Monitoring Personal Movement

Reproductible Research Project1 - Data Science Specialization

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10 12 2021

1. Loading and preprocessing the data

Show any code that is needed to

1.1. Load the data (i.e. read.csv())

Unzip the data:

```
#url <- "https://d396qusza40orc.cloudfront.net/repdata%2Fdata%2Factivity.zip"
#download.file(url, dest="activity.zip", mode="wb")
unzip ("activity.zip", exdir = "./activity")
```

Read the data:

```
activity <- read.csv("./activity/activity.csv")
```

Show the first 6 rows:

```
head(activity)
```

```
##   steps       date interval
## 1    NA 2012-10-01        0
## 2    NA 2012-10-01        5
## 3    NA 2012-10-01       10
## 4    NA 2012-10-01       15
## 5    NA 2012-10-01       20
## 6    NA 2012-10-01       25
```

1.2. Process/transform the data (if necessary) into a format suitable for your analysis

Generate time column from interval column:

```
temp <- activity$interval
temp <- sprintf("%04d", temp)
interval_time <- format(strptime(temp, format="%H%M"), format = "%H:%M")
head(interval_time)
```

```
## [1] "00:00" "00:05" "00:10" "00:15" "00:20" "00:25"
```

Add time column to dataframe:

```
library(dplyr)
activity_df <- mutate(activity, time=interval_time)
head(activity_df)
```

```
##   steps       date interval  time
## 1    NA 2012-10-01        0 00:00
## 2    NA 2012-10-01        5 00:05
## 3    NA 2012-10-01       10 00:10
## 4    NA 2012-10-01       15 00:15
## 5    NA 2012-10-01       20 00:20
## 6    NA 2012-10-01       25 00:25
```

Add date and time together to a datetime column:

```
#library(lubridate)
activity_df <- mutate(activity_df, datetime=as.POSIXct(as.character(paste(activity_df$date, activity_df$
head(activity_df)
```

```
##   steps       date interval  time            datetime
## 1    NA 2012-10-01        0 00:00 2012-10-01 00:00:00
## 2    NA 2012-10-01        5 00:05 2012-10-01 00:05:00
## 3    NA 2012-10-01       10 00:10 2012-10-01 00:10:00
## 4    NA 2012-10-01       15 00:15 2012-10-01 00:15:00
## 5    NA 2012-10-01       20 00:20 2012-10-01 00:20:00
## 6    NA 2012-10-01       25 00:25 2012-10-01 00:25:00
```

```
class(activity_df$datetime)
```

```
## [1] "POSIXct" "POSIXt"
```

2. What is mean total number of steps taken per day?

For this part of the assignment, you can ignore the missing values in the dataset.

2.1. Calculate the total number of steps taken per day

Calculate the total daysteps:

```
totaldaysteps <- aggregate(x = activity_df$steps,
                 by = list(activity_df$date),
                 FUN = sum, na.rm = F)
names(totaldaysteps)[names(totaldaysteps) == "Group.1"] <- "date"
names(totaldaysteps)[names(totaldaysteps) == "x"] <- "totaldaysteps"
head(totaldaysteps)
```

