Attrition_code_book

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```r
# Load dataset and set working directory
setwd("~/Downloads")  # Set the working directory to where the CSV file is stored
data <- read.csv("HR-Employee-Attrition.csv") # Read the CSV file into a data frame

# Remove unnecessary columns
columns_to_remove <- c("DailyRate","EmployeeNumber", "HourlyRate", "MonthlyRate", "StandardHours", "StockOptionLevel", "EmployeeCount")

data <- data[, !(names(data) %in% columns_to_remove)] # Drop the unnecessary columns

# View the first few rows of the dataset
head(data)
```

```
##   Age Attrition    BusinessTravel              Department DistanceFromHome
## 1  41       Yes     Travel_Rarely                   Sales                1
## 2  49        No Travel_Frequently Research & Development                8
## 3  37       Yes     Travel_Rarely Research & Development                2
## 4  33        No Travel_Frequently Research & Development                3
## 5  27        No     Travel_Rarely Research & Development                2
## 6  32        No Travel_Frequently Research & Development                2
##   Education EducationField EnvironmentSatisfaction Gender JobInvolvement
## 1         2  Life Sciences                         2 Female             3
## 2         1  Life Sciences                         3   Male             2
## 3         2          Other                         4   Male             2
## 4         4  Life Sciences                         4 Female             3
## 5         1        Medical                         1   Male             3
## 6         2  Life Sciences                         4   Male             3
##   JobLevel              JobRole JobSatisfaction MaritalStatus
MonthlyIncome
## 1        2       Sales Executive               4        Single
5993
## 2        2    Research Scientist               2       Married
5130
## 3        1 Laboratory Technician               3        Single
2090
## 4        1    Research Scientist               3       Married
2909
## 5        1 Laboratory Technician               2       Married
3468
```

```
## 6        1 Laboratory Technician               4        Single
3068
##   NumCompaniesWorked Over18 OverTime PercentSalaryHike PerformanceRating
## 1                  8      Y      Yes                11                 3
## 2                  1      Y       No                23                 4
## 3                  6      Y      Yes                15                 3
## 4                  1      Y      Yes                11                 3
## 5                  9      Y       No                12                 3
## 6                  0      Y       No                13                 3
##   RelationshipSatisfaction TotalWorkingYears TrainingTimesLastYear
## 1                        1                 8                     0
## 2                        4                10                     3
## 3                        2                 7                     3
## 4                        3                 8                     3
## 5                        4                 6                     3
## 6                        3                 8                     2
##   WorkLifeBalance YearsAtCompany YearsInCurrentRole
YearsSinceLastPromotion
## 1               1              6                  4
0
## 2               3             10                  7
1
## 3               3              0                  0
0
## 4               3              8                  7
3
## 5               3              2                  2
2
## 6               2              7                  7
3
##   YearsWithCurrManager
## 1                    5
## 2                    7
## 3                    0
## 4                    0
## 5                    2
## 6                    6
```

```r
# Get summary statistics for each column
summary(data)
```

```
##       Age         Attrition         BusinessTravel      Department
##  Min.   :18.00   Length:1470        Length:1470        Length:1470
##  1st Qu.:30.00   Class :character   Class :character   Class :character
##  Median :36.00   Mode  :character   Mode  :character   Mode  :character
##  Mean   :36.92
##  3rd Qu.:43.00
##  Max.   :60.00
##  DistanceFromHome   Education     EducationField
EnvironmentSatisfaction
```

```
##  Min.   : 1.000   Min.   :1.000   Length:1470        Min.   :1.000
##  1st Qu.: 2.000   1st Qu.:2.000   Class :character   1st Qu.:2.000
##  Median : 7.000   Median :3.000   Mode  :character   Median :3.000
##  Mean   : 9.193   Mean   :2.913                      Mean   :2.722
##  3rd Qu.:14.000   3rd Qu.:4.000                      3rd Qu.:4.000
##  Max.   :29.000   Max.   :5.000                      Max.   :4.000
##     Gender          JobInvolvement    JobLevel       JobRole
##  Length:1470        Min.   :1.00   Min.   :1.000   Length:1470
##  Class :character   1st Qu.:2.00   1st Qu.:1.000   Class :character
##  Mode  :character   Median :3.00   Median :2.000   Mode  :character
##                     Mean   :2.73   Mean   :2.064
##                     3rd Qu.:3.00   3rd Qu.:3.000
##                     Max.   :4.00   Max.   :5.000
##  JobSatisfaction MaritalStatus      MonthlyIncome   NumCompaniesWorked
##  Min.   :1.000   Length:1470        Min.   : 1009   Min.   :0.000
##  1st Qu.:2.000   Class :character   1st Qu.: 2911   1st Qu.:1.000
##  Median :3.000   Mode  :character   Median : 4919   Median :2.000
##  Mean   :2.729                      Mean   : 6503   Mean   :2.693
##  3rd Qu.:4.000                      3rd Qu.: 8379   3rd Qu.:4.000
##  Max.   :4.000                      Max.   :19999   Max.   :9.000
##     Over18            OverTime         PercentSalaryHike PerformanceRating
##  Length:1470        Length:1470        Min.   :11.00     Min.   :3.000
##  Class :character   Class :character   1st Qu.:12.00     1st Qu.:3.000
##  Mode  :character   Mode  :character   Median :14.00     Median :3.000
##                                        Mean   :15.21     Mean   :3.154
##                                        3rd Qu.:18.00     3rd Qu.:3.000
##                                        Max.   :25.00     Max.   :4.000
##  RelationshipSatisfaction TotalWorkingYears TrainingTimesLastYear
##  Min.   :1.000            Min.   : 0.00     Min.   :0.000
##  1st Qu.:2.000            1st Qu.: 6.00     1st Qu.:2.000
##  Median :3.000            Median :10.00     Median :3.000
##  Mean   :2.712            Mean   :11.28     Mean   :2.799
##  3rd Qu.:4.000            3rd Qu.:15.00     3rd Qu.:3.000
##  Max.   :4.000            Max.   :40.00     Max.   :6.000
##  WorkLifeBalance YearsAtCompany   YearsInCurrentRole
YearsSinceLastPromotion
##  Min.   :1.000   Min.   : 0.000   Min.   : 0.000     Min.   : 0.000
##  1st Qu.:2.000   1st Qu.: 3.000   1st Qu.: 2.000     1st Qu.: 0.000
##  Median :3.000   Median : 5.000   Median : 3.000     Median : 1.000
##  Mean   :2.761   Mean   : 7.008   Mean   : 4.229     Mean   : 2.188
##  3rd Qu.:3.000   3rd Qu.: 9.000   3rd Qu.: 7.000     3rd Qu.: 3.000
##  Max.   :4.000   Max.   :40.000   Max.   :18.000     Max.   :15.000
##  YearsWithCurrManager
##  Min.   : 0.000
##  1st Qu.: 2.000
##  Median : 3.000
##  Mean   : 4.123
##  3rd Qu.: 7.000
##  Max.   :17.000
```

```r
# Returns the number of rows and columns
dim(data)
```

```
## [1] 1470   28
```

```r
# Provides the structure of the dataset including data types
str(data)
```

```
## 'data.frame':    1470 obs. of  28 variables:
##  $ Age                     : int  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" ...
##  $ Department              : chr  "Sales" "Research & Development"
"Research & Development" "Research & Development" ...
##  $ DistanceFromHome        : int  1 8 2 3 2 2 3 24 23 27 ...
##  $ Education               : int  2 1 2 4 1 2 3 1 3 3 ...
##  $ EducationField          : chr  "Life Sciences" "Life Sciences" "Other"
"Life Sciences" ...
##  $ EnvironmentSatisfaction : int  2 3 4 4 1 4 3 4 4 3 ...
##  $ Gender                  : chr  "Female" "Male" "Male" "Female" ...
##  $ JobInvolvement          : int  3 2 2 3 3 3 4 3 2 3 ...
##  $ JobLevel                : int  2 2 1 1 1 1 1 1 3 2 ...
##  $ JobRole                 : chr  "Sales Executive" "Research Scientist"
"Laboratory Technician" "Research Scientist" ...
##  $ JobSatisfaction         : int  4 2 3 3 2 4 1 3 3 3 ...
##  $ MaritalStatus           : chr  "Single" "Married" "Single" "Married"
...
##  $ MonthlyIncome           : int  5993 5130 2090 2909 3468 3068 2670 2693
9526 5237 ...
##  $ NumCompaniesWorked      : int  8 1 6 1 9 0 4 1 0 6 ...
##  $ Over18                  : chr  "Y" "Y" "Y" "Y" ...
##  $ OverTime                : chr  "Yes" "No" "Yes" "Yes" ...
##  $ PercentSalaryHike       : int  11 23 15 11 12 13 20 22 21 13 ...
##  $ PerformanceRating       : int  3 4 3 3 3 3 4 4 4 3 ...
##  $ RelationshipSatisfaction: int  1 4 2 3 4 3 1 2 2 2 ...
##  $ TotalWorkingYears       : int  8 10 7 8 6 8 12 1 10 17 ...
##  $ TrainingTimesLastYear   : int  0 3 3 3 3 2 3 2 2 3 ...
##  $ WorkLifeBalance         : int  1 3 3 3 3 2 2 3 3 2 ...
##  $ YearsAtCompany          : int  6 10 0 8 2 7 1 1 9 7 ...
##  $ YearsInCurrentRole      : int  4 7 0 7 2 7 0 0 7 7 ...
##  $ YearsSinceLastPromotion : int  0 1 0 3 2 3 0 0 1 7 ...
##  $ YearsWithCurrManager    : int  5 7 0 0 2 6 0 0 8 7 ...
```

```r
# Check for Null values in the entire data frame
if (any(is.na(data))) {
  print("There are NA values in the data frame.")
} else {
  print("There are no NA values in the data frame.")
}
```

```
## [1] "There are no NA values in the data frame."
```

```
# Check for duplicate records
any(duplicated(data))
```

```
## [1] FALSE
```

```
# Check for outliers in 'Age' column using IQR method
variable <- data$Age
Q1 <- quantile(variable, 0.25) # First quartile (25th percentile)
Q3 <- quantile(variable, 0.75) # Third quartile (75th percentile)
IQR <- Q3 - Q1

# Identify potential outliers
potential_outliers <- variable < (Q1 - 1.5 * IQR) | variable > (Q3 + 1.5 *
IQR)

# Print the result
print(any(potential_outliers))
```

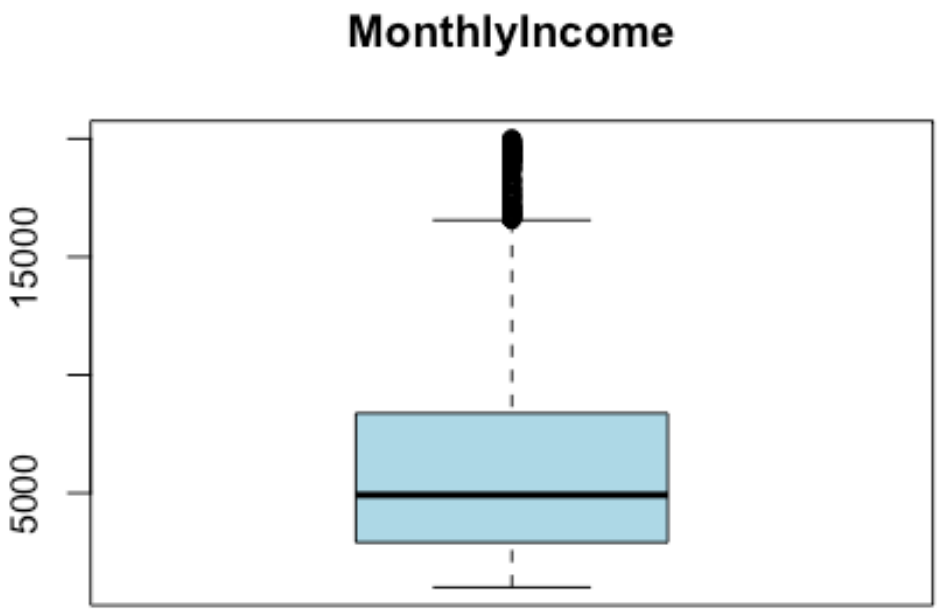
```
## [1] FALSE
```

```
# Function to detect outliers using IQR method
detect_outliers <- function(variable) {
  Q1 <- quantile(variable, 0.25)
  Q3 <- quantile(variable, 0.75)
  IQR <- Q3 - Q1

  # Identify potential outliers
  potential_outliers <- variable < (Q1 - 1.5 * IQR) | variable > (Q3 + 1.5 *
IQR)

  return(potential_outliers)
}

# Columns to check for outliers
columns_to_check <- c(
  "DistanceFromHome",
  "MonthlyIncome",
  "NumCompaniesWorked",
  "PercentSalaryHike",
  "TotalWorkingYears",
  "YearsAtCompany",
  "YearsInCurrentRole",
  "YearsSinceLastPromotion",
  "YearsWithCurrManager"
)

# Check for outliers in each column
for (col in columns_to_check) {
```

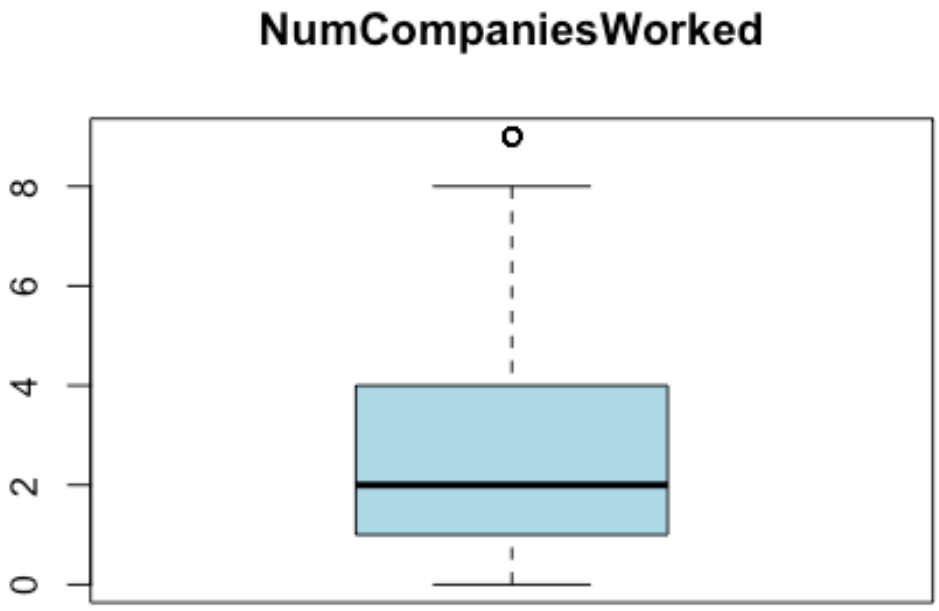
```
  variable <- data[[col]]
  outliers <- detect_outliers(variable)
  print(paste("Outliers in", col, ":", any(outliers)))
}
```

```
## [1] "Outliers in DistanceFromHome : FALSE"
## [1] "Outliers in MonthlyIncome : TRUE"
## [1] "Outliers in NumCompaniesWorked : TRUE"
## [1] "Outliers in PercentSalaryHike : FALSE"
## [1] "Outliers in TotalWorkingYears : TRUE"
## [1] "Outliers in YearsAtCompany : TRUE"
## [1] "Outliers in YearsInCurrentRole : TRUE"
## [1] "Outliers in YearsSinceLastPromotion : TRUE"
## [1] "Outliers in YearsWithCurrManager : TRUE"
```

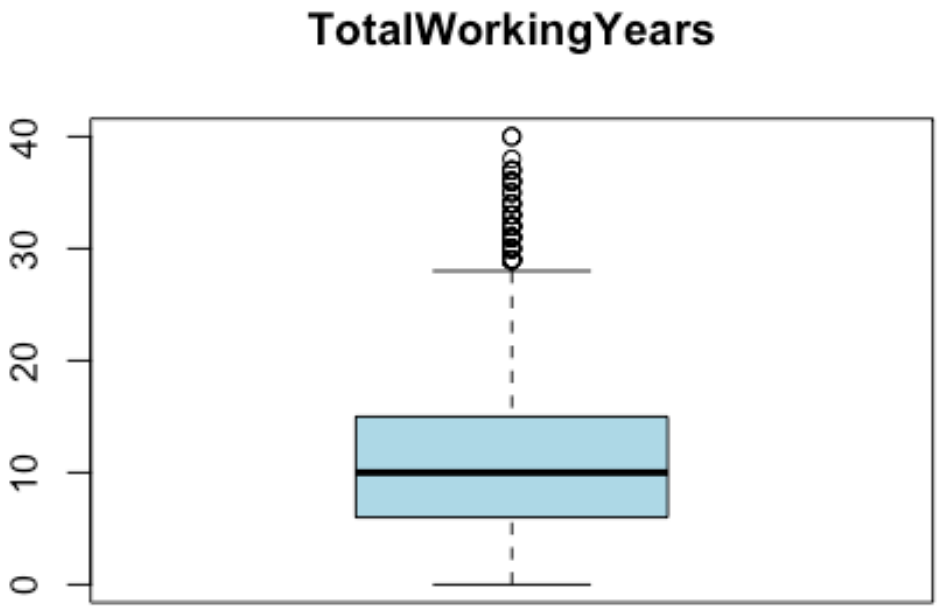
```
# Boxplots before outlier treatment
boxplot(data$MonthlyIncome, main = "MonthlyIncome", col = "lightblue", border
= "black", notch = FALSE)
```



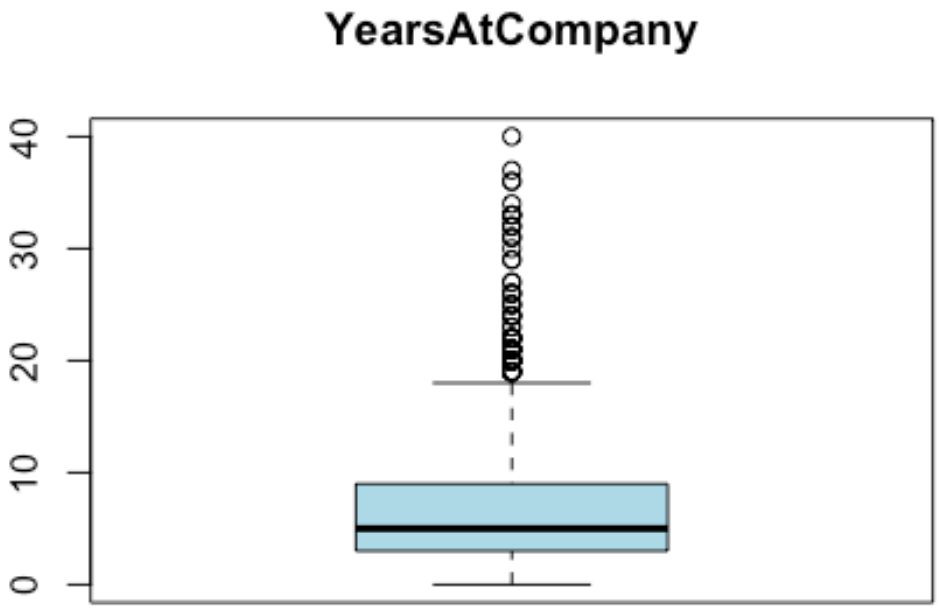

