IBM HR Employee Attrition Analysis

Statistical Computing Project

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2025-12-30

Contents

1 Introduction

The IBM HR Employee Attrition dataset serves as a sample of workforce data, organized as a data matrix of observations and qualitative and quantitative variables. This report performs a comprehensive descriptive statistical analysis to summarize the distribution of individual variables using frequencies, measures of location, and measures of dispersion. Bivariate techniques, including contingency tables and correlation coefficients, are applied to investigate the joint behavior and co-dependency between employee attributes and attrition. Furthermore, simple linear regression is utilized to model the linear relationship between tenure and monthly income by estimating the regression coefficients.

1.1 Dataset & Data Preparation

We analyze ten key variables classified into the following datatypes :

- **Nominal**: `Attrition`, `OverTime`
- **Ordinal**: `JobLevel` (1-5), `JobSatisfaction` (1-4), `WorkLifeBalance` (1-4)
- **Numeric (Discrete)**: `Age`, `YearsAtCompany`, `TotalWorkingYears`, `NumCompaniesWorked`
- **Numeric (Continuous)**: `MonthlyIncome`

```r
# Load data and select variables
hr <- read.csv("WA_Fn-UseC_-HR-Employee-Attrition.csv", stringsAsFactors = FALSE)
hr_sub <- hr[, c("Attrition", "OverTime", "JobLevel", "JobSatisfaction",
                 "WorkLifeBalance","Age", "YearsAtCompany", "TotalWorkingYears",
                 "NumCompaniesWorked", "MonthlyIncome")]

# Convert data types
hr_sub$Attrition <- factor(hr_sub$Attrition)
hr_sub$OverTime  <- factor(hr_sub$OverTime)
hr_sub$JobLevel <- factor(hr_sub$JobLevel, levels = 1:5, ordered = TRUE)
hr_sub$JobSatisfaction <- factor(hr_sub$JobSatisfaction, levels = 1:4, ordered = TRUE)
hr_sub$WorkLifeBalance <- factor(hr_sub$WorkLifeBalance, levels = 1:4, ordered = TRUE)
```

1.2 Data Summary

Table 1: Dataset Dimensions

Rows	Columns
1470	10

```
##  Attrition  OverTime   JobLevel JobSatisfaction WorkLifeBalance      Age
##  No :1233   No :1054   1:543    1:289           1: 80           Min.   :18.00
##  Yes: 237   Yes: 416   2:534    2:280           2:344           1st Qu.:30.00
##                        3:218    3:442           3:893           Median :36.00
##                        4:106    4:459           4:153           Mean   :36.92
##                        5: 69                                    3rd Qu.:43.00
##                                                                 Max.   :60.00
##  YearsAtCompany   TotalWorkingYears NumCompaniesWorked MonthlyIncome
##  Min.   : 0.000   Min.   : 0.00     Min.   :0.000      Min.   : 1009
##  1st Qu.: 3.000   1st Qu.: 6.00     1st Qu.:1.000      1st Qu.: 2911
##  Median : 5.000   Median :10.00     Median :2.000      Median : 4919
##  Mean   : 7.008   Mean   :11.28     Mean   :2.693      Mean   : 6503
##  3rd Qu.: 9.000   3rd Qu.:15.00     3rd Qu.:4.000      3rd Qu.: 8379
##  Max.   :40.000   Max.   :40.00     Max.   :9.000      Max.   :19999
```

Table 2: First 6 Observations (Transposed View)

	1	2	3	4	5	6
Attrition	Yes	No	Yes	No	No	No
OverTime	Yes	No	Yes	Yes	No	No
JobLevel	2	2	1	1	1	1
JobSatisfaction	4	2	3	3	2	4
WorkLifeBalance	1	3	3	3	3	2
Age	41	49	37	33	27	32
YearsAtCompany	6	10	0	8	2	7
TotalWorkingYears	8	10	7	8	6	8

	1	2	3	4	5	6
NumCompaniesWorked	8	1	6	1	9	0
MonthlyIncome	5993	5130	2090	2909	3468	3068

2 Univariate Analysis

Univariate analysis examines each variable individually to understand its distribution, measures of location & measures of dispersion.

2.1 Categorical and Ordinal Variables

2.1.1 Attrition Status

Here we tabulate the absolute and relative frequencies of employees who left the company versus those who stayed.

Table 3: Attrition Status: Frequency and Proportion

Attrition	Frequency	Proportion
No	1233	0.839
Yes	237	0.161

2.1.2 Overtime Status

This shows the distribution of employees working overtime versus standard hours.

Table 4: Overtime Status: Frequency and Proportion

OverTime	Frequency	Proportion
No	1054	0.717
Yes	416	0.283

2.1.3 Job Level (Ordinal)

The frequency distributions reveal employee composition. The attrition rate indicates what proportion of employees left the company. Job level cumulative frequencies show the hierarchical distribution from entry-level to senior positions.

