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Subject: Computing Lab - III | Project Based Learning (PBL) (3rd YEAR CSE-AIML 2023-2024)

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PRN: 2143110133	Date of Experiment: __ / __ / 2024
Marks (Out of 25):	Date of Submission: __ / __ / 2024

Aim:

The aim of this project is to develop a predictive model for identifying diabetes in individuals using machine learning techniques. Specifically, we aim to train a logistic regression model on the provided diabetes dataset to accurately classify an individual as diabetic or non-diabetic based on certain features such as Glucose level, BMI, and Age.

Theory:

1. **Required Libraries**

I have imported the necessary libraries for data manipulation (tidyverse), data visualization (ggplot2), machine learning model training and evaluation (caret), and handling imbalanced datasets (DMwR2).

```
library(tidyverse)
```

```
## ── Attaching core tidyverse packages ──────────────────────── tidyverse 2.0.0 ──
## ✓ dplyr     1.1.4     ✓ readr     2.1.5
## ✓ forcats   1.0.0     ✓ stringr   1.5.1
## ✓ ggplot2   3.5.0     ✓ tibble    3.2.1
## ✓ lubridate 1.9.3     ✓ tidyr     1.3.1
## ✓ purrr     1.0.2
## ── Conflicts ────────────────────────────────────────── tidyverse_conflicts() ──
## ✖ dplyr::filter() masks stats::filter()
## ✖ dplyr::lag()    masks stats::lag()
## ℹ Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to be
come errors
```

```
library(caret)
```

```
## Loading required package: lattice
##
## Attaching package: 'caret'
##
## The following object is masked from 'package:purrr':
##
##     lift
```

```
library(smotefamily)
library(corrplot)
```

```
## corrplot 0.92 loaded
```

2. **Load the Dataset**

I have loaded the “diabetes.csv” dataset into the R environment for further analysis.

```
cd <- read.csv('diabetes.csv')
```

3. **Exploratory Data Analysis**

In this section, I perform exploratory data analysis to understand the structure and characteristics of the dataset. We check the first few rows, the data types of the variables, and the summary statistics.

```
head(cd)
```

```
##   Pregnancies Glucose BloodPressure SkinThickness Insulin  BMI
## 1           6     148            72            35       0 33.6
## 2           1      85            66            29       0 26.6
## 3           8     183            64             0       0 23.3
## 4           1      89            66            23      94 28.1
## 5           0     137            40            35     168 43.1
## 6           5     116            74             0       0 25.6
##   DiabetesPedigreeFunction Age Outcome
## 1                    0.627  50       1
## 2                    0.351  31       0
## 3                    0.672  32       1
## 4                    0.167  21       0
## 5                    2.288  33       1
## 6                    0.201  30       0
```

```
str(cd)
```

```
## 'data.frame':    768 obs. of  9 variables:
##  $ Pregnancies             : int  6 1 8 1 0 5 3 10 2 8 ...
##  $ Glucose                 : int  148 85 183 89 137 116 78 115 197 125 ...
##  $ BloodPressure           : int  72 66 64 66 40 74 50 0 70 96 ...
##  $ SkinThickness           : int  35 29 0 23 35 0 32 0 45 0 ...
##  $ Insulin                 : int  0 0 0 94 168 0 88 0 543 0 ...
##  $ BMI                     : num  33.6 26.6 23.3 28.1 43.1 25.6 31 35.3 30.5 0 ...
##  $ DiabetesPedigreeFunction: num  0.627 0.351 0.672 0.167 2.288 ...
##  $ Age                     : int  50 31 32 21 33 30 26 29 53 54 ...
##  $ Outcome                 : int  1 0 1 0 1 0 1 0 1 1 ...
```

```
summary(cd)
```

```
##   Pregnancies        Glucose      BloodPressure    SkinThickness
##  Min.   : 0.000   Min.   :  0.0   Min.   :  0.00   Min.   : 0.00
##  1st Qu.: 1.000   1st Qu.: 99.0   1st Qu.: 62.00   1st Qu.: 0.00
##  Median : 3.000   Median :117.0   Median : 72.00   Median :23.00
##  Mean   : 3.845   Mean   :120.9   Mean   : 69.11   Mean   :20.54
##  3rd Qu.: 6.000   3rd Qu.:140.2   3rd Qu.: 80.00   3rd Qu.:32.00
##  Max.   :17.000   Max.   :199.0   Max.   :122.00   Max.   :99.00
##     Insulin           BMI        DiabetesPedigreeFunction      Age
##  Min.   :  0.0   Min.   : 0.00   Min.   :0.0780           Min.   :21.00
##  1st Qu.:  0.0   1st Qu.:27.30   1st Qu.:0.2437           1st Qu.:24.00
##  Median : 30.5   Median :32.00   Median :0.3725           Median :29.00
##  Mean   : 79.8   Mean   :31.99   Mean   :0.4719           Mean   :33.24
##  3rd Qu.:127.2   3rd Qu.:36.60   3rd Qu.:0.6262           3rd Qu.:41.00
##  Max.   :846.0   Max.   :67.10   Max.   :2.4200           Max.   :81.00
##     Outcome
##  Min.   :0.000
##  1st Qu.:0.000
##  Median :0.000
##  Mean   :0.349
##  3rd Qu.:1.000
##  Max.   :1.000
```

4. **Check for missing values**

I check if there are any missing values in the dataset, which is an important step before proceeding with further analysis and modeling.

