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SMM641 Individual Assessment

Question 1:

Suppose the hotel operates on a first-come first-serve (FCFS) basis. Compute the hotel's expected daily revenue.

£3591.99

How many rooms should the hotel reserve for regular (late) arrivals in order to maximise their expected daily revenue?

14 rooms

What is the expected daily revenue from this protection (reserve) policy?

£4066.47

What is the percent improvement compared to the expected daily revenue from the FCFS allocation that you computed in part (a).

13.21%

Explore how the allocation decision changes with changes in key problem parameters (e.g., prices for each reservation type, etc.). Please also briefly comment on whether you would expect these changes and why.

Price: A 40% discount increases the protection level as expected to ensure sufficient capacity for full-price demand. This results in a higher revenue improvement compared to a FSFC approach.

Demand: If demand at both price points is similar, the protection level remains unchanged, as rooms can be filled across both segments without prioritising one. Only a drastic drop in demand would reduce the protection level.

Capacity: Surprisingly, increasing the number of rooms doesn't change the protection level. This can be attributed to the stable demand characteristics of Poisson distribution. The demand for each room is discrete, and variance remains proportional to the mean arrival rate, even as capacity increases. The only significant difference would be the expected total revenue.

<u>Question 2</u>

Please explain in words what the **value function** for the state (50,50,100) represents.

The value function determines the optimal strategy for allocating remaining seats on both flight routes over x time periods. In the state (50, 50, 100), it assesses the expected value of protecting 50 seats from Dublin to London at $150 and 50 seats from London to Edinburgh at $120 with 100 time periods remaining. Accepting demand assumes the expected revenue from selling the seats exceeds that from preserving inventory.

Consider the structure of the optimal acceptance decision for product 2 at t=100 periods to go (available in the slides). Please explain in words the main insights you gain from this figure.

This figure illustrates a switching curve that defines the boundary between acceptance and rejection decisions based on available seats on both flights. It depicts a non-linear interaction between Legs 1 and 2, with the red region indicating demand rejection for Leg 2. Accepting demand here would reduce availability of demand for Leg 1 & 2, and demand for Leg 2 is typically rejected only after about half the seats have been sold.

Suppose the company is considering adding a new product, which will be a flight from Dublin to London at a premium fare for £200, for which it estimates that the per-period arrival probability will be 1/20. Please explain how you would modify the dynamic program we have discussed in class to accommodate this new product.

1) Create an array (accept5) for product 5 that creates a matrix with value 0. This is so when the algorithm is repeated for each possible iteration the corresponding expected value can be stored.

2) Store product 5's arrival probability in 'arrivalprob' vector. Adjust the value for 'totalarrivalprob', hence the 'noarrivalprob' should be 0.05.

$$\lambda_0 = 1 - \frac{1}{5} - \frac{4}{15} - \frac{1}{6} - \frac{4}{15} - \frac{1}{20}$$
$$= 0.05$$

3) Within the "for" loops, create 'vforarrival5' to calculate the maximum value between selling one more premium seat from Dublin to London or not selling it. Since Product 5 requires 1 unit of i, a single "if" statement suffices to check seat availability on the Dublin to London flight. The 'vforarrival5' calculation should reflect the value function below.

$$\max\left\{200 + V(x_1 - 1, x_2, t-1),\ V(x_1, x_2, t-1)\right\}$$

4) When calculating the overall value function, include product 5's value function multiplied by its associated arrival probability (0.05).

Question 3
Identify a relatable setting either based on a service/operation on campus, in London, in which any of the concepts and methodologies we have learned so far can potentially improve the service provider's objective

Setting
Santander Cycle, also known as Boris Bikes, is a public bike hire scheme in London. Users pick up bikes from one station and return them to another. The challenge has been managing demand between high-demand (HD) and low-demand (LD) stations. These models aim to balance demand and increase revenue.

Goal:
- Increases prices at high-demand stations to reduce demand
- Lower prices at low-demand stations to encourage bike rental and return

Variables
d1 = Demand at hD station
d2 = Demand at lD station
pL = discounted fare
pN = normal fare
pH = premium fare
c = capacity at bike stations

Approach:
Identify each station as either HD or LD. For HD stations, introduce a dynamic programming model between the normal fare (pN) and premium fare (pH) and conversely for LD stations, another dynamic programming model between normal fare (pN) and discounted fare (pL). Each model will identify a protection level, based on historical and real-time demand, that will maximise revenue whilst redistributing demand, increasing the number of bikes hired daily. Changes to fare price should be reflected in real time on the app to influence which stations people hire bikes from.