BDA HW1

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```
set.seed(0)
```

```
n_batch <- 100
# With high probablity the total number of patients that...
# ...arrive before 4pm will be less than 100.

# If more than 100 we have a loop to continue adding patients as written down below.

arrive_gap <- rexp(n=n_batch, rate=1/10)
meet_time <- runif(n=n_batch, 5, 20)

while (sum(arrive_gap) <= (16-9) * 60) {
    print("Somehow we have an unbelievable number of patients before 4pm")
    arrive_time <- c(arrive_gap, rexp(n=n_batch, rate=1/10))
    meet_time <- c(meet_time, runif(n=n_batch, 5, 20))
}
```

How many patients visited our office?

```
last_patient <- tail(which(cumsum(arrive_gap) <= (16-9) * 60), n=1)
last_patient
```

```
## [1] 43
```

```
if (length(last_patient) == 0) {
    print("Nobody comes before 4pm, what happened?")
}
```

Continue Simulating for patient waiting information

```
arrive_time <- cumsum(arrive_gap)

doctor_schedule <- data.frame(matrix(0, last_patient+1, 3))
colnames(doctor_schedule) <- c('A', 'B', 'C')

wait_time <- c()

for (i in 1:last_patient) {
    hello_doctor <- doctor_schedule[i, ]
    next_avaliable <- which.min(hello_doctor)

    if (hello_doctor[next_avaliable] <= arrive_time[i]) {
        ### There is at least one doctor avaliable for the ith patient on arrival. ###

        doctor_schedule[i+1, ] <- doctor_schedule[i, ]
        # Keep the current schedule of other two doctors for next patient.
        doctor_schedule[i+1, next_avaliable] <- arrive_time[i] + meet_time[i]
        # Change the meeting doctor's schedule.

    } else {
        ### No doctor is avaliable at this time. Let's wait. ###

        wait_time <- c(wait_time, hello_doctor[next_avaliable] - arrive_time[i])
        doctor_schedule[i+1, ] <- doctor_schedule[i, ]
        doctor_schedule[i+1, next_avaliable] <-
          doctor_schedule[i, next_avaliable] + meet_time[i]
        # Notice that the way we calculate next avaliable time for this doctor...
        # ...is different comparing to the above chunk.

    }

    ### Poor doctors, they couldn't even take a break. ###
}
```

How many had to wait?

```
how_many_had_to_wait <- length(wait_time)
how_many_had_to_wait
```

```
## [1] 4
```

What was their average wait?

```
what_was_their_average_wait <- mean(as.numeric(wait_time))
if (is.na(what_was_their_average_wait)) what_was_their_average_wait <- 0
# in case no one ever waited.
what_was_their_average_wait # in minutes
```

```
## [1] 3.490962
```

When did the office close?

```
when_did_the_office_close <- format(as.POSIXct((max(doctor_schedule) + 9*60) * 60,
                                        origin = "1970-01-01", tz = "UTC"),
                                        "%H:%M")
if (when_did_the_office_close <= '16:00') when_did_the_office_close <- '16:00'
# In case all patients are treated before 4pm (and...
# ...the next potential patient will arrives after 4pm).

# It depends on how you understand '... closes when the last patient is through with the doctor'.
# The question is how do you know this is the last patient before 4pm. You don't.
# So I think it's reasonable to wait until 4pm to close.
# This definition will certainly change the distribution of 'close time' as a random variable.

when_did_the_office_close
```

```
## [1] "16:09"
```

Repeat 100 times

- Write above chunks of code into a function and repeat the simulation for 100 times.
- Comments are deleted. Please see above chunks for code explaination.