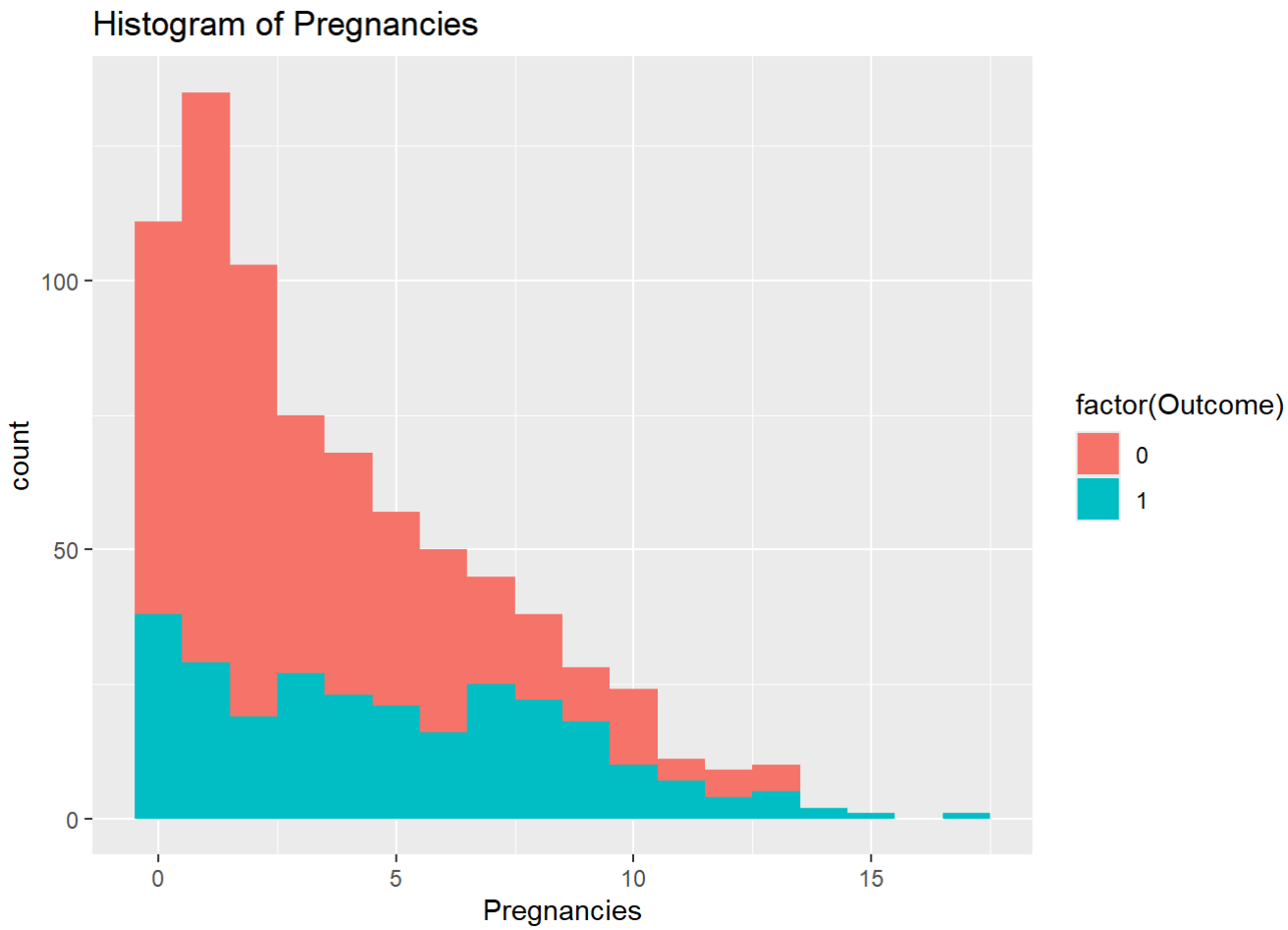
```
sum(is.na(cd))
```

```
## [1] 0
```

