**Assignment Instructions: Assignment 2**

**Purpose**

**The purpose of this assignment is to**

* **continue deepening your ability of modeling a problem with linear programming;**
* **solve a linear programming problem graphically.**

**Directions**

**1. (Computer Center Staffing) You are the Director of the Computer Center for Gaillard College and responsible for scheduling the staffing of the center. It is open from 8 am until midnight. You have monitored the usage of the center at various times of the day and determined that the following numbers of computer consultants are required.**

**Time of day Minimum number of consultants required to be on duty**

**8 am–noon 4**

**Noon–4 pm 8  
4 am–8 pm 10  
8 am–midnight 6**

**Two types of computer consultants can be hired: full-time and part-time. The full-time consultants work for eight consecutive hours in any of the following shifts: morning (8 am – 4 pm), afternoon (noon – 8 pm), and evening (4 pm – midnight). Full-time consult- ants are paid $14 per hour.**

**Part-time consultants can be hired to work any of the four shifts listed in the table. Part-time consultants are paid $12 per hour. An additional requirement is that during every time period, at least one full-time consultant must be on duty for every part-time consultant on duty.**

1. **a)  Determine a minimum-cost staffing plan for the center. In your solution, how many consultants will be paid to work full time and how many will be paid to work part time? What is the minimum cost?**

Constraints= 28 Time of day: 4

28/4 = 7 full time employees \* 2 = 14 part time employees

Minimum cost staffing plan = $14 per hour \* 8 hours = $112 per day

7 full time employees \* $112 per day = $784 per day

Full time cost per day = $784

Part time = $12 \* 4 = $48 per day \* 14 part time employees = $672 for part time employees per day

Full time cost + total part time cost = minimum cost daily staffing plan

$784+$672 = $1,456 minimum cost of daily staffing plan

1. **b)  After thinking about this problem for a while, you have decided to recognize meal breaks explicitly in the scheduling of full-time consultants. In particular, full-time consultants are entitled to a one-hour lunch break during their eight-hour shift. In addition, employment rules specify that the lunch break can start after three hours of work or after four hours of work, but those are the only alternatives. Part-time consultants do not receive a meal break. Under these conditions, find a minimum-cost staffing plan. What is the minimum cost?**

* Full time employee get 1 hour lunch, part time do not get lunch

$14 \* (8-1) = $98 per day for one full time employee

$98 \* 7 full time employees = $686

Part time is the same as they do not get lunch, therefore $672 per day for part time staff

Full time cost + total part time cost = minimum cost daily staffing plan

$686+$672 = $1,358 minimum cost

Adding lunch break will save the computer staffing center $98 per day.

**Hint: for this problem, you only need to formulate the LP problem without solving it. 2. Consider the problem from the previous assignment.**

**Back Savers is a company that produces backpacks primarily for students. They are considering offering some combination of two different models—the Collegiate and the Mini. Both are made out of the same rip-resistant nylon fabric. Back Savers has a long-term contract with a supplier of the nylon and receives a 5000 square-foot shipment of the material each week. Each Collegiate requires 3 square feet while each Mini requires 2 square feet.  
The sales forecasts indicate that at most 1000 Collegiates and 1200 Minis can be sold per week. Each Collegiate requires 45 minutes of labor to produce and generates a unit profit of $32. Each Mini requires 40 minutes of labor and generates a unit profit of $24. Back Savers has 35 laborers that each provides 40 hours of labor per week. Management wishes to know what quantity of each type of backpack to produce per week. Solve this problem graphically.**

c= number of collegiate backpacks

m= number of mini backpacks

Z is the objective function

Z= 32c +24m

Contraints :

3c + 2 m **≤** 5000

c **≤** 1000

m **≤**1200

45c+40m **≤**35\*60\*40 which is --- > 45c +40m **≤** 84000

c , m ≥ 0

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Description automatically generated**

**3. (Weigelt Production) The Weigelt Corporation has three branch plants with excess production capacity. Fortunately, the corporation has a new product ready to begin production, and all three plants have this capability, so some of the excess capacity can be used in this way. This product can be made in three sizes--large, medium, and small-- that yield a net unit profit of $420, $360, and $300, respectively. Plants 1, 2, and 3 have the excess capacity to produce 750, 900, and 450 units per day of this product, respectively, regardless of the size or combination of sizes involved.**

**The amount of available in-process storage space also imposes a limitation on the production rates of the new product. Plants 1, 2, and 3 have 13,000, 12,000, and 5,000 square feet, respectively, of in-process storage space available for a day's production of this product. Each unit of the large, medium, and small sizes produced per day requires 20, 15, and 12 square feet, respectively.**

**Sales forecasts indicate that if available, 900, 1,200, and 750 units of the large, medium, and small sizes, respectively, would be sold per day.**

**At each plant, some employees will need to be laid off unless most of the plant’s excess production capacity can be used to produce the new product. To avoid layoffs if possible, management has decided that the plants should use the same percentage of their excess capacity to produce the new product.**

1. **Formulate a linear programming model for this problem.**

1. **Solve the problem using *lpsolve*, or any other equivalent library in R.**

**Management wishes to know how much of each of the sizes should be produced by each of the plants to maximize profit.**

1. **Define the decision variables**

Decision variables:

X1 = number of small units produced per day Plant 1

X2=number of medium units produced per day Plant 1

X3=number of large units produced per day Plant 1

X4=number of small units produced per day Plant 2

X5=number of medium units produced per day plant 2

X6=number of large units produced per day plant 2

X7= number of small units produced per day plant 3

X8= number of medium units produced per day plant 3

X9= number of large units produced per day plant 3

**Maximize Z :** 420X3 + 360 X2 + 300X1 + 420X6 + 360X5 + 300X4 + 420X9 + 360X8 + 300X7

Constraints:

X1+X2+X3 ≤ 750

X4+X5+X6 ≤ 900

X7+X8+x9 ≤ 450

X3+X6+X9 ≤ 900 (sales forecast of large)

X2+X5+X8 ≤1200 (sales forecast of medium)

X1+X4+X7 ≤ 750 (sales forecast of small)

12X1+15X2+20X3 ≤ 13,000 (storage space in plant 1)

12X4+15X5+20X6 ≤12,000 (storage space in plant 2)

12X7+15X8+20X9 ≤ 5000 (storage space in plant 3)

1. **Formulate a linear programming model for this problem.**

1. **Solve the problem using *lpsolve*, or any other equivalent library in R.**

**Write your equations first and copy them and put them in LP part and call LP part**

**Learning Outcomes**

The assignment will help you with the following course outcomes: 1. To formulate and solve an LP model

Requirements

All assignments are due before the next class.

General Submission Instructions

*All work must be your own. Copying other people’s work or from the Internet is a form of plagiarism and will be prosecuted as such.*

● Upload a pdf file to your git repository. Name your file Username\_#.ext, where Username is your Kent State User ID (the part before @), and # is the Assignment number. In this case, 2.

Provide the link to your git repository in Blackboard Learn for the assignment.