```
boxplot(data$NumCompaniesWorked, main = "NumCompaniesWorked", col =
"lightblue", border = "black", notch = FALSE)
```



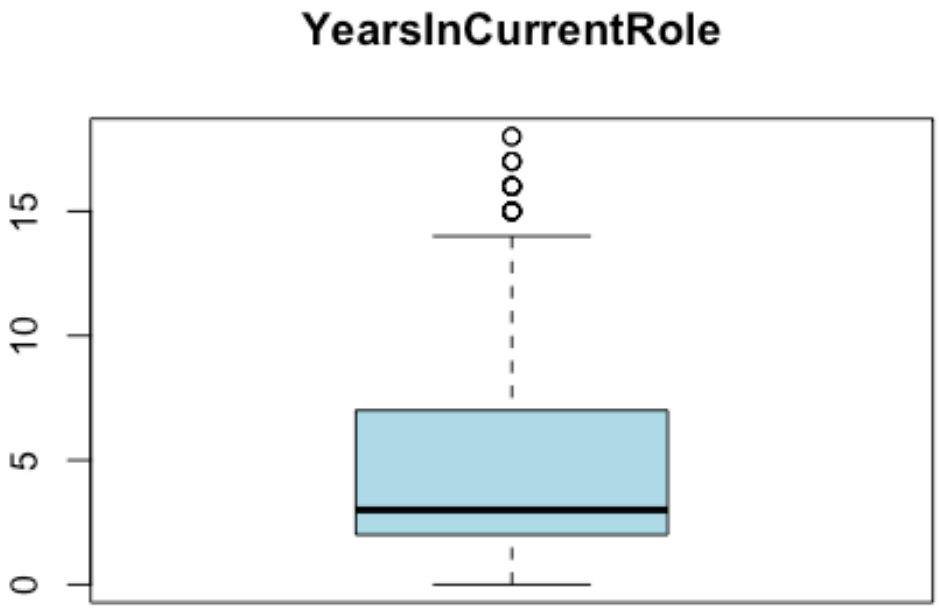

```r
boxplot(data$TotalWorkingYears, main = "TotalWorkingYears", col =
"lightblue", border = "black", notch = FALSE)
```



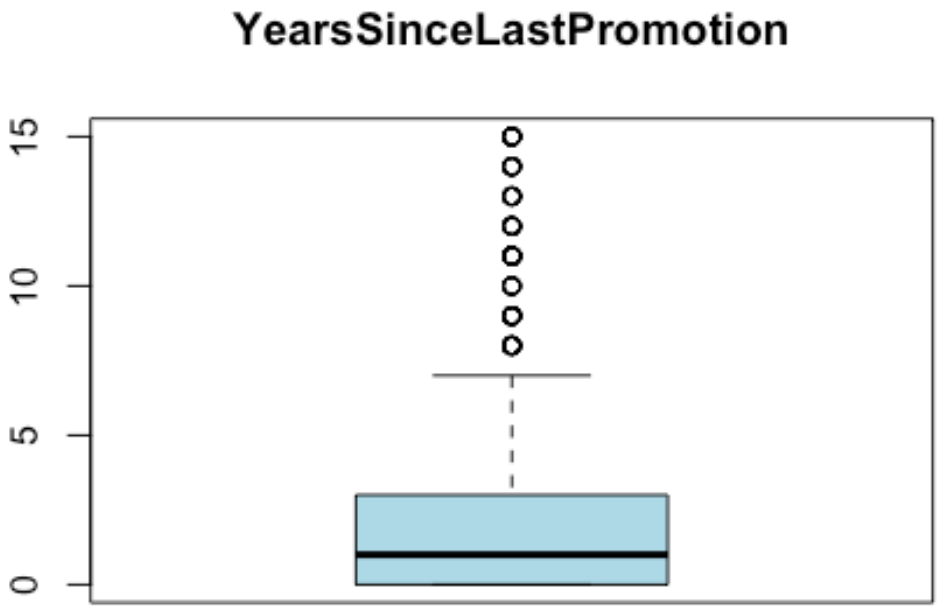

```r
boxplot(data$YearsAtCompany, main = "YearsAtCompany", col = "lightblue",
border = "black", notch = FALSE)
```



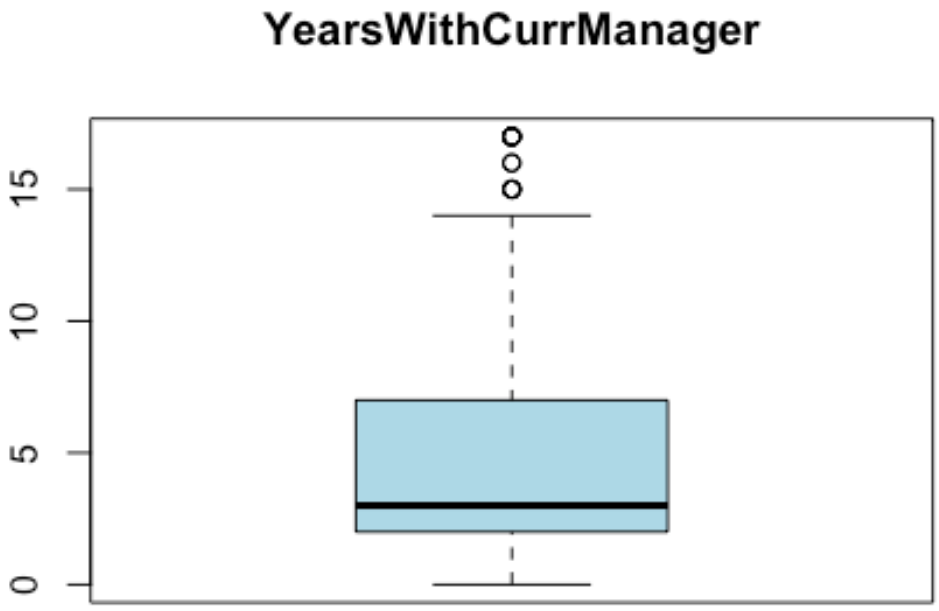

```r
boxplot(data$YearsInCurrentRole, main = "YearsInCurrentRole", col =
"lightblue", border = "black", notch = FALSE)
```




```r
boxplot(data$YearsSinceLastPromotion, main = "YearsSinceLastPromotion", col = "lightblue", border = "black", notch = FALSE)
```

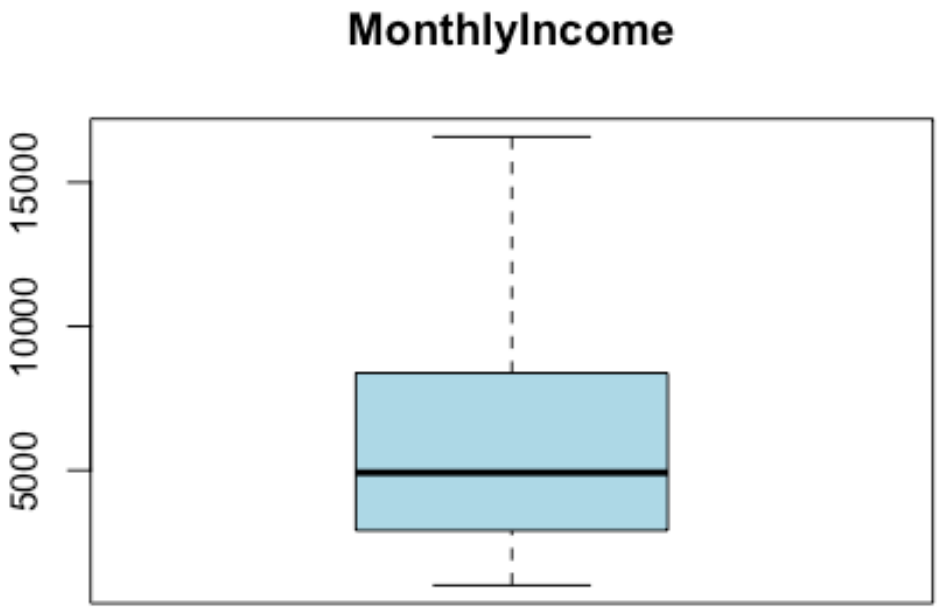



```
boxplot(data$YearsWithCurrManager, main = "YearsWithCurrManager", col =
"lightblue", border = "black", notch = FALSE)
```

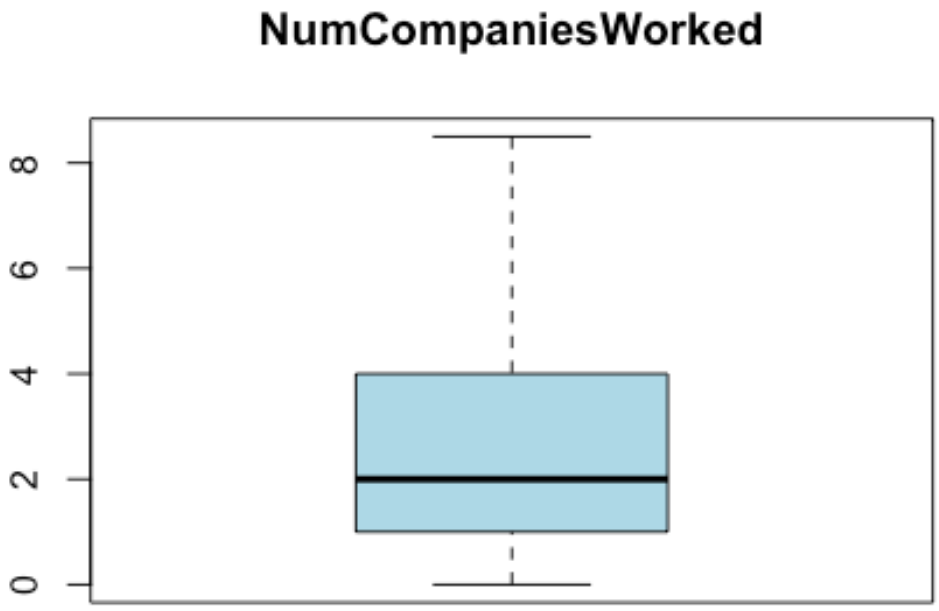



```r
# Function to clip (cap) outliers based on IQR method
clip_outliers <- function(variable) {
  Q1 <- quantile(variable, 0.25)
  Q3 <- quantile(variable, 0.75)
  IQR <- Q3 - Q1

  # Set the clipping threshold
  threshold <- 1.5

  # Clip (cap) values beyond the threshold
  variable[variable < (Q1 - threshold * IQR)] <- (Q1 - threshold * IQR)
  variable[variable > (Q3 + threshold * IQR)] <- (Q3 + threshold * IQR)

  return(variable)
}

# Columns to clip (cap) outliers
columns_to_clip <- c(
  "DistanceFromHome",
  "MonthlyIncome",
  "NumCompaniesWorked",
  "PercentSalaryHike",
  "TotalWorkingYears",
```

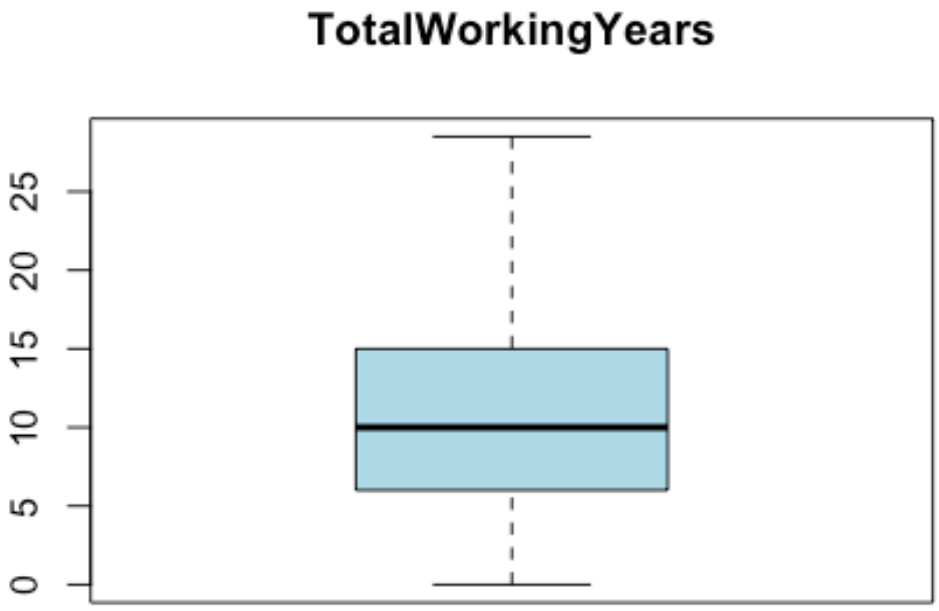
```
  "YearsAtCompany",
  "YearsInCurrentRole",
  "YearsSinceLastPromotion",
  "YearsWithCurrManager"
)

# Clip (cap) outliers in each column
for (col in columns_to_clip) {
  variable <- data[[col]]
  data[[col]] <- clip_outliers(variable)
}

# Boxplots after outlier treatment
boxplot(data$MonthlyIncome, main = "MonthlyIncome", col = "lightblue", border
= "black", notch = FALSE)
```



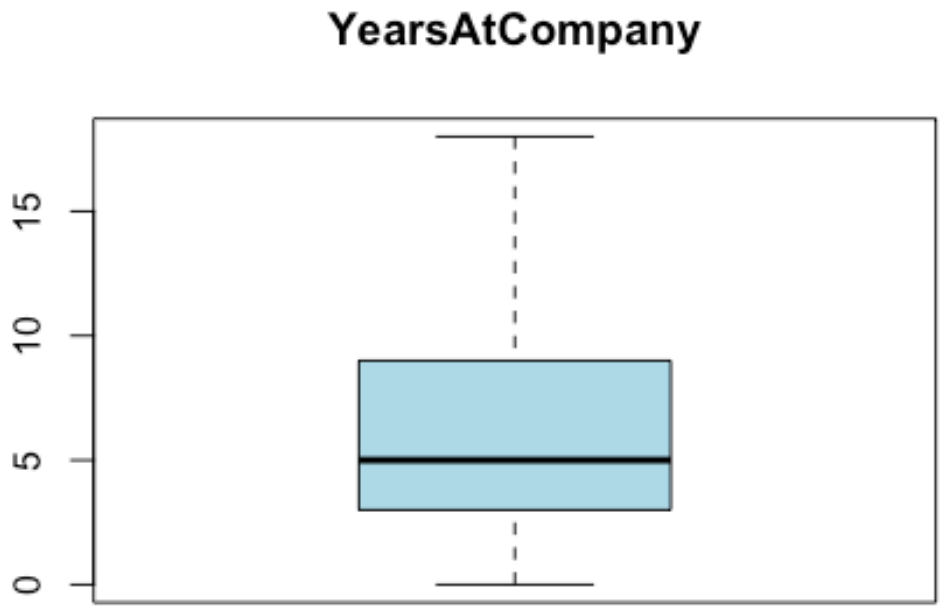

```
boxplot(data$NumCompaniesWorked, main = "NumCompaniesWorked", col =
"lightblue", border = "black", notch = FALSE)
```



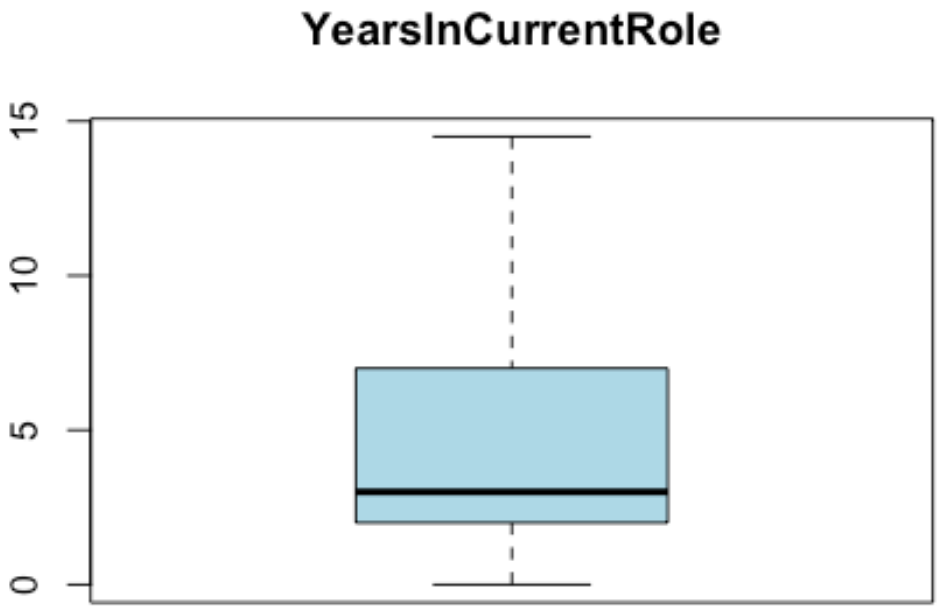

