Report on improving customer queuing times

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The Problem

A small bank employs a single teller, of which the manager is considering improving queuing times, thus improve customer satisfaction through either buying a new machine or employing a new teller.

The outcome that is expected is that whilst both solutions would yield an improvement in customer queuing times, the machine will provide a greater improvement in all qualitative service situations.

Method

This method judges the efficiency of improvement based on the max queue that the queue(s) would reach at the end of the simulation time. The less the max queue is at the end of the simulation time, the better it will be. Which method improves max queue to the most degree would be the best solution.

1. Calculating improvement in machine (reference file Q12.py, plot.py)
    a. Beta Value = 0.7, 0.5, 0.3, assumed 30%, 50% and 70% improvement from installation of machine.
    b. Create function runSimulation, running function singleQueue 10000 times throughout set alpha/beta value (reference file: plot12.py)
    c. Run simulation of single queue 10000 times over with alpha values from 2-10 with 1 increments for a service time of 480 minutes (8 hours). Take average result of the 10000 simulations for all alpha values for both 0.7, 0.5, 0.3 and baseline 1 beta value.
2. Calculating improvement in second teller (reference file Q3.py, plot.py)
    a. Modify algorithm from single queue to double queue (named doubleQueue) through separation of variable Q into Q1 and Q2 (reference file: Q3)
    b. Modify function runSimulation, adding the running of function doubleQueue and it's dependencies (addition of list, appending of list etc).
    c. Run simulation for a service time of 480 minutes (8 hours). Take average results of the 10000 simulations for all alpha beta values and beta value of 1.
3. Graphing of results (reference file plot.py):
    a. Use matplotlib and combine list results and matplotlib functions to create result graph.

Assumptions of simulations:

- The mean time of arriving customers and the mean service time (alpha, beta values) are assumed to be constant at a certain time frame during the simulation time. This means that any changes in real world operating conditions won't be accounted for, including but not limited to:
    - Downtime of equipment (affecting beta value)
    - 2 people arriving at the same time (affected alpha value)
- Algorithm has a set simulation time that assumes a set opening and closing time every single day, meaning changes in demand opening time would not be accounted for, reducing accuracy. In addition, the algorithm will disregard whether anyone is still in queue at the 480th minute of the simulation and end it abruptly, which in the real world, would not happen.
- Algorithm only considers each event as discrete events, thus 2 events cannot happen at the same time, which
- The use of theoreticalMeanQueueLength function does not allow calculation where alpha and beta equals 1 at the same time due to a zero devision error.

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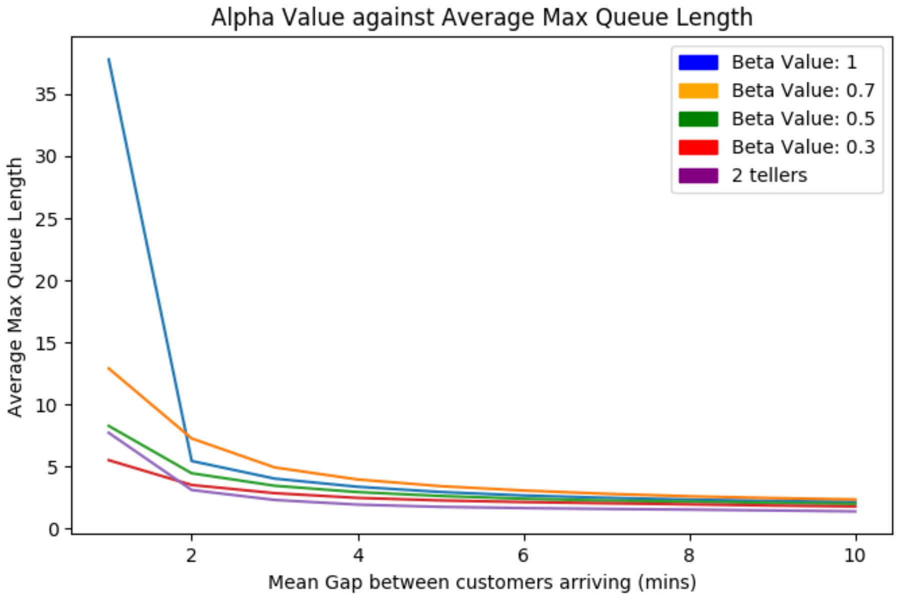

Results

This graph demonstrates the improvements in the maximum queue length that installing a new machine would have, for assumed improvements of 30%, 50% and 70%. As seen in the results, an assumed improvement of 30% already yields an extreme improvement in the bank's average queue length, but only in extreme demand (alpha between 1 and 2). Throughout the rest of Alpha values, not only the addition of the new machine isn't very effective, the assumption that the machine would yield 30% improvement will in fact worsen average maximum queue length for alpha values high than 2. However, as seen with the purple line, the simulation results of the 2 tellers show that for alpha values higher than 2, it beats the new machine in all assumed improvement scenarios.

Conclusion:

The report assumed that the machine would provide far superior improvements compared to a new teller and should be chosen. However, based on the results, it is concluded that from a purely quantitative, fairly limited simulation standpoint, the improvements that the 2 teller system creates is better than buying a new machine in most situations. Therefore, it is advised that the bank manager consider hiring another bank teller to improve customer satisfaction by reducing the queue lines. However, it is to note that both solutions show rapid diminishing returns at approximately the same rate as demand lowers, thus it should be considered whether the investment in improving queue times is worth it or not in the first place.

However, this recommendation is purely based on a quantitative review of the simulation data and does not account for real life qualitative operating conditions of the bank itself. Further work would have to be made in terms of the assessment in qualitative operating conditions e.g surveys for a better decision to be made.

In terms of limitations of the experiment itself, due to nature of the simulation being discrete, the bank teller may not have the most accurate information to make a proper decision whether to hire another teller or install a machine. Further work such as the modification of the algorithm so that it can simulate concurrent events and the implementation of simulating possible changes in real life operating conditions should be done to make the simulation more convincing and this allow the bank manager to make a more informed and data backed decision.