(aes( label = scales::percent(..prop..),
                    y= ..prop.. ), stat= "count", vjust = -.5) +
    labs(y = "Percent", fill="Churn") +
    labs(title = "Senior Citizen")+
    facet_grid(~SeniorCitizen) +
    scale_y_continuous(labels = scales::percent)+
  coord_flip() + theme_minimal()

#Yes means that the customer has partner;
p3<- ggplot(data=telechurn02, aes(x=Churn, group =Partner)) +
          geom_bar(aes(y = ..prop.., fill = factor(..x..)), stat="co
unt") +
          geom_text(aes( label = scales::percent(..prop..),
                    y= ..prop.. ), stat= "count", vjust = -.5) +
    labs(y = "Percent", fill="Churn") +
    labs(title = "Partner")+
    facet_grid(~Partner) +
    scale_y_continuous(labels = scales::percent)+  coord_flip() + th
eme_minimal()
grid.arrange(p1,p2,p3, nrow=2)
```

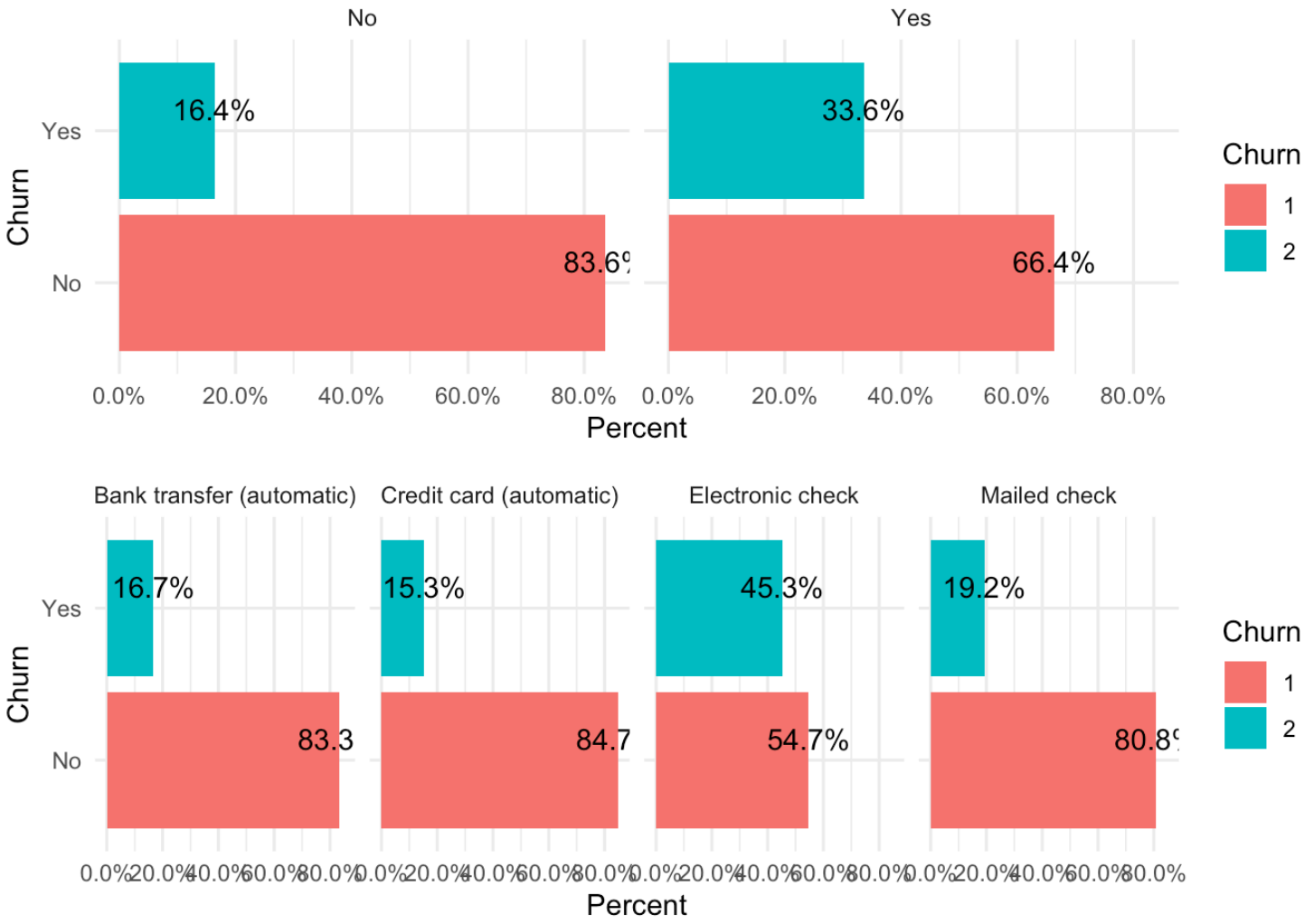




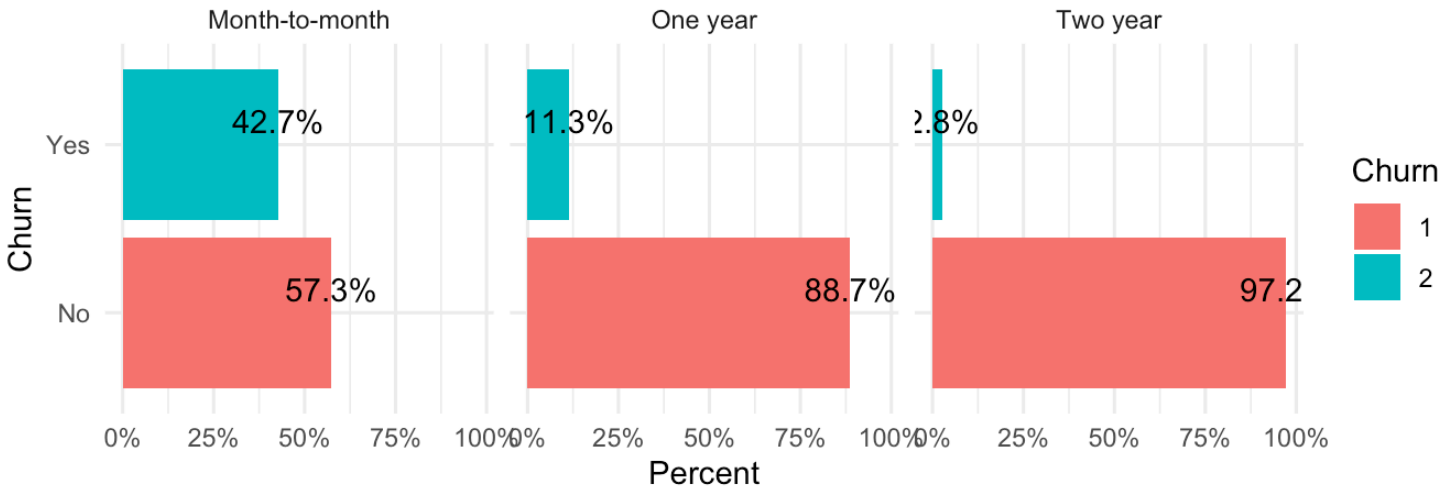


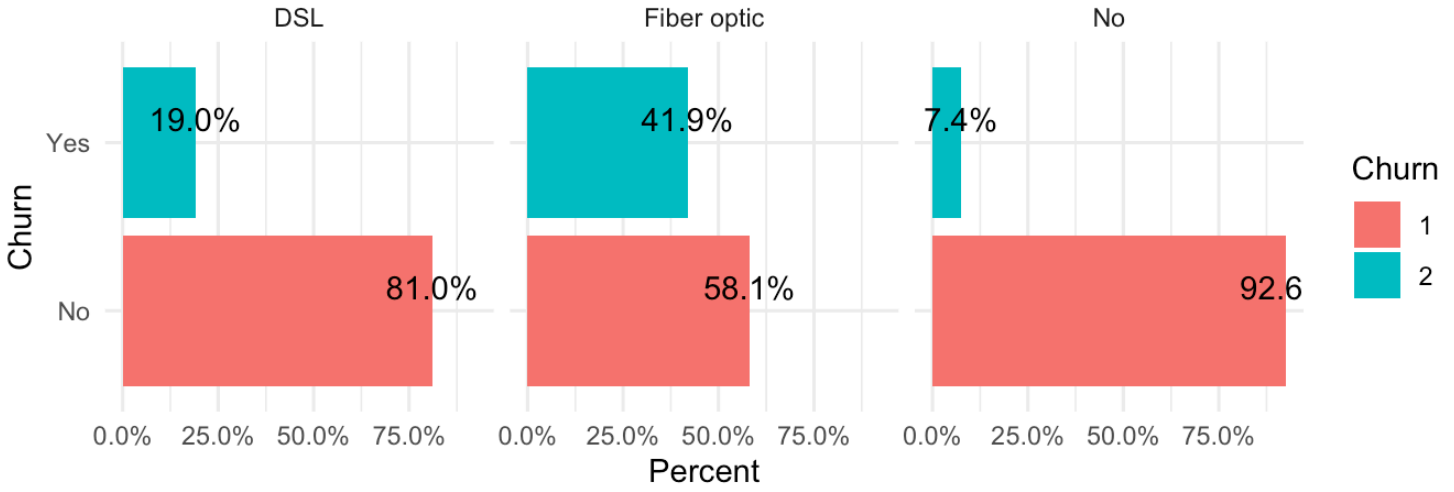

