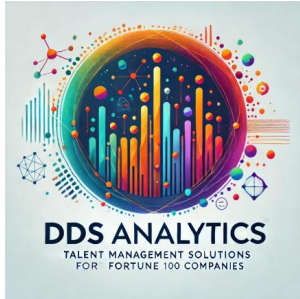




# Employee Attrition Project



Presented By: Mike Flores  
March 9, 2025



# AGENDA

- ☐ Executive Summary
- ☐ Classification Modeling
- ☐ Attrition Cost Analysis
- ☐ Exploratory Data Analysis (EDA)
- ☐ Questions

# Executive Summary

**DDS Analytics** is pleased to present an initial analysis, predictive modeling strategy, and key findings to **assist Frito Lay in understanding and mitigating employee attrition**. Our approach leverages advanced analytics to identify key drivers of attrition, predict potential turnover, and estimate the financial impact of our intervention strategies.

## Objective

Frito Lay aims to gain insight into employee attrition and proactively implement measures to retain key talent.

- **Identifying top factors** contributing to employee turnover.
- **Building predictive models** to anticipate attrition.
- **Estimating the financial implications** of attrition and intervention strategies.

## Predictive Model Development

We developed two classification models to predict employee attrition, **k-Nearest Neighbor**, and **Naïve Bayer**. Our best-performing model achieves a high degree of accuracy in predicting attrition risk, enabling targeted retention efforts.

By utilizing our predictive model, Frito Lay can focus retention strategies on employees most likely to leave, optimizing the use of incentives and reducing turnover-related expenses. Our preliminary cost-benefit analysis suggests that implementing these targeted interventions can generate substantial cost savings.

# Classification Modeling

KNN & Naïve Bayer Models



# Classification Models Comparison

## Comparison of Confusion Matrix:

Metric	KNN Model	Naïve Bayer Model
<b>Accuracy</b>	79.3%	72.8%
<b>Sensitivity</b>	82.7%	74.7%
<b>Specificity</b>	61.0%	61.1%

Cost Modeling Rationale: **Applied KNN Model** predictions to Cost Model.

- **Accuracy:** KNN model has **higher accuracy** (79.3% vs. 72.8%).
- **Sensitivity:** KNN model has **better sensitivity** (82.7% vs. 74.7%), meaning it correctly identifies more cases of non-attribution.
- **Specificity:** Naïve Bayer model is **slightly better in specificity** (61.1% vs. 61.0%), meaning it makes slightly fewer false positive predictions, **but these differences are minimal.**

# Attrition Cost Analysis

# Cost Analysis – KNN Model Predictions

- **Cost of Attrition = \$10,000:** Cost incurred when an employee leaves the company (e.g., hiring, training, lost productivity).
- **Cost of Retention Intervention = \$2,500:** Cost associated with attempting to retain an employee (e.g., bonuses, promotions, PTO, reskilling, additional support).

The formula used:

Total Cost = (Cost of Attrition × Missed Attrition) + (Cost of Retention Intervention × Missed Retention)

Total Cost = (\$10,000 × 16) + (\$2,500 × 38)

**Total Cost = \$255,000**

# Exploratory Data Analysis (EDA)





# Data Dictionary

Variable	Description	Levels within Variables
<b>ID</b>	Employee's unique company ID	
<b>Age</b>	Employee's age in years	
<b>Attrition</b>	Indicates whether the employee has left the company	Yes = Left company, No = Still employed
<b>BusinessTravel</b>	Employee's frequency of business travel	Non-Travel, Travel_Rarely, Travel_Frequently
<b>DailyRate</b>	Employee's daily salary rate of pay (USD)	
<b>Department</b>	Employee's related company department	Human Resources, Research & Development, Sales
<b>DistanceFromHome</b>	Employee's distance traveled from home to workplace (miles)	
<b>Education</b>	Employee's highest level of education achieved	1 = Below College, 2 = College, 3 = Bachelor, 4 = Master, 5 = Doctor
<b>EducationField</b>	Employee's field of education	Human Resources, Life Sciences, Marketing, Medical Sciences, Other, Technical Degree
<b>EmployeeCount</b>	A constant value of 1 for all records, possibly used as a placeholder	
<b>EmployeeNumber</b>	Unique identifier assigned to each employee	
<b>EnvironmentSatisfaction</b>	Employee's satisfaction with their work environment on a scale from 1 to 4	1 = Low, 2 = Medium, 3 = High, 4 = Very High
<b>Gender</b>	Employee's gender	Male, Female
<b>HourlyRate</b>	Employee's hourly wage (USD)	
<b>JobInvolvement</b>	Employee's level of job involvement on a scale from 1 to 4	1 = Low, 2 = Medium, 3 = High, 4 = Very High
<b>JobLevel</b>	Employee's job level within the company on a scale from 1 to 5	1 = Entry Level, 2 = Junior Level, 3 = Mid Level, 4 = Senior Level, 5 = Executive Level
<b>JobRole</b>	Employee's specific role within the company	Healthcare Representative, Human Resources, Laboratory Technician, Manager, Manufacturing Director, Research Director, Research Scientist, Sales Executive, Sales Representative
<b>JobSatisfaction</b>	Employee's satisfaction with their job on a scale from 1 to 4	1 = Low, 2 = Medium, 3 = High, 4 = Very High
<b>MaritalStatus</b>	Employee's marital status	Single, Married, or Divorced
<b>MonthlyIncome</b>	Employee's monthly salary (USD)	
<b>MonthlyRate</b>	Employee's monthly wage rate (USD)	
<b>NumCompaniesWorked</b>	Number of companies the employee has previously worked for	
<b>Over18</b>	Indicates whether the employee is over 18 years old	Y = Yes
<b>OverTime</b>	Whether the employee works overtime	Yes, No
<b>PercentSalaryHike</b>	Employee's percentage increase in salary	
<b>PerformanceRating</b>	Employee's performance rating on a scale from 1 to 4	1 = Low, 2 = Good, 3 = Excellent, 4 = Outstanding
<b>RelationshipSatisfaction</b>	Satisfaction with work relationships on a scale from 1 to 4	1 = Low, 2 = Medium, 3 = High, 4 = Very High
<b>StandardHours</b>	Standard working hours	80
<b>StockOptionLevel</b>	Employee's stock option level on a scale from 0 to 3	0 = None, 1 = Low, 2 = Medium, 3 = High
<b>TotalWorkingYears</b>	Employee's total years of work experience	
<b>TrainingTimesLastYear</b>	Number of training sessions attended in the past year	
<b>WorkLifeBalance</b>	Employee's work-life balance rating on a scale from 1 to 4	1 = Bad, 2 = Good, 3 = Better, 4 = Best
<b>YearsAtCompany</b>	Number of years the employee has worked at the company	
<b>YearsInCurrentRole</b>	Number of years in the employee's current role	
<b>YearsSinceLastPromotion</b>	Number of years since employee's last promotion	
<b>YearsWithCurrManager</b>	Number of years the employee has worked with their current manager	

