American University of Beirut
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Department of Industrial Engineering and Management
INDE 303 Operations Research II
Spring 2024

Course Project: *CarBestBuy Inventory Management*

You received the following letter from Layla Nassar.

Dear OR consultant,

I am the CEO of CarBestBuy - the leading car dealership in Hamra. Recently, we are facing a serious problem. Our inventory runs out so often that we are losing many customers. I am suspicious that we do not have an effective inventory control policy but I have no idea how we can improve it. Given your expertise in OR, I am reaching out to you to ask you to help us analyze our inventory system. Currently our parking lot holds up to **8 cars and costs us $20 per day in rent**. At the end of each day, we make a call to our supplier, CarSupplier at Tripoli, if our inventory **drops to 2 or lower**. The truck CarSupplier used to ship the cars has a maximum capacity of 8. They charge a **handling fee of $100** for each car we order, and a **fixed round-trip fee of $300 for the truck**. For example, if we order 2 cars, the total order fee is $100×2+$300 = $500. Because of the fixed cost of $300, we generally make an order that brings **our inventory back to 8**. CarSupplier is a very good company with an excellent reputation. Their driver always delivers our order by the next morning.

We were doing a good job last year and seldom have complaints from the customers about inventory shortage. The market, however, has been getting better the last few months, and we are losing many customers because quite often we do not have enough cars in inventory. Thus, customers are not willing to accept a late delivery; instead, they buy cars from our competitors. I decided that I must do something to fix the situation. To give you an idea about our market, I have compiled the attached data log that indicates the number of customers we had on each day, that is, the number of cars we can sell if we have sufficient inventory, for the past 100 days. As you can see, on some days we have a demand for 4, 5, 6, 7 or 8 cars. If we start with 3 cars in the inventory on that day, then we lose some customers. We are making a **$500 profit on each car sale we make**. We believe the market will stay the same way in the foreseeable future.

I have the following thoughts in mind:
1- At what end of day inventory capacity is it best to make a call to our supplier and order a capacity that brings our inventory back up to 8? Is our practice of ordering when the inventory drops to 2 or below good?
2- Currently, we are paying $20 per day to rent our parking lot that can fit up to 8 cars. The landlord agrees that we can pay an additional $15 to rent 3 additional parking spaces. This will raise our maximum inventory to 11 instead of 8. If we proceed with this option, we can order a fixed quantity of 8 cars when our end of day inventory drops to 3 or below and can fit them all in our expanded parking lot. Please help me evaluate this proposal too.

Sincerely yours,

Layla Nassar, CEO at CarBestBuy

Questions

1- Assuming that the future daily demand is IID and follows the same distribution as the historical data provided in the file **inputB*j*.xlsx**[1], where *j* is your group number. develop a Markov Chain model by letting the state on day n be the number of cars in inventory at the <u>beginning of day *n*</u> for each of the following proposals,
   a. Keep the parking lot size the same (at 8) and test **all the possible reorder points** from the end of day inventory (0 to 7) to fill the parking lot by the next morning (eight MC systems),
   b. Increase the parking lot size to 11 (and pay an extra $15 for daily rent), then reorder 8 cars when the end of day inventory drops to 3 or below (one additional MC system).

2- For each of the nine MC systems in (1), find the long-term expected number of cars sold per day.

3- For each of the nine systems in (1), compute the long-term average profit per day.

Deliverables

1- Prepare a report to Ms. Nassar containing the following: (i) an abstract (not exceeding 200 words); (ii) an introduction section describing CarBestBuy problem, your analysis methodology, assumptions, and recommendations for Ms. Nassar in plain English (with no equations, tables or figures), and (iii) various sections showing the details of your analysis (with equations, tables or figures when needed). Your report should be double-spaced, font 12, with ample margins, and should not exceed six pages. Do not forget page numbers. Remember: Less is more. Avoid complicated statements that Ms. Nassar is not interested in, especially in the introduction. Having learned a little about OR at the business school, she's looking for an objective and straightforward answer based on quantitative analysis.

2- A detailed, "by-hand" analysis, addressing the three questions above for the "base case" representing the current system with a parking lot of eight spaces and a reorder point of two.

3- One or more Python files that do the work for you for all the MC systems developed. Do not perform computations by hand (other than for the "base case") and write a code that formulates and solves the various MCs for you. It is recommended that you use functions to formulate the situation.

Logistics

1- Teams of **four students** are to be formed. Enter your team members at the online sign-up sheet <u>here</u> by March 25, at 5 PM. If you have a team of three, two, or even a team of one (yourself), do enter this in the sign-up sheet. I will mix and match teams with two or less students into teams of three or four. The final list of teams will be communicated to you on March 26.

2- Each team must work independently from other teams on the project. **Cheating will not be tolerated. A different input file of historical demand data will be assigned to each team.**

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[1] The demand data sets are available <u>here</u>. Make sure you use the one corresponding to your team.

Evaluation Criteria

You will be evaluated based on the following.

1- The correctness of your formulations and the clarity of the answers provided in your reports.

2- The correctness of your Python code. If your code contains syntax errors (and therefore does not run), you will lose points.

3- The clarity of your report (both the plain English section and the more mathematical and analytical sections).

Deadline

April 25, 2024

Good luck!