DATA 604 Hmwk 6

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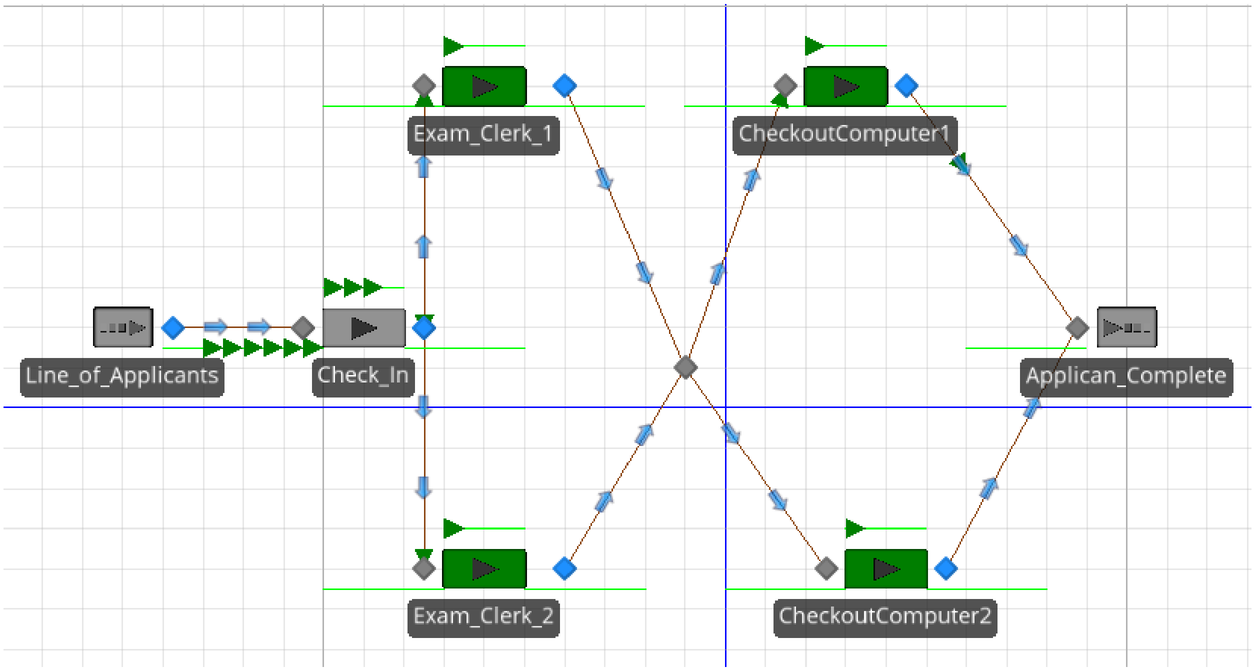
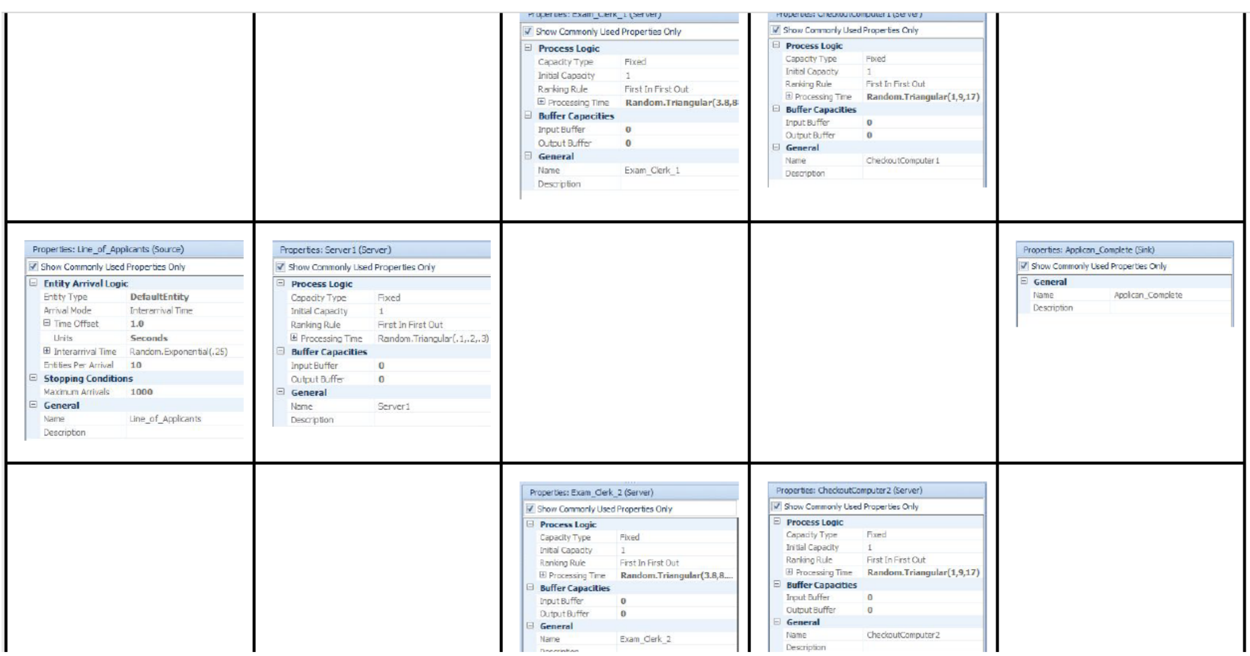
Simeo Model