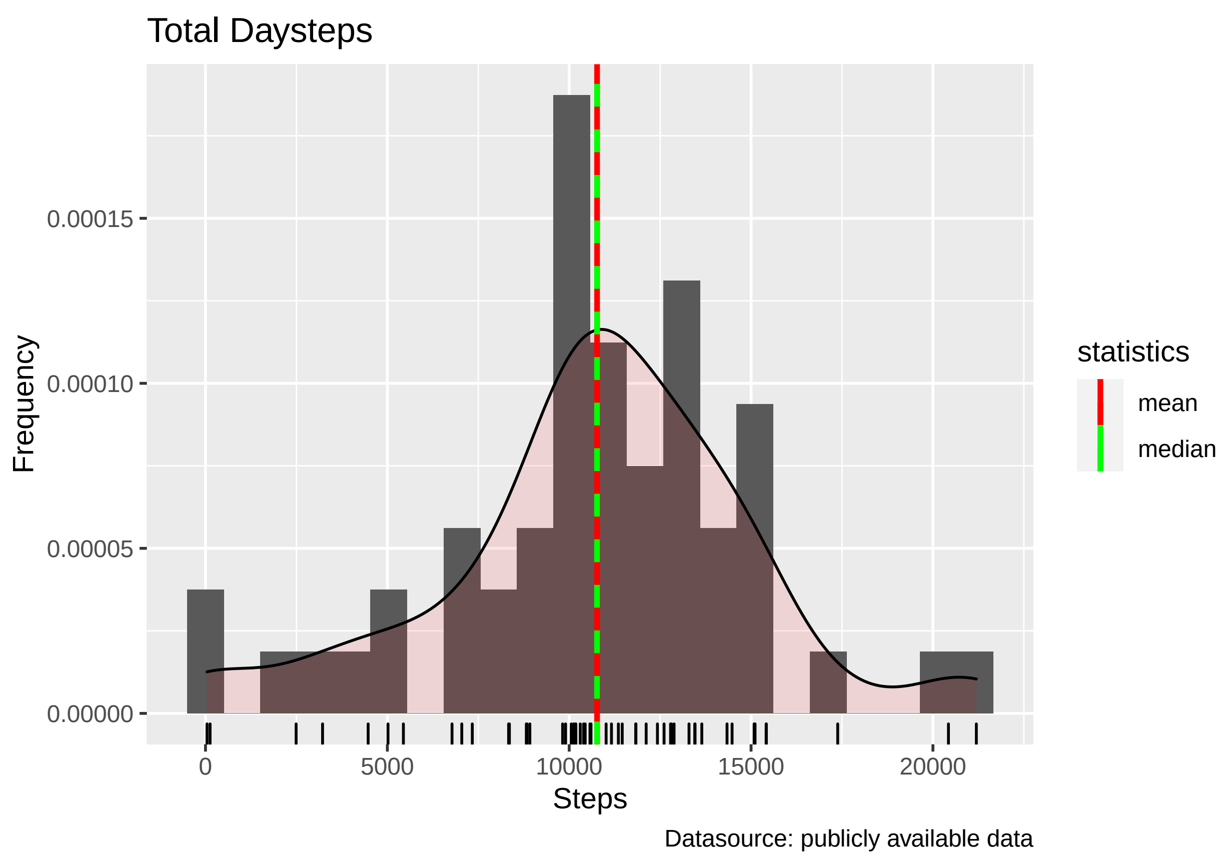
```
##         date totaldaysteps
## 1 2012-10-01            NA
## 2 2012-10-02           126
## 3 2012-10-03         11352
## 4 2012-10-04         12116
## 5 2012-10-05         13294
## 6 2012-10-06         15420
```

2.2. Make a histogram of the total number of steps taken each day

If you do not understand the difference between a histogram and a barplot, research the difference between them.

Histogram of the total daysteps:

```
library("ggplot2")
ggplot(totaldaysteps, aes(x = totaldaysteps)) +                           # Draw density above histogra
  geom_histogram(aes(y = ..density..),bins=22) +
  geom_density(alpha = 0.1, fill = "red") +
  geom_rug() +         # Draw Frequency below x axis
  geom_vline(aes(xintercept=mean(totaldaysteps, na.rm = T),
             color="mean"), linetype="solid", size=1) +
  geom_vline(aes(xintercept=median(totaldaysteps, na.rm = T),
             color="median"), linetype="dashed", size=1)+
  labs(x = 'Steps', y = 'Frequency',
       title = 'Total Daysteps',
       caption = 'Datasource: publicly available data')+
  scale_color_manual(
        name = "statistics",
        values = c(mean = "red", median = "green"))
```



2.3. Calculate and report the mean and median of the total number of steps taken per day

Calculate and print the mean and median:

```
mn <- mean(totaldaysteps$totaldaysteps, na.rm=T)
md <- median(totaldaysteps$totaldaysteps, na.rm=T)
print(paste("The mean is: ", round(mn,0), " steps."))
print(paste("The median is: ", md, " steps."))
```

Show the summary table:

```
library(xtable)
xt <- xtable(summary(totaldaysteps))
#print(xt, type="html")
print(xt, type="latex")
```

% latex table generated in R 4.1.0 by xtable 1.8-4 package % Fri Dec 10 20:14:07 2021