```
boxplot(data$TotalWorkingYears, main = "TotalWorkingYears", col =
"lightblue", border = "black", notch = FALSE)
```



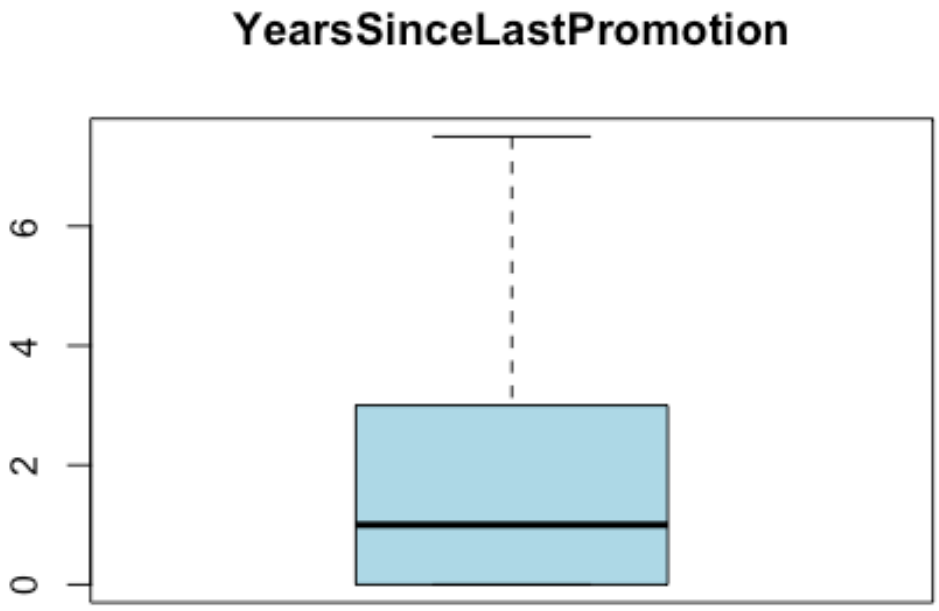

```r
boxplot(data$YearsAtCompany, main = "YearsAtCompany", col = "lightblue",
border = "black", notch = FALSE)
```



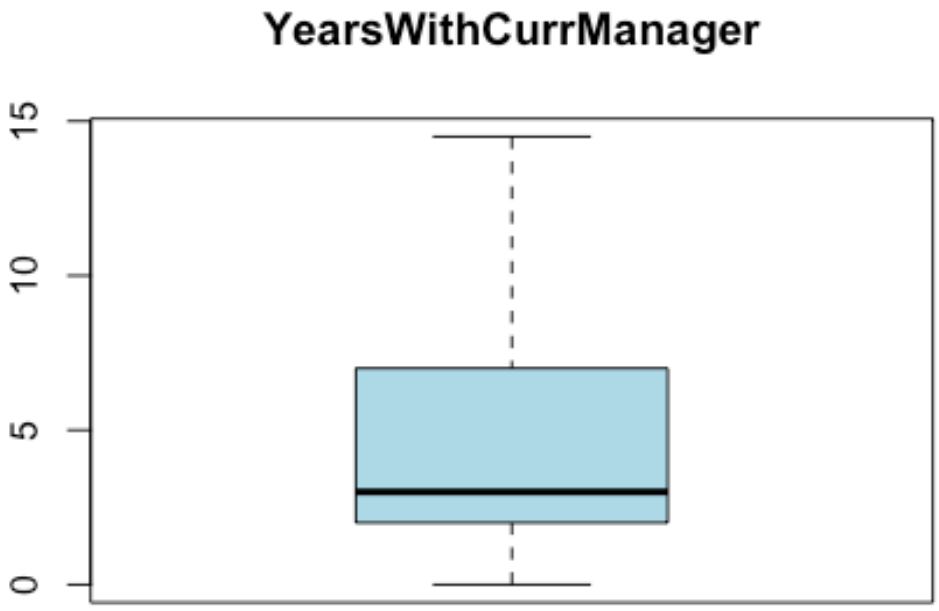

```r
boxplot(data$YearsInCurrentRole, main = "YearsInCurrentRole", col =
"lightblue", border = "black", notch = FALSE)
```




```r
boxplot(data$YearsSinceLastPromotion, main = "YearsSinceLastPromotion", col = "lightblue", border = "black", notch = FALSE)
```



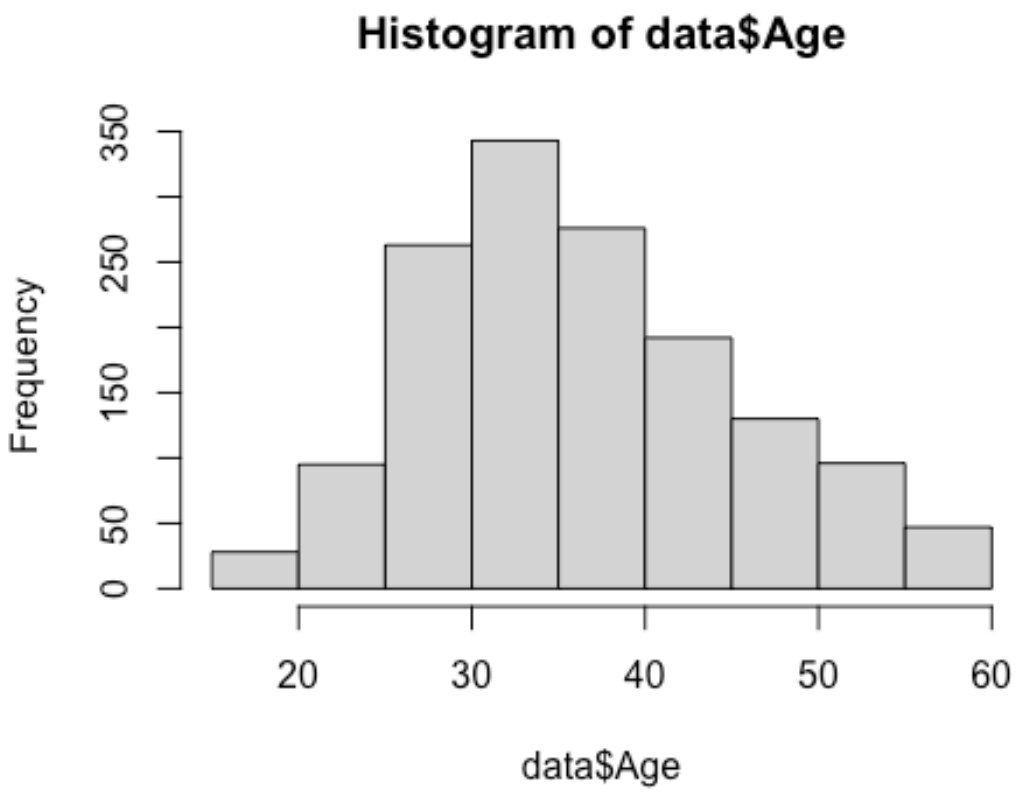

```r
boxplot(data$YearsWithCurrManager, main = "YearsWithCurrManager", col =
"lightblue", border = "black", notch = FALSE)
```



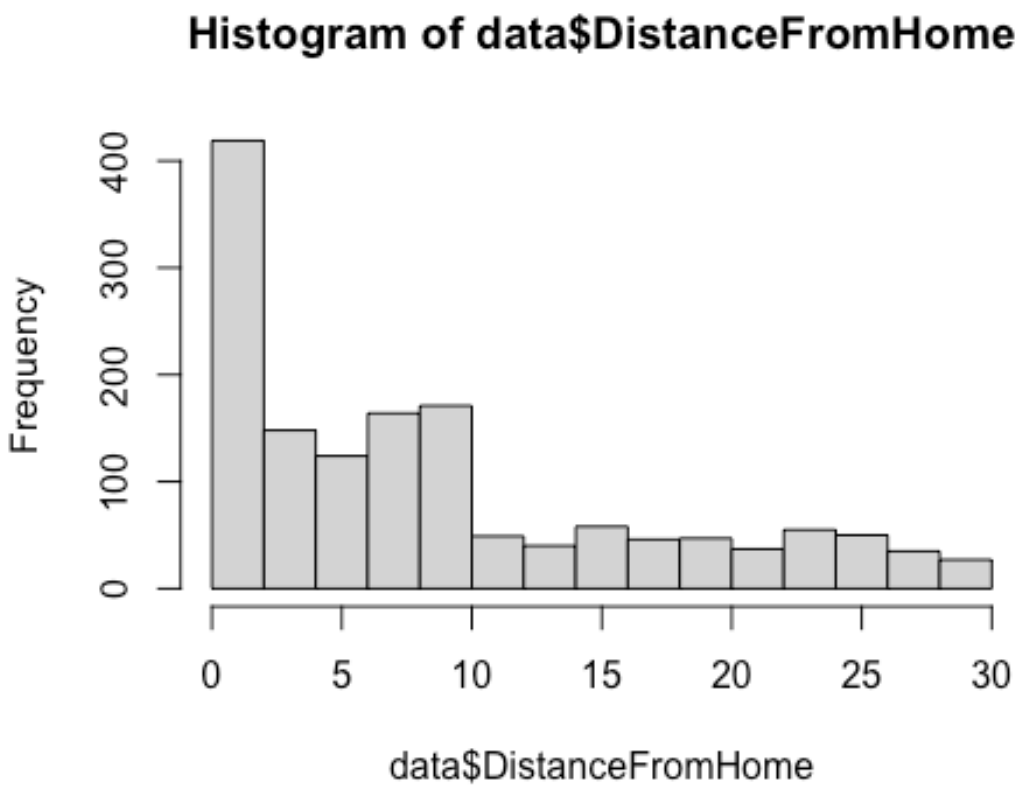

```
# Summary of dataset
summary(data)
```

```
##       Age         Attrition         BusinessTravel      Department
##  Min.   :18.00   Length:1470        Length:1470        Length:1470
##  1st Qu.:30.00   Class :character   Class :character   Class :character
##  Median :36.00   Mode  :character   Mode  :character   Mode  :character
##  Mean   :36.92
##  3rd Qu.:43.00
##  Max.   :60.00
##  DistanceFromHome   Education     EducationField
EnvironmentSatisfaction
##  Min.   : 1.000   Min.   :1.000   Length:1470        Min.   :1.000
##  1st Qu.: 2.000   1st Qu.:2.000   Class :character   1st Qu.:2.000
##  Median : 7.000   Median :3.000   Mode  :character   Median :3.000
##  Mean   : 9.193   Mean   :2.913                      Mean   :2.722
##  3rd Qu.:14.000   3rd Qu.:4.000                      3rd Qu.:4.000
##  Max.   :29.000   Max.   :5.000                      Max.   :4.000
##     Gender          JobInvolvement    JobLevel       JobRole
##  Length:1470        Min.   :1.00   Min.   :1.000   Length:1470
##  Class :character   1st Qu.:2.00   1st Qu.:1.000   Class :character
##  Mode  :character   Median :3.00   Median :2.000   Mode  :character
##                     Mean   :2.73   Mean   :2.064
```

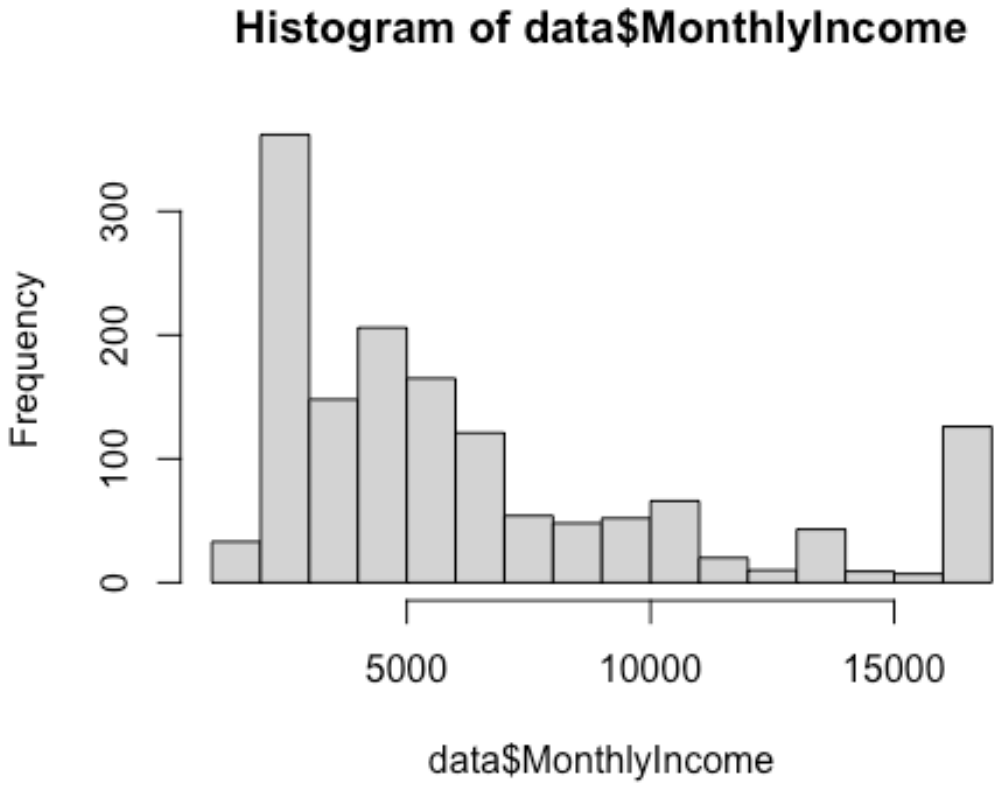
```
##                    3rd Qu.:3.00   3rd Qu.:3.000
##                    Max.   :4.00   Max.   :5.000
##  JobSatisfaction MaritalStatus      MonthlyIncome   NumCompaniesWorked
##  Min.   :1.000   Length:1470        Min.   : 1009   Min.   :0.000
##  1st Qu.:2.000   Class :character   1st Qu.: 2911   1st Qu.:1.000
##  Median :3.000   Mode  :character   Median : 4919   Median :2.000
##  Mean   :2.729                      Mean   : 6362   Mean   :2.676
##  3rd Qu.:4.000                      3rd Qu.: 8379   3rd Qu.:4.000
##  Max.   :4.000                      Max.   :16581   Max.   :8.500
##     Over18            OverTime         PercentSalaryHike PerformanceRating
##  Length:1470        Length:1470        Min.   :11.00     Min.   :3.000
##  Class :character   Class :character   1st Qu.:12.00     1st Qu.:3.000
##  Mode  :character   Mode  :character   Median :14.00     Median :3.000
##                                        Mean   :15.21     Mean   :3.154
##                                        3rd Qu.:18.00     3rd Qu.:3.000
##                                        Max.   :25.00     Max.   :4.000
##  RelationshipSatisfaction TotalWorkingYears TrainingTimesLastYear
##  Min.   :1.000            Min.   : 0.0      Min.   :0.000
##  1st Qu.:2.000            1st Qu.: 6.0      1st Qu.:2.000
##  Median :3.000            Median :10.0      Median :3.000
##  Mean   :2.712            Mean   :11.1      Mean   :2.799
##  3rd Qu.:4.000            3rd Qu.:15.0      3rd Qu.:3.000
##  Max.   :4.000            Max.   :28.5      Max.   :6.000
##  WorkLifeBalance YearsAtCompany   YearsInCurrentRole
YearsSinceLastPromotion
##  Min.   :1.000   Min.   : 0.000   Min.   : 0.000     Min.   :0.000
##  1st Qu.:2.000   1st Qu.: 3.000   1st Qu.: 2.000     1st Qu.:0.000
##  Median :3.000   Median : 5.000   Median : 3.000     Median :1.000
##  Mean   :2.761   Mean   : 6.618   Mean   : 4.208     Mean   :1.923
##  3rd Qu.:3.000   3rd Qu.: 9.000   3rd Qu.: 7.000     3rd Qu.:3.000
##  Max.   :4.000   Max.   :18.000   Max.   :14.500     Max.   :7.500
##  YearsWithCurrManager
##  Min.   : 0.000
##  1st Qu.: 2.000
##  Median : 3.000
##  Mean   : 4.107
##  3rd Qu.: 7.000
##  Max.   :14.500

