DS632 System Simulation
Assignment 1

Team

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Question 1 : Calculate the 5 fundamental performance metrics, as done in example exercise 1

Answer :

For Exponential distribution

Intermediate arrival time = 1.25 minutes

Mean service time = 1 minute

λ= 1 entity /1.25 min (arrival rate)

λ= 0.8 / min

μ= 1 entity/1 min (service rate)

μ= 1/min

$\boldsymbol{\rho = \lambda/c\mu}$

= 0.8/min / 1/min

= 0.8

$\mathbf{L = \rho/1-\rho}$

= 0.8/(1-0.8)

= 4 entities

$\mathbf{W = L/\lambda}$

= 4 / 0.8/min

= 5 min

$\mathbf{W_q = W - E(s)}$

= 5 min - 1 min

= 4 min

$\mathbf{L_q = \lambda W_q}$

= 0.8/ min * 4 min
= 3.2 entities

For Uniform Distribution:

Intermediate arrival time = 1.25 min
Mean service time = 1 min
Arrival Rate ; λ = 1 entity /1.25 min (arrival rate) = 0.8 entities/ min
Service Rate ; μ = 1/E(s) = 1 entity / min
a= 0.1
b= 1.9

Standard Deviation =sqrt((b-a)^2/12)
=sqrt((1.9-0.1)^2/12)
=0.5196

$\rho = \lambda/\mu$
= 0.8/min / 1/min = 0.8
= 0.8

$W_q = \lambda(SD^2+1/\mu^2)/2(1-\lambda/\mu)$
= $0.8(0.5196^2+1^2)/(2*(1-0.8/1)$
= 2.54 min

$W = W_q + E(s)$
= 2.54 + 1
= 3.54 mins

$L_q = \lambda W_q$
= 0.8*2.54
= 2.032 entities

$L = \lambda W$

= 0.8*3.54

= 2.832 entities

For Triangular distribution:

a= 0.1

b= 1.9

m=1.0

Arrival Rate; λ= 1 entity /1.25 min (arrival rate) = 0.8 entities/ min

Expected Service Time; E(s)= (a+m+b)/3 = (0.1+1.0+1.9)/3 = 1 min

Service rate; μ= 1/E(s) = 1 entity / min

Standard Deviation = θ= $\sqrt{}$((a^2+m^2+b^2)-am-ab-bm/18)

= $\sqrt{}$((0·1)^2+(1)^2+(1·9)^2-0.1*1.0-0.1*1·9-1·9*1/18)

= $\sqrt{}$(2.43/18)

= $\sqrt{}$0.135

= 0.367 min

$\rho = \lambda/\mu$

= 0.8/min / 1/min

= 0.8

$W_q = \lambda(SD^2+1/\mu^2)/2(1-\lambda/\mu)$

= 0.8(0.367^2+1/1^2)/(2*(1-0.8/1)

= 2.27 min

$W = W_q + E(s)$

= 2.27 + 1

= 3.27 minutes

$L_q = \lambda W_q$

= 0.8 (2.27)

= 1.816 entities

$L = \lambda W$

$= 0.8/\text{ min} * 3.27 \text{ min}$

$= 2.616$ entities

Sr. No.	Service time distribution	L (entity)	L_Q (entity)	W (min)	W_Q (min)	ρ
1	Exponential	4.00	3.20	5.00	4.00	0.8
2	Uniform	2.832	2.032	3.54	2.54	0.8
3	Triangular	2.616	1.816	3.27	2.27	0.8

Question 2 **:** Comment on whether this queuing system, relative to the one in exercise 1, performs better or worse

Answer **:** In Comparison with the exponential distribution and triangular distribution, **Triangular distribution performs better**. As in Triangular distribution service time has the smallest steady-state with average number of entities in queue,L(q) and average number of entities in the system L. For the same utilization of the system and for the same expected service times [E(s)], less waiting times and shorter queue implies the better service for customers and better overall performance.

Question 3 **:** Write *one* sentence specifying your understanding of why -- in a conceptual sense -- this system performs better or worse.

Answer **:**Reason for better performance in Triangular Distribution is less variance in service time resulting in reduced average number of entities in queue and reduced average wait time in queue.