Assignment 1

Instructions for this assignment:

1. Please submit a doc file with your solutions on ALL problems. You will earn zero point without submitting this doc file.
2. For each problem, please submit a spreadsheet file with your analysis on that problem.
3. You will be required to state and sign, in writing, "*On my honor, I have neither given nor received unauthorized aid in completing this academic work.*" You will earn ZERO point in this assignment if you do not state and sign this sentence in this homework.
4. If you do Monte Carlo Simulation, please set the sample size as 1000.
5. The submission deadline is March 22 (Sunday), 2020, 11:59pm Eastern Standard Time. Late submission will NOT be accepted. NO EXCEPTION. Please submit your solutions on Canvas.

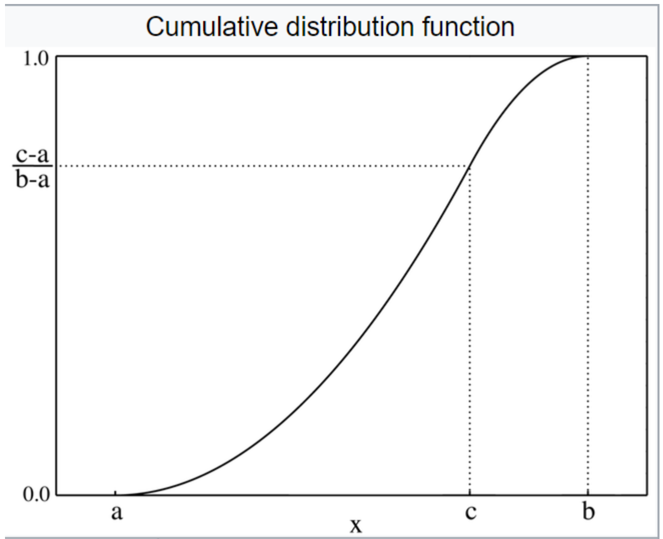
Problem 1 (3 points)

(1) (2 points) Please write down the formula to generate a random variable X that follows the triangular distribution with lower bound value a, upper bound value b, and most likely value c.

Hint: the CDF function and its plot are, respectively,[1]

$$\begin{cases} 0 & \text{for } x \le a, \\ \frac{(x-a)^2}{(b-a)(c-a)} & \text{for } a < x \le c, \\ 1 - \frac{(b-x)^2}{(b-a)(b-c)} & \text{for } c < x < b, \\ 1 & \text{for } b \le x. \end{cases}$$

[1] https://en.wikipedia.org/wiki/Triangular_distribution



(2) (1 points) In CINNOV8 case, we assume that “Market Share Increase” follows the triangular distribution with lower bound value -3%, upper bound value 4%, and most likely value 1%. “Markov Growth Factor” follows the triangular distribution with lower bound value 0.8, upper bound value 1.1, and most likely value 1.05. Please use Monte Carlo Simulation to compute the expected NPV.

Problem 2 (4 points)

Consider the multi-product newsvendor model. All input data is in the file “Multi-product newsvendor.xlsx”.

(1) (1 point) In this part, we do not consider the supply constraint (assuming that the firm has infinite supply capability). Please compute each product’s optimal production quantity that maximizes its expected profit.

Hint: If your analysis is correct, then you should get a solution that the total production quantity exceeds the supply constraint.

In the rest of this problem, we study three different approaches for seeking feasible and reasonably good solutions.

(2) (1 point) (Proportional scaling) We cut down each product’s production quantity computed in Part (1) in a way that all products have the same supply reduction percent.

For this approach, please compute each product's production quantity and use Monte Carlo Simulation to compute the seller's expected total profit.

(3) (1 point) (Priority on profit margin) We give priority to first produce the product with the highest profit margin, and then the product with the second highest profit margin, and so on, until no supply capacity is available. For this approach, please compute each product's production quantity and use Monte Carlo Simulation to compute the seller's expected total profit.