# Histograms for selected columns
hist(data$Age)
```



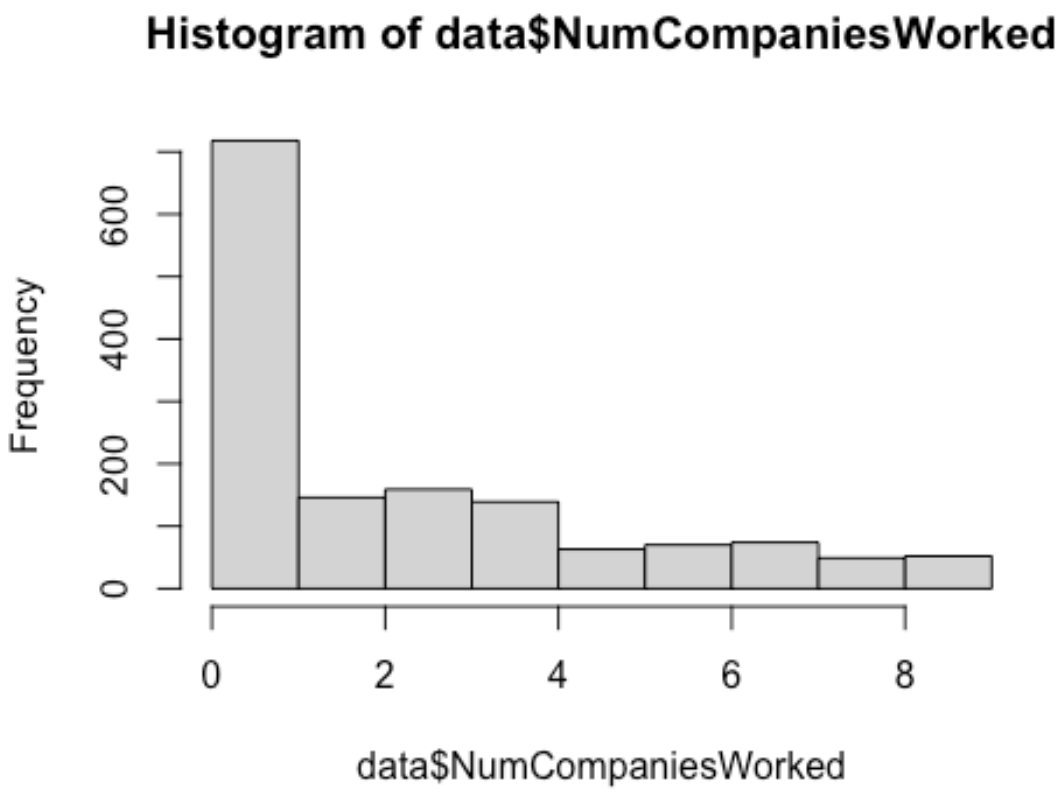

```r
hist(data$DistanceFromHome)
```



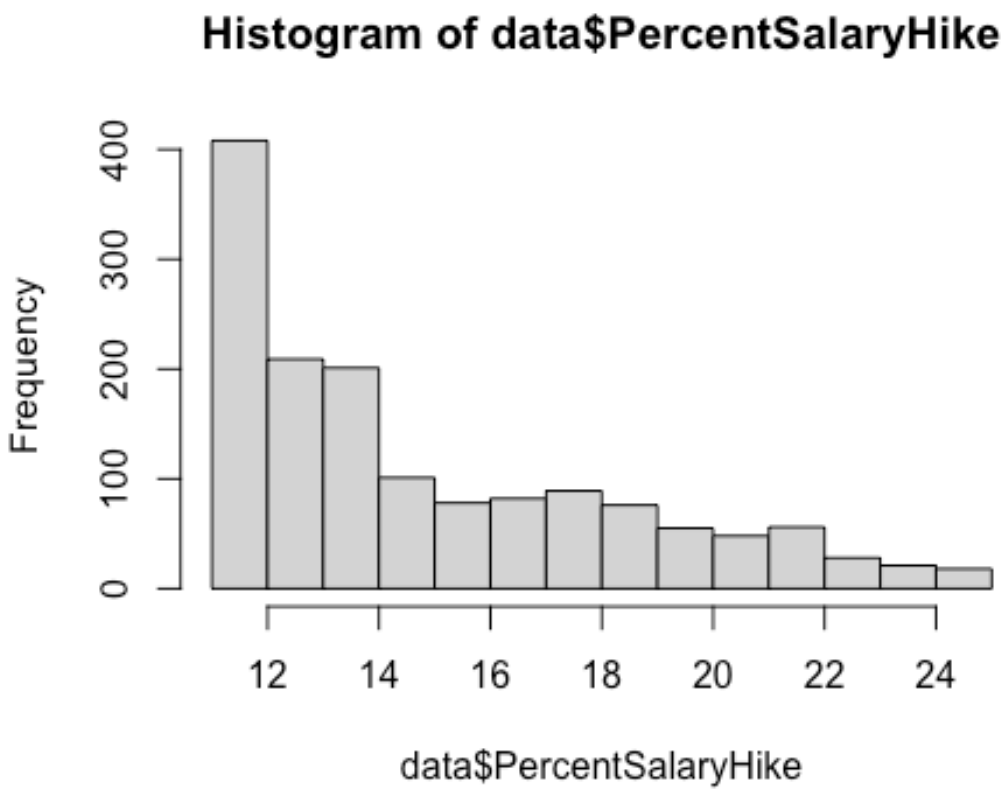

```r
hist(data$MonthlyIncome)
```



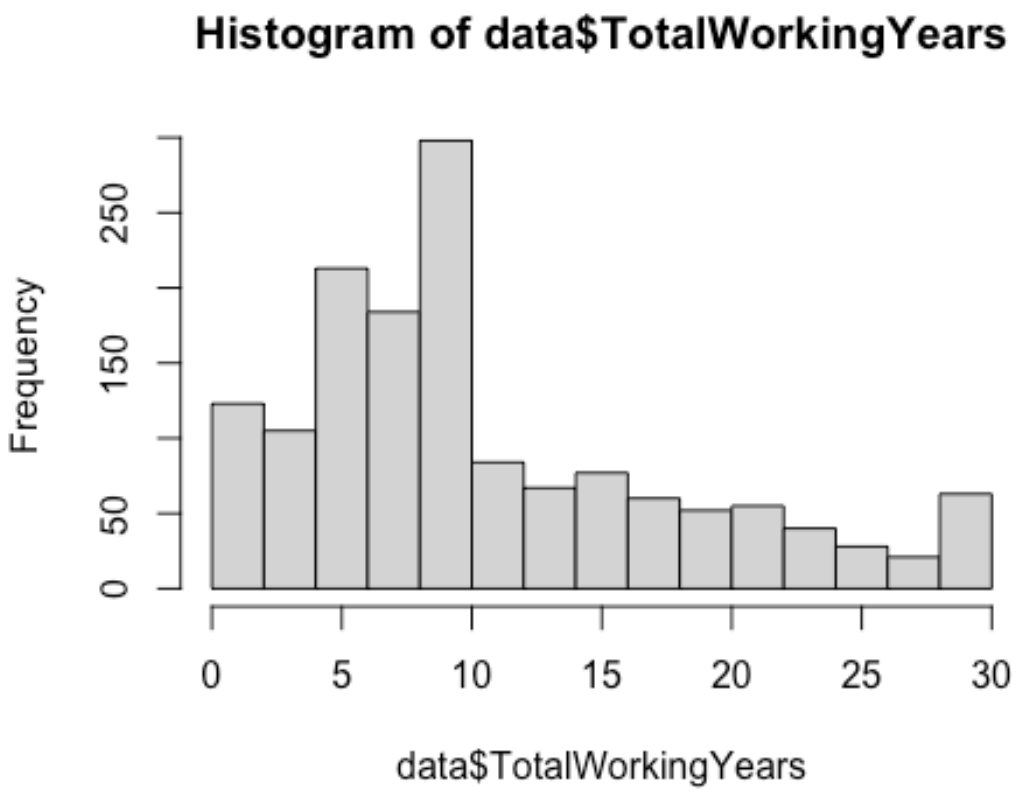

```r
hist(data$NumCompaniesWorked)
```



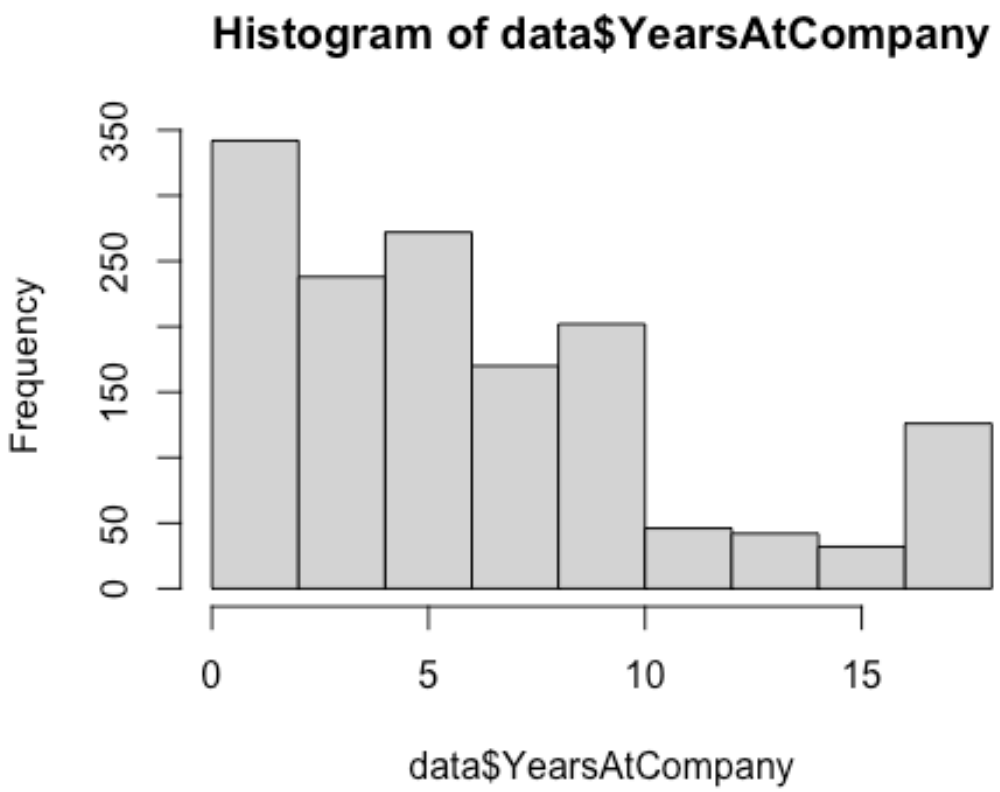

```r
hist(data$PercentSalaryHike)
```



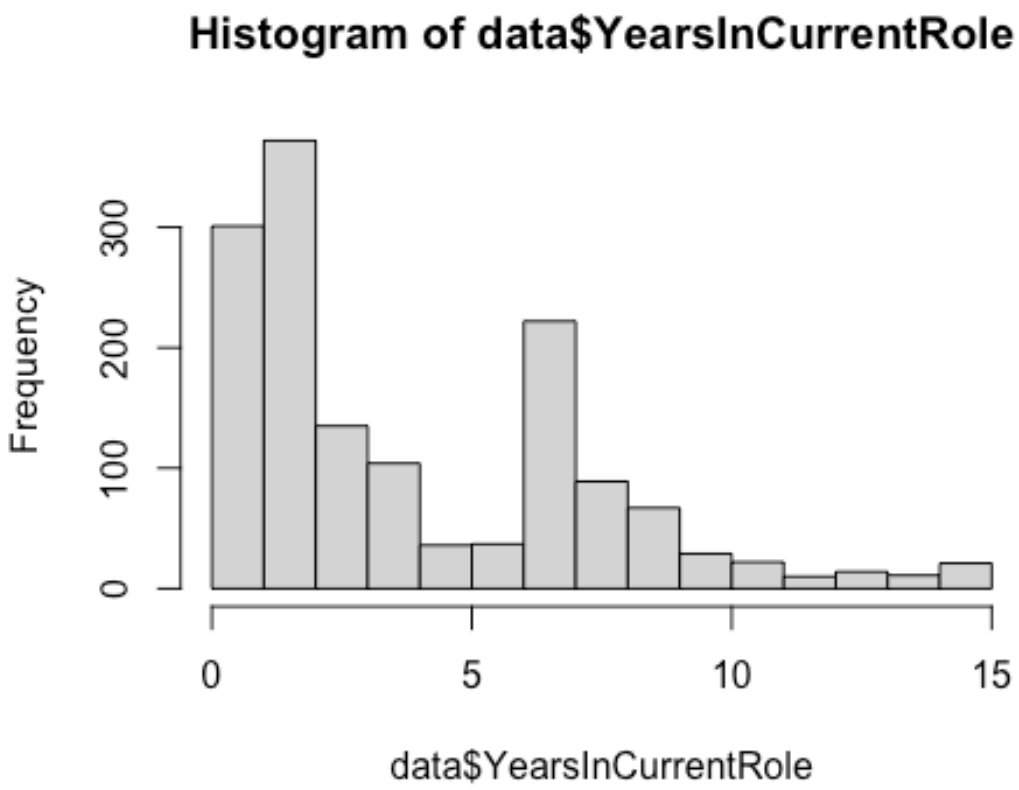

```r
hist(data$TotalWorkingYears)
```



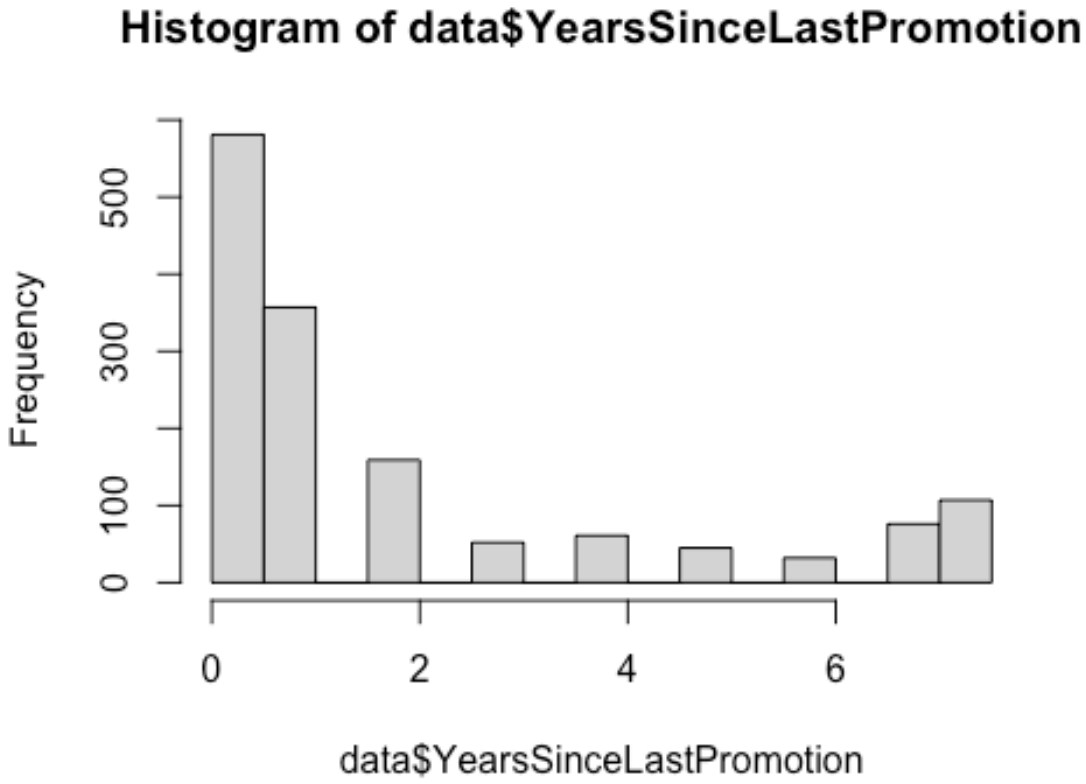

```r
hist(data$YearsAtCompany)
```



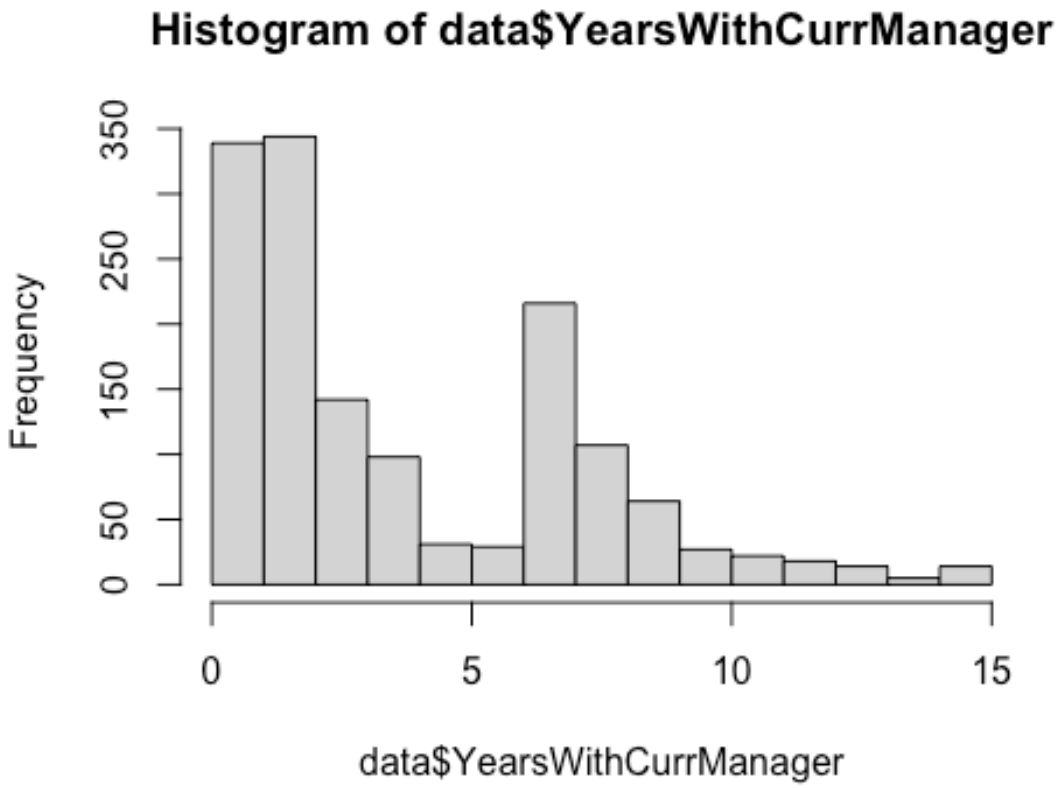

```r
hist(data$YearsInCurrentRole)
```



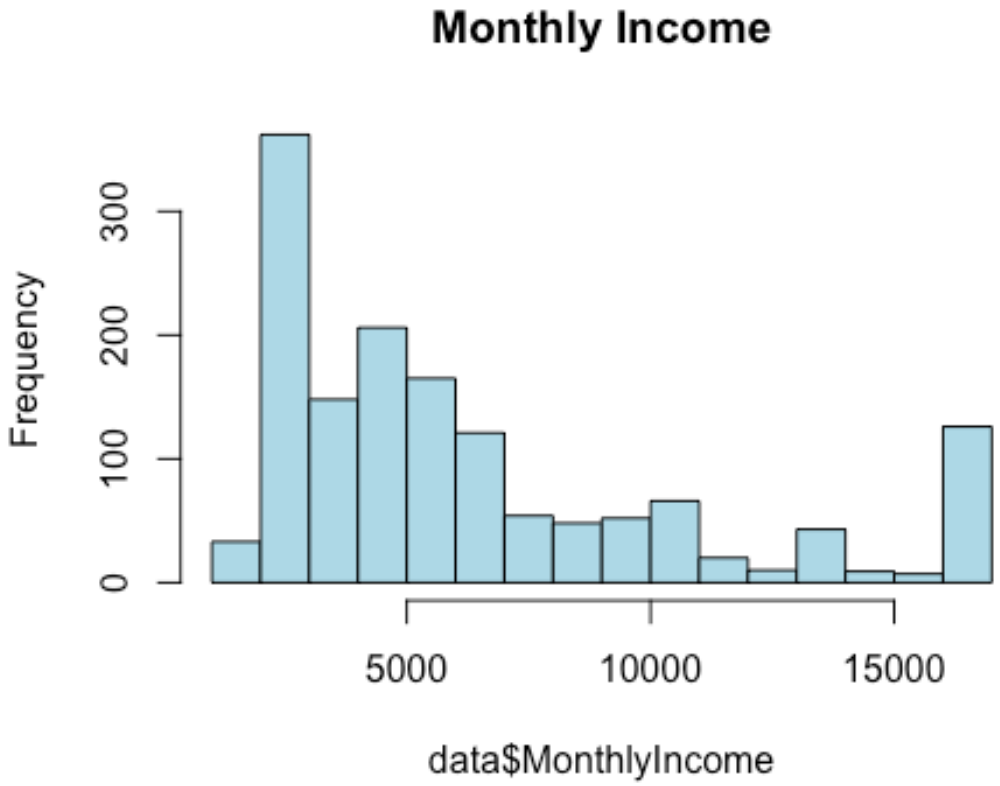

