EDA

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Introduction to data

This section introduces the purpose of the exploratory data analysis (EDA) and sets up the necessary libraries and data files.

```
# import libraries
library(tidyverse)
library(corrplot)
library(ggplot2)
library(gridExtra)
library(correlation)
library(reshape)
library(reshape2)

data_train = read.csv("train.csv")
data_test = read.csv("test.csv")

# merge train and test data
data = rbind(data_train, data_test)
attach(data)
```

Variable description

This section provides a summary of each variable in the dataset, grouped by the target variable (satisfaction).

```
# Print summary for each variable grouped by satisfaction, including the name of the variable
for (col in names(data)) {
  print(col)
  print(by(data[[col]], data$satisfaction, summary))
}
```

```
## [1] "X"
## data$satisfaction: neutral or dissatisfied
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##       0   16334   39327   44318   71685  103903
## ------------------------------------------------------------
## data$satisfaction: satisfied
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##       0   16101   38477   43951   71136  103900
## [1] "id"
## data$satisfaction: neutral or dissatisfied
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##       1   31813   64082   64507   97173  129880
```

```
## ------------------------------------------------------------
## data$satisfaction: satisfied
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##       2   33201   65948   65504   97758  129879
## [1] "Gender"
## data$satisfaction: neutral or dissatisfied
##    Length     Class      Mode
##     73452 character character
## ------------------------------------------------------------
## data$satisfaction: satisfied
##    Length     Class      Mode
##     56428 character character
## [1] "Customer.Type"
## data$satisfaction: neutral or dissatisfied
##    Length     Class      Mode
##     73452 character character
## ------------------------------------------------------------
## data$satisfaction: satisfied
##    Length     Class      Mode
##     56428 character character
## [1] "Age"
## data$satisfaction: neutral or dissatisfied
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    7.00   25.00   37.00   37.65   50.00   85.00
## ------------------------------------------------------------
## data$satisfaction: satisfied
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    7.00   32.00   43.00   41.74   51.00   85.00
## [1] "Type.of.Travel"
## data$satisfaction: neutral or dissatisfied
##    Length     Class      Mode
##     73452 character character
## ------------------------------------------------------------
## data$satisfaction: satisfied
##    Length     Class      Mode
##     56428 character character
## [1] "Class"
## data$satisfaction: neutral or dissatisfied
##    Length     Class      Mode
##     73452 character character
## ------------------------------------------------------------
## data$satisfaction: satisfied
##    Length     Class      Mode
##     56428 character character
## [1] "Flight.Distance"
## data$satisfaction: neutral or dissatisfied
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    31.0   372.0   674.0   929.7  1149.0  4983.0
## ------------------------------------------------------------
## data$satisfaction: satisfied
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      31     525    1249    1530    2407    4983
## [1] "Inflight.wifi.service"
## data$satisfaction: neutral or dissatisfied
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   0.000   2.000   2.000   2.398   3.000   5.000
## ------------------------------------------------------------
## data$satisfaction: satisfied
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   0.000   2.000   4.000   3.159   5.000   5.000
## [1] "Departure.Arrival.time.convenient"
## data$satisfaction: neutral or dissatisfied
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    0.00    2.00    3.00    3.13    4.00    5.00
## ------------------------------------------------------------
## data$satisfaction: satisfied
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   0.000   2.000   3.000   2.963   4.000   5.000
## [1] "Ease.of.Online.booking"
## data$satisfaction: neutral or dissatisfied
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   0.000   2.000   3.000   2.549   3.000   5.000
## ------------------------------------------------------------
## data$satisfaction: satisfied
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   0.000   2.000   3.000   3.027   4.000   5.000
## [1] "Gate.location"
## data$satisfaction: neutral or dissatisfied
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    1.00    2.00    3.00    2.98    4.00    5.00
## ------------------------------------------------------------
## data$satisfaction: satisfied
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   0.000   2.000   3.000   2.973   4.000   5.000
## [1] "Food.and.drink"
## data$satisfaction: neutral or dissatisfied
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   0.000   2.000   3.000   2.958   4.000   5.000
## ------------------------------------------------------------
## data$satisfaction: satisfied
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   0.000   3.000   4.000   3.525   5.000   5.000
## [1] "Online.boarding"
## data$satisfaction: neutral or dissatisfied
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   0.000   2.000   3.000   2.659   3.000   5.000
## ------------------------------------------------------------
## data$satisfaction: satisfied
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   0.000   4.000   4.000   4.026   5.000   5.000
## [1] "Seat.comfort"
## data$satisfaction: neutral or dissatisfied
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   0.000   2.000   3.000   3.038   4.000   5.000
## ------------------------------------------------------------
## data$satisfaction: satisfied
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   1.000   4.000   4.000   3.966   5.000   5.000
```

```
## [1] "Inflight.entertainment"
## data$satisfaction: neutral or dissatisfied
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   0.000   2.000   3.000   2.892   4.000   5.000
## ------------------------------------------------------------
## data$satisfaction: satisfied
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   1.000   4.000   4.000   3.964   5.000   5.000
## [1] "On.board.service"
## data$satisfaction: neutral or dissatisfied
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    0.00    2.00    3.00    3.02    4.00    5.00
## ------------------------------------------------------------
## data$satisfaction: satisfied
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   1.000   3.000   4.000   3.856   5.000   5.000
## [1] "Leg.room.service"
## data$satisfaction: neutral or dissatisfied
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    0.00    2.00    3.00    2.99    4.00    5.00
## ------------------------------------------------------------
## data$satisfaction: satisfied
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    0.00    3.00    4.00    3.82    5.00    5.00
## [1] "Baggage.handling"
## data$satisfaction: neutral or dissatisfied
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   1.000   3.000   4.000   3.375   4.000   5.000
## ------------------------------------------------------------
## data$satisfaction: satisfied
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   1.000   4.000   4.000   3.967   5.000   5.000
## [1] "Checkin.service"
## data$satisfaction: neutral or dissatisfied
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   0.000   2.000   3.000   3.043   4.000   5.000
## ------------------------------------------------------------
## data$satisfaction: satisfied
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   1.000   3.000   4.000   3.649   5.000   5.000
## [1] "Inflight.service"
## data$satisfaction: neutral or dissatisfied
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    0.00    3.00    4.00    3.39    4.00    5.00
## ------------------------------------------------------------
## data$satisfaction: satisfied
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   1.000   4.000   4.000   3.971   5.000   5.000
## [1] "Cleanliness"
## data$satisfaction: neutral or dissatisfied
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   0.000   2.000   3.000   2.933   4.000   5.000
## ------------------------------------------------------------
## data$satisfaction: satisfied
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   1.000   3.000   4.000   3.747   5.000   5.000
## [1] "Departure.Delay.in.Minutes"
## data$satisfaction: neutral or dissatisfied
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    0.00    0.00    0.00   16.41   15.00 1592.00
## ------------------------------------------------------------
## data$satisfaction: satisfied
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    0.00    0.00    0.00   12.51    9.00 1305.00
## [1] "Arrival.Delay.in.Minutes"
## data$satisfaction: neutral or dissatisfied
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
##    0.00    0.00    0.00   17.06   16.00 1584.00     227
## ------------------------------------------------------------
## data$satisfaction: satisfied
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
##    0.00    0.00    0.00   12.53    8.00 1280.00     166
## [1] "satisfaction"
## data$satisfaction: neutral or dissatisfied
##    Length     Class      Mode
##     73452 character character
## ------------------------------------------------------------
## data$satisfaction: satisfied
##    Length     Class      Mode
##     56428 character character
```

```r
# print names of the columns
names(data)
```

```
##  [1] "X"                                "id"
##  [3] "Gender"                           "Customer.Type"
##  [5] "Age"                              "Type.of.Travel"
##  [7] "Class"                            "Flight.Distance"
##  [9] "Inflight.wifi.service"            "Departure.Arrival.time.convenient"
## [11] "Ease.of.Online.booking"           "Gate.location"
## [13] "Food.and.drink"                   "Online.boarding"
## [15] "Seat.comfort"                     "Inflight.entertainment"
## [17] "On.board.service"                 "Leg.room.service"
## [19] "Baggage.handling"                 "Checkin.service"
## [21] "Inflight.service"                 "Cleanliness"
## [23] "Departure.Delay.in.Minutes"       "Arrival.Delay.in.Minutes"
## [25] "satisfaction"
```

