Optimizing My Diet With Linear Programming

Methods

For this diet optimization assignment I selected foods that I frequently eat. Most of these items

were recently purchased from Costco. Using the nutritional label I recorded serving size, sodium,

energy, protein, vitamin d, calcium, iron, and potassium. Since I didn't have my receipt I looked

up the price at sameday.costco.com for each item in order to calculate the price per serving.

Documentation

Pictures of the labels and prices can be found in the README.md of this git repo.

Linear Programming Problem

The standard form for this linear programming problem given the data in Appendix A is as

follows:

Minimize $\quad 2.838x_1 + 0.292x_2 + 2.046x_3 + 0.150x_4 + 0.386x_5$

Subject to:

$$225x_1 + 70x_2 + 950x_3 + 40x_4 + 410x_5 \leq 5000$$
$$810x_1 + 70x_2 + 610x_3 + 80x_4 + 195x_5 \geq 2000$$
$$72x_1 + 6x_2 + 17x_3 + x_4 + 4.6x_5 \geq 50$$
$$0.3x_1 + 4x_2 \geq 20$$
$$39x_1 + 30x_2 + 30x_3 + 260x_5 \geq 1300$$
$$1.2x_1 + 0.9x_2 + 4.8x_3 + 3.6x_5 \geq 18$$
$$1335x_1 + 70x_2 + 270x_3 + 50x_5 \geq 4700$$
$$x_1, x_2, x_3, x_4, x_5 \geq 0$$

In other words, given my food options, I want to minimize the daily cost of food while ensuring

that I do not exceed 5000 mg of sodium while consuming at least 2000 calories, 50 g of protein,

20 mcg of vitamin d, 1300 mg of calcium, 18 mg of iron, and 4700 mg of potassium.

Solution

Using this linear programming model I was able to calculate the minimum daily cost of $11.79 using:

> 3.12 meals of chicken and rice
> 4.77 eggs
> 3.98 servings of waffles

Additional Constraints

If I added a constraint where I had to include at least one serving/meal from each of the items the minimum daily cost would raise to $13.39 using:

> 2.92 meals of chicken and rice
> 4.78 eggs
> 3.89 servings of waffles
> 1 chicken pot pie
> 1 snickers

Even with these constraints my diet would lack variety and I would be eating a lot of chicken and rice. In order to increase my variety I could add additional constraints that would limit the amount of each food/serving that I could eat.

LLM

I have access to ChatGPT4 at chat.openai.com from work. I asked ChatGPT4 to find the minimum cost of food given the constraints from the assignment and gave it my markdown table found in Appendix A. The code produced from ChatGPT4 had no issues and was very similar to mine but addressed the case where an optimal solution was not found which I did not implement. Given these results, ChatGPT4 can absolutely complete this assignment. The conversation can be found in chatpgtconvo.txt and the code can be found in gptdiet.py.

Appendix A:Nutrition and Cost Information

Variable	Item	Price	Sodium	Energy	Protein	Vitamin D	Calcium	Iron	Potassium
x1	Chicken + Rice	$2.838	225mg	810cal	72g	0.3mcg	39mg	1.2mg	1335mg
x2	Eggs	$0.292	70mg	70cal	6g	4mcg	30mg	0.9mg	70mg
x3	Chicken Pot Pie	$2.046	950mg	610cal	17g	0mcg	30mg	4.8mg	270mg
x4	Snickers	$0.150	40mg	80cal	1g	0mcg	0mg	0mg	0mg
x5	Waffles	$0.386	410mg	195cal	4.6g	0mcg	260mg	3.6mg	50mg
	Chicken	$0.875	75mg	110cal	24g	0.1mcg	0mg	0.4mg	410mg
	Rice	$0.071	0mg	160cal	0g	0mcg	13mg	0mg	35mg

Chicken + Rice is a meal consisting of 3 servings of chicken and 3 servings of rice. The others are the per serving representation.