```r
hist(data$YearsSinceLastPromotion)
```



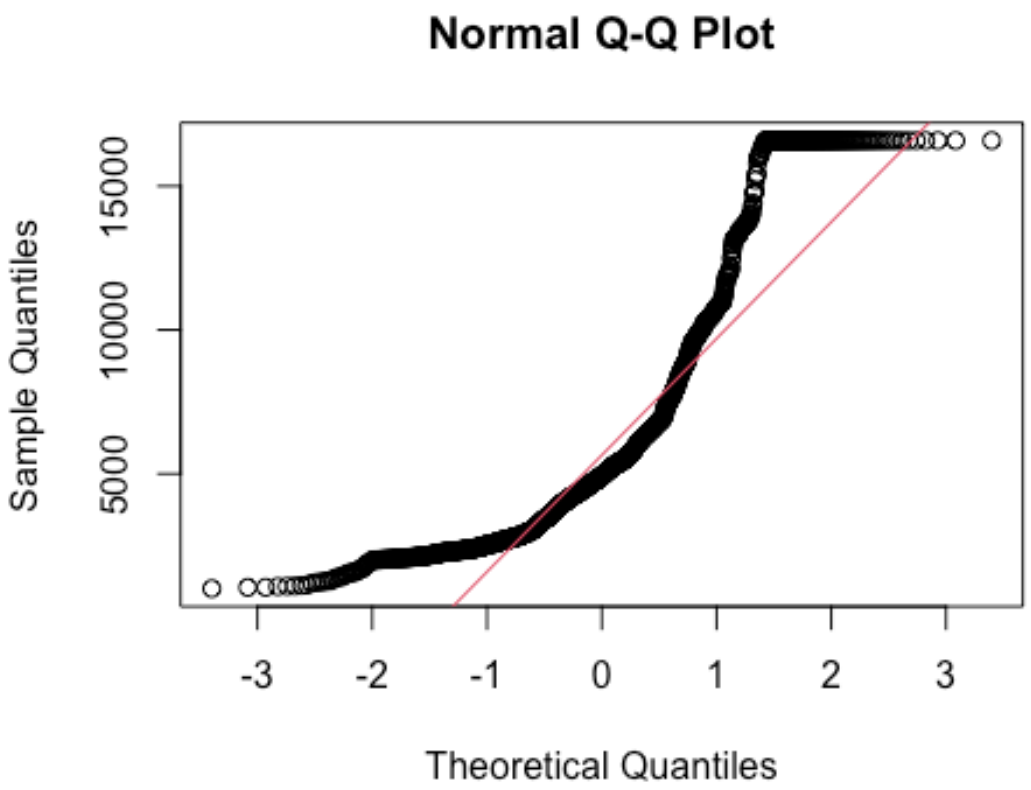

```r
hist(data$YearsWithCurrManager)
```




```r
# Histogram
hist(data$MonthlyIncome, main="Monthly Income", col="lightblue",
border="black")
```




```r
# Q-Q Plot
qqnorm(data$MonthlyIncome)
qqline(data$MonthlyIncome, col = 2)
```

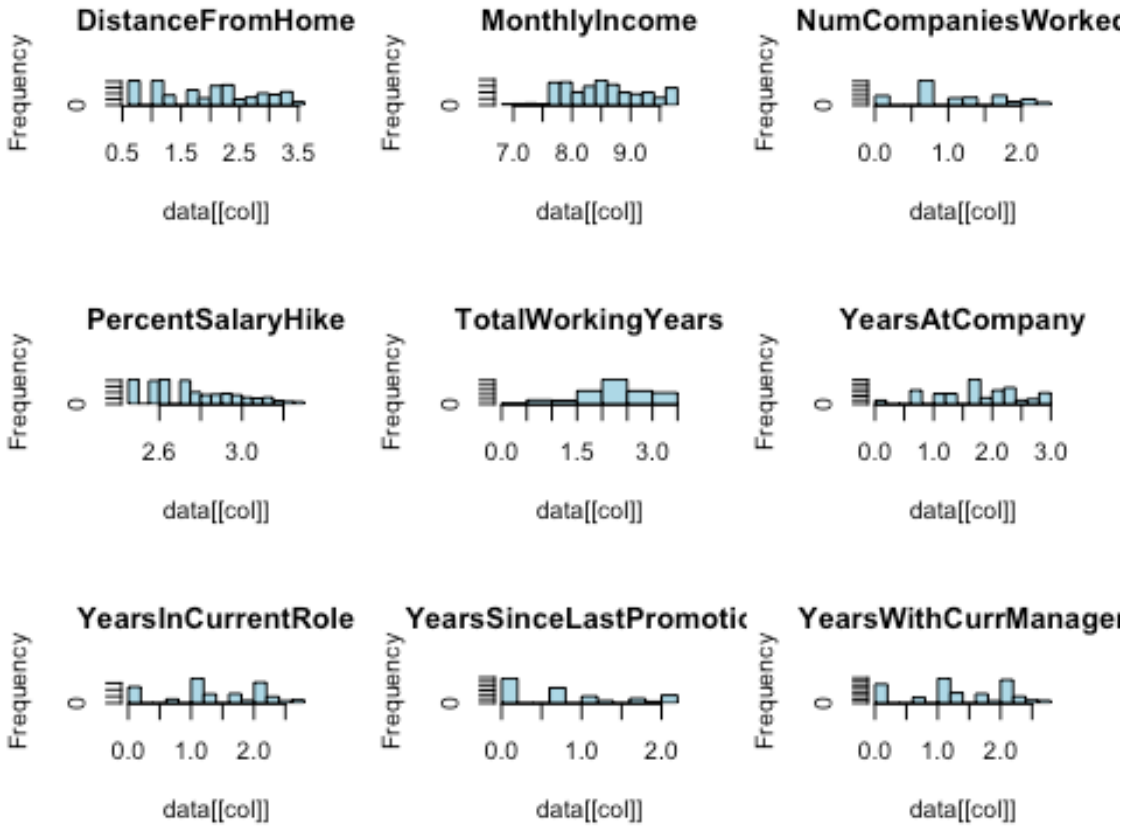



```r
# Shapiro-Wilk Test for Normality
shapiro.test(data$MonthlyIncome)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  data$MonthlyIncome
## W = 0.84037, p-value < 2.2e-16
```

```r
#columns_to_remove <- c("Over18")

#data <- data[, !(names(data) %in% columns_to_remove)]

columns_to_transform <- c(
  "DistanceFromHome",
  "MonthlyIncome",
  "NumCompaniesWorked",
  "PercentSalaryHike",
  "TotalWorkingYears",
  "YearsAtCompany",
  "YearsInCurrentRole",
  "YearsSinceLastPromotion",
  "YearsWithCurrManager"
)
```

```r
for (col in columns_to_transform) {
  data[[col]] <- ifelse(data[[col]] > 0, log(data[[col]] + 1), 0)
}

par(mfrow = c(3, 3))
for (col in columns_to_transform) {
  hist(data[[col]], main = col, col = "lightblue", border = "black")
}
```




```r
# Correlation matrix
numeric_data <- data[, sapply(data, is.numeric)]

# Calculate the correlation matrix
correlation_matrix <- cor(numeric_data)

# Print the correlation matrix
print(correlation_matrix)
```

```
##                                Age DistanceFromHome    Education
## Age                    1.000000000     -0.021953855  0.208033731
## DistanceFromHome      -0.021953855      1.000000000  0.019414538
## Education              0.208033731      0.019414538  1.000000000
```

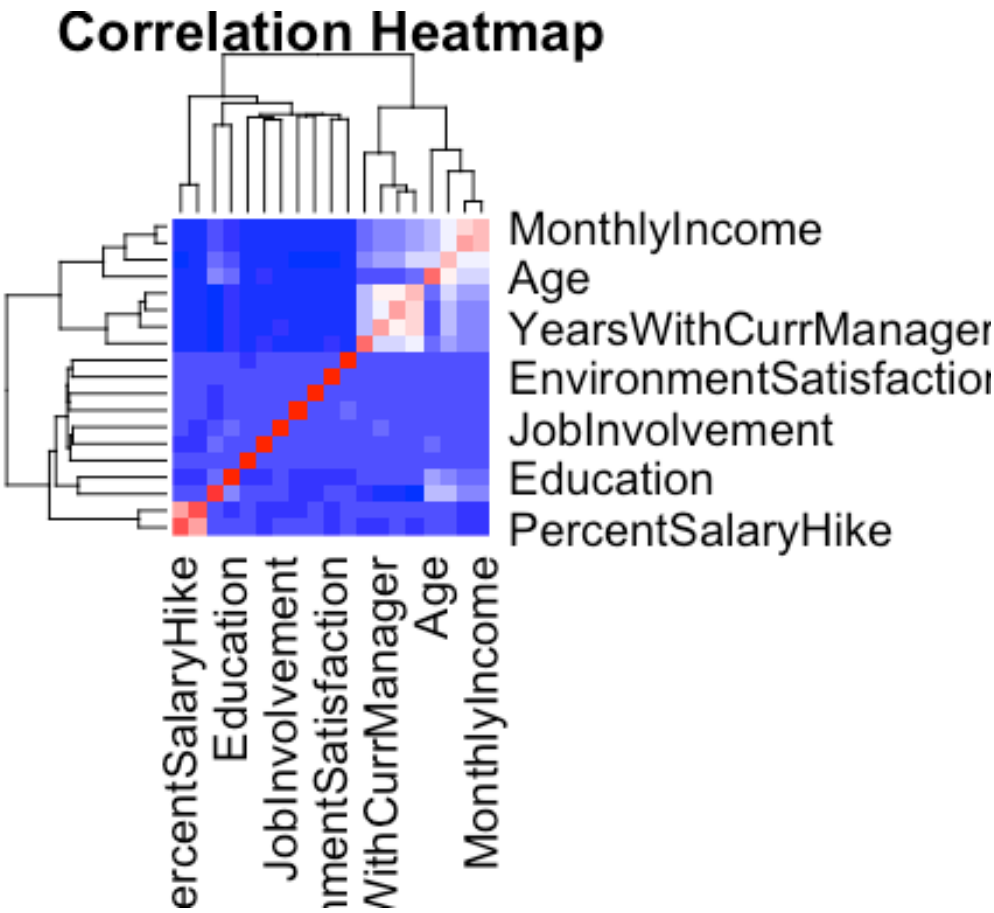
```
## EnvironmentSatisfaction   0.010146428     -0.009394644 -0.027128313
## JobInvolvement            0.029819959      0.031489190  0.042437634
## JobLevel                  0.509604228     -0.004163625  0.101588886
## JobSatisfaction          -0.004891877     -0.011575089 -0.011296117
## MonthlyIncome             0.491101313     -0.003100256  0.123132296
## NumCompaniesWorked        0.329479594     -0.007007570  0.134197648
## PercentSalaryHike         0.004219954      0.032099747 -0.006973840
## PerformanceRating         0.001903896      0.011243042 -0.024538791
## RelationshipSatisfaction  0.053534720      0.009517637 -0.009118377
## TotalWorkingYears         0.648820781     -0.002108873  0.172696984
## TrainingTimesLastYear    -0.019620819     -0.017957375 -0.025100241
## WorkLifeBalance          -0.021490028     -0.023031058  0.009819189
## YearsAtCompany            0.249425723      0.009945118  0.058541047
## YearsInCurrentRole        0.184896347      0.016578402  0.056683882
## YearsSinceLastPromotion   0.180329599     -0.002057297  0.039439521
## YearsWithCurrManager      0.174974607      0.003337656  0.051920142
##                         EnvironmentSatisfaction JobInvolvement
JobLevel
## Age                           0.0101464279    0.029819959
0.509604228
## DistanceFromHome             -0.0093946436    0.031489190 -
0.004163625
## Education                    -0.0271283133    0.042437634
0.101588886
## EnvironmentSatisfaction       1.0000000000   -0.008277598
0.001211699
## JobInvolvement               -0.0082775982    1.000000000 -
0.012629883
## JobLevel                      0.0012116994   -0.012629883
1.000000000
## JobSatisfaction              -0.0067843526   -0.021475910 -
0.001943708
## MonthlyIncome                -0.0170130875   -0.016791320
0.910295009
## NumCompaniesWorked            0.0042947187    0.010960082
0.161525586
## PercentSalaryHike            -0.0311518054   -0.018065938 -
0.038179810
## PerformanceRating            -0.0295479523   -0.029071333 -
0.021222082
## RelationshipSatisfaction      0.0076653835    0.034296821
0.021641511
## TotalWorkingYears            -0.0248540877    0.015371371
0.699664841
## TrainingTimesLastYear        -0.0193593083   -0.015337826 -
0.018190550
## WorkLifeBalance               0.0276272955   -0.014616593
0.037817746
## YearsAtCompany                0.0095999614    0.019737471
0.428004073
```

```
## YearsInCurrentRole                  0.0177477983    0.020918916
0.328248355
## YearsSinceLastPromotion             0.0267488930   -0.008943892
0.290561031
## YearsWithCurrManager                0.0006257353    0.052569246
0.318352664
##                           JobSatisfaction MonthlyIncome NumCompaniesWorked
## Age                        -0.0048918771   0.491101313        0.329479594
## DistanceFromHome           -0.0115750892  -0.003100256       -0.007007570
## Education                  -0.0112961167   0.123132296        0.134197648
## EnvironmentSatisfaction    -0.0067843526  -0.017013088        0.004294719
## JobInvolvement             -0.0214759103  -0.016791320        0.010960082
## JobLevel                   -0.0019437080   0.910295009        0.161525586
## JobSatisfaction             1.0000000000  -0.004709971       -0.050550281
## MonthlyIncome              -0.0047099713   1.000000000        0.181323836
## NumCompaniesWorked         -0.0505502812   0.181323836        1.000000000
## PercentSalaryHike           0.0202742838  -0.029636034       -0.006927221
## PerformanceRating           0.0022971971  -0.024053131       -0.006085083
## RelationshipSatisfaction   -0.0124535932   0.006049574        0.047612803
## TotalWorkingYears          -0.0213530642   0.729311449        0.303678405
## TrainingTimesLastYear      -0.0057793350  -0.032830834       -0.057376274
## WorkLifeBalance            -0.0194587102   0.033389828        0.003888189
## YearsAtCompany              0.0098506535   0.460257229       -0.152960869
## YearsInCurrentRole          0.0004203887   0.379218393       -0.113330170
## YearsSinceLastPromotion     0.0003238095   0.290952764       -0.067096605
## YearsWithCurrManager       -0.0163095256   0.351363999       -0.132376325
##                           PercentSalaryHike PerformanceRating
## Age                           0.004219954       0.001903896
## DistanceFromHome              0.032099747       0.011243042
## Education                    -0.006973840      -0.024538791
## EnvironmentSatisfaction      -0.031151805      -0.029547952
## JobInvolvement               -0.018065938      -0.029071333
## JobLevel                     -0.038179810      -0.021222082
## JobSatisfaction               0.020274284       0.002297197
## MonthlyIncome                -0.029636034      -0.024053131
## NumCompaniesWorked           -0.006927221      -0.006085083
## PercentSalaryHike             1.000000000       0.725712189
## PerformanceRating             0.725712189       1.000000000
## RelationshipSatisfaction     -0.039901401      -0.031351455
## TotalWorkingYears            -0.022035934       0.008214099
## TrainingTimesLastYear        -0.006839233      -0.015578882
## WorkLifeBalance              -0.004613474       0.002572361
## YearsAtCompany               -0.046350725       0.013126661
## YearsInCurrentRole           -0.021899921       0.024818382
## YearsSinceLastPromotion      -0.044746329      -0.000421025
## YearsWithCurrManager         -0.026543040       0.014621483
##                           RelationshipSatisfaction TotalWorkingYears
## Age                                  0.0535347197       0.648820781
## DistanceFromHome                     0.0095176374      -0.002108873
## Education                           -0.0091183767       0.172696984
```

```
## EnvironmentSatisfaction              0.0076653835      -0.024854088
## JobInvolvement                       0.0342968206       0.015371371
## JobLevel                             0.0216415105       0.699664841
## JobSatisfaction                     -0.0124535932      -0.021353064
## MonthlyIncome                        0.0060495738       0.729311449
## NumCompaniesWorked                   0.0476128030       0.303678405
## PercentSalaryHike                   -0.0399014012      -0.022035934
## PerformanceRating                   -0.0313514554       0.008214099
## RelationshipSatisfaction             1.0000000000      -0.002243549
## TotalWorkingYears                   -0.0022435493       1.000000000
## TrainingTimesLastYear                0.0024965264      -0.024971703
## WorkLifeBalance                      0.0196044057       0.004964684
## YearsAtCompany                      -0.0074956580       0.609458913
## YearsInCurrentRole                  -0.0153592659       0.500897860
## YearsSinceLastPromotion              0.0259582307       0.355128695
## YearsWithCurrManager                 0.0003347191       0.501464349
##                          TrainingTimesLastYear WorkLifeBalance
YearsAtCompany
## Age                                -0.019620819    -0.021490028
0.249425723
## DistanceFromHome                   -0.017957375    -0.023031058
0.009945118
## Education                          -0.025100241     0.009819189
0.058541047
## EnvironmentSatisfaction            -0.019359308     0.027627295
0.009599961
## JobInvolvement                     -0.015337826    -0.014616593
0.019737471
## JobLevel                           -0.018190550     0.037817746
0.428004073
## JobSatisfaction                    -0.005779335    -0.019458710
0.009850654
## MonthlyIncome                      -0.032830834     0.033389828
0.460257229
## NumCompaniesWorked                 -0.057376274     0.003888189   -
0.152960869
## PercentSalaryHike                  -0.006839233    -0.004613474   -
0.046350725
## PerformanceRating                  -0.015578882     0.002572361
0.013126661
## RelationshipSatisfaction            0.002496526     0.019604406   -
0.007495658
## TotalWorkingYears                  -0.024971703     0.004964684
0.609458913
## TrainingTimesLastYear               1.000000000     0.028072207   -
0.013795777
## WorkLifeBalance                     0.028072207     1.000000000
0.010549362
## YearsAtCompany                     -0.013795777     0.010549362
1.000000000
```

