Data Science Specialisation, Course 5, assignment 1

HCS' assignment 1 for Reproductible Research course

Loading and preprocessing the data

Downloading data if necessary

The following chunk of code evaluates if the data files are already present. If not, it will download the data, uncompress it, and then remove the compressed file that is no longer necessary.

```
file_url <- "https://d396qusza40orc.cloudfront.net/repdata%2Fdata%2Factivity.zip"
file_zip <- "repdata%2Fdata%2Factivity.zip"
file_unzip <- c("activity.csv")

if (!all(file.exists(file_unzip))) {
  if (!file.exists(file_zip)) { download.file(file_url,destfile=file_zip,mode="wb") }
  unzip(file_zip)
  file.remove(file_zip)
}
```

Loading and cleaning the data

The following section reads the row data, and then transforms the columns concerning time measures into a time format suitable for R. We will also take a look on how the data looks like.

```
data <- read.csv(file_unzip)
data$date <- as.Date(data$date)
data$interval <- as.POSIXct(sprintf("%04d",data$interval),format="%H%M")
str(data)
```

```
## 'data.frame':    17568 obs. of  3 variables:
##  $ steps   : int  NA NA NA NA NA NA NA NA NA NA ...
##  $ date    : Date, format: "2012-10-01" "2012-10-01" ...
##  $ interval: POSIXct, format: "2019-12-04 00:00:00" "2019-12-04 00:05:00" ...
```

As we can notice, the data$interval column contains the intervals of time as if they were for the current day. Since this part of the data is only used to group and compare intervals of time regardless the date, we will ignore the fact that the date doesn't match that on the data$date column.

What is mean total number of steps taken per day?

Summarise data

First, we will report the total number of steps per day using the dplyr library. The data us grouped by date (day) and the sum of steps for each day is calculated. This is stored in the variable steps.perday.

```
library(dplyr)
```

```
steps.perday <- data %>% group_by(date) %>% summarise(steps=sum(steps,na.rm=T))
steps.perday$steps[steps.perday$steps==0] <- NA
head(steps.perday)
```

```
## # A tibble: 6 x 2
##   date       steps
##   <date>     <int>
## 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
```

Then the number of steps per day is summarised and stored in the variable steps.summary, which shows the mean and the median.

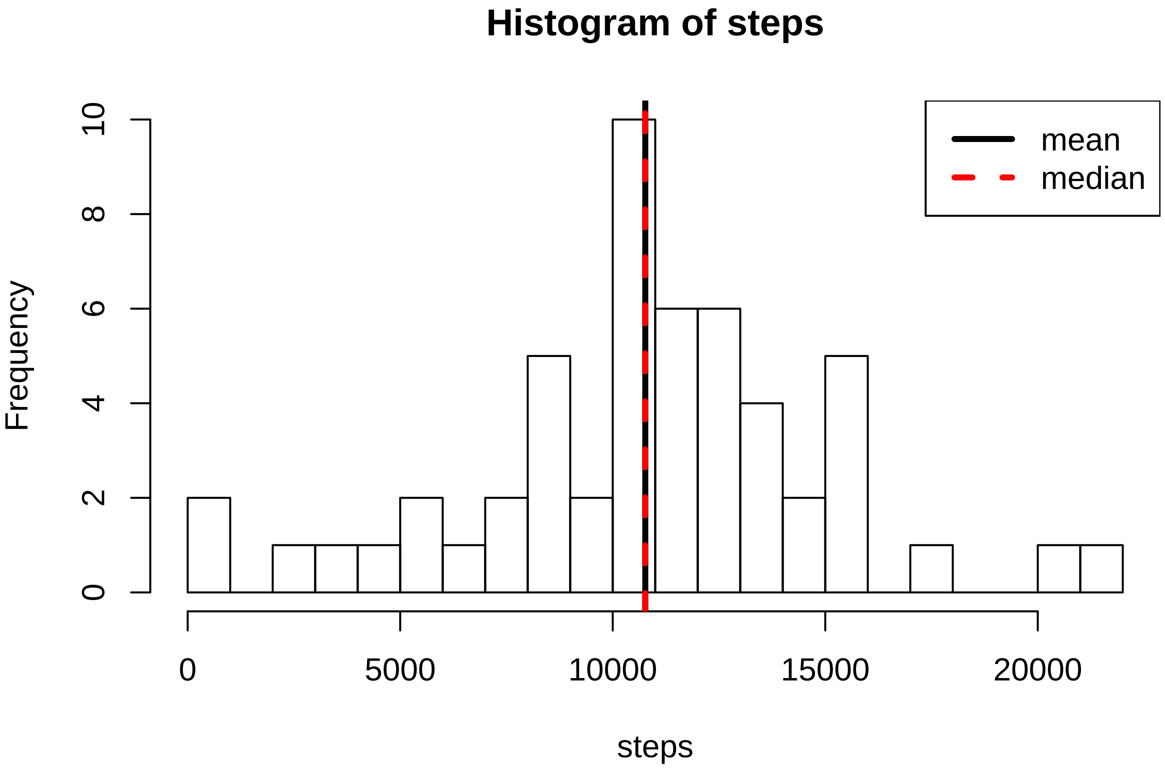
```
steps.summary <- summary(steps.perday$steps,na.rm=T)
steps.summary
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's 
##      41    8841   10765   10766   13294   21194       8
```

