Urban Pedals: Unveiling Toronto’s Bike Share Story

Overview

This report contains the code and data for a data analysis project focused on exploring the ridership patterns of the bike-share scheme in Toronto. The analysis is conducted using the R programming language to gain insights into user behaviors, popular routes, and temporal trends.

Data Source

- Ref:
  - https://open.toronto.ca/dataset/bike-share-toronto-ridership-data/ (https://open.toronto.ca/dataset/bike-share-toronto-ridership-data/)

Download and Import data.

- Import libraries.

```
# load library
library(opendatatoronto)
library(dplyr)
```

```
##
## 载入程辑包：'dplyr'
```

```
## The following objects are masked from 'package:stats':
##
##     filter, lag
```

```
## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
library(tidyr)
library(ggplot2)
```

- Manually download data files from data source.
    - We have 52 files of 5-year data, from 2019 to 2023.
    - List of all data files

```
# Define path of dataset
DATA_PATH <- "./source/"

# get the paths for each data file.
FILE_PATH_LIST <- list.files(DATA_PATH, pattern = "\\.csv$", full.names = TRUE)
FILE_PATH_LIST
```

```
##  [1] "./source/2019-Q1.csv"
##  [2] "./source/2019-Q2.csv"
##  [3] "./source/2019-Q3.csv"
##  [4] "./source/2019-Q4.csv"
##  [5] "./source/2020-01.csv"
##  [6] "./source/2020-02.csv"
##  [7] "./source/2020-03.csv"
##  [8] "./source/2020-04.csv"
##  [9] "./source/2020-05.csv"
## [10] "./source/2020-06.csv"
## [11] "./source/2020-07.csv"
## [12] "./source/2020-08.csv"
## [13] "./source/2020-09.csv"
## [14] "./source/2020-10.csv"
## [15] "./source/2020-11.csv"
## [16] "./source/2020-12.csv"
## [17] "./source/Bike share ridership 2021-01.csv"
## [18] "./source/Bike share ridership 2021-02.csv"
## [19] "./source/Bike share ridership 2021-03.csv"
## [20] "./source/Bike share ridership 2021-04.csv"
## [21] "./source/Bike share ridership 2021-05.csv"
## [22] "./source/Bike share ridership 2021-06.csv"
## [23] "./source/Bike share ridership 2021-07.csv"
## [24] "./source/Bike share ridership 2021-08.csv"
## [25] "./source/Bike share ridership 2021-09.csv"
## [26] "./source/Bike share ridership 2021-10.csv"
## [27] "./source/Bike share ridership 2021-11.csv"
## [28] "./source/Bike share ridership 2021-12.csv"
## [29] "./source/Bike share ridership 2022-01.csv"
## [30] "./source/Bike share ridership 2022-02.csv"
## [31] "./source/Bike share ridership 2022-03.csv"
## [32] "./source/Bike share ridership 2022-04.csv"
## [33] "./source/Bike share ridership 2022-05.csv"
## [34] "./source/Bike share ridership 2022-06.csv"
## [35] "./source/Bike share ridership 2022-07.csv"
## [36] "./source/Bike share ridership 2022-08.csv"
## [37] "./source/Bike share ridership 2022-09.csv"
## [38] "./source/Bike share ridership 2022-10.csv"
```

```
## [39] "./source/Bike share ridership 2022-11.csv"
## [40] "./source/Bike share ridership 2022-12.csv"
## [41] "./source/Bike share ridership 2023-01.csv"
## [42] "./source/Bike share ridership 2023-02.csv"
## [43] "./source/Bike share ridership 2023-03.csv"
## [44] "./source/Bike share ridership 2023-04.csv"
## [45] "./source/Bike share ridership 2023-05.csv"
## [46] "./source/Bike share ridership 2023-06.csv"
## [47] "./source/Bike share ridership 2023-07.csv"
## [48] "./source/Bike share ridership 2023-08.csv"
## [49] "./source/Bike share ridership 2023-09.csv"
## [50] "./source/Bike share ridership 2023-10.csv"
## [51] "./source/Bike share ridership 2023-11.csv"
## [52] "./source/Bike share ridership 2023-12.csv"
```

- Import data from data files.
    - Check the columns of each csv file for data consisitence.
    - Combine all data into a uniformed dataframe for further anaysis.

```
# # Apply read.csv, a function to import data from csv file, for each file.
# # Get a list of df
# df_list <- lapply(FILE_PATH_LIST, read.csv)
#
#
# # Union all df by row
# raw_df <- do.call(rbind, df_list)
# raw_df
```

- Test using selective data

```
# paths <- c(
#   "./source/2019-Q1.csv",
#   "./source/2019-Q2.csv",
#   "./source/2019-Q3.csv",
#   "./source/2019-Q4.csv",
#   "./source/2020-01.csv",
#   "./source/2020-02.csv",
#   "./source/2020-03.csv",
#   "./source/2020-04.csv",
#   "./source/2020-05.csv",
#   "./source/2020-06.csv",
#   "./source/2020-07.csv",
#   "./source/2020-08.csv",
#   "./source/2020-09.csv",
#   "./source/2020-10.csv",
#   "./source/2020-11.csv",
#   "./source/2020-12.csv"
# )
# # paths <- c("./source/2020-01.csv")
# df_list <- lapply(paths, read.csv)
# raw_df <- do.call(rbind, df_list)
# raw_df
```

Data Processing

Handling NA and NULL value

- Handle NA value that exist in the raw data

```
# # Remove rows with any NA values
# proc_NA_df <- raw_df[complete.cases(raw_df), ]
#
# # Remove rows with "NULL" values
# proc_null_df <- proc_NA_df %>%
#   filter(!(End.Station.Name == "NULL" | End.Station.Id == "NULL" | Start.Station.Id =="NULL" | Start.Station.Name == "NUL
L"))
# proc_df <- proc_null_df
```

Converting Time-Dimension Data

- Divide time into year, month, date, hour, and minute.

```
# # Divide "Start.Time" into columns
# proc_df$Start.Time <- as.POSIXct(proc_df$Start.Time, format = "%m/%d/%Y %H:%M")
# proc_df$Start.Year <- as.factor(format(proc_df$Start.Time, "%Y"))
# proc_df$Start.Month <- as.factor(format(proc_df$Start.Time, "%m"))
# proc_df$Start.Date <- as.factor(format(proc_df$Start.Time, "%d"))
# proc_df$Start.Hours <- as.factor(format(proc_df$Start.Time, "%H"))
# proc_df$Start.Minutes <- as.factor(format(proc_df$Start.Time, "%M"))
#
# # Divide "End" into columns
# proc_df$End.Time <- as.POSIXct(proc_df$End.Time, format = "%m/%d/%Y %H:%M")
# proc_df$End.Year <- as.factor(format(proc_df$End.Time, "%Y"))
# proc_df$End.Month <- as.factor(format(proc_df$End.Time, "%m"))
# proc_df$End.Date <- as.factor(format(proc_df$End.Time, "%d"))
# proc_df$End.Hours <- as.factor(format(proc_df$End.Time, "%H"))
# proc_df$End.Minutes <- as.factor(format(proc_df$End.Time, "%M"))
#
# # factor user.type
# proc_df$User.Type <- as.factor(proc_df$User.Type)
#
#
# # Drop Start.Time and End.Time
# proc_df <- proc_df %>% select(-Start.Time, -End.Time)
```

- Check NA value again, in case of any possible values generated during the data processing.

```
# is_miss <- any(is.na(proc_df))
#
# # if the processed_df contains missing value, drop the rows with missing values and assign to df
# if (is_miss) {
#   df <- proc_df[complete.cases(proc_df), ]
# # otherwise, df = proc_df
# }else{
#   df <- proc_df
# }
#
# is_miss <- any(is.na(df))
# cat("df has missing value? ", is_miss)  # output result
```

- Data Overview after data processing.

```
# # Data overview after data processing
# num_row <- nrow(df)             # total rows
# column_names <- colnames(df)    # column names
# cat("\n\nNumber of rows: ", "\n", num_row)
# cat("\n\nColumn names: ", "\n", column_names)
#
# cat("\n\nDisplay the Structure:\n")
# str(df)
#
# cat("\n\nDisplay Summaries:\n")
# summary(df)
```

- Preview data

```
# df
# head(df, 10)
```

Exporting Processed Data(Optional)

- Export the Processed data to permanently store the processed data.

```
# # Path to export
# output_file <- "./data/dataset.csv"
# # export
# write.csv(df, file = output_file, row.names = FALSE)
```

ReLoading Processed Data

```
data_file <- "./data/dataset.csv"
df <- read.csv(data_file)
df
```

