Homework 6

James Hamski

November 12, 2016

1

a. The model requires:
sources: one source, which represents applicants arriving at the facility.
servers: five servers, representing one check in desk, two testing desks, and two check out computers.
sinks: one sink, representing applicants leaving the facility.

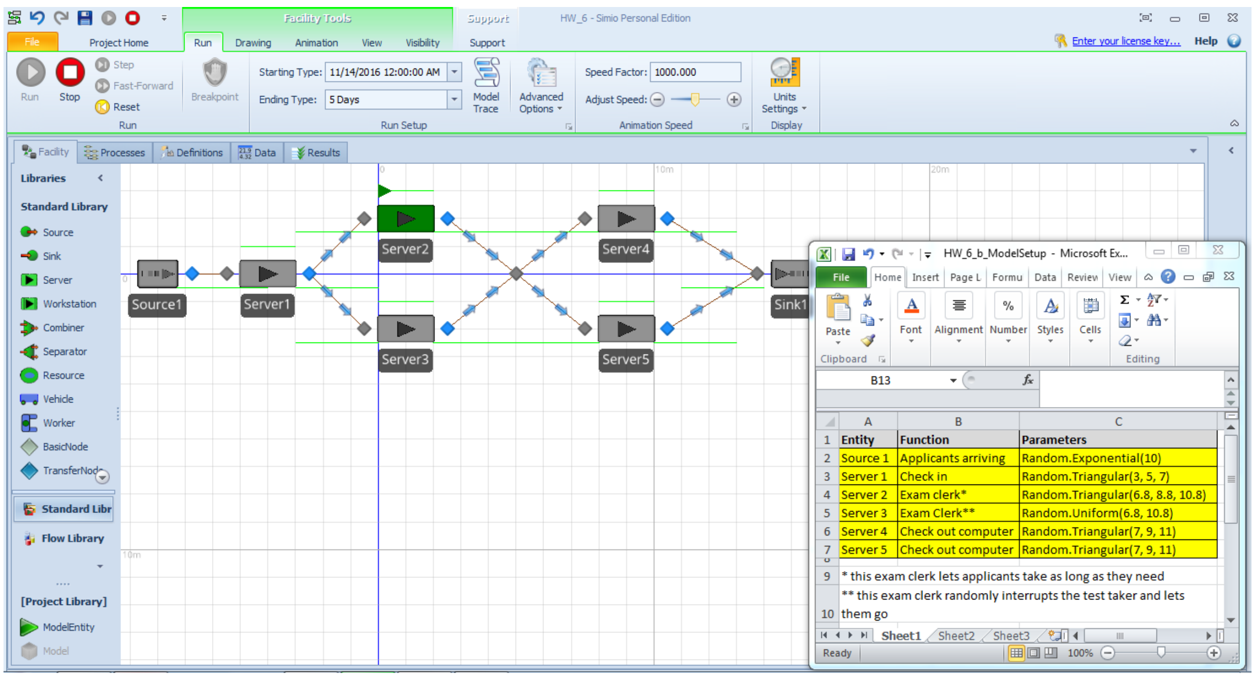


Figure 1: Simio screenshot 1

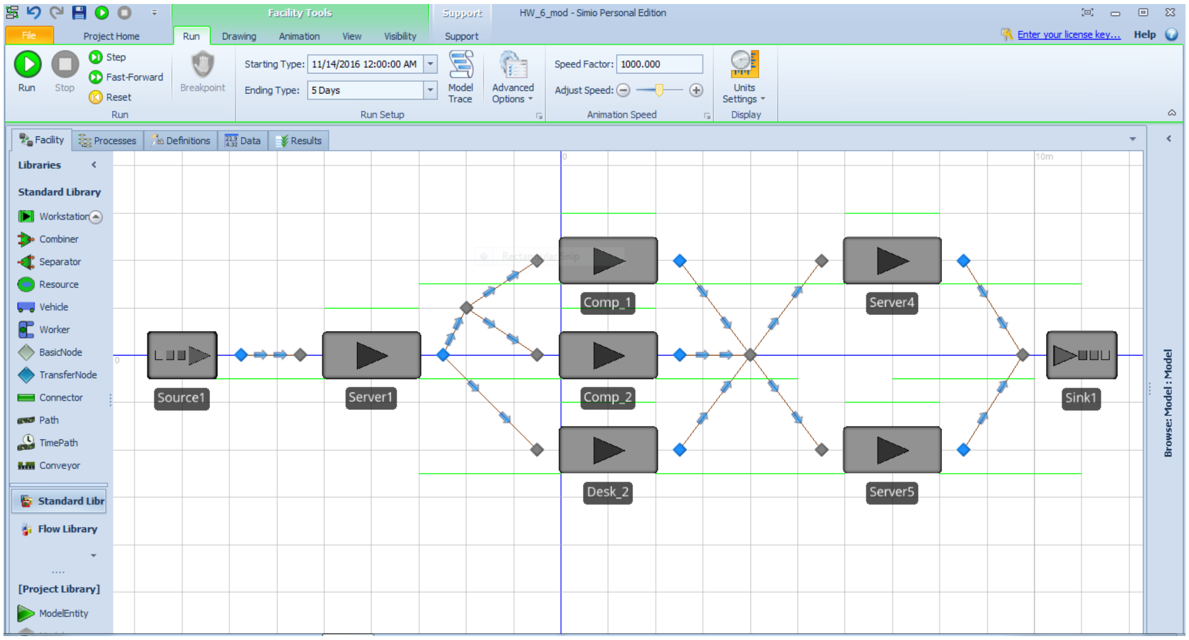
b.

