

國立中央大學 109 學年度碩士班考試入學試題

所別： 工業管理研究所碩士班 不分組(一般生)

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科目： 作業研究

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*請在答案卷(卡)內作答

1. (20%):

Please design a linear programming (LP) model in the 2-dimensional space (that is, the x - y plane) such that the value of this LP model's objective function can be as large as we want. In other words, the optimal solution for this LP model is unbounded and moves towards "positive infinity." Please note: When designing this LP model, please make sure that it has at least 2 *linearly independent* constraints.

(10%) Please clearly present the objective function and every constraint in your LP model. Also, please draw a figure to show the following clearly:

- (5%) the feasible region (可行解區域) of your LP model
- (5%) why the value of the objective function can be as large as we want

2. (20%):

If A is a square matrix such that A^{-1} exists, then A^{-1} can be calculated by using the following two steps:

Step 1: Create a new matrix " $[A, I]$ " where its left half is A and its right half is the identity matrix.

Step 2: Use elementary row operations to reduce the left half of the new matrix to an identity matrix.

At such a moment, the right half of the new matrix will be A^{-1} .

$$A^{-1}[A, I] = [I, A^{-1}]$$

Please use the above 2-step approach to calculate the inverse matrix of the following matrix (you will get 0 points if you use any other method to find A^{-1}).

$$A = \begin{bmatrix} 1/7 & 2/7 & 1/7 & -2/7 \\ -1/7 & 2/7 & -1/7 & 1/7 \\ 0 & 1/7 & 1/7 & 0 \\ 1/7 & 0 & 0 & 0 \end{bmatrix}$$

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注意:背面有試題

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3. (60%):

Consider the scenario where the administration office of Jade Mountain National Park (let's just call it "the office" hereafter) is thinking about deploying a high-tech trash collection device around the park. These high-tech devices are capable of compressing (壓縮) garbage to a very small size, so they can carry much more garbage compared to ordinary trash boxes. Therefore, the office believes that these high-tech trash collection devices should significantly reduce the human labor required to collect garbage around the park in the future.

The office has received money to buy the new trash collection devices and deploy them in the park. However, their money is not enough for every trash collection site to use the new device. Therefore, the office wishes to know how they should spend the money so they can save the most human labor (which is measured in terms of travel distance to collect trash and bring it back to the office).

This problem can be formulated as an integer linear programming (ILP) model. And the following are parameters (that is, numerical data which we already know their value) that you must use to develop such a model.

- budget** the maximum amount of money that the office is allowed to spend to buy high-tech trash collection devices
- N** the total number of trash collection sites in Jade Mountain National Park
- current_{*i*}** the current number of visits to site *i* per year that the office must send one person to collect trash (that is, it is the number of visits to site *i* with the old trash box), $1 \leq i \leq N$
- distance_{*i*}** the total round-trip (來回) distance traveled from the office to site *i*, collect the trash over there and then bring it back to the office, $1 \leq i \leq N$
- cost_{*i*}** the total cost required to deploy the new high-tech trash collection device at site *i*, including purchasing, shipping/handling, installation, etc., $1 \leq i \leq N$
- saved_{*i*}** the number of visits to site *i* which is expected to be saved due to the deployment of the new trash collection device at that site ($0 < \text{saved}_i < \text{current}_i$), $1 \leq i \leq N$

And the following are the decision variables that you must use in the model.

- F_i** the number of visits to site *i* (with or without using the new trash collection device), $1 \leq i \leq N$
- X_i** a binary (0/1) variable which indicates whether site *i* will use the new high-tech trash collection device or not, $1 \leq i \leq N$

注意:背面有試題

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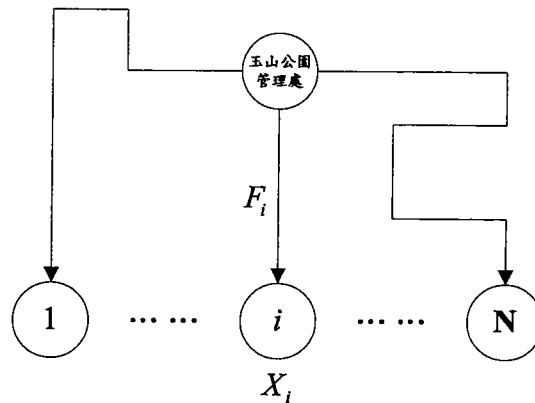
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Please use the above already-defined parameters and decision variables to develop an integer linear model which minimizes the total distance traveled to collect trash from all N sites (模型必需是線性的). *****Note:** You are NOT allowed to define anything new in your model, regardless they are symbols, parameters, decision variables, whatever (在模型中禁止使用任何新的符號、參數、決策變數等).

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