- Data Overview afater loading data.

```
# Data overview after data processing
num_row <- nrow(df)             # total rows
column_names <- colnames(df)    # column names
cat("\n\nNumber of rows: ", "\n", num_row)
```

```
##
##
## Number of rows:
##  17789237
```

```
cat("\n\nColumn names: ", "\n", column_names)
```

```
##
##
## Column names:
##  Trip.Id Trip..Duration Start.Station.Id Start.Station.Name End.Station.Id End.Station.Name Bike.Id User.Type Start.Year
Start.Month Start.Date Start.Hours Start.Minutes End.Year End.Month End.Date End.Hours End.Minutes
```

```
cat("\n\nDisplay the Structure:\n")
```

```
##
##
## Display the Structure:
```

```
str(df)
```

```
## 'data.frame':    17789237 obs. of  18 variables:
##  $ Trip.Id           : num  4581278 4581279 4581280 4581281 4581282 ...
##  $ Trip..Duration    : int  1547 1112 589 259 281 624 604 416 192 518 ...
##  $ Start.Station.Id  : int  7021 7160 7055 7012 7041 7041 7041 7275 7071 7199 ...
##  $ Start.Station.Name: chr  "Bay St / Albert St" "King St W / Tecumseth St" "Jarvis St / Carlton St" "Elizabeth St / Edwa
rd St (Bus Terminal)" ...
##  $ End.Station.Id    : int  7233 7051 7013 7235 7257 7031 7031 7041 7311 7252 ...
##  $ End.Station.Name  : chr  "King / Cowan Ave - SMART" "Wellesley St E / Yonge St (Green P)" "Scott St / The Esplanade"
"Bay St / College St (West Side) - SMART" ...
##  $ Bike.Id           : chr  "1296" "2947" "2293" "283" ...
##  $ User.Type         : chr  "Annual Member" "Annual Member" "Annual Member" "Annual Member" ...
##  $ Start.Year        : int  2019 2019 2019 2019 2019 2019 2019 2019 2019 2019 ...
##  $ Start.Month       : int  1 1 1 1 1 1 1 1 1 1 ...
##  $ Start.Date        : int  1 1 1 1 1 1 1 1 1 1 ...
##  $ Start.Hours       : int  0 0 0 0 0 0 0 0 0 0 ...
##  $ Start.Minutes     : int  8 10 15 16 19 26 26 26 34 38 ...
##  $ End.Year          : int  2019 2019 2019 2019 2019 2019 2019 2019 2019 2019 ...
##  $ End.Month         : int  1 1 1 1 1 1 1 1 1 1 ...
##  $ End.Date          : int  1 1 1 1 1 1 1 1 1 1 ...
##  $ End.Hours         : int  0 0 0 0 0 0 0 0 0 0 ...
##  $ End.Minutes       : int  33 29 25 20 24 36 36 33 37 46 ...
```

```
cat("\n\nDisplay Summaries:\n")
```

```
##
##
## Display Summaries:
```

```
summary(df)
```

```
##     Trip.Id         Trip..Duration     Start.Station.Id Start.Station.Name
##  Min.   : 4581278   Min.   :       0   Min.   :7000     Length:17789237
##  1st Qu.: 9607762   1st Qu.:     439   1st Qu.:7078     Class :character
##  Median :14783657   Median :     729   Median :7227     Mode  :character
##  Mean   :15075490   Mean   :    1047   Mean   :7246
##  3rd Qu.:20359050   3rd Qu.:    1164   3rd Qu.:7383
##  Max.   :26682738   Max.   :12403785   Max.   :7681
##  End.Station.Id End.Station.Name     Bike.Id           User.Type
##  Min.   :7000   Length:17789237    Length:17789237    Length:17789237
##  1st Qu.:7077   Class :character   Class :character   Class :character
##  Median :7224   Mode  :character   Mode  :character   Mode  :character
##  Mean   :7243
##  3rd Qu.:7381
##  Max.   :7681
##    Start.Year    Start.Month       Start.Date     Start.Hours
##  Min.   :2019   Min.   : 1.000   Min.   : 1.00   Min.   : 0.00
##  1st Qu.:2020   1st Qu.: 6.000   1st Qu.: 8.00   1st Qu.:11.00
##  Median :2021   Median : 7.000   Median :16.00   Median :15.00
##  Mean   :2021   Mean   : 7.246   Mean   :15.73   Mean   :14.57
##  3rd Qu.:2023   3rd Qu.: 9.000   3rd Qu.:23.00   3rd Qu.:18.00
##  Max.   :2023   Max.   :12.000   Max.   :31.00   Max.   :23.00
##  Start.Minutes      End.Year      End.Month         End.Date
##  Min.   : 0.00   Min.   :2019   Min.   : 1.000   Min.   : 1.00
##  1st Qu.:14.00   1st Qu.:2020   1st Qu.: 6.000   1st Qu.: 8.00
##  Median :30.00   Median :2021   Median : 7.000   Median :16.00
##  Mean   :29.55   Mean   :2021   Mean   : 7.246   Mean   :15.73
##  3rd Qu.:45.00   3rd Qu.:2023   3rd Qu.: 9.000   3rd Qu.:23.00
##  Max.   :59.00   Max.   :2024   Max.   :12.000   Max.   :31.00
##    End.Hours      End.Minutes
##  Min.   : 0.00   Min.   : 0.00
##  1st Qu.:11.00   1st Qu.:15.00
##  Median :16.00   Median :30.00
##  Mean   :14.71   Mean   :29.79
##  3rd Qu.:18.00   3rd Qu.:45.00
##  Max.   :23.00   Max.   :59.00
```

- Preview data

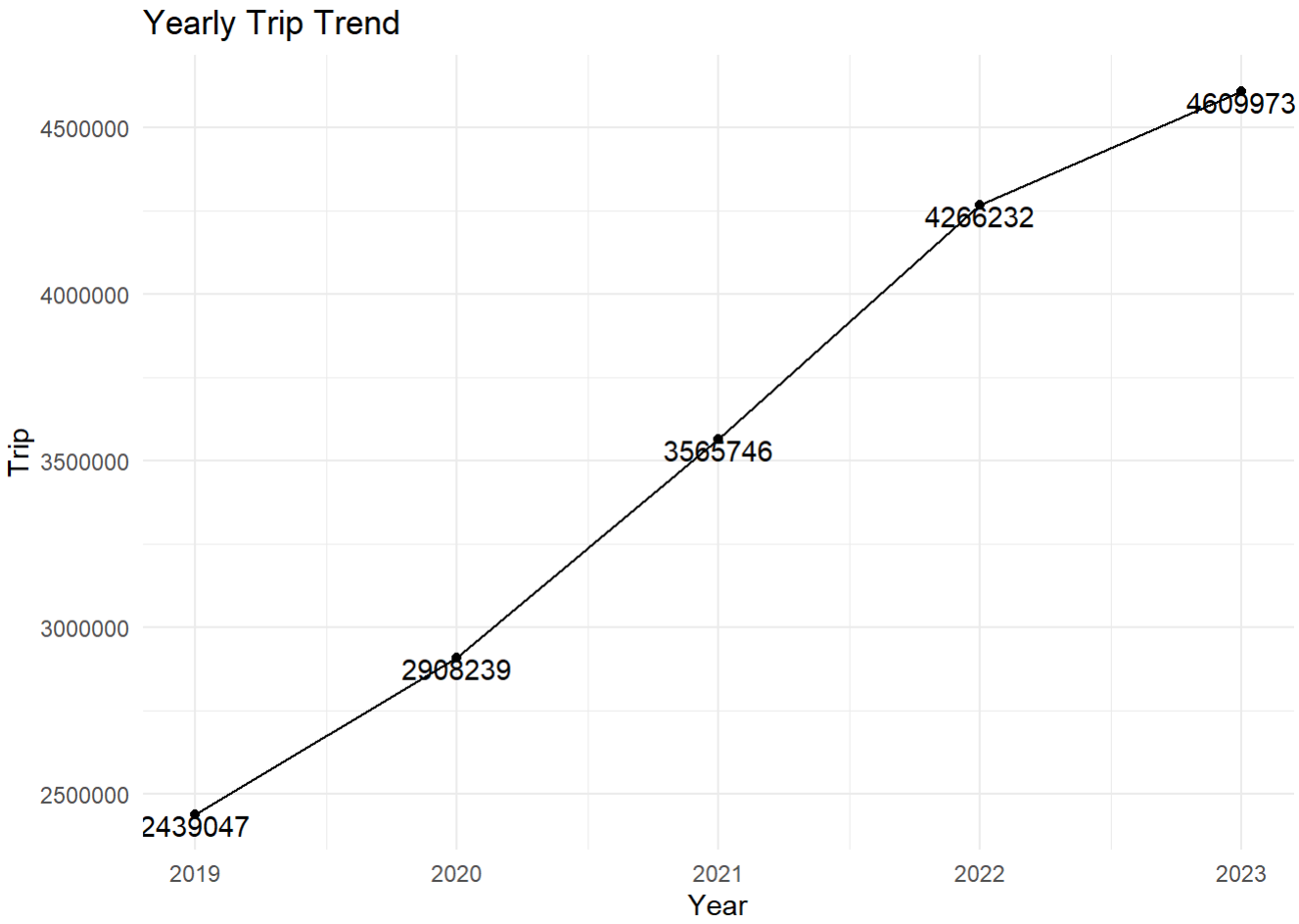
```
# df
head(df, 10)
```

Trip analysis

Yearly Trip Trends

```
trip_yearly <- df %>%
  group_by(Year = Start.Year) %>%
  summarize(Trip = n())
trip_yearly
```

```
ggplot(
  data = trip_yearly,
  mapping = aes(
      x = Year,
      y = Trip,
      group = 1
  )
) +
  geom_line() +
  geom_point() +
  geom_text(aes(label = as.character(Trip)), vjust = 1, hjust = 0.5) +
  labs(
    title = "Yearly Trip Trend",
    x = "Year",
    y = "Trip"
  ) +
  theme_minimal()
```