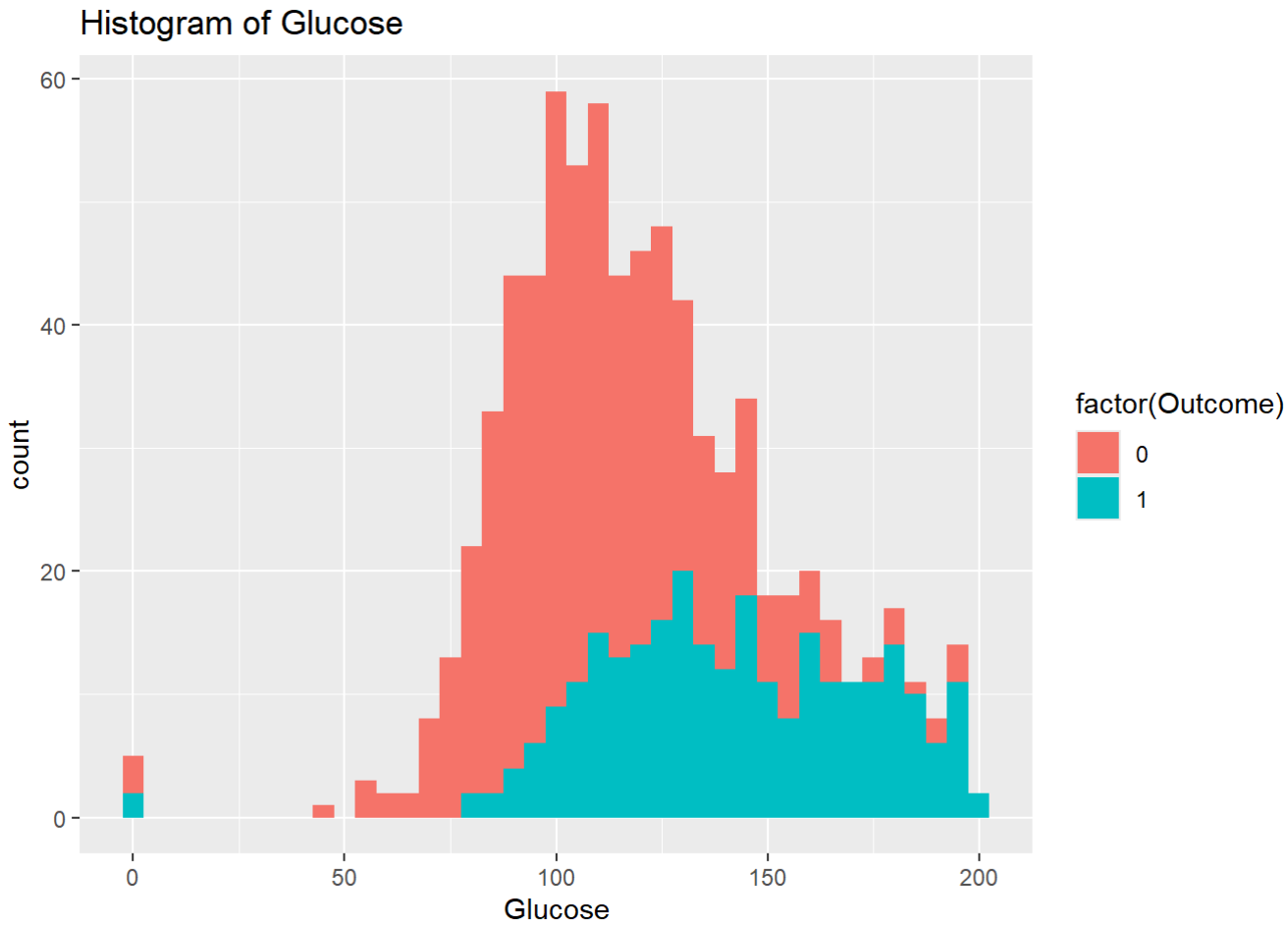
5. **Data Visualization**

I create various histograms to visualize the distribution of different features in the dataset, such as Pregnancies, Glucose, Blood Pressure, Skin Thickness, Insulin, BMI, Diabetes Pedigree Function, and Age. This helps us gain a better understanding of the data and identify any potential patterns or outliers.

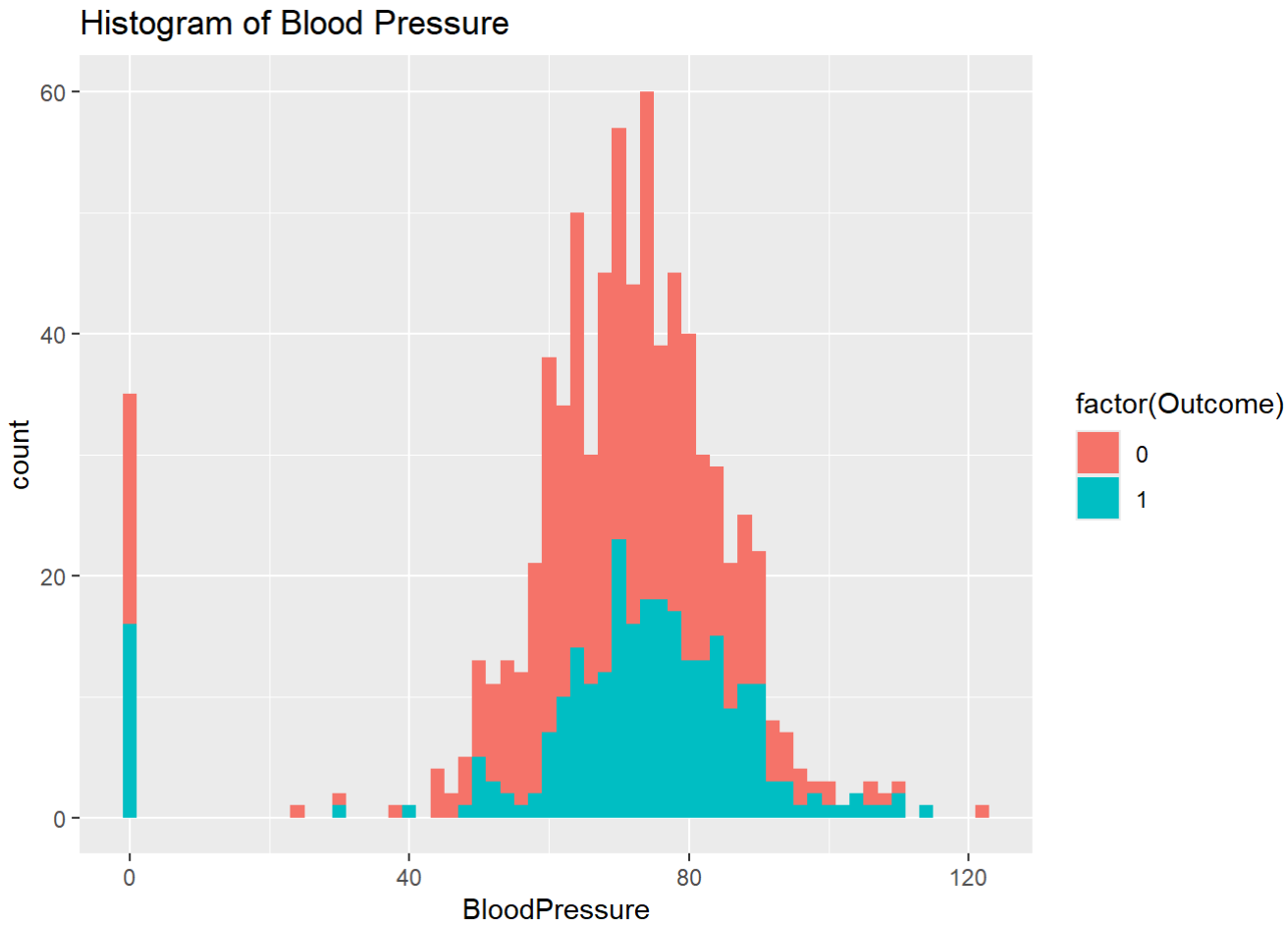
```
# Explore the data visually
ggplot(cd, aes(x = Pregnancies, fill = factor(Outcome))) +
  geom_histogram(binwidth = 1) +
  labs(title = "Histogram of Pregnancies")
```