```
## YearsInCurrentRole                -0.013718344     0.025722530
0.846560664
## YearsSinceLastPromotion            0.009660688     0.011785458
0.543584433
## YearsWithCurrManager              -0.019920856    -0.006772938
0.834248045
##                           YearsInCurrentRole YearsSinceLastPromotion
## Age                           0.1848963466            0.1803295992
## DistanceFromHome              0.0165784020           -0.0020572970
## Education                     0.0566838822            0.0394395213
## EnvironmentSatisfaction       0.0177477983            0.0267488930
## JobInvolvement                0.0209189156           -0.0089438921
## JobLevel                      0.3282483548            0.2905610306
## JobSatisfaction               0.0004203887            0.0003238095
## MonthlyIncome                 0.3792183927            0.2909527637
## NumCompaniesWorked           -0.1133301704           -0.0670966045
## PercentSalaryHike            -0.0218999214           -0.0447463295
## PerformanceRating             0.0248183820           -0.0004210250
## RelationshipSatisfaction     -0.0153592659            0.0259582307
## TotalWorkingYears             0.5008978600            0.3551286948
## TrainingTimesLastYear        -0.0137183438            0.0096606877
## WorkLifeBalance               0.0257225296            0.0117854584
## YearsAtCompany                0.8465606645            0.5435844327
## YearsInCurrentRole            1.0000000000            0.5246673131
## YearsSinceLastPromotion       0.5246673131            1.0000000000
## YearsWithCurrManager          0.7318547779            0.4939325400
##                           YearsWithCurrManager
## Age                              0.1749746074
## DistanceFromHome                 0.0033376563
## Education                        0.0519201424
## EnvironmentSatisfaction          0.0006257353
## JobInvolvement                   0.0525692463
## JobLevel                         0.3183526641
## JobSatisfaction                 -0.0163095256
## MonthlyIncome                    0.3513639990
## NumCompaniesWorked              -0.1323763248
## PercentSalaryHike               -0.0265430404
## PerformanceRating                0.0146214829
## RelationshipSatisfaction         0.0003347191
## TotalWorkingYears                0.5014643494
## TrainingTimesLastYear           -0.0199208557
## WorkLifeBalance                 -0.0067729380
## YearsAtCompany                   0.8342480449
## YearsInCurrentRole               0.7318547779
## YearsSinceLastPromotion          0.4939325400
## YearsWithCurrManager             1.0000000000

par(mar = c(5, 5, 2, 2))  # Adjust the margins
heatmap(correlation_matrix,
        col = colorRampPalette(c("blue", "white", "red"))(20),
```

```
        main = "Correlation Heatmap",
        cexRow = 1.5, cexCol = 1.5,  # Adjust label size
        margins = c(10, 10))  # Adjust margins in the heatmap
```




```
# Fisher's Exact Test for categorical associations
your_data <- lapply(data, as.factor)
your_data <- as.data.frame(your_data)


variable_pairs <- combn(names(your_data), 2, simplify = TRUE)

associations <- list()

# Perform Fisher's Exact Test for each pair
for (i in seq(ncol(variable_pairs))) {
  # Create contingency table
  contingency_table <- table(your_data[, variable_pairs[1, i]], your_data[,
variable_pairs[2, i]])


  if (all(dim(contingency_table) >= 2)) {
    test_result <- fisher.test(contingency_table, simulate.p.value = TRUE)
```

```
    # Check if the p-value is below a significance threshold (e.g., 0.05)
    if (test_result$p.value < 0.05) {
      associations[[paste(variable_pairs[1, i], variable_pairs[2, i], sep =
"_")]] <- test_result
    }
  } else {
    cat("Insufficient data for Fisher's Exact Test for", variable_pairs[1,
i], "and", variable_pairs[2, i], "\n")
  }
}
```

```
## Insufficient data for Fisher's Exact Test for Age and Over18
## Insufficient data for Fisher's Exact Test for Attrition and Over18
## Insufficient data for Fisher's Exact Test for BusinessTravel and Over18
## Insufficient data for Fisher's Exact Test for Department and Over18
## Insufficient data for Fisher's Exact Test for DistanceFromHome and Over18
## Insufficient data for Fisher's Exact Test for Education and Over18
## Insufficient data for Fisher's Exact Test for EducationField and Over18
## Insufficient data for Fisher's Exact Test for EnvironmentSatisfaction and
Over18
## Insufficient data for Fisher's Exact Test for Gender and Over18
## Insufficient data for Fisher's Exact Test for JobInvolvement and Over18
## Insufficient data for Fisher's Exact Test for JobLevel and Over18
## Insufficient data for Fisher's Exact Test for JobRole and Over18
## Insufficient data for Fisher's Exact Test for JobSatisfaction and Over18
## Insufficient data for Fisher's Exact Test for MaritalStatus and Over18
## Insufficient data for Fisher's Exact Test for MonthlyIncome and Over18
## Insufficient data for Fisher's Exact Test for NumCompaniesWorked and
Over18
## Insufficient data for Fisher's Exact Test for Over18 and OverTime
## Insufficient data for Fisher's Exact Test for Over18 and PercentSalaryHike
## Insufficient data for Fisher's Exact Test for Over18 and PerformanceRating
## Insufficient data for Fisher's Exact Test for Over18 and
RelationshipSatisfaction
## Insufficient data for Fisher's Exact Test for Over18 and TotalWorkingYears
## Insufficient data for Fisher's Exact Test for Over18 and
TrainingTimesLastYear
## Insufficient data for Fisher's Exact Test for Over18 and WorkLifeBalance
## Insufficient data for Fisher's Exact Test for Over18 and YearsAtCompany
## Insufficient data for Fisher's Exact Test for Over18 and
YearsInCurrentRole
## Insufficient data for Fisher's Exact Test for Over18 and
YearsSinceLastPromotion
## Insufficient data for Fisher's Exact Test for Over18 and
YearsWithCurrManager
```

```
# Print the list of associations
cat("List of associations:\n")
```

```
## List of associations:
```

```r
print(associations)
```

```
## $Age_Attrition
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $Age_Education
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $Age_JobLevel
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $Age_JobRole
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $Age_MaritalStatus
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0009995
## alternative hypothesis: two.sided
```

```
##
##
## $Age_MonthlyIncome
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $Age_NumCompaniesWorked
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $Age_TotalWorkingYears
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $Age_TrainingTimesLastYear
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.02099
## alternative hypothesis: two.sided
##
##
## $Age_YearsAtCompany
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
```

```
##
##
## $Age_YearsInCurrentRole
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $Age_YearsSinceLastPromotion
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.001499
## alternative hypothesis: two.sided
##
##
## $Age_YearsWithCurrManager
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.004998
## alternative hypothesis: two.sided
##
##
## $Attrition_BusinessTravel
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $Attrition_Department
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.005497
## alternative hypothesis: two.sided
```

```
##
##
## $Attrition_EducationField
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.009495
## alternative hypothesis: two.sided
##
##
## $Attrition_EnvironmentSatisfaction
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0009995
## alternative hypothesis: two.sided
##
##
## $Attrition_JobInvolvement
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $Attrition_JobLevel
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $Attrition_JobRole
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
```

```
##
##
## $Attrition_JobSatisfaction
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $Attrition_MaritalStatus
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $Attrition_MonthlyIncome
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0009995
## alternative hypothesis: two.sided
##
##
## $Attrition_NumCompaniesWorked
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.001499
## alternative hypothesis: two.sided
##
##
## $Attrition_OverTime
##
##  Fisher's Exact Test for Count Data
##
## data:  contingency_table
## p-value < 2.2e-16
## alternative hypothesis: true odds ratio is not equal to 1
## 95 percent confidence interval:
```

```
##  2.799096 5.078460
## sample estimates:
## odds ratio
##   3.767353
##
##
## $Attrition_TotalWorkingYears
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $Attrition_TrainingTimesLastYear
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.02149
## alternative hypothesis: two.sided
##
##
## $Attrition_WorkLifeBalance
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.002499
## alternative hypothesis: two.sided
##
##
## $Attrition_YearsAtCompany
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $Attrition_YearsInCurrentRole
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
```

```
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $Attrition_YearsSinceLastPromotion
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.04148
## alternative hypothesis: two.sided
##
##
## $Attrition_YearsWithCurrManager
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $BusinessTravel_PercentSalaryHike
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.01299
## alternative hypothesis: two.sided
##
##
## $BusinessTravel_YearsWithCurrManager
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.04398
## alternative hypothesis: two.sided
##
##
## $Department_EducationField
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
```

```
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $Department_JobLevel
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $Department_JobRole
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $Department_WorkLifeBalance
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.03148
## alternative hypothesis: two.sided
##
##
## $DistanceFromHome_Gender
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.03598
## alternative hypothesis: two.sided
##
##
## $DistanceFromHome_MonthlyIncome
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
```

```
##
## data:  contingency_table
## p-value = 0.002999
## alternative hypothesis: two.sided
##
##
## $DistanceFromHome_YearsSinceLastPromotion
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.02549
## alternative hypothesis: two.sided
##
##
## $Education_EducationField
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.01299
## alternative hypothesis: two.sided
##
##
## $Education_JobLevel
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $Education_NumCompaniesWorked
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $Education_TotalWorkingYears
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
```

```
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $EducationField_JobLevel
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $EducationField_JobRole
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $EducationField_NumCompaniesWorked
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.002499
## alternative hypothesis: two.sided
##
##
## $EnvironmentSatisfaction_OverTime
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.03448
## alternative hypothesis: two.sided
##
##
## $Gender_JobRole
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
```

```
##
## data:  contingency_table
## p-value = 0.03698
## alternative hypothesis: two.sided
##
##
## $JobLevel_JobRole
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $JobLevel_MonthlyIncome
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $JobLevel_NumCompaniesWorked
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $JobLevel_TotalWorkingYears
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $JobLevel_YearsAtCompany
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
```

```
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $JobLevel_YearsInCurrentRole
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $JobLevel_YearsSinceLastPromotion
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $JobLevel_YearsWithCurrManager
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $JobRole_MaritalStatus
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.04448
## alternative hypothesis: two.sided
##
##
## $JobRole_MonthlyIncome
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
```

```
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $JobRole_NumCompaniesWorked
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $JobRole_TotalWorkingYears
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $JobRole_YearsAtCompany
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $JobRole_YearsInCurrentRole
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $JobRole_YearsSinceLastPromotion
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
```

```
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $JobRole_YearsWithCurrManager
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $MaritalStatus_TotalWorkingYears
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.01749
## alternative hypothesis: two.sided
##
##
## $MaritalStatus_YearsAtCompany
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.03498
## alternative hypothesis: two.sided
##
##
## $MonthlyIncome_TotalWorkingYears
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $MonthlyIncome_YearsAtCompany
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
```

```
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $NumCompaniesWorked_TotalWorkingYears
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $NumCompaniesWorked_WorkLifeBalance
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.03848
## alternative hypothesis: two.sided
##
##
## $NumCompaniesWorked_YearsAtCompany
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $NumCompaniesWorked_YearsInCurrentRole
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $NumCompaniesWorked_YearsWithCurrManager
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
```

```
##
## data:  contingency_table
## p-value = 0.002499
## alternative hypothesis: two.sided
##
##
## $OverTime_TrainingTimesLastYear
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.002999
## alternative hypothesis: two.sided
##
##
## $PercentSalaryHike_PerformanceRating
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $TotalWorkingYears_YearsAtCompany
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $TotalWorkingYears_YearsInCurrentRole
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $TotalWorkingYears_YearsSinceLastPromotion
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
```

```
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $TotalWorkingYears_YearsWithCurrManager
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $WorkLifeBalance_YearsWithCurrManager
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.04948
## alternative hypothesis: two.sided
##
##
## $YearsAtCompany_YearsInCurrentRole
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $YearsAtCompany_YearsSinceLastPromotion
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $YearsAtCompany_YearsWithCurrManager
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
```

```
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $YearsInCurrentRole_YearsSinceLastPromotion
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $YearsInCurrentRole_YearsWithCurrManager
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
##
##
## $YearsSinceLastPromotion_YearsWithCurrManager
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  contingency_table
## p-value = 0.0004998
## alternative hypothesis: two.sided
```

```
# Linear regression
model = lm(MonthlyIncome ~ Age + Attrition + BusinessTravel + Department +
DistanceFromHome + Education + EducationField + EnvironmentSatisfaction +
Gender + JobInvolvement + JobLevel + JobRole + JobSatisfaction +
MaritalStatus + NumCompaniesWorked + OverTime + PercentSalaryHike +
PerformanceRating + RelationshipSatisfaction + TotalWorkingYears +
TrainingTimesLastYear + WorkLifeBalance + YearsAtCompany + YearsInCurrentRole
+ YearsSinceLastPromotion + YearsWithCurrManager, data = data)

summary(model)
```

```
##
## Call:
## lm(formula = MonthlyIncome ~ Age + Attrition + BusinessTravel +
##     Department + DistanceFromHome + Education + EducationField +
```

```
##     EnvironmentSatisfaction + Gender + JobInvolvement + JobLevel +
##     JobRole + JobSatisfaction + MaritalStatus + NumCompaniesWorked +
##     OverTime + PercentSalaryHike + PerformanceRating +
RelationshipSatisfaction +
##     TotalWorkingYears + TrainingTimesLastYear + WorkLifeBalance +
##     YearsAtCompany + YearsInCurrentRole + YearsSinceLastPromotion +
##     YearsWithCurrManager, data = data)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.82940 -0.15394  0.00715  0.15135  0.64647
##
## Coefficients:
##                                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)                     7.5944838  0.1329497  57.123  < 2e-16
***
## Age                            -0.0017825  0.0009128  -1.953 0.051052 .
## AttritionYes                   -0.0471153  0.0188418  -2.501 0.012510 *
## BusinessTravelTravel_Frequently  0.0320385  0.0235285   1.362 0.173511
## BusinessTravelTravel_Rarely      0.0270216  0.0201515   1.341 0.180157
## DepartmentResearch & Development 0.0878774  0.0821742   1.069 0.285068
## DepartmentSales                  0.0825627  0.0852733   0.968 0.333102
## DistanceFromHome                 0.0017354  0.0070188   0.247 0.804756
## Education                        0.0056146  0.0060195   0.933 0.351114
## EducationFieldLife Sciences      0.0264577  0.0590486   0.448 0.654173
## EducationFieldMarketing          0.0315339  0.0629184   0.501 0.616316
## EducationFieldMedical            0.0218582  0.0592614   0.369 0.712299
## EducationFieldOther              0.0344217  0.0634257   0.543 0.587415
## EducationFieldTechnical Degree   0.0406051  0.0616258   0.659 0.510068
## EnvironmentSatisfaction         -0.0097805  0.0055617  -1.759 0.078870 .
## GenderMale                       0.0014889  0.0122997   0.121 0.903665
## JobInvolvement                  -0.0155101  0.0085084  -1.823 0.068525 .
## JobLevel                         0.3212808  0.0126460  25.406  < 2e-16
***
## JobRoleHuman Resources          -0.1475279  0.0861107  -1.713 0.086886 .
## JobRoleLaboratory Technician    -0.3372791  0.0280668 -12.017  < 2e-16
***
## JobRoleManager                   0.1481949  0.0423067   3.503 0.000474
***
## JobRoleManufacturing Director   -0.0136659  0.0276279  -0.495 0.620929
## JobRoleResearch Director         0.1909328  0.0367447   5.196 2.33e-07
***
## JobRoleResearch Scientist       -0.3414362  0.0276990 -12.327  < 2e-16
***
## JobRoleSales Executive           0.0020522  0.0543952   0.038 0.969910
## JobRoleSales Representative     -0.3992807  0.0609997  -6.546 8.24e-11
***
## JobSatisfaction                 -0.0023358  0.0054663  -0.427 0.669224
## MaritalStatusMarried             0.0150356  0.0154695   0.972 0.331239
## MaritalStatusSingle              0.0127142  0.0168287   0.756 0.450071
```

```
## NumCompaniesWorked                0.0154414  0.0107852   1.432 0.152444
## OverTimeYes                       0.0295194  0.0139528   2.116 0.034546 *
## PercentSalaryHike                 0.0648837  0.0408374   1.589 0.112320
## PerformanceRating                -0.0463788  0.0241347  -1.922 0.054847 .
## RelationshipSatisfaction         -0.0055853  0.0055766  -1.002 0.316723
## TotalWorkingYears                 0.1557096  0.0178543   8.721  < 2e-16
***
## TrainingTimesLastYear            -0.0078878  0.0046799  -1.685 0.092119 .
## WorkLifeBalance                  -0.0013517  0.0085090  -0.159 0.873806
## YearsAtCompany                    0.0044703  0.0215360   0.208 0.835592
## YearsInCurrentRole                0.0381616  0.0144802   2.635 0.008494 **
## YearsSinceLastPromotion          -0.0015368  0.0096380  -0.159 0.873338
## YearsWithCurrManager             -0.0205978  0.0137027  -1.503 0.133011
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.2271 on 1429 degrees of freedom
## Multiple R-squared:  0.881,  Adjusted R-squared:  0.8776
## F-statistic: 264.4 on 40 and 1429 DF,  p-value: < 2.2e-16
```

