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DATA604
Assignment 4

Problem 2.9: Analytical solution to M/D/1 queue

- Constant service time:
  - Lambda = 1 unit/minute → interarrival-time = 1 minute between units
  - Mu = 1/0.9 unit/minute → E(S) = 0.9 minute between units
  - Sigma = 0; since no variation
  - Wq = lambda * (sigma^2 + 1/mu^2) / (2 * (1 – lambda/mu)) = 0.81 / 0.2 = 4.05 minutes
  - W = Wq + E(S) = 4.95 minutes
  - L = lambda * W = 4.95 units
  - Lq = lambda * Wq = 4.05 units
  - Rho = lambda / (c * mu) = 0.9
- Non-constant service time (e.g. M/M/1):
  - Rho = 0.9; unchanged
  - L = 9 units; much higher than 4.95 units in M/D/1 scenario
  - W = 9 minutes; much higher than 4.95 minutes in M/D/1 scenario
  - Wq = 8.1 minutes; much higher than 4.05 minutes in M/D/1 scenario
  - Lq = 8.1 units; much higher than 4.05 units in M/D/1 scenario
- Takeaway – removing variation in service/processing time dramatically reduces overall units and time in system and in queue

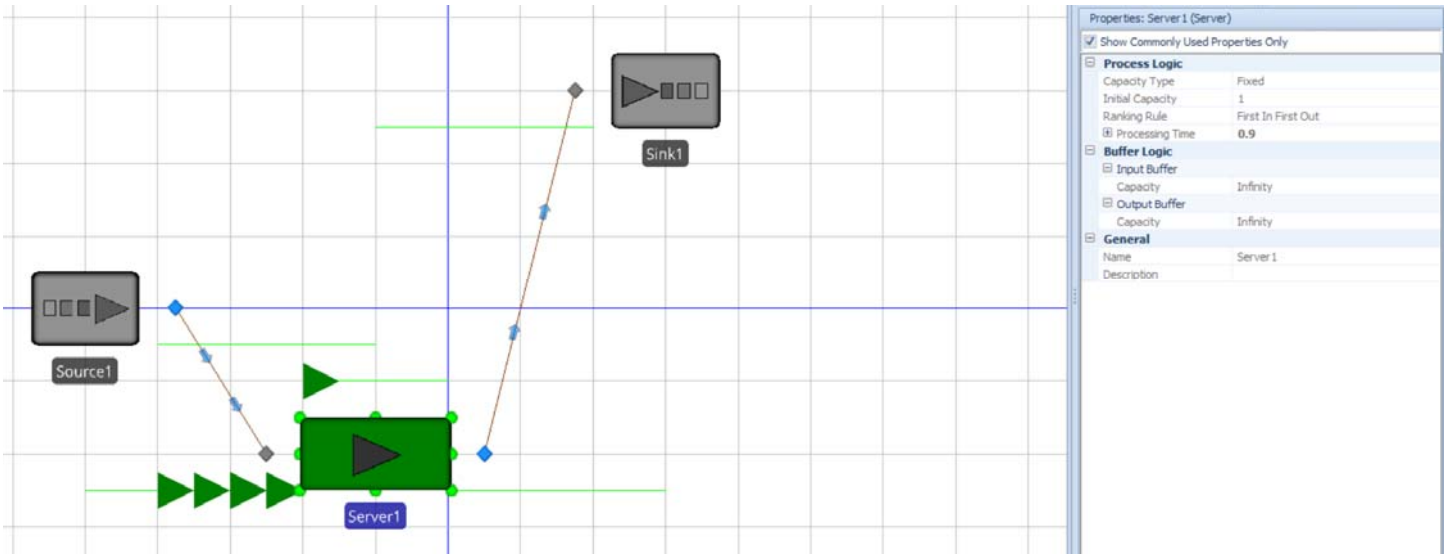
Problem 4.15: Simio-based simulation of M/D/1 queue

- Experiment: 30 hour total runtime; 20 hour warm-up time; 500 replications
- As illustrated below, the 95% confidence intervals for all metrics include the analytically calculated values
- A screenshot of the model is also included, with the constant 0.9 minute processing time highlighted

Average | Minimum | Maximum | Half Width

Scenario

Object Type	Object Name	Data Source	Category	Data Item	Statistic	Scenario1 Average	Minimum	Maximum	Half Width
ModelEntity	DefaultEntity	[Population]	Content	NumberInSystem	Average	5.0738	1.9257	29.8955	0.2279
			FlowTime	TimeInSystem	Average (Min...	4.9908	2.1651	27.2015	0.2032
Server	Server1	[Resource]	Capacity	ScheduledUtilization	Percent	90.3069	80.0988	100.0000	0.3145
				UnitsScheduled	Average	1.0000	1.0000	1.0000	0.0000
				UnitsUtilized	Average	0.9031	0.8010	1.0000	0.0031
		InputBuffer	Content	NumberInStation	Average	4.1708	1.1247	28.8955	0.2257
			HoldingTime	TimeInStation	Average (Min...	4.0910	1.2627	26.2859	0.2032
		Processing	Content	NumberInStation	Average	0.9031	0.8010	1.0000	0.0031
			HoldingTime	TimeInStation	Average (Min...	0.9000	0.9000	0.9000	0.0000


Sink1
Source1
Server1
Properties: Server 1 (Server)
Show Commonly Used Properties Only
Process Logic
Capacity Type
Fixed
Initial Capacity
1
Ranking Rule
First In First Out
Processing Time
0.9
Buffer Logic
Input Buffer
Capacity
Infinity
Output Buffer
Capacity
Infinity
General
Name
Server 1
Description