```r
Hurtado_Health_Center <- function(n_rep) {
    result <- data.frame(matrix(, n_rep, 4))
    for (n in 1:n_rep) {
        n_batch <- 100
        arrive_gap <- rexp(n=n_batch, rate=1/10)
        meet_time <- runif(n=n_batch, 5, 20)

        while (sum(arrive_gap) <= (16-9) * 60) {
            print("Somehow we have an unbelievable number of patients before 4pm")
            arrive_time <- c(arrive_gap, rexp(n=n_batch, rate=1/10))
            meet_time <- c(meet_time, runif(n=n_batch, 5, 20))
        }

        last_patient <- tail(which(cumsum(arrive_gap) <= (16-9) * 60), n=1)
        result[n, 1] <- last_patient

        if (length(last_patient) == 0) {
            print("Nobody comes before 4pm, what happened?")
        }

        arrive_time <- cumsum(arrive_gap)

        doctor_schedule <- data.frame(matrix(0, last_patient+1, 3))
        colnames(doctor_schedule) <- c('A', 'B', 'C')

        wait_time <- c()

        for (i in 1:last_patient) {
            hello_doctor <- doctor_schedule[i, ]
            next_avaliable <- which.min(hello_doctor)

            if (hello_doctor[next_avaliable] <= arrive_time[i]) {

                doctor_schedule[i+1, ] <- doctor_schedule[i, ]
                doctor_schedule[i+1, next_avaliable] <- arrive_time[i] + meet_time[i]

            } else {

                wait_time <- c(wait_time, hello_doctor[next_avaliable] - arrive_time[i])
                doctor_schedule[i+1, ] <- doctor_schedule[i, ]
                doctor_schedule[i+1, next_avaliable] <-
                  doctor_schedule[i, next_avaliable] + meet_time[i]

            }
        }

        how_many_had_to_wait <- length(wait_time)
        result[n, 2] <- how_many_had_to_wait

        what_was_their_average_wait <- mean(as.numeric(wait_time))
        if (is.na(what_was_their_average_wait)) what_was_their_average_wait <- 0
        result[n, 3] <- what_was_their_average_wait

        when_did_the_office_close <- max(doctor_schedule)
        if (when_did_the_office_close <= 420) when_did_the_office_close <- 420
        result[n, 4] <- when_did_the_office_close
    }
    return(result)
}
```

Take a glance at simulation results

```
res <- Hurtado_Health_Center(100)
colnames(res) <- c('p_number', 'wait_count', 'wait_time_avg', 'close')
head(res)
```

```
##   p_number wait_count wait_time_avg    close
## 1       42          2      2.049634 430.4233
## 2       47          6      2.563495 434.8551
## 3       49          7      2.035736 426.2373
## 4       37          3      4.354265 426.7133
## 5       31          3      8.758707 420.4448
## 6       32          2      3.406471 420.0000
```

```
tail(res)
```

```
##     p_number wait_count wait_time_avg    close
## 95        46          3      2.796880 426.8117
## 96        52          7      6.390701 432.3017
## 97        40          2      3.625204 435.1705
## 98        48          7      4.815937 437.7422
## 99        44         17      6.033319 420.0000
## 100       40          2      3.087213 422.2469
```

Quantiles and Histogram

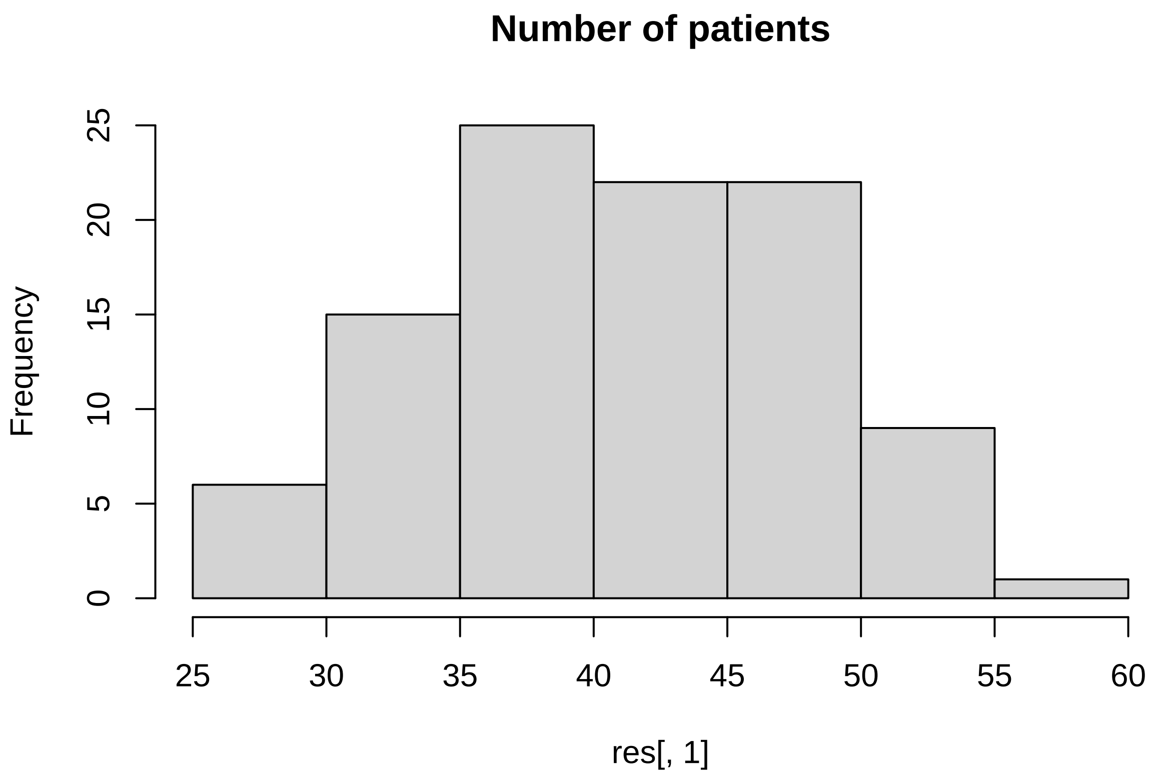
```
print(paste('Meidan for patients # is', quantile(res[,1], probs=.5)))
```