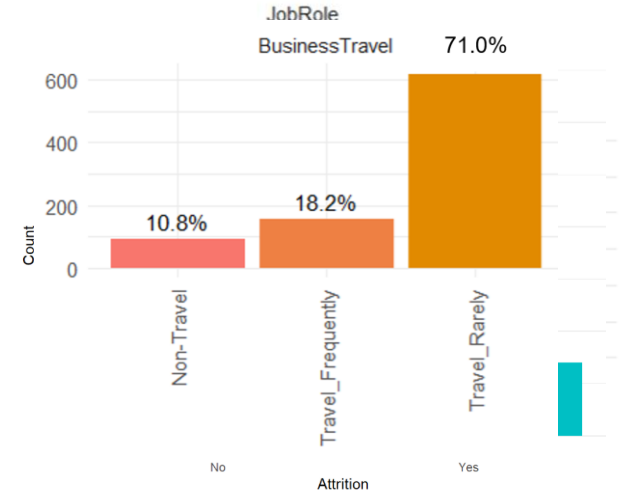
# Frito Lay Data Sample

Variable	Description	Levels within Variables
<b>ID</b>	Employee's unique company ID	
<b>Age</b>	Employee's age in years	
<b>Attrition</b>	Indicates whether the employee has left the company	Yes = Left company, No = Still employed
<b>BusinessTravel</b>	Employee's frequency of business travel	Non-Travel, Travel_Rarely, Travel_Frequently

- Dataset has 870 rows and 36 columns.
- The 36 columns consist of; 27 – Quantitative & 9 – Qualitative (Categorical) data types
- Removed non-informative columns, e.g., little to no relationship to Attrition
- Verified that no missing data was present across all columns.
- Retained all outliers as they were valid numerical values.

# Data Overview – Attrition Frequency

- **Attrition Rate:** 140 employees (16%) left the company, making retention a key concern.
- **Business Travel:** 158 employees travel frequently, which may *contribute to attrition* compared to the 618 who rarely travel.
- **Overtime:** 252 employees work overtime, which could impact job satisfaction and burnout, while 618 do not.
- **Education Field:** Life Sciences (40%) and Medical (31%) dominate, showing potential industry-specific retention patterns.
- **Job Roles & Leadership:** 33% (287) of employees hold leadership roles, which may indicate retention challenges at different career levels.

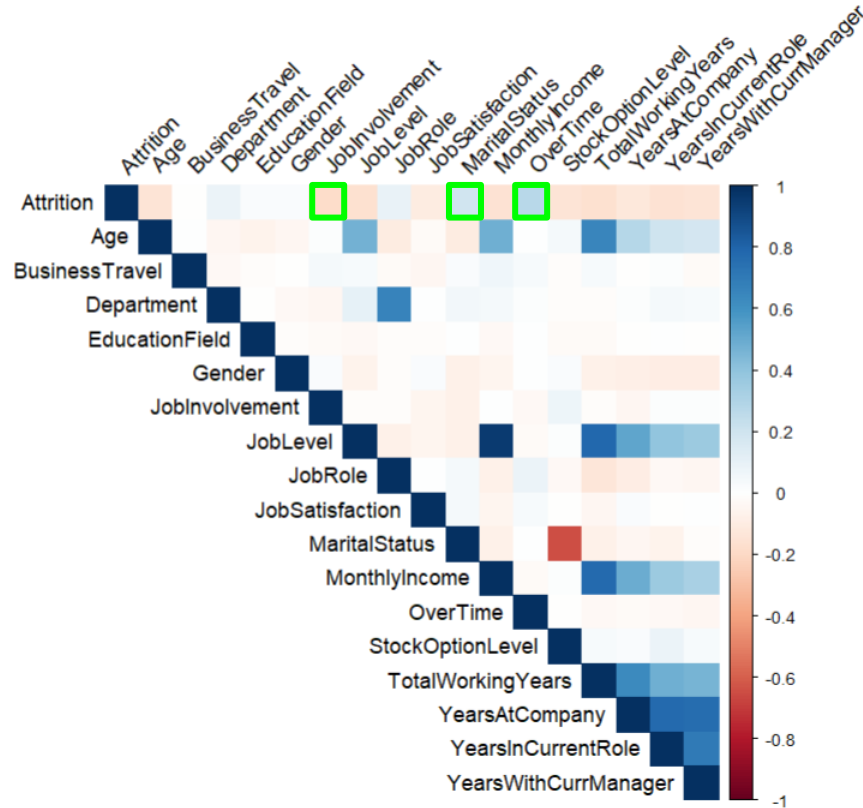


# Data Overview – Quantitative Variable Statistical Summary

- Years at Company: Tenure ranges from 0 to 40 years, averaging 7 years. 50% have stayed 5 years or less, while 25% have been here for 3 years or less.
- Job Satisfaction: Scores range from 1 to 4, averaging 2.71. Half rate it 3 or lower, and 25% report low satisfaction (2 or less), affecting retention.
- Work-Life Balance: Ratings span 1 to 4, averaging 2.78. Half rate it 3 or lower, suggesting work-life challenges that may drive attrition.
- Years Since Last Promotion: Time since last promotion ranges from 0 to 15 years, averaging 2.17 years. 25% have waited at least 3 years, which may impact motivation.
- Num Companies Worked: Employees have worked at 0 to 9 companies, averaging 2.73. 25% have worked at 4+ companies, indicating higher mobility.