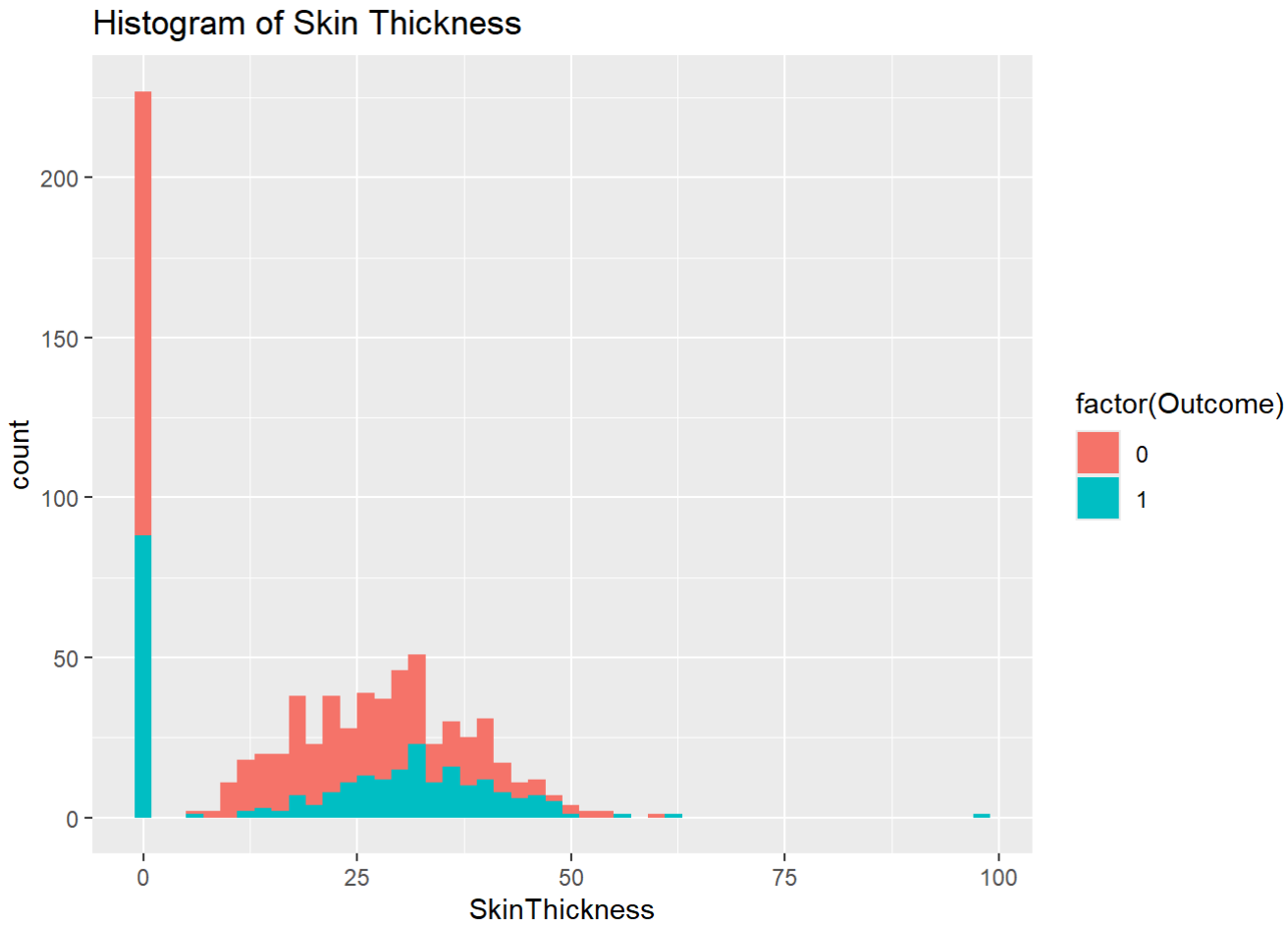

```
ggplot(cd, aes(x = Glucose, fill = factor(Outcome))) +
  geom_histogram(binwidth = 5) +
  labs(title = "Histogram of Glucose")
```



