Bertinelli_Gabriele_rlab01

April 9, 2024

1 RLab01 - Gabriele Bertinelli (2103359)

[ ]:
```
library(tidyverse)
library(ggplot2)
library(tibble)
library(dplyr)
library(geosphere)
```

1)

[ ]:
```
# read_csv is from tidyverse, faster than read.csv

d1 <- read_csv('./Data_CitiBike/JC-201902-citibike-tripdata.csv')
d2 <- read_csv('./Data_CitiBike/JC-201903-citibike-tripdata.csv')
d3 <- read_csv('./Data_CitiBike/JC-201904-citibike-tripdata.csv')
d4 <- read_csv('./Data_CitiBike/JC-201905-citibike-tripdata.csv')
d5 <- read_csv('./Data_CitiBike/JC-201906-citibike-tripdata.csv')
```

2)

[3]:
```
# bind_rows() is useful for combining data frames wherein the columns are all␣
 ↪identical
df <- bind_rows(d1, d2, d3, d4, d5)
```

[4]:
```
str(df)
```

```
spc_tbl_ [150,792 × 15] (S3: spec_tbl_df/tbl_df/tbl/data.frame)
 $ tripduration           : num [1:150792] 142 223 106 370 315 …
 $ starttime              : POSIXct[1:150792], format: "2019-02-01 15:35:02"
"2019-02-01 17:00:46" …
 $ stoptime               : POSIXct[1:150792], format: "2019-02-01 15:37:24"
"2019-02-01 17:04:30" …
 $ start station id       : num [1:150792] 3183 3183 3183 3183 3183 …
 $ start station name     : chr [1:150792] "Exchange Place" "Exchange Place"
"Exchange Place" "Exchange Place" …
 $ start station latitude : num [1:150792] 40.7 40.7 40.7 40.7 40.7 …
 $ start station longitude: num [1:150792] -74 -74 -74 -74 -74 …
 $ end station id         : num [1:150792] 3639 3681 3184 3211 3273 …
 $ end station name       : chr [1:150792] "Harborside" "Grand St" "Paulus Hook"
"Newark Ave" …
 $ end station latitude   : num [1:150792] 40.7 40.7 40.7 40.7 40.7 …
 $ end station longitude  : num [1:150792] -74 -74 -74 -74 -74 …
 $ bikeid                 : num [1:150792] 29677 26234 29588 29250 29586 …
 $ usertype               : chr [1:150792] "Subscriber" "Subscriber"
"Subscriber" "Subscriber" …
 $ birth year             : num [1:150792] 1963 1992 1960 1976 1980 …
 $ gender                 : num [1:150792] 1 2 1 1 1 1 1 1 1 1 …
 - attr(*, "spec")=
  .. cols(
  ..   tripduration = col_double(),
  ..   starttime = col_datetime(format = ""),
  ..   stoptime = col_datetime(format = ""),
  ..   `start station id` = col_double(),
  ..   `start station name` = col_character(),
  ..   `start station latitude` = col_double(),
  ..   `start station longitude` = col_double(),
  ..   `end station id` = col_double(),
  ..   `end station name` = col_character(),
  ..   `end station latitude` = col_double(),
  ..   `end station longitude` = col_double(),
  ..   bikeid = col_double(),
  ..   usertype = col_character(),
  ..   `birth year` = col_double(),
  ..   gender = col_double()
  .. )
 - attr(*, "problems")=<externalptr>
```

3)

[5]:

```
df <- drop_na(df) # drop rows with NA values
```

[6]:

```
str(df)

# no rows removed due to NA values
```

```
tibble [150,792 × 15] (S3: tbl_df/tbl/data.frame)
 $ tripduration           : num [1:150792] 142 223 106 370 315 …
 $ starttime              : POSIXct[1:150792], format: "2019-02-01 15:35:02"
"2019-02-01 17:00:46" …
 $ stoptime               : POSIXct[1:150792], format: "2019-02-01 15:37:24"
"2019-02-01 17:04:30" …
 $ start station id       : num [1:150792] 3183 3183 3183 3183 3183 …
 $ start station name     : chr [1:150792] "Exchange Place" "Exchange Place"
"Exchange Place" "Exchange Place" …
 $ start station latitude : num [1:150792] 40.7 40.7 40.7 40.7 40.7 …
 $ start station longitude: num [1:150792] -74 -74 -74 -74 -74 …
 $ end station id         : num [1:150792] 3639 3681 3184 3211 3273 …
 $ end station name       : chr [1:150792] "Harborside" "Grand St" "Paulus Hook"
"Newark Ave" …
 $ end station latitude   : num [1:150792] 40.7 40.7 40.7 40.7 40.7 …
 $ end station longitude  : num [1:150792] -74 -74 -74 -74 -74 …
 $ bikeid                 : num [1:150792] 29677 26234 29588 29250 29586 …
 $ usertype               : chr [1:150792] "Subscriber" "Subscriber"
"Subscriber" "Subscriber" …
 $ birth year             : num [1:150792] 1963 1992 1960 1976 1980 …
 $ gender                 : num [1:150792] 1 2 1 1 1 1 1 1 1 1 …
```

4) 4.1)

[7]:

```
avg_trip_duration <- mean(df$tripduration)

median_trip_duration <- median(df$tripduration)

sprintf("Average trip duration: %.2f sec", avg_trip_duration)
sprintf("Median trip duration: %.2f sec", median_trip_duration)
```

'Average trip duration: 768.64 sec'

'Median trip duration: 341.00 sec'

4.2)

[8]:

```
min_trip_duration <- min(df$tripduration)
max_trip_duration <- max(df$tripduration)

sprintf("Min trip duration: %.2f sec", min_trip_duration)
sprintf("Max trip duration: %.2f sec", max_trip_duration)

sprintf('max in hours: %.2f h', max_trip_duration/3600)
```