Monthly Trip Distribution

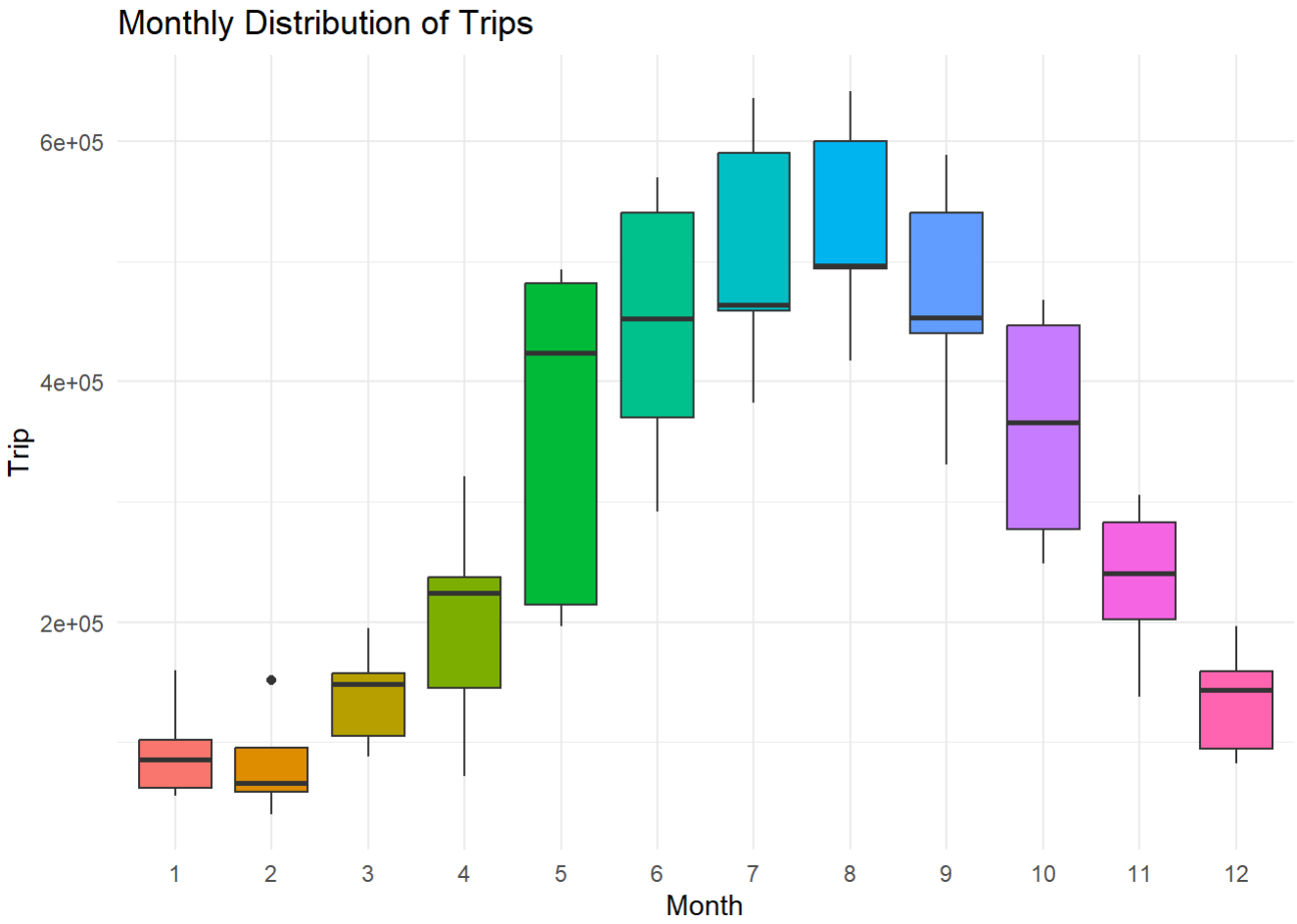
- Comparing monthly trip to unveil patterns over the months

```
trip_monthly_across_year <- df %>%
  group_by(
    Year = Start.Year,
    Month = Start.Month
    ) %>%
  summarize(Trip = n())
```

```
## `summarise()` has grouped output by 'Year'. You can override using the
## `.groups` argument.
```

```
trip_monthly_across_year
```

```
ggplot(
  data = trip_monthly_across_year,
  mapping = aes(
    x = factor(Month),
    y = Trip,
    fill = factor(Month)
    )
  ) +
  geom_boxplot(show.legend = FALSE) +
  labs(
    title = "Monthly Distribution of Trips",
    x = "Month",
    y = "Trip",
    fill = "Month"
  ) +
  theme_minimal()
```



Hourly Trip Pattern

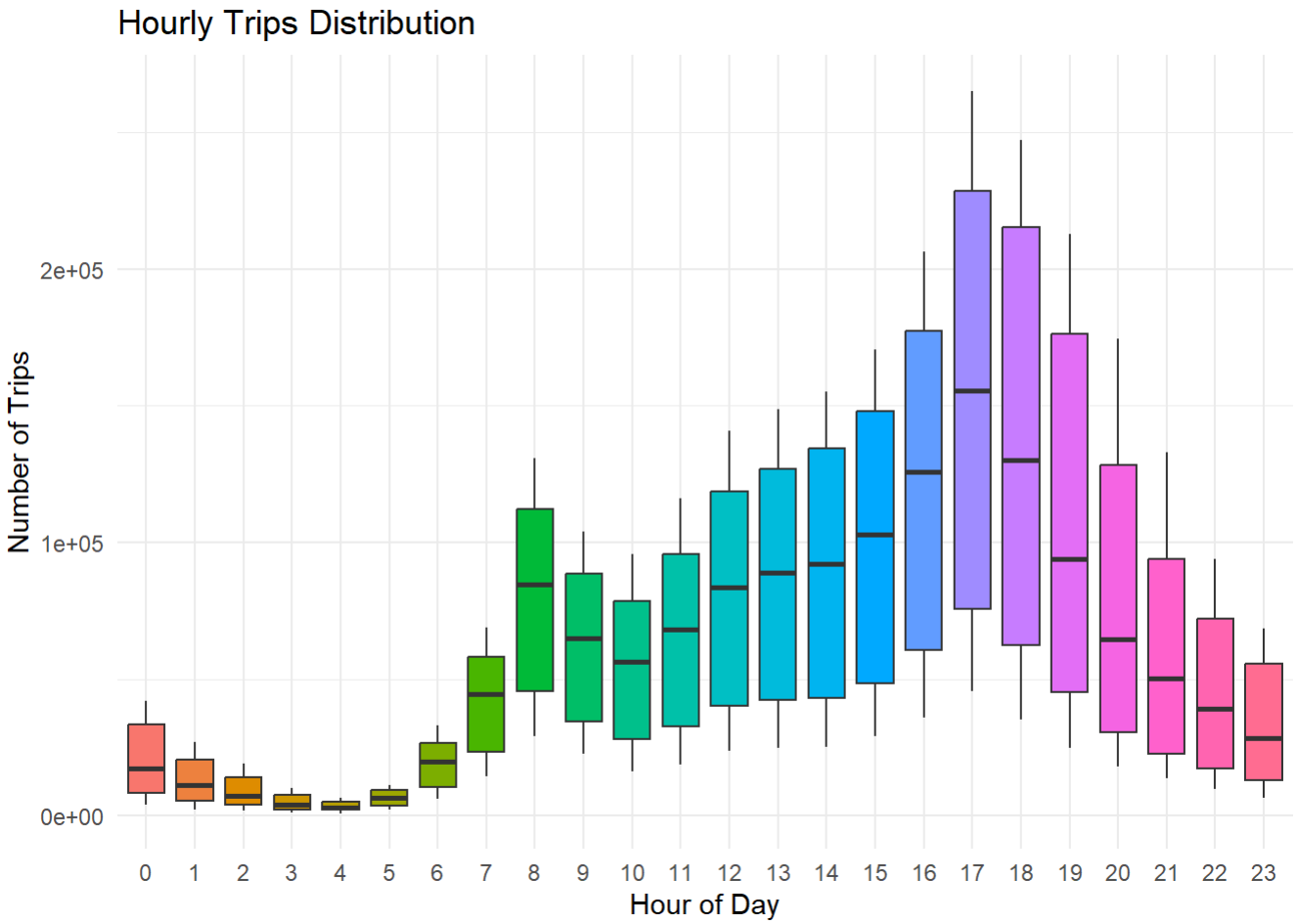
- Exploring Patterns Throughout the Day

```
trip_hourly_across_month <- df %>%
  group_by(
    Month = Start.Month,
    Hour = Start.Hours
    ) %>%
  summarize(Trip = n())
```

```
## `summarise()` has grouped output by 'Month'. You can override using the
## `.groups` argument.
```

```
trip_hourly_across_month
```

```
ggplot(
  trip_hourly_across_month,
  aes(
    x = factor(Hour),
    y = Trip,
    fill = factor(Hour)
    )
  ) +
  geom_boxplot(show.legend = FALSE) +
  labs(
    title = "Hourly Trips Distribution",
    x = "Hour of Day",
    y = "Number of Trips",
    fill = "Hour of Day") +
  theme_minimal()
```


Hourly Trips Distribution
Number of Trips
2e+05
1e+05
0e+00
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Hour of Day