# Correlation Between Variables – Relationships to Attrition



Correlation Hierarchy

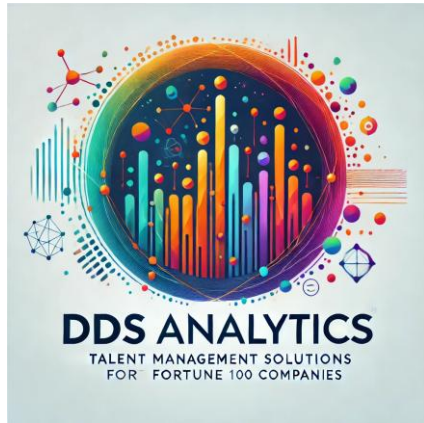
Rank	Category	Correlation
1	OverTime	0.2720
2	MaritalStatus	0.1970
3	JobInvolvement	0.1878
4	TotalWorkingYears	0.1672
5	JobLevel	0.1621
6	YearsInCurrentRole	0.1562
7	MonthlyIncome	0.1549
8	Age	0.1494
9	StockOptionLevel	0.1487
10	YearsWithCurrManager	0.1468
11	YearsAtCompany	0.1288
12	JobSatisfaction	0.1075
13	JobRole	0.0905
14	Department	0.0870
15	EducationField	0.0261
16	Gender	0.0253
17	BusinessTravel	0.0061

## Conclusion & Next Steps

- **Refine our predictive models** to improve accuracy.
- **Develop targeted retention programs** based on key risk factors.
- **Monitor and assess intervention outcomes** to measure effectiveness and adjust strategies accordingly.

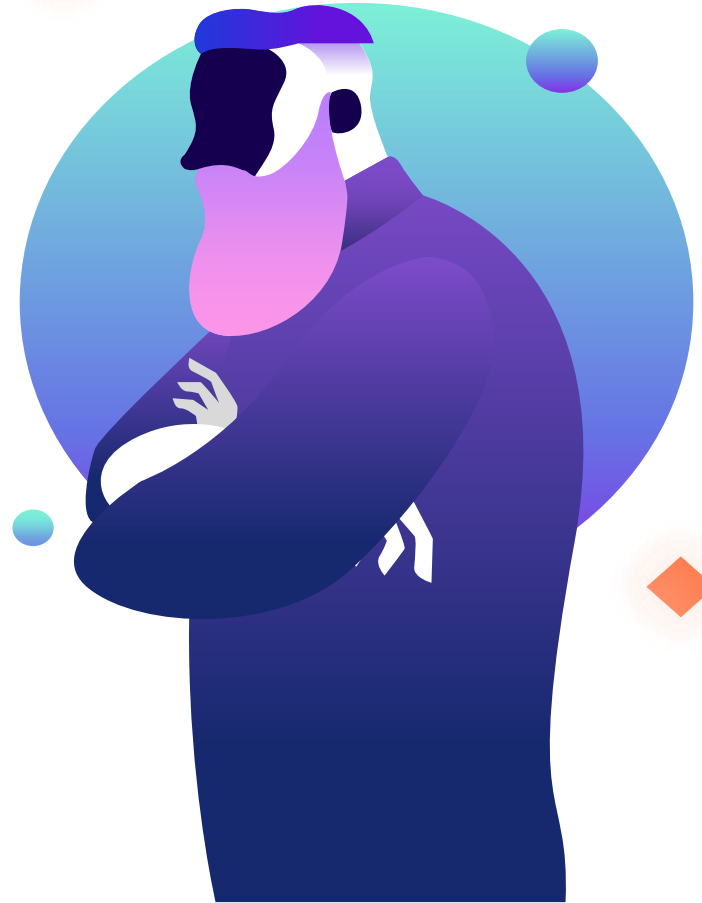
# QUESTIONS?

# Thank You



Contact Info:

Mike Flores  
555-555-1212  
mikeflores@dds.com





# Appendix

# Solution Approach

- **Data** – Collect and acquire relevant data from various sources.
- **Wrangle** – Clean, preprocess, and transform the data for analysis.
- **Explore** – Conduct exploratory data analysis (EDA) to identify patterns and insights.
- **Model** – Build, train, and evaluate predictive models using statistical and machine learning techniques.
- **Report** – Communicate findings and insights through visualizations, reports, and presentations.



# Data Overview

## Sample Data: First 5 Rows:

ID	Attrition	BusinessTravel	DailyRate	Department	DistanceFromHome	Education	EducationField	EmployeeCount	EmployeeNumber	EnvironmentSatisfaction	Gender	HourlyRate	Age	JobInvolvement
1	No	Travel_Rarely	117	Sales	13	4	Life Sciences	1	859	2	Male	73	32	3
2	No	Travel_Rarely	1308	Research & Development	14	3	Medical	1	1128	3	Male	44	40	2
3	No	Travel_Frequently	200	Research & Development	18	2	Life Sciences	1	1412	3	Male	60	35	3
4	No	Travel_Rarely	801	Sales	1	4	Marketing	1	2016	3	Female	48	32	3
5	No	Travel_Frequently	567	Research & Development	2	1	Technical Degree	1	1646	1	Female	32	24	3
6	No	Travel_Frequently	294	Research & Development	10	2	Life Sciences	1	733	4	Male	32	27	3

ID	JobLevel	JobRole	JobSatisfaction	MaritalStatus	MonthlyIncome	MonthlyRate	NumCompaniesWorked	Over18	OverTime	PercentSalaryHike	PerformanceRating	RelationshipSatisfaction
1	2	Sales Executive	4	Divorced	4403	9250	2	Y	No	11	3	3
2	5	Research Director	3	Single	19626	17544	1	Y	No	14	3	1
3	3	Manufacturing Director	4	Single	9362	19944	2	Y	No	11	3	3
4	3	Sales Executive	4	Married	10422	24032	1	Y	No	19	3	3
5	1	Research Scientist	4	Single	3760	17218	1	Y	Yes	13	3	3
6	3	Manufacturing Director	1	Divorced	8793	4809	1	Y	No	21	4	3

ID	StandardHours	StockOptionLevel	TotalWorkingYears	TrainingTimesLastYear	WorkLifeBalance	YearsAtCompany	YearsInCurrentRole	YearsSinceLastPromotion	YearsWithCurrManager
1	80	1	8	3	2	5	2	0	3
2	80	0	21	2	4	20	7	4	9
3	80	0	10	2	3	2	2	2	2
4	80	2	14	3	3	14	10	5	7
5	80	0	6	2	3	6	3	1	3
6	80	2	9	4	2	9	7	1	7

- Dataset has 870 rows and 36 columns.
- The 36 columns consist of; 27 – Quantitative & 9 – Qualitative (Categorical) data types
- There is not any missing data in any of the columns.
- There are several columns which add little (no) value to the solution: ID, EmployeeCount, EmployeeNumber, Over18, StandardHours

