Homework 6

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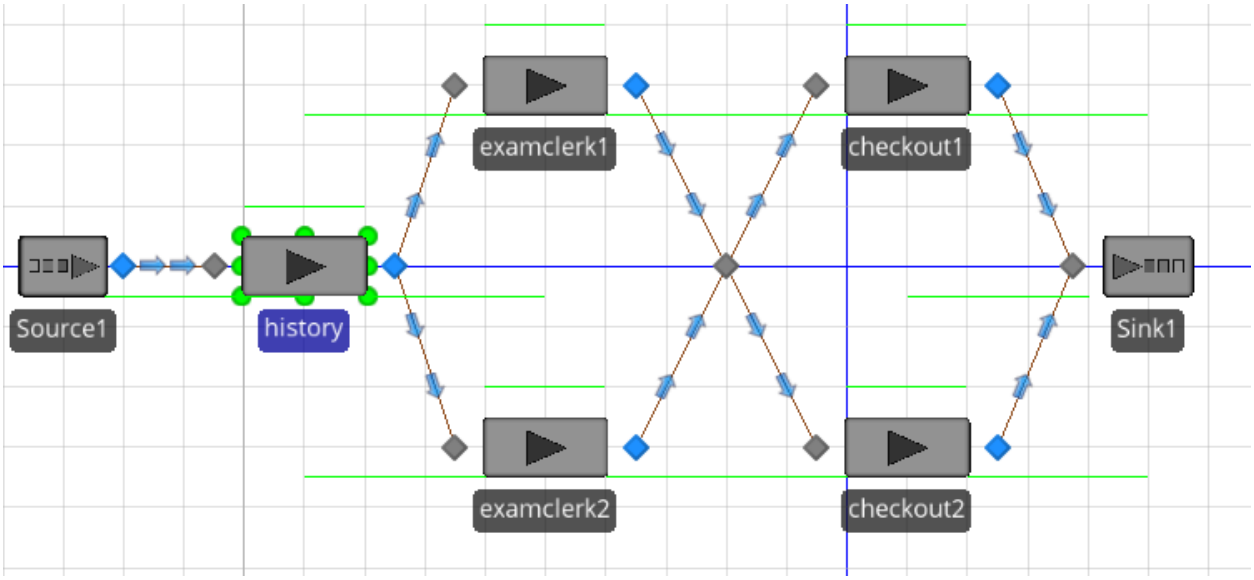
April 12, 2016

My other classes put off due dates an extra week due to break, I assumed the same. Didn't mean it to be late.

1a.

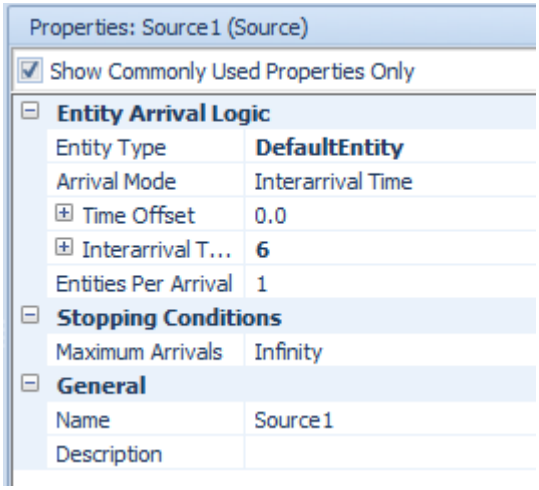
In this case, there is one source, 5 servers (a single clerk getting the driving history, two clerks each giving a written exam in parallel, and two checkout computers in parallel), and 1 sink.



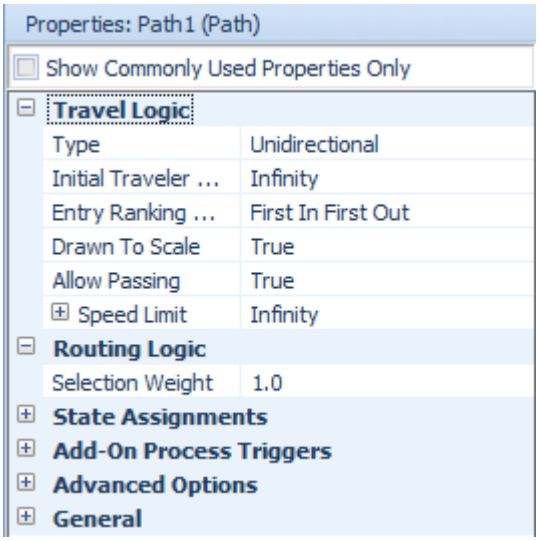
1b.