3. What is the average daily activity pattern?

3.1. Make a time series plot

Make a time series plot (i.e. type = "l") of the 5-minute interval (x-axis) and the average number of steps taken, averaged across all days (y-axis)

	date	totaldaysteps
X	Length:61	Min. : 41
X.1	Class :character	1st Qu.: 8841
X.2	Mode :character	Median :10765
X.3		Mean :10766
X.4		3rd Qu.:13294
X.5		Max. :21194
X.6		NA's :8

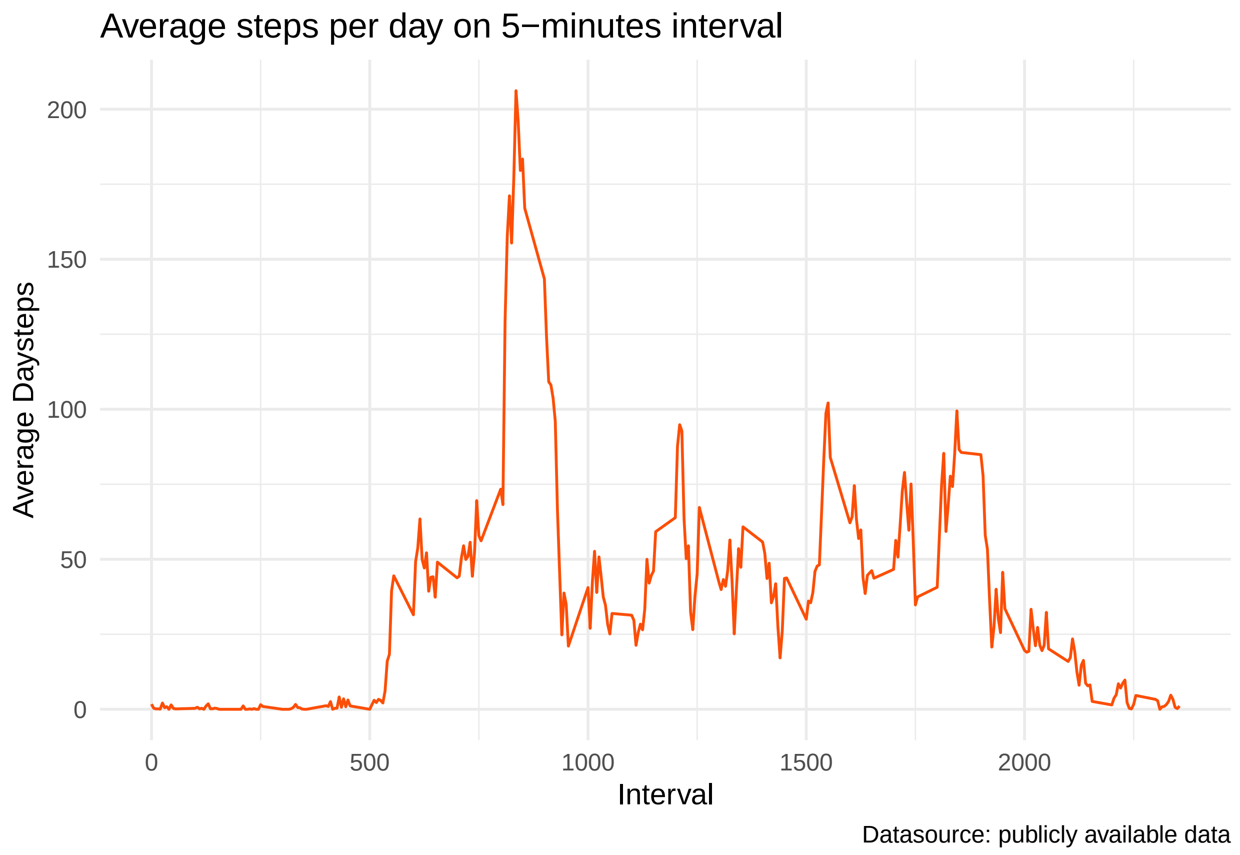
Calculate the average daysteps:

```
avgdaysteps <- aggregate(x = activity_df$steps,
                by = list( activity_df$interval),
                FUN = mean, na.rm = T)
names(avgdaysteps)[names(avgdaysteps) == "Group.1"] <- "interval"
names(avgdaysteps)[names(avgdaysteps) == "x"] <- "avgdaysteps"
head(avgdaysteps)
```

```
##   interval avgdaysteps
## 1        0   1.7169811
## 2        5   0.3396226
## 3       10   0.1320755
## 4       15   0.1509434
## 5       20   0.0754717
## 6       25   2.0943396
```