Data preprocessing

This section performs data preprocessing steps such as renaming columns, dropping unnecessary columns, and converting categorical variables to factors.

```r
# replace dots with underscores in column names
names(data) = gsub("\\.", "_", names(data))

# drop X and id column
data = data %>% select(-X, -id)
```

```r
names(data)
```

```
##  [1] "Gender"                          "Customer_Type"
##  [3] "Age"                             "Type_of_Travel"
##  [5] "Class"                           "Flight_Distance"
##  [7] "Inflight_wifi_service"           "Departure_Arrival_time_convenient"
##  [9] "Ease_of_Online_booking"          "Gate_location"
## [11] "Food_and_drink"                  "Online_boarding"
## [13] "Seat_comfort"                    "Inflight_entertainment"
## [15] "On_board_service"                "Leg_room_service"
## [17] "Baggage_handling"                "Checkin_service"
## [19] "Inflight_service"                "Cleanliness"
## [21] "Departure_Delay_in_Minutes"      "Arrival_Delay_in_Minutes"
## [23] "satisfaction"
```

```r
# convert categorical features to factor
data$Gender = factor(data$Gender, levels = c("Male", "Female"))
data$Customer_Type = factor(data$Customer_Type, levels = c("Loyal Customer", "disloyal Customer"))
data$Type_of_Travel = factor(data$Type_of_Travel, levels = c("Personal Travel", "Business travel"))
data$Class = factor(data$Class, levels = c("Business", "Eco Plus", "Eco"))
data$satisfaction = factor(data$satisfaction, levels = c("neutral or dissatisfied", "satisfied"))
```

Handling na values

This section identifies the variables with missing values and calculates the proportion of missing values for the "Arrival_Delay_in_Minutes" variable. It then drops the examples with missing values.

```r
# list features with na values
prop.table(colSums(is.na(data)))
```

```
##                          Gender                   Customer_Type
##                               0                               0
##                             Age                  Type_of_Travel
##                               0                               0
##                           Class                  Flight_Distance
##                               0                               0
##           Inflight_wifi_service Departure_Arrival_time_convenient
##                               0                               0
##          Ease_of_Online_booking                   Gate_location
##                               0                               0
##                  Food_and_drink                  Online_boarding
##                               0                               0
##                    Seat_comfort           Inflight_entertainment
##                               0                               0
##                On_board_service                 Leg_room_service
##                               0                               0
##                Baggage_handling                  Checkin_service
##                               0                               0
##                Inflight_service                      Cleanliness
##                               0                               0
##       Departure_Delay_in_Minutes         Arrival_Delay_in_Minutes
##                               0                               1
##                    satisfaction
##                               0
```

From here we can see that Arrival_Delay_in_Minutes has missing values, let's the proportion of na values

```
# Arrival_Delay_in_Minutes has na values, proportion of na values
prop.table(table(is.na(data$Arrival_Delay_in_Minutes)))
```

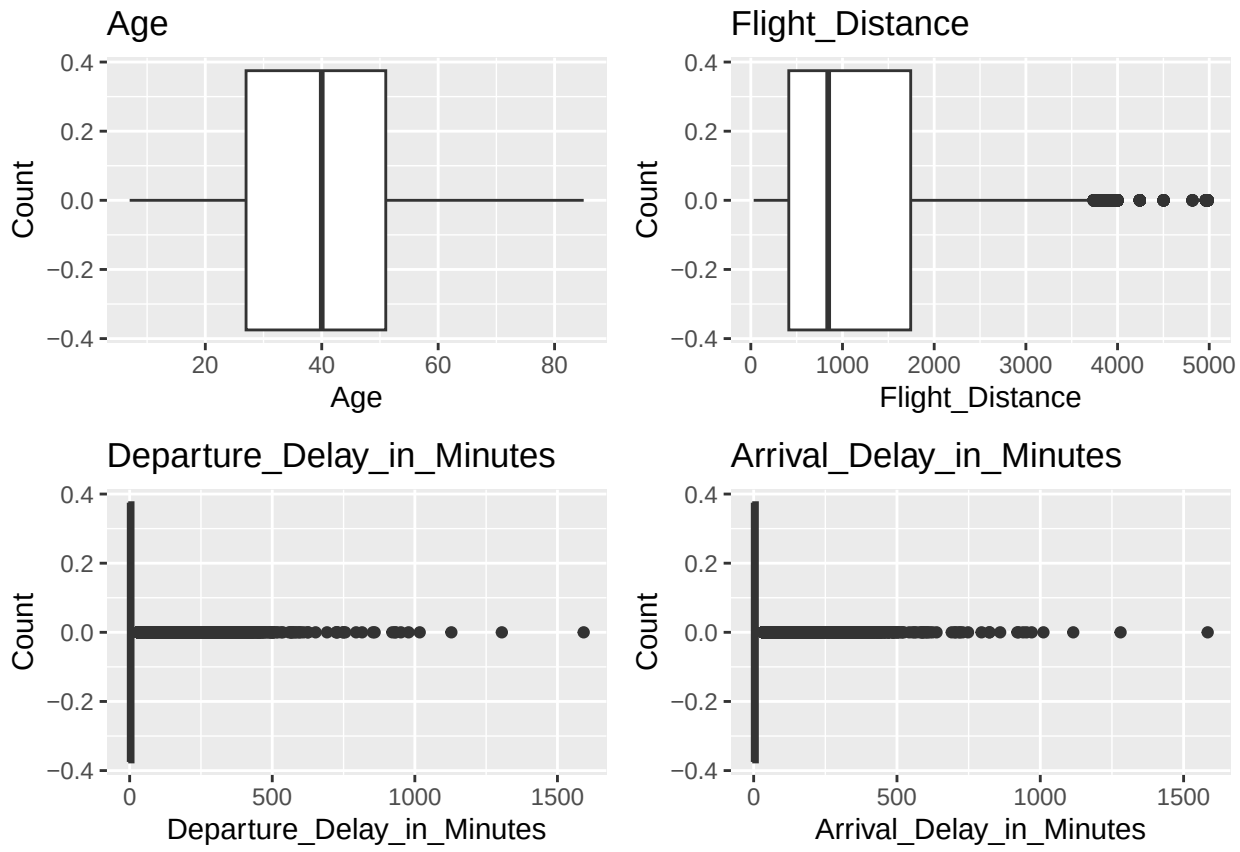
```
##
##      FALSE       TRUE
## 0.99697413 0.00302587
```

```
# na values are only 0.03% of the data -> drop na values
data = data %>% drop_na(Arrival_Delay_in_Minutes)
```