```
#Paperless Billing

p1 <- ggplot(data=telechurn02, aes(x=Churn, group = PaperlessBilling
)) +
          geom_bar(aes(y = ..prop.., fill = factor(..x..)), stat="co
unt") +
          geom_text(aes( label = scales::percent(..prop..),
                    y= ..prop.. ), stat= "count", vjust = -.5) +
    labs(y = "Percent", fill="Churn") +
    facet_grid(~PaperlessBilling) +
    scale_y_continuous(labels = scales::percent)+
    coord_flip() + theme_minimal()
#Payment Methods

p2 <- ggplot(data=telechurn02, aes(x=Churn, group = PaymentMethod))
+
          geom_bar(aes(y = ..prop.., fill = factor(..x..)), stat="co
unt") +
          geom_text(aes( label = scales::percent(..prop..),
```

```
                    y= ..prop.. ), stat= "count", vjust = -.5) +
    labs(y = "Percent", fill="Churn") +
    facet_grid(~PaymentMethod) +
    scale_y_continuous(labels = scales::percent)+
    coord_flip() + theme_minimal()

#Contract Methods

p3 <- ggplot(data=telechurn02, aes(x=Churn, group = Contract)) +
          geom_bar(aes(y = ..prop.., fill = factor(..x..)), stat="co
unt") +
          geom_text(aes( label = scales::percent(..prop..),
                    y= ..prop.. ), stat= "count", vjust = -.5) +
    labs(y = "Percent", fill="Churn") +
    facet_grid(~Contract) +
    scale_y_continuous(labels = scales::percent)+
    coord_flip() + theme_minimal()