c. I chose a model runtime of 8 hours to represent one working day. It is necissary to reset the model at the end of each day to simulate a closing time - it is unrealistic to assume the facility can just run continuously 24 hours a day for multiple days. The queues must be cleared and restarted.

Results
Average time in system: 1.3 hrs
Maximum time in system: 2.0 hours
Number entered in system: 58
Number exited: 49
This indicates some applicants were left over at closing time.

Precent Utilizations:
Server 1 Check in: 98.9%
Server 2 Exam Clerk: 43.9%
Server 3 Exam Clerk: 46.0%

Server 4 Check-out Computer: 57.0%
Server 5 Check-out Computer: 32.2%

d. 

2

a. Simio Output
Utilization (p): 0.5985
Customers in queue (L_Q): 0.93
Expected system time (W): 0.29

b.

```
iter <- 1000

int.arr <- rexp(1000, 1/10) %>% round()
ser.time <- rexp(1000, 1/7) %>% round()

t.arr <- int.arr[1]

for(i in 2:iter){
  t.arr[i] <- t.arr[i-1] + int.arr[i]
}

t.finish <- t.arr[1] + ser.time[1]

for(i in 2:iter){
  t.finish[i] <- max(t.arr[i] + ser.time[i], t.finish[i-1] + ser.time[i])
}

total.time <- t.finish - t.arr
sys.time <- cumsum(total.time)
wait.time <- total.time - ser.time
```

```
sim.output <- cbind(int.arr, ser.time, t.arr, t.finish, total.time, sys.time, wait.time) %>% as.data.fra
```

```
lm = 1/10
u = 1/7

(utilization <- lm / u)
```

```
## [1] 0.7
```

```
(L <- lm / u - lm)
```

```
## [1] 0.6
```

```
(w <- 1 / (u - lm))
```

```
## [1] 23.33333
```

c. Calculated

6.1

System: a tool crib that services a large group of mechanics Interarrival times: exponential distribution Service times: exponental distribution Mean time between arrivals: 4 minutes Average service time: 3 minutes Attendant pay: $10 per hour Mechanic pay: $15 per hour

Would it be advisable to have a second tool-crib attendant?

```
P0.calc <- function(c, p, n){
  frnt <- sum(((c*p)^n)/factorial(n))
  bck <- ((c*p)^c*(1/(factorial(c)))* (1/(1-p)))^(-1)
  P0 <- frnt + bck
  return(P0)
}
```

```
p <- (1/4)/(2*(1/3))
P0 <- P0.calc(2, p, c(0,1))
```

```
calc.L <- function(c, p, P0){

  frnt <- c * p

  top <- (c*p)^(c+1) * P0
  bot <- c*(factorial(c)*(1-p))^2

  L <- frnt + (top / bot)
  return(L)
}
```

```
L <- calc.L(2, p, P0)
```

Two attendant cost

```
L * 15 + 10
```

```
## [1] 29.29375
```

One attendant cost

```
P0.2 <- P0.calc(1, p, c(0,1))
L.2 <- calc.L(1, p, P0)
L.2 * 15 + 10
```

```
## [1] 37.075
```

It makes sense to add another attendant.

6.2

A two-runway (onefor landing, one for take off) airport is being designed. The time to land an airplan is exponentially distributed, with a mean of 1.5 minutes. If airplane arrivals occur at random, what arrival rate can be tolerated if the average wait in the sky is not to exceed 3 minutes?
The highest arrival rate possible is 4/9.

$$W_Q = \frac{\lambda}{\mu(\mu - \lambda)}$$

$$3 = \frac{\lambda}{\frac{2}{3}\left(\frac{2}{3} - \lambda\right)}$$

$$3 = \frac{3\lambda}{2\left(\frac{2}{3} - \lambda\right)} = \frac{3\lambda}{\frac{4}{3} - 2\lambda}$$

$$3\left(\frac{4}{3} - 2\lambda\right) = 3\lambda$$

$$\left(\frac{12}{3} - 6\lambda\right) = 3\lambda$$

$$(4 - 6\lambda) = 3\lambda$$

$$+6\lambda \qquad +6\lambda$$

$$\frac{4}{9} = \frac{9\lambda}{9}$$

$$\frac{4}{9} = \lambda$$

Figure 2: