DES Operator and Machine Example

Alireza Sheikh-Zadeh, PhD

Consider a manufacturing system comprising two different machines and one operator.

- The operator is assigned to run both machines.
- Parts arrive with an exponentially distributed interarrival time with a mean of 4 minutes. The arriving parts are one of two types.
- Fifty percent of the arriving parts are Type 1 and are processed on Machine 1. These parts require the assigned operator for a 2-minute setup operation.
- The remaining 50% of the parts are Type 2 and are processed on Machine 2. These parts require the assigned operator for a 3-minute setup operation.
- The service times (excluding the setup time) are normally distributed with a mean of 2.5 minutes and a standard deviation of 0.5 minutes for Type 1 parts, a mean of 4.5 minutes, and a standard deviation of 0.5 minutes for Type 2 parts.

Run your model for 800 minutes, with 50 replications. Report the average total time spent in the system (flow time) for each type of part.

```
library(simmer)

## Warning: package 'simmer' was built under R version 3.5.3

part <- trajectory("parts' path") %>%

  branch(option = function() sample(1:2, 1, prob = c(0.5, 0.5), replace=T), c
ontinue = c(T,T),

         trajectory("A") %>%
           set_attribute("type", 1) %>%
           seize("machine1", 1) %>%
           seize("operator", 1) %>%
           timeout(2) %>%
           release("operator", 1)%>%
           timeout(function() rnorm(1, 2.5, 0.5))%>%
           release("machine1", 1),

         trajectory("B") %>%
           set_attribute("type", 2) %>%
           seize("machine2", 1) %>%
           seize("operator", 1) %>%
           timeout(3) %>%
           release("operator", 1)%>%
```

```
            timeout(function() rnorm(1, 4.5, 0.5))%>%
            release("machine2", 1)
  )

envs <- lapply(1:50, function(i) {
  simmer("Man") %>%
    add_resource("operator", 1) %>%
    add_resource("machine1", 1) %>%
    add_resource("machine2", 1) %>%
    add_generator("part", part, function() rexp(1, 1/4), mon = 2) %>%
    run(800)
})

#res = get_mon_resources(envs)
#plot(res, metric = "utilization")

# Finding the average flow time for each type of part:

x1 <- get_mon_arrivals(envs)
x2 <- get_mon_attributes(envs)

all <- merge(x1, x2, by=c("name", "replication"), all = T)

head(all)
```

```
##    name replication start_time  end_time activity_time finished       time
## 1 part0           1  3.5934693 11.472666      7.879197     TRUE  3.5934693
## 2 part0           2  1.2369717  8.108369      6.871397     TRUE  1.2369717
## 3 part0           3 10.8204487 16.086723      5.266274     TRUE 10.8204487
## 4 part0           4  0.5570574  7.214056      6.656998     TRUE  0.5570574
## 5 part0           5  3.2586334  7.267088      4.008455     TRUE  3.2586334
## 6 part0           6  4.8401787 10.781921      5.941742     TRUE  4.8401787
##    key value
## 1 type     2
## 2 type     2
## 3 type     1
## 4 type     2
## 5 type     1
## 6 type     2
```

```
TypeA <- subset(all, all$value == 1)
TypeB <- subset(all, all$value == 2)

typeA.flowTime =  (TypeA$end_time-TypeA$start_time)
typeB.flowTime =  (TypeB$end_time-TypeB$start_time)
# Average
mean(typeA.flowTime, na.rm = T)
```

```
## [1] 10.80073
```

```
mean(typeB.flowTime, na.rm = T)
```

```
## [1] 41.08361
```