'Min trip duration: 61.00 sec'

'Max trip duration: 1729020.00 sec'

'max in hours: 480.28 h'

There's a trip that's really really long ahah. Almost 20 days. Maybe some long excursion… (or, more likely, wrong data)

4.3)

[9]:

```
df_clean <- df %>% filter(tripduration <= 3*3600)
```

[10]:

```
avg_trip_duration_clean <- mean(df_clean$tripduration)

median_trip_duration_clean <- median(df_clean$tripduration)
```

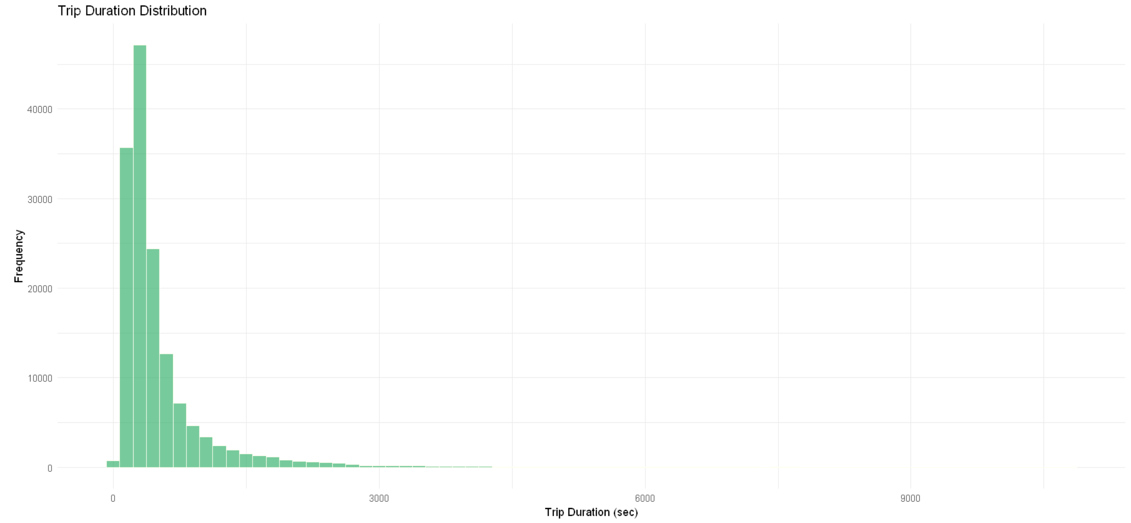
```
sprintf("Average trip duration: %.2f sec", avg_trip_duration_clean)
sprintf("Median trip duration: %.2f sec", median_trip_duration_clean)

min_trip_duration_clean <- min(df_clean$tripduration)
max_trip_duration_clean <- max(df_clean$tripduration)

sprintf("Min trip duration: %.2f sec", min_trip_duration_clean)
sprintf("Max trip duration: %.2f sec", max_trip_duration_clean)

sprintf('max in hours: %.2f h', max_trip_duration_clean/3600)
```

```
'Average trip duration: 553.38 sec'

'Median trip duration: 340.00 sec'

'Min trip duration: 61.00 sec'

'Max trip duration: 10800.00 sec'

'max in hours: 3.00 h'
```

4.4)

[11]:

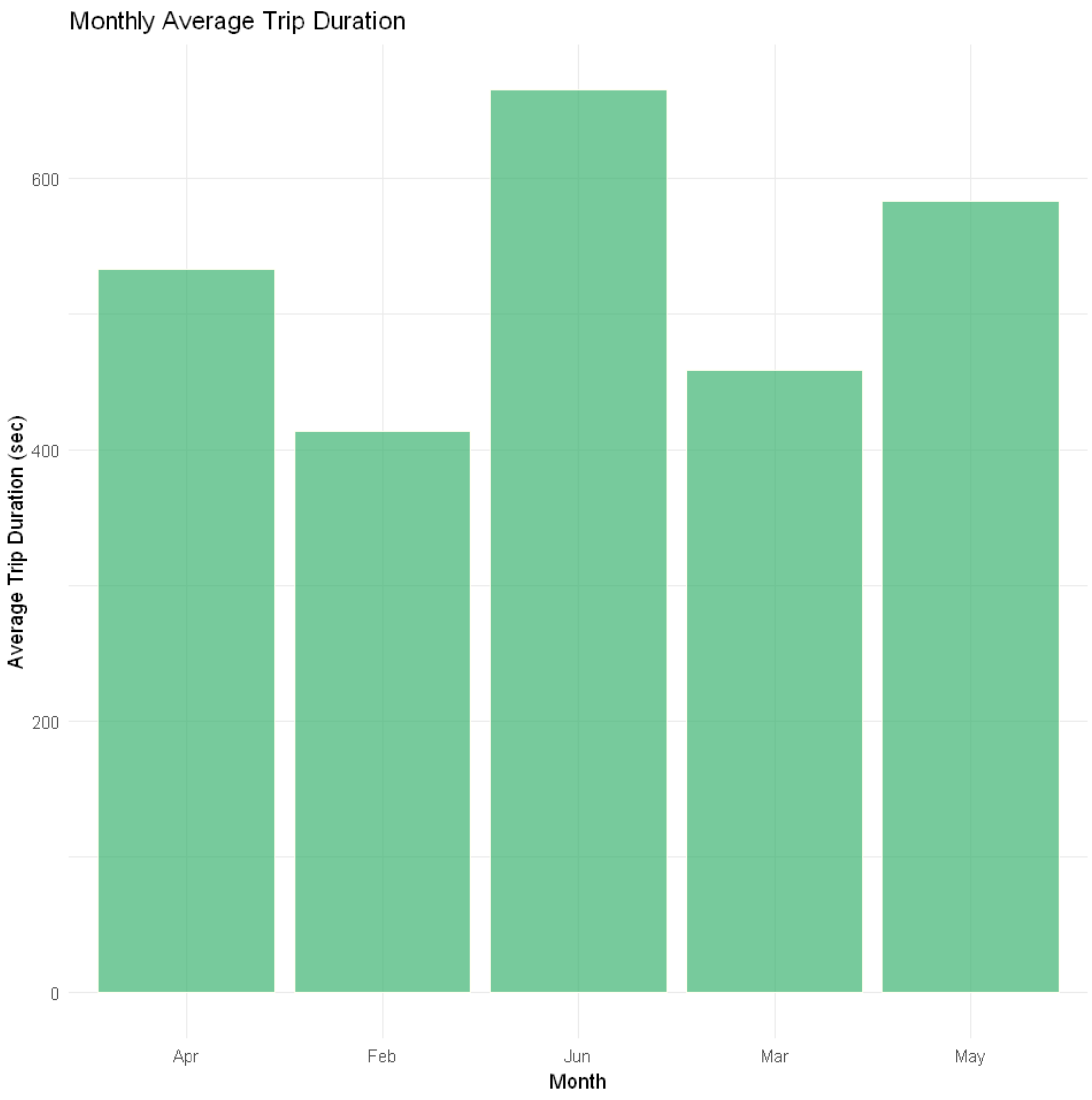
```
options(repr.plot.width = 15, repr.plot.height = 7)
time_duration_hist <- ggplot(data=df_clean, aes(x=tripduration)) +
                        geom_histogram(binwidth=150, fill='mediumseagreen',␣
 ↪color='ivory', alpha=0.7) +
                        labs(title='Trip Duration Distribution', x='Trip␣
 ↪Duration (sec)', y='Frequency') +
                        # xlim(c(0, 3600)) +
                        theme_minimal()

time_duration_hist
```



