BABI DataMining Group 10

## R Markdown

##This is an R Markdown document. Markdown is a simple formatting syntax for authoring HTML, PDF, and MS Word documents. For more details on using R Markdown see <http://rmarkdown.rstudio.com>.

##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:

## Including Plots

#Starting EDA of the Data #

# Read the file and load the data  
library(readr)  
HR\_Data <- read\_csv("1452762979\_586\_\_HR\_Employee\_Attrition\_Data.csv")

## Parsed with column specification:  
## cols(  
## .default = col\_double(),  
## Attrition = col\_character(),  
## BusinessTravel = col\_character(),  
## Department = col\_character(),  
## EducationField = col\_character(),  
## Gender = col\_character(),  
## JobRole = col\_character(),  
## MaritalStatus = col\_character(),  
## Over18 = col\_character(),  
## OverTime = col\_character()  
## )

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

View(HR\_Data)  
dim(HR\_Data)

## [1] 2940 35

str(HR\_Data)

## Classes 'spec\_tbl\_df', 'tbl\_df', 'tbl' and 'data.frame': 2940 obs. of 35 variables:  
## $ Age : num 41 49 37 33 27 32 59 30 38 36 ...  
## $ Attrition : chr "Yes" "No" "Yes" "No" ...  
## $ BusinessTravel : chr "Travel\_Rarely" "Travel\_Frequently" "Travel\_Rarely" "Travel\_Frequently" ...  
## $ DailyRate : num 1102 279 1373 1392 591 ...  
## $ Department : chr "Sales" "Research & Development" "Research & Development" "Research & Development" ...  
## $ DistanceFromHome : num 1 8 2 3 2 2 3 24 23 27 ...  
## $ Education : num 2 1 2 4 1 2 3 1 3 3 ...  
## $ EducationField : chr "Life Sciences" "Life Sciences" "Other" "Life Sciences" ...  
## $ EmployeeCount : num 1 1 1 1 1 1 1 1 1 1 ...  
## $ EmployeeNumber : num 1 2 3 4 5 6 7 8 9 10 ...  
## $ EnvironmentSatisfaction : num 2 3 4 4 1 4 3 4 4 3 ...  
## $ Gender : chr "Female" "Male" "Male" "Female" ...  
## $ HourlyRate : num 94 61 92 56 40 79 81 67 44 94 ...  
## $ JobInvolvement : num 3 2 2 3 3 3 4 3 2 3 ...  
## $ JobLevel : num 2 2 1 1 1 1 1 1 3 2 ...  
## $ JobRole : chr "Sales Executive" "Research Scientist" "Laboratory Technician" "Research Scientist" ...  
## $ JobSatisfaction : num 4 2 3 3 2 4 1 3 3 3 ...  
## $ MaritalStatus : chr "Single" "Married" "Single" "Married" ...  
## $ MonthlyIncome : num 5993 5130 2090 2909 3468 ...  
## $ MonthlyRate : num 19479 24907 2396 23159 16632 ...  
## $ NumCompaniesWorked : num 8 1 6 1 9 0 4 1 0 6 ...  
## $ Over18 : chr "Y" "Y" "Y" "Y" ...  
## $ OverTime : chr "Yes" "No" "Yes" "Yes" ...  
## $ PercentSalaryHike : num 11 23 15 11 12 13 20 22 21 13 ...  
## $ PerformanceRating : num 3 4 3 3 3 3 4 4 4 3 ...  
## $ RelationshipSatisfaction: num 1 4 2 3 4 3 1 2 2 2 ...  
## $ StandardHours : num 80 80 80 80 80 80 80 80 80 80 ...  
## $ StockOptionLevel : num 0 1 0 0 1 0 3 1 0 2 ...  
## $ TotalWorkingYears : num 8 10 7 8 6 8 12 1 10 17 ...  
## $ TrainingTimesLastYear : num 0 3 3 3 3 2 3 2 2 3 ...  
## $ WorkLifeBalance : num 1 3 3 3 3 2 2 3 3 2 ...  
## $ YearsAtCompany : num 6 10 0 8 2 7 1 1 9 7 ...  
## $ YearsInCurrentRole : num 4 7 0 7 2 7 0 0 7 7 ...  
## $ YearsSinceLastPromotion : num 0 1 0 3 2 3 0 0 1 7 ...  
## $ YearsWithCurrManager : num 5 7 0 0 2 6 0 0 8 7 ...  
## - attr(\*, "spec")=  
## .. cols(  
## .. Age = col\_double(),  
## .. Attrition = col\_character(),  
## .. BusinessTravel = col\_character(),  
## .. DailyRate = col\_double(),  
## .. Department = col\_character(),  
## .. DistanceFromHome = col\_double(),  
## .. Education = col\_double(),  
## .. EducationField = col\_character(),  
## .. EmployeeCount = col\_double(),  
## .. EmployeeNumber = col\_double(),  
## .. EnvironmentSatisfaction = col\_double(),  
## .. Gender = col\_character(),  
## .. HourlyRate = col\_double(),  
## .. JobInvolvement = col\_double(),  
## .. JobLevel = col\_double(),  
## .. JobRole = col\_character(),  
## .. JobSatisfaction = col\_double(),  
## .. MaritalStatus = col\_character(),  
## .. MonthlyIncome = col\_double(),  
## .. MonthlyRate = col\_double(),  
## .. NumCompaniesWorked = col\_double(),  
## .. Over18 = col\_character(),  
## .. OverTime = col\_character(),  
## .. PercentSalaryHike = col\_double(),  
## .. PerformanceRating = col\_double(),  
## .. RelationshipSatisfaction = col\_double(),  
## .. StandardHours = col\_double(),  
## .. StockOptionLevel = col\_double(),  
## .. TotalWorkingYears = col\_double(),  
## .. TrainingTimesLastYear = col\_double(),  
## .. WorkLifeBalance = col\_double(),  
## .. YearsAtCompany = col\_double(),  
## .. YearsInCurrentRole = col\_double(),  
## .. YearsSinceLastPromotion = col\_double(),  
## .. YearsWithCurrManager = col\_double()  
## .. )

head(HR\_Data)

## # A tibble: 6 x 35  
## Age Attrition BusinessTravel DailyRate Department DistanceFromHome  
## <dbl> <chr> <chr> <dbl> <chr> <dbl>  
## 1 41 Yes Travel\_Rarely 1102 Sales 1  
## 2 49 No Travel\_Freque~ 279 Research ~ 8  
## 3 37 Yes Travel\_Rarely 1373 Research ~ 2  
## 4 33 No Travel\_Freque~ 1392 Research ~ 3  
## 5 27 No Travel\_Rarely 591 Research ~ 2  
## 6 32 No Travel\_Freque~ 1005 Research ~ 2  
## # ... with 29 more variables: Education <dbl>, EducationField <chr>,  
## # EmployeeCount <dbl>, EmployeeNumber <dbl>,  
## # EnvironmentSatisfaction <dbl>, Gender <chr>, HourlyRate <dbl>,  
## # JobInvolvement <dbl>, JobLevel <dbl>, JobRole <chr>,  
## # JobSatisfaction <dbl>, MaritalStatus <chr>, MonthlyIncome <dbl>,  
## # MonthlyRate <dbl>, NumCompaniesWorked <dbl>, Over18 <chr>,  
## # OverTime <chr>, PercentSalaryHike <dbl>, PerformanceRating <dbl>,  
## # RelationshipSatisfaction <dbl>, StandardHours <dbl>,  
## # StockOptionLevel <dbl>, TotalWorkingYears <dbl>,  
## # TrainingTimesLastYear <dbl>, WorkLifeBalance <dbl>,  
## # YearsAtCompany <dbl>, YearsInCurrentRole <dbl>,  
## # YearsSinceLastPromotion <dbl>, YearsWithCurrManager <dbl>

tail(HR\_Data)

## # A tibble: 6 x 35  
## Age Attrition BusinessTravel DailyRate Department DistanceFromHome  
## <dbl> <chr> <chr> <dbl> <chr> <dbl>  
## 1 26 No Travel\_Rarely 1167 Sales 5  
## 2 36 No Travel\_Freque~ 884 Research ~ 23  
## 3 39 No Travel\_Rarely 613 Research ~ 6  
## 4 27 No Travel\_Rarely 155 Research ~ 4  
## 5 49 No Travel\_Freque~ 1023 Sales 2  
## 6 34 No Travel\_Rarely 628 Research ~ 8  
## # ... with 29 more variables: Education <dbl>, EducationField <chr>,  
## # EmployeeCount <dbl>, EmployeeNumber <dbl>,  
## # EnvironmentSatisfaction <dbl>, Gender <chr>, HourlyRate <dbl>,  
## # JobInvolvement <dbl>, JobLevel <dbl>, JobRole <chr>,  
## # JobSatisfaction <dbl>, MaritalStatus <chr>, MonthlyIncome <dbl>,  
## # MonthlyRate <dbl>, NumCompaniesWorked <dbl>, Over18 <chr>,  
## # OverTime <chr>, PercentSalaryHike <dbl>, PerformanceRating <dbl>,  
## # RelationshipSatisfaction <dbl>, StandardHours <dbl>,  
## # StockOptionLevel <dbl>, TotalWorkingYears <dbl>,  
## # TrainingTimesLastYear <dbl>, WorkLifeBalance <dbl>,  
## # YearsAtCompany <dbl>, YearsInCurrentRole <dbl>,  
## # YearsSinceLastPromotion <dbl>, YearsWithCurrManager <dbl>

summary(HR\_Data)

## Age Attrition BusinessTravel DailyRate   
## Min. :18.00 Length:2940 Length:2940 Min. : 102.0   
## 1st Qu.:30.00 Class :character Class :character 1st Qu.: 465.0   
## Median :36.00 Mode :character Mode :character Median : 802.0   
## Mean :36.92 Mean : 802.5   
## 3rd Qu.:43.00 3rd Qu.:1157.0   
## Max. :60.00 Max. :1499.0   
## Department DistanceFromHome Education EducationField   
## Length:2940 Min. : 1.000 Min. :1.000 Length:2940   
## Class :character 1st Qu.: 2.000 1st Qu.:2.000 Class :character   
## Mode :character Median : 7.000 Median :3.000 Mode :character   
## Mean : 9.193 Mean :2.913   
## 3rd Qu.:14.000 3rd Qu.:4.000   
## Max. :29.000 Max. :5.000   
## EmployeeCount EmployeeNumber EnvironmentSatisfaction Gender   
## Min. :1 Min. : 1.0 Min. :1.000 Length:2940   
## 1st Qu.:1 1st Qu.: 735.8 1st Qu.:2.000 Class :character   
## Median :1 Median :1470.5 Median :3.000 Mode :character   
## Mean :1 Mean :1470.5 Mean :2.722   
## 3rd Qu.:1 3rd Qu.:2205.2 3rd Qu.:4.000   
## Max. :1 Max. :2940.0 Max. :4.000   
## HourlyRate JobInvolvement JobLevel JobRole   
## Min. : 30.00 Min. :1.00 Min. :1.000 Length:2940   
## 1st Qu.: 48.00 1st Qu.:2.00 1st Qu.:1.000 Class :character   
## Median : 66.00 Median :3.00 Median :2.000 Mode :character   
## Mean : 65.89 Mean :2.73 Mean :2.064   
## 3rd Qu.: 84.00 3rd Qu.:3.00 3rd Qu.:3.000   
## Max. :100.00 Max. :4.00 Max. :5.000   
## JobSatisfaction MaritalStatus MonthlyIncome MonthlyRate   
## Min. :1.000 Length:2940 Min. : 1009 Min. : 2094   
## 1st Qu.:2.000 Class :character 1st Qu.: 2911 1st Qu.: 8045   
## Median :3.000 Mode :character Median : 4919 Median :14236   
## Mean :2.729 Mean : 6503 Mean :14313   
## 3rd Qu.:4.000 3rd Qu.: 8380 3rd Qu.:20462   
## Max. :4.000 Max. :19999 Max. :26999   
## NumCompaniesWorked Over18 OverTime   
## Min. :0.000 Length:2940 Length:2940   
## 1st Qu.:1.000 Class :character Class :character   
## Median :2.000 Mode :character Mode :character   
## Mean :2.693   
## 3rd Qu.:4.000   
## Max. :9.000   
## PercentSalaryHike PerformanceRating RelationshipSatisfaction  
## Min. :11.00 Min. :3.000 Min. :1.000   
## 1st Qu.:12.00 1st Qu.:3.000 1st Qu.:2.000   
## Median :14.00 Median :3.000 Median :3.000   
## Mean :15.21 Mean :3.154 Mean :2.712   
## 3rd Qu.:18.00 3rd Qu.:3.000 3rd Qu.:4.000   
## Max. :25.00 Max. :4.000 Max. :4.000   
## StandardHours StockOptionLevel TotalWorkingYears TrainingTimesLastYear  
## Min. :80 Min. :0.0000 Min. : 0.00 Min. :0.000   
## 1st Qu.:80 1st Qu.:0.0000 1st Qu.: 6.00 1st Qu.:2.000   
## Median :80 Median :1.0000 Median :10.00 Median :3.000   
## Mean :80 Mean :0.7939 Mean :11.28 Mean :2.799   
## 3rd Qu.:80 3rd Qu.:1.0000 3rd Qu.:15.00 3rd Qu.:3.000   
## Max. :80 Max. :3.0000 Max. :40.00 Max. :6.000   
## WorkLifeBalance YearsAtCompany YearsInCurrentRole  
## Min. :1.000 Min. : 0.000 Min. : 0.000   
## 1st Qu.:2.000 1st Qu.: 3.000 1st Qu.: 2.000   
## Median :3.000 Median : 5.000 Median : 3.000   
## Mean :2.761 Mean : 7.008 Mean : 4.229   
## 3rd Qu.:3.000 3rd Qu.: 9.000 3rd Qu.: 7.000   
## Max. :4.000 Max. :40.000 Max. :18.000   
## YearsSinceLastPromotion YearsWithCurrManager  
## Min. : 0.000 Min. : 0.000   
## 1st Qu.: 0.000 1st Qu.: 2.000   
## Median : 1.000 Median : 3.000   
## Mean : 2.188 Mean : 4.123   
## 3rd Qu.: 3.000 3rd Qu.: 7.000   
## Max. :15.000 Max. :17.000

HR\_Data$Attrition <- as.factor(HR\_Data$Attrition)  
 HR\_Data$BusinessTravel <- as.factor(HR\_Data$BusinessTravel)  
 HR\_Data$Department <- as.factor(HR\_Data$Department)  
 HR\_Data$EducationField <- as.factor(HR\_Data$EducationField)  
 HR\_Data$Gender <- as.factor(HR\_Data$Gender)  
 HR\_Data$JobRole <- as.factor(HR\_Data$JobRole)  
 HR\_Data$MaritalStatus <- as.factor(HR\_Data$MaritalStatus)  
 HR\_Data$Over18 <- as.factor(HR\_Data$Over18)  
 HR\_Data$OverTime <- as.factor(HR\_Data$OverTime)  
   
 str(HR\_Data)

