Decision Analytics for Business and Policy

Homework 6: Optimization Under Uncertainty

Due Date: Oct 19, 11:59am ET **Submission:** Canvas

Aircraft Configuration.

Your aim to support the configuration of an aircraft into Economy, Economy+, Business, and First Class seats in order to maximize operating revenues, given the aircraft capacity constraints. The aircraft under consideration can hold 190 Economy seats. Each Economy+ seat takes the space of 1.2 Economy seat, each Business seat takes the space of 1.5 Economy seat, and each First Class seat takes the space of 2 Economy seats. The aircraft will be used on one flight segment exclusively with only direct passengers (no connecting passengers). On this segment, the estimated fares are \$400, \$500, \$800 and \$1,000, respectively. Seat demand is subject to uncertainty. Demand forecast shows 1,000 different demand scenarios. The `Pb1_D_stochastic.csv` file lists the demand estimate in each single scenario (the rows correspond to Economy, Economy+, Business, and First Class, respectively). The `Pb1_prob.csv` file reports the probability of each of the 1,000 scenarios. We further assume that demand for seats is independent across classes, e.g., passengers looking for Economy seats will not purchase Economy+ seats, and vice versa. Your objective is to determine a single seating allocation to maximize future expected revenues.

- Formulate this problem as a Stochastic Programming model. Make sure to specify the first-stage and second-stage decision variables, and to define the objective function and the constraints. Implement the model computationally.
- Characterize the optimal solution, and the intuition behind it. You may find useful to compute the average demand across all 1,000 scenarios.
- For each seat category, in how many scenarios did you sell fewer seats than the demand, and in how many scenarios did you have excess capacity? Comment briefly.

You are worried that the entry of a low-cost airline will affect prices for the highest classes, and aim to also capture fare uncertainty into your model. You assume that the fares of the four classes will be \$400, \$500, \$800 and \$1,000 with 40% probability, \$400, \$500, \$600 and \$700 with 30% probability, and \$400, \$420, \$600 and \$700 with 30% probability. Demand and price uncertainties are independent.

- Define the scenarios and their probabilities carefully. Formulate this problem as a Stochastic Programming model. Implement it computationally.
- How many seats did you allocate to each category? Please compare with the solution from the previous model, and comment briefly.