5)

[12]:

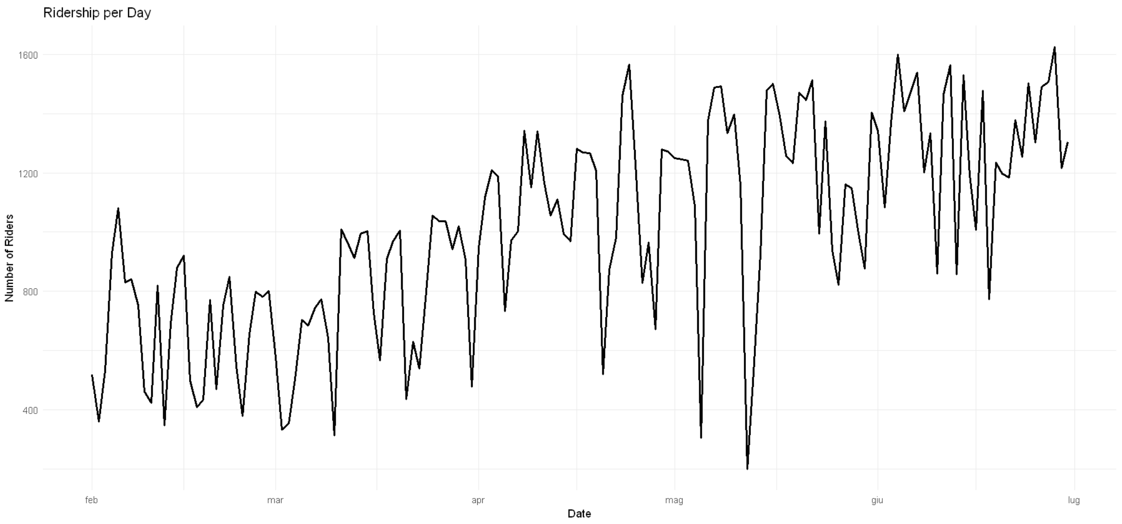
```
monthly_avg_trip_duration <- df_clean %>%
  mutate(month = lubridate::month(starttime)) %>% # mutate add a new col.␣
 ↪lubridate::month() returns the month number
  group_by(month) %>%
  summarize(avg_trip_duration = mean(tripduration)) # summarize() is used to␣
 ↪aggregate data by group

monthly_avg_trip_duration <- monthly_avg_trip_duration %>% mutate(month_w =␣
 ↪c('Feb', 'Mar', 'Apr', 'May', 'Jun'))

options(repr.plot.width = 8, repr.plot.height = 8)

monthly_plot <- ggplot(data= monthly_avg_trip_duration, aes(x=month_w,␣
 ↪y=avg_trip_duration)) +
                  geom_bar(stat='identity', fill='mediumseagreen',␣
 ↪color='ivory', alpha=0.7) +
                  labs(title='Monthly Average Trip Duration', x='Month',␣
 ↪y='Average Trip Duration (sec)') +
                  theme_minimal()

monthly_plot
```



