Diet Problem Write Up

Grace Fujinaga

Methods

The diet problem is solved here using linear programming. The diet problem is a minimization problem that minimizes cost while meeting nutritional constraints. First, the problem was formulated and set up with decision variables, constraints, and the objective function. Then, python was used to solve the minimization problem. The first solution resulted in very little variety, so a second pass was conducted requiring each food to be purchased at least once throughout the week. Then, chatgpt was used to explore other ways to solve the problem. Each step is discussed in parts throughout this write up.

Part 1

See nutrition_labels.pdf for all nutrition labels and information.

Calculations for cost per serving:
PB Overnight Oats: $1.99 per item, 1 serving per item *$1.99 per serving*
Sweet Chili Mango Salad: $3.99 per item, 3 servings per item *3.99/3 = $1.33 per serving*
Cottage Cheese: $3.99 per item, 8 servings per item *3.99 / 8 = $0.50 per serving*
Tofu: $2.69 per item, 2 servings per item *2.69 / 2 = $1.35 per serving*
Chicken Burrito Bowl: $3.69 per item, 1 serving per item *2.69 per serving*
Salmon Burger: $7.49 per item, 4 servings per item *1.8725 per serving*

Part 2

The problem in English and standard form is below. The python code for this assignment is in the file titled minimization_problem.py and the output of this code is in minimization_problem_output.txt in the repository.

LP in Standard Form:
Decision Variables:
O: quantity of Overnight Oats servings
S: quantity of mango chili salad servings
C: quantity of cottage cheese servings
T: quantity of Tofu servings
CB: quantity of chicken bowl servings
SB: quantity of salmon burger servings

Objective Function:
Minimize profit = 1.99*O + 1.33*S + 0.5*C + 1.35*T + 2.69*CB + 1.8725*SB

Constraints:
210*O + 240*S + 320*C + 15*T + 630*CB + 330*SB <= 35000 [sodium]
270*O + 130*S + 110*C + 130*T + 370*CB + 100*SB >= 14000 [energy]
12*O + 3*S + 12*C + 14*T + 22*CB + 15*SB >= 350 [protein]
0.2*C + 20.9 *SB >= 140 [Vitamin D]

30*O + 50*S + 100*C + 60*T + 130*CB >= 9100 [Calcium]
1.5*O + 1.2*S + 2.7*T + 2.6*CB + 0.3*SB >= 126 [Iron]
290*O + 280*S + 100*C + 110*T + 690*CB + 320*SB >= 32900 [Potassium]

Problem in English:
Each week, adults should eat enough to meet certain nutritional requirements. For daily and weekly requirements for each nutrient see Appendix A. I have 6 foods I will eat this week to meet these requirements. These are overnight oats, mango chili salad, cottage cheese, Tofu, Chicken bowl, and salmon burgers. For nutritional values and cost per serving, see Appendix B. Formulate an LP model that will minimize the weekly cost.

Part 3

The solution to the linear programming problem is in "minimization_problem_output.txt" file, but the essential part of the output to this part is below:

C = 29.294456, CB = 36.761704, O = 0.0, S = 0.0, SB = 6.4182349, T = 23.192215
Objective = 156.86384686025

The minimum cost as listed above is $156.87. In practice, I would probably need to buy whole servings of items, so I would purchase 29 cottage cheese servings, 37 chicken bowl servings, 7 salmon burger servings, and 24 tofu servings.

Part 4

From above, we can see that the solution lacks variety. There are zero servings of overnight oats and mango chili salad. In addition, I only chose 6 foods for this problem. In reality, we (hopefully) eat way more than 6 foods in a week. We would likely result in a solution with little variety due to cost minimization, but it would be interesting to do this problem with even more foods. After adjusting the problem so that we require at least one serving of each food item during the week, the full output is in the minimization_problem_output.txt but the essential output was as follows:

C = 29.614594, CB = 35.885671, O = 1.0, S = 1.0, SB = 6.4151714, T = 23.22339
Objective (Part 4) = 158.0237369365

I would have to spend about 2 dollars more on food each week. To me, that 2 dollars is very worth it for more variety! I would want even more variety. To add more variety, I would probably require the 5 servings of overnight oats per week because that is my favorite breakfast. I would also add more foods. I might also limit the number of chicken bowls to 4 a week and number of salmon burgers to 4 a week as well. With these additional constraints and more food items, I would expect to see more variety.

Part 5

I used ChatGPT, and the whole conversation is in chatgpt_conversation.pdf. The code that it gave is in minimization_problem_chatgpt.py and the output is minimization_problem_chatgpt_output.txt. The LLM did solve the problem using linear programing and also gave code to solve the problem. It resulted in almost exactly the same solution as the code I wrote. The conversation was easy because I used the English prompt I already wrote. I did have to make a few adjustments, but that was because I did not specify that the sodium amount was a maximum and not a minimum.

Appendix A

Nutrient Requirements:

Nutrient	Sodium	Energy	Protein	Vitamin D	Iron	Calcium	Potassium
Daily Amount	5000 mg	2000 cal	50 g	20 mcg	18 mg	1200 mg	9100 mg
Weekly Amount	35000 mg	14000 cal	350 g	140 mcg	126 mg	9100 mg	32900 mg

Appendix B

Food Items and Nutrients:

Item	Sodium (mg)	Energy (cal)	Protein (g)	Vitamin D (mcg)	Iron (mg)	Calcium (mg)	Potassium (mg)	Cost per serving (dollars)
Overnight Oats	210	270	12	0	1.5	30	290	1.99
Mango Chili Salad	240	130	3	0	1.2	50	280	1.33
Cottage Cheese	320	110	12	0.2	0	100	100	0.50
Tofu	15	130	14	0	2.7	60	110	1.35
Chicken Bowl	630	370	22	0	2.6	130	690	2.69
Salmon Burger	330	100	15	20.9	0.3	0	320	1.8725