Time series plot: Average number of steps on 5-minute interval

```
ggplot(data = avgdaysteps, aes(x = interval, y = avgdaysteps)) +
geom_line(color = "#FC4E07", size = 0.5)+
#geom_rug()+
labs(x = 'Interval', y = 'Average Daysteps',
       title = 'Average steps per day on 5-minutes interval',
       caption = 'Datasource: publicly available data')+
theme_minimal()
```



3.2. The 5-minute interval containing the maximum number of steps

Which 5-minute interval, on average across all the days in the dataset, contains the maximum number of steps?

```
#install.packages("dplyr")
#library("dplyr")
subset(avgdaysteps,avgdaysteps==max(avgdaysteps))
```

```
##     interval avgdaysteps
## 104      835    206.1698
```

4. Imputing missing values

Note that there are a number of days/intervals where there are missing values (coded as NA). The presence of missing days may introduce bias into some calculations or summaries of the data.

4.1. Calculate and report the total number of NAs

Calculate and report the total number of missing values in the dataset (i.e. the total number of rows with NAs)

```
print("The total number of missing values in the dataset (in the steps column) is: ")
```

```
## [1] "The total number of missing values in the dataset (in the steps column) is: "
```

```
sum(is.na(activity_df))
```

```
## [1] 2304
```

```
#library(xtable)
xt_activity_df <- xtable(summary(activity_df[1]))
#print(xt_activity_df, type="html")
print(xt_activity_df, type="latex")
```

% latex table generated in R 4.1.0 by xtable 1.8-4 package % Fri Dec 10 20:14:07 2021

	steps
X	Min. : 0.00
X.1	1st Qu.: 0.00
X.2	Median : 0.00
X.3	Mean : 37.38
X.4	3rd Qu.: 12.00
X.5	Max. :806.00
X.6	NA's :2304

4.2. Filling in all of the missing values in the dataset

Devise a strategy for filling in all of the missing values in the dataset. The strategy does not need to be sophisticated. For example, you could use the mean/median for that day, or the mean for that 5-minute interval, etc.

Calculate steps mean for each 5-minutes interval:

```
intervalmean <- aggregate(x = activity_df$steps,
                          by = list(activity_df$interval),
                          FUN = mean, na.rm=T)
names(intervalmean)[names(intervalmean) == "Group.1"] <- "interval"
names(intervalmean)[names(intervalmean) == "x"] <- "steps_intervalmean"
head(intervalmean)
```

```
##   interval steps_intervalmean
## 1        0          1.7169811
## 2        5          0.3396226
## 3       10          0.1320755
## 4       15          0.1509434
## 5       20          0.0754717
## 6       25          2.0943396
```

```
#intervalmean
```

Calculate steps mean for each date:

```
datemean <- aggregate(x = activity_df$steps,
                by = list(activity_df$date),
                FUN = mean, na.rm=T)
names(datemean)[names(datemean) == "Group.1"] <- "date"
names(datemean)[names(datemean) == "x"] <- "steps_datemean"
head(datemean)
```

```
##         date steps_datemean
## 1 2012-10-01            NaN
## 2 2012-10-02        0.43750
## 3 2012-10-03       39.41667
## 4 2012-10-04       42.06944
## 5 2012-10-05       46.15972
## 6 2012-10-06       53.54167
```

4.3. Create a new dataset with the filled in data

Create a new dataset that is equal to the original dataset but with the missing data filled in.

