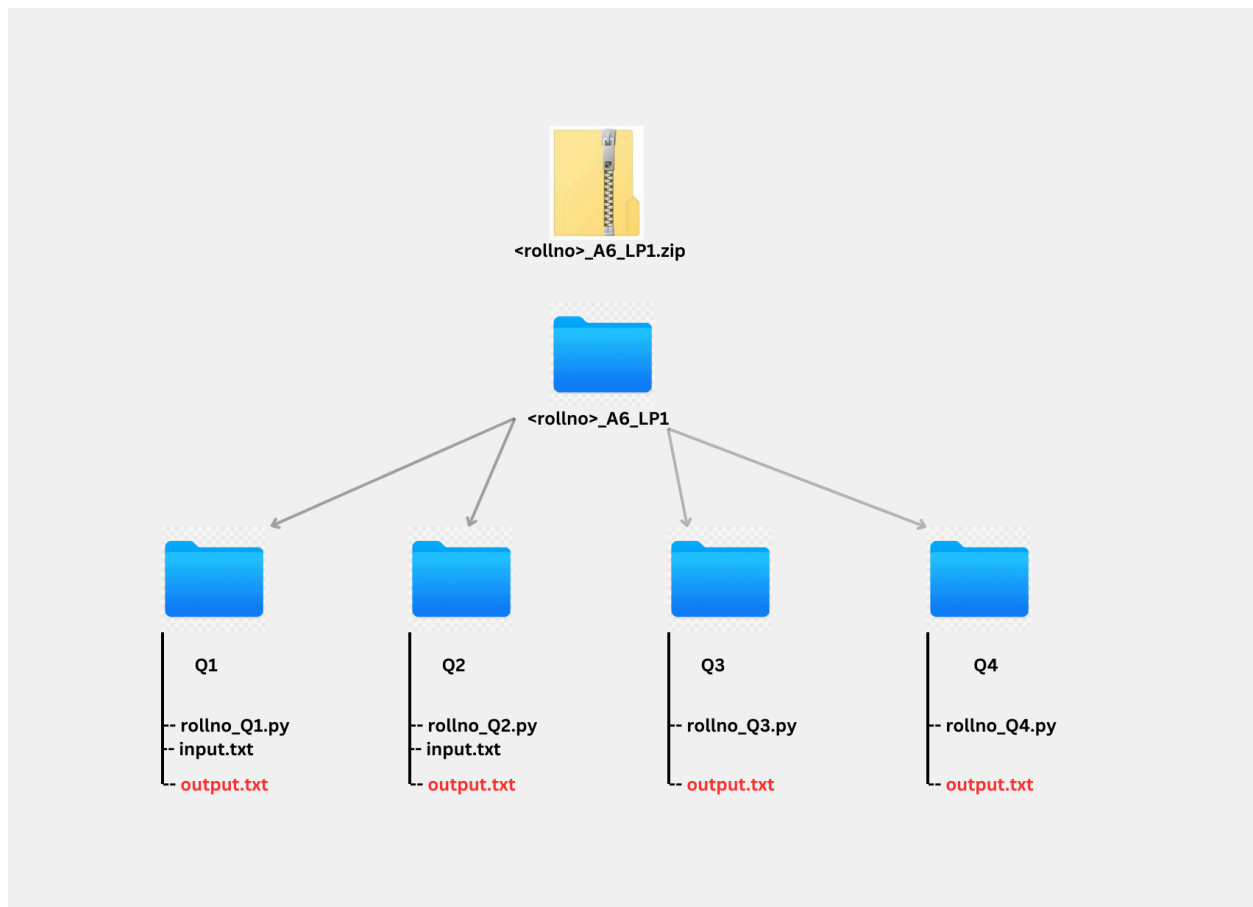


CS69201: Computing Lab-1
Assignment 6 (Part 1) - Linear Programming
August 27, 2024
Time - 120 minutes

===== Instructions =====

1. In the case of user input assume only valid values will be passed as input.
2. You will use Python for this assignment.
3. Regarding Submission: For each question create a separate python file. -> <rollno>_Q1.py, <rollno>_Q2.py ...so on. Create a zip file of all these python files in the name <rollno>_A6_LP1.zip and submit it to Moodle. For example, if your roll number is 24CS60R15, then your file name will be 24CS60R15_Q1.py, 24CS60R15_Q2.py, 24CS60R15_Q3.py, 24CS60R15_Q4.py and your zip file name will be 24CS60R15_A6_LP1.zip.
4. Inputs should be taken from a file (as mentioned in each question) **and outputs should be printed to file named output.txt.**
5. **For each question , boiler plate code is provided , use it accordingly. But you need to strictly follow the output format. Failing, would lead to penalty.**

=====



Question-1

Food items Available

Food Item	Cost (Per unit in \$)	Calories (gm)	Protein (gm)	Carbohydrates (gm)	Fat (gm)
Chicken	5	250	30	0	10
Rice	2	200	5	45	1
Broccoli	1	50	4	10	0.5
Salmon	8	300	25	0	20
Quinoa	4	220	8	39	4

You are a nutritionist tasked with creating a healthy meal plan for a client while minimising costs. You have several food items available, each with a **cost, calorie, protein, carbohydrate, and fat content**. The goal is to determine the optimal quantities of each food item to include in the meal plan to meet the client's nutritional needs while minimising the total cost.

Nutritional Requirements:

- Total Calories: At least A calories
- Total Protein: At least B grams
- Total Carbohydrates: At least 150 grams
- Total Fat: At least 40 grams

[A and B are taken as input from the user. A and B lie between 50 and 5000 (both inclusive)]

How can you determine the optimal quantities of each food item to include in the meal plan to minimise the total cost ? And what are the optimal quantities for each food item to meet the nutritional requirements?

Sample Input (The first line represents the value of A and the second line represents the value of B)

1500

70

Sample output (All values be rounded to 2 decimal places)

Minimum Cost = \$ 23.80

Quantities:

Chicken: 0.11

Rice: 4.80

Broccoli: 0.00

Salmon: 1.70

Quinoa: 0.00

Content of the output.txt [Sequence must be correct]

23.80

0.11

4.80

0.00

1.70

0.00

Question-2

N-Queens problem - Place n number of queens in a nXn chessboard (or grid) such that no two queens attack each other. Display error message if no such configuration is possible.

Sample Input- 4 (Read this from input.txt)

Sample Output- (This is to be written to output.txt)

```
_ Q _ _  
_ _ _ Q  
Q _ _ _  
_ _ Q _
```

Question 3

GlobalTech Manufacturing produces four types of electronic products across three factories. The company aims to maximise its profit by optimizing the production quantities of each product in each factory, subject to various constraints. Use the following data to formulate and solve a linear programming model:

Products: **A (Smartphone), B (Tablet), C (Laptop), D (Smart Watch)**

Factories: **1 (Asia), 2 (Europe), 3 (North America)**

Table 1: Sell Price of products

Product	Sell Prices (\$)
A	100
B	120
C	80
D	150

Table 2: Production costs

product	Factory 1(\$)	Factory 2(\$)	Factory 3(\$)
A	60	65	55
B	70	75	80
C	40	45	50
D	90	100	95

Table 3: Resource requirement per unit

Product	Raw material(units)	Labour (Hours)	CO2 emission(units)
A	2	3	5
B	3	4	7
C	1.5	2	3
D	4	5	8

Table 4: Maximum Market Demands

Product	Max demand (units)
A	1500
B	1200
C	1800
D	1000

Constraints :

- Total Raw Material: 5000 units
- Labour Hours per factory: 800 hours
- Production capacity per factory: 1000 units
- Minimum Production per product: 100 units
- Maximum Storage per product: 2000 units
- Maximum Total CO2 emissions 10000 units
- Maximum production Budget: \$500000

Your task is to:

1. Formulate a linear programming model to maximize GlobalTech's total profit.
 - Define appropriate decision variables.
 - Construct the objective function.
 - Formulate all necessary constraints based on the given data.

2. Solve the model and provide the following outputs:

- The maximum achievable profit.
- The optimal production quantity for each product in each factory.
- Utilization of resources (raw materials, labour, CO2 emissions).
- Whether the production budget constraint is binding.

Sample Input - There is no input for this file. The data is already present in the boilerplate provided.

Sample output:

Optimal solution found

Optimal profit: \$37,500.00

Produce 0 units of product A in factory 1

Produce 0 units of product A in factory 2

Produce 100 units of product A in factory 3

Produce 0 units of product B in factory 1

Produce 100 units of product B in factory 2

Produce 0 units of product B in factory 3

Produce 400 units of product C in factory 1

Produce 200 units of product C in factory 2

Produce 0 units of product C in factory 3

Produce 0 units of product D in factory 1

Produce 0 units of product D in factory 2

Produce 100 units of product D in factory 3

Resource Utilization:

Raw Material: 1,800 / 5,000 units

Labour Hours: 2,400 / 2,400 hours

CO2 Emissions: 3,800 / 10,000 units

Production Cost: \$47,500.00 / \$500,000

Content of the output.txt [Sequence must be correct]

0
0
100
0
100
0
400
200
0
0
0
100
1800 / 5000
2400 / 2400
3800 / 10000
47500 / 500000

Question 4

There are four possible projects, which each run for 3 years and have the following characteristics.

		Capital Requirements for Each Year		
Project	Return	1st year	2nd year	3rd year
1	0.2	0.5	0.3	0.2
2	0.3	1.0	0.8	0.2
3	0.5	1.5	1.5	0.3
4	0.1	0.1	0.4	0.1
Available Capital		3.1	2.5	0.4

We have a decision problem here: Which projects would you choose in order to maximise the total return?

Sample Input - There is no input for this file. The data is already present in the boilerplate provided.

Sample output:

Project chosen - 3,4

Optimal return - 0.6

Content of the output.txt [Sequence must be correct]

0

0

1

1

0.6