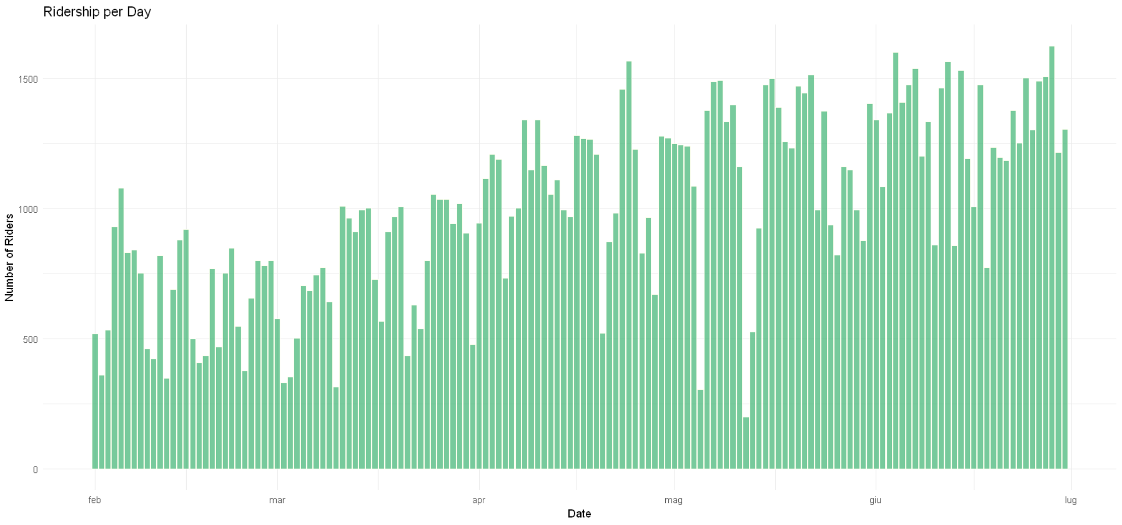
6) 6.1)

[13]:

```
riders_per_day <- df_clean %>%
mutate(date = as.Date(starttime)) %>%
group_by(date) %>%
summarize(riders = n())

options(repr.plot.width = 15, repr.plot.height = 7)

riders_per_day_plot <- ggplot(data=riders_per_day, aes(x=date, y=riders)) +
                        geom_line(color='black', lwd=1) +
                        labs(title='Ridership per Day', x='Date', y='Number of␣
  ↪Riders') +
                                theme_minimal()

riders_per_day_plot
```



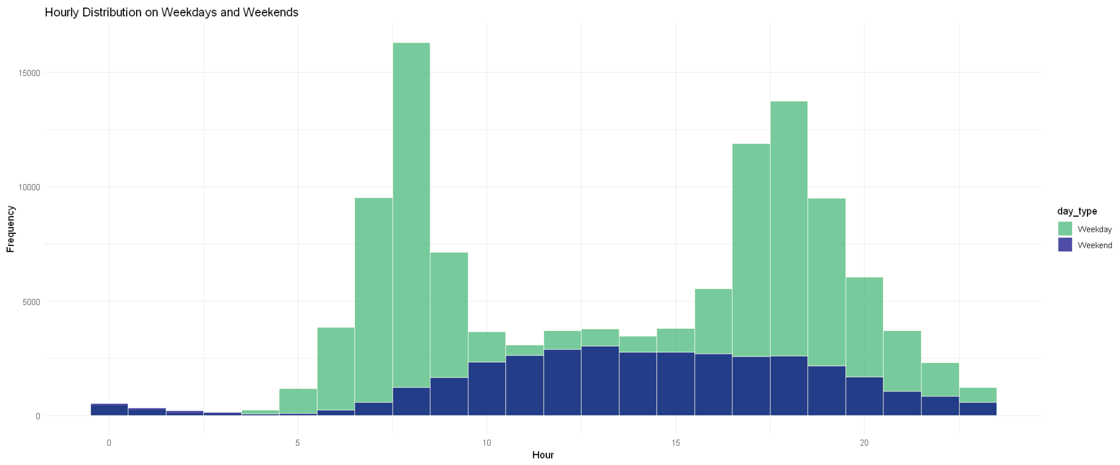
```
[14]: options(repr.plot.width = 15, repr.plot.height = 7)
      riders_per_day_barplot <- ggplot(data=riders_per_day, aes(x=date, y=riders)) +
                                geom_bar(stat='identity', fill='mediumseagreen',␣
        ↪color='ivory', alpha=0.7) +
                                labs(title='Ridership per Day', x='Date', y='Number of␣
        ↪Riders') +
                                theme_minimal()

      riders_per_day_barplot
```



6.2)

[15]:

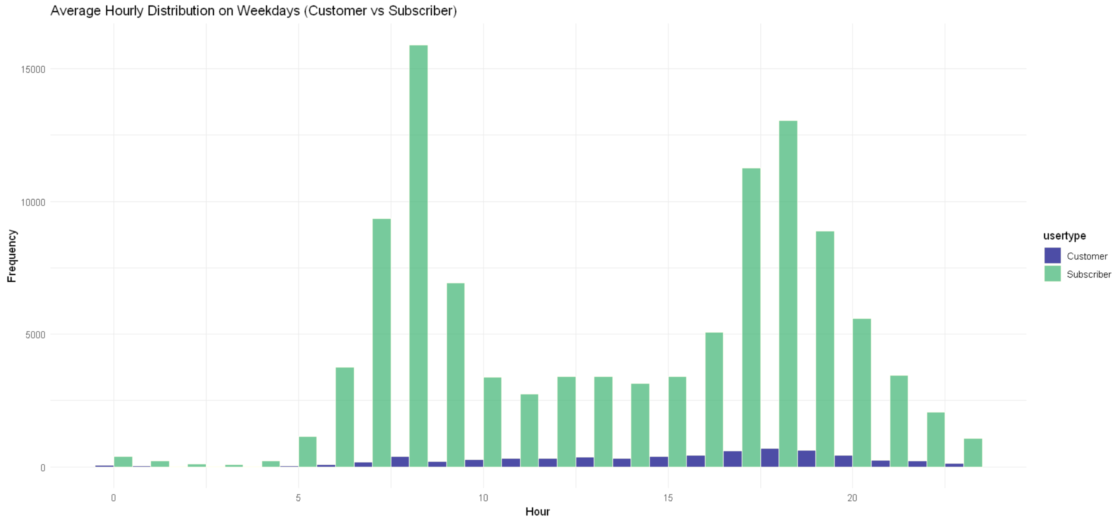
```
# Extract the day of the week from the starttime column
df_clean$weekday <- lubridate::wday(df_clean$starttime, label = TRUE,␣
 ↪locale="EN-us")

# Create a new column to differentiate between weekdays and weekends
df_clean$day_type <- ifelse(df_clean$weekday %in% c("Sat", "Sun"), "Weekend",␣
 ↪"Weekday")

# Extract the hour from the starttime column
df_clean$hour <- hour(df_clean$starttime)

# Plot the hourly distribution on weekdays and weekends
options(repr.plot.width = 17, repr.plot.height = 7)

hourly_distribution <- ggplot(data = df_clean, aes(x = hour, fill = day_type)) +
  geom_histogram(binwidth = 1, position = "identity", alpha = 0.7,␣
 ↪color='ivory') +
  labs(title = "Hourly Distribution on Weekdays and Weekends", x = "Hour", y =␣
 ↪"Frequency") +
  scale_fill_manual(values = c("Weekday" = "mediumseagreen", "Weekend" =␣
 ↪"navy")) +
  theme_minimal()

hourly_distribution
```