Join the interval and date mean columns together with the original dataframe:

```
library(dplyr)
df <- merge(x=activity_df,y=intervalmean,by="interval")
df <- merge(x=df,y=datemean,by="date")
head(df)
```

```
##         date interval steps  time            datetime steps_intervalmean
## 1 2012-10-01        0    NA 00:00 2012-10-01 00:00:00           1.716981
## 2 2012-10-01      955    NA 09:55 2012-10-01 09:55:00          21.056604
## 3 2012-10-01      905    NA 09:05 2012-10-01 09:05:00         124.037736
## 4 2012-10-01      125    NA 01:25 2012-10-01 01:25:00           1.113208
## 5 2012-10-01      635    NA 06:35 2012-10-01 06:35:00          39.339623
## 6 2012-10-01     1455    NA 14:55 2012-10-01 14:55:00          43.773585
##   steps_datemean
## 1            NaN
## 2            NaN
## 3            NaN
## 4            NaN
## 5            NaN
## 6            NaN
```

Fill in the NAs in step column with the interval means:

```
df_na_intervalmean <- df
df_na_intervalmean <- mutate(df_na_intervalmean, steps = ifelse(is.na(df$steps), df$steps_intervalmean,
df_na_intervalmean <- mutate(df_na_intervalmean, steps_datemean = ifelse(is.na(df_na_intervalmean$steps_
head(df_na_intervalmean)
```

```
##         date interval      steps  time            datetime steps_intervalmean
## 1 2012-10-01        0   1.716981 00:00 2012-10-01 00:00:00           1.716981
## 2 2012-10-01      955  21.056604 09:55 2012-10-01 09:55:00          21.056604
## 3 2012-10-01      905 124.037736 09:05 2012-10-01 09:05:00         124.037736
## 4 2012-10-01      125   1.113208 01:25 2012-10-01 01:25:00           1.113208
## 5 2012-10-01      635  39.339623 06:35 2012-10-01 06:35:00          39.339623
## 6 2012-10-01     1455  43.773585 14:55 2012-10-01 14:55:00          43.773585
##   steps_datemean
## 1        37.3826
## 2        37.3826
## 3        37.3826
## 4        37.3826
## 5        37.3826
## 6        37.3826
```

4.4. Make a histogram of the total number of steps and report the mean and median

Make a histogram of the total number of steps taken each day and calculate and report the mean and median total number of steps taken per day. Do these values differ from the estimates from the first part of the assignment? What is the impact of imputing missing data on the estimates of the total daily number of steps?

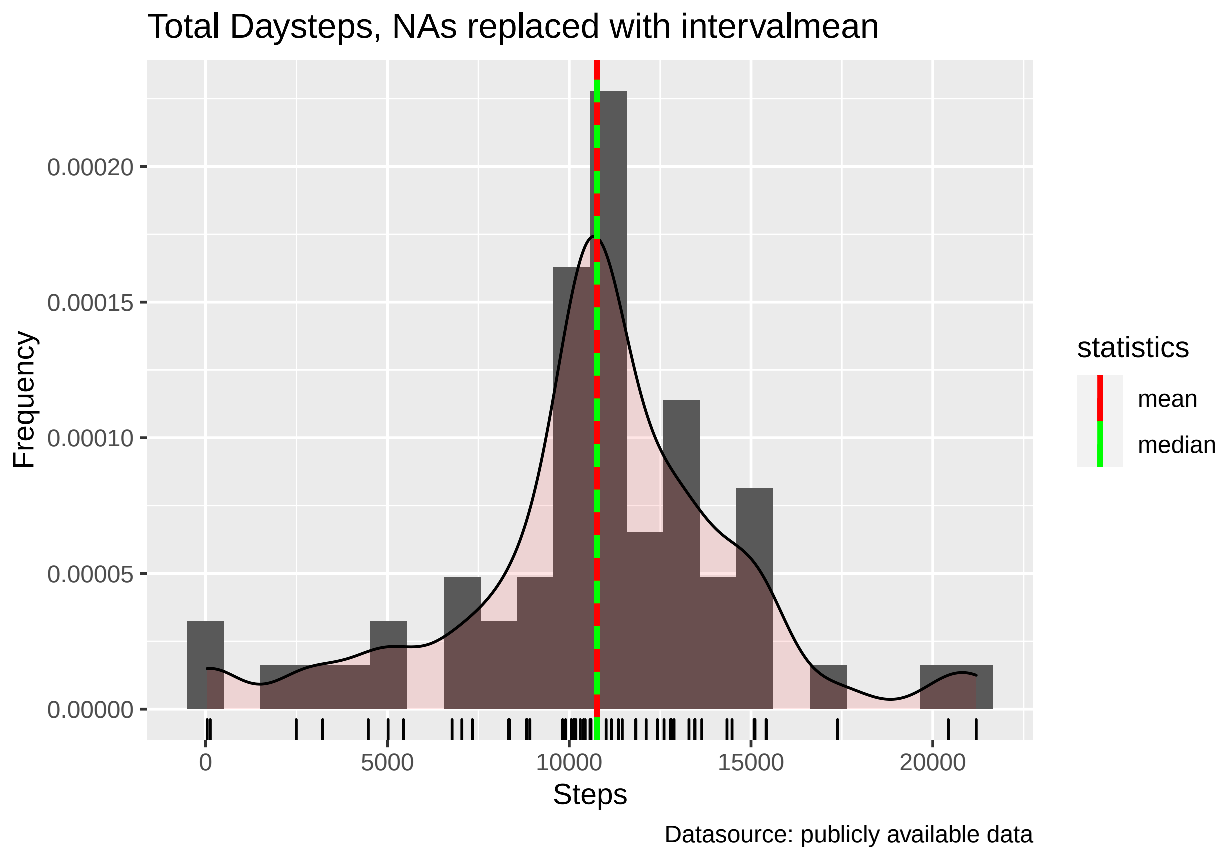
Calculate the total daysteps, Nas replaced with intervalmean:

```
totaldaysteps_na_intervalmean <- aggregate(x = df_na_intervalmean$steps,
                by = list(df_na_intervalmean$date),
                FUN = sum)
names(totaldaysteps_na_intervalmean)[names(totaldaysteps_na_intervalmean) == "Group.1"] <- "date"
names(totaldaysteps_na_intervalmean)[names(totaldaysteps_na_intervalmean) == "x"] <- "totaldaysteps_na_
head(totaldaysteps_na_intervalmean)
```

```
##         date totaldaysteps_na_intervalmean
## 1 2012-10-01                      10766.19
## 2 2012-10-02                        126.00
## 3 2012-10-03                      11352.00
## 4 2012-10-04                      12116.00
## 5 2012-10-05                      13294.00
## 6 2012-10-06                      15420.00
```