```
## [1] "Meidan for patients # is 41"
```

```
print(paste('50% interval for patients # is', quantile(res[,1], probs=.25),
            'to', quantile(res[,1], probs=.75)))
```

```
## [1] "50% interval for patients # is 37 to 47"
```

```
hist(res[,1], main = 'Number of patients')
```



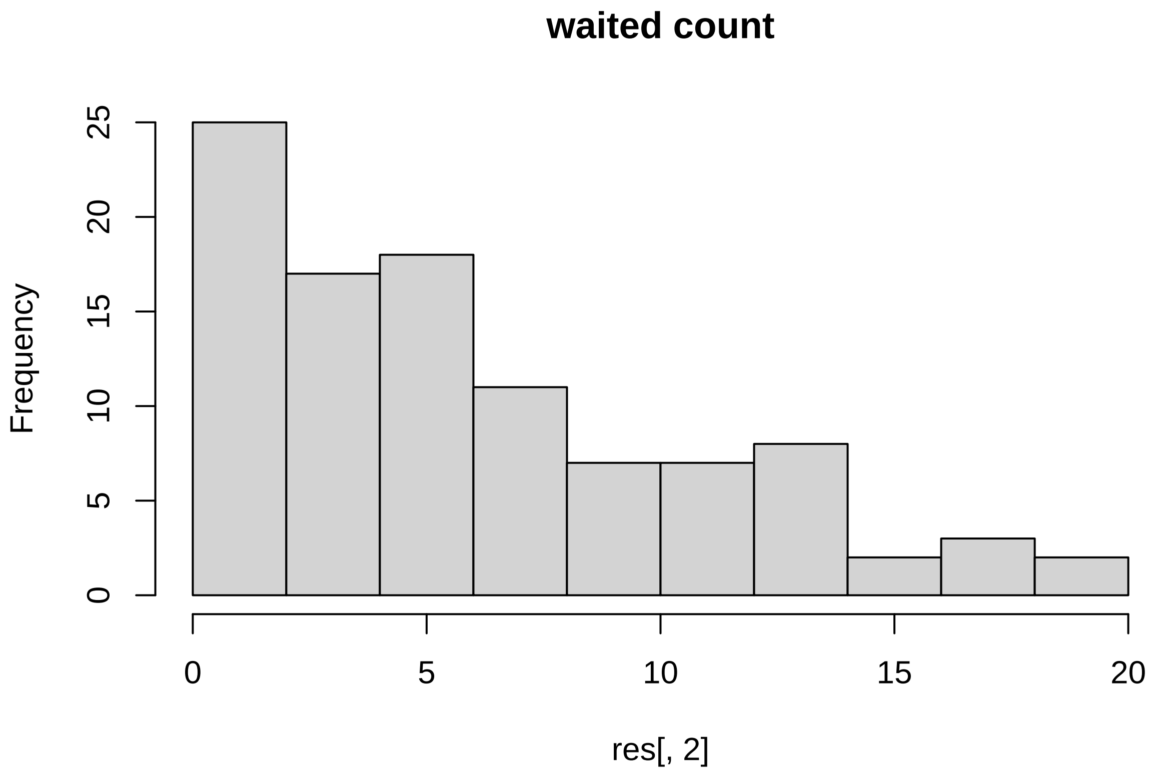
```
print(paste('Meidan for waited count is', quantile(res[,2], probs=.5)))
```

