OPS 807 Midterm Exam

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Problem 1 (40 pts):

California Motors Corporation (CMC) just introduced a new luxury sedan. As part of its promotional campaign, the marketing department decided to send personalized invitations to test-drive the new sedan to two target groups: 1) current owners of an CMC luxury car and 2) owners of the luxury cars manufactured by CMC competitors. The cost of sending a personalized invitation is estimated to be $1 per letter. Based on previous experience with this type of advertising, CMC estimates that 25% of the customers contacted from group 1 and 10% of the customers contacted from group 2 will test-drive the new sedan. As part of this campaign, CMC has set the following goals:

1. Get at least 10,000 customers from group 1 to test-drive the new sedan. (priority level 1)
2. Get at least 5000 customers from group 2 to test-drive the new sedan. (priority level 1)
3. Limit the expense of sending out the invitations to $ 70,000. (priority level 2)

Assume goals 1 and 2 are equally important.

1. Formulate this goal programming problem (define the decision and deviation variables, objective function and constraints).
2. Solve the program using a Python optimization library and display the results (output of the program should be displayed with correct format).
3. Explain and interpret the results.
4. If management believes that contacting customers from group 2 is twice as important as contacting customers from group 1, what should CMC do? (solve the program a second time with the new condition and display the results)
5. Compare the results from these two scenarios and explain what it means.
6. Include your Python code and the output of it in one file (the results could be as comments in the code) and your explanation in a separate file (word file).

Problem 2 (40 pts):

An Art Gallery is considering installing a video camera security system to reduce its insurance premiums. A diagram of the eight display rooms the gallery uses for exhibitions is shown. The openings between rooms are numbered 1 through 13. A security firm proposed that two-way cameras be installed at some room openings. Each camera has the capability to monitor the two rooms between which the camera is located. For example, if a camera were located at opening number 4, room 1 and 4 would be covered. If a camera were located at opening 11, rooms 7 and 8 would be covered. Management decided not to locate a camera system at the entrance to the display rooms.

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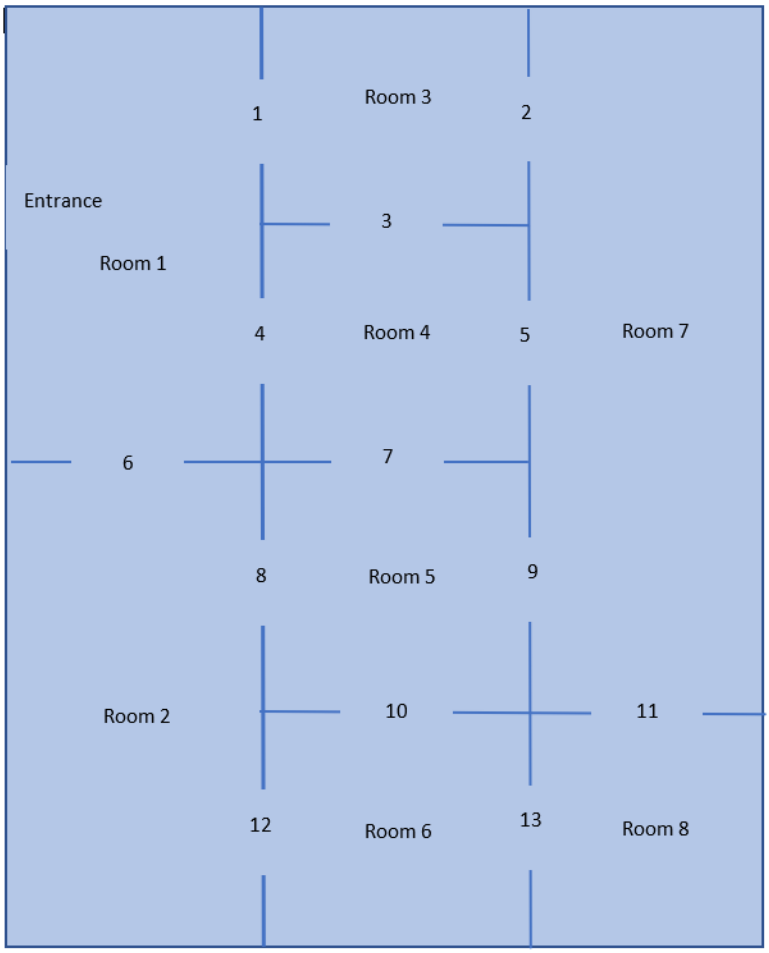
The objective is to provide security coverage for all eight rooms using the minimum number of two-way cameras.

1. Formulate this optimization problem and determine the decision variables, objective function and the constraints.
2. Determine how many cameras and the location of the cameras. (by solving the optimization problem using Python. Hint: use binary decision variables to determine a camera exists at a location or not).
3. If management wants extra security in room 7 by installing two cameras, how do you change your problem formulation to deal with this condition. (redo the problem with the addition of this condition).
4. Display the solution to these two scenarios, i.e. the output of your optimization code with proper format and compare them.
5. Include your Python code and the output of it in one file (the results could be as comments in the code) and your explanation in a separate file (word file).



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Problem 3 (20 pts):

Consider the following LP problem:

Maximize profit = 5X + 6 Y
subject to:

2X + Y <= 120
2X + 3Y <= 240
X, Y >= 0

1. What is the optimal solution to this problem (calculate the maximum profit as well)? Solve it graphically.
2. If a technical breakthrough occurred that raised the profit per unit of X to $8, would this affect the optimal solution? (Solve it graphically + max profit)
3. Instead of an increase in the profit coefficient X to $8, suppose that profit was overestimated and should only have been $3. Does this change the optimal solution? (Solve it graphically + max profit)