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Bank Booth Simulation: From Modeling to Simulation

Studying a bank booth is a great example to go from a model to a simulation. We can create a model that has certain properties and features that represent real bank booths. The whole point of modeling is to give an approximate representation of any given behavior of a system/process. With this we can simulate a bank booth processing customers throughout the day.

How can we simulate a bank booth? First we must think abstractly of what makes a booth operate. A worker does tasks that take a certain amount of time. Opening the customers bank information usually takes the same amount of time. Then the customers specific needs need to be addressed which can vary between customers. Lastly we must take note of other customers in line and if there is a priority queue of importance. Most banks have separate lines and you are separated when you first enter the bank. You either go to the normal bank line or you see a specialist (Priority queue). To conclude results we just need two pieces of information: booth worker task list and customer task list. The sum of these two values is the total time spent at the booth before the next customer in line can be seen.

Begin with a bank with 10 booth windows and at each window the worker has a flat work rate (efficiency) of 10 (work units) wu/hour. Adding

customers now the work units of the customer are within the range [5, 15]. The catch is we will be using a normal distribution with a mean of 5 and a standard deviation of 0.5. In return the actual values a customer will return are like Fig. 1.

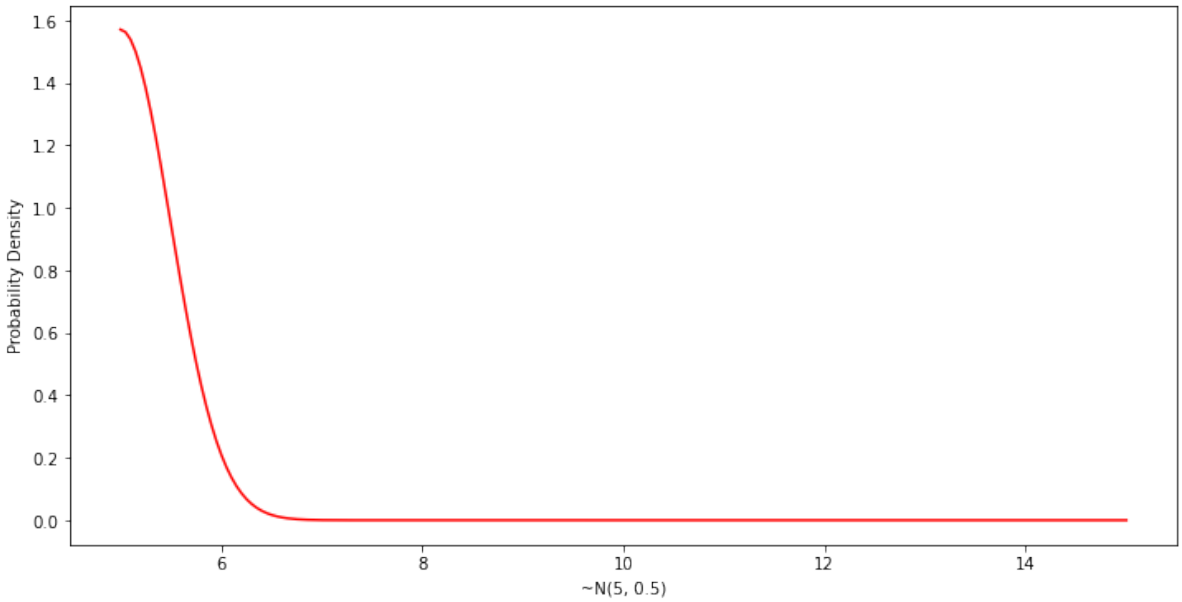

Fig. 1. The probability density function and the samples at each point. Samples are truncated between [5,15] although realistically the highest value in our simulation is 6 – 7. 15 is never reached.

