Tepper 46-888
Optimization for Prescriptive Analytics
Summer 2022 Mini-5
Recitation 1

Problem 1. *Linear Programming*

FreshNutsCo is a company focusing on tasty and healthy trail mixes featuring organic nuts that are sustainably grown and fair-trade. They have decided to design a new trail mix, named Yosemite, composed of five types of nuts: almonds, brazil nuts, cashews, hazelnuts, and pistachios.

FreshNutsCo will package Yosemite trail mix in 1 ounce grab-and-go bags to ensure freshness and ease of use during trekking. Their marketing survey has identified a number of requirements for the nutritional content of the new trail mix. Based on this, each grab-and-go bag must contain:

- at most 200 calories,
- at least 3g protein,
- at most 20g total fat,
- at most 8g carbohydrates,
- at least 1g dietary fiber.

The table below indicates the nutritional content (per ounce) of the nuts, as well as their cost per ounce.

	Cost ($/ounce)	Calories	Protein (g)	Total Fat (g)	Carbohydrates (g)	Dietary Fiber (g)
Almond	8.02	163	6.0	14.0	6.1	3.5
Brazil Nut	7.4	186	4.1	18.8	3.5	2.1
Cashew	8.5	157	5.2	12.4	8.6	0.9
Hazelnut	7.75	178	4.2	17.2	4.7	2.7
Pistachio	7.3	204	2.2	21.5	3.9	2.4

Cost and content composition per ounce of different type of nuts.

You are hired as the chief product manager to use a linear programming model to determine the optimal composition of the grab-and-go bag that satisfies the above requirements, with minimum total cost.

1. Formulate a linear programming model for this problem.

2. Implement your model in Python and solve it to optimality. What is the optimal solution?

3. What are some other constraints that might appear in this type of problem? How can you add these constraints to the model?

    - The amount of Almonds plus the amount of Hazelnuts must be less than 25 percent of the mix.
    - The amount of Cashews must be at least the amount of Pistachios.
    - What other constraints might FreshNutsCo encounter and could you easily add them to your linear programming model?

Problem 2. *Transportation Problem*

Recall the Transportation Problem from the asynchronous material. In that problem there were three customers that can be shipped items from two plants. We will show how this problem can be scaled up to a larger size, and how additional constraints can be added to the model.

4. Recall the linear programming model for this problem.

5. How could you change the model if there was not enough supply to meet demand, but the company still wanted to solve the model as best as possible?

6. What happens if another the company receives an order from one more customer and opens up one more plant? Do you have to change your python code for the model?

7. What additional constraints might the company encounter? For example, consider the variant where total supply is greater than demand. Maybe the optimal solution only uses plant 1, but the company would like to keep plant 2 in business because it is new. Could you add a constraint that plant 2 must output at least 50% of what plant 1 outputs?

8. Suppose the customers were segmented and the company wanted plant 1 and 2 to ship at least 75% of the demand to customers 1 and 2. Could you add this constraint to the model?