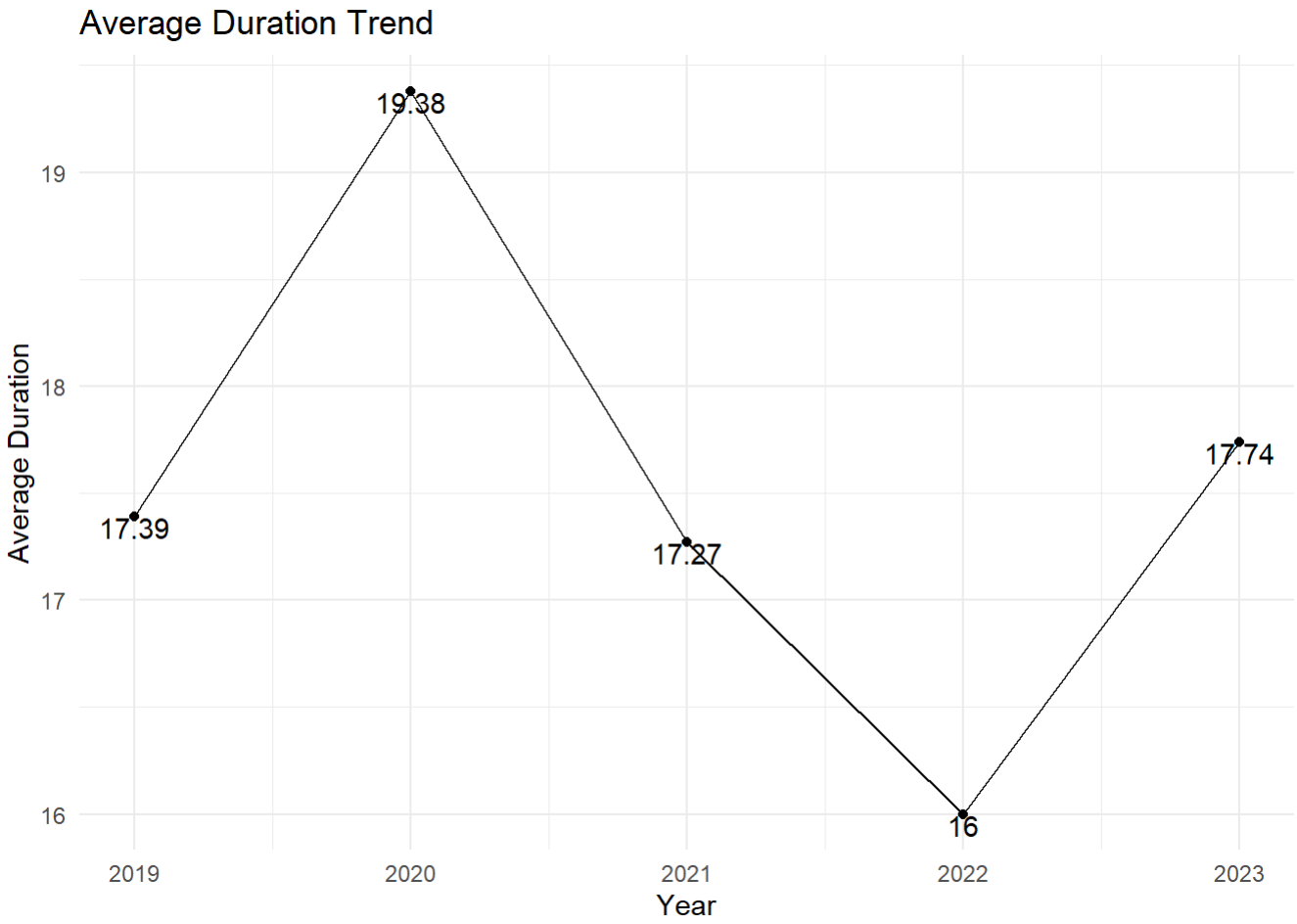
Duration Analysis

Duration Yearly Trend

```
duration_yearly <- df %>%
  group_by(Year = Start.Year) %>%
  summarize(Mean_Duration = round(mean(Trip..Duration) / 60, 2))

duration_yearly
```

```
ggplot(
  data = duration_yearly,
  mapping = aes(
      x = Year,
      y = Mean_Duration,
      group = 1
    )
  ) +
  geom_line() +
  geom_point() +
  geom_text(
    aes(
      label = as.character(Mean_Duration)
      ),
    vjust = 1,
    hjust = 0.5
  ) +
  labs(
    title = "Average Duration Trend",
    x = "Year",
    y = "Average Duration"
  ) +
  theme_minimal()
```



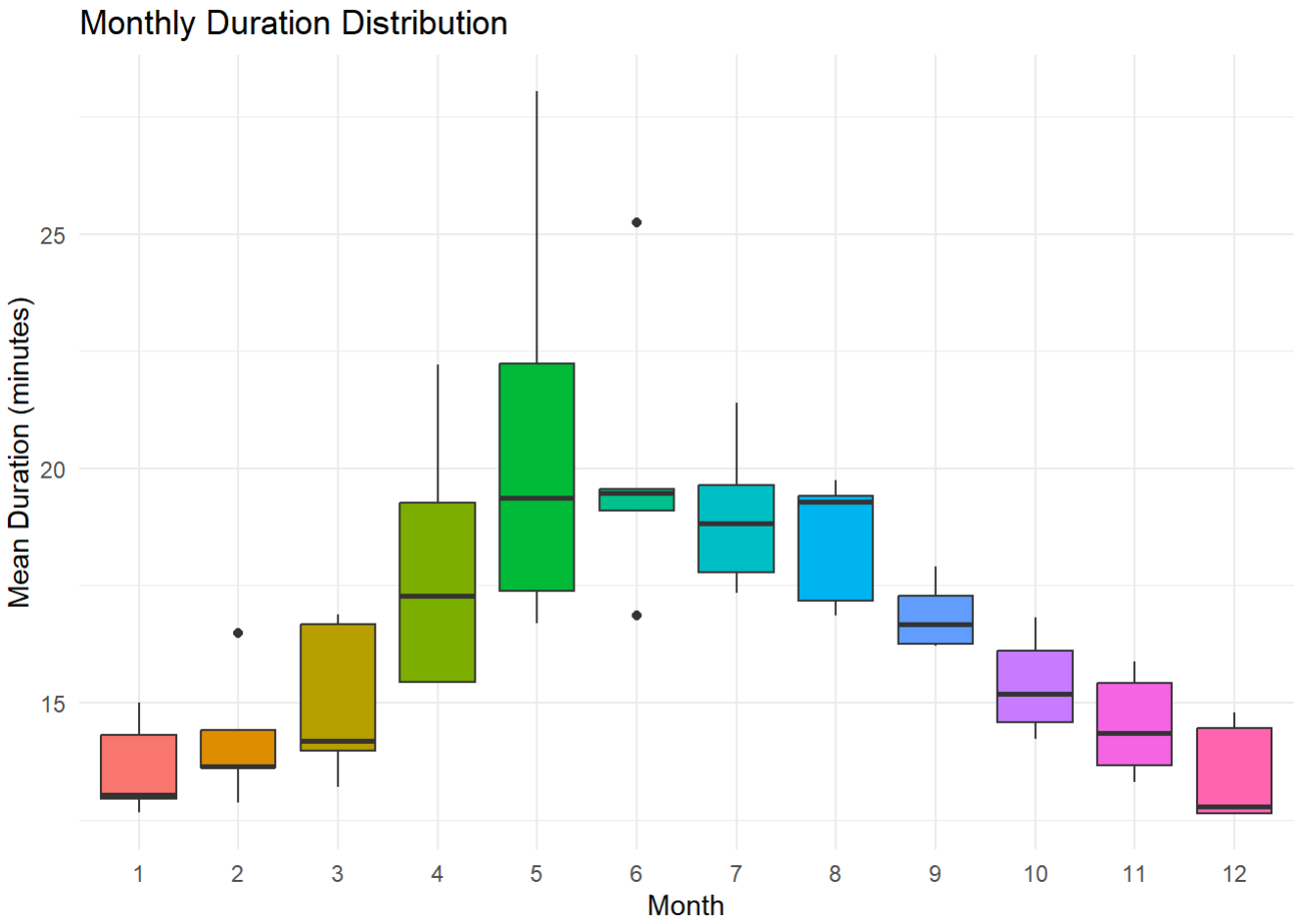
Duration Pattern over Months

```
duration_monthly_across_year <- df %>%
  group_by(
    Year = Start.Year,
    Month = Start.Month) %>%
  summarize(Mean_Duration = round(mean(Trip..Duration) / 60, 2))  # Convert mean to minutes
```

```
## `summarise()` has grouped output by 'Year'. You can override using the
## `.groups` argument.
```

```
duration_monthly_across_year
```

```
ggplot(
  data = duration_monthly_across_year,
  mapping = aes(
    x = factor(Month),
    y = Mean_Duration,
    fill = factor(Month)
    )
  ) +
  geom_boxplot(show.legend = FALSE) +
  labs(
    title = "Monthly Duration Distribution",
    x = "Month",
    y = "Mean Duration (minutes)"
  ) +
  theme_minimal()
```



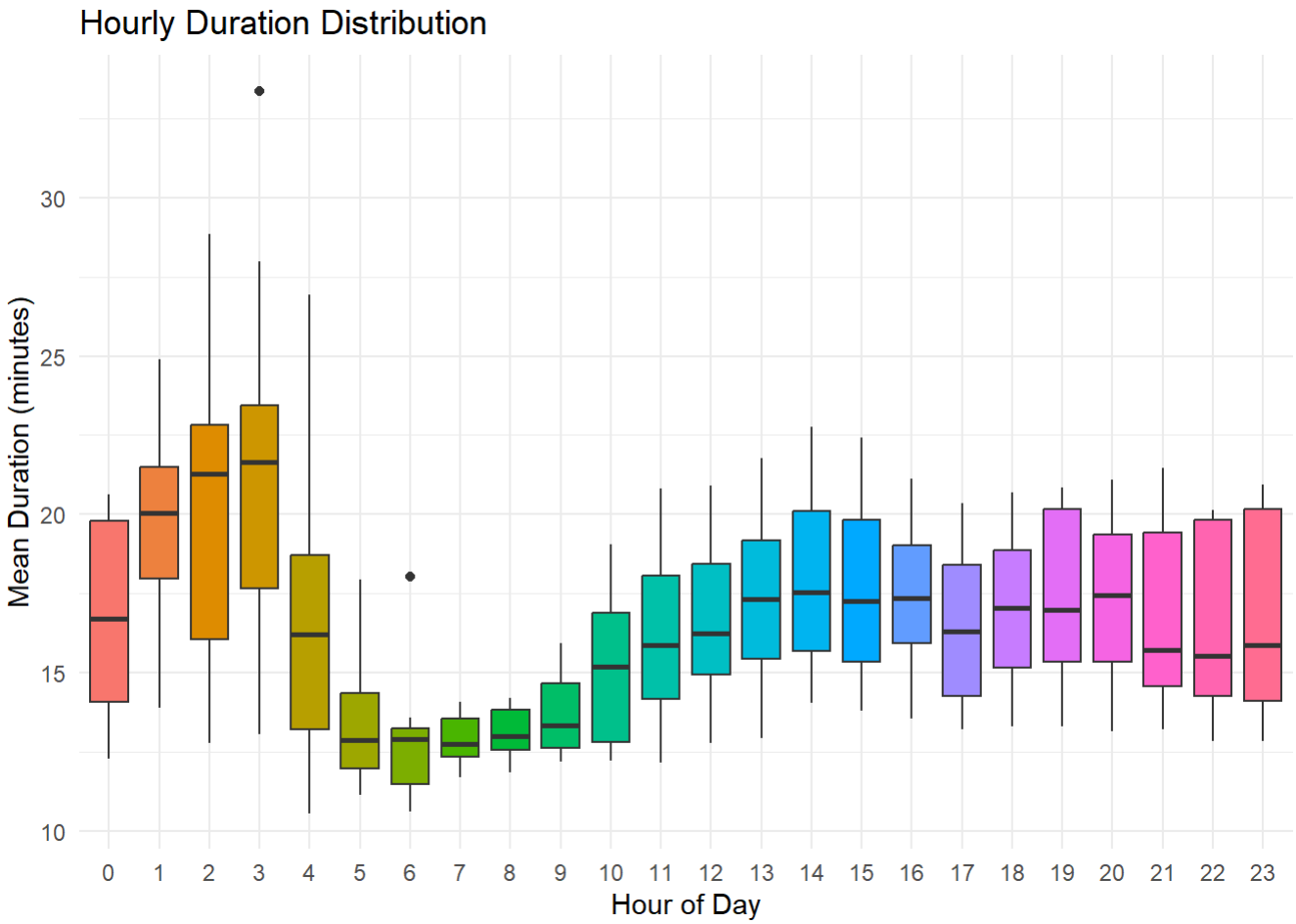
Duration Pattern throughout A Day

```
duration_hourly_across_month <- df %>%
  group_by(
    Month = Start.Month,
    Hour = Start.Hours
    ) %>%
  summarize(Mean_Duration = round(mean(Trip..Duration) / 60, 2))  # Convert mean to minutes
```

```
## `summarise()` has grouped output by 'Month'. You can override using the
## `.groups` argument.
```

```
duration_hourly_across_month
```

```
ggplot(
  data = duration_hourly_across_month,
  mapping = aes(
    x = factor(Hour),
    y = Mean_Duration,
    fill = factor(Hour)
    )
  ) +
  geom_boxplot(show.legend = FALSE) +
  labs(
    title = "Hourly Duration Distribution",
    x = "Hour of Day",
    y = "Mean Duration (minutes)"
  ) +
  theme_minimal()
```