Table 5: Job Level Distribution (Ordinal)

Job Level	Frequency	Percentage	Cumulative Frequency	Cumulative %
1	543	36.94	543	36.94
2	534	36.33	1077	73.27
3	218	14.83	1295	88.10

Job Level	Frequency	Percentage	Cumulative Frequency	Cumulative %
4	106	7.21	1401	95.31
5	69	4.69	1470	100.00

2.1.4 Job Satisfaction (Ordinal)

Job satisfaction levels reveal employee contentment with their roles. The distribution shows how satisfaction is spread across the workforce, with higher levels indicating greater job fulfillment.

Table 6: Job Satisfaction Distribution (1=Low, 4=High)

Satisfaction Level	Frequency	Percentage	Cumulative %
1	289	19.66	19.66
2	280	19.05	38.71
3	442	30.07	68.78
4	459	31.22	100.00

2.1.5 Work-Life Balance (Ordinal)

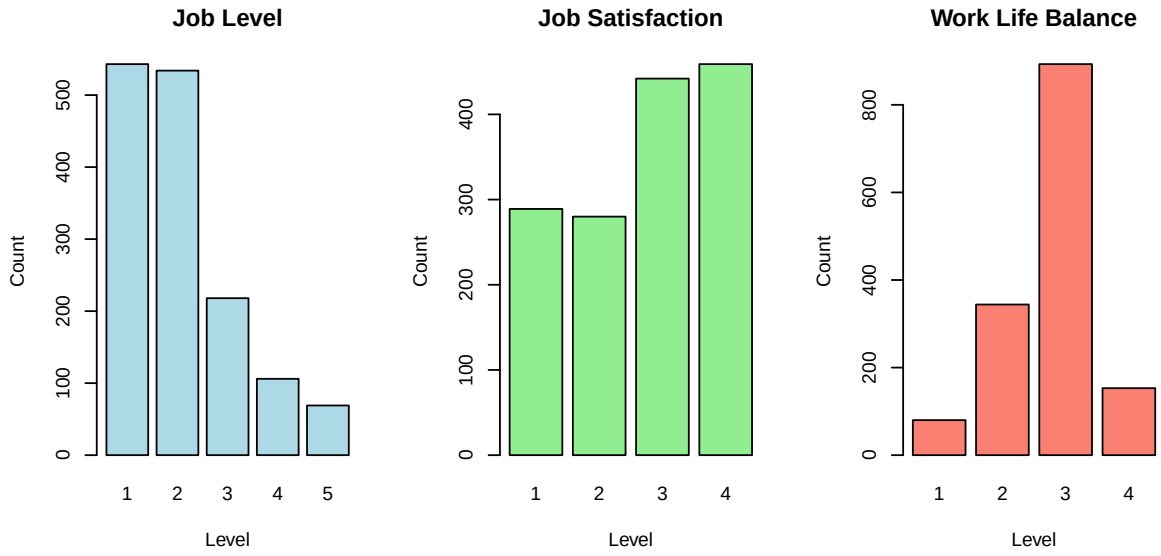
Work-life balance distribution indicates how well employees manage their professional and personal lives. This metric is crucial for understanding employee well-being and potential burnout risks.

Table 7: Work-Life Balance Distribution (1=Bad, 4=Best)

Balance Level	Frequency	Percentage	Cumulative %
1	80	5.44	5.44
2	344	23.40	28.84
3	893	60.75	89.59
4	153	10.41	100.00

2.1.6 Visualizing Categorical Distributions

To better compare the distributions of these ordinal variables, we visualize them using bar charts.



2.2 Numeric Variables

For quantitative variables, we analyze the distribution shape using histograms and boxplots, and we calculate measures of central tendency and dispersion.

2.2.1 Age Distribution

The age distribution helps us understand the demographic maturity of the workforce.

