SMM641 REVENUE MANAGEMENT AND PRICING

Problem Set 1 (due 22 February 2021)

General Guidelines:

- The assessment will be based on both the quality of your analysis and the expositional clarity and presentation of your overall work. Specifically, your work should not only have some computations and a result, but it should also clearly describe the steps you take and allow a reader to follow your methodology and calculations with ease. Please also try to highlight any additional insights you might have discovered from your analysis.
- Please feel free to make assumptions that might aid your analysis. However, make sure that you provide a justification for all your assumptions.
- Please submit a single short report as a .pdf file per group to Moodle with a title page that indicates the names of all group members.
- Please make sure you also submit any codes separately (e.g., as an .R, or an .Rmd file), which should be clear to follow and be ready to run.

Question 1: (20 points)

A café receives 50 croissants daily. During the morning hours, the croissants can be sold individually for £1.00. The croissants can also be used to make sandwiches for lunch time. Regardless of the other ingredients in a sandwich, each croissant brings £1.50 if used for a sandwich. Suppose that the demand in the morning for individual croissants is Poisson with mean 50 and the demand for croissant sandwiches during lunch is Poisson with mean 20.

(a) Suppose that the café does not reserve any croissants for lunch time and serves customers based on a first-come first-served (FCFS) basis. Compute the café's expected daily revenue.
(b) How many croissants should the café reserve to be used for lunch time sandwiches in order to maximise their expected daily revenue?
(c) What is the expected daily revenue from this protection (reserve) policy? What is the per cent improvement compared to the expected daily revenue from the FCFS allocation that you computed in part (a).
(d) Explore how the allocation decision changes with changes in the expected demand for sandwiches, the revenues that each croissant brings as an individual breakfast item or as a sandwich, and the number of croissants the café receives daily. For example, is it better to protect more croissants for lunch time if the demand for lunch time is higher? (Hint, run your analysis again many times with different values for these parameters and discuss how the optimal decision changes.)

Question 2: (40 points)

A sporting event organizer is consulting you regarding their seat allocations for a two-day sporting event. Customers can request to attend either a single day of the event, Day 1 or Day 2, or attend both days of the event. There are two fare classes for each day (combination) of the event. Specifically, let $(p_1, p_2, \dots, p_6)$= (150,100,120,80,250,150) denote, respectively, the high fare

for Day 1, low fare for Day 1, high fare for Day 2, low fare for Day 2, high fare for a combined Day 1 and Day 2 ticket, and low fare for a combined Day 1 and Day 2 ticket. The expected demands are (30,60,30,60,30,60), respectively. The event venue has a capacity of 100 seats for Day 1 and 100 seats for Day 2.

(a) Suppose that we divide the reservation horizon into T=300 smaller time periods such that at most one customer request arrives in each period. The probabilities of receiving a request for each ticket type is given as (1/10, 1/5, 1/10, 1/5, 1/10, 1/5). Formulate a Dynamic Program that allows the firm to dynamically accept or reject reservation requests as they arrive. What is the optimal expected total revenue?

(b) Incorporate a first-come first-serve decision rule into the Dynamic Programming recursions you have constructed for part (a). That is, at each arrival, rather than implementing the optimal policy of part (a), admit all requests as long as there is available capacity. Compute the expected revenue from this first-come first-serve policy.

(c) Determine a heuristic policy using the bid prices that you obtain from solving an LP treating the demands as deterministic at the expected values. Incorporate this heuristic to the Dynamic Programming recursions you have constructed. At each arrival, rather than implementing the optimal policy, admit or reject a request based on the heuristic policy. Compute the expected revenue from this bid-price heuristic.

(d) Come up with your own heuristic solution approach. Describe the logic of your heuristic, implement it in your code, and obtain the expected revenue based on your heuristic.

(e) Compare and comment on the revenues you obtain from parts (a)-(d).

Question 3: (40 points)

Identify a relatable setting either based on a service/operation on campus or around your neighbourhoods that you use, or a service/operation that you can do some initial research on to gather some information and data, in which any of the concepts and methodologies we have learned so far can potentially improve the service provider's revenues.

Please describe the setting clearly and provide an initial model and analysis for the setting in order to improve the revenues.

Through reasonable estimations and assumptions, identify a potential revenue improvement.

Please make sure to try to pick a setting that allows a sufficiently rich variation and extension to the examples we have covered in class, that is, your analysis should not be a very simple variation of the examples we have discussed in class but be challenging and require you to think creatively on how to solve the problem.

If you'd like, and if the setting is relevant and enables a sufficient depth of analysis, you will have the option to expand on your initial analysis for your projects as well.