Source:

Interval arrival time set to 6 minutes

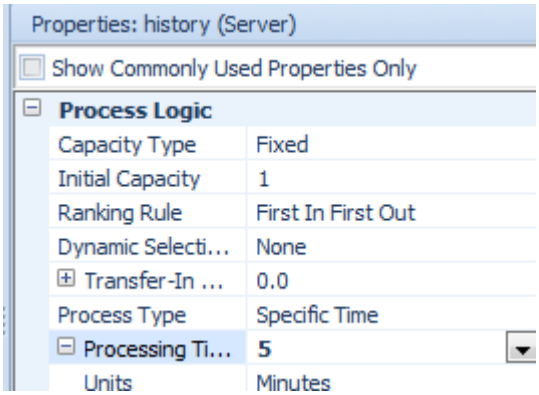


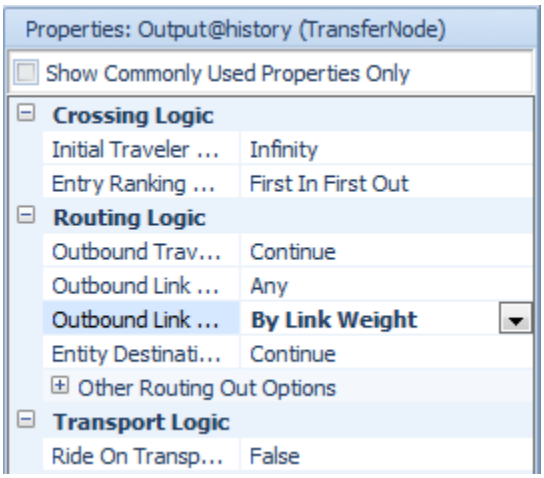
Path Source -> History:



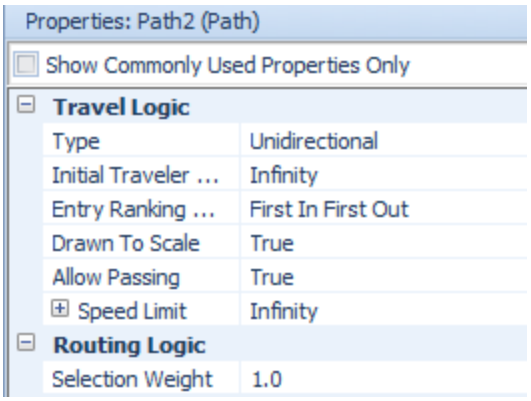
History:

A process time of 5, and a outemp2ound rule to link weight, so there is a 50/50 chance of where they go.



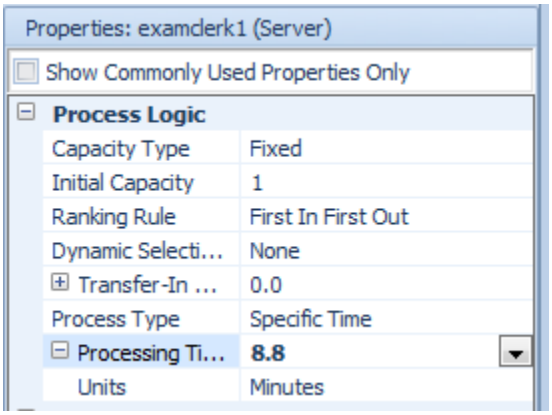


Path History -> ExamClerk:

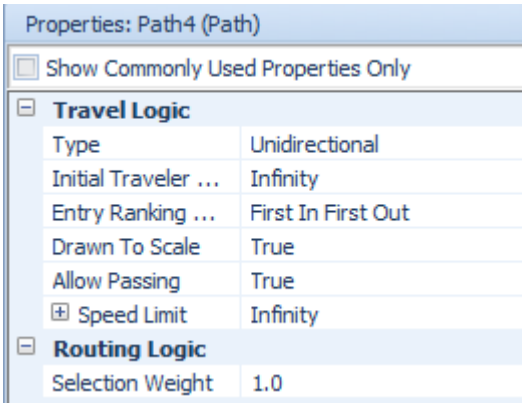


ExamClerk 1/2:

Set process time to 8.8 minutes

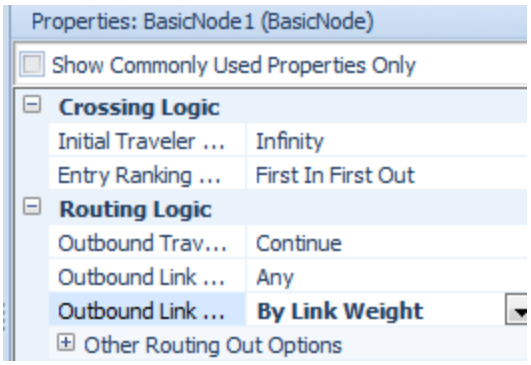


Path ExamClerk -> Node:

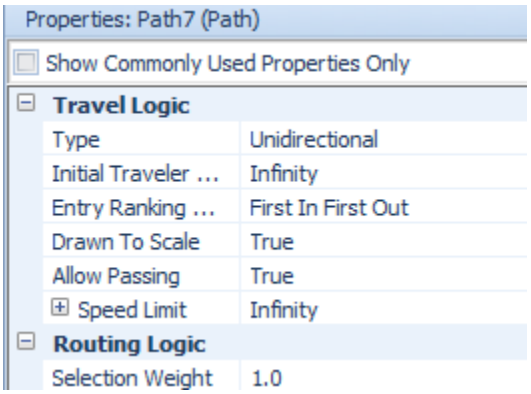


Node:

Again set by link weight

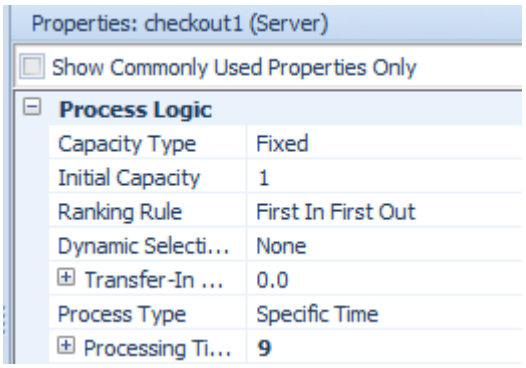


Path Node -> Checkout 1/2:

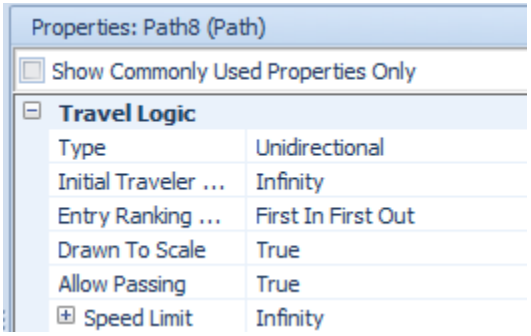


Checkout 1/2:

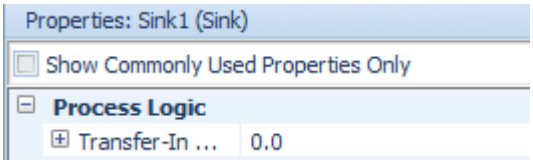
Process time of 9 minutes



Path Checkout 1/2 to Sink:



Sink:



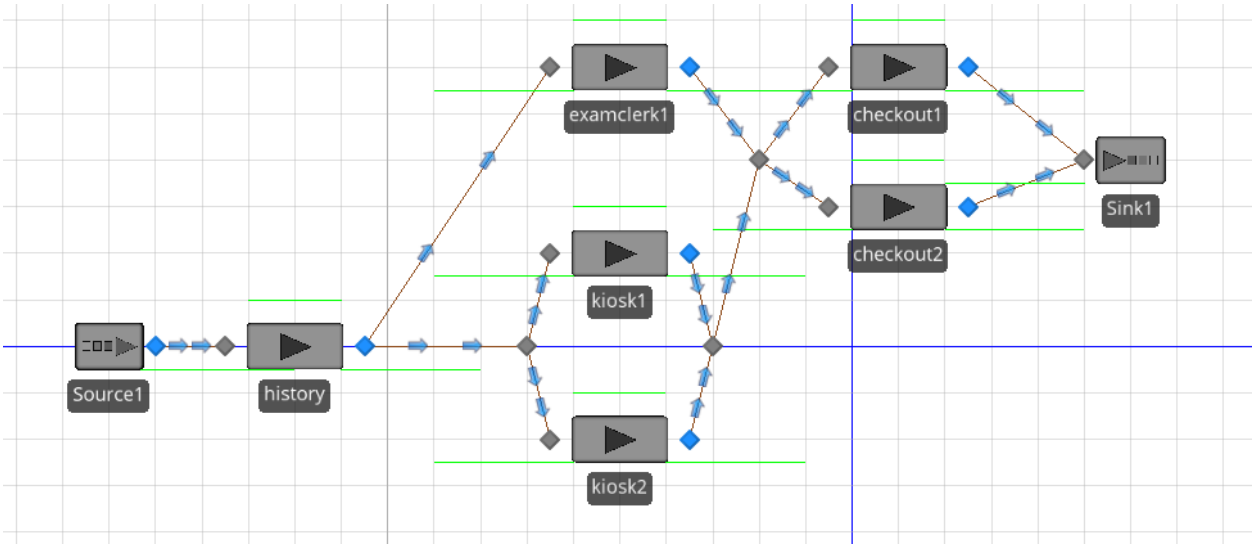
1c.

Some average run times from the system.

Object Type	Object Name	Data Source	Category	Data Item	Statistic	Average Total
ModelEntity	DefaultEntity	[Population]	FlowTime	TimeInSystem	Maximum (Ho...	0.8620
					Minimum (Ho...	0.3820
Server	checkout1	[Resource]	Capacity	ScheduledUtilization	Percent	61.4443
				UnitsScheduled	Average	1.0000
					Maximum	1.0000
				UnitsUtilized	Average	0.6144
					Maximum	1.0000
	checkout2	[Resource]	Capacity	ScheduledUtilization	Percent	77.5612
				UnitsScheduled	Average	1.0000
					Maximum	1.0000
				UnitsUtilized	Average	0.7756
					Maximum	1.0000
	examclerk1	[Resource]	Capacity	ScheduledUtilization	Percent	79.0511
				UnitsScheduled	Average	1.0000
					Maximum	1.0000
				UnitsUtilized	Average	0.7905
					Maximum	1.0000
	examclerk2	[Resource]	Capacity	ScheduledUtilization	Percent	63.8810
				UnitsScheduled	Average	1.0000
					Maximum	1.0000
				UnitsUtilized	Average	0.6388
					Maximum	1.0000
	history	[Resource]	Capacity	ScheduledUtilization	Percent	83.4689
				UnitsScheduled	Average	1.0000
					Maximum	1.0000
				UnitsUtilized	Average	0.8347
					Maximum	1.0000

1d.

It gets rid of one of the human clerks, and adds in two new kiosks in parallel. The paths can be set to be equal lengths even though they aren't the same in the picute.



2.