## Classes 'spec\_tbl\_df', 'tbl\_df', 'tbl' and 'data.frame': 2940 obs. of 35 variables:  
## $ Age : num 41 49 37 33 27 32 59 30 38 36 ...  
## $ Attrition : Factor w/ 2 levels "No","Yes": 2 1 2 1 1 1 1 1 1 1 ...  
## $ BusinessTravel : Factor w/ 3 levels "Non-Travel","Travel\_Frequently",..: 3 2 3 2 3 2 3 3 2 3 ...  
## $ DailyRate : num 1102 279 1373 1392 591 ...  
## $ Department : Factor w/ 3 levels "Human Resources",..: 3 2 2 2 2 2 2 2 2 2 ...  
## $ DistanceFromHome : num 1 8 2 3 2 2 3 24 23 27 ...  
## $ Education : num 2 1 2 4 1 2 3 1 3 3 ...  
## $ EducationField : Factor w/ 6 levels "Human Resources",..: 2 2 5 2 4 2 4 2 2 4 ...  
## $ EmployeeCount : num 1 1 1 1 1 1 1 1 1 1 ...  
## $ EmployeeNumber : num 1 2 3 4 5 6 7 8 9 10 ...  
## $ EnvironmentSatisfaction : num 2 3 4 4 1 4 3 4 4 3 ...  
## $ Gender : Factor w/ 2 levels "Female","Male": 1 2 2 1 2 2 1 2 2 2 ...  
## $ HourlyRate : num 94 61 92 56 40 79 81 67 44 94 ...  
## $ JobInvolvement : num 3 2 2 3 3 3 4 3 2 3 ...  
## $ JobLevel : num 2 2 1 1 1 1 1 1 3 2 ...  
## $ JobRole : Factor w/ 9 levels "Healthcare Representative",..: 8 7 3 7 3 3 3 3 5 1 ...  
## $ JobSatisfaction : num 4 2 3 3 2 4 1 3 3 3 ...  
## $ MaritalStatus : Factor w/ 3 levels "Divorced","Married",..: 3 2 3 2 2 3 2 1 3 2 ...  
## $ MonthlyIncome : num 5993 5130 2090 2909 3468 ...  
## $ MonthlyRate : num 19479 24907 2396 23159 16632 ...  
## $ NumCompaniesWorked : num 8 1 6 1 9 0 4 1 0 6 ...  
## $ Over18 : Factor w/ 1 level "Y": 1 1 1 1 1 1 1 1 1 1 ...  
## $ OverTime : Factor w/ 2 levels "No","Yes": 2 1 2 2 1 1 2 1 1 1 ...  
## $ PercentSalaryHike : num 11 23 15 11 12 13 20 22 21 13 ...  
## $ PerformanceRating : num 3 4 3 3 3 3 4 4 4 3 ...  
## $ RelationshipSatisfaction: num 1 4 2 3 4 3 1 2 2 2 ...  
## $ StandardHours : num 80 80 80 80 80 80 80 80 80 80 ...  
## $ StockOptionLevel : num 0 1 0 0 1 0 3 1 0 2 ...  
## $ TotalWorkingYears : num 8 10 7 8 6 8 12 1 10 17 ...  
## $ TrainingTimesLastYear : num 0 3 3 3 3 2 3 2 2 3 ...  
## $ WorkLifeBalance : num 1 3 3 3 3 2 2 3 3 2 ...  
## $ YearsAtCompany : num 6 10 0 8 2 7 1 1 9 7 ...  
## $ YearsInCurrentRole : num 4 7 0 7 2 7 0 0 7 7 ...  
## $ YearsSinceLastPromotion : num 0 1 0 3 2 3 0 0 1 7 ...  
## $ YearsWithCurrManager : num 5 7 0 0 2 6 0 0 8 7 ...  
## - attr(\*, "spec")=  
## .. cols(  
## .. Age = col\_double(),  
## .. Attrition = col\_character(),  
## .. BusinessTravel = col\_character(),  
## .. DailyRate = col\_double(),  
## .. Department = col\_character(),  
## .. DistanceFromHome = col\_double(),  
## .. Education = col\_double(),  
## .. EducationField = col\_character(),  
## .. EmployeeCount = col\_double(),  
## .. EmployeeNumber = col\_double(),  
## .. EnvironmentSatisfaction = col\_double(),  
## .. Gender = col\_character(),  
## .. HourlyRate = col\_double(),  
## .. JobInvolvement = col\_double(),  
## .. JobLevel = col\_double(),  
## .. JobRole = col\_character(),  
## .. JobSatisfaction = col\_double(),  
## .. MaritalStatus = col\_character(),  
## .. MonthlyIncome = col\_double(),  
## .. MonthlyRate = col\_double(),  
## .. NumCompaniesWorked = col\_double(),  
## .. Over18 = col\_character(),  
## .. OverTime = col\_character(),  
## .. PercentSalaryHike = col\_double(),  
## .. PerformanceRating = col\_double(),  
## .. RelationshipSatisfaction = col\_double(),  
## .. StandardHours = col\_double(),  
## .. StockOptionLevel = col\_double(),  
## .. TotalWorkingYears = col\_double(),  
## .. TrainingTimesLastYear = col\_double(),  
## .. WorkLifeBalance = col\_double(),  
## .. YearsAtCompany = col\_double(),  
## .. YearsInCurrentRole = col\_double(),  
## .. YearsSinceLastPromotion = col\_double(),  
## .. YearsWithCurrManager = col\_double()  
## .. )

library(lattice)  
library(ggplot2)

## Warning: package 'ggplot2' was built under R version 3.6.1

library(corrplot)

## Warning: package 'corrplot' was built under R version 3.6.1

## corrplot 0.84 loaded

library(ggpubr)

## Warning: package 'ggpubr' was built under R version 3.6.1

## Loading required package: magrittr

library(ggplot2)  
library(corrplot)

names(HR\_Data)

## [1] "Age" "Attrition"   
## [3] "BusinessTravel" "DailyRate"   
## [5] "Department" "DistanceFromHome"   
## [7] "Education" "EducationField"   
## [9] "EmployeeCount" "EmployeeNumber"   
## [11] "EnvironmentSatisfaction" "Gender"   
## [13] "HourlyRate" "JobInvolvement"   
## [15] "JobLevel" "JobRole"   
## [17] "JobSatisfaction" "MaritalStatus"   
## [19] "MonthlyIncome" "MonthlyRate"   
## [21] "NumCompaniesWorked" "Over18"   
## [23] "OverTime" "PercentSalaryHike"   
## [25] "PerformanceRating" "RelationshipSatisfaction"  
## [27] "StandardHours" "StockOptionLevel"   
## [29] "TotalWorkingYears" "TrainingTimesLastYear"   
## [31] "WorkLifeBalance" "YearsAtCompany"   
## [33] "YearsInCurrentRole" "YearsSinceLastPromotion"   
## [35] "YearsWithCurrManager"

HR\_Data\_Corr <- subset(HR\_Data, select = -c(Attrition , BusinessTravel , Department , EducationField , Gender , JobRole , MaritalStatus , Over18 , OverTime ))  
   
str(HR\_Data\_Corr)

## Classes 'tbl\_df', 'tbl' and 'data.frame': 2940 obs. of 26 variables:  
## $ Age : num 41 49 37 33 27 32 59 30 38 36 ...  
## $ DailyRate : num 1102 279 1373 1392 591 ...  
## $ DistanceFromHome : num 1 8 2 3 2 2 3 24 23 27 ...  
## $ Education : num 2 1 2 4 1 2 3 1 3 3 ...  
## $ EmployeeCount : num 1 1 1 1 1 1 1 1 1 1 ...  
## $ EmployeeNumber : num 1 2 3 4 5 6 7 8 9 10 ...  
## $ EnvironmentSatisfaction : num 2 3 4 4 1 4 3 4 4 3 ...  
## $ HourlyRate : num 94 61 92 56 40 79 81 67 44 94 ...  
## $ JobInvolvement : num 3 2 2 3 3 3 4 3 2 3 ...  
## $ JobLevel : num 2 2 1 1 1 1 1 1 3 2 ...  
## $ JobSatisfaction : num 4 2 3 3 2 4 1 3 3 3 ...  
## $ MonthlyIncome : num 5993 5130 2090 2909 3468 ...  
## $ MonthlyRate : num 19479 24907 2396 23159 16632 ...  
## $ NumCompaniesWorked : num 8 1 6 1 9 0 4 1 0 6 ...  
## $ PercentSalaryHike : num 11 23 15 11 12 13 20 22 21 13 ...  
## $ PerformanceRating : num 3 4 3 3 3 3 4 4 4 3 ...  
## $ RelationshipSatisfaction: num 1 4 2 3 4 3 1 2 2 2 ...  
## $ StandardHours : num 80 80 80 80 80 80 80 80 80 80 ...  
## $ StockOptionLevel : num 0 1 0 0 1 0 3 1 0 2 ...  
## $ TotalWorkingYears : num 8 10 7 8 6 8 12 1 10 17 ...  
## $ TrainingTimesLastYear : num 0 3 3 3 3 2 3 2 2 3 ...  
## $ WorkLifeBalance : num 1 3 3 3 3 2 2 3 3 2 ...  
## $ YearsAtCompany : num 6 10 0 8 2 7 1 1 9 7 ...  
## $ YearsInCurrentRole : num 4 7 0 7 2 7 0 0 7 7 ...  
## $ YearsSinceLastPromotion : num 0 1 0 3 2 3 0 0 1 7 ...  
## $ YearsWithCurrManager : num 5 7 0 0 2 6 0 0 8 7 ...

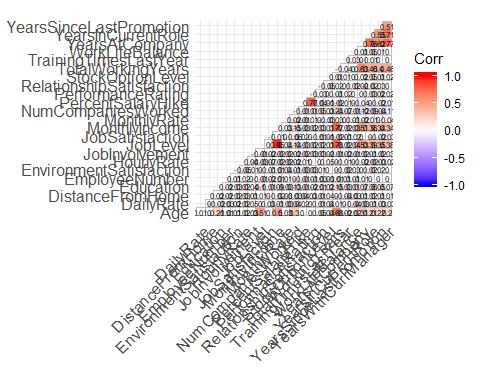
cor(HR\_Data\_Corr)