# Data Post Processing Overview

## Final Dataset: First 5 Rows:

Attrition	Age	BusinessTravel	Department	EducationField	Gender	JobInvolvement	JobLevel	JobRole	JobSatisfaction	MaritalStatus	MonthlyIncome	OverTime	StockOptionLevel	TotalWorkingYears	YearsAtCompany	YearsInCurrentRole	YearsWithCurrManager
0	32	Travel_Rarely	Sales	Life Sciences	Male	3	2	Sales Executive	4	Divorced	4403	No	1	8	5	2	3
0	40	Travel_Rarely	Research & Development	Medical	Male	2	5	Research Director	3	Single	19626	No	0	21	20	7	9
0	35	Travel_Frequently	Research & Development	Life Sciences	Male	3	3	Manufacturing Director	4	Single	9362	No	0	10	2	2	2
0	32	Travel_Rarely	Sales	Marketing	Female	3	3	Sales Executive	4	Married	10422	No	2	14	14	10	7
0	24	Travel_Frequently	Research & Development	Technical Degree	Female	3	1	Research Scientist	4	Single	3760	Yes	0	6	6	3	3
0	27	Travel_Frequently	Research & Development	Life Sciences	Male	3	3	Manufacturing Director	1	Divorced	8793	No	2	9	9	7	7

- Removed non-informative columns: ID, EmployeeCount, EmployeeNumber, Over18 (only "Yes"), and StandardHours (always 80).
- Verified that no missing data was present across all columns.
- Retained all outliers as they were valid numerical values.
- Converted categorical variables into factors for analysis.
- Analyzed correlations between variables and Attrition.
- Confirmed that no missing data exists in any column.
- Dropped columns with little to no relationship to Attrition: DailyRate, DistanceFromHome, Education, EnvironmentSatisfaction, HourlyRate, MonthlyRate, NumCompaniesWorked, PercentSalaryHike, RelationshipSatisfaction, TrainingTimesLastYear, WorkLifeBalance, and YearsSinceLastPromotion.

# Data Overview – Statistical Summary

## Quantitative Variables - 5 Number Summaries

5 Number Summary	Age	DailyRate	DistanceFromHome	Education	EnvironmentSatisfaction	HourlyRate	JobInvolvement	JobLevel	JobSatisfaction	MonthlyIncome	MonthlyRate	NumCompaniesWorked	PercentSalaryHike
Min Value:	18	\$103.00	1	1	1	\$30.00	1	1	1	\$1,081.00	\$2,094.00	0	11%
1st Quartile (Q1):	30	\$472.50	2	2	2	\$48.00	2	1	2	\$2,840.00	\$8,092.00	1	12%
Median (Q2):	35	\$817.50	7	3	3	\$66.00	3	2	3	\$4,946.00	\$14,074.00	2	14%
Mean :36.83	36.83	\$815.20	9.339	2.901	2.701	\$65.61	2.723	2.039	2.709	\$6,390.00	\$14,326.00	2.728	15%
3rd Quartile (Q3):	43	\$1,165.80	14	4	4	\$83.00	3	3	4	\$8,182.00	\$20,456.00	4	18%
Max Value:	60	\$1,499.00	29	5	4	\$100.00	4	5	4	\$19,999.00	\$26,997.00	9	25%

5 Number Summary	PerformanceRating	RelationshipSatisfaction	StockOptionLevel	TotalWorkingYears	TrainingTimesLastYear	WorkLifeBalance	YearsAtCompany	YearsInCurrentRole	YearsSinceLastPromotion	YearsWithCurrManager
Min Value:	3	1	0	0	0	1	0	0	0	0
1st Quartile (Q1):	3	2	0	6	2	2	3	2	0	2
Median (Q2):	3	3	1	10	3	3	5	3	1	3
Mean :36.83	3.152	2.707	0.7839	11.05	2.832	2.782	6.962	4.205	2.169	4.14
3rd Quartile (Q3):	3	4	1	15	3	3	10	7	3	7
Max Value:	4	4	3	40	6	4	40	18	15	17

- **Min Value (Minimum)** – The smallest data point in the dataset.
- **First Quartile (Q1/ 25th Percentile)** – The median of the lower half of the dataset. 25% of the data falls below this value.
- **Second Quartile (Q2/ Median / 50th Percentile)** – The middle value of the dataset, splitting it into two equal halves. 50% or half of the data falls below this value.
- **Third Quartile (Q3/ 75th Percentile)** – The median of the upper half of the data. 75% of the data falls below this value.
- **Max Value (Maximum)** – The largest data point in the dataset.