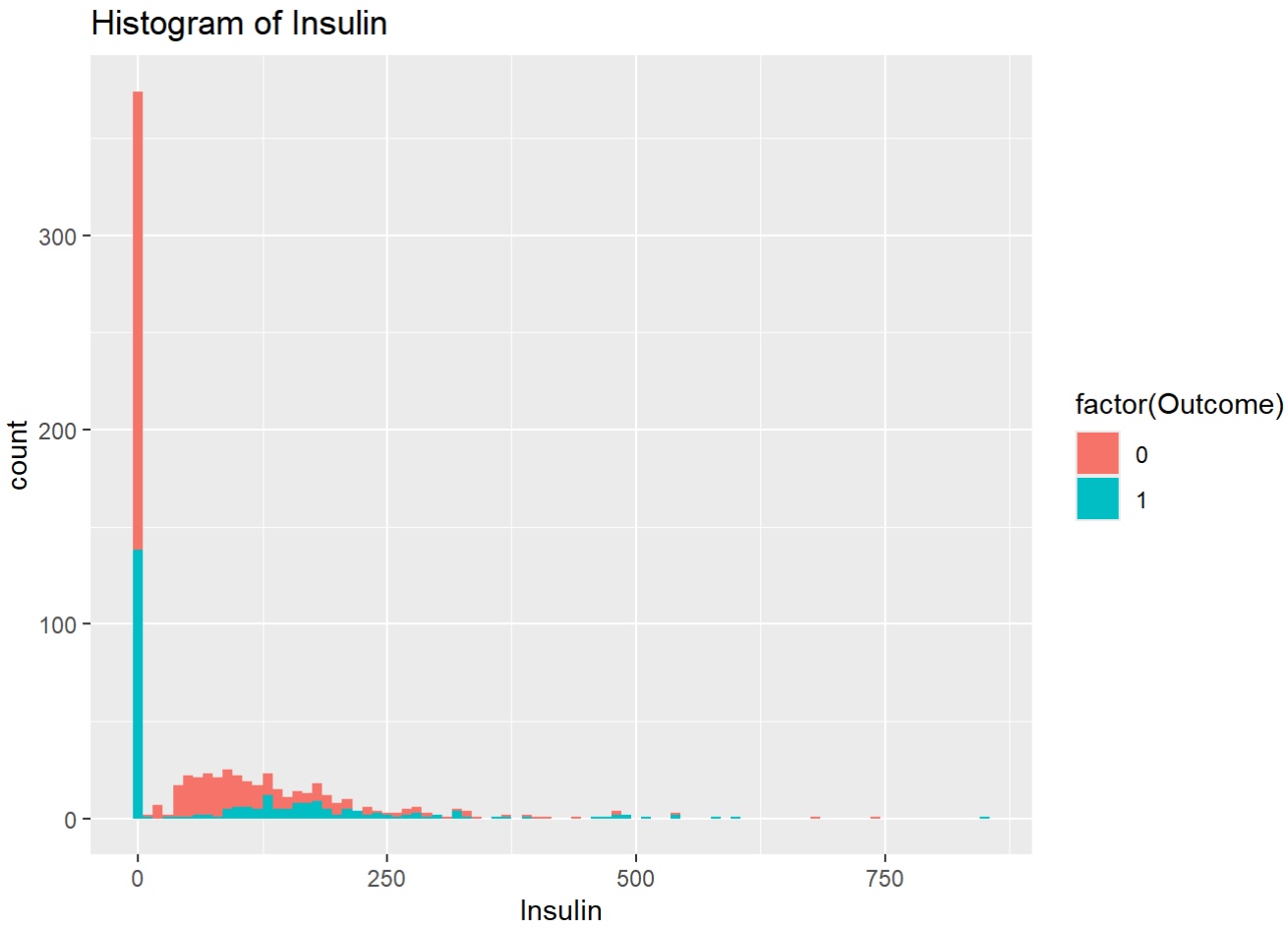

```
ggplot(cd, aes(x = BloodPressure, fill = factor(Outcome))) +
  geom_histogram(binwidth = 2) +
  labs(title = "Histogram of Blood Pressure")
```



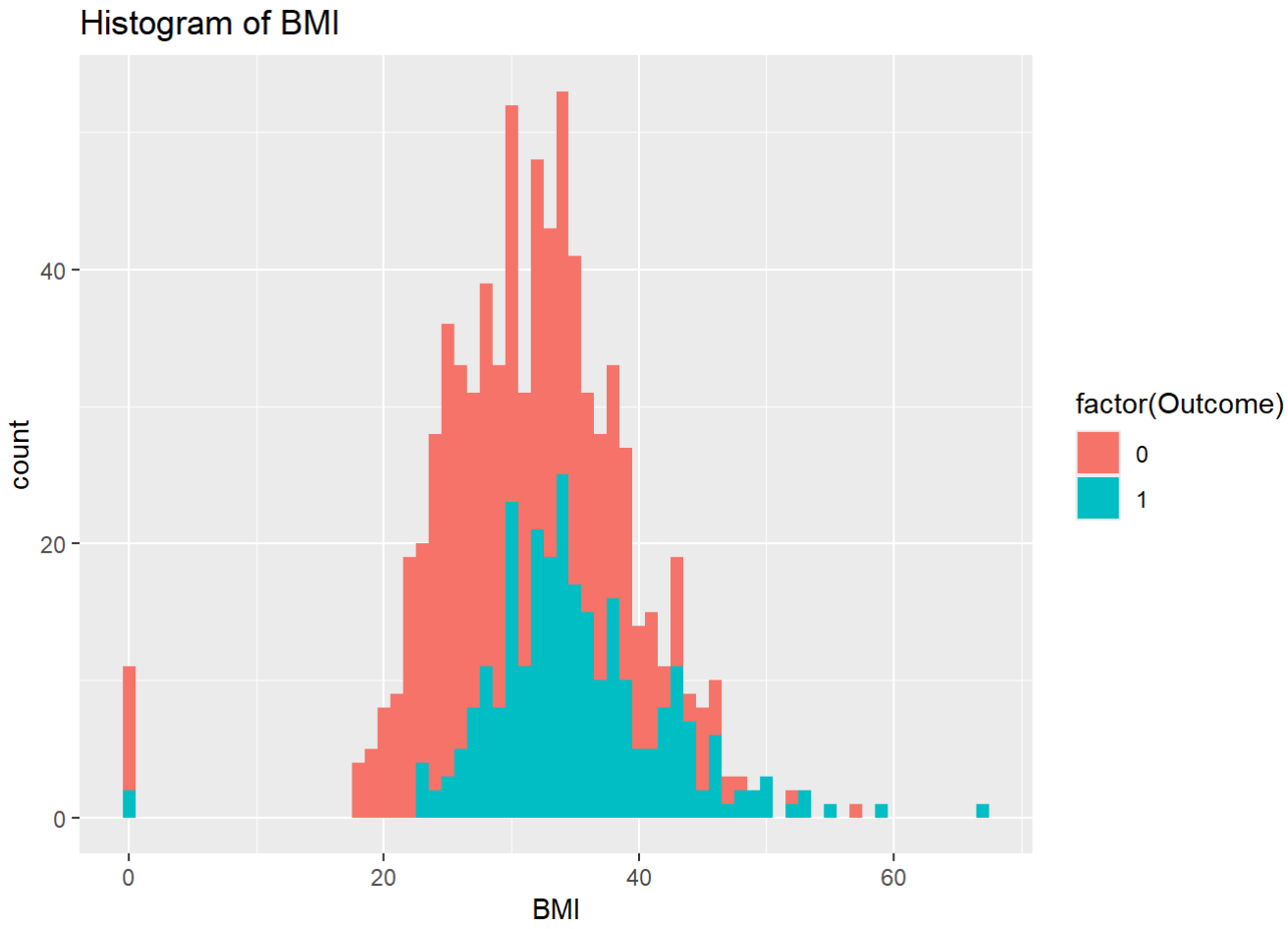

```
ggplot(cd, aes(x = SkinThickness, fill = factor(Outcome))) +
  geom_histogram(binwidth = 2) +
  labs(title = "Histogram of Skin Thickness")
```