Make plot

The following code generates a histogram of the number of steps per day, along with the mean and median.

```
with(steps.perday, {
  hist(steps,breaks=25)
  abline(v=mean(steps,na.rm=T),lty=1,lwd=3)
  abline(v=median(steps,na.rm=T),lty=2,lwd=3,col="red")
  legend("topright",lwd=3,lty=c(1,2),col=c("black","red"),legend=c("mean","median"))})
```

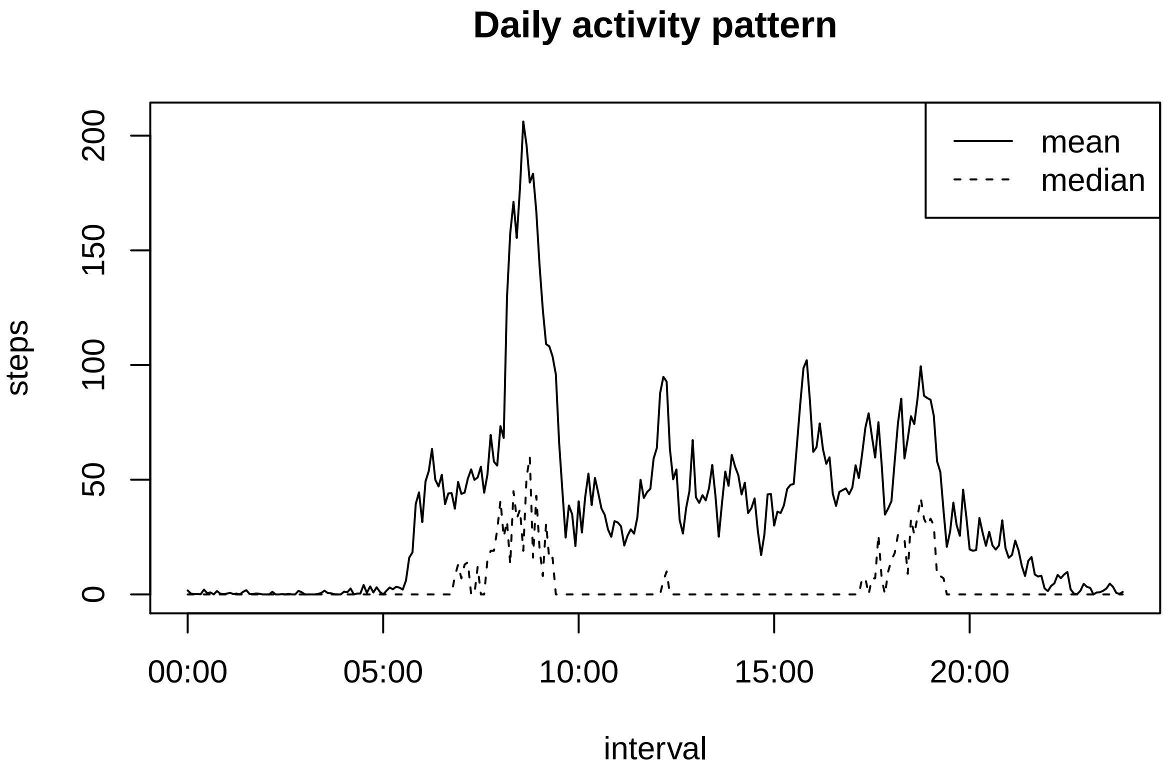


What is the average daily activity pattern?