#internet service
p4 <- ggplot(data=telechurn02, aes(x=Churn, group = InternetService)
) +
          geom_bar(aes(y = ..prop.., fill = factor(..x..)), stat="co
unt") +
          geom_text(aes( label = scales::percent(..prop..),
                    y= ..prop.. ), stat= "count", vjust = -.5) +
    labs(y = "Percent", fill="Churn") +
    facet_grid(~InternetService) +
    scale_y_continuous(labels = scales::percent)+
    coord_flip() + theme_minimal()

 grid.arrange(p1,p2)
```

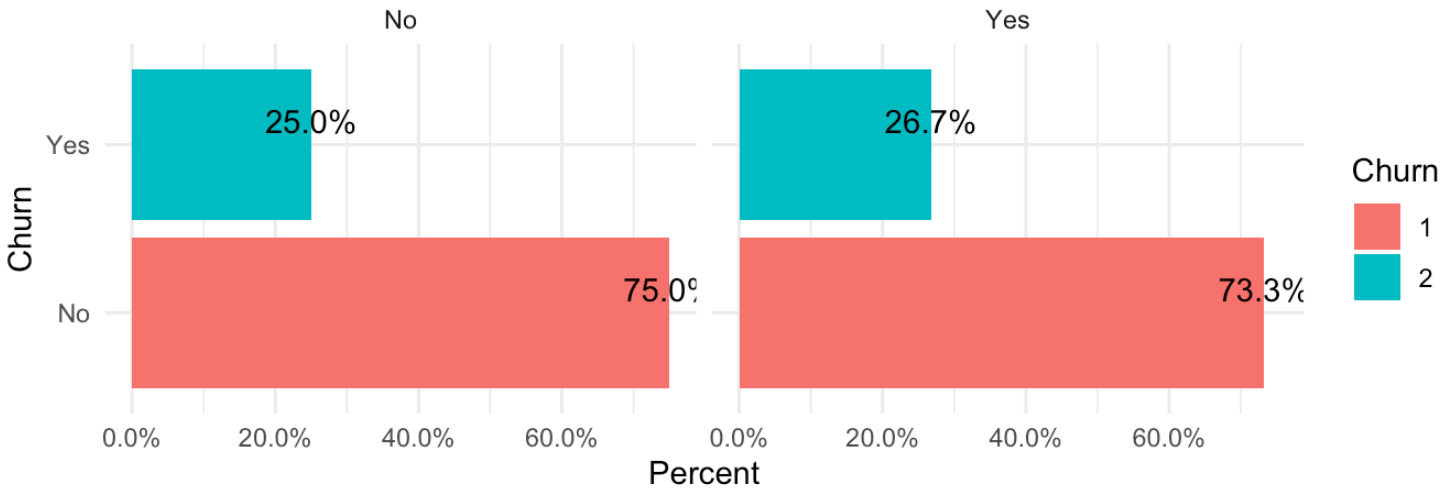


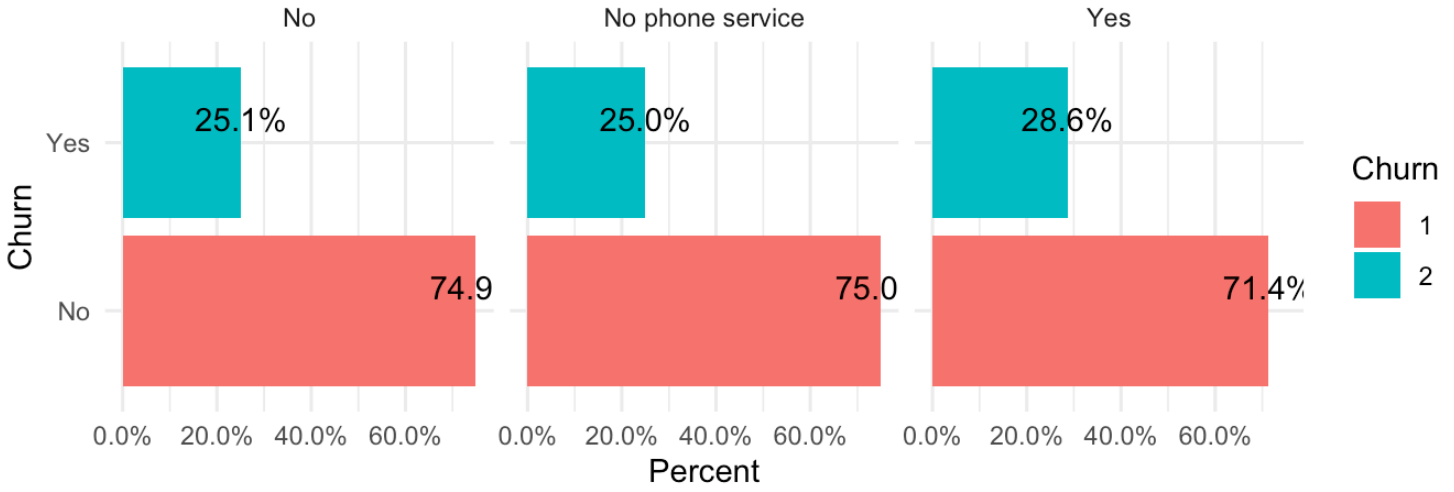

```
grid.arrange(p3,p4)
```


Month-to-month
One year
Two year
Churn
Yes
No
42.7%
57.3%
11.3%
88.7%
97.2
0%
25%
50%
75%
100%
Percent
Churn
1
2

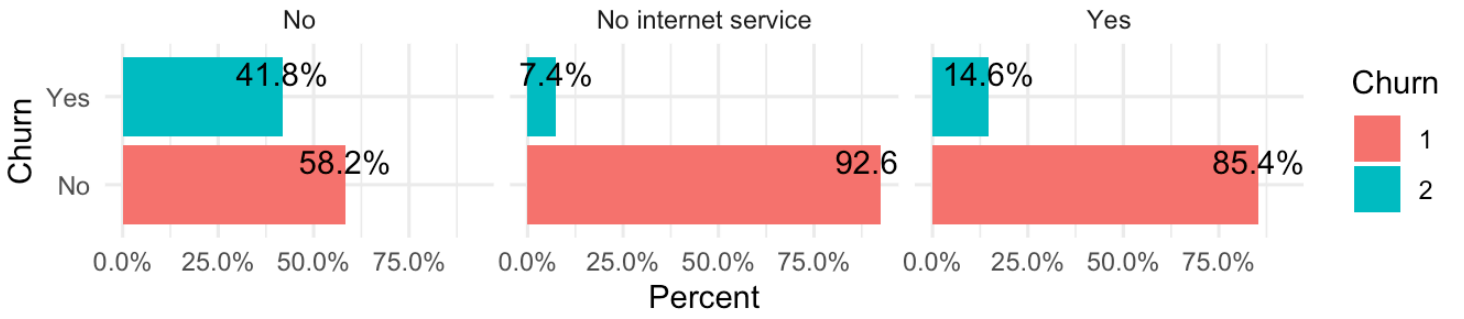

DSL
Fiber optic
No
Churn
Yes
No
19.0%
81.0%
41.9%
58.1%
7.4%
92.6
0.0%
25.0%
50.0%
75.0%
Percent
Churn
1
2

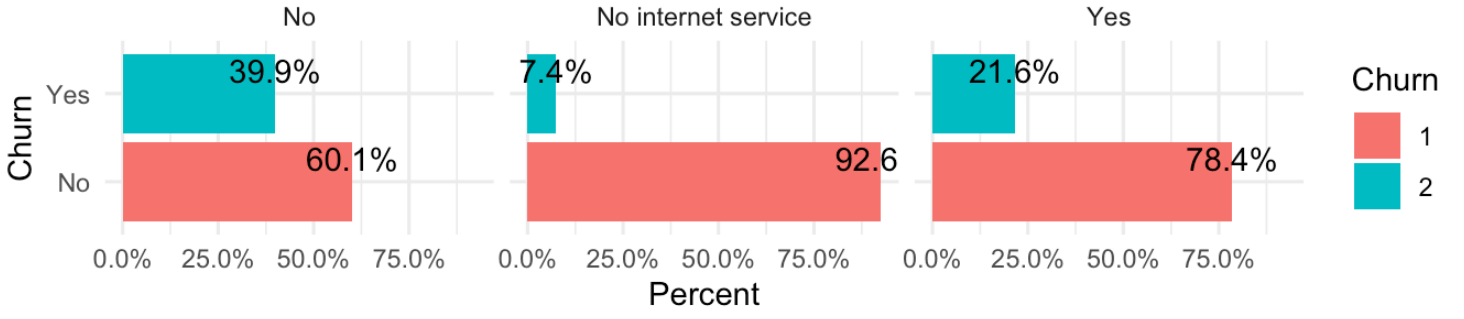
```
#churn based on the service
#phone service
p1 <- ggplot(data=telechurn02, aes(x=Churn, group = PhoneService)) +
          geom_bar(aes(y = ..prop.., fill = factor(..x..)), stat="co
unt") +
          geom_text(aes( label = scales::percent(..prop..),
                    y= ..prop.. ), stat= "count", vjust = -.5) +
    labs(y = "Percent", fill="Churn") +
    facet_grid(~PhoneService) +
    scale_y_continuous(labels = scales::percent)+
    coord_flip() + theme_minimal()

#Multiple lines
p2 <- ggplot(data=telechurn02, aes(x=Churn, group = MultipleLines))
+
          geom_bar(aes(y = ..prop.., fill = factor(..x..)), stat="co
unt") +
          geom_text(aes( label = scales::percent(..prop..),
                    y= ..prop.. ), stat= "count", vjust = -.5) +
    labs(y = "Percent", fill="Churn") +
    facet_grid(~MultipleLines) +
    scale_y_continuous(labels = scales::percent)+
    coord_flip() + theme_minimal()