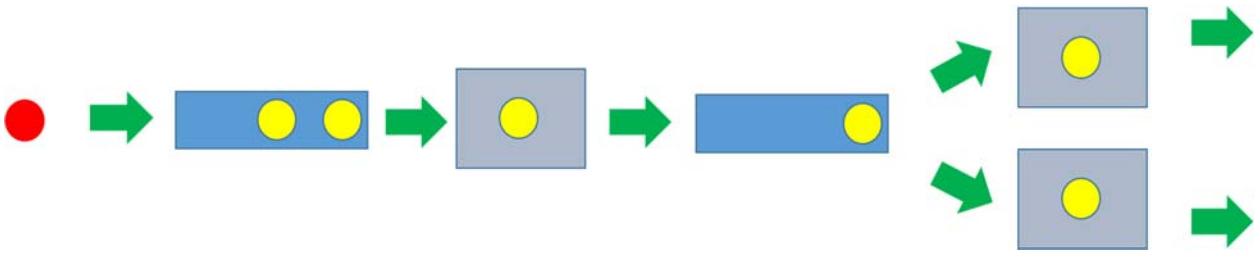
(4) (1 point) (Priority on demand coefficient of variation) We give priority to first produce the product with the smallest demand coefficient of variation, and then the product with the second smallest demand coefficient of variation, and so on, until no supply capacity is available. For this approach, please compute each product's production quantity and use Monte Carlo Simulation to compute the seller's expected total profit.

Problem 3 (2 points)

Customers arrive to a system according to a Poisson process with parameter 1/min. Customer service time is exponentially distributed with parameter 2/min. A single server serves all customers. Each customer is endowed with a patience level that is uniformly distributed between 0.3 min and 0.7 min. If a customer's time of waiting in the queue reaches his/her patience level, then he/she immediately leaves system without waiting for the service any more. Please compute (1) the 50^{th} customer's expected waiting time, (2) the probability that the 50^{th} customer leaves the system after receiving the service, (3) the 50^{th} customer's expected time of staying in the system.

Problem 4 (2 points)

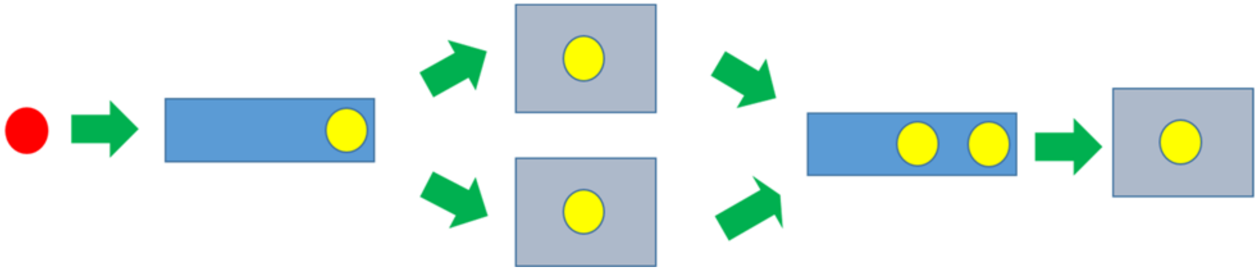
Customers arrive to a system according to a Poisson process with parameter 1/min. Each customer who arrives to the system receives two sequential services. The first service is operated by one agent. The second service is operated by two agents. Customer service time of the first service is exponentially distributed with parameter 2/min. Customer service time of the second service is exponentially distributed with parameter 1.5/min. Each arriving customer who cannot immediately receive the first service upon his/her arrival to the system wait in the first waiting lane. Each customer who completes the first service and cannot immediately receive the second service waits in the second waiting lane. For the second service, a customer goes to the agent who is available at an earlier time. If both agents for the second service are available at the same time, then the customer goes to the first agent.



Please compute (1) the mean of the 50th arriving customer's time of staying in the system, (2) the standard deviation of the 50th arriving customer's time of staying in the system.

Problem 5 (2 points)

Customers arrive to a system according to a Poisson process with parameter 1/min. Each customer who arrives to the system receives two sequential services. The first service is operated by two agent. The second service is operated by one agent. Customer service time of the first service is exponentially distributed with parameter 1.5/min. Customer service time of the second service is exponentially distributed with parameter 2/min. Each arriving customer who cannot immediately receive the first service upon his/her arrival to the system wait in the first waiting lane. Each customer who completes the first service and cannot immediately receive the second service waits in the second waiting lane. For the first service, a customer goes to the agent who is available at an earlier time. If both agents for the second service are available at the same time, then the customer goes to the first agent. The system only accepts the first 50 arriving customers.



Please compute the mean of the average of all 50 arriving customers' time of staying in the system.

Hint: Because there are two agents who provide the first service, it is possible that customer A who arrives to the system later than customer B finishes the first service (equivalently, enter the queue for the second service) earlier than customer B. That being said, it is possible that the 10th arriving customer enters the waiting lane for the second service earlier than the 9th customer or later than the 11st customer.

Problem 6 (2 points)

Let us use what we have learned in this course to celebrate Pi day, 03/14. Please use Monte Carlo Simulation approach to estimate the value of Pi.