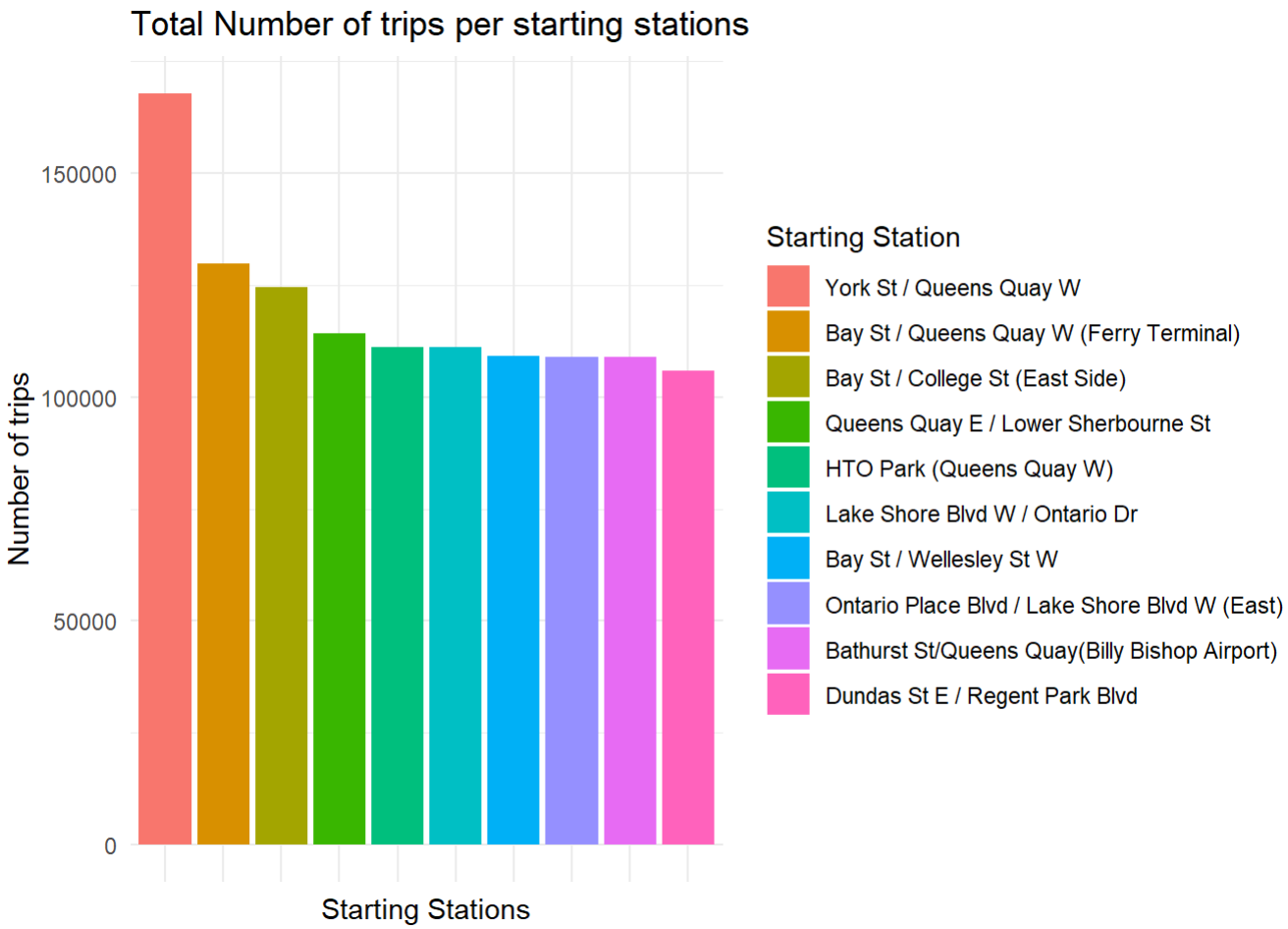
Geolocation Analysis

Hot Start Locations

Hot start spot (Top 10)

```
hot_start_spot <- df %>%
  group_by(Start.Station.Name) %>%
  summarize(Total_Trips = n()) %>%
  arrange(desc(Total_Trips)) %>%
  slice_head(n = 10)
hot_start_spot
```

```
ggplot(
  data = hot_start_spot,
  mapping = aes(
      x = reorder(Start.Station.Name, -Total_Trips),
      y = Total_Trips,
      fill = reorder(Start.Station.Name, -Total_Trips)
      )
  ) +
  geom_bar(
    stat = "identity"
  ) +
  labs(
    title = "Total Number of trips per starting stations",
    x = "Starting Stations",
    y = "Number of trips",
    fill = "Starting Station"
  ) +
  theme_minimal()+
  theme(axis.text.x = element_blank())
```



Hot start street (Top 10)

```
library(stringr)

hot_start_streets <- df %>%
  separate_rows(Start.Station.Name, sep = " / ") %>% # Separate the station names
  mutate(Start.Station.Street = Start.Station.Name) %>%
  group_by(Start.Station.Street) %>%
  summarize(Total_Trips = n()) %>%
  arrange(desc(Total_Trips)) %>%
  slice_head(n = 10)
```

```
## Warning in gregexpr(pattern, x, perl = TRUE): 输入的字符串5347586不是UTF-8
```

```
## Warning in gregexpr(pattern, x, perl = TRUE): 输入的字符串5347588不是UTF-8
```

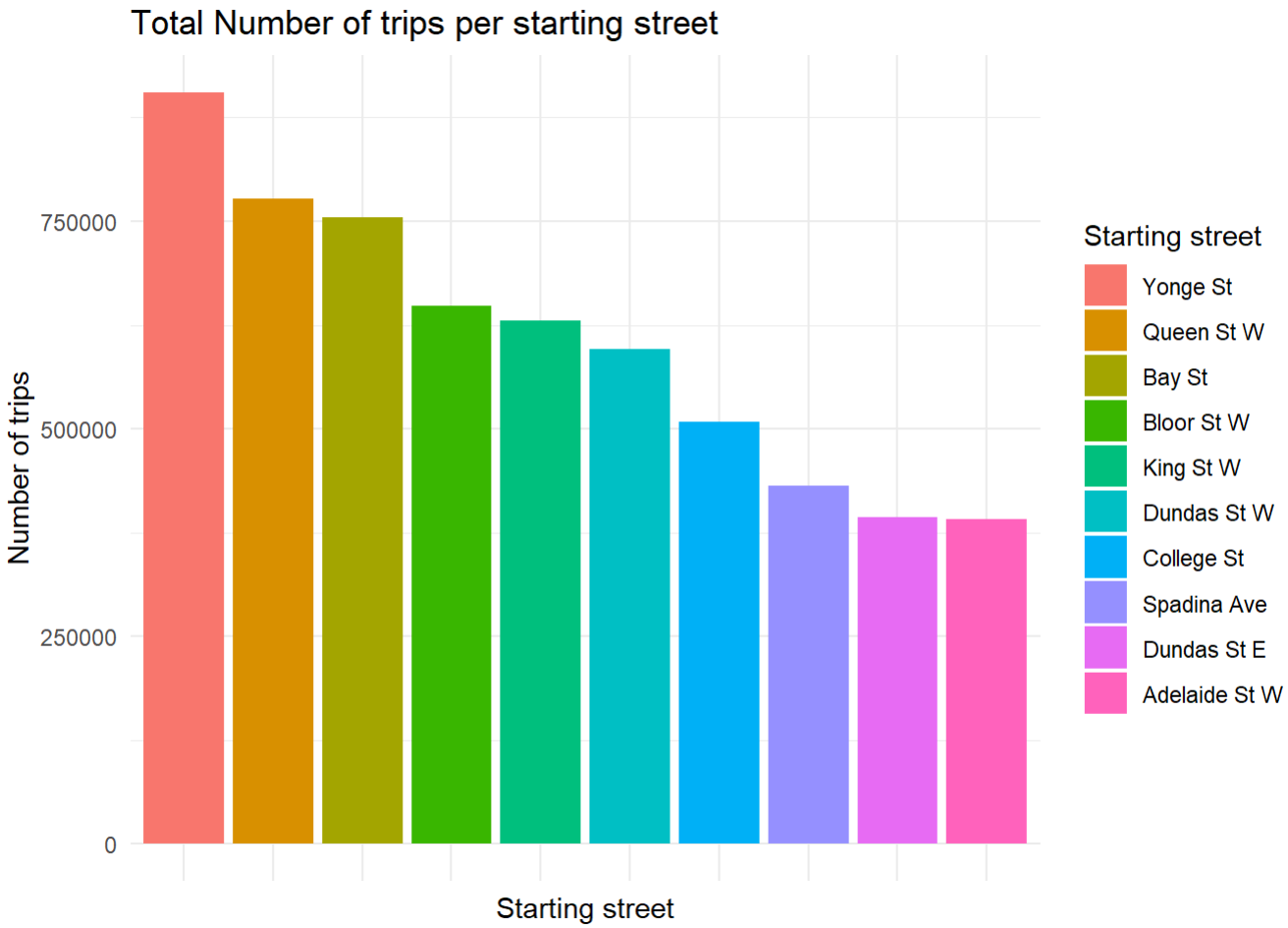
```
## Warning in gregexpr(pattern, x, perl = TRUE): 输入的字符串5350238不是UTF-8
```

```
## Warning in gregexpr(pattern, x, perl = TRUE): 输入的字符串5350495不是UTF-8
```

```
## Warning in gregexpr(pattern, x, perl = TRUE): 输入的字符串5350926不是UTF-8
```

```
hot_start_streets
```

```
ggplot(
  data = hot_start_streets,
  mapping = aes(
      x = reorder(Start.Station.Street, -Total_Trips),
      y = Total_Trips,
      fill = reorder(Start.Station.Street, -Total_Trips)
      )
  ) +
  geom_bar(
    stat = "identity"
  ) +
  labs(
    title = "Total Number of trips per starting street",
    x = "Starting street",
    y = "Number of trips",
    fill = "Starting street"
  ) +
  theme_minimal()+
  theme(axis.text.x = element_blank())
```