# Data Overview – Statistical Summary

## Categorical Variables

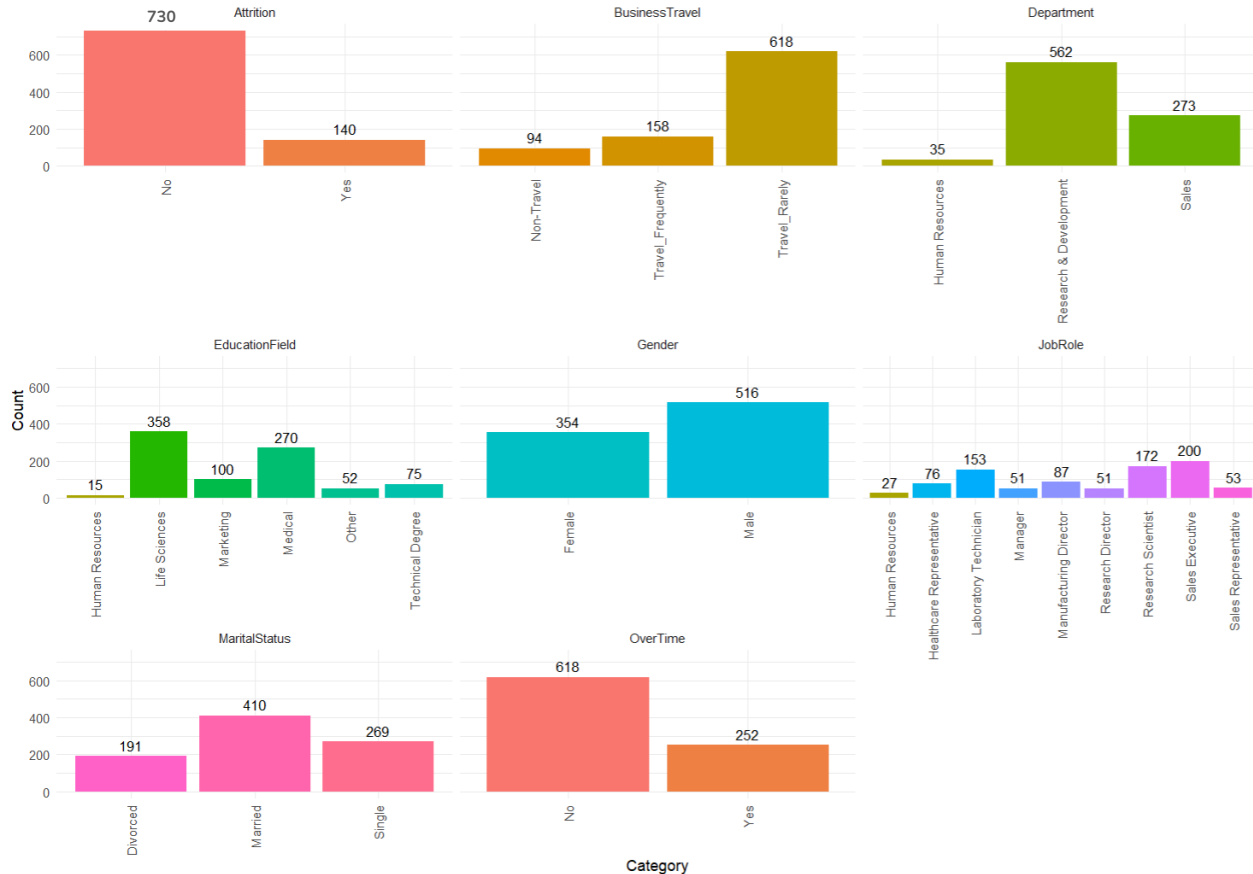
Attrition	BusinessTravel	Department	EducationField	Gender	JobRole	MaritalStatus	OverTime
No: 730 (84%)	Non-Travel: 94	Human Resources: 35	Human Resources: 15	Female: 354	Sales Executive: 200	Divorced: 191	No: 618
Yes: 140 (16%)	Travel_Frequently: 158 Travel_Rarely: 618	Research & Development: 562 Sales: 273	Life Sciences: 358 Marketing: 100	Male: 516	Research Scientist: 172 Laboratory Technician: 153 Manufacturing Director: 87 Healthcare Representative: 76 Sales Representative: 53	Married: 410 Single: 269	Yes: 252
			Medical: 270				
			Other: 52				
			Technical Degree: 75				

- **140 (16%) Employees** left the company.
- Majority, **618**, of employees rarely travel.
- Human resources staff makes up less than **4%** of company.
- **40%** of company is **educated in Life Sciences**, **31%** is **educated in Medical**.
- Almost **60%** of company is Male.
- **33%** (287) of **employees are leadership roles**.
- **47%** (410) of employees are **Married**.
- Majority, **618**, of employees do not work overtime.