```
## [1] "Meidan for waited count is 5"
```

```
print(paste('50% interval for waited count is', quantile(res[,2], probs=.25),
            'to', quantile(res[,2], probs=.75)))
```

```
## [1] "50% interval for waited count is 2.75 to 10"
```

```
hist(res[,2],  main = 'waited count')
```



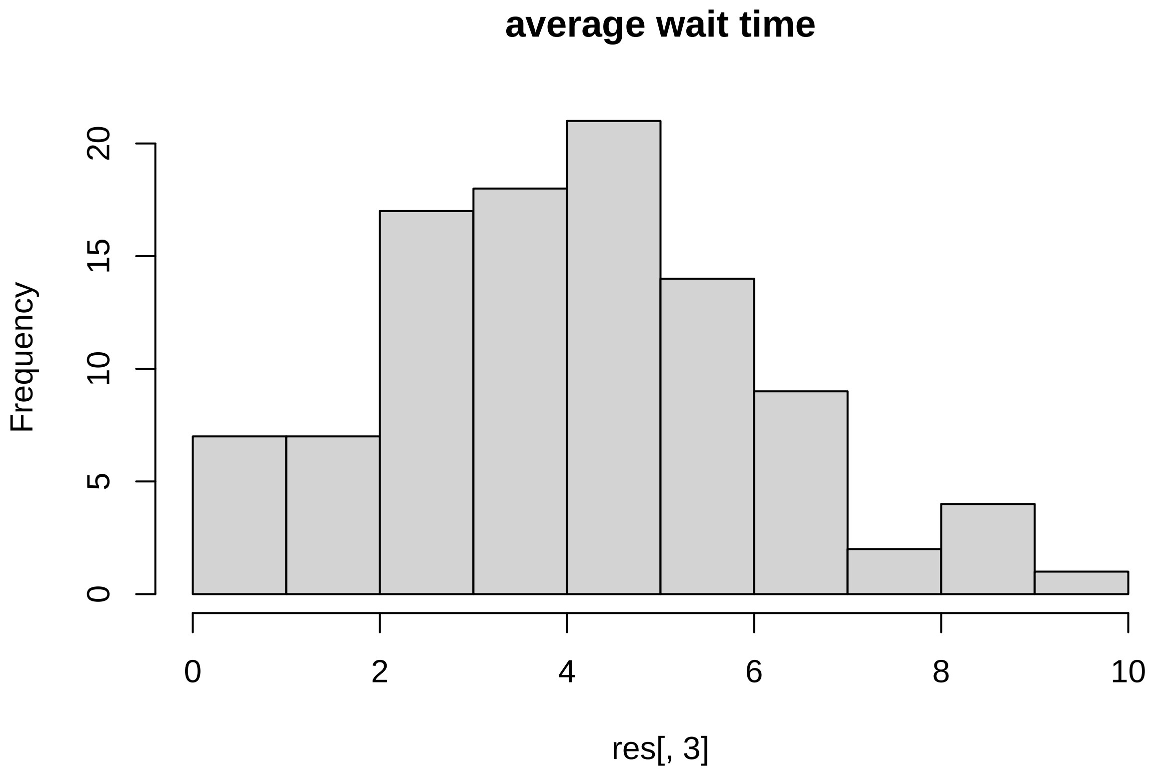
```r
print(paste('Meidan for average wait time is', quantile(res[,3], probs=.5)))
```

