DATA 604 Discussion 4: First Simio Models

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Section 14.10, Problem 14a

Mathematical Solution

Given $\lambda = 1$, $\mu = 1/0.9 \approx 1.11$, and $c = 1$

$$\rho = \frac{\lambda}{c\mu} = \frac{1}{1 \times 1/0.9} = 0.9$$

For an $M/M/1$ system,

$$L = \frac{\rho}{1-\rho} = \frac{0.9}{1-0.9} = 9$$

Using Little's Law,

$$W = \frac{L}{\lambda} = \frac{9}{1} = 9$$

$$W_q = W - \frac{1}{E(S)} = W - \mu = 9 - 0.9 = 8.1$$

$$L_q = \lambda W_q = 1 \times 8.1 = 8.1$$

These results can be confirmed using `mmc.exe`:

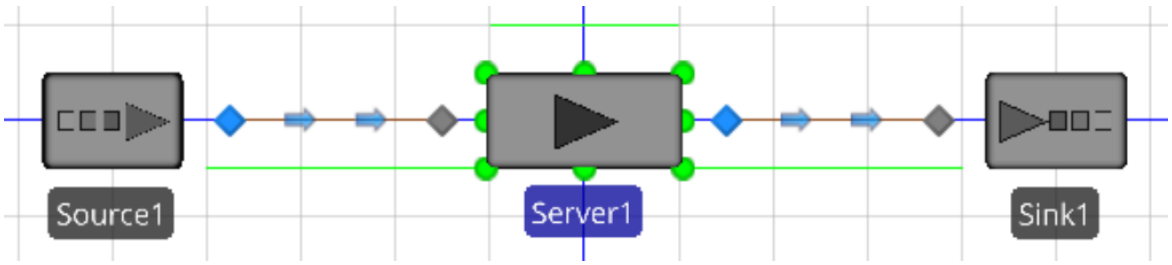
```
PS C:\Users\Dan\Dropbox\School\MSDA\DATA604\Texts> .\mmc 1 1.111111111 1

Queue:  Queue 1
Arrival:          1.0000
Service:          1.1111
Servers:               1
Utilization:     0.90000 (system stable)
p(0):            0.10000
NumInSystem:      9.0000
NumInQueue:       8.1000
TimeInSystem:     9.0000
TimeInQueue:      8.1000
```

These figures indicate the following:

- The server is occupied 90% of the time
- The average number of entities in the system is 9
- The average time in the system is 9 minutes
- The average time in the queue is 8.1 minutes
- The average number of entities in the queue is 8.1

Simio Solution

A one-source, one-server system is set up as shown below:



The source processing time is `Random.Exponential(1)` and the server processing time is `Random.Exponential(0.9)`.

The results following a 10-day simulation are below:

ModelEntity	DefaultEntity	[Population]	Content	NumberInSystem	Average	8.7563
			FlowTime	TimeInSystem	Average (Minutes)	8.8068
Server	Server 1	[Resource]	Capacity	UnitsUtilized	Average	0.9017
		InputBuffer	Content	NumberInStation	Average	7.8013
			HoldingTime	TimeInStation	Average (Minutes)	7.8459

These results align fairly well with the mathematical results:

- The average server UnitsUtilized of 0.9017 is quite close to $\rho = 0.9$
- The average model NumberInSystem of 8.7563 is resonably close to $L = 9$
- The average model TimeInSystem of 8.8068 is reasonable close to $W = 9$
- The server TimeInStation of 7.8459 is close to $W_q = 8.1$
- The server NumberInStation of 7.8013 is close to $L_q = 8.1$