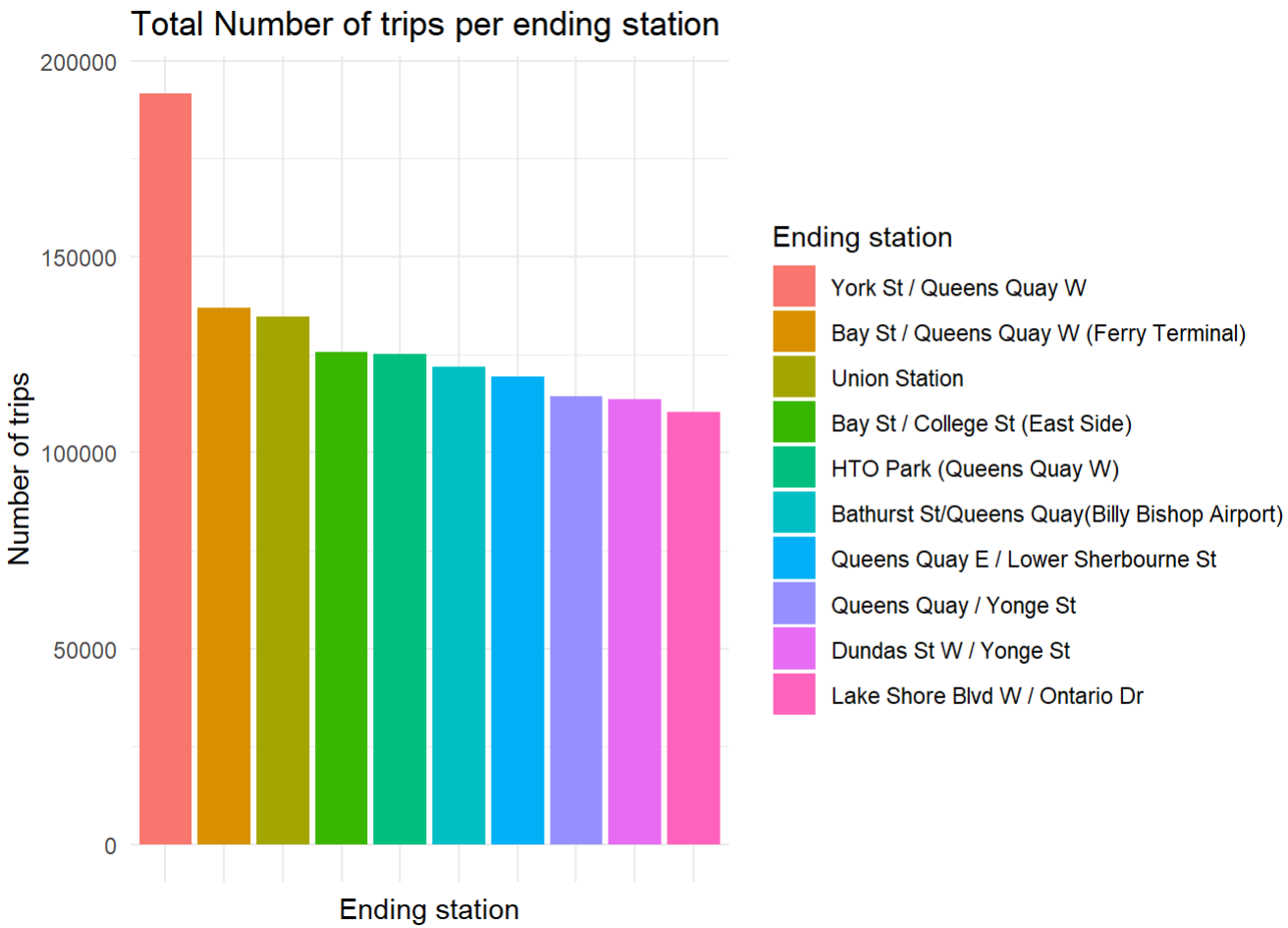


Hot End Locations

Hot End spot (Top 10)

```
hot_end_spot <- df %>%
  group_by(End.Station.Name) %>%
  summarize(Total_Trips = n()) %>%
  arrange(desc(Total_Trips)) %>%
  slice_head(n = 10)
hot_end_spot
```

```
ggplot(
  data = hot_end_spot,
  mapping = aes(
      x = reorder(End.Station.Name, -Total_Trips),
      y = Total_Trips,
      fill = reorder(End.Station.Name, -Total_Trips)
      )
  ) +
  geom_bar(
    stat = "identity"
  ) +
  labs(
    title = "Total Number of trips per ending station",
    x = "Ending station",
    y = "Number of trips",
    fill = "Ending station"
  ) +
  theme_minimal()+
  theme(axis.text.x = element_blank())
```



Hot end street (Top 10)

```
hot_end_streets <- df %>%
  separate_rows(End.Station.Name, sep = " / ") %>% # Separate the station names
  mutate(End.Station.Street = End.Station.Name) %>%
  group_by(End.Station.Street) %>%
  summarize(Total_Trips = n()) %>%
  arrange(desc(Total_Trips)) %>%
  slice_head(n = 10)
```

```
## Warning in gregexpr(pattern, x, perl = TRUE): 输入的字符串5348071不是UTF-8
```

```
## Warning in gregexpr(pattern, x, perl = TRUE): 输入的字符串5348390不是UTF-8
```

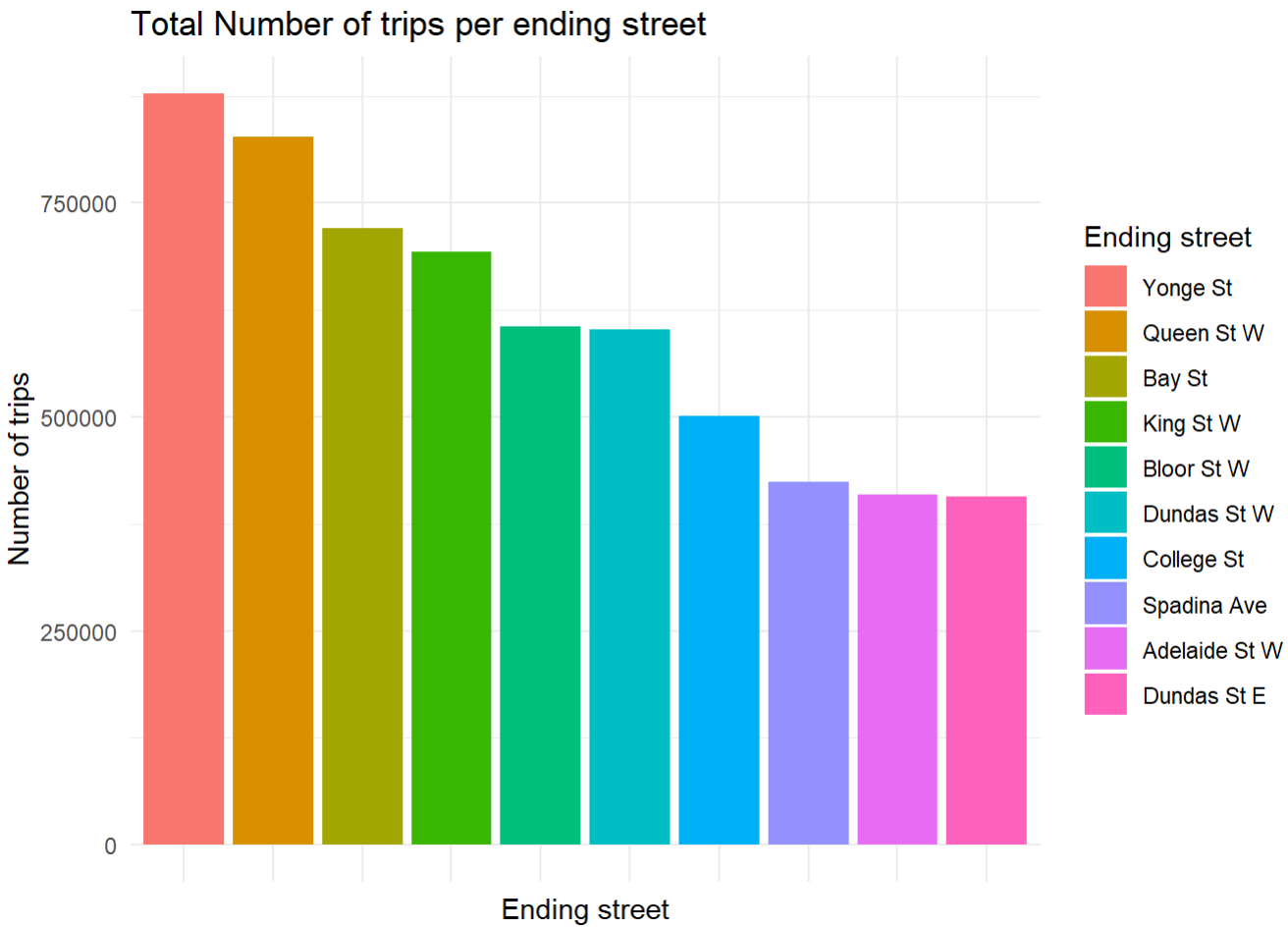
```
## Warning in gregexpr(pattern, x, perl = TRUE): 输入的字符串5348452不是UTF-8
```

```
## Warning in gregexpr(pattern, x, perl = TRUE): 输入的字符串5349390不是UTF-8
```

```
## Warning in gregexpr(pattern, x, perl = TRUE): 输入的字符串5349530不是UTF-8
```

```
hot_end_streets
```