```
## [1] "Meidan for average wait time is 4.12498239125524"
```

```r
print(paste('50% interval for average wait time is', quantile(res[,3], probs=.25),
            'to', quantile(res[,3], probs=.75)))
```

```
## [1] "50% interval for average wait time is 2.56338285421338 to 5.32078694792142"
```

```r
hist(res[,3], main = 'average wait time')
```



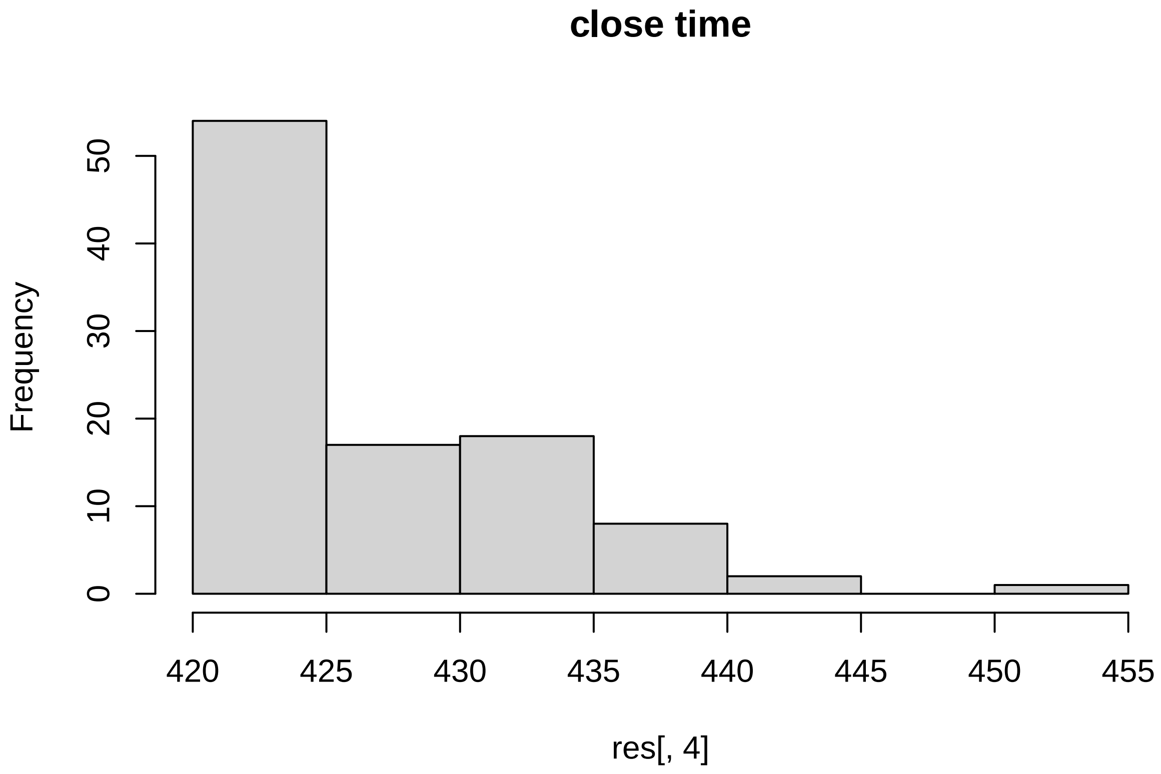
```
print(paste('Meidan for close time (in minutes after 9am) is', quantile(res[,4], probs=.5)))
```

```
## [1] "Meidan for close time (in minutes after 9am) is 424.198327354349"
```

```
print(paste('50% interval for close time (in minutes after 9am) is', quantile(res[,4], probs=.25),
            'to', quantile(res[,4], probs=.75)))
```

```
## [1] "50% interval for close time (in minutes after 9am) is 420 to 430.903126228668"
```

```
hist(res[,4], main = 'close time')
```


close time
Frequency
0
10
20
30
40
50
420
425
430
435
440
445
450
455
res[, 4]