This section summarises the data by intervals of time across days and saves it in the variable steps.pertime. This variable is then used to plot the mean and median number of steps for each interval.

```
steps.pertime <- data %>% group_by(interval) %>%
  summarise(median=median(steps,na.rm=T),mean=mean(steps,na.rm=T))
```

```
with(steps.pertime, {
  plot(mean~interval,type="l",xlab="interval",ylab="steps",main="Daily activity pattern")
  lines(median~interval,lty=2)
  legend('topright',legend=c("mean","median"),lty=c(1,2))})
```



The hour at which the maximum mean number of step is reported is the following:

```
maxhour <- steps.pertime %>% filter(mean==max(mean)) %>% select(interval)
maxhour <- format(maxhour$interval[1],"%H:%M")
maxhour
```

```
## [1] "08:35"
```

As can be seen, the peak hour is at 08:35.

Imputing missing values

Since some data is missing from the dataset, we will first impute the missing data.

Explore missing data

First we explore how the NA values are distributed by measuring the percentage of NA observations per day. We start by counting the NA values:

```
sum(is.na(data$steps))
```

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

Then we explore the data:

```
data.na <- with(data, tapply(steps,date,function(x) mean(is.na(x))))
data.naT <- sum(data.na)
data.na
```

```
## 2012-10-01 2012-10-02 2012-10-03 2012-10-04 2012-10-05 2012-10-06 2012-10-07
##          1          0          0          0          0          0          0
## 2012-10-08 2012-10-09 2012-10-10 2012-10-11 2012-10-12 2012-10-13 2012-10-14
##          1          0          0          0          0          0          0
## 2012-10-15 2012-10-16 2012-10-17 2012-10-18 2012-10-19 2012-10-20 2012-10-21
##          0          0          0          0          0          0          0
## 2012-10-22 2012-10-23 2012-10-24 2012-10-25 2012-10-26 2012-10-27 2012-10-28
##          0          0          0          0          0          0          0
## 2012-10-29 2012-10-30 2012-10-31 2012-11-01 2012-11-02 2012-11-03 2012-11-04
##          0          0          0          1          0          0          1
## 2012-11-05 2012-11-06 2012-11-07 2012-11-08 2012-11-09 2012-11-10 2012-11-11
##          0          0          0          0          1          1          0
## 2012-11-12 2012-11-13 2012-11-14 2012-11-15 2012-11-16 2012-11-17 2012-11-18
##          0          0          1          0          0          0          0
## 2012-11-19 2012-11-20 2012-11-21 2012-11-22 2012-11-23 2012-11-24 2012-11-25
##          0          0          0          0          0          0          0
## 2012-11-26 2012-11-27 2012-11-28 2012-11-29 2012-11-30
##          0          0          0          0          1
```

As shown above, 8 days have 100% NA values, while others only have complete observations.

Fill missing data with median from other days

The days with missing data can be imputed with the calculated median for all the other days, by intervals, as shown in the code above:

```
data.imputed <- data
data.imputed$steps[is.na(data.imputed$steps)] <- rep(steps.pertime$median,
                              sum(with(data, tapply(steps,date,function(x) mean(is.na(x))))))
steps.perday.imp <- data.imputed %>% group_by(date) %>% summarise(steps=sum(steps,na.rm=T))
steps.summary.imp <- summary(steps.perday.imp$steps,na.rm=T)
steps.summary.imp
```

