MSBA7003 Quantitative Analysis Methods

Assignment 3 (Due October 2 at 23:55; Please submit with the template)

Q1.

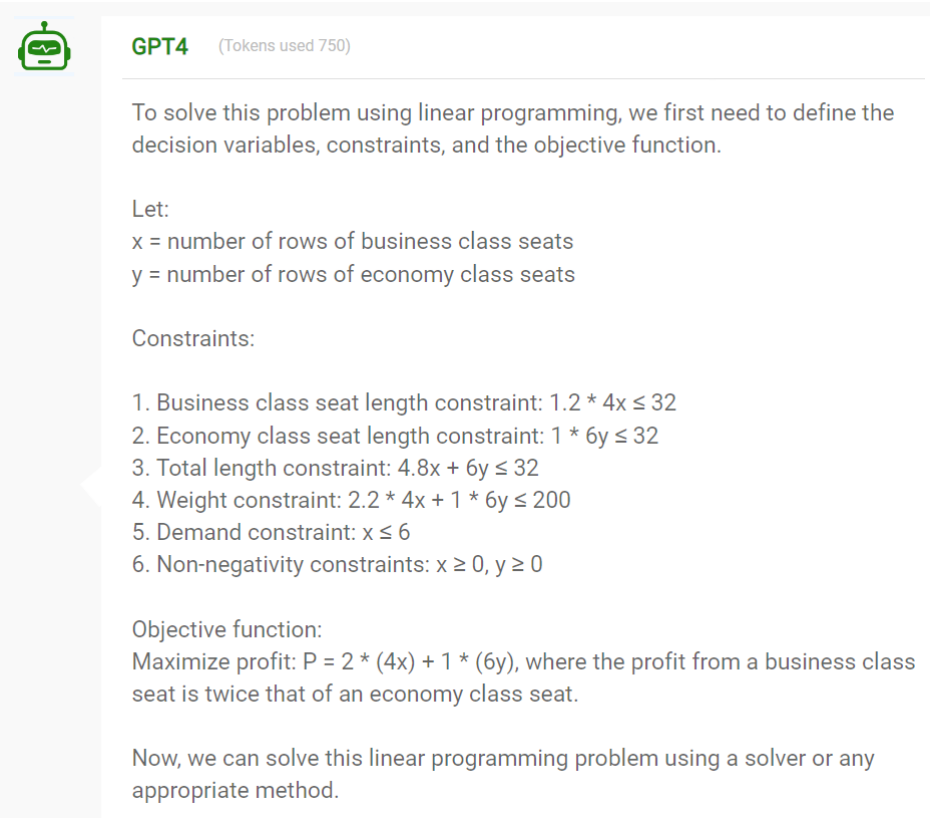
Jimmy, an aircraft engineer, is designing the passenger cabin for a new aircraft model. This model will be used by an airline for a specific route. Jimmy needs to decide on the number of seats for both business class and economy class. There must be 4 seats per row in business class; the seat length is 1.2 length units; the seat weight is 2.2 weight units. In economy class, there must be 6 seats per row; the seat length is 1 unit; the seat weight is 1 weight unit. The total cabin length is 32 length units, and the seat weight limit is 200 weight units. Additionally, due to limited demand, business class cannot have more than 6 rows. Jimmy's optimization goal is to maximize the expected profit of the aircraft model for its entire lifecycle on this route. It is known that the profit margin of business class seats is twice that of economy class seats.

Which of the following statement(s) is(are) true?

A) In the optimal design plan, there should be 4 rows for business class and 27 rows for economy class.

B) In the optimal design plan, there should be 5 rows for business class and 26 rows for economy class.

C) In the following problem formulation given by GPT4, constraints 1 – 3 are all wrong.



GPT4 (Tokens used 750)

To solve this problem using linear programming, we first need to define the decision variables, constraints, and the objective function.

Let:
x = number of rows of business class seats
y = number of rows of economy class seats

Constraints:

1. Business class seat length constraint: $1.2 * 4x \leq 32$
2. Economy class seat length constraint: $1 * 6y \leq 32$
3. Total length constraint: $4.8x + 6y \leq 32$
4. Weight constraint: $2.2 * 4x + 1 * 6y \leq 200$
5. Demand constraint: $x \leq 6$
6. Non-negativity constraints: $x \geq 0, y \geq 0$

Objective function:
Maximize profit: $P = 2 * (4x) + 1 * (6y)$, where the profit from a business class seat is twice that of an economy class seat.

Now, we can solve this linear programming problem using a solver or any appropriate method.

D) The total weight constraint is not binding.

E) None of the above.

Q2.

The Heinlein and Krampf Brokerage firm is instructed by a client to invest $250,000 among five possible asset classes as shown in the table below. The return of each security is uncertain and depends on the market scenario. The client listed the following guidelines:

(1) Investment Grade Bonds should constitute at least 20% of the invested value;
(2) At least 40% of the invested value should be placed in a combination of international equity and S&P 500;
(3) No more than 80% of the amount invested in bonds should be placed in hedge funds;
(4) No short selling, and it is okay to hold some cash.

Projected Return (%)	in Scenario 1	In Scenario 2
Investment Grade Bonds	1.1	-2.3
Commodities	-5.0	6.8
Hedge Funds	-1.7	4.9
International Equity	-0.3	8.4
S&P 500	-7.5	11.8

The objective is to maximize the worse-case return. Which of the following is(are) true?

A) It is optimal to hold some cash.

B) In the optimal solution, the investment in S&P 500 is zero.

C) In the optimal solution, the worst-case expected return is $1,350.

D) In the optimal solution, the return for an additional invested dollar is $0.0054.

E) None of the above.

Q3.

The Salem Board of Education wants to evaluate the efficiency of the town's four elementary schools. The three outputs of these schools are: (1) average reading score, (2) average mathematics score, and (3) average self-esteem score. The three inputs to these schools are: (1) average educational level of mothers (defined by highest grade completed: 12 = high school graduate, 16 = college graduate, and so on), (2) number of parent visits to school (per child), and (3) teacher-to-student ratio. The relevant information for the four schools is given in the table below.

School	Input 1	Input 2	Input 3	Output 1	Output 1	Output 3
A	14.5	3	0.25	3.5	2.7	3
B	13	2	0.13	3.3	2.5	2.4
C	15.5	4	0.28	3.8	3	3.3
D	16.2	3	0.33	4	3.8	4

Which of the following statement(s) is(are) true?

A) If we assume constant returns to scale, school both A and C are inefficient.

B) If we assume constant returns to scale, school Both B and D are efficient.

C) If we assume non-constant returns to scale, school B is efficient.

D) If we assume non-constant returns to scale, school C is efficient.

E) None of the above.