The model: 1 source, 1 sink, 4 total servers.



Specs:



Server Utilization:

Object Type	Object Name	Data Source	Category	Data Item	Statistic	Average Total
Server	Check_In	[Resource]	Capacity	UnitsUtilized	Average	2.9979
					Maximum	3.0000
	CheckoutComputer1	[Resource]	Capacity	UnitsUtilized	Average	0.9637
					Maximum	1.0000
	CheckoutComputer2	[Resource]	Capacity	UnitsUtilized	Average	0.9505
					Maximum	1.0000
	Exam_Clerk_1	[Resource]	Capacity	UnitsUtilized	Average	0.9949
					Maximum	1.0000
	Exam_Clerk_2	[Resource]	Capacity	UnitsUtilized	Average	0.9954
					Maximum	1.0000

Time in System:

Object Type	Object Name	Data Source	Category	Data Item	Statistic	Average Total
ModelEntity	DefaultEntity	[Population]	FlowTime	TimeInSystem	Average (Ho...	12.3058
Server	Exam_Clerk_2	Processing	HoldingTime	TimeInStation	Average (Ho...	0.1433
	Exam_Clerk_1	Processing	HoldingTime	TimeInStation	Average (Ho...	0.1461
	CheckoutComputer2	Processing	HoldingTime	TimeInStation	Average (Ho...	0.1487
	CheckoutComputer1	Processing	HoldingTime	TimeInStation	Average (Ho...	0.1445
	Check_In	InputBuffer	HoldingTime	TimeInStation	Average (Ho...	11.9046
		Processing	HoldingTime	TimeInStation	Average (Ho...	0.0835
Sink	Applican_Complete	[DestroyedObjects]	FlowTime	TimeInSystem	Average (Ho...	12.3058
TimePath	TimePath9	[Travelers]	FlowTime	TimeOnLink	Average (Ho...	0.0167
	TimePath8	[Travelers]	FlowTime	TimeOnLink	Average (Ho...	0.0167
	TimePath7	[Travelers]	FlowTime	TimeOnLink	Average (Ho...	0.6339
	TimePath6	[Travelers]	FlowTime	TimeOnLink	Average (Ho...	0.7265
	TimePath5	[Travelers]	FlowTime	TimeOnLink	Average (Ho...	0.0179
	TimePath4	[Travelers]	FlowTime	TimeOnLink	Average (Ho...	0.0179
	TimePath3	[Travelers]	FlowTime	TimeOnLink	Average (Ho...	7.2062
	TimePath2	[Travelers]	FlowTime	TimeOnLink	Average (Ho...	7.4097
	TimePath1	[Travelers]	FlowTime	TimeOnLink	Average (Ho...	0.0167

Number in System:

Object Type	Object Name	Data Source	Category	Data Item	Statistic	Average Total
ModelEntity	DefaultEntity	[Population]	Content	NumberInSystem	Average	8,931.9016
			FlowTime	TimeInSystem	Average (Ho...	12.3058
Sink	Applican_Complete	[DestroyedObjects]	FlowTime	TimeInSystem	Average (Ho...	12.3058