Outliers

This section creates box plots for each numeric variable in the dataset to visualize the presence of outliers. It also compares the box plots against the target variable (satisfaction).

```
ratings_fts_names = c("Inflight_wifi_service", "Departure_Arrival_time_convenient",
  "Ease_of_Online_booking", "Gate_location", "Food_and_drink", "Online_boarding",
  "Seat_comfort", "Inflight_entertainment", "On-board_service", "Leg_room_service",
  "Baggage_handling", "Checkin_service", "Inflight_service", "Cleanliness", "On_board_service")
# plot boxplot of each numeric variable excluding ratings features
plots = list()
for (col in names(data)[sapply(data, is.numeric)]) {
  if (col %in% ratings_fts_names) {
    next
  }
  plot = ggplot(data, aes(x = .data[[col]])) +
  geom_boxplot() +
  labs(title = col, x = col, y = "Count")
  plots[[col]] = plot
}

grid.arrange(grobs = plots, ncol = 2)
```



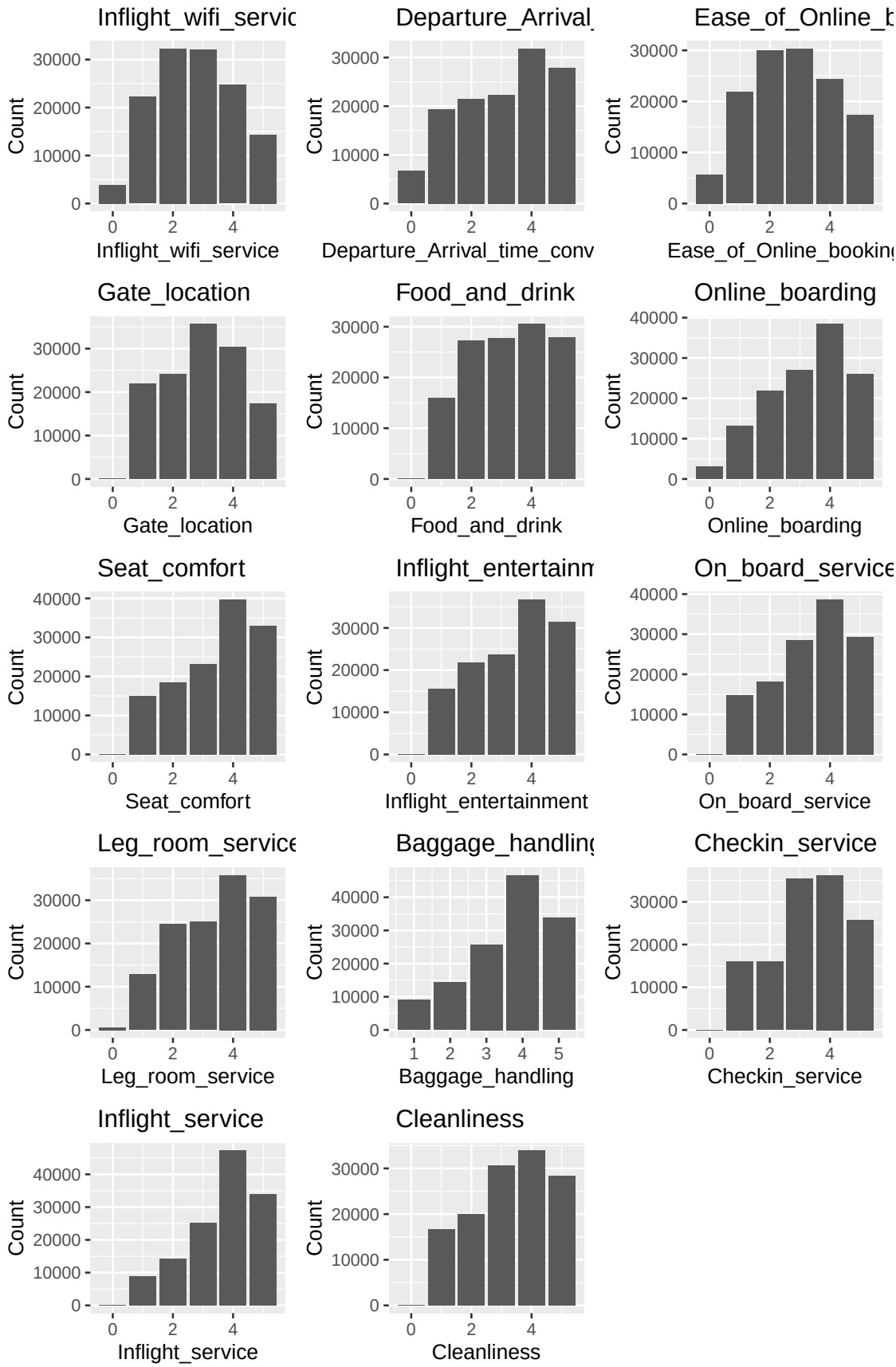
Visualization

This section includes histograms to visualize the distribution of categorical variables in the dataset.

```
# plot distribution of categorical variables
plots = list()
for (col in names(data)[sapply(data, is.factor)]) {
  plot = ggplot(data, aes(x = .data[[col]], fill = .data[[col]])) +
  geom_bar() +
  labs(title = paste("Histogram of", col), x = col, y = "Count")

  plots[[col]] = plot
}

grid.arrange(grobs = plots, ncol = 2)
```