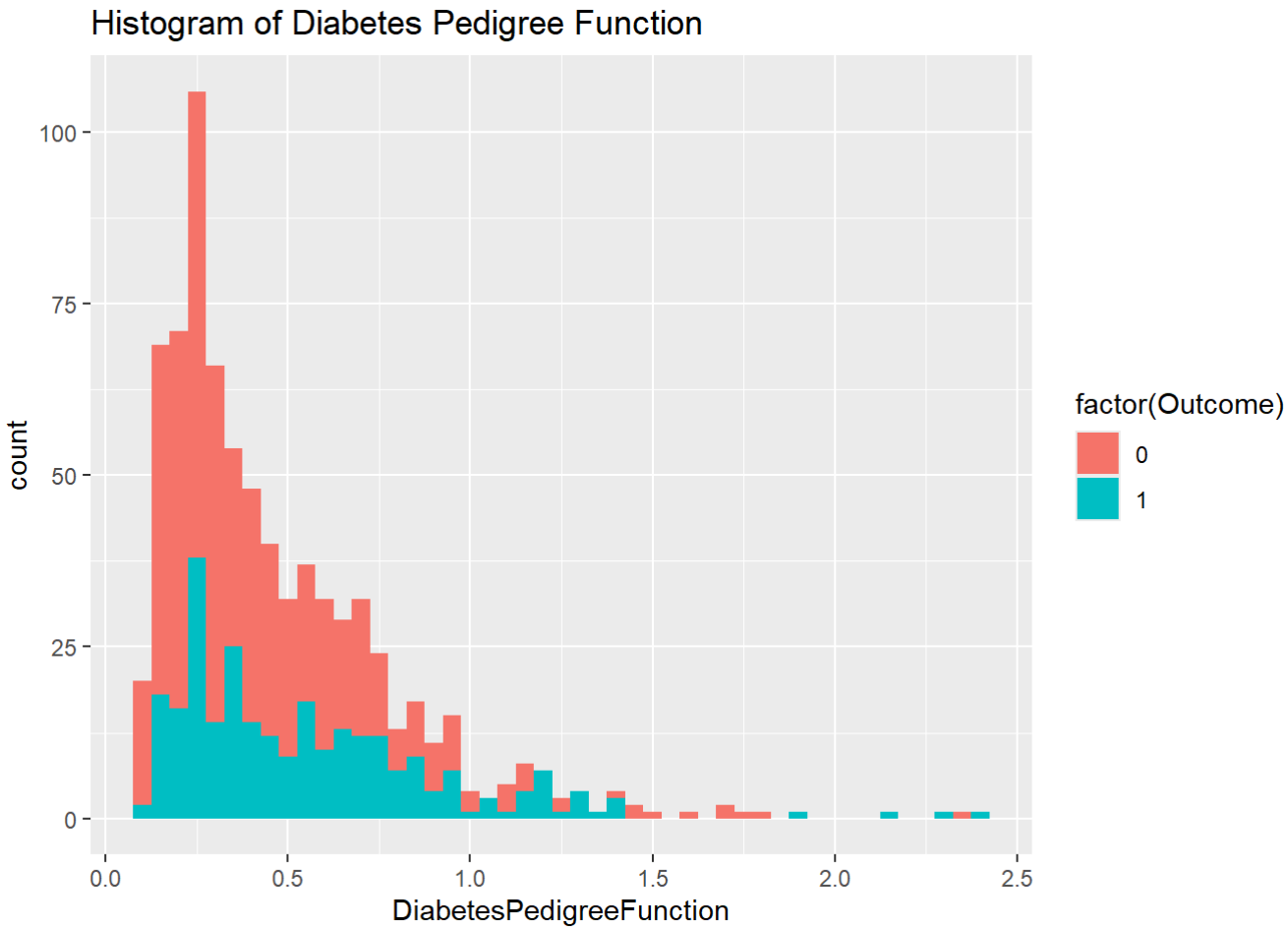

```
ggplot(cd, aes(x = Insulin, fill = factor(Outcome))) +
  geom_histogram(binwidth = 10) +
  labs(title = "Histogram of Insulin")
```



