CS69011: Computing Lab
Assignment 5: Linear Programming (Part - A)

September 6, 2023

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1. Regarding submission: Create separate Python file(s): **<RollNo>_Q1.py, <RollNo>_Q2.py.**
2. Create a .zip file containing the two Python file(s) with the name: **<RollNo>_A5_Part_A.zip** and submit it to Moodle.
3. The input to the program will be available in a .txt file given as **command line arguments**.
4. The final output for the program needs to be stored in a separate .txt file as 'Summary_Q1.txt' for Q1 and 'Summary_Q2.txt' for Q2.
5. Feel free to modify the problem to suit your needs and implement the linear programming optimization using libraries like `ortools`, `SciPy`, or others that provide LP solvers, **but you need to restrict yourselves to using only LP solvers to solve this problem.**

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Q 1: Basic Production Planning

Consider a manufacturing company that produces a set of products using various resources. You are the production manager and your goal is to optimize the production plan to maximize profit. You are given **N** products $\{p_1, p_2, \ldots, p_N\}$ that add a profit margin of $\{P_1, P_2, \ldots, P_N\}$ respectively to the company. Due to limited funding, you can acquire only **M** resources $\{R_1, R_2, \ldots, R_M\}$. You can manufacture only a u_{ij} number of units for product **i** and resource **j**.

1. **Input Format:**
- The first line contains the number of products, `N`.
- The second line contains the number of resources, `M`.
- The third line contains `N` space-separated numbers denoting the profit per unit for each product.
- The fourth line contains `M` space-separated numbers denoting the availability of each resource.
- Then `N' lines follow.
- Each line has 'M' space-separated numbers denoting the resource usage (consumption) for each product.

2. **Output:**
   - Display the optimal production plan for each product, along with the maximum achievable profit.

3. **Sample Input:**

```
3
2
100 150 200
300 200
2 1
1 2
3 2
```

4. **Sample Output:**

```
Optimal production plan found:
Product 0: Quantity = 0.0
Product 1: Quantity = 0.0
Product 2: Quantity = 100.0
Maximum Profit: 20000.0
```

Q 2: Production Planning with Production Capacity Constraints

Consider a manufacturing company that produces a set of products using various resources. You are the production manager and your goal is to optimize the production plan to maximize profit. You are given **N** products $\{p_1, p_2, \ldots, p_N\}$ that add a profit margin of $\{P_1, P_2, \ldots, P_N\}$ respectively to the company. Due to limited funding, you can acquire only **M** resources $\{R_1, R_2, \ldots, R_M\}$. You can manufacture only a u_{ij} number of units for product **i** and resource **j**. Due limited marketing budget, the company has decided now that it can only sell $\{x_1, x_2, \ldots, x_N\}$ units for the products $\{p_1, p_2, \ldots, p_N\}$ respectively.

1. **Input Format:**
   - The first line contains the number of products, `N`.
   - The second line contains the number of resources, `M`.

- The third line contains `N` space-separated numbers denoting the profit per unit for each product.
- The fourth line contains `M` space-separated numbers denoting the availability of each resource.
- The fifth line contains ‘N’ space-separated numbers denoting the maximum production capacity for each product.
- Then `N’ lines follow.
- Each line has ‘M’ space-separated numbers denoting the resource usage (consumption) for each product.

2. **Output:**
- Display the optimal production plan for each product, considering maximum production capacities, along with the maximum achievable profit.

3. **Sample Input**

```
3
2
100 150 170
300 200
2 1
1 2
3 2
150 100 190
```

4. **Sample output:**

```
Optimal production plan found:
Product 0: Quantity = 132.0
Product 1: Quantity = 33.0
Product 2: Quantity = 1.0
Maximum Profit: 18320.0
```