Simulating 160 customers with 10 booths the average work time between each customer is ~15-16 (float precision in program) work units. The average wait time in queue is 1.145 hours. Due to the tendency of banks not being open for 24 hours we simulated 8 hour work days and not every customer was seen. Only 60/100 customers were helped this day. The amount of booths it takes to serve all customers is 27 booths. In this setup the total time to finish all events was 9.329 hours and this makes the booth workers work overtime. Adding 32 booths the finish time becomes 7.781 hours completely avoiding worker overtime.

The next question to be answered is what is the efficiency of adding more booths versus making the workers work harder/faster? An image can help distinguish results. Refer to Fig. 2, 3, and 4.

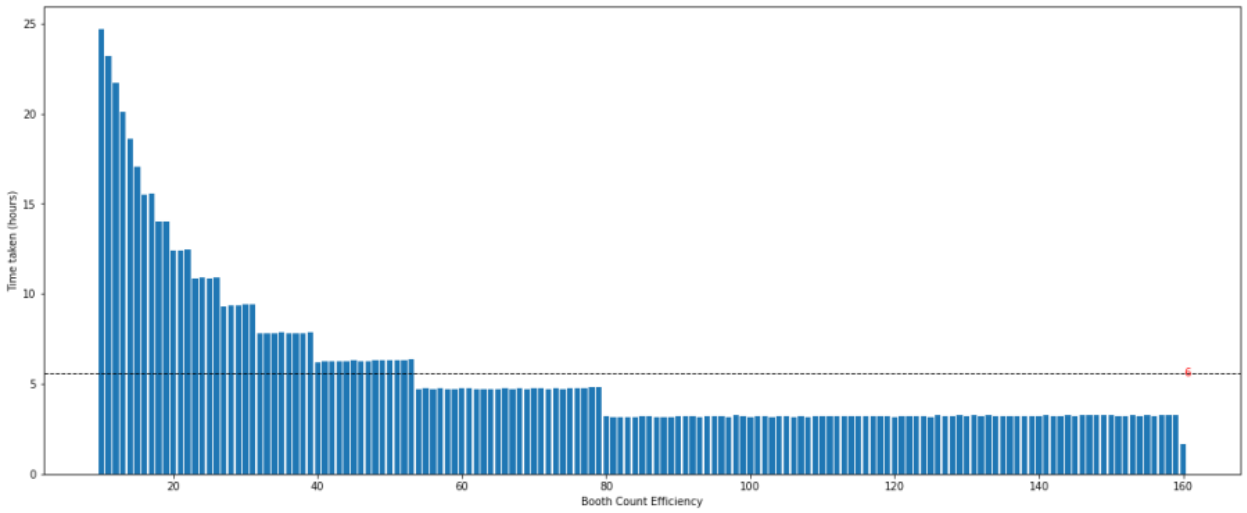

Fig. 2. A graph of increasing booth count over time taken to finish 160 customers in queue

