BA 875
Operations and Supply Chain Analytics
Homework Assignment 4 (Due 04/24)

Deliverable: Submit your homework assignment as a single Python Notebook only and clearly state your answer to each component of a question. Ensure to save Notebook with output shown. The delivery requirement has been stated here and in the HW submission portal. *You shall receive a 10 point reduction in grade if you do not submit in the format specified*.

Part I: Inventory & Capacity Planning | Hyatt's Problem (***Overbooking level*** optimization)
Dataset: none needed (building simulation)

The Hyatt hotel has a combination of 100 King/Queen rooms available for reserving on a given night and is interested in mitigating the effect of no-shows on its profits by allowing overbooking. Overbooking occurs when the hotel accepts Y more customer reservations than its current capacity (i.e., $(100 + Y)$ reservations for a given night).

Hyatt offers a $r = \$150$ fare that is fully refundable. The demand for rooms is abundant and generally exceeds capacity. The forecast for the number of customers that do not show up (X) is normally distributed with a mean = 8 and standard deviation = 2. The potential costs of denying a room to the customer with a confirmed reservation or not filling a vacant room are $175 in penalties. The penalties operate differently, where (i) the $25 meal voucher is a penalty of having to deny a customer a reservation because capacity has been reached and (ii) the $150 penalty occurs as an opportunity cost of not fulfilling an open room that was available.

Your main objective is as follows: ***Determine how many rooms (Y) should be overbooked (sold in excess of capacity) by Hyatt, based on the Y that maximizes expected profit***

Summarizing Details:
Capacity: 100 rooms
Room price: $150
Demand forecast for no-shows: normal with mean 8, standard deviation 2

- Specify the input parameters
- Simulate the number of no-shows as shown in the Excel spreadsheet example (use 5000 simulation runs)
- Develop an algorithm that tests different overbooking levels and computes the average expected profit
  - As a rule of thumb, try overbooking levels between (mean - 3SD), (mean + 3SD)
  - Clearly state the recommended overbooking level and profit estimates based on your results - simply showing output of running code does not suffice, provide an interpretation and justification in your own words!
- Plot the relationship between avg profit vs. overbooking level and sd of profit vs. overbooking level
- Plot the profit risk in terms of the efficiency frontier (avg profit vs. sd profit)

Part II: Inventory & Capacity Planning | The Parka Problem (*Inventory level* optimization)
Dataset: none needed (building simulation)

L.L. Bean is planning the order size for winter parkas, for the upcoming selling season. Each parka costs the company c= $70 and sells for p= $140. Any unsold parkas at the end of the season are disposed off by a sale/markdown at v = $40. Using historical data and a feel for the market, L.L. Bean forecasts the winter season demand to be normally distributed with a mean = 26 and standard deviation = 3.

Your main objective is as follows: ***Determine how many parkas (Q) should L.L. Bean purchase from its supplier, based on the Q that maximizes expected profit***

Summarizing Details:
Procurement cost = $70
New item price = $140
Markdown price = $40
Demand forecast for parkas: normal with mean 26, standard deviation 3

- Specify the input parameters
- Simulate the order demand (use 5000 simulation runs)
- Develop an algorithm that tests different order size levels and computes the average expected profit
  - As a rule of thumb, try order size levels between (mean - 3SD), (mean + 3SD)
  - You should track two forms of revenue. One is the revenue from fulfilling the customer demand at the original price. The other is the revenue from any leftover parkas that were unsold to customers and will be sold at the markdown price. After calculating both forms of revenue, you can add the two revenues and subtract the procurement costs of making the Q parkas to obtain the profit
  - Clearly state the recommended order size and profit estimates based on your results - simply showing output of running code does not suffice, provide an interpretation and justification in your own words!
- Plot the relationship between avg profit vs. order level and sd of profit vs. order level
- Plot the profit risk in terms of the efficiency frontier (avg profit vs. sd profit)