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MATH 245- Project 1

Queens College Bike Share Analysis

(Objective) Queens College acquired a new building a few years ago which is not directly connected to the main campus and it was named Queens Hall. Over the last few years, student traffic to Queens Hall from the main campus significantly increased due to more popular classes being held there. In order to assist and accommodate students, the College has hired our firm to implement a bikeshare system between Kiely Hall(KH) and Queens Hall(QH) to reduce travel time between QH and the main campus. In addition to the system itself, the college also requires a mechanic to maintain the system. On that note, the college has tasked us with determining whether they should hire a dedicated bike mechanic with a yearly salary of $35,000 or have the repairs done by their inhouse mechanic who will be paid through commissions, while considering how each choice impacts the cost per ride for students. Our firm has decided to answer these questions by means of a simulation.

(Methodology) Our metrics for this simulation include the number of bikes that get serviced and the total number of rides that occur. To add on, bike service costs $20, which is inclusive of the mechanic's commission. Service occurs when maintenance is required due to wear and tear or because of an accident. It is assumed that bikes tend to require maintenance after every 100 rides based on manufacturer specifications, while the probability of an accident is 0.001 according to national statistics. To add on, there are a total of ten bikes in the simulation, with both KH and QH having the capacity to house all ten bikes. Both bike racks are modeled by means of a single bit array, where 0 means that a bike is at KH, and while 1 means that a bike is at QH.

As bike selection is equally likely, the selection process is simulated by repeatedly and randomly picking an array index between 0 and 9 and checking the value at that index until a valid bike is selected. A valid bike is an array value of 0 if going to QH and 1 if going to KH. As scaling is not a concern for the system, unhandled requests are ignored. Such that, an unhandled request is defined as someone wanting to bike from KH to QH, but there are no bikes at KH or vice-versa. Consequently, nothing happens if there are no bikes at a location, i.e. the array is filled fully with all 0s or all 1s. Moreover, it is assumed that student traffic at both KH and QH is roughly equivalent. Thus, the probability of a bike being picked at either KH or QH is equal with a chance of .5.

Queens College is open for 14 hours, 5 days a week. This comes out to be 16,800 minutes for one whole month. Hence, the simulation simulates a month by looping through events 16,800 times. The event of a bike moving from both locations is independently simulated every minute. Separate arrays are used to track individual bike usage and the number of times each individual bike breaks. Additionally, each bike event has an embedded bike failure event, which accounts for accidents and has a probability of 0.001. If the check for an accident passes, then the count for the number of breaks for that bike is updated. After each minute, two Time Series variables are updated with total number of rides and broken bikes by summing up the corresponding arrays.

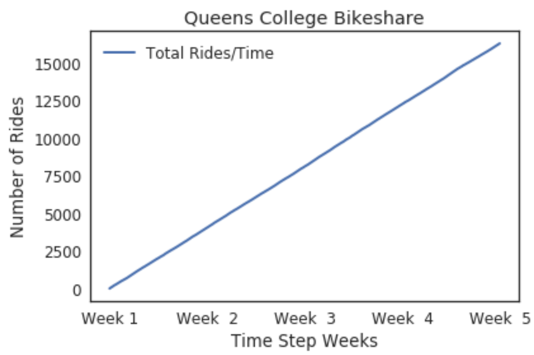

Fig 1

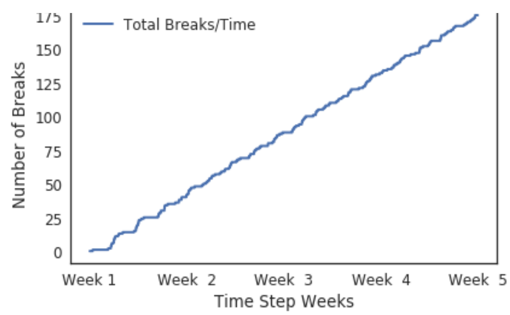

Fig 2

(Results) After executing the simulation with these assumptions in place, the results show that a total of ~16,000 rides, and ~170 service events occur in a month. Based on the total number of broken bikes, the yearly cost for the inhouse mechanic comes out to be approximately ~$41,000 dollars, by the following calculation: $170_{breaks/month} \times \$20_{svc.Cost} \times 12_{months} \approx 41{,}000$ Fig.1 provides a visualization for the total number of expected rides over time, which increase linearly, while, Fig. 2 shows how the expected number of breaks is nearly linear as well with respect to time.

(Analysis) Considering our assumptions, we can conclude that the salaried mechanic would be cheaper to hire, as he would cost $35,000 per year ,while the mechanic getting paid through commissions is more expensive at a yearly rate of $41,000. This fact is reflected in the cost per ride as hiring the in house mechanic brings the cost to ~.21 cents per ride as $\frac{(170_{breaks}\times\$20)}{16{,}000_{rides}} \cong \$.21$, while the dedicated mechanic lowers the ticket price down to ~.18, as $\frac{35{,}000}{12_{months}\times 16000} \cong \$.18$. These numbers indicate that by choosing the dedicated mechanic, the school can keep the bikeshare self-sufficient with a cheaper cost to students. Moreover, note that the analysis of the second graph suggests that, in the beginning, few bikes will break and soon after, in a short period of time, many bikes will break at the same time. This is because of our code's ability to randomly select a bike, due to which bikes approach the maintenance mark around the same time.

Despite these results, there are some deficiencies in this model. That is, there was never an assumption made regarding the repair rate of the mechanic. The simulation would have been made more accurate if every bike was taken out of circulation for a certain number of steps, while "repairing". Different types of repair would suggest different periods of time for bikes to be out of circulation.

Additionally, with the implementation of a metric for unhandled requests, we could measure if people are left without a bike at either QH or KH at a time when they would otherwise take a ride. This metric could help make decisions regarding scaling and even planned growth if detailed student population growth statistics are available. Another example of an unrealistic assumption is that the bike demand never changed. This is unrealistic as weather conditions, extended hours and days of school closure holidays impact bike demand. With that knowledge we could modify the probability of someone requesting a ride from .5 to a more accurate, like .1. This would lend to a decrease in rides, which decreases the number of broken bikes, and could possibly make the inhouse mechanic a preferable choice. With these differences in mind we would be able run a more accurate simulation in the future when faced with this situation.