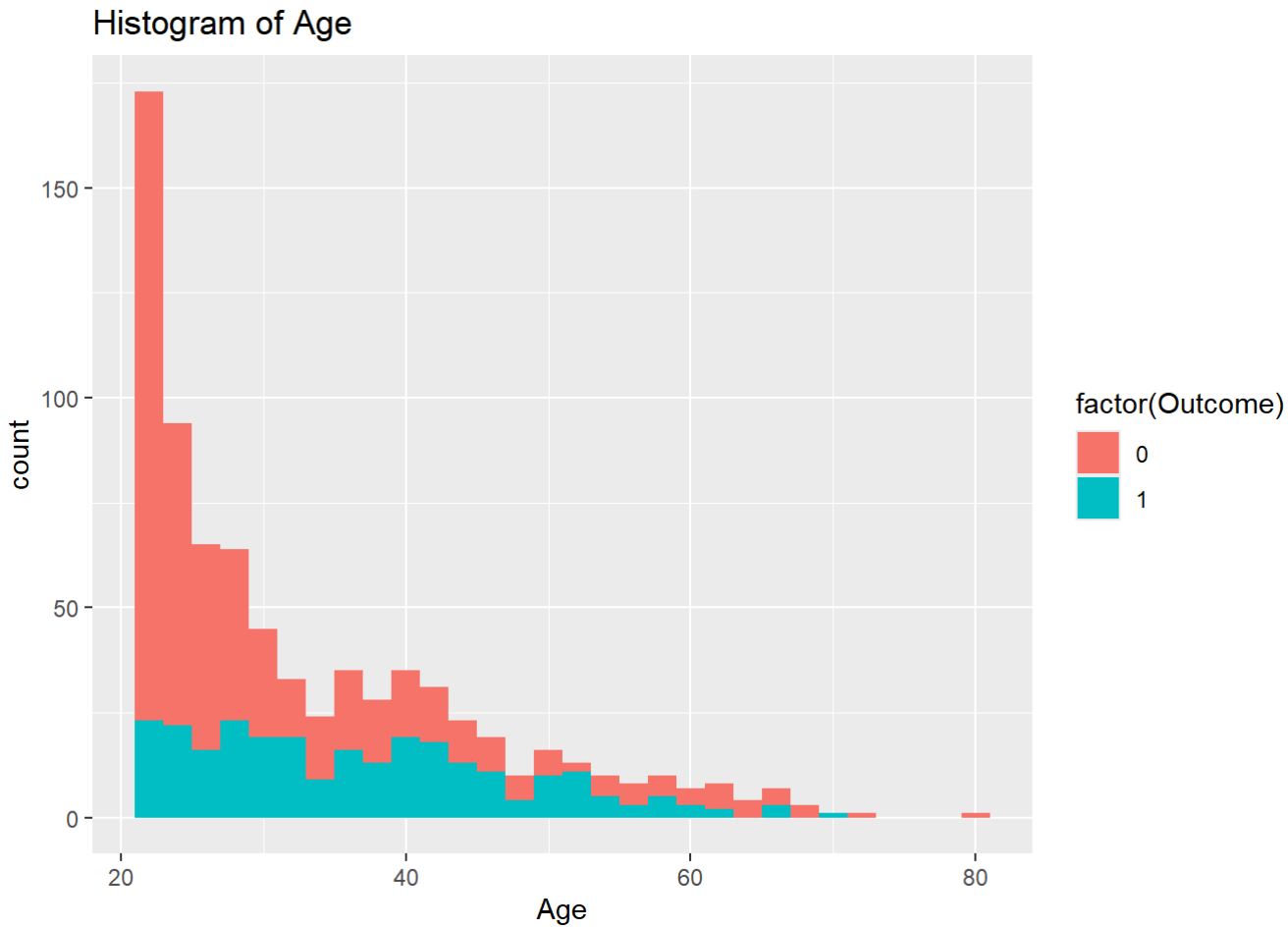

```
ggplot(cd, aes(x = BMI, fill = factor(Outcome))) +
  geom_histogram(binwidth = 1) +
  labs(title = "Histogram of BMI")
```




```
ggplot(cd, aes(x = DiabetesPedigreeFunction, fill = factor(Outcome))) +
  geom_histogram(binwidth = 0.05) +
  labs(title = "Histogram of Diabetes Pedigree Function")
```