grid.arrange(p1,p2)
```

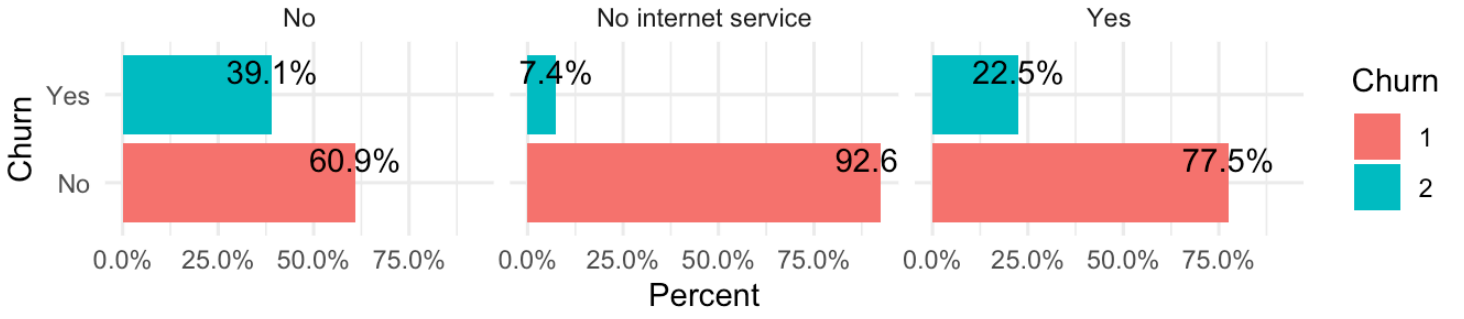

No
Yes
25.0%
26.7%
Churn
Yes
No
75.0%
73.3%
0.0%
20.0%
40.0%
60.0%
Percent
Churn
1
2


No
No phone service
Yes
25.1%
25.0%
28.6%
Churn
Yes
No
74.9
75.0
71.4%
0.0%
20.0%
40.0%
60.0%
Percent
Churn
1
2

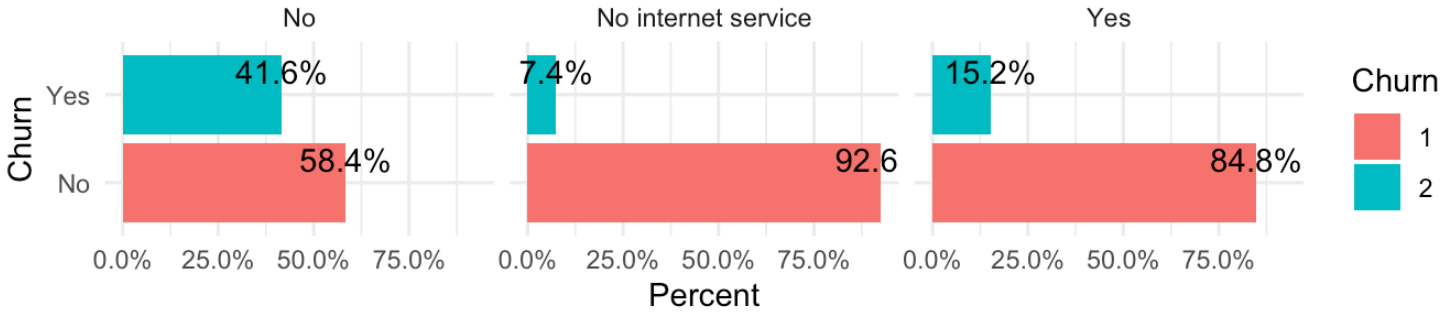
```
#online security
p4 <- ggplot(data=telechurn02, aes(x=Churn, group = OnlineSecurity))
+
          geom_bar(aes(y = ..prop.., fill = factor(..x..)), stat="co
unt") +
          geom_text(aes( label = scales::percent(..prop..),
                    y= ..prop.. ), stat= "count", vjust = -.5) +
    labs(y = "Percent", fill="Churn") +
    facet_grid(~OnlineSecurity) +
    scale_y_continuous(labels = scales::percent)+
    coord_flip() + theme_minimal()

#online backup
p5 <- ggplot(data=telechurn02, aes(x=Churn, group = OnlineBackup)) +
          geom_bar(aes(y = ..prop.., fill = factor(..x..)), stat="co
unt") +
          geom_text(aes( label = scales::percent(..prop..),
                    y= ..prop.. ), stat= "count", vjust = -.5) +
    labs(y = "Percent", fill="Churn") +
    facet_grid(~OnlineBackup) +
    scale_y_continuous(labels = scales::percent)+
    coord_flip() + theme_minimal()

#device protection
p6 <- ggplot(data=telechurn02, aes(x=Churn, group = DeviceProtection
)) +
          geom_bar(aes(y = ..prop.., fill = factor(..x..)), stat="co
unt") +
          geom_text(aes( label = scales::percent(..prop..),
                    y= ..prop.. ), stat= "count", vjust = -.5) +
    labs(y = "Percent", fill="Churn") +
    facet_grid(~DeviceProtection) +
    scale_y_continuous(labels = scales::percent)+
    coord_flip() + theme_minimal()