Histogramm of totaldaysteps, NAs replaced with intervalmean:

```
library("ggplot2")
ggplot(totaldaysteps_na_intervalmean, aes(x = totaldaysteps_na_intervalmean)) +
  geom_histogram(aes(y = ..density..), bins = 22) +
  geom_density(alpha = 0.1, fill = "red") +
  geom_rug() +         # Draw Frequency below x axis
  geom_vline(aes(xintercept=mean(totaldaysteps_na_intervalmean),
           color="mean"), linetype="solid", size=1) +
  geom_vline(aes(xintercept=median(totaldaysteps_na_intervalmean),
           color="median"), linetype="dashed", size=1)+
  labs(x = 'Steps', y = 'Frequency',
       title = 'Total Daysteps, NAs replaced with intervalmean',
       caption = 'Datasource: publicly available data')+
  scale_color_manual(
        name = "statistics",
        values = c(mean = "red", median = "green"))
```



Report the mean and median total number of steps taken per day:

Calculate and print the mean and median:

```
mn <- mean(totaldaysteps$totaldaysteps, na.rm=T)
md <- median(totaldaysteps$totaldaysteps, na.rm=T)
mn_na_intervalmean <- mean(totaldaysteps_na_intervalmean$totaldaysteps_na_intervalmean, na.rm=T)
md_na_intervalmean <- median(totaldaysteps_na_intervalmean$totaldaysteps_na_intervalmean, na.rm=T)
print(paste("The mean is: ", round(mn,2), " steps."))
print(paste("The mean (NAs replaced by intervalmean) is: ", round(mn_na_intervalmean,2), " steps."))
print(paste("The median is: ", round(md,2), " steps."))
print(paste("The median (NAs replaced by intervalmean) is: ", round(md_na_intervalmean,2), " steps."))
```

Show the summary table:

```
library(xtable)
xt_na <- xtable(summary(totaldaysteps_na_intervalmean))
#print(xt_na, type="html")
print(xt_na, type="latex")
```

% latex table generated in R 4.1.0 by xtable 1.8-4 package % Fri Dec 10 20:14:07 2021

5. Are there differences in activity patterns between weekdays and weekends?

For this part the weekdays() function may be of some help here. Use the dataset with the filled-in missing values for this part.

	date	totaldaysteps_na_intervalmean
X	Length:61	Min. : 41
X.1	Class :character	1st Qu.: 9819
X.2	Mode :character	Median :10766
X.3		Mean :10766
X.4		3rd Qu.:12811
X.5		Max. :21194

5.1. Create "weekday" and "weekend" of the date

Create a new factor variable in the dataset with two levels – "weekday" and "weekend" indicating whether a given date is a weekday or weekend day.