2) M/M/1 Queue

```
# some help from: https://www.r-bloggers.com/simulating-a-queue-in-r/
t.end   <- 10^5 # duration of sim
t.clock <- 0    # sim time
Ta <- 10    # interarrival period
Ts <- 7    # service period
t1 <- 0          # time for next arrival
t2 <- t.end      # time for next departure
tn <- t.clock    # tmp var for last event time
tb <- 0          # tmp var for last busy-time start
n <- 0           # number in system
s <- 0           # cumulative number-time product
b <- 0           # total busy time
c <- 0           # total completions
qc <- 0          # plot instantaneous q size
tc <- 0          # plot time delta
plotSamples <- 100
set.seed(1)

############################

while (t.clock < t.end) {
    if (t1 < t2) {      # arrival event
        t.clock <- t1
        s <- s + n * (t.clock - tn)  # delta time-weighted number in queue
        n <- n + 1
        if (t.clock < plotSamples) {
            qc <- append(qc,n)
            tc <- append(tc,t.clock)
        }
        tn <- t.clock
        t1 <- t.clock + rexp(1, 1/Ta)
        if(n == 1) {
            tb <- t.clock
            t2 <- t.clock + rexp(1, 1/Ts)  # exponential  interarrival period
        }
    } else {             # departure event
        t.clock <- t2
        s <- s + n * (t.clock - tn)  # delta time-weighted number in queue
        n <- n - 1
        if (t.clock < plotSamples) {
            qc <- append(qc,n)
            tc <- append(tc,t.clock)
        }
        tn <- t.clock
        c <- c + 1
        if (n > 0) {
            t2 <- t.clock + rexp(1, 1/Ts)  # exponential  service period
        }
        else {
            t2 <- t.end
            b <- b + t.clock - tb
```

```
        }
    }
}

##########################

u <- b/t.clock       # utilization B/T
u
```

```
## [1] 0.7036567
```

```
N <- s/t.clock       # mean queue length (see the Load Average notes)
N
```

```
## [1] 2.359942
```

```
x <- c/t.clock       # mean throughput C/T
x
```

```
## [1] 0.10064
```

```
r <- N/x             # mean residence time (from Little's law: Q = XR)
r
```

```
## [1] 23.44934
```

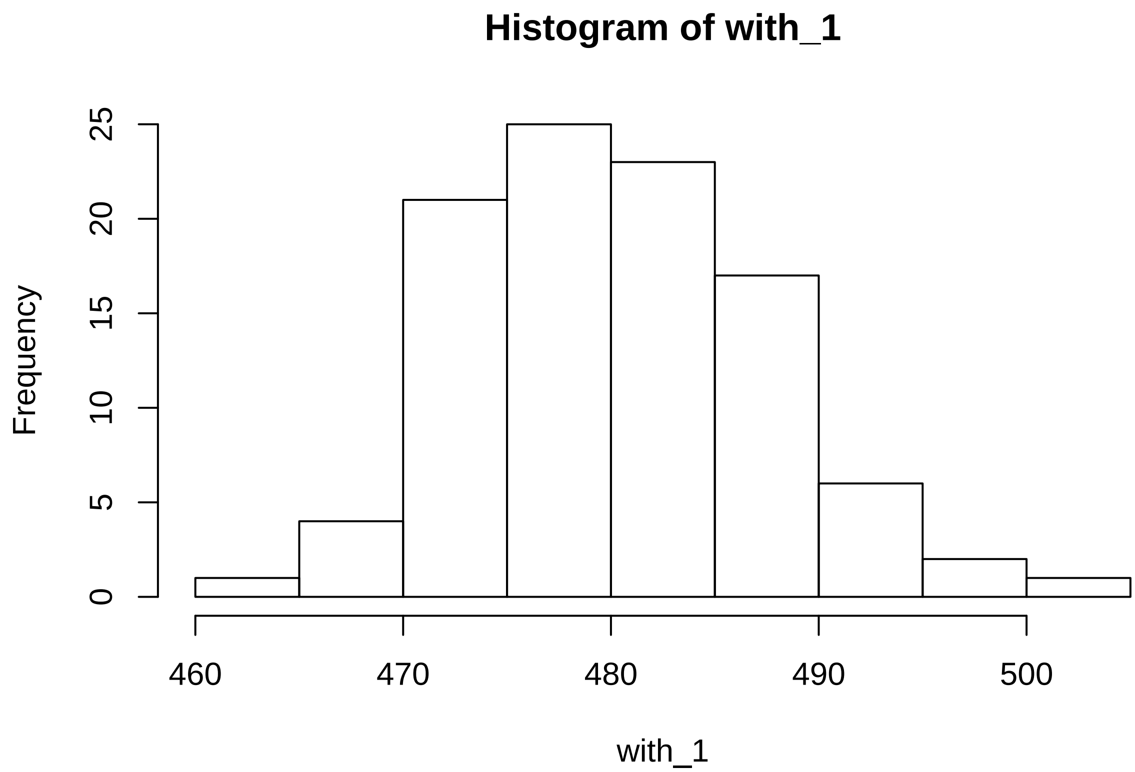
```
q <- sum(qc)/max(tc) # estimated queue length for plot
q
```

```
## [1] 0.3464116
```