# Data Overview – Quantitative Variable Frequency

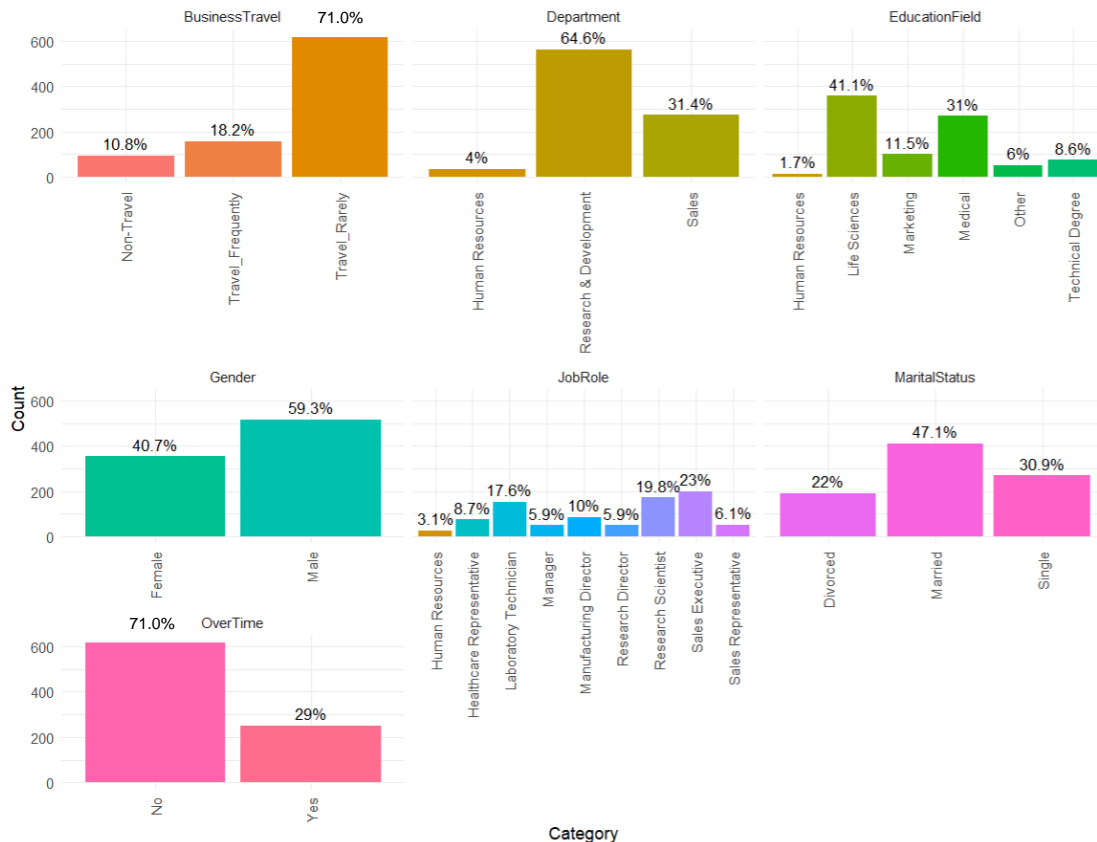


# Data Overview – Categorical Variable Frequency

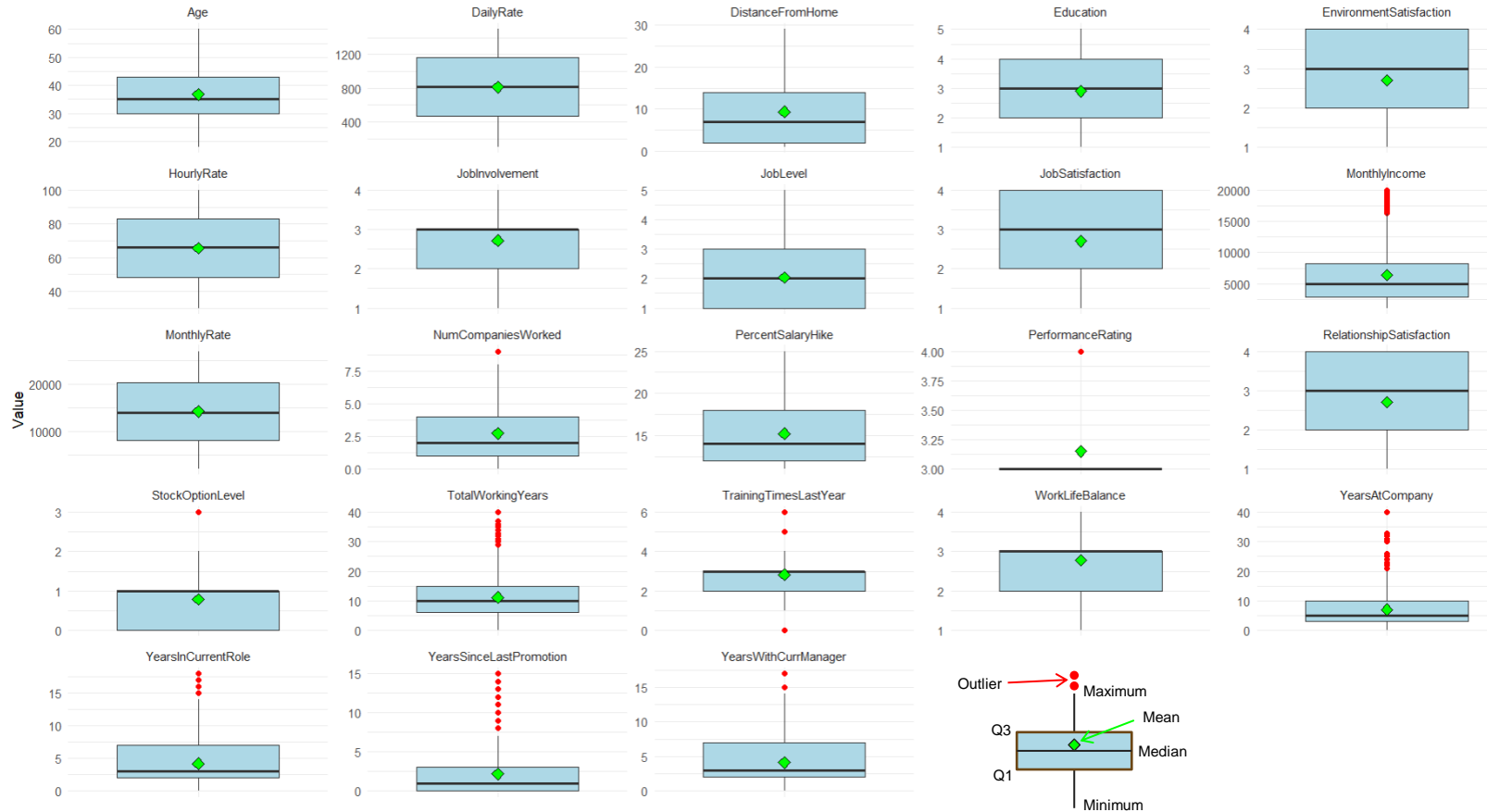




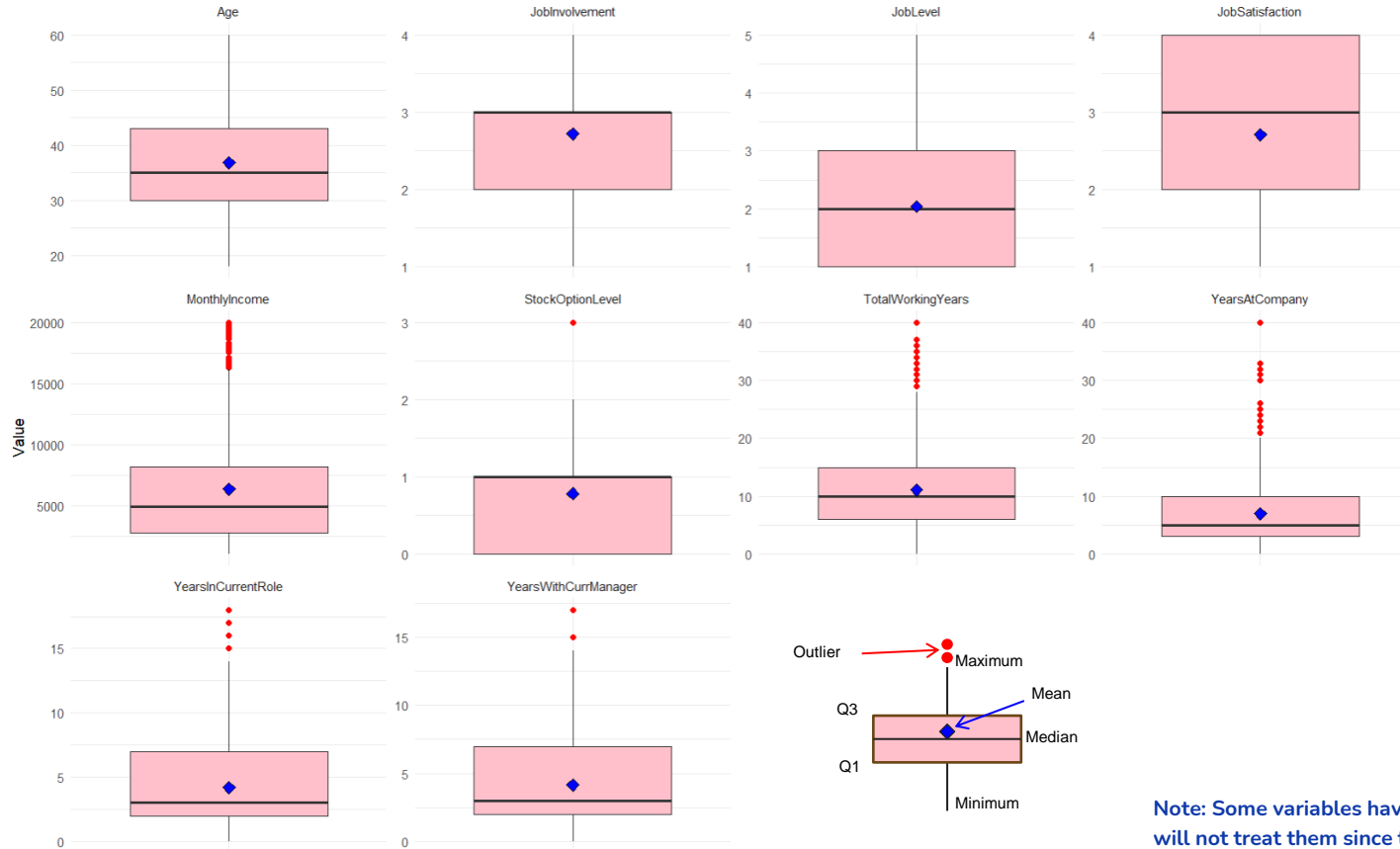
# Data Overview – Categorical Variable Frequency