## Warning in cor(HR\_Data\_Corr): the standard deviation is zero

## Age DailyRate DistanceFromHome  
## Age 1.000000000 0.0106609426 -0.001686120  
## DailyRate 0.010660943 1.0000000000 -0.004985337  
## DistanceFromHome -0.001686120 -0.0049853374 1.000000000  
## Education 0.208033731 -0.0168064332 0.021041826  
## EmployeeCount NA NA NA  
## EmployeeNumber -0.005174672 -0.0257418149 0.016464171  
## EnvironmentSatisfaction 0.010146428 0.0183548543 -0.016075327  
## HourlyRate 0.024286543 0.0233814215 0.031130586  
## JobInvolvement 0.029819959 0.0461348740 0.008783280  
## JobLevel 0.509604228 0.0029663349 0.005302731  
## JobSatisfaction -0.004891877 0.0305710078 -0.003668839  
## MonthlyIncome 0.497854567 0.0077070589 -0.017014445  
## MonthlyRate 0.028051167 -0.0321816015 0.027472864  
## NumCompaniesWorked 0.299634758 0.0381534343 -0.029250804  
## PercentSalaryHike 0.003633585 0.0227036775 0.040235377  
## PerformanceRating 0.001903896 0.0004732963 0.027109618  
## RelationshipSatisfaction 0.053534720 0.0078460310 0.006557475  
## StandardHours NA NA NA  
## StockOptionLevel 0.037509712 0.0421427964 0.044871999  
## TotalWorkingYears 0.680380536 0.0145147387 0.004628426  
## TrainingTimesLastYear -0.019620819 0.0024525427 -0.036942234  
## WorkLifeBalance -0.021490028 -0.0378480510 -0.026556004  
## YearsAtCompany 0.311308770 -0.0340547676 0.009507720  
## YearsInCurrentRole 0.212901056 0.0099320150 0.018844999  
## YearsSinceLastPromotion 0.216513368 -0.0332289848 0.010028836  
## YearsWithCurrManager 0.202088602 -0.0263631782 0.014406048  
## Education EmployeeCount EmployeeNumber  
## Age 0.208033731 NA -0.0051746719  
## DailyRate -0.016806433 NA -0.0257418149  
## DistanceFromHome 0.021041826 NA 0.0164641708  
## Education 1.000000000 NA 0.0209502859  
## EmployeeCount NA 1 NA  
## EmployeeNumber 0.020950286 NA 1.0000000000  
## EnvironmentSatisfaction -0.027128313 NA 0.0087118301  
## HourlyRate 0.016774829 NA 0.0173769037  
## JobInvolvement 0.042437634 NA -0.0035523572  
## JobLevel 0.101588886 NA -0.0090203564  
## JobSatisfaction -0.011296117 NA -0.0229704931  
## MonthlyIncome 0.094960677 NA -0.0071883547  
## MonthlyRate -0.026084197 NA 0.0061773879  
## NumCompaniesWorked 0.126316560 NA -0.0003445734  
## PercentSalaryHike -0.011110941 NA -0.0066847469  
## PerformanceRating -0.024538791 NA -0.0103375736  
## RelationshipSatisfaction -0.009118377 NA -0.0348269429  
## StandardHours NA NA NA  
## StockOptionLevel 0.018422220 NA 0.0312260658  
## TotalWorkingYears 0.148279697 NA -0.0070474759  
## TrainingTimesLastYear -0.025100241 NA 0.0119534797  
## WorkLifeBalance 0.009819189 NA 0.0053700124  
## YearsAtCompany 0.069113696 NA -0.0057786925  
## YearsInCurrentRole 0.060235554 NA -0.0044266305  
## YearsSinceLastPromotion 0.054254334 NA -0.0045753542  
## YearsWithCurrManager 0.069065378 NA -0.0047162091  
## EnvironmentSatisfaction HourlyRate  
## Age 0.010146428 0.024286543  
## DailyRate 0.018354854 0.023381422  
## DistanceFromHome -0.016075327 0.031130586  
## Education -0.027128313 0.016774829  
## EmployeeCount NA NA  
## EmployeeNumber 0.008711830 0.017376904  
## EnvironmentSatisfaction 1.000000000 -0.049856956  
## HourlyRate -0.049856956 1.000000000  
## JobInvolvement -0.008277598 0.042860641  
## JobLevel 0.001211699 -0.027853486  
## JobSatisfaction -0.006784353 -0.071334624  
## MonthlyIncome -0.006259088 -0.015794304  
## MonthlyRate 0.037599623 -0.015296750  
## NumCompaniesWorked 0.012594323 0.022156883  
## PercentSalaryHike -0.031701195 -0.009061986  
## PerformanceRating -0.029547952 -0.002171697  
## RelationshipSatisfaction 0.007665384 0.001330453  
## StandardHours NA NA  
## StockOptionLevel 0.003432158 0.050263399  
## TotalWorkingYears -0.002693070 -0.002333682  
## TrainingTimesLastYear -0.019359308 -0.008547685  
## WorkLifeBalance 0.027627295 -0.004607234  
## YearsAtCompany 0.001457549 -0.019581616  
## YearsInCurrentRole 0.018007460 -0.024106220  
## YearsSinceLastPromotion 0.016193606 -0.026715586  
## YearsWithCurrManager -0.004998723 -0.020123200  
## JobInvolvement JobLevel JobSatisfaction  
## Age 0.029819959 0.509604228 -0.0048918771  
## DailyRate 0.046134874 0.002966335 0.0305710078  
## DistanceFromHome 0.008783280 0.005302731 -0.0036688392  
## Education 0.042437634 0.101588886 -0.0112961167  
## EmployeeCount NA NA NA  
## EmployeeNumber -0.003552357 -0.009020356 -0.0229704931  
## EnvironmentSatisfaction -0.008277598 0.001211699 -0.0067843526  
## HourlyRate 0.042860641 -0.027853486 -0.0713346244  
## JobInvolvement 1.000000000 -0.012629883 -0.0214759103  
## JobLevel -0.012629883 1.000000000 -0.0019437080  
## JobSatisfaction -0.021475910 -0.001943708 1.0000000000  
## MonthlyIncome -0.015271491 0.950299913 -0.0071567424  
## MonthlyRate -0.016322079 0.039562951 0.0006439169  
## NumCompaniesWorked 0.015012413 0.142501124 -0.0556994260  
## PercentSalaryHike -0.017204572 -0.034730492 0.0200020394  
## PerformanceRating -0.029071333 -0.021222082 0.0022971971  
## RelationshipSatisfaction 0.034296821 0.021641511 -0.0124535932  
## StandardHours NA NA NA  
## StockOptionLevel 0.021522640 0.013983911 0.0106902261  
## TotalWorkingYears -0.005533182 0.782207805 -0.0201850727  
## TrainingTimesLastYear -0.015337826 -0.018190550 -0.0057793350  
## WorkLifeBalance -0.014616593 0.037817746 -0.0194587102  
## YearsAtCompany -0.021355427 0.534738687 -0.0038026279  
## YearsInCurrentRole 0.008716963 0.389446733 -0.0023047852  
## YearsSinceLastPromotion -0.024184292 0.353885347 -0.0182135678  
## YearsWithCurrManager 0.025975808 0.375280608 -0.0276562139  
## MonthlyIncome MonthlyRate NumCompaniesWorked  
## Age 0.497854567 0.0280511671 0.2996347580  
## DailyRate 0.007707059 -0.0321816015 0.0381534343  
## DistanceFromHome -0.017014445 0.0274728635 -0.0292508042  
## Education 0.094960677 -0.0260841972 0.1263165602  
## EmployeeCount NA NA NA  
## EmployeeNumber -0.007188355 0.0061773879 -0.0003445734  
## EnvironmentSatisfaction -0.006259088 0.0375996229 0.0125943232  
## HourlyRate -0.015794304 -0.0152967496 0.0221568834  
## JobInvolvement -0.015271491 -0.0163220791 0.0150124132  
## JobLevel 0.950299913 0.0395629510 0.1425011238  
## JobSatisfaction -0.007156742 0.0006439169 -0.0556994260  
## MonthlyIncome 1.000000000 0.0348136261 0.1495152160  
## MonthlyRate 0.034813626 1.0000000000 0.0175213534  
## NumCompaniesWorked 0.149515216 0.0175213534 1.0000000000  
## PercentSalaryHike -0.027268586 -0.0064293459 -0.0102383094  
## PerformanceRating -0.017120138 -0.0098114285 -0.0140948728  
## RelationshipSatisfaction 0.025873436 -0.0040853293 0.0527330486  
## StandardHours NA NA NA  
## StockOptionLevel 0.005407677 -0.0343228302 0.0300754751  
## TotalWorkingYears 0.772893246 0.0264424712 0.2376385898  
## TrainingTimesLastYear -0.021736277 0.0014668806 -0.0660540717  
## WorkLifeBalance 0.030683082 0.0079631575 -0.0083656848  
## YearsAtCompany 0.514284826 -0.0236551067 -0.1184213402  
## YearsInCurrentRole 0.363817667 -0.0128148744 -0.0907539337  
## YearsSinceLastPromotion 0.344977638 0.0015667995 -0.0368138924  
## YearsWithCurrManager 0.344078883 -0.0367459053 -0.1103191554  
## PercentSalaryHike PerformanceRating  
## Age 0.003633585 0.0019038955  
## DailyRate 0.022703677 0.0004732963  
## DistanceFromHome 0.040235377 0.0271096185  
## Education -0.011110941 -0.0245387912  
## EmployeeCount NA NA  
## EmployeeNumber -0.006684747 -0.0103375736  
## EnvironmentSatisfaction -0.031701195 -0.0295479523  
## HourlyRate -0.009061986 -0.0021716974  
## JobInvolvement -0.017204572 -0.0290713334  
## JobLevel -0.034730492 -0.0212220821  
## JobSatisfaction 0.020002039 0.0022971971  
## MonthlyIncome -0.027268586 -0.0171201382  
## MonthlyRate -0.006429346 -0.0098114285  
## NumCompaniesWorked -0.010238309 -0.0140948728  
## PercentSalaryHike 1.000000000 0.7735499964  
## PerformanceRating 0.773549996 1.0000000000  
## RelationshipSatisfaction -0.040490081 -0.0313514554  
## StandardHours NA NA  
## StockOptionLevel 0.007527748 0.0035064716  
## TotalWorkingYears -0.020608488 0.0067436679  
## TrainingTimesLastYear -0.005221012 -0.0155788817  
## WorkLifeBalance -0.003279636 0.0025723613  
## YearsAtCompany -0.035991262 0.0034351261  
## YearsInCurrentRole -0.001520027 0.0349862604  
## YearsSinceLastPromotion -0.022154313 0.0178960661  
## YearsWithCurrManager -0.011985248 0.0228271689  
## RelationshipSatisfaction StandardHours  
## Age 0.0535347197 NA  
## DailyRate 0.0078460310 NA  
## DistanceFromHome 0.0065574746 NA  
## Education -0.0091183767 NA  
## EmployeeCount NA NA  
## EmployeeNumber -0.0348269429 NA  
## EnvironmentSatisfaction 0.0076653835 NA  
## HourlyRate 0.0013304528 NA  
## JobInvolvement 0.0342968206 NA  
## JobLevel 0.0216415105 NA  
## JobSatisfaction -0.0124535932 NA  
## MonthlyIncome 0.0258734361 NA  
## MonthlyRate -0.0040853293 NA  
## NumCompaniesWorked 0.0527330486 NA  
## PercentSalaryHike -0.0404900811 NA  
## PerformanceRating -0.0313514554 NA  
## RelationshipSatisfaction 1.0000000000 NA  
## StandardHours NA 1  
## StockOptionLevel -0.0459524907 NA  
## TotalWorkingYears 0.0240542918 NA  
## TrainingTimesLastYear 0.0024965264 NA  
## WorkLifeBalance 0.0196044057 NA  
## YearsAtCompany 0.0193667869 NA  
## YearsInCurrentRole -0.0151229149 NA  
## YearsSinceLastPromotion 0.0334925021 NA  
## YearsWithCurrManager -0.0008674968 NA  
## StockOptionLevel TotalWorkingYears  
## Age 0.037509712 0.680380536  
## DailyRate 0.042142796 0.014514739  
## DistanceFromHome 0.044871999 0.004628426  
## Education 0.018422220 0.148279697  
## EmployeeCount NA NA  
## EmployeeNumber 0.031226066 -0.007047476  
## EnvironmentSatisfaction 0.003432158 -0.002693070  
## HourlyRate 0.050263399 -0.002333682  
## JobInvolvement 0.021522640 -0.005533182  
## JobLevel 0.013983911 0.782207805  
## JobSatisfaction 0.010690226 -0.020185073  
## MonthlyIncome 0.005407677 0.772893246  
## MonthlyRate -0.034322830 0.026442471  
## NumCompaniesWorked 0.030075475 0.237638590  
## PercentSalaryHike 0.007527748 -0.020608488  
## PerformanceRating 0.003506472 0.006743668  
## RelationshipSatisfaction -0.045952491 0.024054292  
## StandardHours NA NA  
## StockOptionLevel 1.000000000 0.010135969  
## TotalWorkingYears 0.010135969 1.000000000  
## TrainingTimesLastYear 0.011274070 -0.035661571  
## WorkLifeBalance 0.004128730 0.001007646  
## YearsAtCompany 0.015058008 0.628133155  
## YearsInCurrentRole 0.050817873 0.460364638  
## YearsSinceLastPromotion 0.014352185 0.404857759  
## YearsWithCurrManager 0.024698227 0.459188397  
## TrainingTimesLastYear WorkLifeBalance  
## Age -0.019620819 -0.021490028  
## DailyRate 0.002452543 -0.037848051  
## DistanceFromHome -0.036942234 -0.026556004  
## Education -0.025100241 0.009819189  
## EmployeeCount NA NA  
## EmployeeNumber 0.011953480 0.005370012  
## EnvironmentSatisfaction -0.019359308 0.027627295  
## HourlyRate -0.008547685 -0.004607234  
## JobInvolvement -0.015337826 -0.014616593  
## JobLevel -0.018190550 0.037817746  
## JobSatisfaction -0.005779335 -0.019458710  
## MonthlyIncome -0.021736277 0.030683082  
## MonthlyRate 0.001466881 0.007963158  
## NumCompaniesWorked -0.066054072 -0.008365685  
## PercentSalaryHike -0.005221012 -0.003279636  
## PerformanceRating -0.015578882 0.002572361  
## RelationshipSatisfaction 0.002496526 0.019604406  
## StandardHours NA NA  
## StockOptionLevel 0.011274070 0.004128730  
## TotalWorkingYears -0.035661571 0.001007646  
## TrainingTimesLastYear 1.000000000 0.028072207  
## WorkLifeBalance 0.028072207 1.000000000  
## YearsAtCompany 0.003568666 0.012089185  
## YearsInCurrentRole -0.005737504 0.049856498  
## YearsSinceLastPromotion -0.002066536 0.008941249  
## YearsWithCurrManager -0.004095526 0.002759440  
## YearsAtCompany YearsInCurrentRole  
## Age 0.311308770 0.212901056  
## DailyRate -0.034054768 0.009932015  
## DistanceFromHome 0.009507720 0.018844999  
## Education 0.069113696 0.060235554  
## EmployeeCount NA NA  
## EmployeeNumber -0.005778692 -0.004426630  
## EnvironmentSatisfaction 0.001457549 0.018007460  
## HourlyRate -0.019581616 -0.024106220  
## JobInvolvement -0.021355427 0.008716963  
## JobLevel 0.534738687 0.389446733  
## JobSatisfaction -0.003802628 -0.002304785  
## MonthlyIncome 0.514284826 0.363817667  
## MonthlyRate -0.023655107 -0.012814874  
## NumCompaniesWorked -0.118421340 -0.090753934  
## PercentSalaryHike -0.035991262 -0.001520027  
## PerformanceRating 0.003435126 0.034986260  
## RelationshipSatisfaction 0.019366787 -0.015122915  
## StandardHours NA NA  
## StockOptionLevel 0.015058008 0.050817873  
## TotalWorkingYears 0.628133155 0.460364638  
## TrainingTimesLastYear 0.003568666 -0.005737504  
## WorkLifeBalance 0.012089185 0.049856498  
## YearsAtCompany 1.000000000 0.758753737  
## YearsInCurrentRole 0.758753737 1.000000000  
## YearsSinceLastPromotion 0.618408865 0.548056248  
## YearsWithCurrManager 0.769212425 0.714364762  
## YearsSinceLastPromotion YearsWithCurrManager  
## Age 0.216513368 0.2020886024  
## DailyRate -0.033228985 -0.0263631782  
## DistanceFromHome 0.010028836 0.0144060484  
## Education 0.054254334 0.0690653783  
## EmployeeCount NA NA  
## EmployeeNumber -0.004575354 -0.0047162091  
## EnvironmentSatisfaction 0.016193606 -0.0049987226  
## HourlyRate -0.026715586 -0.0201232002  
## JobInvolvement -0.024184292 0.0259758079  
## JobLevel 0.353885347 0.3752806078  
## JobSatisfaction -0.018213568 -0.0276562139  
## MonthlyIncome 0.344977638 0.3440788833  
## MonthlyRate 0.001566800 -0.0367459053  
## NumCompaniesWorked -0.036813892 -0.1103191554  
## PercentSalaryHike -0.022154313 -0.0119852485  
## PerformanceRating 0.017896066 0.0228271689  
## RelationshipSatisfaction 0.033492502 -0.0008674968  
## StandardHours NA NA  
## StockOptionLevel 0.014352185 0.0246982266  
## TotalWorkingYears 0.404857759 0.4591883971  
## TrainingTimesLastYear -0.002066536 -0.0040955260  
## WorkLifeBalance 0.008941249 0.0027594402  
## YearsAtCompany 0.618408865 0.7692124251  
## YearsInCurrentRole 0.548056248 0.7143647616  
## YearsSinceLastPromotion 1.000000000 0.5102236358  
## YearsWithCurrManager 0.510223636 1.0000000000

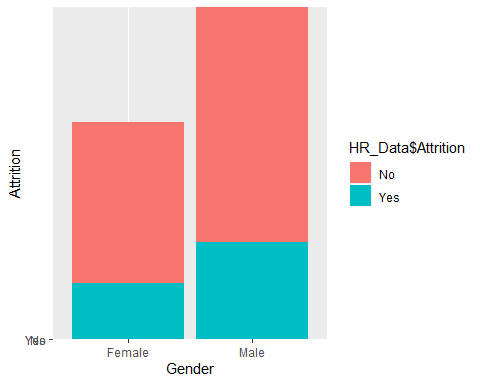
#corrplot(HR\_Data\_Corr , method = "number" , type ="lower" , tl.cex = 1.2 , addgrid.col = "gray50" , mar=c(0,0,0,0) )  
  
  
ggcorrplot::ggcorrplot(corr = cor(HR\_Data\_Corr), type= "lower" , lab = TRUE , lab\_size = 2, insig = c("pch") )

## Warning in cor(HR\_Data\_Corr): the standard deviation is zero

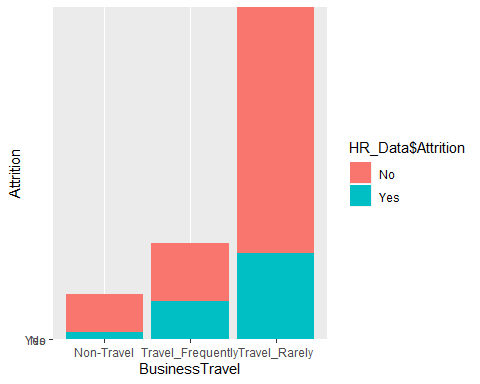
 *Based on corr plot it is seen , there is not very strong correlation between ay of the deoendent vriables*

*Stacked Bar chart for categorical variables with Target variable*

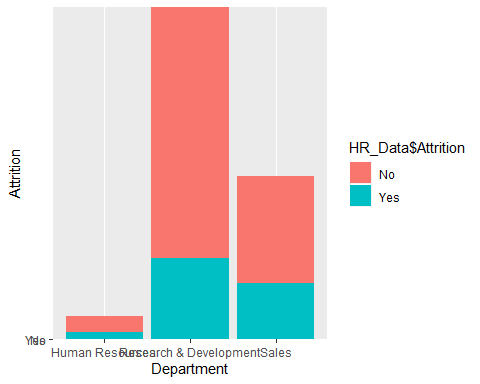
Attr\_Gender <- ggplot(HR\_Data, aes(x = HR\_Data$Gender , y = HR\_Data$Attrition , fill = HR\_Data$Attrition))+  
 geom\_bar( position = "stack" , stat = "identity" ) + xlab("Gender") + ylab("Attrition")  
  
plot(Attr\_Gender)