3a) p268 - 6.1

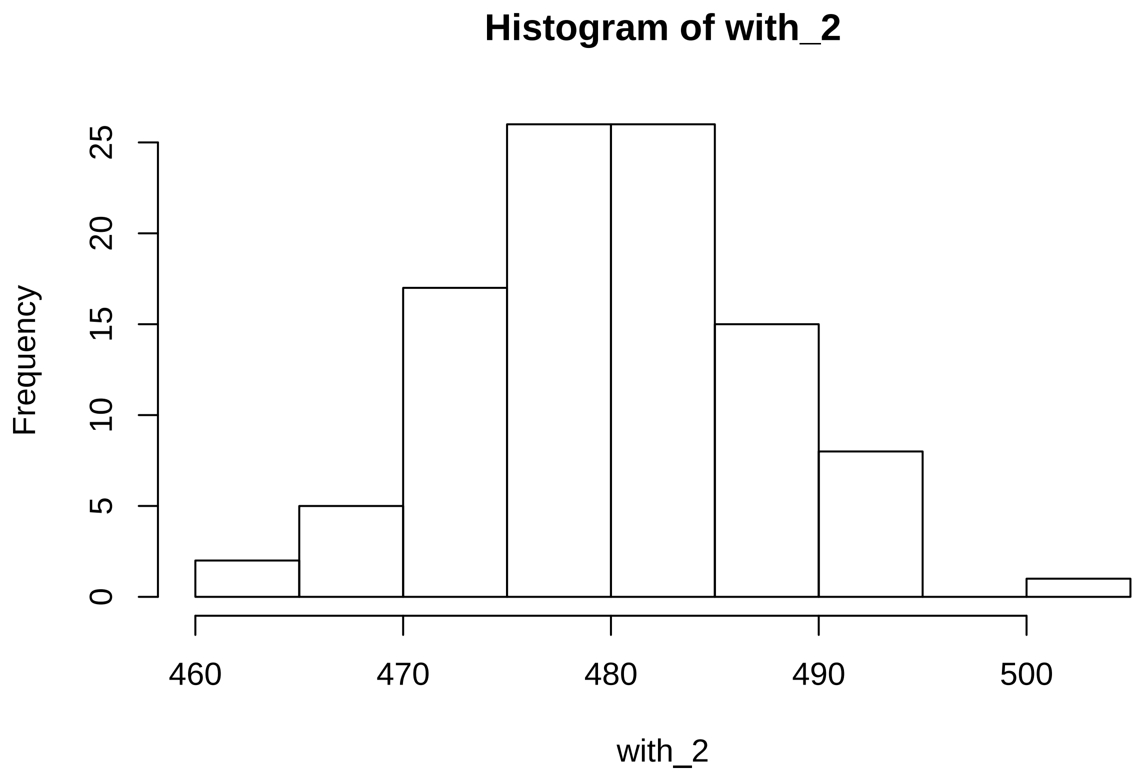
```
day_of_minutes <- 24 * 60 # * 7

minutes_between_arrivals <- 4
minutes_to_service_mechanic <- 3

attendant_cost_per_hour <- 10
mechanic_cost_per_hour <- 15

run_sim_1 <- function(with_2nd_attendant){
  final_num_serviced <- 0
  service_available_at <- 0

  arrival_time_index <- 0
  arrival_times <- rnorm(10000, minutes_between_arrivals)
  service_times_1 <- rnorm(10000, minutes_to_service_mechanic)
```

```r
  service_times_2 <- rnorm(10000, minutes_to_service_mechanic)
  # cant have negatives:
  arrival_times[arrival_times < 0] <- 0
  service_times_1[service_times_1 < 0] <- 0
  service_times_2[service_times_2 < 0] <- 0


  for(m in 1:length(arrival_times)){
    if(service_available_at < day_of_minutes){
      arrival_time_index <- arrival_time_index + arrival_times[m]
      #print(arrival_time_index)
      if(service_available_at < arrival_time_index){
        final_num_serviced <- final_num_serviced + 1
        service_available_at <- service_available_at + service_times_1[m]
      }
      if(with_2nd_attendant){
        if(service_available_at < arrival_time_index){
          final_num_serviced <- final_num_serviced + 1
          service_available_at <- service_available_at + service_times_2[m]
        }
      }

    }
  }
  return (final_num_serviced)
}

with_1 <- c()
with_2 <- c()

for(i in 1:100){
  with_1 <- c(with_1, run_sim_1(FALSE))
  with_2 <- c(with_2, run_sim_1(TRUE))
}

hist(with_1)
```