grid.arrange(p4,p5,p6)
```

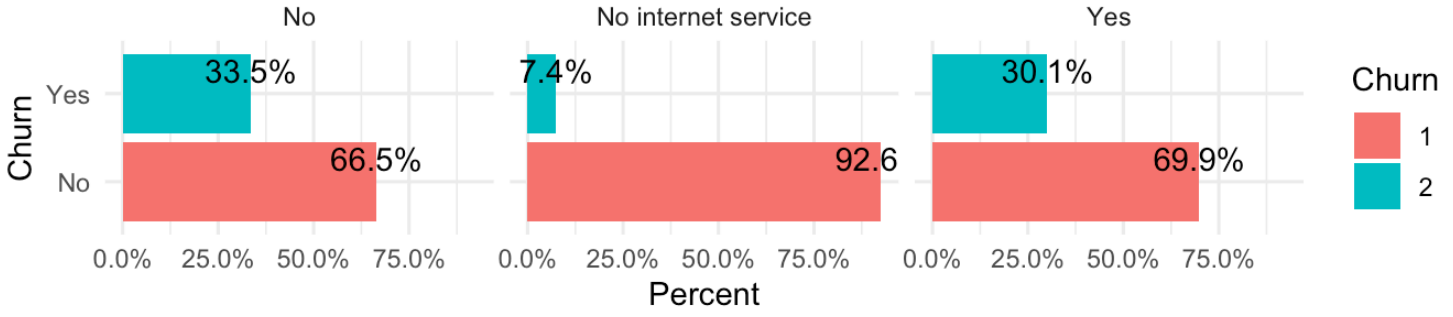

No
No internet service
Yes
Churn
Yes
No
41.8%
58.2%
7.4%
92.6
14.6%
85.4%
0.0% 25.0% 50.0% 75.0%
Percent
Churn
1
2

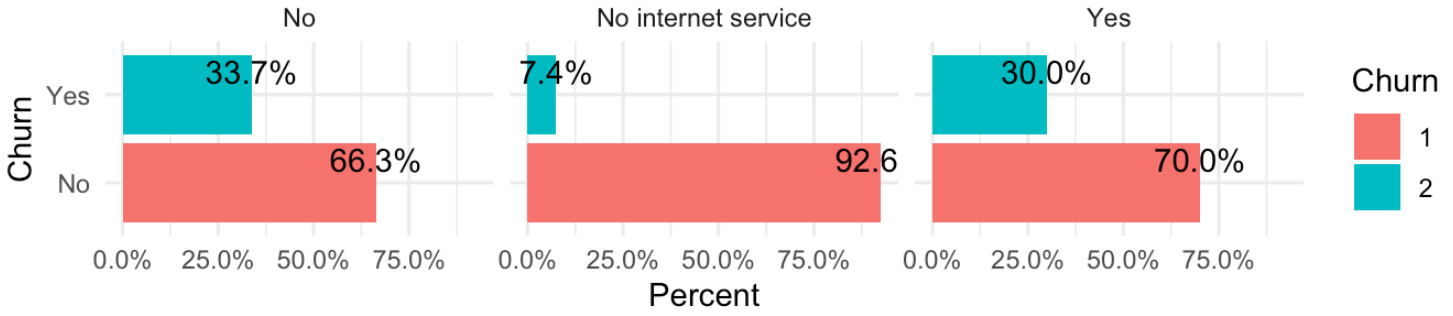

No
No internet service
Yes
Churn
Yes
No
39.9%
60.1%
7.4%
92.6
21.6%
78.4%
0.0% 25.0% 50.0% 75.0%
Percent
Churn
1
2


No
No internet service
Yes
Churn
Yes
No
39.1%
60.9%
7.4%
92.6
22.5%
77.5%
0.0% 25.0% 50.0% 75.0%
Percent
Churn
1
2

```
#TechSupport
p7 <- ggplot(data=telechurn02, aes(x=Churn, group = TechSupport)) +
          geom_bar(aes(y = ..prop.., fill = factor(..x..)), stat="co
unt") +
          geom_text(aes( label = scales::percent(..prop..),
                    y= ..prop.. ), stat= "count", vjust = -.5) +
    labs(y = "Percent", fill="Churn") +
    facet_grid(~TechSupport) +
    scale_y_continuous(labels = scales::percent)+
    coord_flip() + theme_minimal()
#StreamingTV
p8 <- ggplot(data=telechurn02, aes(x=Churn, group = StreamingTV)) +
          geom_bar(aes(y = ..prop.., fill = factor(..x..)), stat="co
unt") +
          geom_text(aes( label = scales::percent(..prop..),
                    y= ..prop.. ), stat= "count", vjust = -.5) +
    labs(y = "Percent", fill="Churn") +
    facet_grid(~StreamingTV) +
    scale_y_continuous(labels = scales::percent)+
    coord_flip() + theme_minimal()
#StreamingMovies
p9 <- ggplot(data=telechurn02, aes(x=Churn, group = StreamingMovies)
) +
          geom_bar(aes(y = ..prop.., fill = factor(..x..)), stat="co
unt") +
          geom_text(aes( label = scales::percent(..prop..),
                    y= ..prop.. ), stat= "count", vjust = -.5) +
    labs(y = "Percent", fill="Churn") +
    facet_grid(~StreamingMovies) +
    scale_y_continuous(labels = scales::percent)+
    coord_flip() + theme_minimal()

grid.arrange(p7,p8,p9)
```








```
#churn prediction
table(telechurn02$Churn)
```

```
##
##   No  Yes
## 5163 1869
```

```
#chr variables to factor variables
index01 <- sapply(telechurn02,is.character)
telechurn02[index01] <- lapply(telechurn02[index01],as.factor)
str(telechurn02)
```