Let's do it in R first.

```
mm1 <- function (){
dura   <- 1220 # duration of sim
start <- 0 # start time
inter <- 10 # interarrival time
serv <- 7 # service time
next.a <- 0 # next arrival
next.d <- dura # next departure
temp1 <- start # temps
temp2 <- 0
n <- 0
s <- 0
b <- 0
c <- 0


# run while clock hasn't reached completion
  while (start < dura) {
    if (next.a < next.d) { # arriving
      start <- next.a
      s <- s + n * (start - temp1)
      n <- n + 1
      temp1 <- start
      next.a <- start + rexp(1, 1/inter)
      if(n == 1) {
        temp2 <- start
        next.d <- start + rexp(1, 1/serv)
      }
    } else { # leaving
      start <- next.d
      s <- s + n * (start - temp1)
      n <- n - 1
```

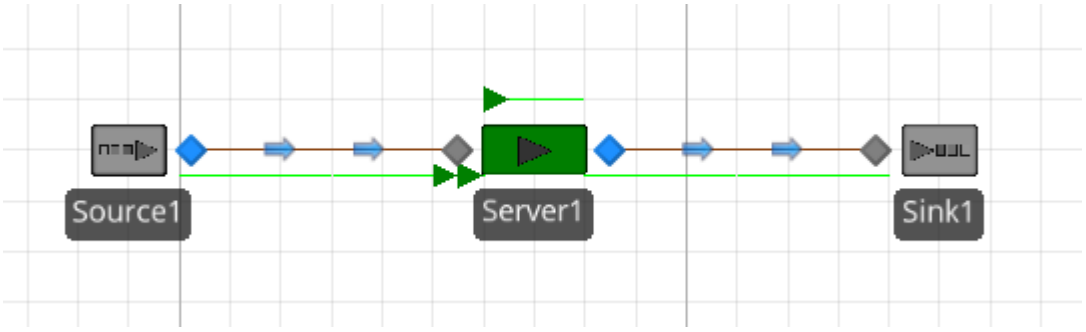
```
      temp1 <- start
      c <- c + 1
      if (n > 0) {
        next.d <- start + rexp(1, 1/serv)
      } else {
        next.d <- dura
        b <- b + start - temp2
      }
    }
  }
return(c(b,c))
}

queue <- replicate(1000, mm1())
paste('Utilization Rate:', mean(queue[1,] / 1220))
```

```
## [1] "Utilization Rate: 0.652115443252272"
```

```
paste('System Time:' , mean(queue[1,]/ mean(queue[2,] )), 'minutes')
```

```
## [1] "System Time: 6.54788267491705 minutes"
```

And the Simio version:



Drop Filter Fields Here

Average

Drop Column Fields Here

Object Type	Object Name	Data Source	Category	Data Item	Statistic	Average Total
ModelEntity	DefaultEntity	[Population]	Content	NumberInSystem	Average	1.0454
			FlowTime	TimeInSystem	Average (Hours)	0.2005
Server	Server1	[Resource]	Capacity	ScheduledUtilization	Percent	53.5540
				UnitsAllocated	Total	58.0000
				UnitsScheduled	Average	1.0000
				UnitsUtilized	Average	0.5355
			ResourceState	TimeProcessing	Average (Hours)	0.2295
					Occurrences	28.0000
					Percent	53.5540
					Total (Hours)	6.4265
				TimeStarved	Average (Hours)	0.1991
					Occurrences	28.0000
					Percent	46.4460
					Total (Hours)	5.5735
		InputBuffer	Content	NumberInStation	Average	0.5027
			HoldingTime	TimeInStation	Average (Hours)	0.0939
		Processing	Content	NumberInStation	Average	0.5355
			HoldingTime	TimeInStation	Average (Hours)	0.1117
Sink	Sink1	[DestroyedObjects]	FlowTime	TimeInSystem	Average (Hours)	0.2005
					Observations	57.0000

6.1

arrival times = every 4 minutes

service time = every 3 minutes

atten pay = 10/hour

mech pay = 15/hour

With one attendant, lets find number of mechanics and then cost to run it:

$$\frac{1/4}{(1/3)-(1/4)} = 3$$

$$15(3) + 10 = 55 dollars$$

With two attendants, we can use a MMc queue. I'll leave out some of the equations but it comes out to a cost of roughly 33 dollars instead of the above 55. This is due to there being less mechanics in use at any given time.

6.2

We can use a MM1 queue in this case and come out with the equation:

$$3 \leq \frac{lambda}{(2/3)(2/3 - lambda)}$$

Solving this gives $lambda = 4/9$ and $lambda = 2/3$. From that, we can assume that rates lower than $lambda = 2/3$ will satisfy the problem.