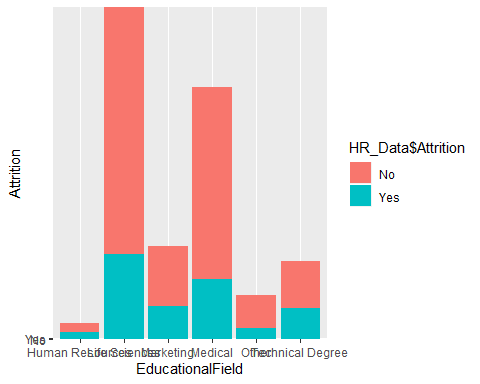
Attr\_BusinessTravel <- ggplot(HR\_Data, aes(x = HR\_Data$BusinessTravel , y = HR\_Data$Attrition , fill = HR\_Data$Attrition))+  
 geom\_bar( position = "stack" , stat = "identity" ) + xlab("BusinessTravel") + ylab("Attrition")  
  
plot(Attr\_BusinessTravel)



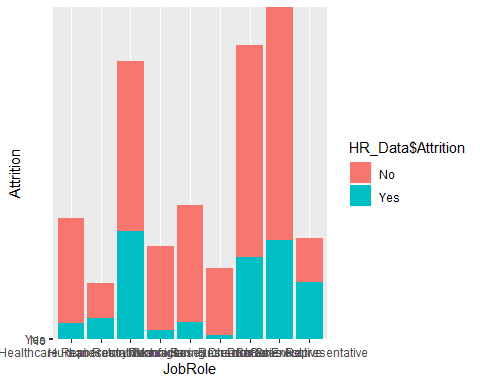
Attr\_Department <- ggplot(HR\_Data, aes(x = HR\_Data$Department , y = HR\_Data$Attrition , fill = HR\_Data$Attrition))+  
 geom\_bar( position = "stack" , stat = "identity" ) + xlab("Department") + ylab("Attrition")  
plot(Attr\_Department)



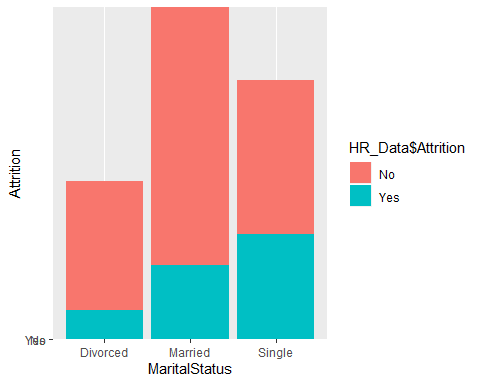
Attr\_EducationField <- ggplot(HR\_Data, aes(x = HR\_Data$EducationField , y = HR\_Data$Attrition , fill = HR\_Data$Attrition))+  
 geom\_bar( position = "stack" , stat = "identity" ) + xlab("EducationalField") + ylab("Attrition")  
  
plot(Attr\_EducationField)



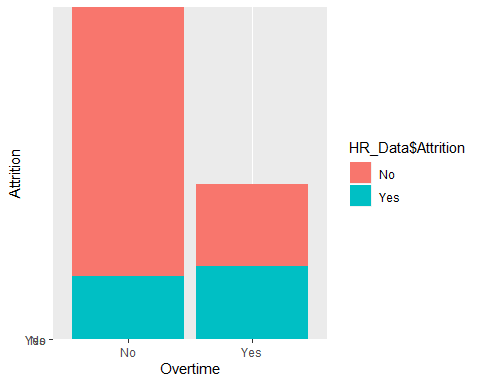
Attr\_JobRole <- ggplot(HR\_Data, aes(x = HR\_Data$JobRole , y = HR\_Data$Attrition , fill = HR\_Data$Attrition))+  
 geom\_bar( position = "stack" , stat = "identity" ) + xlab("JobRole") + ylab("Attrition")  
  
plot(Attr\_JobRole)



Attr\_MaritalStatus <- ggplot(HR\_Data, aes(x = HR\_Data$MaritalStatus , y = HR\_Data$Attrition , fill = HR\_Data$Attrition))+  
 geom\_bar( position = "stack" , stat = "identity" ) + xlab("MaritalStatus") + ylab("Attrition")  
  
plot(Attr\_MaritalStatus)



Attr\_OverTime <- ggplot(HR\_Data, aes(x = HR\_Data$OverTime , y = HR\_Data$Attrition , fill = HR\_Data$Attrition))+  
 geom\_bar( position = "stack" , stat = "identity" ) + xlab("Overtime") + ylab("Attrition")  
  
  
plot(Attr\_OverTime)

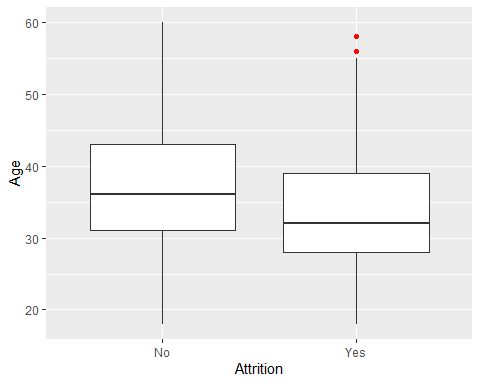


ggarrange(Attr\_Gender, Attr\_BusinessTravel , Attr\_Department , Attr\_EducationField, Attr\_JobRole, Attr\_MaritalStatus, Attr\_OverTime + rremove("x.text"),  
 heights = c(4, 4 , 4 , 4), widths = c(15 ,15),  
 ncol = 2, nrow = 4)

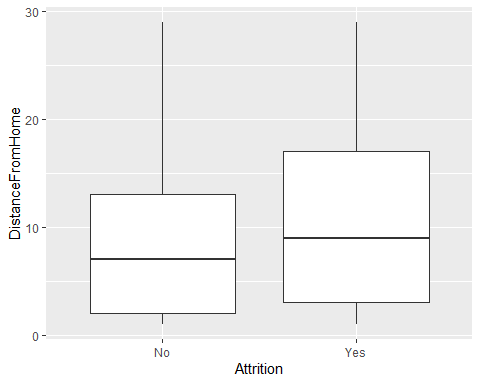


Note that the echo = FALSE parameter was added to the code chunk to prevent printing of the R code that generated the plot.

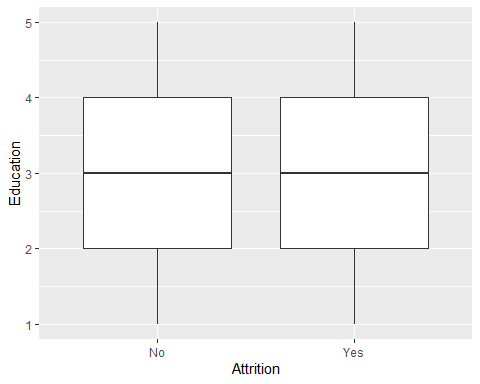
# Age  
  
Attr\_Age <- ggplot(HR\_Data, aes( x = HR\_Data$Attrition , y = HR\_Data$Age))+  
 geom\_boxplot(stat ="boxplot" , outlier.colour = "red" ) + xlab("Attrition") + ylab("Age")  
  
plot(Attr\_Age)



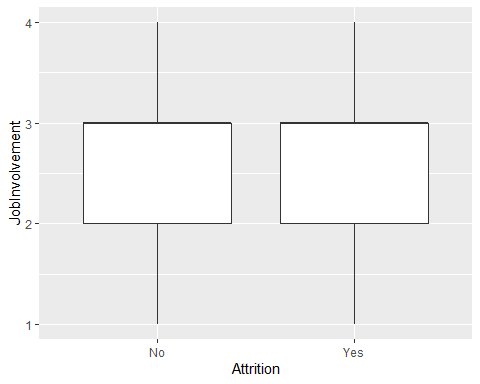
# DistanceFromHome  
  
Attr\_DistanceFromHome <- ggplot(HR\_Data, aes( x = HR\_Data$Attrition , y = HR\_Data$DistanceFromHome))+  
 geom\_boxplot(stat ="boxplot" , outlier.colour = "red") + xlab("Attrition") + ylab("DistanceFromHome")  
  
plot(Attr\_DistanceFromHome)



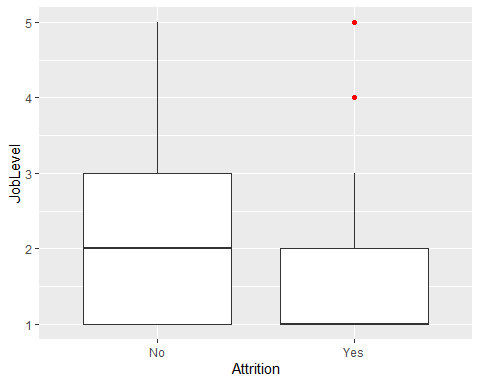
# Education  
  
Attr\_Education <- ggplot(HR\_Data, aes( x = HR\_Data$Attrition , y = HR\_Data$Education))+  
 geom\_boxplot(stat ="boxplot" , outlier.colour = "red") + xlab("Attrition") + ylab("Education")  
  
plot(Attr\_Education)



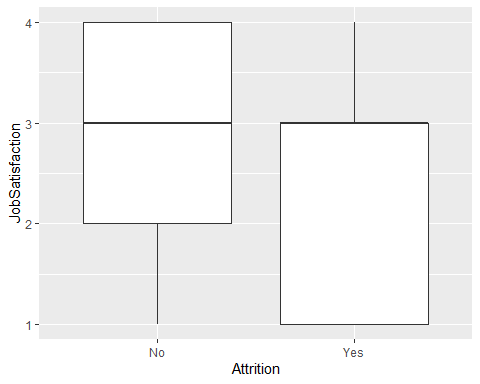
# JobInvolvement  
  
Attr\_JobInvolvement <- ggplot(HR\_Data, aes( x = HR\_Data$Attrition , y = HR\_Data$JobInvolvement))+  
 geom\_boxplot(stat ="boxplot" , outlier.colour = "red") + xlab("Attrition") + ylab("JobInvolvement")  
  
plot(Attr\_JobInvolvement)



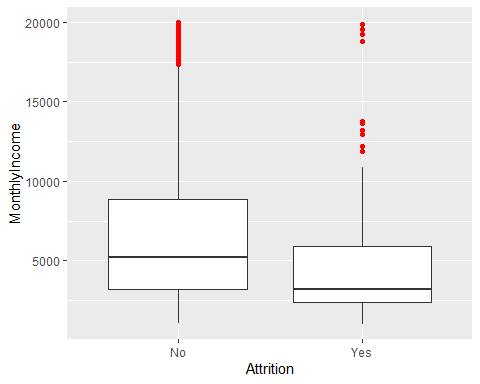
# JobLevel  
  
  
Attr\_JobLevel <- ggplot(HR\_Data, aes( x = HR\_Data$Attrition , y = HR\_Data$JobLevel))+  
 geom\_boxplot(stat ="boxplot" , outlier.colour = "red") + xlab("Attrition") + ylab("JobLevel")  
  
plot(Attr\_JobLevel)



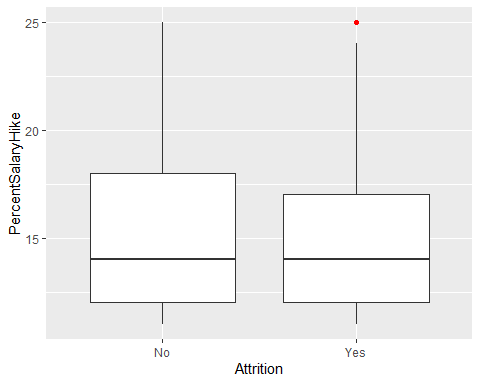
# JobSatisfaction  
  
  
Attr\_JobSatisfaction <- ggplot(HR\_Data, aes( x = HR\_Data$Attrition , y = HR\_Data$JobSatisfaction))+  
 geom\_boxplot(stat ="boxplot" , outlier.colour = "red") + xlab("Attrition") + ylab("JobSatisfaction")  
  
  
plot(Attr\_JobSatisfaction)



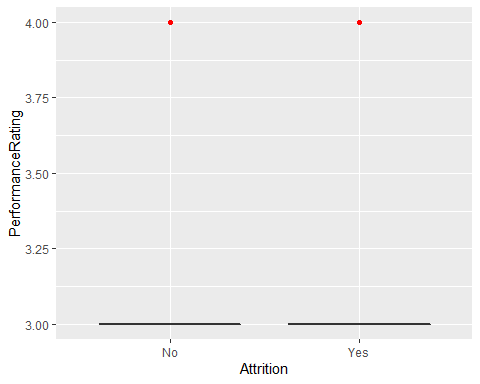
# MonthlyIncome  
  
Attr\_MonthlyIncome <- ggplot(HR\_Data, aes( x = HR\_Data$Attrition , y = HR\_Data$MonthlyIncome))+  
 geom\_boxplot(stat ="boxplot" , outlier.colour = "red") + xlab("Attrition") + ylab("MonthlyIncome")  
  
  
plot(Attr\_MonthlyIncome)



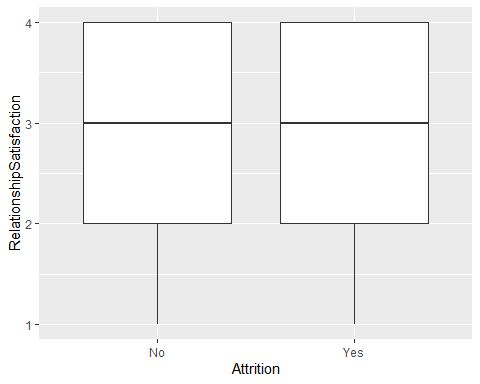
# PercentSalaryHike  
  
Attr\_PercentSalaryHike <- ggplot(HR\_Data, aes( x = HR\_Data$Attrition , y = HR\_Data$PercentSalaryHike))+  
 geom\_boxplot(stat ="boxplot" , outlier.colour = "red") + xlab("Attrition") + ylab("PercentSalaryHike")  
  
  
plot(Attr\_PercentSalaryHike)



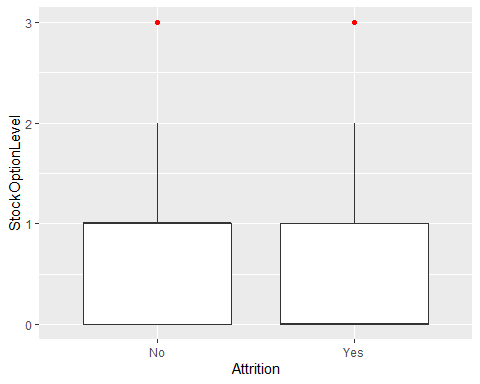
#   
# PerformanceRating  
#   
Attr\_PerformanceRating <- ggplot(HR\_Data, aes( x = HR\_Data$Attrition , y = HR\_Data$PerformanceRating))+  
 geom\_boxplot(stat ="boxplot" , outlier.colour = "red") + xlab("Attrition") + ylab("PerformanceRating")  
  
  
plot(Attr\_PerformanceRating)



