**BUAD 5022 – Individual Problem Set 3**

Due: November 23 by 11:59pm via Blackboard submission *{Date updated from Nov. 22}*

Grade: 15% of your overall class grade

Category A Assignment (i.e., do not discuss with anyone else except the instructor)

*Homework should be neat and organized. It is subject to grade penalties if it is not.*

**1.** Simplex County is trying to determine where to place the county fire station. The locations of the county’s four major towns are provided in the following sentence using (x, y) coordinates in miles. Town 1 is at (10, 20); town 2 is at (60, 20); town 3 is at (40, 30); town 4 is at (80, 60). **Town 1 averages 20 fires** per year; **town 2, 30 fires;** **town 3, 40 fires**; **and town 4, 25 fires.** The county wants to **build the fire station in a location that minimizes the average distance** that a fire engine must travel to respond to a fire. Since most roads run either an east-west or a north-south direction, we assume that the fire engine can only do the same. Thus, if the fire station were located at (30, 40) and a fire occurred at town 4, the fire engine would have to travel (80 – 30) + (60 – 40) = 70 miles to the fire. Use linear programming to determine where the fire station should be located. *{Hint: If the fire station is to be located at the point (x, y) and there is a town at the point (a, b), define variables e, w, n, s (east, west, north, south) that satisfy the equations x – a = w – e and y – b = n – s.}*

* Formulate the model as an LP.

Variables:

Let (x,y) be the position of the fire station, e\_i be the east distance from station to town i, w\_i be the west distance from station to town i, n\_i be the north distance from station to town i, s\_i be the south distance from station to town i.

Objective: Minimize

Subject To:

(Town 1 west, east distance constraint)

(Town 1 north, south distance constraint)

(Town 2 west, east distance constraint)

(Town 2 north, south distance constraint)

(Town 3 west, east distance constraint)

(Town 3 north, south distance constraint)

(Town 4 west, east distance constraint)

(Town 4 north, south distance constraint)

(non-negativity constraint)

* Solve the model using Python (submit your code).
* Summarize the solution in a succinct and presentable manner.

x: 40.0, y: 30.0

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | West | East | North | South |
| Town 1 | 30 | 0 | 10 | 0 |
| Town 2 | 0 | 20 | 10 | 0 |
| Town 3 | 0 | 0 | 0 | 0 |
| Town 4 | 0 | 40 | 0 | 30 |

Optimal is 3450. The fire station should be place at (40,30).

**2.** ABC Publishing sells textbooks to college students. ABC Publishing has **two sales** reps available to assign to **the A-G state area**. The number of college students (in thousands) in each state is given in the map below (next page). Each sales rep must be assigned to two adjacent sites. For example, a sales rep could be assigned to A and B, but not A and D. ABC’s goal is to **maximize the number of total students in the states assigned** to the sales reps. **Formulate an IP** whose solution will tell you where to assign the sales reps.

* Formulate the model as an IP.

Let be the binary variable indicating i area is assigned. Where .

Let be the binary variable indicating a sales representative is assigned to the adjacent sites i and j.

Objective: Maximize

Subject To:  
 (Area A adjacent constraint)

(Area B adjacent constraint)

(Area C adjacent constraint)

(Area D adjacent constraint)

(Area E adjacent constraint)

(Area F adjacent constraint)

(Area G adjacent constraint)

(non-negativity constraint)

* Solve the model using Python (submit your code).
* Summarize the solution in a succinct and presentable manner.

Region assigned representative

A 1

B 0

C 1

D 1

E 0

F 0

G 1

The objective is maximized at 177 thousands students.

**3.** W&M must purchase 1200 computers and they have three vendors to choose from. Vendor 1 charges $250 per computer plus a total delivery charge of $5000. Vendor 2 charges $300 per computer plus a total delivery charge of $4000. Vendor 3 charges $350 per computer plus a total delivery charge of $6000. Vendor 1 will sell the university at most 800 computers. Vendor 2 will sell at most 600. Vendor 3 will sell at most 400. The minimum order from any vendor is 300 computers. Determine how to minimize the total cost of purchasing the needed computers.

* Formulate the model as an IP.

Let be the number of computers purchased from vendor i, where i=1, 2, 3.

Let be the binary number indicating whether buying from vendor i, where i = 1, 2, 3.

Objective: Minimize

Subject To:

(Lower bound for three vendors if purchased from vendor i)

(upper bound for vendor 1 if purchased from vendor 1)

(upper bound for vendor 2 if purchased from vendor 2)

(upper bound for vendor 3 if purchased from vendor 3)

(demand constraint)

(non-negativity)

* Solve the model using Python (submit your code).
* Summarize the solution in a succinct and presentable manner.

Vendor # of computers

Vendor 1 800

Vendor 2 400

Vendor 3 0

The optimal solution for cost is minimized at $329,000.

Map and number of students (in thousands) for problem #2.

*For example, State A has 43,000 students and is adjacent to State B (29,000 students) and State C (42,000) students.*

**A (43)**

**B (29)**

**C (42)**

**D (21)**

**E (56)**

**F (18)**

**G (71)**