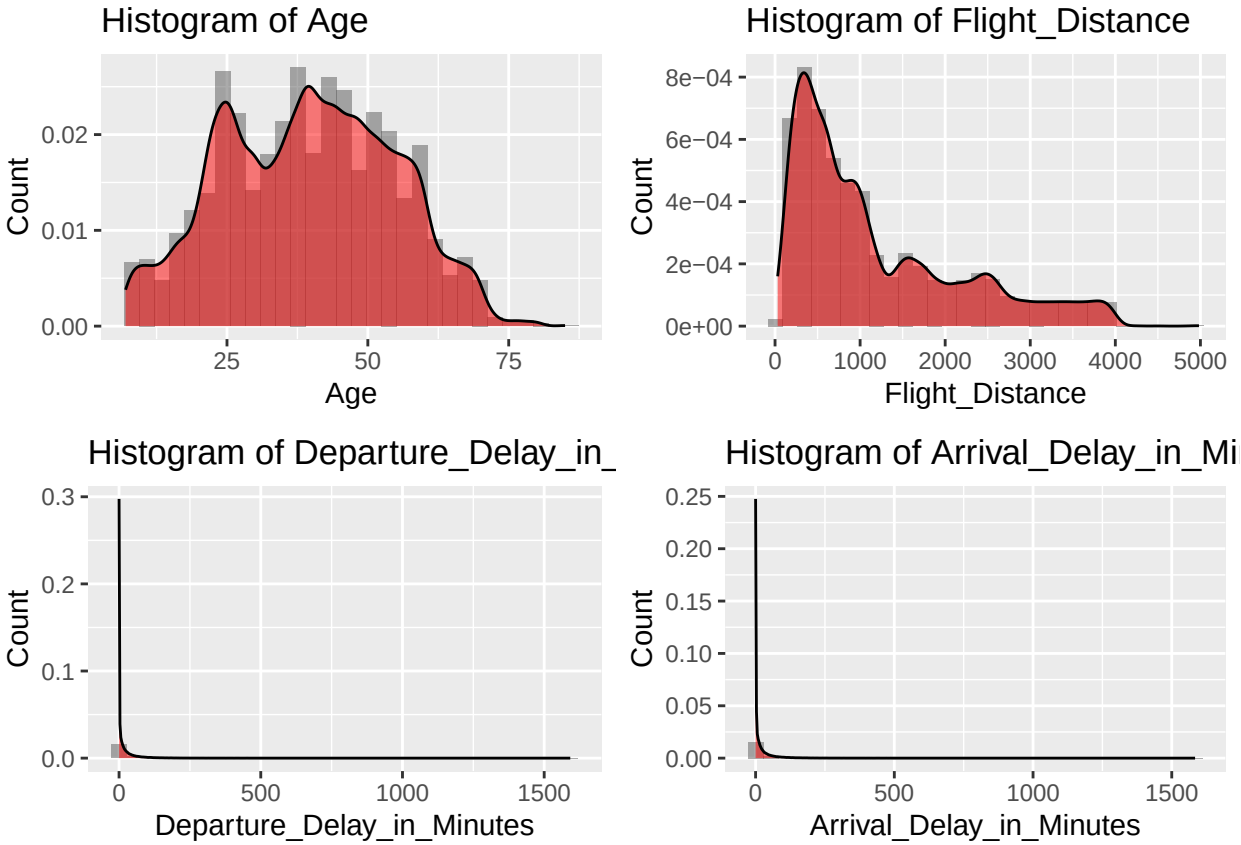
Here we plot the distribution of ratings features.

```
# plot distribution of ratings features
plots = list()
for (col in names(data)[sapply(data, is.numeric)]) {
  if (!col %in% ratings_fts_names) {
    next
  }
  plot = ggplot(data, aes(x = .data[[col]])) +
  geom_bar() +
  labs(title = paste("", col), x = col, y = "Count", bins=5)

  plots[[col]] = plot
}
grid.arrange(grobs = plots, ncol = 3)
```


Inflight_wifi_servic
Count
Inflight_wifi_service
Departure_Arrival
Departure_Arrival_time_conv
Ease_of_Online_b
Ease_of_Online_bookin
Gate_location
Gate_location
Food_and_drink
Food_and_drink
Online_boarding
Online_boarding
Seat_comfort
Seat_comfort
Inflight_entertainm
Inflight_entertainment
On_board_service
On_board_service
Leg_room_service
Leg_room_service
Baggage_handlin
Baggage_handling
Checkin_service
Checkin_service
Inflight_service
Inflight_service
Cleanliness
Cleanliness

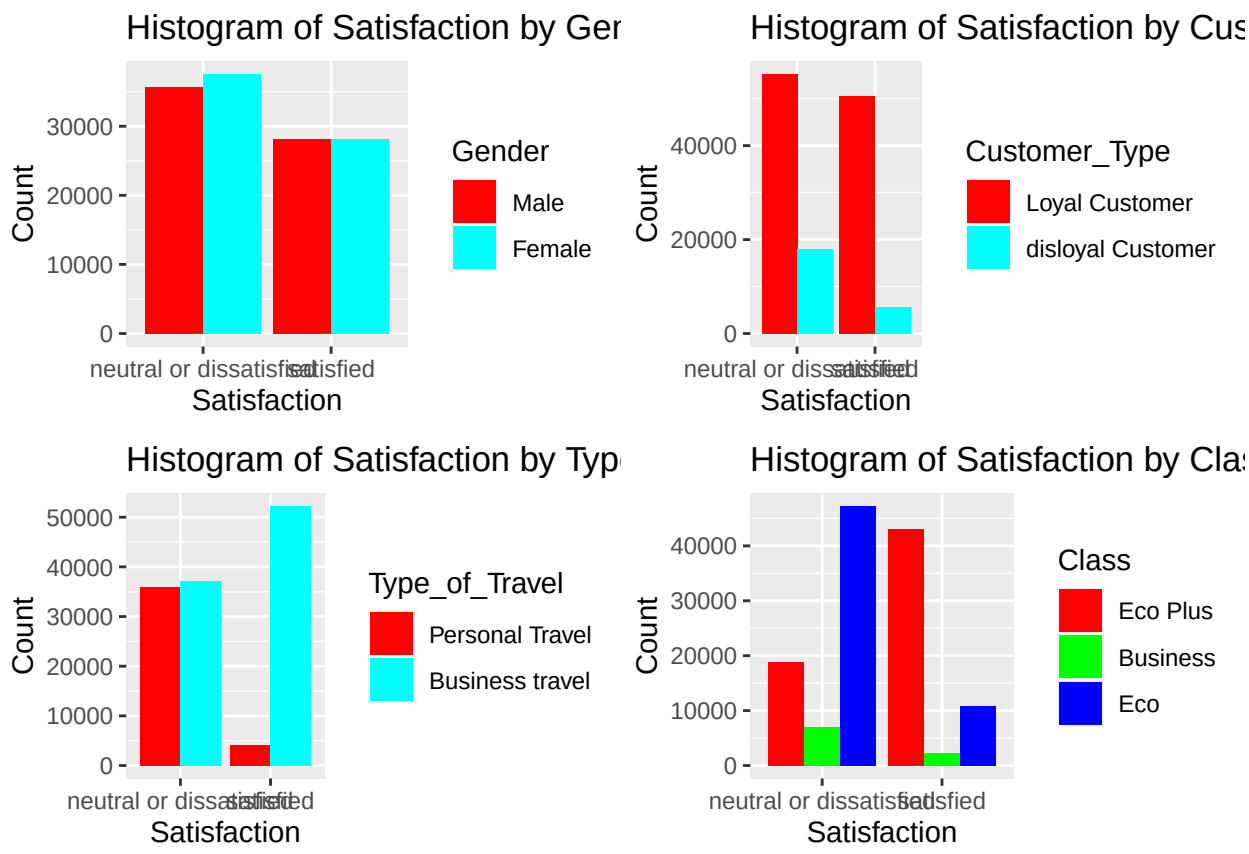
This section includes histograms to visualize the distribution of numeric variables in the dataset.

```
# plot distribution and density of numeric variables excluding ratings features
plots = list()
for (col in names(data)[sapply(data, is.numeric)]) {
  if (col %in% ratings_fts_names) {
    next
  }
  plot = ggplot(data, aes(x = .data[[col]])) +
  geom_histogram(aes(y = after_stat(density)), bins = 30, alpha = 0.5) +
  geom_density(alpha = 0.5, fill = "red") +
  labs(title = paste("Histogram of", col), x = col, y = "Count")

  plots[[col]] = plot
}

grid.arrange(grobs = plots, ncol = 2)
```