6.3)

[16]:

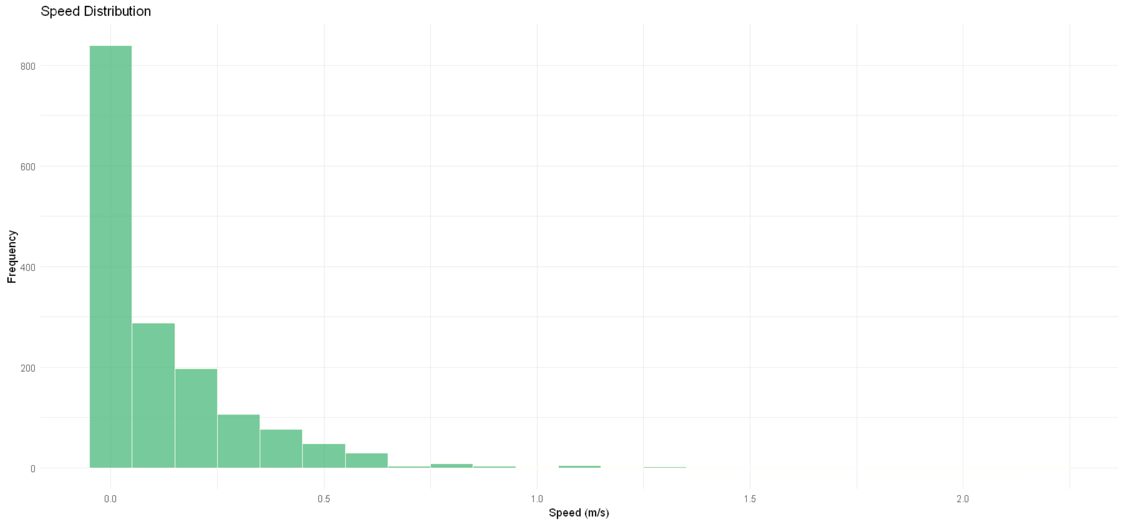
```r
# Filter the data for weekdays
df_weekdays <- df_clean %>% filter(day_type == "Weekday")

# Group the data by hour and user type
hourly_distribution <- df_weekdays %>%
  group_by(hour, usertype) %>%
  # summarize(avg_count = mean(tripduration)) %>%
  ungroup()

# Plot the average hourly distribution on weekdays, separating customer and subscriber users

options(repr.plot.width = 15, repr.plot.height = 7)

hourly_plot <- ggplot(data = hourly_distribution, aes(x = hour, fill = usertype)) +
  geom_histogram(binwidth = 1, position = "dodge", alpha = 0.7, color='ivory') +
  labs(title = "Average Hourly Distribution on Weekdays (Customer vs Subscriber)",
       x = "Hour", y = "Frequency") +
  scale_fill_manual(values = c("Customer" = "navy", "Subscriber" = "mediumseagreen")) +
  theme_minimal()

hourly_plot
```



7) 7.1)

[17]:

```
df_vel <- df_clean %>% filter(tripduration > 3600)

df_vel$dist <- distHaversine(cbind(df_vel$`start station longitude`, df_vel$`start station latitude`),
                                cbind(df_vel$`end station longitude`, df_vel$`end station latitude`))

df_vel$speed <- (df_vel$dist / df_vel$tripduration)#*3.6

options(repr.plot.width = 15, repr.plot.height = 7)

speed_hist <- ggplot(data=df_vel, aes(x=speed)) +
                geom_histogram(binwidth=0.1, fill='mediumseagreen', color='ivory', alpha=0.7) +
                labs(title='Speed Distribution', x='Speed (m/s)', y='Frequency') +
                theme_minimal()

speed_hist
```