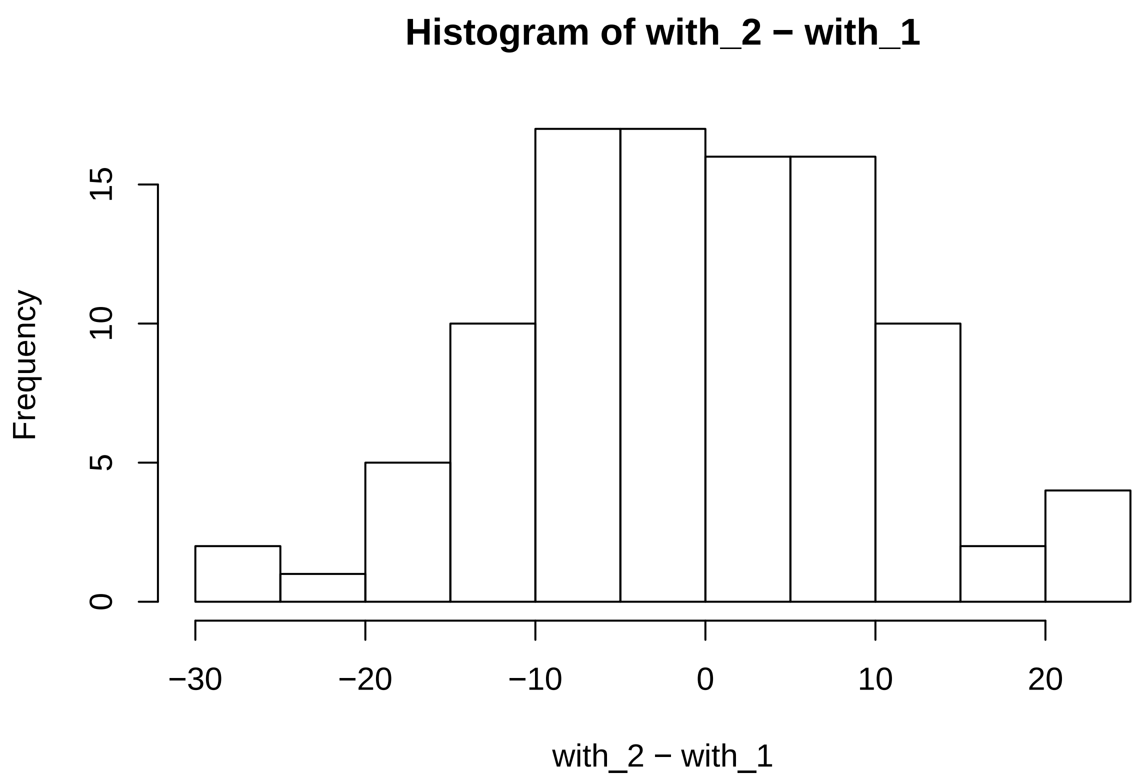


Histogram of with_1
Frequency
0
5
10
15
20
25
460
470
480
490
500
with_1


```
hist(with_2)
```




```r
hist(with_2 - with_1)
```




```
mean(with_2 - with_1)
```

```
## [1] -0.2
```

For 3a, it seems that using 2 does not change the number serviced, so unless the profit for any extra served was HUGE, it would not pay to have the 2nd serviced.

3b) p269 - 6.2

```
arrival_rate_seconds <- c(1:90)
num_failures_for_num_seconds <- c()

runway_taken <- FALSE
for(a in arrival_rate_seconds){
  failures_for_rate <- 0
  # do 1000 trials
  for(x in 1:1000){
    # AVERAGE WAIT IN SKY NOT TO EXCEED 3 MINUTES
    seconds_to_land <- rnorm(1000, 90)
    # cant have negatives:
    seconds_to_land[seconds_to_land < 0] <- 0

  }
```

```
  num_failures_for_num_seconds[a] <- 40
}

plot(arrival_rate_seconds, num_failures_for_num_seconds)
```