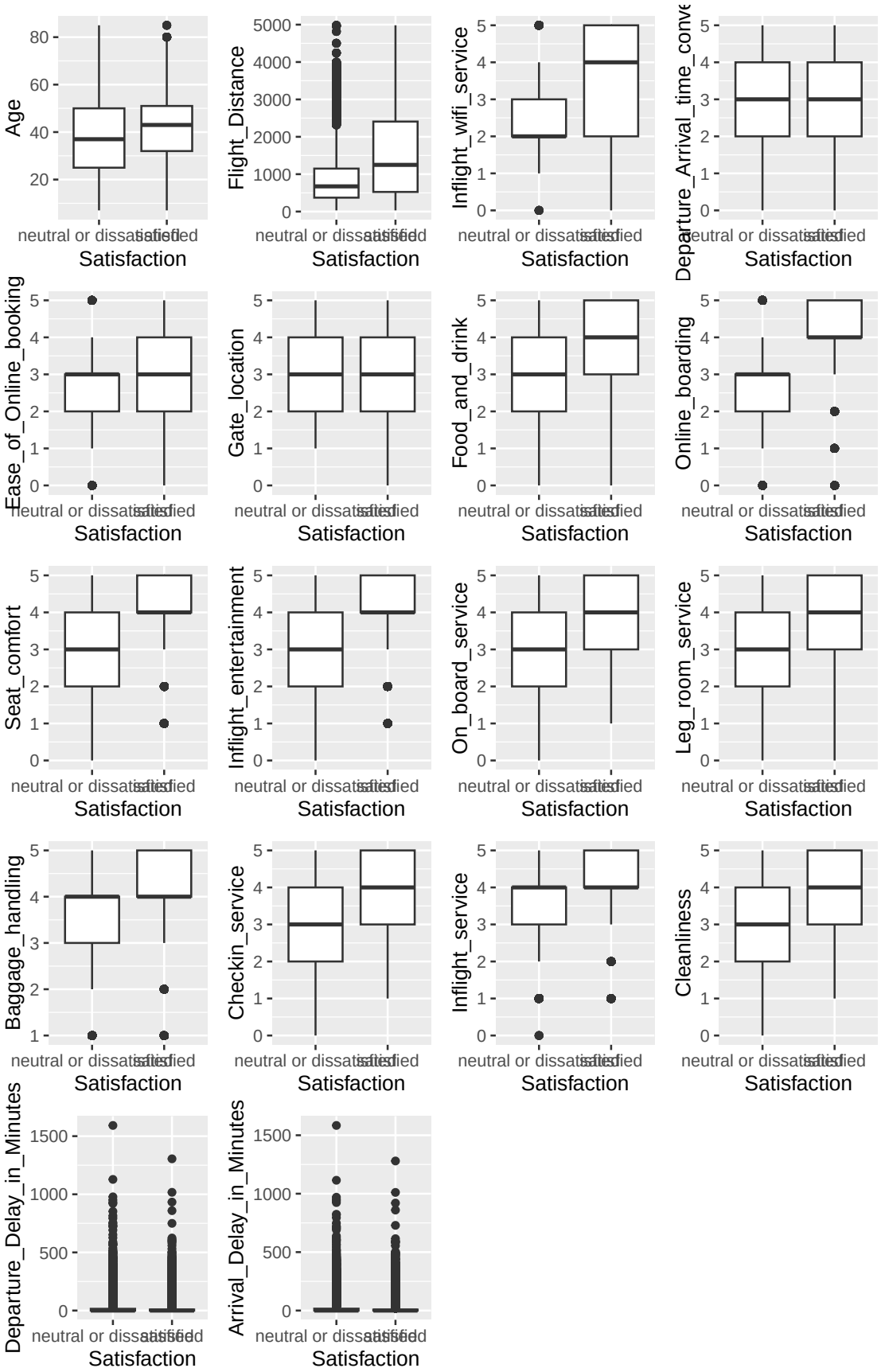



```
# plots categorical variables vs satisfaction
plots = list()
for (col in names(data)[sapply(data, is.factor)]) {
  if (col == "satisfaction") {
    next
  }
  plot = ggplot(data, aes(x = satisfaction, fill = .data[[col]])) +
  geom_bar(position = "dodge") +
  scale_fill_manual(values = rainbow(length(unique(data[[col]]))),
```

```
                    labels = unique(data[[col]]),
                    name = col) +
  labs(title = paste("Histogram of Satisfaction by", col), x = "Satisfaction", y = "Count")

  plots[[col]] = plot

}

grid.arrange(grobs = plots, ncol = 2)
```




```
# plots numeric variables vs satisfaction
plots = list()
for (col in names(data)[sapply(data, is.numeric)]) {
  if (col == "satisfaction") {
    next
  }
  plot = ggplot(data, aes(x = satisfaction, y = .data[[col]])) +
  geom_boxplot() +
  labs(x = "Satisfaction", y = col)

  plots[[col]] = plot

}

grid.arrange(grobs = plots, ncol = 4)
```


Age
Flight_Distance
Inflight_wifi_service
Departure_Arrival_time_conve
Ease_of_Online_booking
Gate_location
Food_and_drink
Online_boarding
Seat_comfort
Inflight_entertainment
On_board_service
Leg_room_service
Baggage_handling
Checkin_service
Inflight_service
Cleanliness
Departure_Delay_in_Minutes
Arrival_Delay_in_Minutes
neutral or dissatisfied
satisfied
Satisfaction

Convert categorical to numerical

This section converts the categorical variables to numeric representation for further analysis.

```
data$Gender = as.numeric(data$Gender) - 1
data$Customer_Type = as.numeric(data$Customer_Type) - 1
data$Type_of_Travel = as.numeric(data$Type_of_Travel) - 1
data$Class = as.numeric(data$Class) - 1
data$satisfaction = as.numeric(data$satisfaction) - 1
```

Data balance

This section calculates the proportion of satisfied and dissatisfied customers in the dataset.

```
prop.table(table(data$satisfaction))
```

```
##
##         0         1
## 0.5655008 0.4344992
```