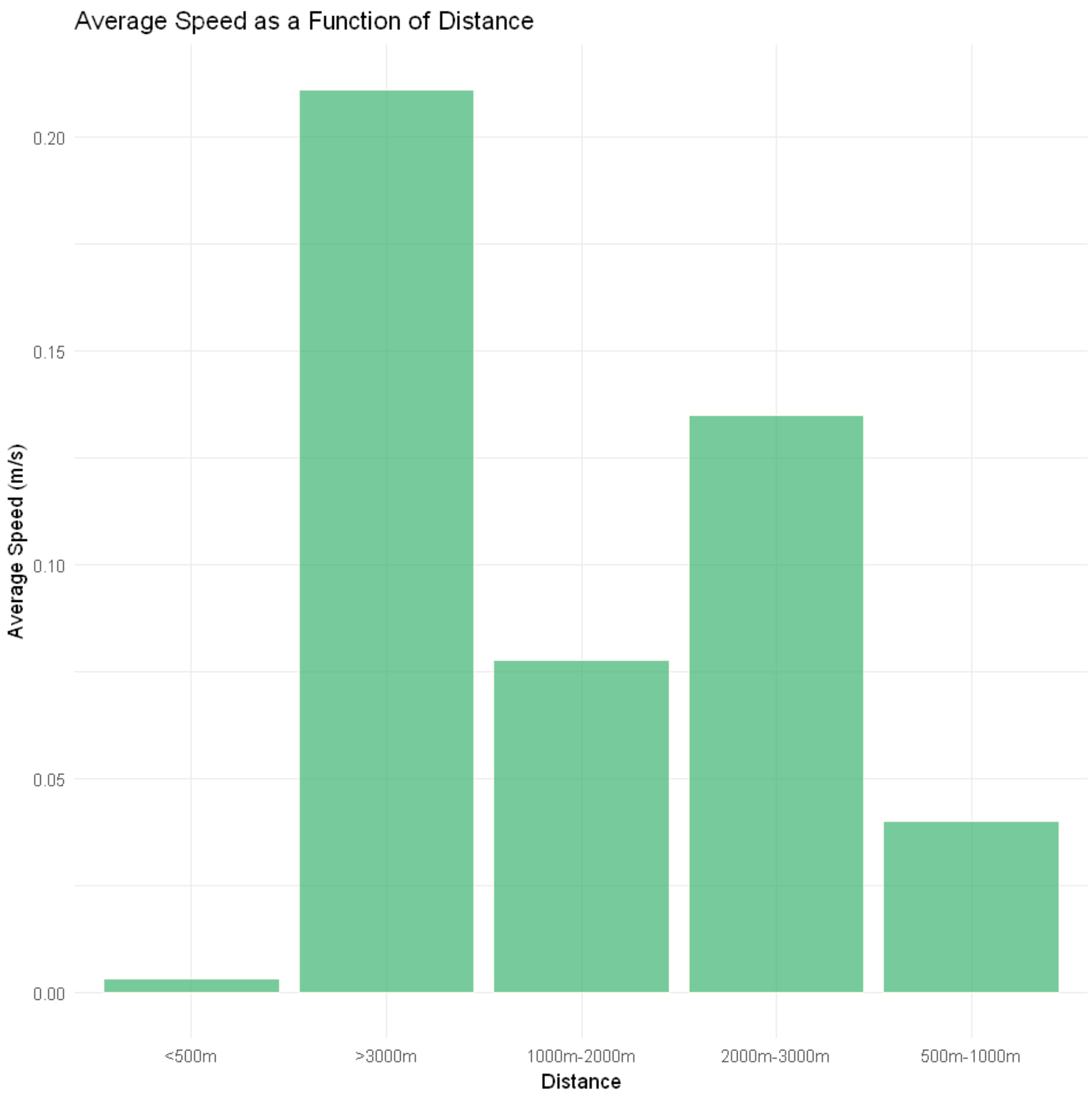


7.2)

[18]:

```
# Filter the data for the specified distance groups
df_group1 <- df_vel %>% filter(dist < 500)
df_group2 <- df_vel %>% filter(dist >= 500 & dist < 1000)
df_group3 <- df_vel %>% filter(dist >= 1000 & dist < 2000)
df_group4 <- df_vel %>% filter(dist >= 2000 & dist < 3000)
df_group5 <- df_vel %>% filter(dist >= 3000)
```

```
# Calculate the average speed for each distance group
avg_speed_group1 <- mean(df_group1$speed)
avg_speed_group2 <- mean(df_group2$speed)
avg_speed_group3 <- mean(df_group3$speed)
avg_speed_group4 <- mean(df_group4$speed)
avg_speed_group5 <- mean(df_group5$speed)

# Create a data frame for plotting
avg_speed_dist <- data.frame(group_dist = c("<500m", "500m-1000m",␣
 ↪"1000m-2000m", "2000m-3000m", ">3000m"),
                                avg_speed = c(avg_speed_group1,␣
 ↪avg_speed_group2, avg_speed_group3,
                                                avg_speed_group4,␣
 ↪avg_speed_group5))

options(repr.plot.width = 8, repr.plot.height = 8)

# Plot the average speed as a function of distance
speed_distance_plot <- ggplot(data = avg_speed_dist, aes(x = group_dist, y =␣
 ↪avg_speed/3.6)) +
                        geom_bar(stat = "identity", fill = "mediumseagreen",␣
 ↪color = "ivory", alpha = 0.7) +
                        labs(title = "Average Speed as a Function of Distance",
                        x = "Distance", y = "Average Speed (m/s)") +
                        theme_minimal()

speed_distance_plot
```



