1.a.

Decision Variable

Choose 4 associates:

Every associate might be 0 or1, 0 for not being chosen, and 1 for being chosen

Associate i= 0 or 1, i=1~8

Objective

Max(Experience), maximize the total experience of the team

= Max(Associate i* Experience i, for Associate i=1)

Constraints

#1. 2 male, 2 female

(∑x[i] for i in Associate if Gender[i] = Male) = 2

(∑x[i] for i in Associate if Gender[i] = Female) = 2

#2. 2 us, 2 non-us

(∑x[i] for i in Associate if the associates are US members) = 2

(∑x[i] for i in Associate if the associates are Non-US members) = 2

#3. 4 people being picked

∑x[i] for i in Associate =4

Optimal:

```
Selected Associates: [2, 3, 6, 8]
Total Experience: 14
```

1.b.

Decision Variable

Same as 1.a

Objective

Same as 1.a

Constraints

#1. 2 male, 2 female

(∑x[i] for i in Associate if Gender[i] = Male) = 2

(∑x[i] for i in Associate if Gender[i] = Female) = 2

#2. 2 us, 2 non-us

(∑x[i] for i in Associate if the associates are US members) = 2

(∑x[i] for i in Associate if the associates are Non-US members) = 2

#3. 4 people being picked

∑x[i] for i in Associate =4

#4. If Associate 1 is chosen, then Associate 3 cannot be chosen.

x[1] + x[3] <= 1

#5. If Associate 2 is chosen, then Associates 6 and 7 need to be chosen.

x[2] - x[6] <= 0 & x[2] - x[7] <= 0

#6. Associates 5 and 8 dislike each other and should not be chosen together.

x[5] + x[8] <= 1

Optimal:

```
Selected Associates: [1, 4, 6, 8]
Total Experience: 11
```

2.a.

Decision Variable

Price of New Books, p_new

Price of Used Books(Old Books), p_old

Objective

MAX(p_new - new_cost)*d_new + (p_old - old_cost)*d_old)

Note: new_cost = 75, old_cost = 25, d_new = demand of new books, d_old = demand of old books

Constraints

price ratio be at most 0.5. -> p_old / p_new <= 0.5

Optimal:

```
New book optimal price: 300.78311195266434
Used book optimal price: 150.3915559763193
Optimal contribution margin: 20080.750091020935
```

2.b.

i. avg price in 2.a. is approximately 207.03

```
optimal_p_new, optimal_p_old = sol.x
demand_new_optimal = best_d_new(optimal_p_new, optimal_p_old)
demand_old_optimal = best_d_old(optimal_p_new, optimal_p_old)


total_revenue = (optimal_p_new * demand_new_optimal) + (optimal_p_old * demand_old_optimal)
average_price_optimal = total_revenue / (demand_new_optimal + demand_old_optimal)
average_price_optimal
```

```
207.03176163225982
```

ii.setting a avg price constraint

Decision Variable

Price of New Books, p_new

Price of Used Books(Old Books), p_old

Objective

MAX(p_new - new_cost)*d_new + (p_old - old_cost)*d_old)

Note: new_cost = 75, old_cost = 25, d_new = demand of new books, d_old = demand of old books

Constraints

price ratio be at most 0.5: p_old / p_new <= 0.5

avg price at most 180: (p_new*d_new + p_old*d_old) / (d_new + d_old) <=180

Optimal:

```
Objective Value (Squared error): 19302.653876748816
Optimal Price of New Books 250.48178535947224
Optimal Price of Old Books 125.24089267979446
```

In this scenario, we can get the optimal solution that both new and old books decreased. However, it does not necessarily lead to lower prices for new and used books.

The average price is a function of the prices and the demands for the new and used books. Lowering the price of one or both types of books might increase their demand, which could help meet the average price constraint. However, there could be scenarios where the average price constraint is met not just by lowering the prices but also by finding a balance between the price and the resulting demand such that the average price stays within the limit.

Hence, **we should re-run the optimization function** model to certify whether new and used books are decreasing their prices.