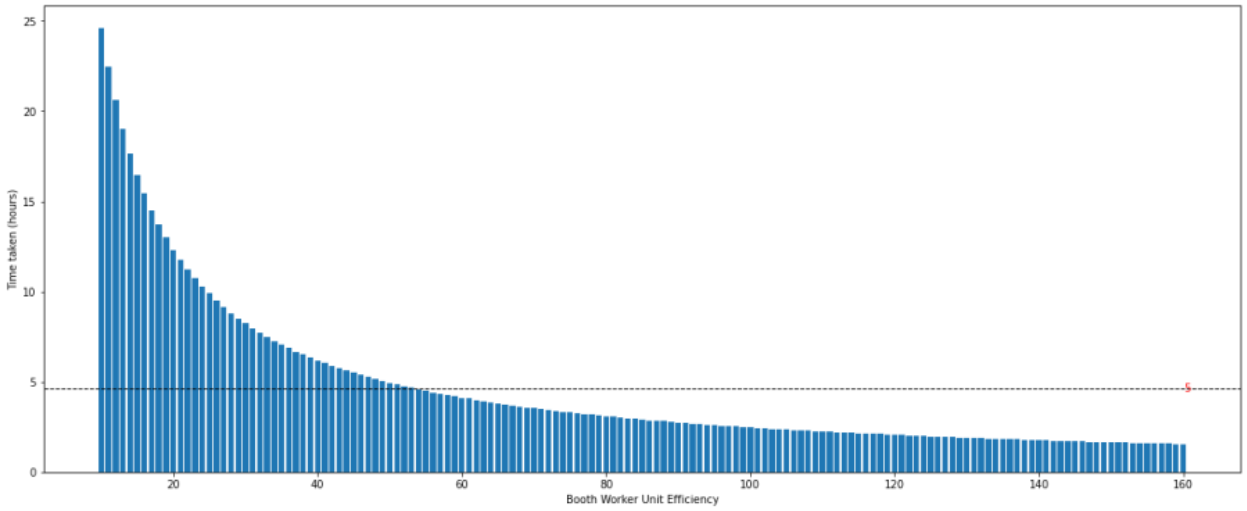

Fig. 3. A graph of increasing booth worker value over time taken to finish 160 customers in queue

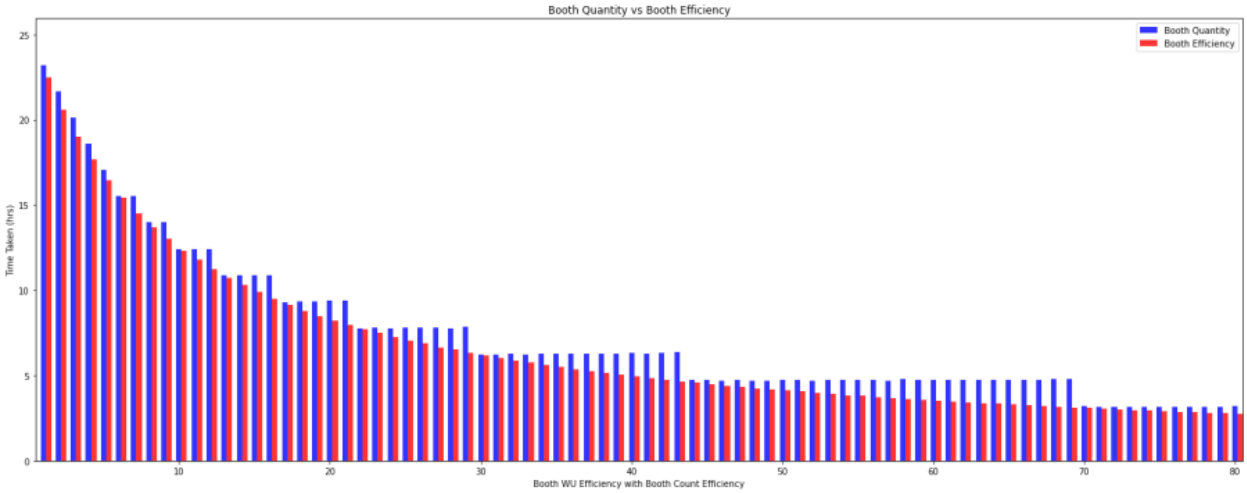

Fig. 4. Overlap between Fig. 2. and Fig. 3. Blue is booth count and red is worker efficiency.

The difference between worker units and booth efficiency is that booth efficiency appears to be more efficient versus adding more booths. The most realistic approach would be having 10 bank windows with variable booth worker speed depending how efficient the worker is that day.

Is it worth it to have a separate priority queue for light requests? Testing the program with a priority queue and a normal queue I've discovered no difference in customer completion in an 8 hour work day. The average customers work unit is 5.00000 – 6.00000. Values less than 5 are truncated. With 160 customers the priority queue doesn't change the result. The customers work unit is too restricted between [5,6] that the ordering doesn't make a huge difference. If we used 16,000 customers the priority queue would definitely make a difference over time. This doesn't change the fact that only 60 customers will be seen in an 8 hour work shift.