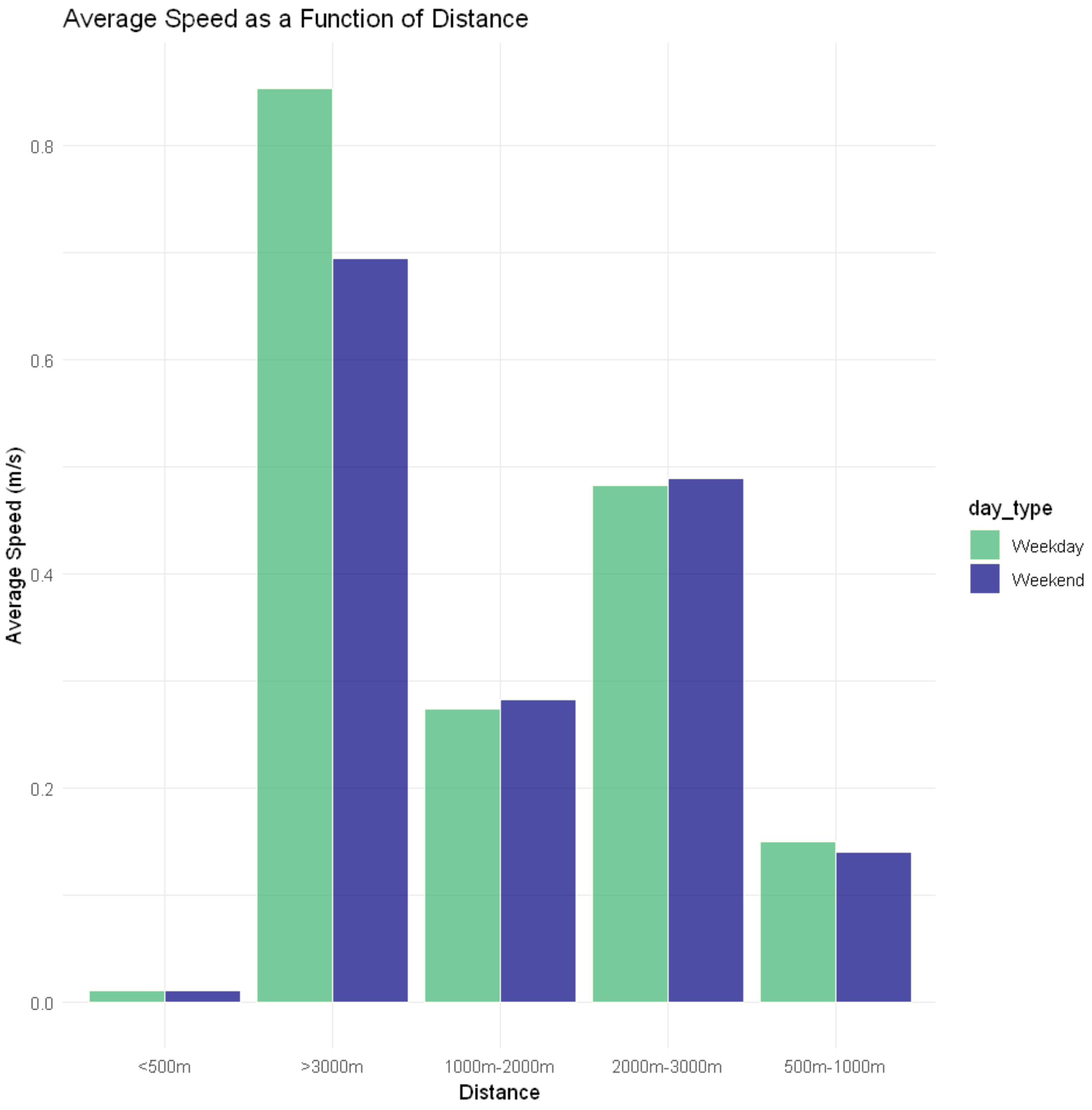
7.3)

[19]:

```
# Filter the data for weekdays
df_weekday <- df_vel %>% filter(day_type == "Weekday")

# Filter the data for weekends
df_weekend <- df_vel %>% filter(day_type == "Weekend")

# Now you can perform the same operations on df_weekday and df_weekend as before
# For example, for weekdays:

# Filter the data for the specified distance groups
df_group1d <- df_weekday %>% filter(dist < 500)
```

```
df_group2d <- df_weekday %>% filter(dist >= 500 & dist < 1000)
df_group3d <- df_weekday %>% filter(dist >= 1000 & dist < 2000)
df_group4d <- df_weekday %>% filter(dist >= 2000 & dist < 3000)
df_group5d <- df_weekday %>% filter(dist >= 3000)

df_group1w <- df_weekend %>% filter(dist < 500)
df_group2w <- df_weekend %>% filter(dist >= 500 & dist < 1000)
df_group3w <- df_weekend %>% filter(dist >= 1000 & dist < 2000)
df_group4w <- df_weekend %>% filter(dist >= 2000 & dist < 3000)
df_group5w <- df_weekend %>% filter(dist >= 3000)

# Calculate the average speed for each distance group
avg_speed_group1d <- mean(df_group1d$speed)
avg_speed_group2d <- mean(df_group2d$speed)
avg_speed_group3d <- mean(df_group3d$speed)
avg_speed_group4d <- mean(df_group4d$speed)
avg_speed_group5d <- mean(df_group5d$speed)

avg_speed_group1w <- mean(df_group1w$speed)
avg_speed_group2w <- mean(df_group2w$speed)
avg_speed_group3w <- mean(df_group3w$speed)
avg_speed_group4w <- mean(df_group4w$speed)
avg_speed_group5w <- mean(df_group5w$speed)

# Create a data frame for plotting
avg_speed_distd <- data.frame(group_dist = c("<500m", "500m-1000m",␣
 ↪"1000m-2000m", "2000m-3000m", ">3000m"),
                                avg_speed = c(avg_speed_group1d,␣
 ↪avg_speed_group2d, avg_speed_group3d,
                                                avg_speed_group4d,␣
 ↪avg_speed_group5d),
                                day_type = 'Weekday')

avg_speed_distw <- data.frame(group_dist = c("<500m", "500m-1000m",␣
 ↪"1000m-2000m", "2000m-3000m", ">3000m"),
                                avg_speed = c(avg_speed_group1w,␣
 ↪avg_speed_group2w, avg_speed_group3w,
                                                avg_speed_group4w,␣
 ↪avg_speed_group5w),
                                day_type = 'Weekend')

df_avg_speed_dist <- rbind(avg_speed_distd, avg_speed_distw)

options(repr.plot.width = 8, repr.plot.height = 8)

# Plot the average speed as a function of distance
```

```
speed_distance_plotwd <- ggplot(data = df_avg_speed_dist, aes(x = group_dist, y␣
↪= avg_speed, fill=day_type)) +
                              geom_bar(position='dodge', stat = "identity", alpha␣
↪= 0.7, color='ivory') +
                              labs(title = "Average Speed as a Function of␣
↪Distance",
                              x = "Distance", y = "Average Speed (m/s)") +
                              scale_fill_manual(values = c("Weekday" =␣
↪"mediumseagreen", "Weekend" = "navy")) +
                              theme_minimal()

speed_distance_plotwd
```