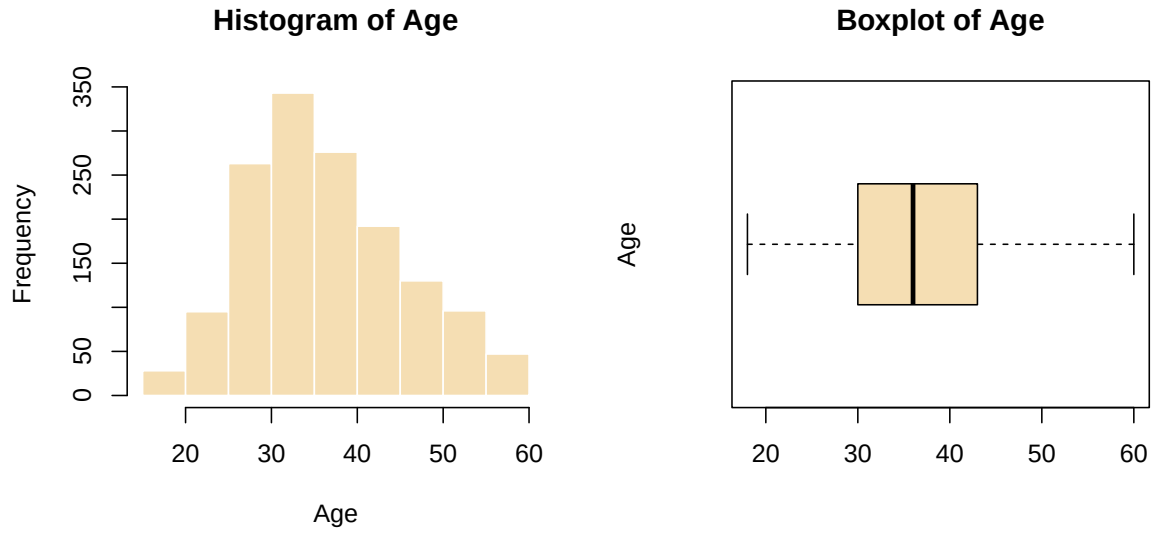


Table 8: Descriptive Statistics: Age

Mean	Median	SD	Min	Max
36.92	36	9.14	18	60

2.2.2 Monthly Income Distribution

Income is analyzed to detect skewness and potential outliers (high earners).

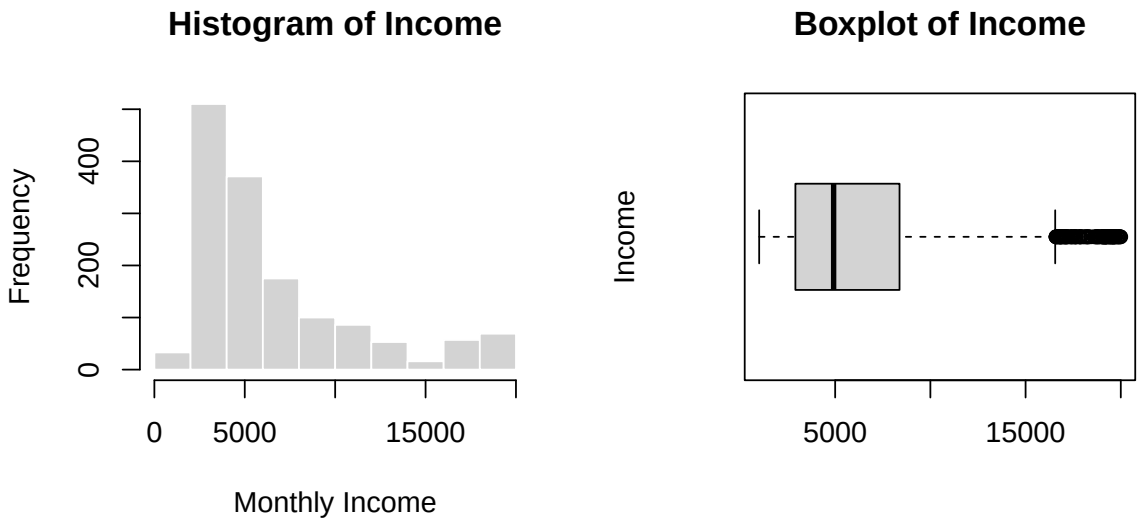


Table 9: Descriptive Statistics: Monthly Income

Mean	Median	SD	IQR
6502.93	4919	4707.96	5468

2.2.3 Years at Company (Tenure)

Tenure analysis reveals loyalty patterns and workforce stability.

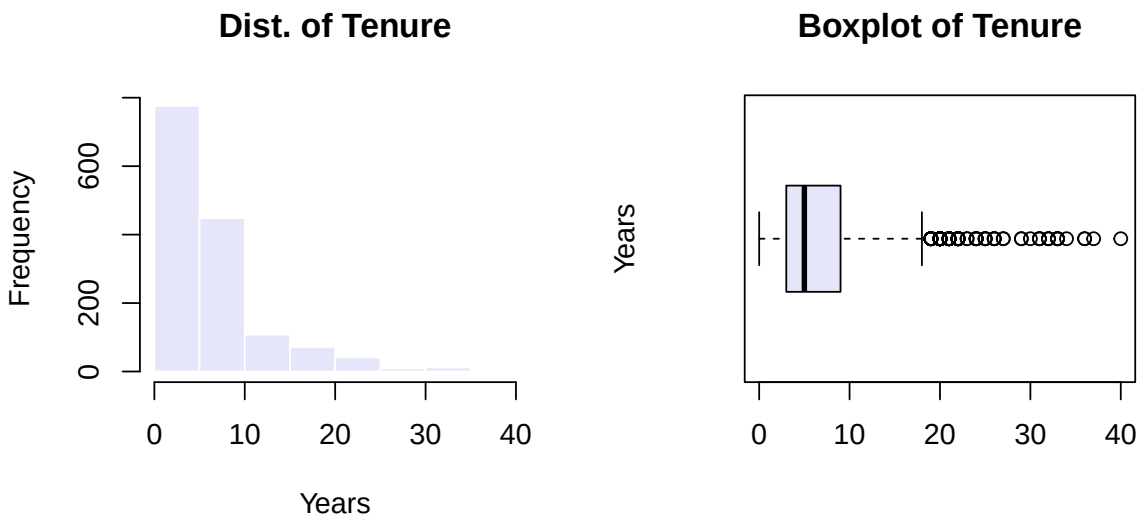


Table 10: Descriptive Statistics: Years at Company

Mean	Median	SD	Max
7.01	5	6.13	40