```
model1 = lm(MonthlyIncome ~ JobLevel + JobRole, data = data)

summary(model1)
```

```
##
## Call:
## lm(formula = MonthlyIncome ~ JobLevel + JobRole, data = data)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.02421 -0.16832  0.00512  0.16726  0.61059
##
## Coefficients:
##                                Estimate Std. Error t value Pr(>|t|)
## (Intercept)                     7.88687    0.03548 222.319  < 2e-16 ***
## JobLevel                        0.39818    0.01153  34.545  < 2e-16 ***
## JobRoleHuman Resources         -0.26281    0.04123  -6.375 2.45e-10 ***
## JobRoleLaboratory Technician   -0.35655    0.02956 -12.064  < 2e-16 ***
## JobRoleManager                  0.06921    0.03826   1.809 0.070643 .
## JobRoleManufacturing Director -0.02931    0.02913  -1.006 0.314590
## JobRoleResearch Director        0.14232    0.03841   3.705 0.000219 ***
## JobRoleResearch Scientist      -0.34314    0.02933 -11.698  < 2e-16 ***
## JobRoleSales Executive         -0.02419    0.02505  -0.966 0.334410
## JobRoleSales Representative    -0.49401    0.03749 -13.176  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.2417 on 1460 degrees of freedom
## Multiple R-squared:  0.8624, Adjusted R-squared:  0.8615
## F-statistic:  1016 on 9 and 1460 DF,  p-value: < 2.2e-16
```

```r
#ANOVA
summary(aov(MonthlyIncome ~ JobRole , data = data))
```

```
##               Df Sum Sq Mean Sq F value Pr(>F)
## JobRole        8  464.5   58.06   547.5 <2e-16 ***
## Residuals   1461  155.0    0.11
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

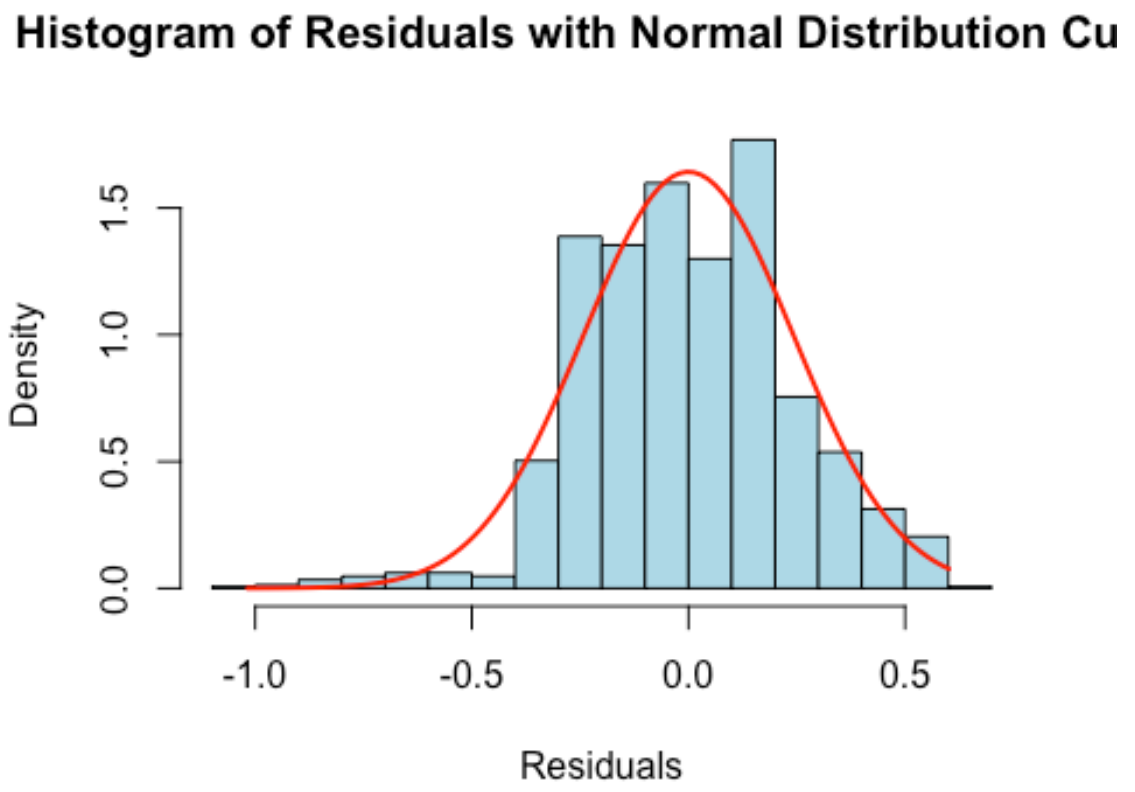
```r
# Pairwise t test
pairwise.t.test(data$MonthlyIncome, data$JobRole, p.adj = "none")
```

```
##
##  Pairwise comparisons using t tests with pooled SD
##
## data:  data$MonthlyIncome and data$JobRole
##
##                       Healthcare Representative Human Resources
## Human Resources       < 2e-16                   -
## Laboratory Technician < 2e-16                   0.00013
## Manager               < 2e-16                   < 2e-16
## Manufacturing Director 0.31740                  < 2e-16
## Research Director     < 2e-16                   < 2e-16
## Research Scientist    < 2e-16                   9.9e-05
## Sales Executive       0.01511                   < 2e-16
## Sales Representative  < 2e-16                   2.1e-11
##                       Laboratory Technician Manager Manufacturing
Director
## Human Resources       -                     -       -
## Laboratory Technician -                     -       -
## Manager               < 2e-16               -       -
## Manufacturing Director < 2e-16              < 2e-16 -
## Research Director     < 2e-16               0.23440 < 2e-16
## Research Scientist    0.95828               < 2e-16 < 2e-16
## Sales Executive       < 2e-16               < 2e-16 0.18931
## Sales Representative  1.4e-06               < 2e-16 < 2e-16
##                       Research Director Research Scientist Sales
Executive
## Human Resources       -                 -                  -
## Laboratory Technician -                 -                  -
## Manager               -                 -                  -
## Manufacturing Director -                -                  -
## Research Director     -                 -                  -
## Research Scientist    < 2e-16           -                  -
## Sales Executive       < 2e-16           < 2e-16            -
## Sales Representative  < 2e-16           1.2e-06            < 2e-16
##
## P value adjustment method: none
```

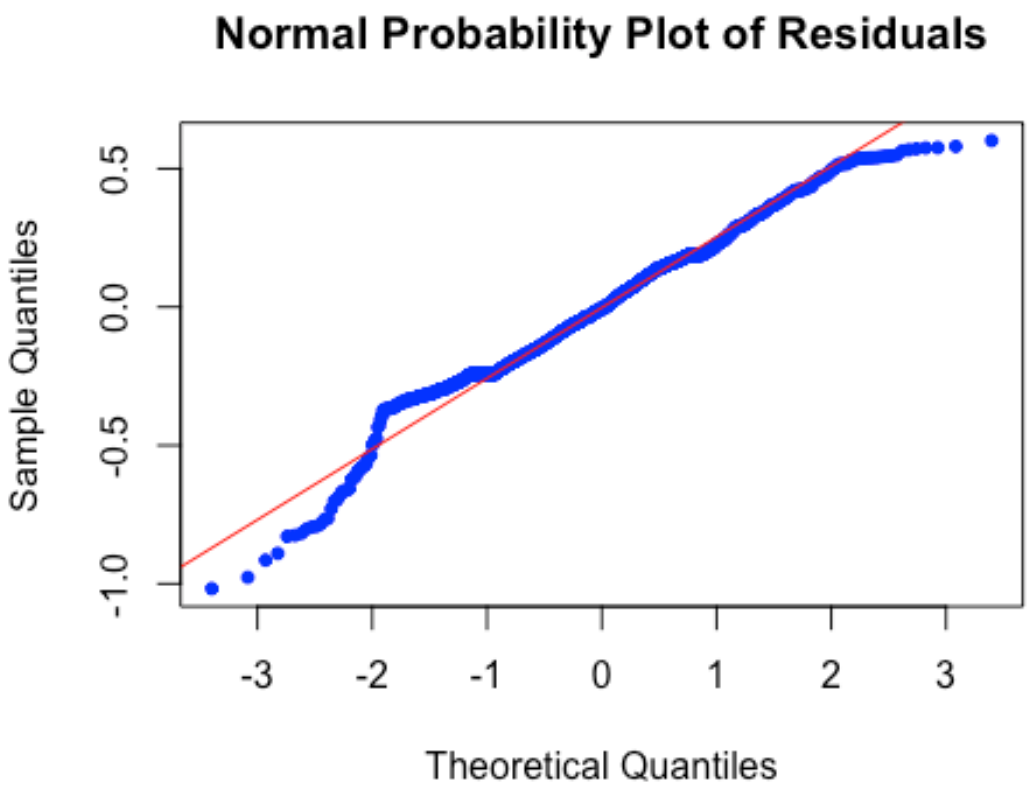
```r
# Encoding categorical variable:
```

```r
encoded_data <- cbind(data, model.matrix(~ JobRole - 1, data = data))

encoded_data <- encoded_data[, -which(names(encoded_data) %in% c("JobRole"))]

colnames(encoded_data)[colnames(encoded_data) == "JobRoleHuman Resources"] <-
"JobRoleHumanResources"
colnames(encoded_data)[colnames(encoded_data) == "JobRoleLaboratory
Technician"] <- "JobRoleLaboratoryTechnician"
colnames(encoded_data)[colnames(encoded_data) == "JobRoleManufacturing
Director"] <- "JobRoleManufacturingDirector"
colnames(encoded_data)[colnames(encoded_data) == "JobRoleResearch Scientist"]
<- "JobRoleResearchScientist"
colnames(encoded_data)[colnames(encoded_data) == "JobRoleSales Executive"] <-
"JobRoleSalesExecutive"
colnames(encoded_data)[colnames(encoded_data) == "JobRoleSales
Representative"] <- "JobRoleSalesRepresentative"
colnames(encoded_data)[colnames(encoded_data) == "JobRoleResearch Director"]
<- "JobRoleResearchDirector"

# Final regression model with encoded job roles
model1 = lm(MonthlyIncome ~ JobLevel + JobRoleHumanResources +
JobRoleLaboratoryTechnician +  JobRoleResearchScientist  +
JobRoleSalesRepresentative , data = encoded_data)

summary(model1)

##
## Call:
## lm(formula = MonthlyIncome ~ JobLevel + JobRoleHumanResources +
##     JobRoleLaboratoryTechnician + JobRoleResearchScientist +
##     JobRoleSalesRepresentative, data = encoded_data)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -1.0175 -0.1747 -0.0049  0.1699  0.6013
##
## Coefficients:
##                               Estimate Std. Error t value Pr(>|t|)
## (Intercept)                   7.802519   0.024490 318.599  < 2e-16 ***
## JobLevel                      0.431186   0.008178  52.725  < 2e-16 ***
## JobRoleHumanResources        -0.227332   0.036474  -6.233 5.98e-10 ***
## JobRoleLaboratoryTechnician -0.313102   0.021609 -14.490  < 2e-16 ***
## JobRoleResearchScientist    -0.298462   0.021189 -14.086  < 2e-16 ***
## JobRoleSalesRepresentative  -0.445451   0.031394 -14.189  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.2433 on 1464 degrees of freedom
## Multiple R-squared:  0.8601, Adjusted R-squared:  0.8596
## F-statistic:  1800 on 5 and 1464 DF,  p-value: < 2.2e-16
```