Train test split

This section splits the data into training and testing sets, prints the proportion of satisfied and dissatisfied customers in each set, and saves the true values of the target variable for the test set.

```
set.seed(123)
train_index = sample(1:nrow(data), 0.8*nrow(data))
# 80% of data is used for training
train = data[train_index,]
# 20% of data is used for testing
test = data[-train_index,]

# merge train and test data
data = rbind(train, test)
# save on cvs
# write.csv(data, "data.csv")

# save true values of test satisfaction column
test_true = test$satisfaction

# drop satisfaction column from test data
test = test %>% select(-satisfaction)

# print proportion of satisfied and dissatisfied customers in train and test data
prop.table(table(train$satisfaction))
```

```
##
##         0         1
## 0.5668845 0.4331155
```

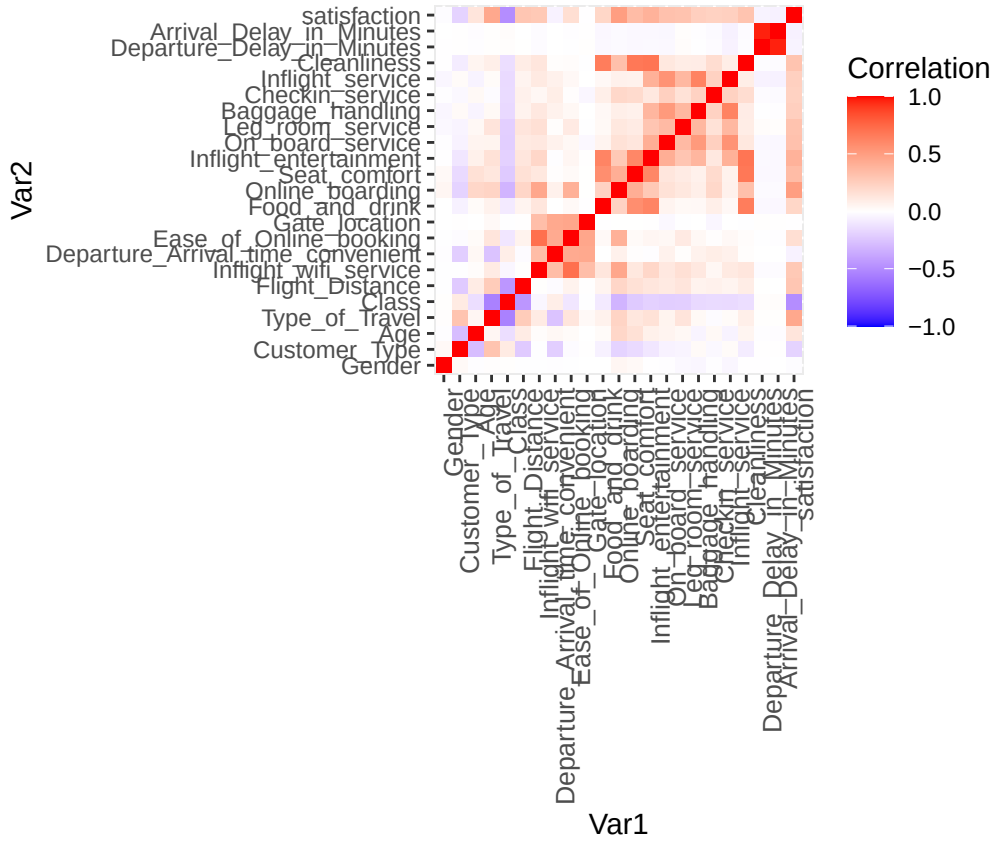
```
prop.table(table(test_true))
```

```
## test_true
##        0        1
## 0.559966 0.440034
```

Correlation matrix

This section calculates the correlation matrix for numeric variables and plots a heatmap to visualize the correlations between variables.

```
# correlation matrix only for numeric variables
correlation_matrix = cor(data[, sapply(data, is.numeric)])

# Plot a heatmap of the correlation matrix
ggplot(data = reshape2::melt(correlation_matrix)) +
  geom_tile(aes(x = Var1, y = Var2, fill = value)) +
  scale_fill_gradient2(low = "blue", mid = "white", high = "red",
                       midpoint = 0, limit = c(-1,1), space = "Lab",
                       name="Correlation") +
  theme(axis.text.x = element_text(angle = 90, vjust = 1,
                                   size = 10, hjust = 1)) +
  coord_fixed()
```




```
# Find high correlated features with satisfaction
# TODO: do the same with different threshold to find differences
# NOTE: i decided to use 0.3 as threshold
satisfaction_corr <- correlation_matrix['satisfaction',]
high_corr_satis <- names(satisfaction_corr[abs(satisfaction_corr) > 0.3 | abs(satisfaction_corr) < -0.3])
high_corr_satis <- high_corr_satis[high_corr_satis != "satisfaction"]
high_corr_satis
```

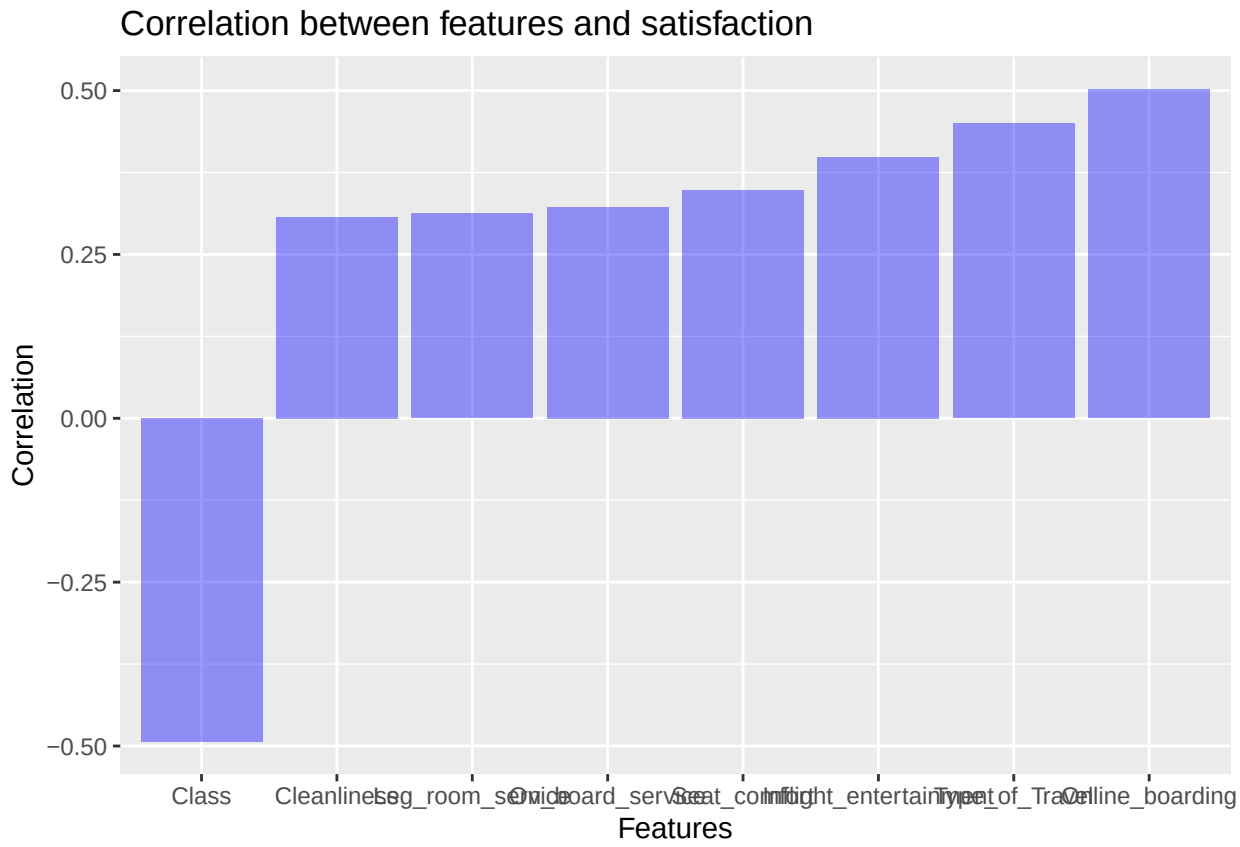
```
## [1] "Type_of_Travel"         "Class"                  "Online_boarding"
## [4] "Seat_comfort"           "Inflight_entertainment" "On_board_service"
```

```
## [7] "Leg_room_service"       "Cleanliness"
```

```r
# Compute the correlations between the high correlation features and satisfaction
correlations <- data.frame(
  feature = high_corr_satis,
  correlation = sapply(high_corr_satis, function(x) cor(data[,x], data$satisfaction))
)
correlations
```

```
##                                     feature correlation
## Type_of_Travel                Type_of_Travel   0.4497939
## Class                                  Class  -0.4930659
## Online_boarding              Online_boarding   0.5016203
## Seat_comfort                    Seat_comfort   0.3485759
## Inflight_entertainment Inflight_entertainment   0.3983339
## On_board_service             On_board_service   0.3223292
## Leg_room_service             Leg_room_service   0.3125570
## Cleanliness                       Cleanliness   0.3068906
```

```r
# plot the correlations
ggplot(correlations, aes(x = reorder(feature, correlation), y = correlation)) +
  geom_bar(stat = "identity", fill = "blue", alpha = 0.4) +
  ggtitle("Correlation between features and satisfaction") +
  xlab('Features') +
  ylab('Correlation')
```




```r
par(mfrow = c(1, 1))
```

```
#save on cvs
# write.csv(correlations, file = "correlations.csv")
```