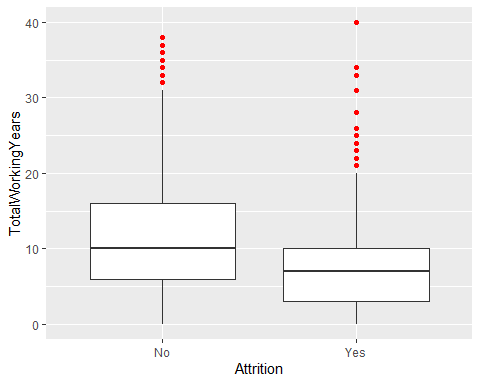
# RelationshipSatisfaction  
#   
  
Attr\_RelationshipSatisfaction <- ggplot(HR\_Data, aes( x = HR\_Data$Attrition , y = HR\_Data$RelationshipSatisfaction))+  
 geom\_boxplot(stat ="boxplot" , outlier.colour = "red") + xlab("Attrition") + ylab("RelationshipSatisfaction")  
  
  
plot(Attr\_RelationshipSatisfaction)



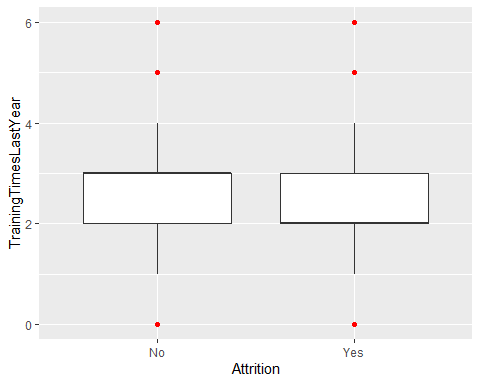
# StockOptionLevel  
  
  
Attr\_StockOptionLevel <- ggplot(HR\_Data, aes( x = HR\_Data$Attrition , y = HR\_Data$StockOptionLevel))+  
 geom\_boxplot(stat ="boxplot" , outlier.colour = "red") + xlab("Attrition") + ylab("StockOptionLevel")  
  
  
plot(Attr\_StockOptionLevel)



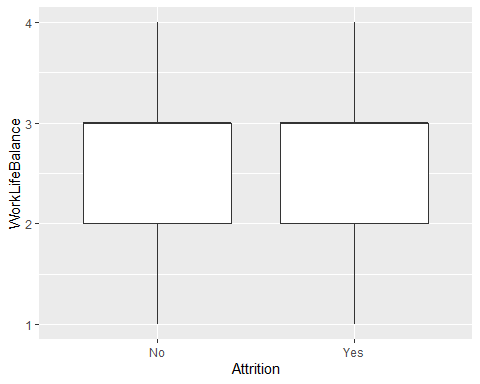
#   
# TotalWorkingYears  
#   
Attr\_TotalWorkingYears <- ggplot(HR\_Data, aes( x = HR\_Data$Attrition , y = HR\_Data$TotalWorkingYears))+  
 geom\_boxplot(stat ="boxplot" , outlier.colour = "red") + xlab("Attrition") + ylab("TotalWorkingYears")  
  
  
plot(Attr\_TotalWorkingYears)



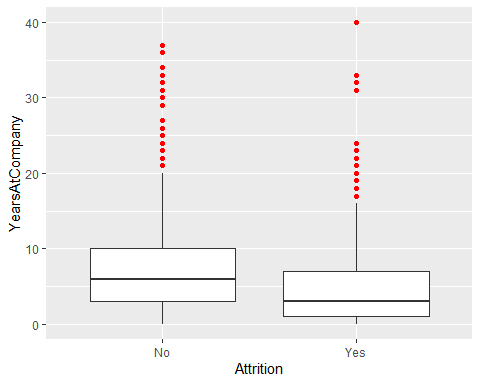
# TrainingTimesLastYear  
  
Attr\_TrainingTimesLastYear <- ggplot(HR\_Data, aes( x = HR\_Data$Attrition , y = HR\_Data$TrainingTimesLastYear))+  
 geom\_boxplot(stat ="boxplot" , outlier.colour = "red") + xlab("Attrition") + ylab("TrainingTimesLastYear")  
  
  
plot(Attr\_TrainingTimesLastYear)



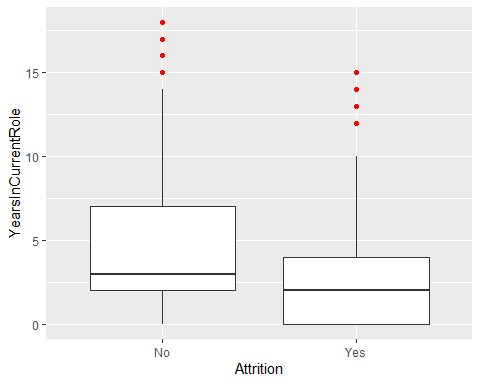
#   
# WorkLifeBalance  
#   
  
Attr\_WorkLifeBalance <- ggplot(HR\_Data, aes( x = HR\_Data$Attrition , y = HR\_Data$WorkLifeBalance))+  
 geom\_boxplot(stat ="boxplot" , outlier.colour = "red") + xlab("Attrition") + ylab("WorkLifeBalance")  
  
  
plot(Attr\_WorkLifeBalance)



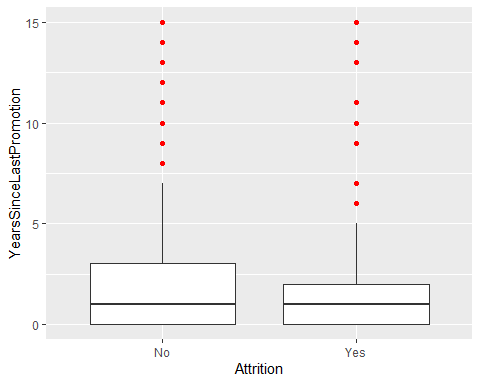
#   
# YearsAtCompany  
#   
Attr\_YearsAtCompany <- ggplot(HR\_Data, aes( x = HR\_Data$Attrition , y = HR\_Data$YearsAtCompany))+  
 geom\_boxplot(stat ="boxplot" , outlier.colour = "red") + xlab("Attrition") + ylab("YearsAtCompany")  
  
  
plot(Attr\_YearsAtCompany)



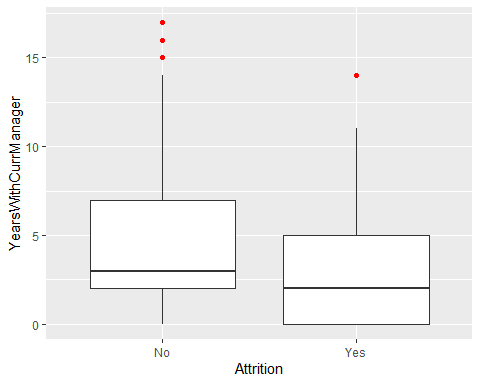
# YearsInCurrentRole  
#   
Attr\_YearsInCurrentRole <- ggplot(HR\_Data, aes( x = HR\_Data$Attrition , y = HR\_Data$YearsInCurrentRole))+  
 geom\_boxplot(stat ="boxplot" , outlier.colour = "red") + xlab("Attrition") + ylab("YearsInCurrentRole")  
  
  
plot(Attr\_YearsInCurrentRole)



# YearsSinceLastPromotion  
#   
Attr\_YearsSinceLastPromotion <- ggplot(HR\_Data, aes( x = HR\_Data$Attrition , y = HR\_Data$YearsSinceLastPromotion))+  
 geom\_boxplot(stat ="boxplot" , outlier.colour = "red") + xlab("Attrition") + ylab("YearsSinceLastPromotion")  
  
  
plot(Attr\_YearsSinceLastPromotion)



#   
# YearsWithCurrManager  
  
Attr\_YearsWithCurrManager <- ggplot(HR\_Data, aes( x = HR\_Data$Attrition , y = HR\_Data$YearsWithCurrManager))+  
 geom\_boxplot(stat ="boxplot" , outlier.colour = "red") + xlab("Attrition") + ylab("YearsWithCurrManager")  
  
  
plot(Attr\_YearsWithCurrManager)



# ggarrange(Attr\_Age , Attr\_DistanceFromHome , Attr\_Education, Attr\_JobInvolvement , Attr\_JobLevel , Attr\_JobSatisfaction , Attr\_MonthlyIncome , Attr\_PercentSalaryHike , Attr\_PerformanceRating , Attr\_RelationshipSatisfaction , Attr\_StockOptionLevel , Attr\_TotalWorkingYears , Attr\_TrainingTimesLastYear , Attr\_WorLifeBalance , Attr\_YearsAtCompany , Attr\_YearsInCurrentRole , Attr\_YearsSinceLastPromotion , Attr\_YearsWithCurrManager + rremove("x.text"),heights = rep( 100 , each = 9), widths = c(15 ,15), ncol = 2, nrow = 9)

*Begin Decision tree analysis*

str(HR\_Data)

## Classes 'spec\_tbl\_df', 'tbl\_df', 'tbl' and 'data.frame': 2940 obs. of 35 variables:  
## $ Age : num 41 49 37 33 27 32 59 30 38 36 ...  
## $ Attrition : Factor w/ 2 levels "No","Yes": 2 1 2 1 1 1 1 1 1 1 ...  
## $ BusinessTravel : Factor w/ 3 levels "Non-Travel","Travel\_Frequently",..: 3 2 3 2 3 2 3 3 2 3 ...  
## $ DailyRate : num 1102 279 1373 1392 591 ...  
## $ Department : Factor w/ 3 levels "Human Resources",..: 3 2 2 2 2 2 2 2 2 2 ...  
## $ DistanceFromHome : num 1 8 2 3 2 2 3 24 23 27 ...  
## $ Education : num 2 1 2 4 1 2 3 1 3 3 ...  
## $ EducationField : Factor w/ 6 levels "Human Resources",..: 2 2 5 2 4 2 4 2 2 4 ...  
## $ EmployeeCount : num 1 1 1 1 1 1 1 1 1 1 ...  
## $ EmployeeNumber : num 1 2 3 4 5 6 7 8 9 10 ...  
## $ EnvironmentSatisfaction : num 2 3 4 4 1 4 3 4 4 3 ...  
## $ Gender : Factor w/ 2 levels "Female","Male": 1 2 2 1 2 2 1 2 2 2 ...  
## $ HourlyRate : num 94 61 92 56 40 79 81 67 44 94 ...  
## $ JobInvolvement : num 3 2 2 3 3 3 4 3 2 3 ...  
## $ JobLevel : num 2 2 1 1 1 1 1 1 3 2 ...  
## $ JobRole : Factor w/ 9 levels "Healthcare Representative",..: 8 7 3 7 3 3 3 3 5 1 ...  
## $ JobSatisfaction : num 4 2 3 3 2 4 1 3 3 3 ...  
## $ MaritalStatus : Factor w/ 3 levels "Divorced","Married",..: 3 2 3 2 2 3 2 1 3 2 ...  
## $ MonthlyIncome : num 5993 5130 2090 2909 3468 ...  
## $ MonthlyRate : num 19479 24907 2396 23159 16632 ...  
## $ NumCompaniesWorked : num 8 1 6 1 9 0 4 1 0 6 ...  
## $ Over18 : Factor w/ 1 level "Y": 1 1 1 1 1 1 1 1 1 1 ...  
## $ OverTime : Factor w/ 2 levels "No","Yes": 2 1 2 2 1 1 2 1 1 1 ...  
## $ PercentSalaryHike : num 11 23 15 11 12 13 20 22 21 13 ...  
## $ PerformanceRating : num 3 4 3 3 3 3 4 4 4 3 ...  
## $ RelationshipSatisfaction: num 1 4 2 3 4 3 1 2 2 2 ...  
## $ StandardHours : num 80 80 80 80 80 80 80 80 80 80 ...  
## $ StockOptionLevel : num 0 1 0 0 1 0 3 1 0 2 ...  
## $ TotalWorkingYears : num 8 10 7 8 6 8 12 1 10 17 ...  
## $ TrainingTimesLastYear : num 0 3 3 3 3 2 3 2 2 3 ...  
## $ WorkLifeBalance : num 1 3 3 3 3 2 2 3 3 2 ...  
## $ YearsAtCompany : num 6 10 0 8 2 7 1 1 9 7 ...  
## $ YearsInCurrentRole : num 4 7 0 7 2 7 0 0 7 7 ...  
## $ YearsSinceLastPromotion : num 0 1 0 3 2 3 0 0 1 7 ...  
## $ YearsWithCurrManager : num 5 7 0 0 2 6 0 0 8 7 ...  
## - attr(\*, "spec")=  
## .. cols(  
## .. Age = col\_double(),  
## .. Attrition = col\_character(),  
## .. BusinessTravel = col\_character(),  
## .. DailyRate = col\_double(),  
## .. Department = col\_character(),  
## .. DistanceFromHome = col\_double(),  
## .. Education = col\_double(),  
## .. EducationField = col\_character(),  
## .. EmployeeCount = col\_double(),  
## .. EmployeeNumber = col\_double(),  
## .. EnvironmentSatisfaction = col\_double(),  
## .. Gender = col\_character(),  
## .. HourlyRate = col\_double(),  
## .. JobInvolvement = col\_double(),  
## .. JobLevel = col\_double(),  
## .. JobRole = col\_character(),  
## .. JobSatisfaction = col\_double(),  
## .. MaritalStatus = col\_character(),  
## .. MonthlyIncome = col\_double(),  
## .. MonthlyRate = col\_double(),  
## .. NumCompaniesWorked = col\_double(),  
## .. Over18 = col\_character(),  
## .. OverTime = col\_character(),  
## .. PercentSalaryHike = col\_double(),  
## .. PerformanceRating = col\_double(),  
## .. RelationshipSatisfaction = col\_double(),  
## .. StandardHours = col\_double(),  
## .. StockOptionLevel = col\_double(),  
## .. TotalWorkingYears = col\_double(),  
## .. TrainingTimesLastYear = col\_double(),  
## .. WorkLifeBalance = col\_double(),  
## .. YearsAtCompany = col\_double(),  
## .. YearsInCurrentRole = col\_double(),  
## .. YearsSinceLastPromotion = col\_double(),  
## .. YearsWithCurrManager = col\_double()  
## .. )

prop.table(table(HR\_Data$Attrition))

##   
## No Yes   
## 0.8387755 0.1612245

library(caTools)

## Warning: package 'caTools' was built under R version 3.6.1

library(caret)

## Warning: package 'caret' was built under R version 3.6.1

library(rpart)

## Warning: package 'rpart' was built under R version 3.6.1

library(rpart.plot)

## Warning: package 'rpart.plot' was built under R version 3.6.1

*Based on the dataset shared , the data doesn’t seem be extremely biased towards a specific class i.e class of Yes / No*

## split into training and test sets  
  
  
set.seed(123)  
split = sample.split(HR\_Data$Attrition, SplitRatio = 0.7)  
HR\_traindata = subset(HR\_Data, split == TRUE)  
HR\_testdata = subset(HR\_Data, split == FALSE)  
  
## Check if distribution of partition data is correct Testing dataset  
  
  
# Check the distribution of the proportion in train and test data as well  
  
prop.table(table(HR\_traindata$Attrition))

