SIE 431 - Simulation Modeling and Analysis
Fall 2018
Chris Miller

Homework 5

Model

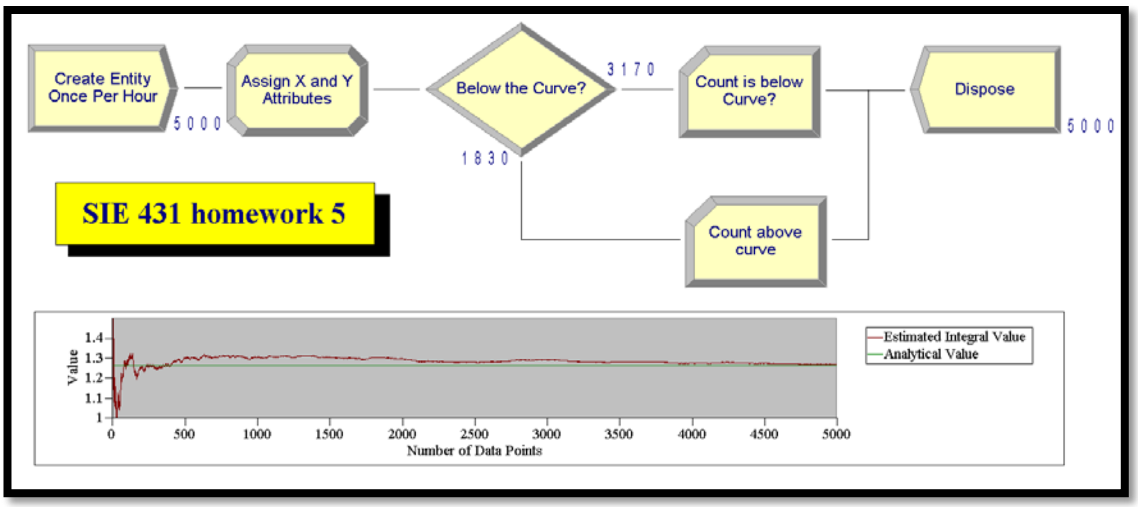

Figure 1. ARENA Model and plot of the estimate for the integral

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                              ARENA Simulation Results
                               College of Engineering

                            Summary for Replication 1 of 1

Project: SIE 431 homework 5                                      Run execution date :10/18/2018
Analyst: Chris Miller                                            Model revision date:10/18/2018

Replication ended at time      : 49999999.0 Hours
Base Time Units: Hours

                                          COUNTERS

Identifier                                 Count    Limit
_____________________________________________________________

below curve                             31607891  Infinite
above curve                             18392109  Infinite


Simulation run time: 0.90 minutes.
Simulation run complete.
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Figure 2. Final count of data points above and below the curve

Model Summary

The ARENA model first generates one entity per hour. After entering the system, the entity is assigned 2 attributes: randX and randY. randX is a value taken from a uniform distribution from 0 to 2 and randY is also a value taken from a uniform distribution, but it is from 0 to 1. Each entity represents one random data point in a 1 by 2 rectangle. From there, the decide module is true when the entity's attributes fall under the exponential function in the integral, otherwise it is false. The number of true and false entities are counted and then the entities leave the system. The plot shows the estimate of the integral based off of how many entities have entered the system compared to the analytic solution (for the first 5000 entities).

Analytical Result

$$\int_0^2 e^{-0.5x}dx \qquad u = -0.5x, \; du = -0.5dx$$

$$\int_0^2 e^{-0.5x}dx = -2\int_0^{-1} e^u du = -2[e^u|_0^{-1}] = -2[e^{-1} - e^0] = -2\left[\frac{1}{e} - 1\right] \approx 1.26424$$

Results

1) From the simulation, the integral is estimated by using the ratio of points below the curve of the exponential function: $\frac{(\#\, below\, curve)}{(\#\, below\, curve + \#\, above\, curve)} = 0.5(Arena\ under\ the\ curve)$

   Therefore: $\frac{2(\#\, below\, curve)}{(\#\, below\, curve + \#\, above\, curve)} = (Arena\ under\ the\ curve)$

   From Figure 2: $\frac{2(31607891)}{(31607891 + 18392109)} = 1.2643$

   This is a very close approximation to the analytical result above.

2) Figure 1 shows the plot of the current estimated value of the integral vs the current number of entities that entered the system. It uses the equation from the previous answer and shows that as more entities enter the system, the estimate generally gets closer and closer to the analytic solution to the integral. This result occurs due to the fact that having more information provides a more accurate representation for the estimation, so the estimate will converge to the analytic solution.