# Data Overview – Quantitative Variable Statistical Summary

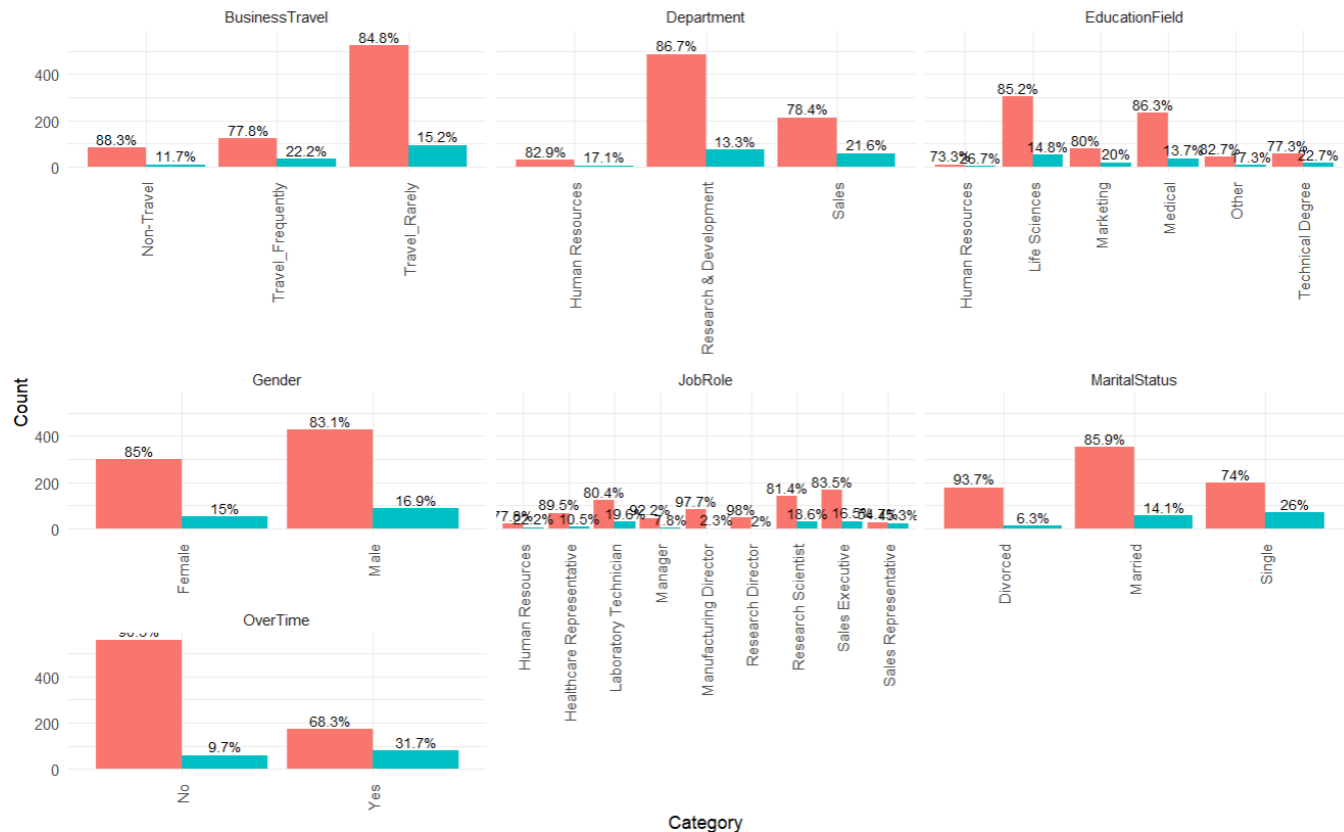


# Data Overview – Quantitative Variable Statistical Summary



Note: Some variables have outliers. We will not treat them since they are proper values.

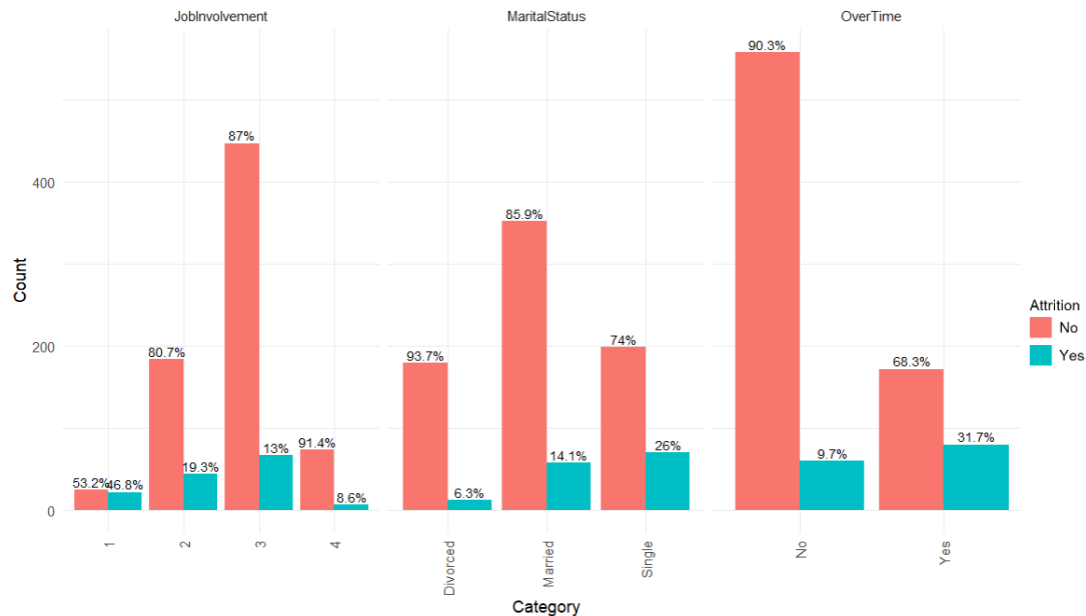
# Data Overview – Attrition vs. Highest Correlations