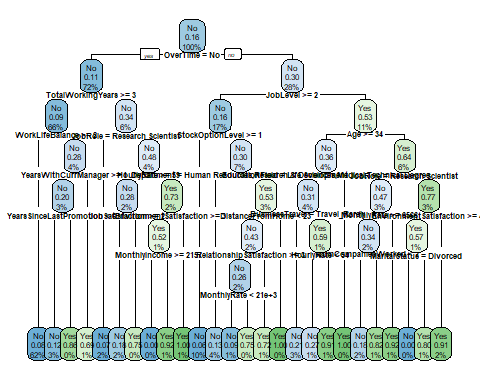
##   
## No Yes   
## 0.8386783 0.1613217

prop.table(table(HR\_testdata$Attrition))

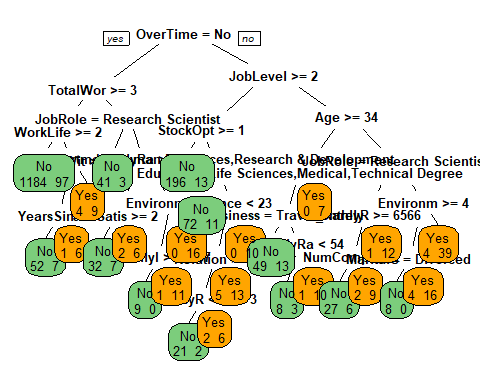
##   
## No Yes   
## 0.8390023 0.1609977

*Post split , its seen that train and test data are split retaining the same ratio between Yes and No* *We should drop the 4 columns , which are not significant , as there is no criteria for them to split*

# Develop a fully grown tree  
set.seed(123)  
  
# data$EmployeeCount = NULL  
# data$EmployeeNumber = NULL  
# data$Over18 = NULL  
# data$StandardHours = NULL  
  
hr\_tree\_full = rpart(formula = HR\_traindata$Attrition~., data = HR\_traindata , method = "class" )  
rpart.plot(hr\_tree\_full, cex=0.5)



boxcols <- c("palegreen3", "orange")[hr\_tree\_full$frame$yval]  
  
par(xpd=TRUE)  
prp(hr\_tree\_full, faclen = 0, cex = 0.8, extra = 1, box.col = boxcols)



#summary(tree\_full)

`*Variable importance of full Tree* \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*Documentation - Compare CART , RF and NN\*\*\*\*\*\*\*\*\*

#summary(hr\_tree\_fulltree\_full)  
hr\_tree\_full$variable.importance

## JobRole MonthlyIncome TotalWorkingYears   
## 53.581458 50.985706 46.846094   
## JobLevel Age OverTime   
## 36.609214 32.337837 29.560112   
## YearsAtCompany MonthlyRate HourlyRate   
## 25.726497 17.200791 16.159010   
## StockOptionLevel NumCompaniesWorked EducationField   
## 15.926418 15.618099 14.531594   
## MaritalStatus Department EnvironmentSatisfaction   
## 13.766011 13.234490 13.132521   
## YearsWithCurrManager YearsInCurrentRole DailyRate   
## 12.560925 12.490785 12.490702   
## YearsSinceLastPromotion JobSatisfaction DistanceFromHome   
## 9.802058 9.737403 9.446297   
## WorkLifeBalance PercentSalaryHike BusinessTravel   
## 6.936529 6.720520 6.548583   
## RelationshipSatisfaction JobInvolvement EmployeeNumber   
## 6.217770 6.067617 3.095307   
## Education Gender TrainingTimesLastYear   
## 2.525662 1.619835 1.304698   
## PerformanceRating   
## 1.287001

hr\_df\_cart=data.frame(round(hr\_tree\_full$variable.importance,2))  
hr\_df\_cart

## round.hr\_tree\_full.variable.importance..2.  
## JobRole 53.58  
## MonthlyIncome 50.99  
## TotalWorkingYears 46.85  
## JobLevel 36.61  
## Age 32.34  
## OverTime 29.56  
## YearsAtCompany 25.73  
## MonthlyRate 17.20  
## HourlyRate 16.16  
## StockOptionLevel 15.93  
## NumCompaniesWorked 15.62  
## EducationField 14.53  
## MaritalStatus 13.77  
## Department 13.23  
## EnvironmentSatisfaction 13.13  
## YearsWithCurrManager 12.56  
## YearsInCurrentRole 12.49  
## DailyRate 12.49  
## YearsSinceLastPromotion 9.80  
## JobSatisfaction 9.74  
## DistanceFromHome 9.45  
## WorkLifeBalance 6.94  
## PercentSalaryHike 6.72  
## BusinessTravel 6.55  
## RelationshipSatisfaction 6.22  
## JobInvolvement 6.07  
## EmployeeNumber 3.10  
## Education 2.53  
## Gender 1.62  
## TrainingTimesLastYear 1.30  
## PerformanceRating 1.29

*Predict using Train and Test Dataset*

## Predict using the CART model  
HR\_traindata$predict.class=predict(hr\_tree\_full,HR\_traindata,type="class")  
HR\_traindata$predict.score=predict(hr\_tree\_full,HR\_traindata)  
head(HR\_traindata$predict.score)

## No Yes  
## 1 0.2777778 0.72222222  
## 2 0.9242779 0.07572209  
## 3 0.8181818 0.18181818  
## 4 0.9242779 0.07572209  
## 5 0.9242779 0.07572209  
## 6 0.7903226 0.20967742

## Creating the confusion matrix  
tabtrain=with(HR\_traindata,table(HR\_traindata$Attrition,predict.class))  
tabtrain

## predict.class  
## No Yes  
## No 1699 27  
## Yes 162 170

TN\_train = tabtrain[1,1]  
TP\_train = tabtrain[2,2]  
FN\_train = tabtrain[2,1]  
FP\_train = tabtrain[1,2]  
  
train\_acc = (TN\_train+TP\_train)/(TN\_train+TP\_train+FN\_train+FP\_train)  
train\_acc

## [1] 0.9081633

train\_sens = TP\_train/(TP\_train+FN\_train)  
train\_sens

## [1] 0.5120482

train\_spec = TN\_train/(TN\_train+FP\_train)  
train\_spec

## [1] 0.9843569

# Prediction on Test Data using the same tree built  
  
## Predict using the CART model  
HR\_testdata$predict.class=predict(hr\_tree\_full,HR\_testdata,type="class")  
HR\_testdata$predict.score=predict(hr\_tree\_full,HR\_testdata)  
  
## Creating the confusion matrix  
tabtest=with(HR\_testdata,table(HR\_testdata$Attrition,predict.class))  
tabtest

## predict.class  
## No Yes  
## No 719 21  
## Yes 82 60

TN\_test = tabtest[1,1]  
TP\_test = tabtest[2,2]  
FN\_test = tabtest[2,1]  
FP\_test = tabtest[1,2]  
  
test\_acc = (TN\_test+TP\_test)/(TN\_test+TP\_test+FN\_test+FP\_test)  
test\_acc

## [1] 0.88322

test\_sens = TP\_test/(TP\_test+FN\_test)  
test\_sens

## [1] 0.4225352

test\_spec = TN\_test/(TN\_test+FP\_test)  
test\_spec

## [1] 0.9716216

*Comparing the results of train and test*

hr\_df\_results\_train = data.frame(train\_acc, train\_sens, train\_spec)  
names(hr\_df\_results\_train) = c("ACC", "SENS", "SPEC")  
hr\_df\_results\_test = data.frame(test\_acc, test\_sens, test\_spec)  
names(hr\_df\_results\_test) = c("ACC", "SENS", "SPEC")  
  
?rbind

## starting httpd help server ... done

hr\_df\_final =rbind(hr\_df\_results\_train, hr\_df\_results\_test)  
row.names(hr\_df\_final) = c('hr\_tree\_full\_train', 'hr\_tree\_full\_test')  
hr\_df\_final

## ACC SENS SPEC  
## hr\_tree\_full\_train 0.9081633 0.5120482 0.9843569  
## hr\_tree\_full\_test 0.8832200 0.4225352 0.9716216

*Model is performing relatively closer wrt Train and test data* *Next steps are to optimize the model , to validate for better accuracy and performance*

*Optimization chosen is by means of pruning the tree based on CV Error, which is minimum*

# Some cleanup before building the next tree  
  
#remove predicted score and class before running other models  
HR\_traindata$predict.class = NULL  
HR\_traindata$predict.score = NULL  
HR\_testdata$predict.class = NULL  
HR\_testdata$predict.score = NULL

*The unncessarily complex tree above can be pruned using a cost complexity threshold. Using a complexity threshold of 0.015 gives us a much simpler tree*

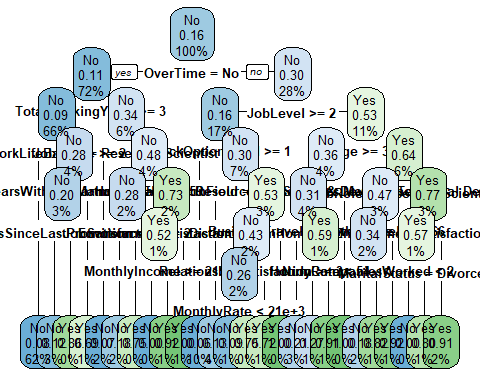
hr\_ptree = prune(hr\_tree\_full, cp= 0.00001 ,"CP" )  
printcp(hr\_ptree)

##   
## Classification tree:  
## rpart(formula = HR\_traindata$Attrition ~ ., data = HR\_traindata,   
## method = "class")  
##   
## Variables actually used in tree construction:  
## [1] Age BusinessTravel   
## [3] Department DistanceFromHome   
## [5] EducationField EnvironmentSatisfaction   
## [7] HourlyRate JobLevel   
## [9] JobRole JobSatisfaction   
## [11] MaritalStatus MonthlyIncome   
## [13] MonthlyRate NumCompaniesWorked   
## [15] OverTime RelationshipSatisfaction  
## [17] StockOptionLevel TotalWorkingYears   
## [19] WorkLifeBalance YearsSinceLastPromotion   
## [21] YearsWithCurrManager   
##   
## Root node error: 332/2058 = 0.16132  
##   
## n= 2058   
##   
## CP nsplit rel error xerror xstd  
## 1 0.036145 0 1.00000 1.00000 0.050261  
## 2 0.021084 3 0.89157 0.99699 0.050200  
## 3 0.017068 7 0.80723 0.96687 0.049578  
## 4 0.013554 10 0.75602 0.90060 0.048151  
## 5 0.012048 18 0.64759 0.88253 0.047747  
## 6 0.010040 22 0.59940 0.85843 0.047197  
## 7 0.010000 25 0.56928 0.84337 0.046847

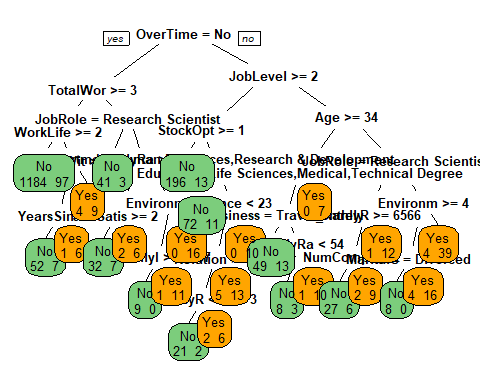
hr\_ptree

## n= 2058   
##   
## node), split, n, loss, yval, (yprob)  
## \* denotes terminal node  
##   
## 1) root 2058 332 No (0.83867833 0.16132167)   
## 2) OverTime=No 1488 162 No (0.89112903 0.10887097)   
## 4) TotalWorkingYears>=2.5 1360 119 No (0.91250000 0.08750000)   
## 8) WorkLifeBalance>=1.5 1281 97 No (0.92427791 0.07572209) \*  
## 9) WorkLifeBalance< 1.5 79 22 No (0.72151899 0.27848101)   
## 18) YearsWithCurrManager>=0.5 66 13 No (0.80303030 0.19696970)   
## 36) YearsSinceLastPromotion< 6 59 7 No (0.88135593 0.11864407) \*  
## 37) YearsSinceLastPromotion>=6 7 1 Yes (0.14285714 0.85714286) \*  
## 19) YearsWithCurrManager< 0.5 13 4 Yes (0.30769231 0.69230769) \*  
## 5) TotalWorkingYears< 2.5 128 43 No (0.66406250 0.33593750)   
## 10) JobRole=Research Scientist 44 3 No (0.93181818 0.06818182) \*  
## 11) JobRole=Human Resources,Laboratory Technician,Sales Representative 84 40 No (0.52380952 0.47619048)   
## 22) HourlyRate>=58.5 47 13 No (0.72340426 0.27659574)   
## 44) JobSatisfaction>=1.5 39 7 No (0.82051282 0.17948718) \*  
## 45) JobSatisfaction< 1.5 8 2 Yes (0.25000000 0.75000000) \*  
## 23) HourlyRate< 58.5 37 10 Yes (0.27027027 0.72972973)   
## 46) EnvironmentSatisfaction>=2.5 21 10 Yes (0.47619048 0.52380952)   
## 92) MonthlyIncome>=2156.5 9 0 No (1.00000000 0.00000000) \*  
## 93) MonthlyIncome< 2156.5 12 1 Yes (0.08333333 0.91666667) \*  
## 47) EnvironmentSatisfaction< 2.5 16 0 Yes (0.00000000 1.00000000) \*  
## 3) OverTime=Yes 570 170 No (0.70175439 0.29824561)   
## 6) JobLevel>=1.5 351 55 No (0.84330484 0.15669516)   
## 12) StockOptionLevel>=0.5 209 13 No (0.93779904 0.06220096) \*  
## 13) StockOptionLevel< 0.5 142 42 No (0.70422535 0.29577465)   
## 26) Department=Human Resources,Research & Development 83 11 No (0.86746988 0.13253012) \*  
## 27) Department=Sales 59 28 Yes (0.47457627 0.52542373)   
## 54) DistanceFromHome< 22.5 49 21 No (0.57142857 0.42857143)   
## 108) RelationshipSatisfaction>=2.5 31 8 No (0.74193548 0.25806452)   
## 216) MonthlyRate< 21282 23 2 No (0.91304348 0.08695652) \*  
## 217) MonthlyRate>=21282 8 2 Yes (0.25000000 0.75000000) \*  
## 109) RelationshipSatisfaction< 2.5 18 5 Yes (0.27777778 0.72222222) \*  
## 55) DistanceFromHome>=22.5 10 0 Yes (0.00000000 1.00000000) \*  
## 7) JobLevel< 1.5 219 104 Yes (0.47488584 0.52511416)   
## 14) Age>=33.5 91 33 No (0.63736264 0.36263736)   
## 28) EducationField=Life Sciences,Medical,Technical Degree 84 26 No (0.69047619 0.30952381)   
## 56) BusinessTravel=Travel\_Rarely 62 13 No (0.79032258 0.20967742) \*  
## 57) BusinessTravel=Non-Travel,Travel\_Frequently 22 9 Yes (0.40909091 0.59090909)   
## 114) HourlyRate< 53.5 11 3 No (0.72727273 0.27272727) \*  
## 115) HourlyRate>=53.5 11 1 Yes (0.09090909 0.90909091) \*  
## 29) EducationField=Human Resources,Marketing,Other 7 0 Yes (0.00000000 1.00000000) \*  
## 15) Age< 33.5 128 46 Yes (0.35937500 0.64062500)   
## 30) JobRole=Research Scientist 57 27 No (0.52631579 0.47368421)   
## 60) MonthlyRate>=6566 44 15 No (0.65909091 0.34090909)   
## 120) NumCompaniesWorked< 2 33 6 No (0.81818182 0.18181818) \*  
## 121) NumCompaniesWorked>=2 11 2 Yes (0.18181818 0.81818182) \*  
## 61) MonthlyRate< 6566 13 1 Yes (0.07692308 0.92307692) \*  
## 31) JobRole=Human Resources,Laboratory Technician,Sales Representative 71 16 Yes (0.22535211 0.77464789)   
## 62) EnvironmentSatisfaction>=3.5 28 12 Yes (0.42857143 0.57142857)   
## 124) MaritalStatus=Divorced 8 0 No (1.00000000 0.00000000) \*  
## 125) MaritalStatus=Married,Single 20 4 Yes (0.20000000 0.80000000) \*  
## 63) EnvironmentSatisfaction< 3.5 43 4 Yes (0.09302326 0.90697674) \*