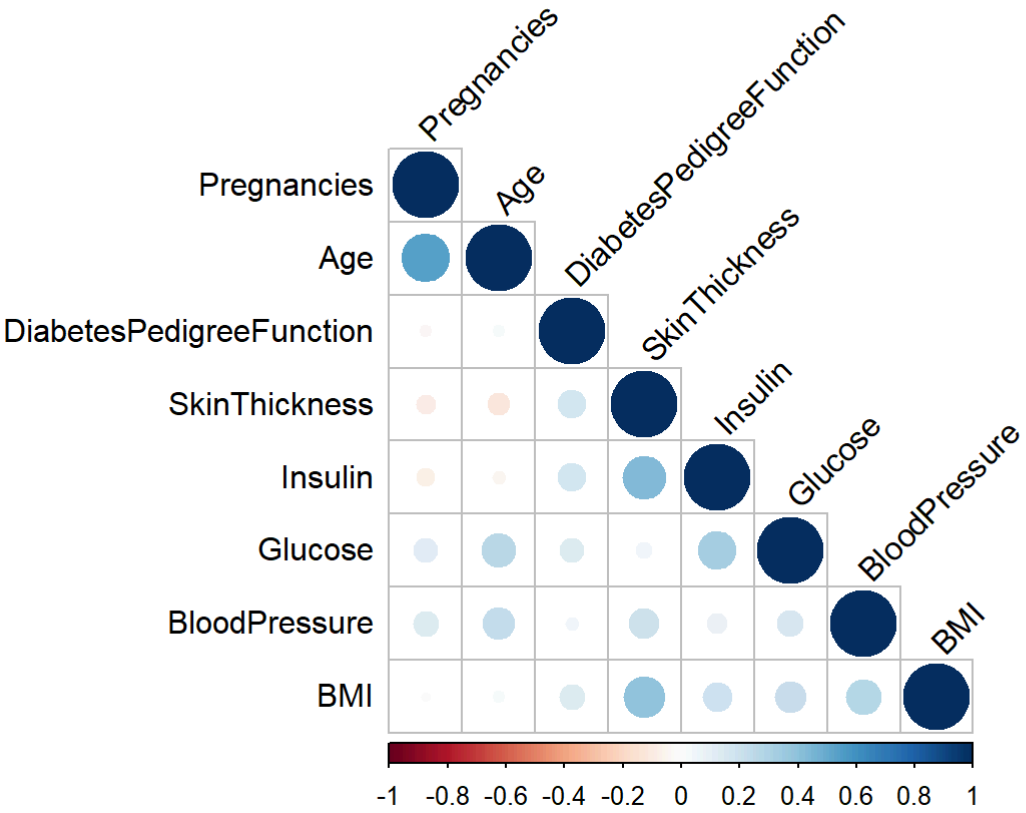

```
ggplot(cd, aes(x = Age, fill = factor(Outcome))) +
  geom_histogram(binwidth = 2) +
  labs(title = "Histogram of Age")
```



6. **Correlation matrix**

The correlation matrix analysis is performed to understand the relationships between the features in the dataset. This information can be used to identify potentially redundant or highly correlated features, which can then inform the feature selection or engineering process.

```
cor_matrix <- cor(cd[, -9])
corrplot(cor_matrix, method = "circle", order = "hclust",
         type = "lower", tl.col = "black", tl.srt = 45)
```



7. **Feature engineering**

In this step, I select the relevant features (Glucose, BMI, and Age) that will be used as input to the Logistic Regression model.

```
X <- cd[, c("Glucose", "BMI", "Age")]
y <- cd$Outcome
```

8. **Handle imbalanced dataset**

The diabetes dataset is likely to be imbalanced, as the number of people with diabetes and without diabetes may not be equal. We use the SMOTE (Synthetic Minority Over-sampling Technique) method to oversample the minority class (people with diabetes) to address the imbalance.

```
table(y)
```

```
## y
##   0   1
## 500 268
```

```
over_sampler <- SMOTE(X, y)
```

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```
X_over <- over_sampler$data[, 1:3]
y_over <- over_sampler$data[, 4]
```

9. **Split the data into training and testing sets**

I split the dataset into training and testing sets, with 70% of the data used for training the model and 30% for evaluating its performance.

```
set.seed(2)
train_index <- createDataPartition(y_over, p = 0.7, list = FALSE)
X_train <- X_over[train_index, ]
y_train <- y_over[train_index]
X_test <- X_over[-train_index, ]
y_test <- y_over[-train_index]
```

8. **Logistic Regression**

I train a Logistic Regression model using the training data. Logistic Regression is a suitable algorithm for this binary classification problem, as it can predict the probability of a person having diabetes or not.

```
logit_model <- train(x = X_train, y = as.factor(y_train), method = "glm", family = "binomia
l", trControl = trainControl(method = "none"))
```

9. **Evaluate the model**

Finally, we evaluate the performance of the Logistic Regression model on the testing data using various metrics such as accuracy, precision, recall, and F1-score. These metrics provide a comprehensive assessment of the model’s performance and help us understand its strengths and weaknesses.

```
y_pred_lr <- predict(logit_model, newdata = X_test)
confusion_matrix <- confusionMatrix(y_pred_lr, as.factor(y_test))

accuracy <- confusion_matrix$overall['Accuracy']
precision <- confusion_matrix$byClass['Pos Pred Value']
recall <- confusion_matrix$byClass['Sensitivity']
f1_score <- 2 * precision * recall / (precision + recall)

print(paste("Accuracy:", accuracy))
```

```
## [1] "Accuracy: 0.760869565217391"
```

```
print(paste("Precision:", precision))
```

```
## [1] "Precision: 0.787878787878788"
```

```
print(paste("Recall:", recall))
```

```
## [1] "Recall: 0.866666666666667"
```

```
print(paste("F1-score:", f1_score))
```

```
## [1] "F1-score: 0.825396825396825"
```

Conclusion:

In this project, I successfully conducted exploratory data analysis (EDA) on the diabetes dataset to understand its structure and characteristics. Visualizations were created to observe the distribution of various features and correlation analysis was performed to identify relationships between them. After handling missing values and addressing the imbalance in the dataset using the SMOTE technique, I proceeded to train a logistic regression model. Overall, this project demonstrates the application of machine learning techniques in healthcare, particularly in the early detection and management of chronic diseases like diabetes.

Signature of Lab Incharge

(Prof. Supriya Khaitan)