8) 8.1)

[20]:

```
start_station <- df_clean %>% group_by(`start station name`) %>%␣
  ↪summarize(count = n()) %>% arrange(desc(count))

end_station <- df_clean %>% group_by(`end station name`) %>% summarize(count =␣
  ↪n()) %>% arrange(count)

sprintf('Most common start station --> %s', start_station$`start station␣
  ↪name`[1])
sprintf('Least popular end station --> %s', end_station$`end station name`[1])
```

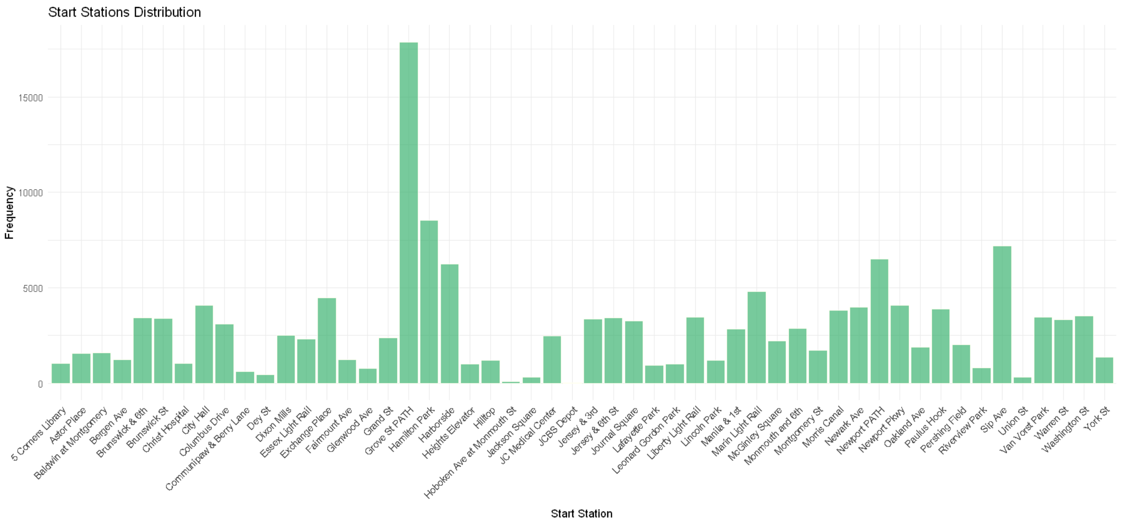
'Most common start station –> Grove St PATH'

'Least popular end station –> 1 Ave & E 16 St'

8.2)

[21]:

```
start_station <- df_clean %>% group_by(`start station name`) #%>%␣
  ↪summarize(count = n())

# start_station

options(repr.plot.width = 15, repr.plot.height = 7)

# start_distr <- ggplot(data=start_station, aes(x=`start station name`)) +
#                  geom_histogram(stat='count', binwidth = 1,␣
  ↪fill='mediumseagreen', color='ivory', alpha=0.7) +
#                  labs(title='Start Station Distribution', x='Start Station',␣
  ↪y='Frequency')
#                  theme_minimal()+
#                  theme(axis.text.x = element_text(angle = 45, hjust = 1))

start_distr <- ggplot(data=start_station, aes(x=`start station name`)) +
                geom_bar(fill='mediumseagreen', color='ivory', alpha=0.7) +
                labs(title='Start Stations Distribution', x='Start Station',␣
  ↪y='Frequency') +
                theme_minimal() +
                theme(axis.text.x = element_text(angle = 45, hjust = 1))

start_distr
```



8.3)

```
[22]: common_route <- df_clean %>% group_by(`start station name`, `end station name`)␣
        ↪%>% summarize(count = n()) %>% arrange(desc(count))

      least_route <- df_clean %>% group_by(`start station name`, `end station name`)␣
        ↪%>% summarize(count = n()) %>% arrange(count)

      cat('\n3 most common routes:\n')
      for (i in 1:3) {
          print(sprintf('%s --> %s', common_route$`start station name`[i],␣
        ↪common_route$`end station name`[i]))
      }

      cat('\n3 least popular routes:\n')
      for (i in 1:3) {
          print(sprintf('%s --> %s', least_route$`start station name`[i],␣
        ↪least_route$`end station name`[i]))
      }
```

```
`summarise()` has grouped output by 'start station name'. You can
override
using the `.groups` argument.
`summarise()` has grouped output by 'start station name'. You can
override
using the `.groups` argument.


3 most common routes:
[1] "Hamilton Park --> Grove St PATH"
```

```
[1] "Grove St PATH --> Hamilton Park"
[1] "Brunswick & 6th --> Grove St PATH"

3 least popular routes:
[1] "5 Corners Library --> Dixon Mills"
[1] "5 Corners Library --> Grand St"
[1] "Astor Place --> Brunswick & 6th"
```