# rpart.plot(hr\_ptree)  
  
rpart.plot(hr\_ptree, cex=0.8)



boxcols <- c("palegreen3", "orange")[hr\_ptree$frame$yval]  
  
par(xpd=TRUE)  
prp(hr\_ptree, faclen = 0, cex = 0.8, extra = 1, box.col = boxcols)



#Variable Importance  
hr\_ptree$variable.importance

## JobRole MonthlyIncome TotalWorkingYears   
## 53.581458 50.985706 46.846094   
## JobLevel Age OverTime   
## 36.609214 32.337837 29.560112   
## YearsAtCompany MonthlyRate HourlyRate   
## 25.726497 17.200791 16.159010   
## StockOptionLevel NumCompaniesWorked EducationField   
## 15.926418 15.618099 14.531594   
## MaritalStatus Department EnvironmentSatisfaction   
## 13.766011 13.234490 13.132521   
## YearsWithCurrManager YearsInCurrentRole DailyRate   
## 12.560925 12.490785 12.490702   
## YearsSinceLastPromotion JobSatisfaction DistanceFromHome   
## 9.802058 9.737403 9.446297   
## WorkLifeBalance PercentSalaryHike BusinessTravel   
## 6.936529 6.720520 6.548583   
## RelationshipSatisfaction JobInvolvement EmployeeNumber   
## 6.217770 6.067617 3.095307   
## Education Gender TrainingTimesLastYear   
## 2.525662 1.619835 1.304698   
## PerformanceRating   
## 1.287001

#summary(hr\_tree\_fulltree\_full)  
hr\_ptree$variable.importance

## JobRole MonthlyIncome TotalWorkingYears   
## 53.581458 50.985706 46.846094   
## JobLevel Age OverTime   
## 36.609214 32.337837 29.560112   
## YearsAtCompany MonthlyRate HourlyRate   
## 25.726497 17.200791 16.159010   
## StockOptionLevel NumCompaniesWorked EducationField   
## 15.926418 15.618099 14.531594   
## MaritalStatus Department EnvironmentSatisfaction   
## 13.766011 13.234490 13.132521   
## YearsWithCurrManager YearsInCurrentRole DailyRate   
## 12.560925 12.490785 12.490702   
## YearsSinceLastPromotion JobSatisfaction DistanceFromHome   
## 9.802058 9.737403 9.446297   
## WorkLifeBalance PercentSalaryHike BusinessTravel   
## 6.936529 6.720520 6.548583   
## RelationshipSatisfaction JobInvolvement EmployeeNumber   
## 6.217770 6.067617 3.095307   
## Education Gender TrainingTimesLastYear   
## 2.525662 1.619835 1.304698   
## PerformanceRating   
## 1.287001

hr\_df\_cart=data.frame(round(hr\_ptree$variable.importance,2))  
hr\_df\_cart

## round.hr\_ptree.variable.importance..2.  
## JobRole 53.58  
## MonthlyIncome 50.99  
## TotalWorkingYears 46.85  
## JobLevel 36.61  
## Age 32.34  
## OverTime 29.56  
## YearsAtCompany 25.73  
## MonthlyRate 17.20  
## HourlyRate 16.16  
## StockOptionLevel 15.93  
## NumCompaniesWorked 15.62  
## EducationField 14.53  
## MaritalStatus 13.77  
## Department 13.23  
## EnvironmentSatisfaction 13.13  
## YearsWithCurrManager 12.56  
## YearsInCurrentRole 12.49  
## DailyRate 12.49  
## YearsSinceLastPromotion 9.80  
## JobSatisfaction 9.74  
## DistanceFromHome 9.45  
## WorkLifeBalance 6.94  
## PercentSalaryHike 6.72  
## BusinessTravel 6.55  
## RelationshipSatisfaction 6.22  
## JobInvolvement 6.07  
## EmployeeNumber 3.10  
## Education 2.53  
## Gender 1.62  
## TrainingTimesLastYear 1.30  
## PerformanceRating 1.29

*Predict using Train and Test Dataset of pruned Tree , pruned on CP*

## Predict using the CART model  
HR\_traindata$predict.class=predict(hr\_ptree,HR\_traindata,type="class")  
HR\_traindata$predict.score=predict(hr\_ptree,HR\_traindata)  
head(HR\_traindata$predict.score)

## No Yes  
## 1 0.2777778 0.72222222  
## 2 0.9242779 0.07572209  
## 3 0.8181818 0.18181818  
## 4 0.9242779 0.07572209  
## 5 0.9242779 0.07572209  
## 6 0.7903226 0.20967742

## Creating the confusion matrix  
tabtrain=with(HR\_traindata,table(HR\_traindata$Attrition,predict.class))  
tabtrain

## predict.class  
## No Yes  
## No 1699 27  
## Yes 162 170

TN\_train = tabtrain[1,1]  
TP\_train = tabtrain[2,2]  
FN\_train = tabtrain[2,1]  
FP\_train = tabtrain[1,2]  
  
train\_acc = (TN\_train+TP\_train)/(TN\_train+TP\_train+FN\_train+FP\_train)  
train\_acc

## [1] 0.9081633

train\_sens = TP\_train/(TP\_train+FN\_train)  
train\_sens

## [1] 0.5120482

train\_spec = TN\_train/(TN\_train+FP\_train)  
train\_spec

## [1] 0.9843569

# Prediction on Test Data using the same tree built  
  
## Predict using the CART model  
HR\_testdata$predict.class=predict(hr\_ptree,HR\_testdata,type="class")  
HR\_testdata$predict.score=predict(hr\_ptree,HR\_testdata)  
  
## Creating the confusion matrix  
tabtest=with(HR\_testdata,table(HR\_testdata$Attrition,predict.class))  
tabtest

## predict.class  
## No Yes  
## No 719 21  
## Yes 82 60

TN\_test = tabtest[1,1]  
TP\_test = tabtest[2,2]  
FN\_test = tabtest[2,1]  
FP\_test = tabtest[1,2]  
  
test\_acc = (TN\_test+TP\_test)/(TN\_test+TP\_test+FN\_test+FP\_test)  
test\_acc

## [1] 0.88322

test\_sens = TP\_test/(TP\_test+FN\_test)  
test\_sens

## [1] 0.4225352

test\_spec = TN\_test/(TN\_test+FP\_test)  
test\_spec

## [1] 0.9716216

*Comparing the results of train and test of a pruned tree pruned on cp*

hr\_df\_results\_train = data.frame(train\_acc, train\_sens, train\_spec)  
names(hr\_df\_results\_train) = c("ACC", "SENS", "SPEC")  
hr\_df\_results\_test = data.frame(test\_acc, test\_sens, test\_spec)  
names(hr\_df\_results\_test) = c("ACC", "SENS", "SPEC")  
  
?rbind  
hr\_df\_final =rbind(hr\_df\_results\_train, hr\_df\_results\_test)  
row.names(hr\_df\_final) = c('hr\_pruned\_cp\_tree\_train', 'hr\_pruned\_cp\_tree\_test')  
hr\_df\_final

## ACC SENS SPEC  
## hr\_pruned\_cp\_tree\_train 0.9081633 0.5120482 0.9843569  
## hr\_pruned\_cp\_tree\_test 0.8832200 0.4225352 0.9716216

*Not much of change seen after pruning the tree based on CP* *Try pruning the tree based on lowest value of CV , which is considering the option of pruning based on best CP*

*cleanup predictor collector variables before that*

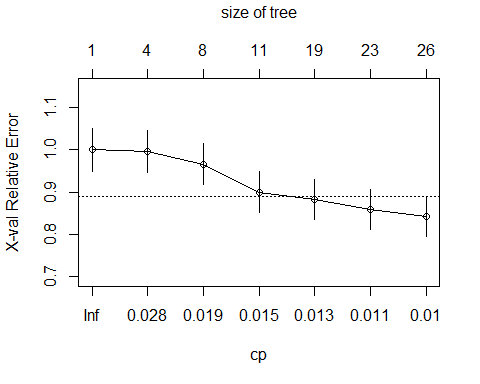
#remove predicted score and class before running other models  
HR\_traindata$predict.class = NULL  
HR\_traindata$predict.score = NULL  
HR\_testdata$predict.class = NULL  
HR\_testdata$predict.score = NULL

*Pruning for best CP, based on XV at a minimum*

library(rpart.plot)  
printcp(hr\_tree\_full)

##   
## Classification tree:  
## rpart(formula = HR\_traindata$Attrition ~ ., data = HR\_traindata,   
## method = "class")  
##   
## Variables actually used in tree construction:  
## [1] Age BusinessTravel   
## [3] Department DistanceFromHome   
## [5] EducationField EnvironmentSatisfaction   
## [7] HourlyRate JobLevel   
## [9] JobRole JobSatisfaction   
## [11] MaritalStatus MonthlyIncome   
## [13] MonthlyRate NumCompaniesWorked   
## [15] OverTime RelationshipSatisfaction  
## [17] StockOptionLevel TotalWorkingYears   
## [19] WorkLifeBalance YearsSinceLastPromotion   
## [21] YearsWithCurrManager   
##   
## Root node error: 332/2058 = 0.16132  
##   
## n= 2058   
##   
## CP nsplit rel error xerror xstd  
## 1 0.036145 0 1.00000 1.00000 0.050261  
## 2 0.021084 3 0.89157 0.99699 0.050200  
## 3 0.017068 7 0.80723 0.96687 0.049578  
## 4 0.013554 10 0.75602 0.90060 0.048151  
## 5 0.012048 18 0.64759 0.88253 0.047747  
## 6 0.010040 22 0.59940 0.85843 0.047197  
## 7 0.010000 25 0.56928 0.84337 0.046847

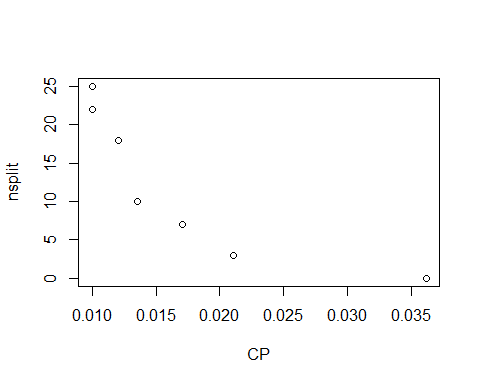
plotcp(hr\_tree\_full)



hr\_bestcp=hr\_tree\_full$cptable[which.min(hr\_tree\_full$cptable[,"xerror"]),"CP"]  
hr\_bestcp

## [1] 0.01

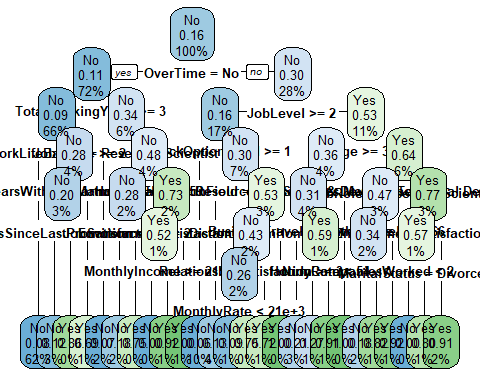
plot(hr\_tree\_full$cptable)



hr\_best\_ptree=prune(hr\_tree\_full,cp=hr\_bestcp)  
print(hr\_best\_ptree)

## n= 2058   
##   
## node), split, n, loss, yval, (yprob)  
## \* denotes terminal node  
##   
## 1) root 2058 332 No (0.83867833 0.16132167)   
## 2) OverTime=No 1488 162 No (0.89112903 0.10887097)   
## 4) TotalWorkingYears>=2.5 1360 119 No (0.91250000 0.08750000)   
## 8) WorkLifeBalance>=1.5 1281 97 No (0.92427791 0.07572209) \*  
## 9) WorkLifeBalance< 1.5 79 22 No (0.72151899 0.27848101)   
## 18) YearsWithCurrManager>=0.5 66 13 No (0.80303030 0.19696970)   
## 36) YearsSinceLastPromotion< 6 59 7 No (0.88135593 0.11864407) \*  
## 37) YearsSinceLastPromotion>=6 7 1 Yes (0.14285714 0.85714286) \*  
## 19) YearsWithCurrManager< 0.5 13 4 Yes (0.30769231 0.69230769) \*  
## 5) TotalWorkingYears< 2.5 128 43 No (0.66406250 0.33593750)   
## 10) JobRole=Research Scientist 44 3 No (0.93181818 0.06818182) \*  
## 11) JobRole=Human Resources,Laboratory Technician,Sales Representative 84 40 No (0.52380952 0.47619048)   
## 22) HourlyRate>=58.5 47 13 No (0.72340426 0.27659574)   
## 44) JobSatisfaction>=1.5 39 7 No (0.82051282 0.17948718) \*  
## 45) JobSatisfaction< 1.5 8 2 Yes (0.25000000 0.75000000) \*  
## 23) HourlyRate< 58.5 37 10 Yes (0.27027027 0.72972973)   
## 46) EnvironmentSatisfaction>=2.5 21 10 Yes (0.47619048 0.52380952)   
## 92) MonthlyIncome>=2156.5 9 0 No (1.00000000 0.00000000) \*  
## 93) MonthlyIncome< 2156.5 12 1 Yes (0.08333333 0.91666667) \*  
## 47) EnvironmentSatisfaction< 2.5 16 0 Yes (0.00000000 1.00000000) \*  
## 3) OverTime=Yes 570 170 No (0.70175439 0.29824561)   
## 6) JobLevel>=1.5 351 55 No (0.84330484 0.15669516)   
## 12) StockOptionLevel>=0.5 209 13 No (0.93779904 0.06220096) \*  
## 13) StockOptionLevel< 0.5 142 42 No (0.70422535 0.29577465)   
## 26) Department=Human Resources,Research & Development 83 11 No (0.86746988 0.13253012) \*  
## 27) Department=Sales 59 28 Yes (0.47457627 0.52542373)   
## 54) DistanceFromHome< 22.5 49 21 No (0.57142857 0.42857143)   
## 108) RelationshipSatisfaction>=2.5 31 8 No (0.74193548 0.25806452)   
## 216) MonthlyRate< 21282 23 2 No (0.91304348 0.08695652) \*  
## 217) MonthlyRate>=21282 8 2 Yes (0.25000000 0.75000000) \*  
## 109) RelationshipSatisfaction< 2.5 18 5 Yes (0.27777778 0.72222222) \*  
## 55) DistanceFromHome>=22.5 10 0 Yes (0.00000000 1.00000000) \*  
## 7) JobLevel< 1.5 219 104 Yes (0.47488584 0.52511416)   
## 14) Age>=33.5 91 33 No (0.63736264 0.36263736)   
## 28) EducationField=Life Sciences,Medical,Technical Degree 84 26 No (0.69047619 0.30952381)   
## 56) BusinessTravel=Travel\_Rarely 62 13 No (0.79032258 0.20967742) \*  
## 57) BusinessTravel=Non-Travel,Travel\_Frequently 22 9 Yes (0.40909091 0.59090909)   
## 114) HourlyRate< 53.5 11 3 No (0.72727273 0.27272727) \*  
## 115) HourlyRate>=53.5 11 1 Yes (0.09090909 0.90909091) \*  
## 29) EducationField=Human Resources,Marketing,Other 7 0 Yes (0.00000000 1.00000000) \*  
## 15) Age< 33.5 128 46 Yes (0.35937500 0.64062500)   
## 30) JobRole=Research Scientist 57 27 No (0.52631579 0.47368421)   
## 60) MonthlyRate>=6566 44 15 No (0.65909091 0.34090909)   
## 120) NumCompaniesWorked< 2 33 6 No (0.81818182 0.18181818) \*  
## 121) NumCompaniesWorked>=2 11 2 Yes (0.18181818 0.81818182) \*  
## 61) MonthlyRate< 6566 13 1 Yes (0.07692308 0.92307692) \*  
## 31) JobRole=Human Resources,Laboratory Technician,Sales Representative 71 16 Yes (0.22535211 0.77464789)   
## 62) EnvironmentSatisfaction>=3.5 28 12 Yes (0.42857143 0.57142857)   
## 124) MaritalStatus=Divorced 8 0 No (1.00000000 0.00000000) \*  
## 125) MaritalStatus=Married,Single 20 4 Yes (0.20000000 0.80000000) \*  
## 63) EnvironmentSatisfaction< 3.5 43 4 Yes (0.09302326 0.90697674) \*

rpart.plot(hr\_tree\_full, cex = 0.8)