# Data Overview – Attrition vs. Highest Correlations

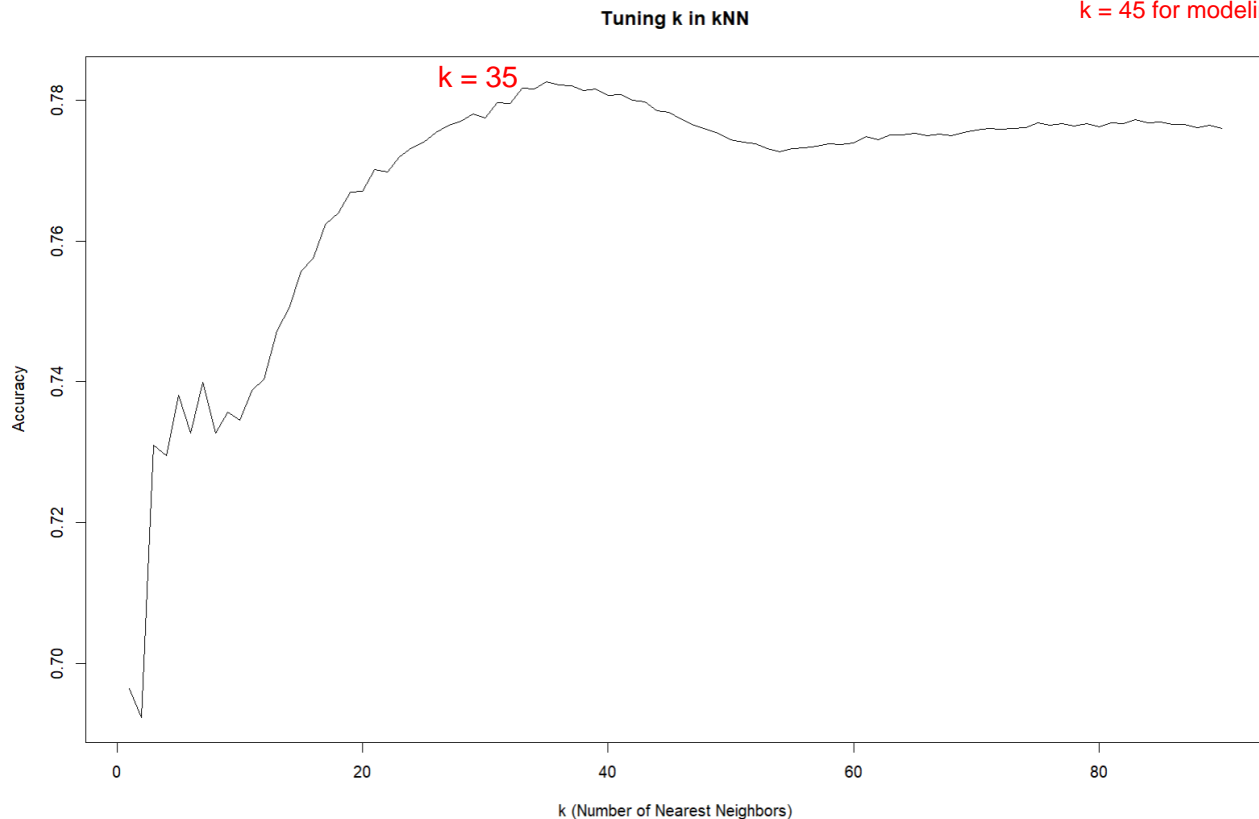
## Reading the Correlation Matrix

- Attrition impact from the variables
- Visualize the strength of relationships
- Darker the color the stronger the relationship to Attrition.
- No color, little to no relationship to Attrition.



# kNN Hyperparameter Tuning – Best k Value

Note:  $k = 35$  did not yield 60% Specificity.  
It achieved 58.5% maximum. Used  
 $k = 45$  for modeling to achieve 60%.



# KNN & Naïve Bayer Model Statistics

## KNN Model

		ACTUALS	
		No (No Attrition)	Yes (Attrition)
PREDICTED	No (No Attrition)	182 (True Negative)	16 (False Negative)
	Yes (Attrition)	38 (False Positive)	25 (True Positive)

KNN Confusion Matrix

- **Accuracy** = model **correctly predicted 79.3% of all cases** (both attrition and non-attrition).
- **Sensitivity (25 TP)** = model **correctly identified 82.7% of employees who actually left (TP)** but, might be misclassifying employees who will stay (FP)
- **Specificity (182 TN)** = only **correctly identified 61.0% of employees who actually stayed (TN)**.

## Naïve Bayer Model

		ACTUALS	
		0 (No Attrition)	1 (Attrition)
PREDICTED	0 (No Attrition)	168 (True Negative)	14 (False Positive)
	1 (Attrition)	57 (False Negative)	22 (True Positive)

Naïve Bayer Confusion Matrix

- **Accuracy** = model **correctly predicted 72.8% of all cases** (both attrition and non-attrition).
- **Sensitivity (22 TP)** = model **correctly identified 74.7% of employees who actually left (TP)** but, might be misclassifying employees who will stay (FP)
- **Specificity (168 TN)** = only **correctly identified 61.1% of employees who actually stayed (TN)**.

# Cost Analysis – KNN Model Predictions

- **Cost of Attrition = \$10,000:** Cost incurred when an employee leaves the company (e.g., hiring, training, lost productivity).
- **Cost of Retention Intervention = \$2,500:** Cost associated with attempting to retain an employee (e.g., bonuses, promotions, PTO, reskilling, additional support).

The formula used:

$$\text{Total Cost} = (\text{Cost of Attrition} \times \text{False Negatives}) + (\text{Cost of Retention Intervention} \times \text{False Positives})$$

		ACTUALS	
		No (No Attrition)	Yes (Attrition)
PREDICTED	No (No Attrition)	182 (True Negative)	16 (False Negative)
	Yes (Attrition)	38 (False Positive)	25 (True Positive)

- Correctly predicted 182 (TN) employees who did not leave.
- 16 (FN) employees who actually left but were incorrectly predicted as staying, Missed Attrition
- 38 (FP) employees who were predicted to leave but actually stayed, Unnecessary Retention
- Correctly predicted 25 (TP) employees who left.