```
## Classes 'tbl_df', 'tbl' and 'data.frame':    7032 obs. of  20 var
iables:
##  $ gender          : Factor w/ 2 levels "Female","Male": 1 2 2 2
1 1 2 1 1 2 ...
##  $ SeniorCitizen   : Factor w/ 2 levels "0","1": 1 1 1 1 1 1 1 1
1 1 ...
##  $ Partner         : Factor w/ 2 levels "No","Yes": 2 1 1 1 1 1 1
1 2 1 ...
##  $ Dependents      : Factor w/ 2 levels "No","Yes": 1 1 1 1 1 1 2
1 1 2 ...
##  $ tenure          : num  1 34 2 45 2 8 22 10 28 62 ...
##  $ PhoneService    : Factor w/ 2 levels "No","Yes": 1 2 2 1 2 2 2
1 2 2 ...
##  $ MultipleLines   : Factor w/ 3 levels "No","No phone service",.
.: 2 1 1 2 1 3 3 2 3 1 ...
##  $ InternetService : Factor w/ 3 levels "DSL","Fiber optic",..: 1
1 1 1 2 2 2 1 2 1 ...
##  $ OnlineSecurity  : Factor w/ 3 levels "No","No internet service
",..: 1 3 3 3 1 1 1 3 1 3 ...
##  $ OnlineBackup    : Factor w/ 3 levels "No","No internet service
",..: 3 1 3 1 1 1 3 1 1 3 ...
##  $ DeviceProtection: Factor w/ 3 levels "No","No internet service
",..: 1 3 1 3 1 3 1 1 3 1 ...
##  $ TechSupport     : Factor w/ 3 levels "No","No internet service
",..: 1 1 1 3 1 1 1 1 3 1 ...
##  $ StreamingTV     : Factor w/ 3 levels "No","No internet service
",..: 1 1 1 1 1 3 3 1 3 1 ...
##  $ StreamingMovies : Factor w/ 3 levels "No","No internet service
",..: 1 1 1 1 1 3 1 1 3 1 ...
##  $ Contract        : Factor w/ 3 levels "Month-to-month",..: 1 2
1 2 1 1 1 1 1 2 ...
##  $ PaperlessBilling: Factor w/ 2 levels "No","Yes": 2 1 2 1 2 2 2
1 2 1 ...
##  $ PaymentMethod   : Factor w/ 4 levels "Bank transfer (automatic
)",..: 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           : Factor w/ 2 levels "No","Yes": 1 1 2 1 2 2 1
1 2 1 ...
```

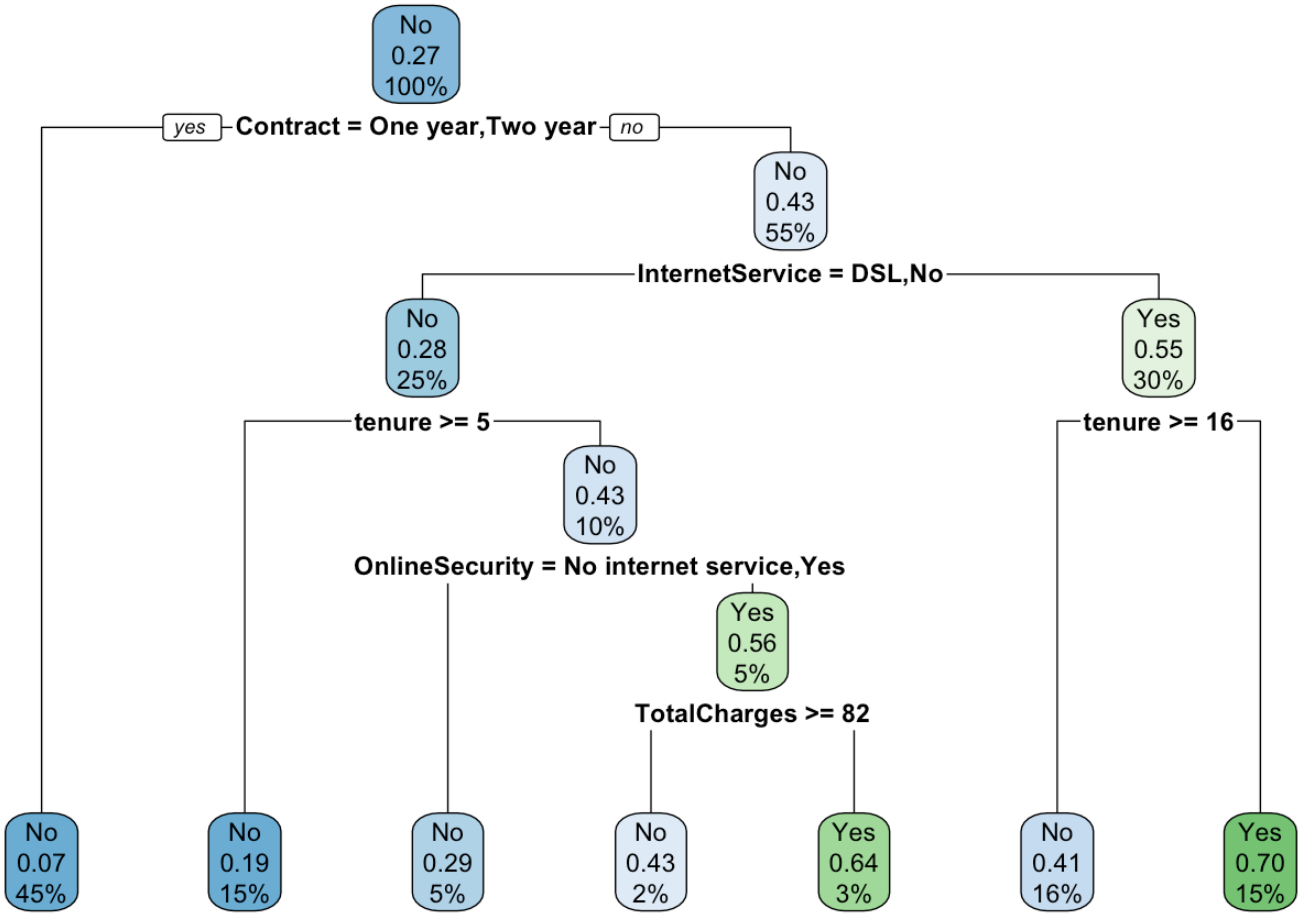
```
#split the dataset
set.seed(100)
index <- createDataPartition(telechurn02$Churn, p = 0.8, list = FALS
E)
teletrain<- telechurn02[index, ]
teletest<- telechurn02[-index, ]

table(teletrain$Churn)
```

```
##
##   No  Yes
## 4131 1496
```

```
table(teletest$Churn)
```

```
##
##   No  Yes
## 1032  373
```

```
#decision tree
library(rpart.plot)
dtmodel <- rpart(formula = Churn ~., data =teletrain,
            method = "class")
rpart.plot(dtmodel)
```