Relation between Arrival_Delay_in_Minutes and Departure_Delay_in_Minutes (linear)

This section explores the partial correlation matrix and identifies variables with high correlations with the target variable (satisfaction). It also creates a bar plot to show the correlations.

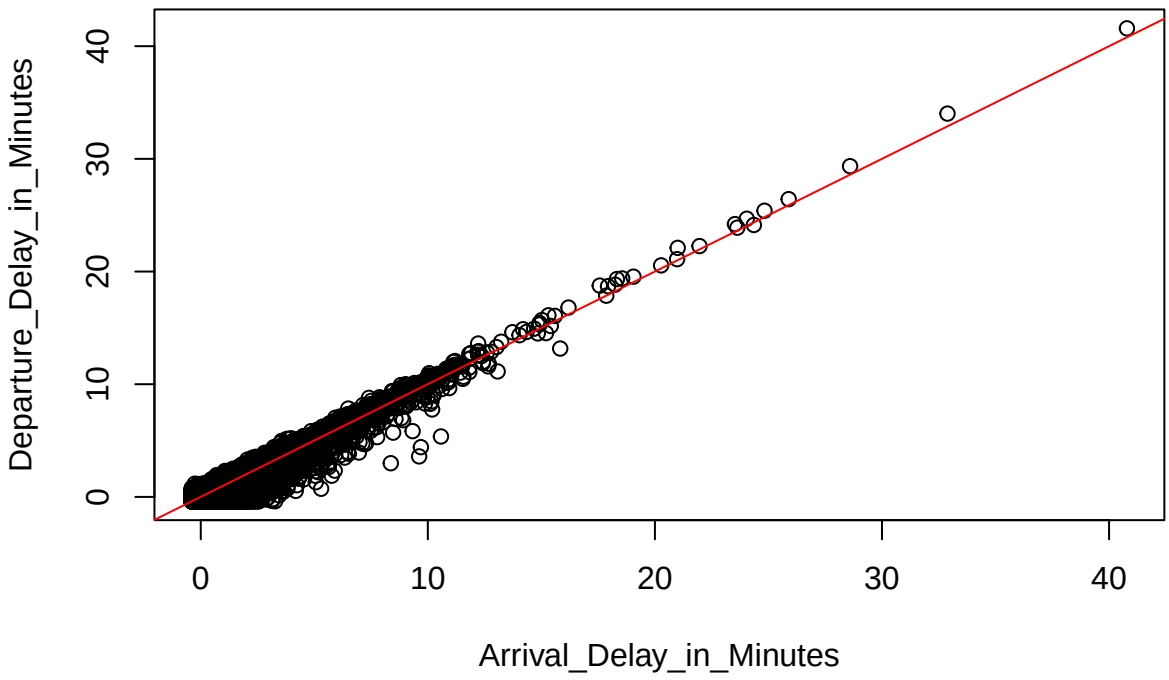
```
#CORRELATION MATRIX again but now we are interested in partial correlation
#So we look for all the correlations between variables
#We pick the highest, setting a treshold of our choice

#build a dataframe where for each variable we look the partial correlation with all the others
#we pick the highest and we save it in a dataframe
#we set a treshold of 0


#correlation(train, partial=TRUE, method='pearson')
#save the partial correlation matrix result in a dataframe and output a file for further analysis


#partial_corr <- correlation(train, partial=TRUE, method='pearson')
#write.csv(partial_corr, file = "partial_corr.csv")

partial_correlations = read.csv("partial_corr.csv", header = TRUE, sep = ",")

#make the first column the row names
rownames(partial_correlations) = partial_correlations[,1]

#drop the first  (X) column
partial_correlations = partial_correlations[,-1]

# Create a new matrix with rounded partial correlations
partial_correlations_rounded <- round(partial_correlations, digits = 3)


# Initialize empty data frame with 0 rows
# We need it to create a data frame with the results and
# so to show better the correlations.
df <- data.frame(variable1 = character(),
                 variable2 = character(),
                 value = numeric(),
                 stringsAsFactors = FALSE)

# Loop over rows and columns of matrix
for (i in 1:nrow(partial_correlations_rounded)) {
  for (j in 1:ncol(partial_correlations_rounded)) {
    # Check if value meets criterion
    if ((partial_correlations_rounded[i,j] > 0.300 | partial_correlations_rounded[i,j] < -0.300)& i != j
      # Add row to data frame
      df <- rbind(df, data.frame(variable1 = rownames(partial_correlations_rounded)[i],
                                 variable2 = colnames(partial_correlations_rounded)[j],
```

```
                                value = partial_correlations_rounded[i,j],
                                stringsAsFactors = FALSE))
    }
  }
}


# Group the data frame by variable1 and extract top 3 values for each group
df_top3 <- df %>% group_by(variable1) %>% top_n(4, value) %>% ungroup()

#order by variable1
df_top3 <- df_top3[order(df_top3$variable1),]


#delete duplicates in the dataframe if variable1 is equal to variable2
df_top3 <- df_top3[!(df_top3$variable1 == df_top3$variable2),]

print(df_top3, n = nrow(df_top3))
```

```
## # A tibble: 16 x 3
##    variable1                  variable2                  value
##    <chr>                      <chr>                      <dbl>
##  1 Arrival_Delay_in_Minutes   Departure_Delay_in_Minutes  0.964
##  2 Baggage_handling           Inflight_service           0.366
##  3 Class                      Type_of_Travel            -0.423
##  4 Cleanliness                Inflight_entertainment     0.411
##  5 Customer_Type              Type_of_Travel             0.497
##  6 Departure_Delay_in_Minutes Arrival_Delay_in_Minutes   0.964
##  7 Ease_of_Online_booking     Inflight_wifi_service      0.539
##  8 Food_and_drink             Inflight_entertainment     0.353
##  9 Inflight_entertainment     Food_and_drink             0.353
## 10 Inflight_entertainment     Cleanliness                0.411
## 11 Inflight_service           Baggage_handling           0.366
## 12 Inflight_wifi_service      Ease_of_Online_booking     0.539
## 13 satisfaction               Type_of_Travel             0.351
## 14 Type_of_Travel             Customer_Type              0.497
## 15 Type_of_Travel             Class                     -0.423
## 16 Type_of_Travel             satisfaction               0.351
```

```
#save on cvs
# write.csv(df_top3, file = "df_top3.csv")
```

```
# standardize Arrival_Delay_in_Minutes and Departure_Delay_in_Minutes
arrival_std = scale(data$Arrival_Delay_in_Minutes)