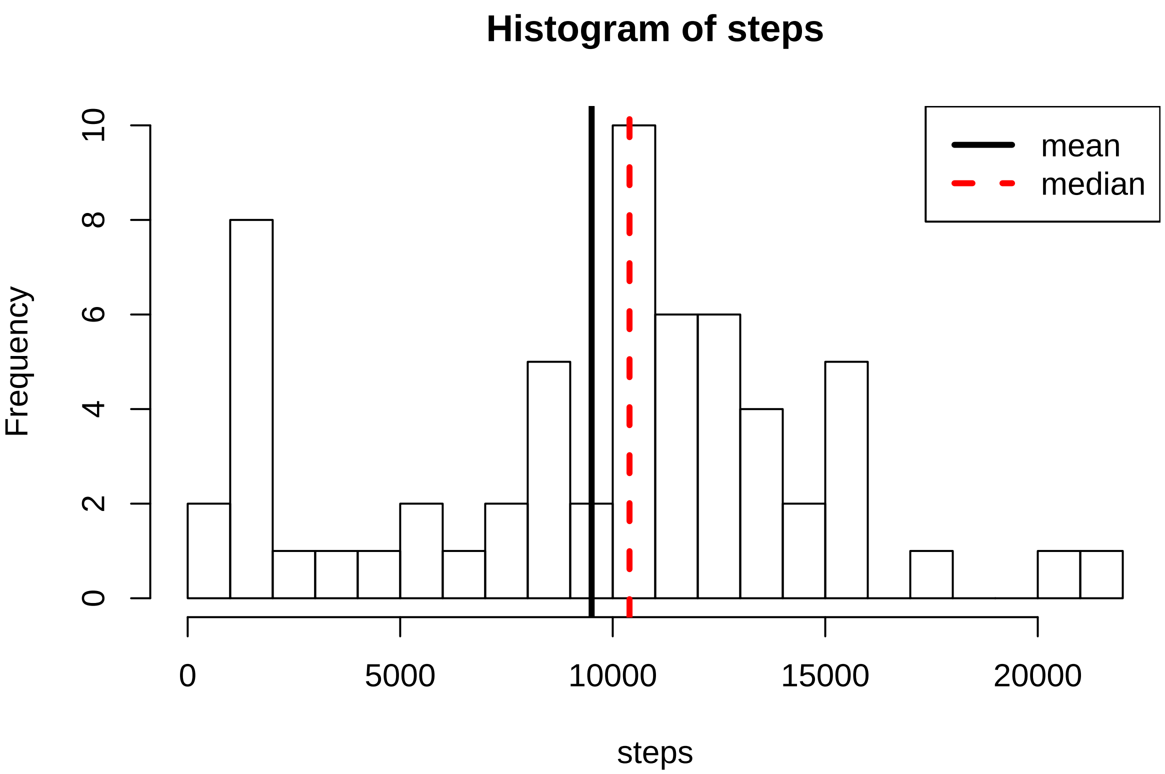
```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      41    6778   10395    9504   12811   21194
```

As we can see, both the median and the mean of the imputed data differ from the original.

Histogram and summary of imputed data

As we did before for the original data, we can visualise a histogram of the total number of steps per day for imputed data along with the mean and median.

```
with(steps.perday.imp, {
  hist(steps,breaks=25)
  abline(v=mean(steps,na.rm=T),lty=1,lwd=3)
  abline(v=median(steps,na.rm=T),lty=2,lwd=3,col="red")
  legend("topright",lwd=3,lty=c(1,2),col=c("black","red"),legend=c("mean","median"))})
```



As shown, imputing the data affects both the mean and the median.

Are there differences in activity patterns between weekdays and weekends?

Creating period variable

In order to discriminate between the measures that occur during weekdays from those that occur during the weekend, we create a new column called period. We will also explore the data in order to check it.

```
data.imputed$period <- factor(ifelse(as.POSIXlt(data$date)$wday %in% 1:5,"weekday","weekend"))
str(data.imputed)
```

```
## 'data.frame':    17568 obs. of  4 variables:
##  $ steps   : int  0 0 0 0 0 0 0 0 0 0 ...
##  $ date    : Date, format: "2012-10-01" "2012-10-01" ...
##  $ interval: POSIXct, format: "2019-12-04 00:00:00" "2019-12-04 00:05:00" ...
##  $ period  : Factor w/ 2 levels "weekday","weekend": 1 1 1 1 1 1 1 1 1 1 ...
```

We can also take a look on the summary of the enriched data just to observe if there are obvious differences by period of the week.

```
with(data.imputed, tapply(steps,period,summary))
```

```
## $weekday
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    0.00    0.00    0.00   31.15    5.00  806.00
##
## $weekend
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    0.00    0.00    0.00   38.19   17.25  785.00
```

Summarise

Finally, we will summarise the new data. For this, we will group the data by period and interval, summarise the mean and median, and reformat the dataframe so it is easier to plot later. This will require the tidyr package. We will also and take a look on the first lines of the reorganised data.