```
library(caret)
dt_test <- predict(object = dtmodel,
                           newdata = teletest,
                           type = "class")
#confusion matrix for prediction
dt1 <-table(Predicted = dt_test, Actual = teletest$Churn)
dt1
```

```
##           Actual
## Predicted  No Yes
##       No  944 210
##       Yes  88 163
```

```
#Evaluation
accuracy = sum(944+163)/ length(teletest$Churn)
precision = dt1[1,1]/sum(dt1[,1])
recall = dt1[1,1]/sum(dt1[1,])
f = 2 * (precision * recall) / (precision + recall)

cat(paste("Accuracy:\t", format(accuracy, digits=2), "\n",sep=" "))
```

```
## Accuracy:     0.79
```

```
cat(paste("Precision:\t", format(precision, digits=2), "\n",sep=" ")
)
```

```
## Precision:    0.91
```

```
cat(paste("Recall:\t\t", format(recall, digits=2), "\n",sep=" "))
```

```
## Recall:       0.82
```

```
cat(paste("F-measure:\t", format(f, digits=2), "\n",sep=" "))
```

```
## F-measure:    0.86
```

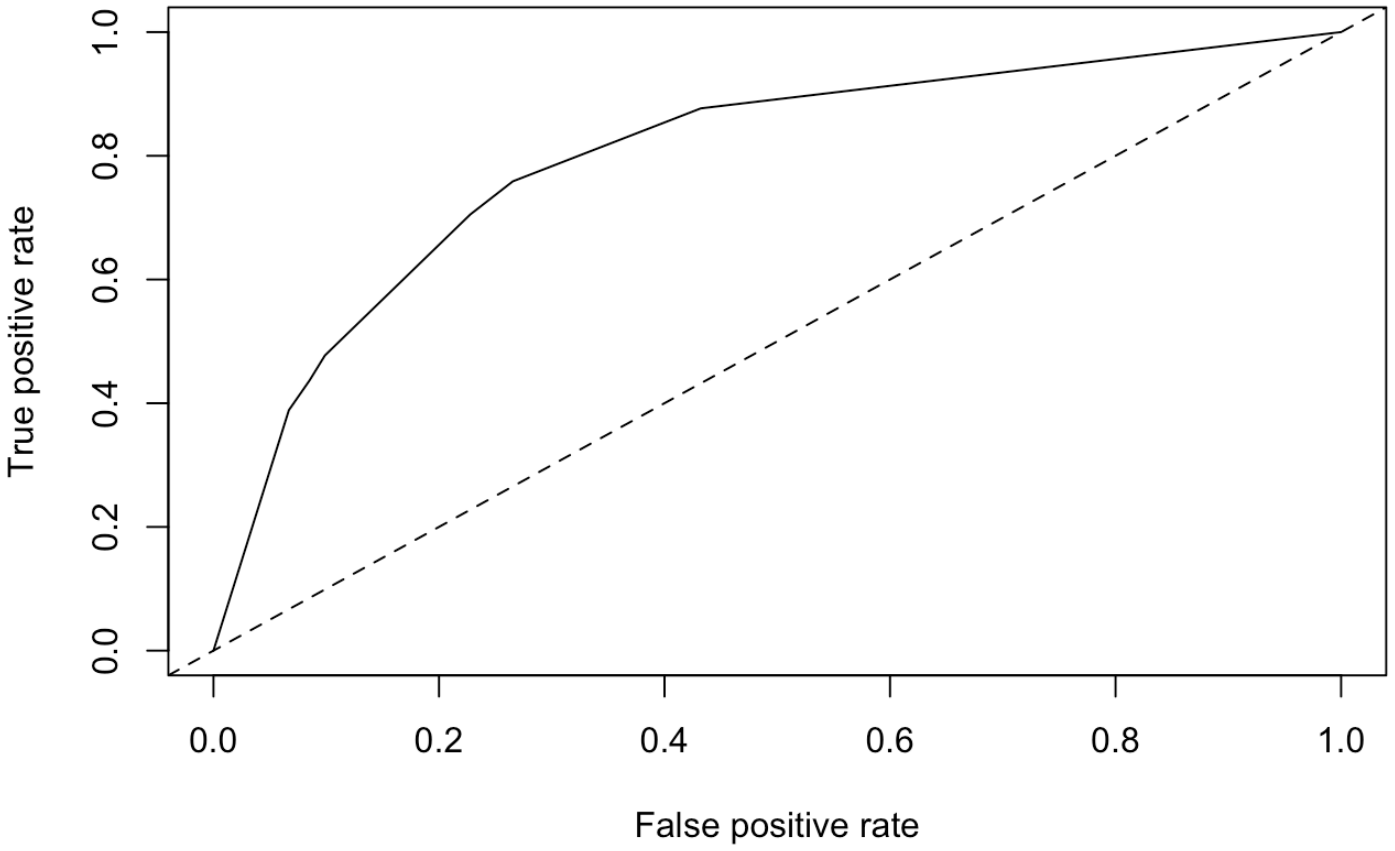
```
#Visualize ROC curve for Decision Tree Model
library(ROCR)
```

```
## Loading required package: gplots
```

```
##
## Attaching package: 'gplots'
```

```
## The following object is masked from 'package:stats':
##
##     lowess
```

```
Pred.cart = predict(dtmodel, newdata =teletest, type = "prob")[,2]
Pred2 = prediction(Pred.cart, teletest$Churn)
plot(performance(Pred2, "tpr", "fpr"))
abline(0, 1, lty = 2)
```




```
#Get the AUC
auc <- performance(Pred2, measure = "auc")
auc@y.values[[1]]
```

```
## [1] 0.7997407
```

```
#AUC=0.799
```