departure_std = scale(data$Departure_Delay_in_Minutes)
# scatter plot of Arrival_Delay_in_Minutes and Departure_Delay_in_Minutes
plot(arrival_std, departure_std, xlab = "Arrival_Delay_in_Minutes", ylab = "Departure_Delay_in_Minutes")
# plot line y = x
abline(0, 1, col = "red")
```




```
# print table of type of travel by satisfacton
table(data$Type_of_Travel, data$satisfaction)
```

```
##
##         0     1
##   0 35987  4055
##   1 37238 52207
```

```
# select examples of departure delay greater than 500
examples=data[data$Departure_Delay_in_Minutes > 800,]
# and print table of satisfaction by departure delay
table(examples$satisfaction)
```

```
##
## 0 1
## 8 4
```

```
# count the number of examples with departure delay = 0
sum(data$Departure_Delay_in_Minutes > 0)
```

```
## [1] 56278
```

```
sum(data$Departure_Delay_in_Minutes <= 0)
```

```
## [1] 73209
```

```
sum(data$Arrival_Delay_in_Minutes > 0)
```

```
## [1] 56734
```

```r
sum(data$Arrival_Delay_in_Minutes <= 0)
```

```
## [1] 72753
```

```r
summary(data)
```

```
##      Gender       Customer_Type         Age        Type_of_Travel
##  Min.   :0.0000   Min.   :0.0000   Min.   : 7.00   Min.   :0.0000
##  1st Qu.:0.0000   1st Qu.:0.0000   1st Qu.:27.00   1st Qu.:0.0000
##  Median :1.0000   Median :0.0000   Median :40.00   Median :1.0000
##  Mean   :0.5074   Mean   :0.1831   Mean   :39.43   Mean   :0.6908
##  3rd Qu.:1.0000   3rd Qu.:0.0000   3rd Qu.:51.00   3rd Qu.:1.0000
##  Max.   :1.0000   Max.   :1.0000   Max.   :85.00   Max.   :1.0000
##      Class        Flight_Distance Inflight_wifi_service
##  Min.   :0.0000   Min.   :  31    Min.   :0.000
##  1st Qu.:0.0000   1st Qu.: 414    1st Qu.:2.000
##  Median :1.0000   Median : 844    Median :3.000
##  Mean   :0.9701   Mean   :1190    Mean   :2.729
##  3rd Qu.:2.0000   3rd Qu.:1744    3rd Qu.:4.000
##  Max.   :2.0000   Max.   :4983    Max.   :5.000
##  Departure_Arrival_time_convenient Ease_of_Online_booking Gate_location
##  Min.   :0.000                     Min.   :0.000          Min.   :0.000
##  1st Qu.:2.000                     1st Qu.:2.000          1st Qu.:2.000
##  Median :3.000                     Median :3.000          Median :3.000
##  Mean   :3.057                     Mean   :2.757          Mean   :2.977
##  3rd Qu.:4.000                     3rd Qu.:4.000          3rd Qu.:4.000
##  Max.   :5.000                     Max.   :5.000          Max.   :5.000
##  Food_and_drink  Online_boarding  Seat_comfort   Inflight_entertainment
##  Min.   :0.000   Min.   :0.000   Min.   :0.000   Min.   :0.000
##  1st Qu.:2.000   1st Qu.:2.000   1st Qu.:2.000   1st Qu.:2.000
##  Median :3.000   Median :3.000   Median :4.000   Median :4.000
##  Mean   :3.205   Mean   :3.253   Mean   :3.442   Mean   :3.358
##  3rd Qu.:4.000   3rd Qu.:4.000   3rd Qu.:5.000   3rd Qu.:4.000
##  Max.   :5.000   Max.   :5.000   Max.   :5.000   Max.   :5.000
##  On_board_service Leg_room_service Baggage_handling Checkin_service
##  Min.   :0.000    Min.   :0.000    Min.   :1.000    Min.   :0.000
##  1st Qu.:2.000    1st Qu.:2.000    1st Qu.:3.000    1st Qu.:3.000
##  Median :4.000    Median :4.000    Median :4.000    Median :3.000
##  Mean   :3.383    Mean   :3.351    Mean   :3.632    Mean   :3.306
##  3rd Qu.:4.000    3rd Qu.:4.000    3rd Qu.:5.000    3rd Qu.:4.000
##  Max.   :5.000    Max.   :5.000    Max.   :5.000    Max.   :5.000
##  Inflight_service  Cleanliness    Departure_Delay_in_Minutes
##  Min.   :0.000    Min.   :0.000   Min.   :   0.00
##  1st Qu.:3.000    1st Qu.:2.000   1st Qu.:   0.00
##  Median :4.000    Median :3.000   Median :   0.00
##  Mean   :3.642    Mean   :3.286   Mean   :  14.64
##  3rd Qu.:5.000    3rd Qu.:4.000   3rd Qu.:  12.00
##  Max.   :5.000    Max.   :5.000   Max.   :1592.00
##  Arrival_Delay_in_Minutes  satisfaction
##  Min.   :   0.00          Min.   :0.0000
##  1st Qu.:   0.00          1st Qu.:0.0000
##  Median :   0.00          Median :0.0000
##  Mean   :  15.09          Mean   :0.4345
##  3rd Qu.:  13.00          3rd Qu.:1.0000
```

```
##  Max.   :1584.00          Max.   :1.0000
```