HW1 Ziyue Wang

In [419…
```
set.seed(0)
```

In [420…
```
n_batch <- 100
# With high probability 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?

In [421…
```
last_patient <- tail(which(cumsum(arrive_gap) <= (16-9) * 60), n=1)
last_patient

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

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In [422…
```
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_available <- which.min(hello_doctor)

    if (hello_doctor[next_available] <= arrive_time[i]) {
        ### There is at least one doctor available 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_available] <- arrive_time[i] + meet_time[i]
        # Change the meeting doctor's schedule.

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

        wait_time <- c(wait_time, hello_doctor[next_available] - arrive_time[i])
        doctor_schedule[i+1, ] <- doctor_schedule[i, ]
        doctor_schedule[i+1, next_available] <- doctor_schedule[i, next_available] + meet_time[i]
        # Notice that the way we calculate next available 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?

In [423…
```
how_many_had_to_wait <- length(wait_time)
how_many_had_to_wait
```

4

What was their average wait?

In [424…
```
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
```

3.4909624120953

When did the office close?

In [425…
```
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
```

'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.

In [426…
```
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_available <- which.min(hello_doctor)

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

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

            } else {

                wait_time <- c(wait_time, hello_doctor[next_available] - arrive_time[i])
                doctor_schedule[i+1, ] <- doctor_schedule[i, ]
                doctor_schedule[i+1, next_available] <- doctor_schedule[i, next_available] + 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)
}
```

In [427…
```
res <- Hurtado_Health_Center(100)
head(res)
tail(res)
```

A data.frame: 6 × 4

	X1 <int>	X2 <int>	X3 <dbl>	X4 <dbl>
1	42	2	2.0449634	430.4233
2	47	6	2.5613495	434.8551
3	49	7	2.0357736	426.2373
4	37	3	4.3542065	426.7133
5	31	3	8.7758707	420.4448
6	32	2	3.406471	420.0000

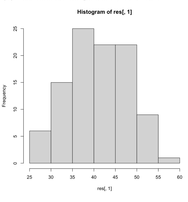
A data.frame: 6 × 4

	X1 <int>	X2 <int>	X3 <dbl>	X4 <dbl>
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

In [428…
```
print(paste('Meidan for patients # is', quantile(res[,1], probs=.5)))
print(paste('50% interval for patients # is', quantile(res[,1], probs=.25),
            'to', quantile(res[,1], probs=.75)))

hist(res[,1])
```

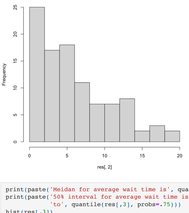
```
[1] "Meidan for patients # is 41"
[1] "50% interval for patients # is 37 to 47"
```



In [429…
```
print(paste('Meidan for waited count is', quantile(res[,2], probs=.5)))
print(paste('50% interval for waited count is', quantile(res[,2], probs=.25),
            'to', quantile(res[,2], probs=.75)))

hist(res[,2])
```

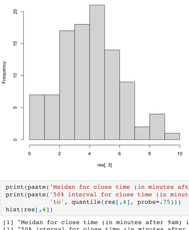
```
[1] "Meidan for waited count is 5"
[1] "50% interval for waited count is 2.75 to 10"
```



In [430…
```
print(paste('Meidan for average wait time is', quantile(res[,3], probs=.5)))
print(paste('50% interval for average wait time is', quantile(res[,3], probs=.25),
            'to', quantile(res[,3], probs=.75)))

hist(res[,3])
```

```
[1] "Meidan for average wait time is 4.12492923125524"
[1] "50% interval for average wait time is 2.56328285421338 to 5.32078694792142"
```



In [431…
```
print(paste('Meidan for close time (in minutes after 9am) is', quantile(res[,4], probs=.5)))
print(paste('50% interval for close time (in minutes after 9am) is', quantile(res[,4], probs=.25),
            'to', quantile(res[,4], probs=.75)))

hist(res[,4])
```

```
[1] "Meidan for close time (in minutes after 9am) is 424.193027354349"
[1] "50% interval for close time (in minutes after 9am) is 420 to 430.903126228668"
```