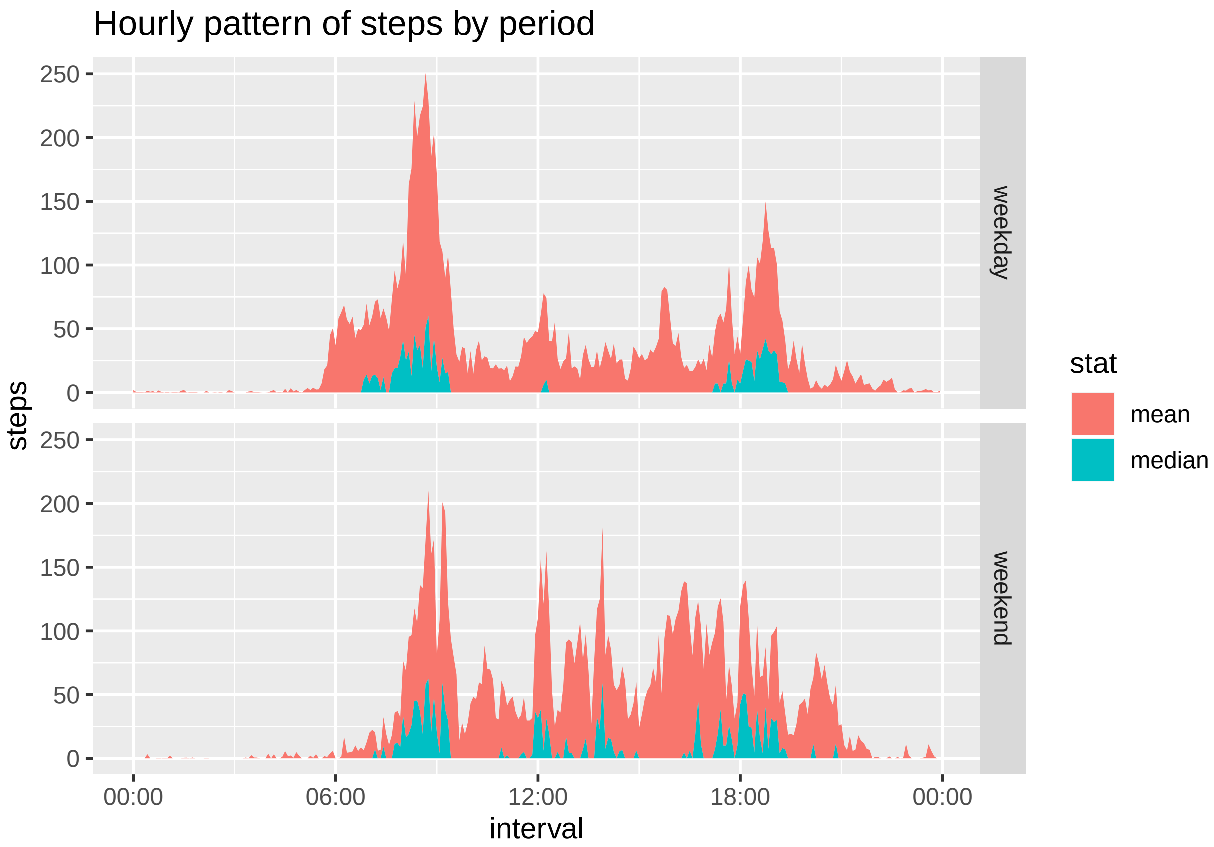
```
library(tidyr)
steps.pertime.week <- data.imputed %>% group_by(period,interval) %>%
  summarise(median=median(steps,na.rm=T),mean=mean(steps,na.rm=T)) %>%
  gather("mean":"median",key="stat",value="steps")
head(steps.pertime.week)
```

```
## # A tibble: 6 x 4
## # Groups:   period [2]
##   period  interval            stat   steps
##   <fct>   <dttm>              <chr>  <dbl>
## 1 weekday 2019-12-04 00:00:00 mean  2.02  
## 2 weekday 2019-12-04 00:05:00 mean  0.4   
## 3 weekday 2019-12-04 00:10:00 mean  0.156 
## 4 weekday 2019-12-04 00:15:00 mean  0.178 
## 5 weekday 2019-12-04 00:20:00 mean  0.0889
## 6 weekday 2019-12-04 00:25:00 mean  1.31  
```

Plot the final data

Finally, we will plot both the mean and the median of each period of the week using the package ggplot2.

```
library(ggplot2)
g <- ggplot(steps.pertime.week,aes(x=interval,y=steps))
g + geom_area(aes(fill=stat)) + ggtitle("Hourly pattern of steps by period") +
  facet_grid(period~.) + scale_x_datetime(date_labels="%H:%M")
```



As we can observe, the distribution of the median and mean steps per period of time changes in function of the period of the week.