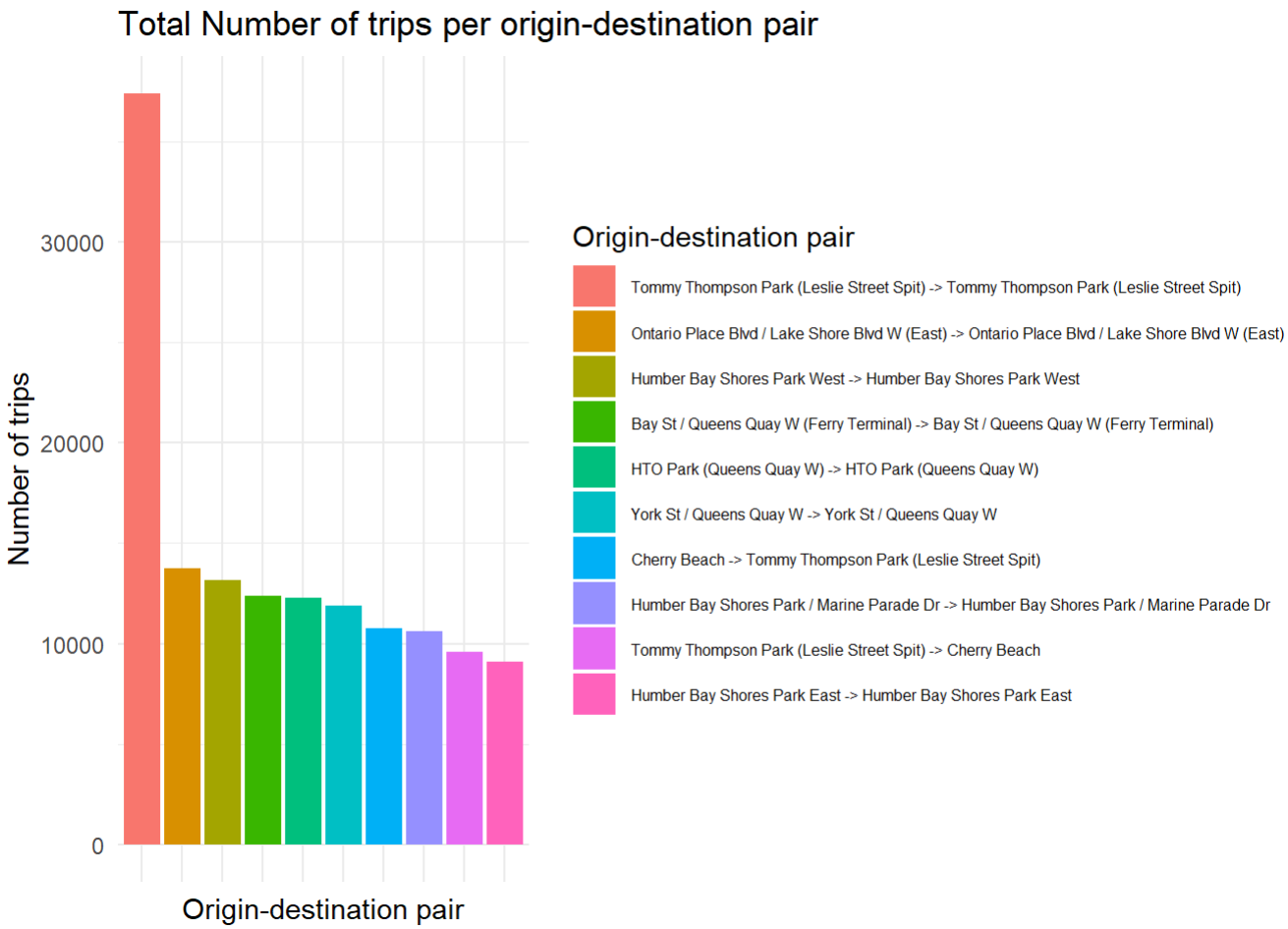
```
ggplot(
  data = hot_end_streets,
  mapping = aes(
      x = reorder(End.Station.Street, -Total_Trips),
      y = Total_Trips,
      fill = reorder(End.Station.Street, -Total_Trips)
      )
  ) +
  geom_bar(
    stat = "identity"
  ) +
  labs(
    title = "Total Number of trips per ending street",
    x = "Ending street",
    y = "Number of trips",
    fill = "Ending street"
  ) +
  theme_minimal()+
  theme(axis.text.x = element_blank())
```



Hot Trips (Top 10)

```
hot_trip <- df %>%
  mutate(Trip.Spots = paste(Start.Station.Name, End.Station.Name, sep =" -> ")) %>%
  group_by(Trip.Spots) %>%
  summarize(Total_Trips = n()) %>%
  arrange(desc(Total_Trips)) %>%
  slice_head(n = 10)
hot_trip
```

```
ggplot(
  data = hot_trip,
  mapping = aes(
      x = reorder(Trip.Spots, -Total_Trips),
      y = Total_Trips,
      fill = reorder(Trip.Spots, -Total_Trips)
      )
  ) +
  geom_bar(
    stat = "identity"
  ) +
  labs(
    title = "Total Number of trips per origin-destination pair",
    x = "Origin-destination pair",
    y = "Number of trips",
    fill = "Origin-destination pair"
  ) +
  theme_minimal()+
  theme(axis.text.x = element_blank()  ,
        legend.text = element_text(size = 6))
```


Total Number of trips per origin-destination pair
Number of trips
30000
20000
10000
0
Origin-destination pair
Origin-destination pair
Tommy Thompson Park (Leslie Street Spit) -> Tommy Thompson Park (Leslie Street Spit)
Ontario Place Blvd / Lake Shore Blvd W (East) -> Ontario Place Blvd / Lake Shore Blvd W (East)
Humber Bay Shores Park West -> Humber Bay Shores Park West
Bay St / Queens Quay W (Ferry Terminal) -> Bay St / Queens Quay W (Ferry Terminal)
HTO Park (Queens Quay W) -> HTO Park (Queens Quay W)
York St / Queens Quay W -> York St / Queens Quay W
Cherry Beach -> Tommy Thompson Park (Leslie Street Spit)
Humber Bay Shores Park / Marine Parade Dr -> Humber Bay Shores Park / Marine Parade Dr
Tommy Thompson Park (Leslie Street Spit) -> Cherry Beach
Humber Bay Shores Park East -> Humber Bay Shores Park East