*Summary of Variable Importance for Bestfit Tree*

#summary(hr\_tree\_fulltree\_full)  
hr\_best\_ptree$variable.importance

## JobRole MonthlyIncome TotalWorkingYears   
## 53.581458 50.985706 46.846094   
## JobLevel Age OverTime   
## 36.609214 32.337837 29.560112   
## YearsAtCompany MonthlyRate HourlyRate   
## 25.726497 17.200791 16.159010   
## StockOptionLevel NumCompaniesWorked EducationField   
## 15.926418 15.618099 14.531594   
## MaritalStatus Department EnvironmentSatisfaction   
## 13.766011 13.234490 13.132521   
## YearsWithCurrManager YearsInCurrentRole DailyRate   
## 12.560925 12.490785 12.490702   
## YearsSinceLastPromotion JobSatisfaction DistanceFromHome   
## 9.802058 9.737403 9.446297   
## WorkLifeBalance PercentSalaryHike BusinessTravel   
## 6.936529 6.720520 6.548583   
## RelationshipSatisfaction JobInvolvement EmployeeNumber   
## 6.217770 6.067617 3.095307   
## Education Gender TrainingTimesLastYear   
## 2.525662 1.619835 1.304698   
## PerformanceRating   
## 1.287001

hr\_df\_cart=data.frame(round(hr\_best\_ptree$variable.importance,2))  
hr\_df\_cart

## round.hr\_best\_ptree.variable.importance..2.  
## JobRole 53.58  
## MonthlyIncome 50.99  
## TotalWorkingYears 46.85  
## JobLevel 36.61  
## Age 32.34  
## OverTime 29.56  
## YearsAtCompany 25.73  
## MonthlyRate 17.20  
## HourlyRate 16.16  
## StockOptionLevel 15.93  
## NumCompaniesWorked 15.62  
## EducationField 14.53  
## MaritalStatus 13.77  
## Department 13.23  
## EnvironmentSatisfaction 13.13  
## YearsWithCurrManager 12.56  
## YearsInCurrentRole 12.49  
## DailyRate 12.49  
## YearsSinceLastPromotion 9.80  
## JobSatisfaction 9.74  
## DistanceFromHome 9.45  
## WorkLifeBalance 6.94  
## PercentSalaryHike 6.72  
## BusinessTravel 6.55  
## RelationshipSatisfaction 6.22  
## JobInvolvement 6.07  
## EmployeeNumber 3.10  
## Education 2.53  
## Gender 1.62  
## TrainingTimesLastYear 1.30  
## PerformanceRating 1.29

*Predict using Train and Test Dataset of pruned Tree , pruned on best CP with Min XV*

## Predict using the CART model  
HR\_traindata$predict.class=predict(hr\_best\_ptree,HR\_traindata,type="class")  
HR\_traindata$predict.score=predict(hr\_best\_ptree,HR\_traindata)  
head(HR\_traindata$predict.score)

## No Yes  
## 1 0.2777778 0.72222222  
## 2 0.9242779 0.07572209  
## 3 0.8181818 0.18181818  
## 4 0.9242779 0.07572209  
## 5 0.9242779 0.07572209  
## 6 0.7903226 0.20967742

## Creating the confusion matrix  
tabtrain=with(HR\_traindata,table(HR\_traindata$Attrition,predict.class))  
tabtrain

## predict.class  
## No Yes  
## No 1699 27  
## Yes 162 170

TN\_train = tabtrain[1,1]  
TP\_train = tabtrain[2,2]  
FN\_train = tabtrain[2,1]  
FP\_train = tabtrain[1,2]  
  
train\_acc = (TN\_train+TP\_train)/(TN\_train+TP\_train+FN\_train+FP\_train)  
train\_acc

## [1] 0.9081633

train\_sens = TP\_train/(TP\_train+FN\_train)  
train\_sens

## [1] 0.5120482

train\_spec = TN\_train/(TN\_train+FP\_train)  
train\_spec

## [1] 0.9843569

# Prediction on Test Data using the same tree built  
  
## Predict using the CART model  
HR\_testdata$predict.class=predict(hr\_best\_ptree,HR\_testdata,type="class")  
HR\_testdata$predict.score=predict(hr\_best\_ptree,HR\_testdata)  
  
## Creating the confusion matrix  
tabtest=with(HR\_testdata,table(HR\_testdata$Attrition,predict.class))  
tabtest

## predict.class  
## No Yes  
## No 719 21  
## Yes 82 60

TN\_test = tabtest[1,1]  
TP\_test = tabtest[2,2]  
FN\_test = tabtest[2,1]  
FP\_test = tabtest[1,2]  
  
test\_acc = (TN\_test+TP\_test)/(TN\_test+TP\_test+FN\_test+FP\_test)  
test\_acc

## [1] 0.88322

test\_sens = TP\_test/(TP\_test+FN\_test)  
test\_sens

## [1] 0.4225352

test\_spec = TN\_test/(TN\_test+FP\_test)  
test\_spec

## [1] 0.9716216

*Comparing the results of train and test of a pruned tree pruned on best cp with min XV*

hr\_df\_results\_train = data.frame(train\_acc, train\_sens, train\_spec)  
names(hr\_df\_results\_train) = c("ACC", "SENS", "SPEC")  
hr\_df\_results\_test = data.frame(test\_acc, test\_sens, test\_spec)  
names(hr\_df\_results\_test) = c("ACC", "SENS", "SPEC")  
  
?rbind  
hr\_df\_final =rbind(hr\_df\_results\_train, hr\_df\_results\_test)  
row.names(hr\_df\_final) = c('hr\_pruned\_bestxv\_tree\_train', 'hr\_pruned\_bestxv\_tree\_test')  
hr\_df\_final

## ACC SENS SPEC  
## hr\_pruned\_bestxv\_tree\_train 0.9081633 0.5120482 0.9843569  
## hr\_pruned\_bestxv\_tree\_test 0.8832200 0.4225352 0.9716216

#Calculate AUC and KS with best model

## Predict using the CART model  
HR\_traindata$predict.class=predict(hr\_best\_ptree,HR\_traindata,type="class")  
HR\_traindata$predict.score=predict(hr\_best\_ptree,HR\_traindata)  
HR\_traindata$predict.score

## No Yes  
## 1 0.27777778 0.72222222  
## 2 0.92427791 0.07572209  
## 3 0.81818182 0.18181818  
## 4 0.92427791 0.07572209  
## 5 0.92427791 0.07572209  
## 6 0.79032258 0.20967742  
## 7 0.92427791 0.07572209  
## 8 0.92427791 0.07572209  
## 9 0.86746988 0.13253012  
## 10 0.92427791 0.07572209  
## 11 0.09302326 0.90697674  
## 12 0.92427791 0.07572209  
## 13 0.81818182 0.18181818  
## 14 1.00000000 0.00000000  
## 15 0.92427791 0.07572209  
## 16 0.92427791 0.07572209  
## 17 0.93181818 0.06818182  
## 18 0.92427791 0.07572209  
## 19 0.07692308 0.92307692  
## 20 0.92427791 0.07572209  
## 21 0.92427791 0.07572209  
## 22 0.92427791 0.07572209  
## 23 0.92427791 0.07572209  
## 24 0.92427791 0.07572209  
## 25 0.92427791 0.07572209  
## 26 0.00000000 1.00000000  
## 27 0.82051282 0.17948718  
## 28 0.79032258 0.20967742  
## 29 0.92427791 0.07572209  
## 30 0.82051282 0.17948718  
## 31 1.00000000 0.00000000  
## 32 0.00000000 1.00000000  
## 33 0.92427791 0.07572209  
## 34 0.92427791 0.07572209  
## 35 0.92427791 0.07572209  
## 36 0.91304348 0.08695652  
## 37 0.86746988 0.13253012  
## 38 0.09302326 0.90697674  
## 39 0.93779904 0.06220096  
## 40 0.93779904 0.06220096  
## 41 0.86746988 0.13253012  
## 42 0.79032258 0.20967742  
## 43 0.92427791 0.07572209  
## 44 0.93779904 0.06220096  
## 45 0.92427791 0.07572209  
## 46 0.93779904 0.06220096  
## 47 0.92427791 0.07572209  
## 48 0.92427791 0.07572209  
## 49 0.92427791 0.07572209  
## 50 0.92427791 0.07572209  
## 51 0.79032258 0.20967742  
## 52 0.92427791 0.07572209  
## 53 0.93181818 0.06818182  
## 54 0.92427791 0.07572209  
## 55 0.92427791 0.07572209  
## 56 0.92427791 0.07572209  
## 57 0.93779904 0.06220096  
## 58 0.92427791 0.07572209  
## 59 0.93779904 0.06220096  
## 60 0.92427791 0.07572209  
## 61 0.92427791 0.07572209  
## 62 0.92427791 0.07572209  
## 63 0.91304348 0.08695652  
## 64 0.93779904 0.06220096  
## 65 0.93779904 0.06220096  
## 66 0.88135593 0.11864407  
## 67 0.92427791 0.07572209  
## 68 0.92427791 0.07572209  
## 69 0.92427791 0.07572209  
## 70 0.92427791 0.07572209  
## 71 0.93181818 0.06818182  
## 72 0.20000000 0.80000000  
## 73 0.92427791 0.07572209  
## 74 0.86746988 0.13253012  
## 75 0.25000000 0.75000000  
## 76 0.93181818 0.06818182  
## 77 0.82051282 0.17948718  
## 78 0.92427791 0.07572209  
## 79 0.86746988 0.13253012  
## 80 0.92427791 0.07572209  
## 81 0.92427791 0.07572209  
## 82 0.92427791 0.07572209  
## 83 0.92427791 0.07572209  
## 84 0.92427791 0.07572209  
## 85 0.92427791 0.07572209  
## 86 0.92427791 0.07572209  
## 87 0.20000000 0.80000000  
## 88 0.92427791 0.07572209  
## 89 0.93779904 0.06220096  
## 90 0.92427791 0.07572209  
## 91 0.92427791 0.07572209  
## 92 0.92427791 0.07572209  
## 93 0.92427791 0.07572209  
## 94 0.92427791 0.07572209  
## 95 0.86746988 0.13253012  
## 96 0.92427791 0.07572209  
## 97 0.92427791 0.07572209  
## 98 0.92427791 0.07572209  
## 99 0.92427791 0.07572209  
## 100 0.82051282 0.17948718  
## 101 0.92427791 0.07572209  
## 102 0.93779904 0.06220096  
## 103 0.88135593 0.11864407  
## 104 0.92427791 0.07572209  
## 105 0.92427791 0.07572209  
## 106 0.92427791 0.07572209  
## 107 0.92427791 0.07572209  
## 108 0.93181818 0.06818182  
## 109 0.88135593 0.11864407  
## 110 0.88135593 0.11864407  
## 111 0.93779904 0.06220096  
## 112 0.81818182 0.18181818  
## 113 0.92427791 0.07572209  
## 114 0.25000000 0.75000000  
## 115 0.92427791 0.07572209  
## 116 0.92427791 0.07572209  
## 117 0.00000000 1.00000000  
## 118 0.92427791 0.07572209  
## 119 0.82051282 0.17948718  
## 120 0.18181818 0.81818182  
## 121 0.00000000 1.00000000  
## 122 0.92427791 0.07572209  
## 123 0.92427791 0.07572209  
## 124 0.92427791 0.07572209  
## 125 0.92427791 0.07572209  
## 126 0.92427791 0.07572209  
## 127 0.86746988 0.13253012  
## 128 0.79032258 0.20967742  
## 129 0.92427791 0.07572209  
## 130 0.88135593 0.11864407  
## 131 0.92427791 0.07572209  
## 132 0.93779904 0.06220096  
## 133 0.93779904 0.06220096  
## 134 0.81818182 0.18181818  
## 135 0.92427791 0.07572209  
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## 1670 0.92427791 0.07572209  
## 1671 0.93181818 0.06818182  
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## 1674 0.81818182 0.18181818  
## 1675 0.93181818 0.06818182  
## 1676 0.09302326 0.90697674  
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## 2058 0.92427791 0.07572209

#View(HR\_traindata)

library(pROC)

## Warning: package 'pROC' was built under R version 3.6.1

## Type 'citation("pROC")' for a citation.

##   
## Attaching package: 'pROC'

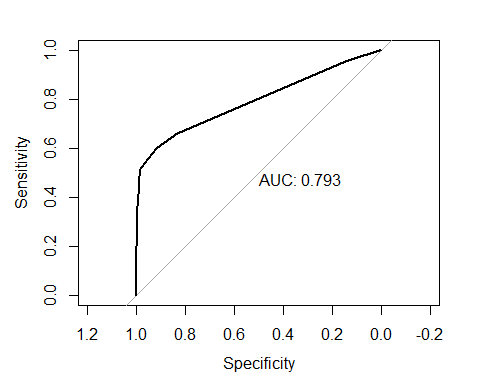
## The following objects are masked from 'package:stats':  
##   
## cov, smooth, var

hr\_roc\_obj\_train = roc(HR\_traindata$Attrition, HR\_traindata$predict.score[,2])

## Setting levels: control = No, case = Yes

## Setting direction: controls < cases

plot(hr\_roc\_obj\_train, print.auc = T)



hr\_roc\_obj\_test = roc(HR\_testdata$Attrition, HR\_testdata$predict.score[,2])

## Setting levels: control = No, case = Yes  
## Setting direction: controls < cases

plot(hr\_roc\_obj\_test, print.auc = T)