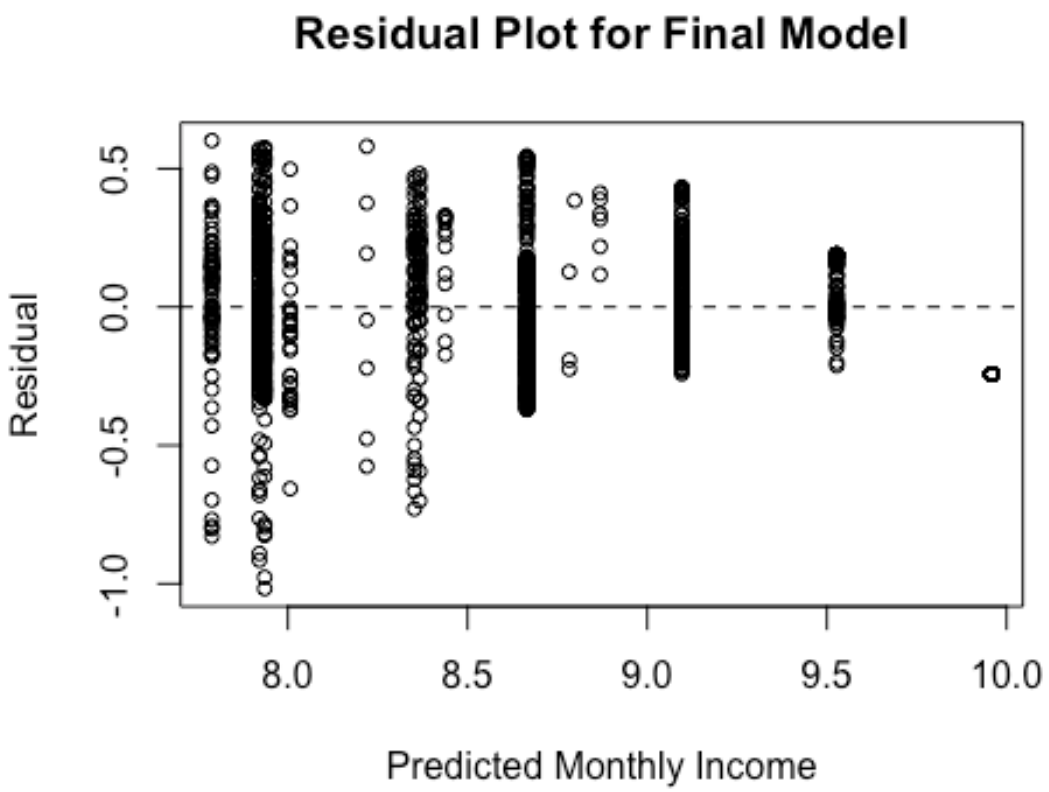
```r
# Residual plots
residuals <- residuals(model1)

hist(residuals, main = "Histogram of Residuals with Normal Distribution
Curve", col = "lightblue", border = "black", xlab = "Residuals", prob = TRUE)


mu <- mean(residuals)
sigma <- sd(residuals)
x <- seq(min(residuals), max(residuals), length = 100)
lines(x, dnorm(x, mean = mu, sd = sigma), col = "red", lwd = 2)
```




```r
qqnorm(residuals, main = "Normal Probability Plot of Residuals", col =
"blue", pch = 20)
qqline(residuals, col = "red")
```




```r
#residual plot
plot(resid(model1) ~ fitted(model1),
     xlab = "Predicted Monthly Income",  ylab = "Residual",
     main = "Residual Plot for Final Model",
     pch = 21, cex = 0.8)
abline(h = 0, lty = 2)
```




```
# Interaction model
model2 = lm(MonthlyIncome ~ JobLevel + JobRole + JobLevel*JobRole, data =
data)

summary(model2)

##
## Call:
## lm(formula = MonthlyIncome ~ JobLevel + JobRole + JobLevel *
##     JobRole, data = data)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.99371 -0.13786 -0.01523  0.13747  0.61013
##
## Coefficients:
##                                      Estimate Std. Error t value
Pr(>|t|)
## (Intercept)                          7.783578   0.080978  96.119  < 2e-
16
## JobLevel                             0.439946   0.031753  13.855  < 2e-
16
## JobRoleHuman Resources              -0.553317   0.109648  -5.046 5.07e-
```

```
07
## JobRoleLaboratory Technician           -0.288425   0.090722  -3.179
0.00151
## JobRoleManager                          1.404181   0.166781   8.419  < 2e-
16
## JobRoleManufacturing Director          -0.122751   0.111311  -1.103
0.27031
## JobRoleResearch Director                1.291956   0.148844   8.680  < 2e-
16
## JobRoleResearch Scientist              -0.421273   0.090753  -4.642 3.76e-
06
## JobRoleSales Executive                 -0.038403   0.097396  -0.394
0.69342
## JobRoleSales Representative            -0.397669   0.128616  -3.092
0.00203
## JobLevel:JobRoleHuman Resources         0.224176   0.055252   4.057 5.23e-
05
## JobLevel:JobRoleLaboratory Technician  -0.013389   0.044374  -0.302
0.76290
## JobLevel:JobRoleManager                -0.327938   0.046139  -7.108 1.85e-
12
## JobLevel:JobRoleManufacturing Director  0.038594   0.043847   0.880
0.37889
## JobLevel:JobRoleResearch Director      -0.304993   0.044215  -6.898 7.85e-
12
## JobLevel:JobRoleResearch Scientist      0.109165   0.045265   2.412
0.01600
## JobLevel:JobRoleSales Executive         0.008705   0.038982   0.223
0.82332
## JobLevel:JobRoleSales Representative   -0.035358   0.094745  -0.373
0.70906
##
## (Intercept)                            ***
## JobLevel                               ***
## JobRoleHuman Resources                 ***
## JobRoleLaboratory Technician           **
## JobRoleManager                         ***
## JobRoleManufacturing Director
## JobRoleResearch Director               ***
## JobRoleResearch Scientist              ***
## JobRoleSales Executive
## JobRoleSales Representative            **
## JobLevel:JobRoleHuman Resources        ***
## JobLevel:JobRoleLaboratory Technician
## JobLevel:JobRoleManager                ***
## JobLevel:JobRoleManufacturing Director
## JobLevel:JobRoleResearch Director      ***
## JobLevel:JobRoleResearch Scientist     *
## JobLevel:JobRoleSales Executive
## JobLevel:JobRoleSales Representative
```

```
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.226 on 1452 degrees of freedom
## Multiple R-squared:  0.8803, Adjusted R-squared:  0.8789
## F-statistic:   628 on 17 and 1452 DF,  p-value: < 2.2e-16

# Attrition balancing
minority_indices <- which(data$Attrition == "Yes")
table(data$Attrition)

##
##   No  Yes
## 1233  237

# Over sampling
minority_indices <- which(data$Attrition == "Yes")

data_oversampled <- data
oversampled_indices <- sample(minority_indices, replace = TRUE, size =
length(setdiff(1:nrow(data), minority_indices)))
data_oversampled <- rbind(data_oversampled, data[oversampled_indices, ])

table(data_oversampled$Attrition)

##
##   No  Yes
## 1233 1470

data_oversampled$Attrition <- as.factor(data_oversampled$Attrition)

# Convert multiple columns to factors and check structure
factor_columns <- c("BusinessTravel", "Department", "Education", "Gender",
                    "JobInvolvement", "JobLevel", "JobRole",
"JobSatisfaction",
                    "MaritalStatus", "NumCompaniesWorked", "OverTime")

for (col in factor_columns) {
  data[[col]] <- as.factor(data[[col]])
  cat("\nStructure of", col, ":\n")
  str(data[[col]])
}

##
## Structure of BusinessTravel :
##  Factor w/ 3 levels "Non-Travel","Travel_Frequently",..: 3 2 3 2 3 2 3 3 2
3 ...
##
## Structure of Department :
##  Factor w/ 3 levels "Human Resources",..: 3 2 2 2 2 2 2 2 2 2 ...
##
```

```
## Structure of Education :
##  Factor w/ 5 levels "1","2","3","4",..: 2 1 2 4 1 2 3 1 3 3 ...
##
## Structure of Gender :
##  Factor w/ 2 levels "Female","Male": 1 2 2 1 2 2 1 2 2 2 ...
##
## Structure of JobInvolvement :
##  Factor w/ 4 levels "1","2","3","4": 3 2 2 3 3 3 4 3 2 3 ...
##
## Structure of JobLevel :
##  Factor w/ 5 levels "1","2","3","4",..: 2 2 1 1 1 1 1 1 3 2 ...
##
## Structure of JobRole :
##  Factor w/ 9 levels "Healthcare Representative",..: 8 7 3 7 3 3 3 3 5 1
...
##
## Structure of JobSatisfaction :
##  Factor w/ 4 levels "1","2","3","4": 4 2 3 3 2 4 1 3 3 3 ...
##
## Structure of MaritalStatus :
##  Factor w/ 3 levels "Divorced","Married",..: 3 2 3 2 2 3 2 1 3 2 ...
##
## Structure of NumCompaniesWorked :
##  Factor w/ 10 levels "0","0.693147180559945",..: 9 2 7 2 10 1 5 2 1 7 ...
##
## Structure of OverTime :
##  Factor w/ 2 levels "No","Yes": 2 1 2 2 1 1 2 1 1 1 ...
```

```
# Display the first few rows of the dataset
cat("\nHead of the data:\n")
```

```
##
## Head of the data:
```

```
head(data)
```

```
##   Age Attrition    BusinessTravel              Department DistanceFromHome
## 1  41       Yes     Travel_Rarely                   Sales        0.6931472
## 2  49        No Travel_Frequently Research & Development        2.1972246
## 3  37       Yes     Travel_Rarely Research & Development        1.0986123
## 4  33        No Travel_Frequently Research & Development        1.3862944
## 5  27        No     Travel_Rarely Research & Development        1.0986123
## 6  32        No Travel_Frequently Research & Development        1.0986123
##   Education EducationField EnvironmentSatisfaction Gender JobInvolvement
## 1         2  Life Sciences                        2 Female              3
## 2         1  Life Sciences                        3   Male              2
## 3         2          Other                        4   Male              2
## 4         4  Life Sciences                        4 Female              3
## 5         1        Medical                        1   Male              3
## 6         2  Life Sciences                        4   Male              3
##   JobLevel              JobRole JobSatisfaction MaritalStatus
```

```
MonthlyIncome
## 1        2       Sales Executive               4        Single
8.698514
## 2        2    Research Scientist               2       Married
8.543056
## 3        1 Laboratory Technician               3        Single
7.645398
## 4        1    Research Scientist               3       Married
7.975908
## 5        1 Laboratory Technician               2       Married
8.151622
## 6        1 Laboratory Technician               4        Single
8.029107
##   NumCompaniesWorked Over18 OverTime PercentSalaryHike PerformanceRating
## 1   2.19722457733622      Y      Yes          2.484907                 3
## 2  0.693147180559945      Y       No          3.178054                 4
## 3   1.94591014905531      Y      Yes          2.772589                 3
## 4  0.693147180559945      Y      Yes          2.484907                 3
## 5    2.2512917986065      Y       No          2.564949                 3
## 6                  0      Y       No          2.639057                 3
##   RelationshipSatisfaction TotalWorkingYears TrainingTimesLastYear
## 1                        1          2.197225                     0
## 2                        4          2.397895                     3
## 3                        2          2.079442                     3
## 4                        3          2.197225                     3
## 5                        4          1.945910                     3
## 6                        3          2.197225                     2
##   WorkLifeBalance YearsAtCompany YearsInCurrentRole
YearsSinceLastPromotion
## 1               1       1.945910           1.609438
0.0000000
## 2               3       2.397895           2.079442
0.6931472
## 3               3       0.000000           0.000000
0.0000000
## 4               3       2.197225           2.079442
1.3862944
## 5               3       1.098612           1.098612
1.0986123
## 6               2       2.079442           2.079442
1.3862944
##   YearsWithCurrManager
## 1             1.791759
## 2             2.079442
## 3             0.000000
## 4             0.000000
## 5             1.098612
## 6             1.945910
```

```r
# Logistic regression model
model <- glm(Attrition ~ Age + MonthlyIncome + BusinessTravel + Department +
             DistanceFromHome + Education + EducationField +
EnvironmentSatisfaction +
             Gender + JobInvolvement + JobLevel + JobRole + JobSatisfaction
+
             MaritalStatus + NumCompaniesWorked + OverTime +
PercentSalaryHike +
             PerformanceRating + RelationshipSatisfaction +
TotalWorkingYears +
             TrainingTimesLastYear + WorkLifeBalance + YearsAtCompany +
             YearsInCurrentRole + YearsSinceLastPromotion +
YearsWithCurrManager,
             data = data_oversampled, family = binomial(link = "logit"))

summary(model)

##
## Call:
## glm(formula = Attrition ~ Age + MonthlyIncome + BusinessTravel +
##     Department + DistanceFromHome + Education + EducationField +
##     EnvironmentSatisfaction + Gender + JobInvolvement + JobLevel +
##     JobRole + JobSatisfaction + MaritalStatus + NumCompaniesWorked +
##     OverTime + PercentSalaryHike + PerformanceRating +
RelationshipSatisfaction +
##     TotalWorkingYears + TrainingTimesLastYear + WorkLifeBalance +
##     YearsAtCompany + YearsInCurrentRole + YearsSinceLastPromotion +
##     YearsWithCurrManager, family = binomial(link = "logit"),
##     data = data_oversampled)
##
## Coefficients:
##                                    Estimate Std. Error z value Pr(>|z|)
## (Intercept)                      -7.036442 374.912357  -0.019 0.985026
## Age                              -0.010383   0.007463  -1.391 0.164129
## MonthlyIncome                    -0.600923   0.221174  -2.717 0.006588 **
## BusinessTravelTravel_Frequently   2.029138   0.233504   8.690  < 2e-16
***
## BusinessTravelTravel_Rarely       1.300437   0.211330   6.154 7.58e-10
***
## DepartmentResearch & Development 14.653433 374.907773   0.039 0.968822
## DepartmentSales                  14.653615 374.907872   0.039 0.968822
## DistanceFromHome                  0.383047   0.062014   6.177 6.54e-10
***
## Education                         0.022864   0.051098   0.447 0.654543
## EducationFieldLife Sciences      -0.830035   0.487328  -1.703 0.088524 .
## EducationFieldMarketing          -0.480855   0.517045  -0.930 0.352368
## EducationFieldMedical            -0.653580   0.482714  -1.354 0.175746
## EducationFieldOther              -0.544790   0.520501  -1.047 0.295255
## EducationFieldTechnical Degree    0.375349   0.500422   0.750 0.453216
## EnvironmentSatisfaction          -0.442212   0.048413  -9.134  < 2e-16
```

```
***
## GenderMale                          0.412284   0.107894   3.821 0.000133
***
## JobInvolvement                     -0.474166   0.071838  -6.600 4.10e-11
***
## JobLevel                            0.537363   0.139800   3.844 0.000121
***
## JobRoleHuman Resources             15.943720 374.907853   0.043 0.966079
## JobRoleLaboratory Technician        1.357135   0.279280   4.859 1.18e-06
***
## JobRoleManager                     -0.203776   0.418860  -0.487 0.626612
## JobRoleManufacturing Director       0.488564   0.277099   1.763 0.077878 .
## JobRoleResearch Director           -1.348057   0.463756  -2.907 0.003651 **
## JobRoleResearch Scientist           0.545651   0.280864   1.943 0.052046 .
## JobRoleSales Executive              1.055278   0.594212   1.776 0.075745 .
## JobRoleSales Representative         1.695012   0.643316   2.635 0.008419 **
## JobSatisfaction                    -0.363152   0.047257  -7.685 1.53e-14
***
## MaritalStatusMarried                0.643293   0.146324   4.396 1.10e-05
***
## MaritalStatusSingle                 1.563136   0.153730  10.168  < 2e-16
***
## NumCompaniesWorked                  0.677657   0.092120   7.356 1.89e-13
***
## OverTimeYes                         1.696707   0.111393  15.232  < 2e-16
***
## PercentSalaryHike                  -0.730475   0.354602  -2.060 0.039400 *
## PerformanceRating                   0.256777   0.212335   1.209 0.226547
## RelationshipSatisfaction           -0.193432   0.046847  -4.129 3.64e-05
***
## TotalWorkingYears                  -0.891578   0.150246  -5.934 2.95e-09
***
## TrainingTimesLastYear              -0.210776   0.040539  -5.199 2.00e-07
***
## WorkLifeBalance                    -0.316888   0.068149  -4.650 3.32e-06
***
## YearsAtCompany                      0.692435   0.187568   3.692 0.000223
***
## YearsInCurrentRole                 -0.524608   0.127920  -4.101 4.11e-05
***
## YearsSinceLastPromotion             0.565229   0.087683   6.446 1.15e-10
***
## YearsWithCurrManager               -0.450479   0.119563  -3.768 0.000165
***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 3726.3  on 2702  degrees of freedom
```

```
## Residual deviance: 2434.1  on 2662  degrees of freedom
## AIC: 2516.1
##
## Number of Fisher Scoring iterations: 14

# Ordinary Least Square Regression

#install.packages("ordinal")
library(ordinal)

data$PerformanceRating <- ordered(data$PerformanceRating)


model3 <- clm(PerformanceRating ~ JobSatisfaction + EnvironmentSatisfaction +
RelationshipSatisfaction +
                WorkLifeBalance, data = data)

summary(model3)

## formula:
## PerformanceRating ~ JobSatisfaction + EnvironmentSatisfaction +
RelationshipSatisfaction + WorkLifeBalance
## data:    data
##
##  link  threshold nobs logLik  AIC     niter max.grad cond.H
##  logit flexible  1470 -627.31 1268.62 5(0)  3.46e-11 8.7e+02
##
## Coefficients:
##                           Estimate Std. Error z value Pr(>|z|)
## JobSatisfaction2         -0.09140    0.22928  -0.399    0.690
## JobSatisfaction3         -0.32837    0.21350  -1.538    0.124
## JobSatisfaction4          0.04191    0.20095   0.209    0.835
## EnvironmentSatisfaction  -0.08000    0.06603  -1.212    0.226
## RelationshipSatisfaction -0.08069    0.06657  -1.212    0.225
## WorkLifeBalance           0.02067    0.10272   0.201    0.841
##
## Threshold coefficients:
##     Estimate Std. Error z value
## 3|4   1.2360     0.4058   3.046

model4 <- clm(PerformanceRating ~ JobSatisfaction + EnvironmentSatisfaction +
RelationshipSatisfaction + WorkLifeBalance + JobInvolvement +
DistanceFromHome + TotalWorkingYears + Education + JobLevel +
NumCompaniesWorked +  TotalWorkingYears + TrainingTimesLastYear +
WorkLifeBalance + YearsAtCompany + YearsInCurrentRole +
YearsSinceLastPromotion + YearsWithCurrManager , data = data)

summary(model4)
```

```
## formula:
## PerformanceRating ~ JobSatisfaction + EnvironmentSatisfaction +
RelationshipSatisfaction + WorkLifeBalance + JobInvolvement +
DistanceFromHome + TotalWorkingYears + Education + JobLevel +
NumCompaniesWorked + TotalWorkingYears + TrainingTimesLastYear +
WorkLifeBalance + YearsAtCompany + YearsInCurrentRole +
YearsSinceLastPromotion + YearsWithCurrManager
## data:    data
##
##  link  threshold nobs logLik  AIC     niter max.grad cond.H
##  logit flexible  1470 -617.34 1302.67 5(0)  7.28e-09 6.2e+03
##
## Coefficients:
##                                      Estimate Std. Error z value Pr(>|z|)
## JobSatisfaction2                    -0.073446   0.233338  -0.315   0.7529
## JobSatisfaction3                    -0.333272   0.216481  -1.539   0.1237
## JobSatisfaction4                     0.018944   0.204497   0.093   0.9262
## EnvironmentSatisfaction             -0.086067   0.067189  -1.281   0.2002
## RelationshipSatisfaction            -0.075268   0.067592  -1.114   0.2655
## WorkLifeBalance                      0.020388   0.104567   0.195   0.8454
## JobInvolvement2                     -0.334485   0.313732  -1.066   0.2864
## JobInvolvement3                     -0.363261   0.293256  -1.239   0.2155
## JobInvolvement4                     -0.498298   0.370337  -1.346   0.1785
## DistanceFromHome                     0.015389   0.085504   0.180   0.8572
## TotalWorkingYears                    0.309281   0.224860   1.375   0.1690
## Education2                          -0.009394   0.262876  -0.036   0.9715
## Education3                          -0.250733   0.241821  -1.037   0.2998
## Education4                          -0.243209   0.257096  -0.946   0.3442
## Education5                           0.101946   0.434727   0.235   0.8146
## JobLevel2                           -0.256543   0.196116  -1.308   0.1908
## JobLevel3                           -0.277246   0.269172  -1.030   0.3030
## JobLevel4                           -0.193539   0.371272  -0.521   0.6022
## JobLevel5                           -0.859478   0.484726  -1.773   0.0762
.
## NumCompaniesWorked0.693147180559945  0.311370   0.242138   1.286   0.1985
## NumCompaniesWorked1.09861228866811  -0.286811   0.362964  -0.790   0.4294
## NumCompaniesWorked1.38629436111989   0.201415   0.325680   0.618   0.5363
## NumCompaniesWorked1.6094379124341    0.227587   0.336662   0.676   0.4990
## NumCompaniesWorked1.79175946922805  -0.048148   0.438861  -0.110   0.9126
## NumCompaniesWorked1.94591014905531  -0.107935   0.436880  -0.247   0.8049
## NumCompaniesWorked2.07944154167984  -0.375589   0.445115  -0.844   0.3988
## NumCompaniesWorked2.19722457733622   0.601352   0.422723   1.423   0.1549
## NumCompaniesWorked2.2512917986065   -0.372075   0.528434  -0.704   0.4814
## TrainingTimesLastYear               -0.039483   0.057919  -0.682   0.4954
## YearsAtCompany                      -0.252151   0.284663  -0.886   0.3757
## YearsInCurrentRole                   0.196936   0.187829   1.048   0.2944
## YearsSinceLastPromotion             -0.048774   0.116679  -0.418   0.6759
## YearsWithCurrManager                 0.052328   0.169210   0.309   0.7571
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
##
## Threshold coefficients:
##     Estimate Std. Error z value
## 3|4    1.153      0.678     1.7
```

```
model4 <- clm(PerformanceRating ~ JobLevel + JobInvolvement +
JobInvolvement*JobLevel, data = data)
```

```
## Warning: (1) Hessian is numerically singular: parameters are not uniquely
determined
## In addition: Absolute convergence criterion was met, but relative
criterion was not met
```

```
# Display summary of the model
summary(model4)
```

```
## formula:
## PerformanceRating ~ JobLevel + JobInvolvement + JobInvolvement * JobLevel
## data:    data
##
##  link  threshold nobs logLik  AIC     niter max.grad cond.H
##  logit flexible  1470 -623.18 1286.35 19(0) 4.33e-09 7.0e+11
##
## Coefficients:
##                             Estimate Std. Error z value Pr(>|z|)
## JobLevel2                    0.39304         NA      NA       NA
## JobLevel3                    0.76214         NA      NA       NA
## JobLevel4                  -19.59346         NA      NA       NA
## JobLevel5                    0.22314         NA      NA       NA
## JobInvolvement2             -0.09963         NA      NA       NA
## JobInvolvement3              0.04462         NA      NA       NA
## JobInvolvement4             -0.37648         NA      NA       NA
## JobLevel2:JobInvolvement2   -0.49408         NA      NA       NA
## JobLevel3:JobInvolvement2   -0.89890         NA      NA       NA
## JobLevel4:JobInvolvement2   20.25271         NA      NA       NA
## JobLevel5:JobInvolvement2   -0.05452         NA      NA       NA
## JobLevel2:JobInvolvement3   -0.68015         NA      NA       NA
## JobLevel3:JobInvolvement3   -0.88372         NA      NA       NA
## JobLevel4:JobInvolvement3   19.50962         NA      NA       NA
## JobLevel5:JobInvolvement3   -1.24859         NA      NA       NA
## JobLevel2:JobInvolvement4    0.22957         NA      NA       NA
## JobLevel3:JobInvolvement4   -1.34117         NA      NA       NA
## JobLevel4:JobInvolvement4   19.01443         NA      NA       NA
## JobLevel5:JobInvolvement4  -19.44012         NA      NA       NA
##
## Threshold coefficients:
##     Estimate Std. Error z value
## 3|4    1.609         NA      NA
```

```
response_variable <- data$PerformanceRating
```

```r
# Check if it is a factor
if (is.factor(response_variable)) {
  print("Response variable is a factor.")
} else {
  print("Response variable is not a factor.")
}
```

```
## [1] "Response variable is a factor."
```

```r
data$PerformanceRating <- as.factor(data$PerformanceRating)

table(data$PercentSalaryHike, data$PerformanceRating)
```

```
##
##                      3   4
##   2.484906649788   210   0
##   2.56494935746154 198   0
##   2.63905732961526 209   0
##   2.70805020110221 201   0
##   2.77258872223978 101   0
##   2.83321334405622  78   0
##   2.89037175789616  82   0
##   2.94443897916644  89   0
##   2.99573227355399  76   0
##   3.04452243772342   0  55
##   3.09104245335832   0  48
##   3.13549421592915   0  56
##   3.17805383034795   0  28
##   3.2188758248682    0  21
##   3.25809653802148   0  18
```