Create weekdays from date and than the factor variable with the two levels – "weekday" and "weekend":

```
df_na_intervalmean <- mutate(df_na_intervalmean, date = as.POSIXct(date))
df_na_intervalmean <- mutate(df_na_intervalmean, weekdays = weekdays(date))
df_na_intervalmean[grepl(pattern = "Montag|Dienstag|Mittwoch|Donnerstag|Freitag", x =df_na_intervalmean
df_na_intervalmean[grepl(pattern = "Samstag|Sontag", x =df_na_intervalmean$weekdays), "weekday_weekend"
df_na_intervalmean$weekday_weekend <- as.factor(df_na_intervalmean$weekday_weekend)
#class(df_na_intervalmean$weekday_weekend)
head(df_na_intervalmean, 10)
```

```
##          date interval       steps  time            datetime steps_intervalmean
## 1  2012-10-01        0   1.7169811 00:00 2012-10-01 00:00:00          1.7169811
## 2  2012-10-01      955  21.0566038 09:55 2012-10-01 09:55:00         21.0566038
## 3  2012-10-01      905 124.0377358 09:05 2012-10-01 09:05:00        124.0377358
## 4  2012-10-01      125   1.1132075 01:25 2012-10-01 01:25:00          1.1132075
## 5  2012-10-01      635  39.3396226 06:35 2012-10-01 06:35:00         39.3396226
## 6  2012-10-01     1455  43.7735849 14:55 2012-10-01 14:55:00         43.7735849
## 7  2012-10-01       10   0.1320755 00:10 2012-10-01 00:10:00          0.1320755
## 8  2012-10-01     2250   1.6037736 22:50 2012-10-01 22:50:00          1.6037736
## 9  2012-10-01      930  66.2075472 09:30 2012-10-01 09:30:00         66.2075472
## 10 2012-10-01     2025  21.1698113 20:25 2012-10-01 20:25:00         21.1698113
##    steps_datemean weekdays weekday_weekend
## 1         37.3826   Montag         weekday
## 2         37.3826   Montag         weekday
## 3         37.3826   Montag         weekday
## 4         37.3826   Montag         weekday
## 5         37.3826   Montag         weekday
## 6         37.3826   Montag         weekday
## 7         37.3826   Montag         weekday
## 8         37.3826   Montag         weekday
## 9         37.3826   Montag         weekday
## 10        37.3826   Montag         weekday
```

5.2. Make a panel plot time series of the 5-minute interval and the average number of steps

Make a panel plot containing a time series plot (i.e. type = "l") of the 5-minute interval (x-axis) and the average number of steps taken, averaged across all weekday days or weekend days (y-axis). See the README file in the GitHub repository to see an example of what this plot should look like using simulated data.