Shiny Rendering

```
library(shiny)
library(ggplot2)

ui <- fluidPage(
  tags$head(
    tags$style(HTML("
      #sidebar {
        position: fixed;
        top: 0;
        left: 0;
        bottom: 0;
        width: 300px; /* Set your desired width */
        background-color: #f8f9fa; /* Set your desired background color */
        padding: 10px;

      },
      #mainPanel {
        font-size: 24px;
        padding-right: 200px;
      }
    "))
  ),

  sidebarLayout(
    sidebarPanel(
      id = "sidebar",
      tags$div(
        tags$h3(tags$a(href = "#title","Urban Pedals")),
        tags$ul(
          tags$li(
            tags$a(href = "#source", "Data Source")
          ),
          tags$li(
            tags$a(href = "#processing", "Data Processing")
          ),
```

```
        # Trip
        tags$li(
          tags$a(href = "#trip", "Trip Analysis"),
          tags$ul(
            tags$li(tags$a(href = "#yearly-trip", "Yearly Trends")),
            tags$li(tags$a(href = "#monthly-trip", "The Pattern over Months")),
            tags$li(tags$a(href = "#hourly-trip", "The Pattern throughout A Day"))
          )
        ),
        # duration
        tags$li(tags$a(href = "#duration", "Duration Analysis"),
                tags$ul(
                  tags$li(tags$a(href = "#yearly-duration", "Yearly Trend")),
                  tags$li(tags$a(href = "#monthly-duration", "The Pattern over Months")),
                  tags$li(tags$a(href = "#hourly-duration", "The Pattern throughout A Day"))
                )
        ),
        # location
        tags$li(tags$a(href = "#location", "Location Analysis"),
                tags$ul(
                  tags$li(tags$a(href = "#start-street", "Count of start street")),
                  tags$li(tags$a(href = "#end-street", "Count of end street")),
                  tags$li(tags$a(href = "#trip-pairs", "Count of trip pairs"))
                )
        )
      )
    )
  ),
  mainPanel(
    style = "padding-right: 100px; text-align: left;",

    h1("Urban Pedals:", align = "center", id = "title"),
    h3("Unveiling Toronto’s Bike Share Story", align = "center"),
    h2("Data Source", id = "source"),
    div(
      style = "font-size: 18px",
      p("Historical Bike Share Toronto ridership data."),
      p("Ref: ",tags$a(href ="https://open.toronto.ca/dataset/bike-share-toronto-ridership-data/", "Toronto Open Data")
```

```
        ),
      ),
      tags$hr(),
      div(style = "height: 50px"),

      # data processing
      h2("Data Processing", id = "processing"),
      div(
        style = "font-size: 18px",
        p("Handle NA and 'NULL' Value"),
        p("Data Overview:"),
      ),
      br(),
      imageOutput("photo"),
      tags$hr(),

      # Trip Analysis
      h2("Trip analysis", id = "trip"),
      h3("Yearly Trends", id = "yearly-trip"),
      tableOutput('trip_yearly_tb'),
      br(),
      plotOutput("trip_yearly_plot"),
      br(),
      div(
        style = "font-size: 24px;",
        p("The annual trip count exhibits a consistent upward trend, doubling from approximately 2.4 million to 4.6 million
over the specified period.")
        ),
      tags$hr(),

      # trip monlty
      h3("The Pattern over Months", id = "monthly-trip"),
      br(),
      DT::dataTableOutput("trip_monthly_tb"),
      br(),
      plotOutput("trip_monthly_plot"),
      div(
        style = "font-size: 24px;",
```

```
  # description
  p("")
  ),
tags$hr(style = "padding-bottom: 50px"),

# trip hourly
h3("The Pattern throughout A Day", id = "hourly-trip"),
br(),
DT::dataTableOutput("trip_hourly_tb"),
br(),
plotOutput("trip_hourly_plot"),
div(
  style = "font-size: 24px;",
  # description
  p("")
  ),
tags$hr(),

# Duration
h2("Duration Analysis", id = "duration"),

# duration yearly
h3("Yearly Trend", id = "yearly-duration"),
br(),
DT::dataTableOutput("duration_yearly_tb"),
br(),
plotOutput("duration_yearly_plot"),
div(
  style = "font-size: 24px;",
  # description
  p("")
  ),
tags$hr(),

# duration monthly
h3("The Pattern over Months", id = "monthly-duration"),
br(),
DT::dataTableOutput("duration_monthly_tb"),
```

```
      br(),
      plotOutput("duration_monthly_plot"),
      div(
        style = "font-size: 24px;",
        # description
        p("")
        ),
      tags$hr(),

      # duration hourly
      h3("The Pattern throughout A Day", id = "hourly-duration"),
      br(),
      DT::dataTableOutput("duration_hourly_tb"),
      br(),
      plotOutput("duration_hourly_plot"),
      div(
        style = "font-size: 24px;",
        # description
        p("")
        ),
      tags$hr(),


      # Location
      h2("Location Analysis", id = "location"),

      # location start street
      h3("Total Number of trips per starting stations", id = "start-street"),
      br(),
      DT::dataTableOutput("hot_start_streets_tb"),
      br(),
      plotOutput("hot_start_streets_plot"),
      div(
        style = "font-size: 24px;",
        # description
        p("")
        ),
      tags$hr(),
```

```
      # location end street
      h3("Total Number of trips per ending street", id = "end-street"),
      br(),
      DT::dataTableOutput("hot_end_streets_tb"),
      br(),
      plotOutput("hot_end_streets_plot"),
      div(
        style = "font-size: 24px;",
        # description
        p("")
        ),
      tags$hr(),

      # location pairs
      h3("Total Number of trips per origin-destination pair", id = "trip-pairs"),
      br(),
      DT::dataTableOutput("hot_trip_tb"),
      br(),
      plotOutput("hot_trip_plot"),
      div(
        style = "font-size: 24px;",
        # description
        p("")
        ),
      tags$hr(),


    )
  )
)

server <- function(input, output) {

  output$photo <- renderImage({
    list(
      src = file.path("info.png"),
      contentType = "image/png",
```

```
    width = 800
    )
}, deleteFile = FALSE)

# trip yearly
output$trip_yearly_tb <- renderTable(trip_yearly)
output$trip_yearly_plot <- renderPlot({
  ggplot(
   data = trip_yearly,
   mapping = aes(
   x = Year,
   y = Trip,
   group = 1
   )
  ) +
   geom_line() +
   geom_point() +
   geom_text(aes(label = as.character(Trip)), vjust = 1, hjust = 0.5) +
   labs(
   title = "Yearly Trip Trend",
   x = "Year",
   y = "Trip"
   ) +
   theme_minimal()
})

# trip monthly
output$trip_monthly_tb <- DT::renderDataTable(DT::datatable({
  data <- trip_monthly_across_year
  data
}))

output$trip_monthly_plot <- renderPlot({
  ggplot(
     data = trip_monthly_across_year,
     mapping = aes(
     x = factor(Month),
     y = Trip,
```

```
      fill = factor(Month)
      )
      ) +
      geom_boxplot(show.legend = FALSE) +
      labs(
      title = "Monthly Distribution of Trips",
      x = "Month",
      y = "Trip",
      fill = "Month"
      ) +
      theme_minimal()
})

# trip hourly
output$trip_hourly_tb <- DT::renderDataTable(DT::datatable({
  data <- trip_hourly_across_month
  data
}))

output$trip_hourly_plot <- renderPlot({
  ggplot(
    trip_hourly_across_month,
    aes(
    x = factor(Hour),
    y = Trip,
    fill = factor(Hour)
    )
    ) +
    geom_boxplot(show.legend = FALSE) +
    labs(
    title = "Hourly Trip Distribution",
    x = "Hour of Day",
    y = "Number of Trips",
    fill = "Hour of Day") +
    theme_minimal()
})

# duration yearly
```

```
  output$duration_yearly_tb <- DT::renderDataTable(DT::datatable({
    data <- duration_yearly
    data
  }))

  output$duration_yearly_plot <- renderPlot({
    ggplot(
      data = duration_yearly,
      mapping = aes(
      x = Year,
      y = Mean_Duration,
      group = 1
      )
      ) +
      geom_line() +
      geom_point() +
      geom_text(
      aes(
      label = as.character(Mean_Duration)
      ),
      vjust = 1,
      hjust = 0.5
      ) +
      labs(
      title = "Average Duration Trend",
      x = "Year",
      y = "Average Duration"
      ) +
      theme_minimal()
  })


 # duration monthly
  output$duration_monthly_tb <- DT::renderDataTable(DT::datatable({
    data <- duration_monthly_across_year
    data
  }))
```

```
output$duration_monthly_plot <- renderPlot({
  ggplot(
   data = duration_monthly_across_year,
   mapping = aes(
   x = factor(Month),
   y = Mean_Duration,
   fill = factor(Month)
   )
   ) +
   geom_boxplot(show.legend = FALSE) +
   labs(
   title = "Monthly Duration Distribution",
   x = "Month",
   y = "Mean Duration (minutes)"
   ) +
   theme_minimal()
})


# duration hourly
output$duration_hourly_tb <- DT::renderDataTable(DT::datatable({
  data <- duration_hourly_across_month
  data
}))

output$duration_hourly_plot <- renderPlot({
  ggplot(
     data = duration_hourly_across_month,
     mapping = aes(
     x = factor(Hour),
     y = Mean_Duration,
     fill = factor(Hour)
     )
     ) +
     geom_boxplot(show.legend = FALSE) +
     labs(
     title = "Hourly Duration Distribution",
     x = "Hour of Day",
```

```
      y = "Mean Duration (minutes)"
      ) +
      theme_minimal()
})

# location start street
output$hot_start_streets_tb <- DT::renderDataTable(DT::datatable({
  data <- hot_start_streets
  data
}))

output$hot_start_streets_plot <- renderPlot({
ggplot(
  data = hot_start_streets,
  mapping = aes(
      x = reorder(Start.Station.Street, -Total_Trips),
      y = Total_Trips,
      fill = reorder(Start.Station.Street, -Total_Trips)
      )
  ) +
  geom_bar(
    stat = "identity"
  ) +
  labs(
    title = "Total Number of trips per starting street",
    x = "Starting street",
    y = "Number of trips",
    fill = "Starting street"
  ) +
  theme_minimal()+
  theme(axis.text.x = element_blank())
})

# location end street
output$hot_end_streets_tb <- DT::renderDataTable(DT::datatable({
  data <- hot_end_streets
  data
}))
```

```
output$hot_end_streets_plot <- renderPlot({
ggplot(
  data = hot_end_streets,
  mapping = aes(
      x = reorder(End.Station.Street, -Total_Trips),
      y = Total_Trips,
      fill = reorder(End.Station.Street, -Total_Trips)
      )
  ) +
  geom_bar(
    stat = "identity"
  ) +
  labs(
    title = "Total Number of trips per ending street",
    x = "Ending street",
    y = "Number of trips",
    fill = "Ending street"
  ) +
  theme_minimal()+
  theme(axis.text.x = element_blank())
})

# location pairs
output$hot_trip_tb <- DT::renderDataTable(DT::datatable({
  data <- hot_trip
  data
}))

output$hot_trip_plot <- renderPlot({
ggplot(
  data = hot_trip,
  mapping = aes(
      x = reorder(Trip.Spots, -Total_Trips),
      y = Total_Trips,
      fill = reorder(Trip.Spots, -Total_Trips)
      )
  ) +
```

```
    geom_bar(
      stat = "identity"
    ) +
    labs(
      title = "Total Number of trips per origin-destination pair",
      x = "Origin-destination pair",
      y = "Number of trips",
      fill = "Origin-destination pair"
    ) +
    theme_minimal()+
    theme(axis.text.x = element_blank()  ,
          legend.text = element_text(size = 6))
  })


}

shinyApp(ui, server)
```

Urban Pedals:

Unveiling Toronto’s Bike Share Story

Data Source

Historical Bike Share Toronto ridership data.

Ref: Toronto Open Data (https://open.toronto.ca/dataset/bike-share-toronto-ridership-data/)