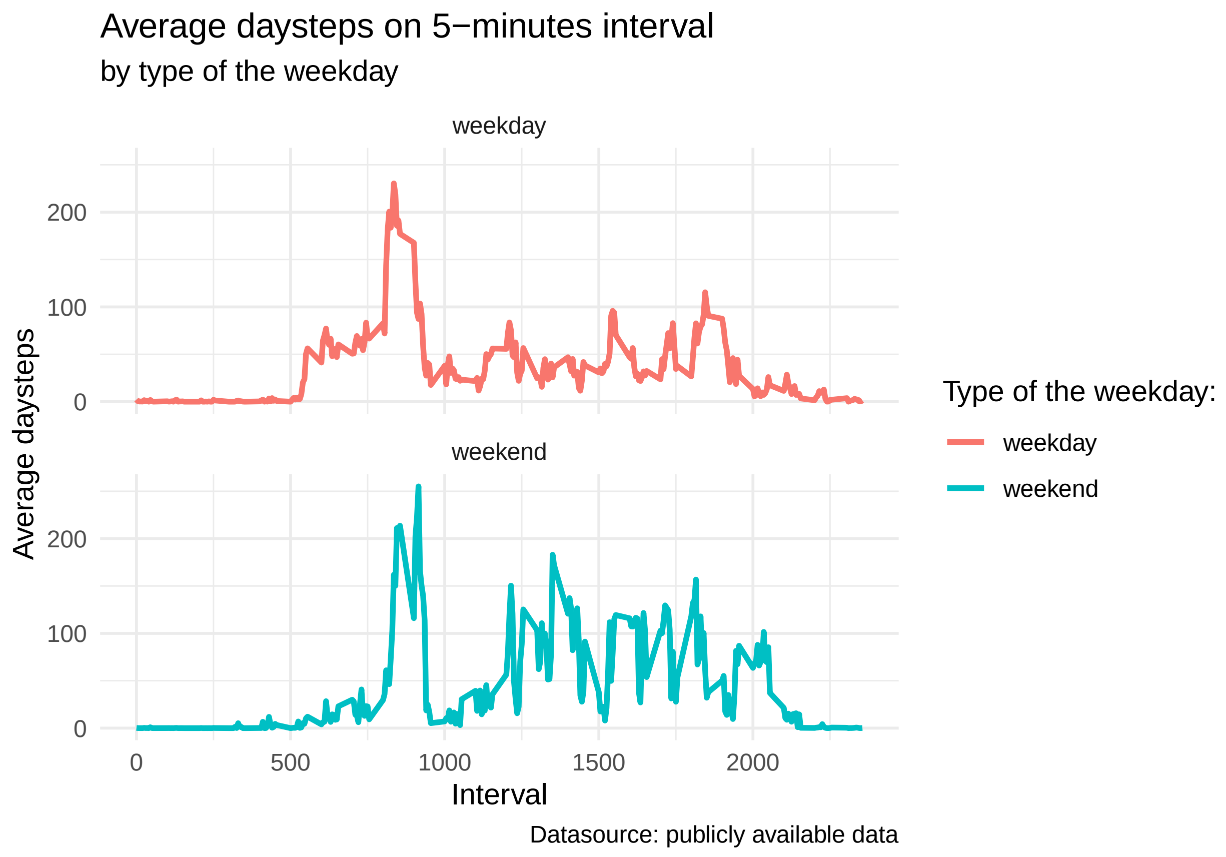
Calculate the average daysteps:

```
avgdaysteps_na_intervalmean <- aggregate(x = df_na_intervalmean$steps,
                by = list( df_na_intervalmean$interval, df_na_intervalmean$weekday_weekend),
                FUN = mean, na.rm = T)
names(avgdaysteps_na_intervalmean)[names(avgdaysteps_na_intervalmean) == "Group.1"] <- "interval"
names(avgdaysteps_na_intervalmean)[names(avgdaysteps_na_intervalmean) == "Group.2"] <- "weekday_weekend
names(avgdaysteps_na_intervalmean)[names(avgdaysteps_na_intervalmean) == "x"] <- "avgdaysteps_na_interva
head(avgdaysteps_na_intervalmean)
```

```
##   interval weekday_weekend avgdaysteps_na_intervalmean
## 1        0         weekday                  2.25115304
## 2        5         weekday                  0.44528302
## 3       10         weekday                  0.17316562
## 4       15         weekday                  0.19790356
## 5       20         weekday                  0.09895178
## 6       25         weekday                  1.59035639
```

Panal of time series plots: Average daysteps on 5-minutes interval by type of the weekday:

```
ggplot(avgdaysteps_na_intervalmean, aes(x=interval, y=avgdaysteps_na_intervalmean, color=weekday_weekend
geom_line(size = 1) +
facet_wrap(~weekday_weekend,  ncol = 1, nrow=2) +
labs(title = 'Average daysteps on 5-minutes interval',
     subtitle="by type of the weekday",
       x = "Interval",
       y = "Average daysteps",
     color="Type of the weekday:",
       caption = 'Datasource: publicly available data')+
theme_minimal()
```



6. Commit containing full submission

All of the R code needed to reproduce the results (numbers, plots, etc.) in the report must be submitted.