The Diet Problem

Thomas Young

Methods

I worked on the diet problem using linear programming with the PuLP library in Python. The diet problem is a minimization problem that aims to find the lowest cost of foods while meeting nutritional requirements. The problem was formulated with decision variables for five food items (cheese, salad, chicken, salmon, and oatmeal), constraints based on nutritional requirements, and an objective function that should minimize total cost.

Part 2: Item and Cost Analysis

The goal was to determine the correct number of servings for each food item (cheese, salad, chicken, salmon, and oatmeal) that would minimize the cost while achieving all nutritional constraints. Each nutrient has either a minimum requirement that must be met or a maximum limit that cannot be exceeded viz., sodium.

Cost calculations per serving for each food item:

- Cheese: $0.56 per serving
- Salad: $1.33 per serving
- Chicken: $2.25 per serving
- Salmon: $3.50 per serving
- Oatmeal: $0.20 per serving

Decision Variables:

- CH: quantity of cheese servings
- SA: quantity of salad servings
- CK: quantity of chicken servings
- SL: quantity of salmon servings
- OA: quantity of oatmeal servings

Objective Function:

Minimize cost = 0.56CH + *1.33*SA + 2.25CK + *3.50*SL + 0.20*OA

Constraints:

1. Sodium: 170CH + *70*SA + 196CK + *540*SL + 0*OA ≤ 35000 mg
2. Energy: 100CH + *70*SA + 122CK + *0*SL + 170*OA ≥ 14000 cal
3. Protein: 7000CH + *4000*SA + 23000CK + *12000*SL + 6000*OA ≥ 350000 mg
4. Vitamin D: 0.1CH + *0*SA + 0.1CK + *18.4*SL + 0*OA ≥ 140 mcg
5. Calcium: 200CH + *130*SA + 6CK + *0*SL + 20*OA ≥ 9100 mg
6. Iron: 0.1CH + *0.9*SA + 0.4CK + *0.1*SL + 1.7*OA ≥ 126 mg
7. Potassium: 30CH + *260*SA + 376CK + *190*SL + 170*OA ≥ 32900 mg

Part 3: Solution Analysis

The solution heavily favored oatmeal (180.35 servings), likely due to its low cost ($0.20 per serving) . Cheese (27.47 servings) and salmon (7.46 servings) are included in moderate amounts, which help meet calcium and vitamin D.

Salad and chicken are completely excluded from the solution, suggesting their nutrient contribution to cost ratio is not cost effective. While this solution meets the requirements and my household eats a lot of oatmeal, it lacks variety.

- Cheese: 27.47 servings
- Salad: 0.00 servings
- Chicken: 0.00 servings
- Salmon: 7.46 servings
- Oatmeal: 180.35 servings

Total cost: $77.56.

Part 4: Requiring 1 Serving

Updating the problem to included at least one serving of all five items only increased the total cost by a few dollars. There wasn't much change in the item and serving dispersions. Salad and chicken were each allotted one serving to meet the requirement.

cheese: 27.15 servings

salad: 1.00 servings

chicken: 1.00 servings

salmon: 7.46 servings

oatmeal: 176.66 servings

Total cost: $80.21

Part 5: LLM Testing

I used Google Gemini for this part and got unsuccessful results. Most of the issues seemed related to a scipy syntax error, which Gemini thought was due to an older package version. From there it was downhill. After trying to get it to work through the errors, I shifted it and recommended using PuLP. This could run but got completely different results. This was probably due to my initial prompt being misunderstood.

Could an LLM complete this assignment? Well, I am sure a group of locked up monkeys with a typewriter might eventually write Shakespeare, but who has time to see. With some prompt engineering and more explicit guidance on the problem could probably lead to a good result.

Appendix A: Nutritional Requirements

Daily Requirements:

- Sodium: Max 5000 mg
- Energy: Min 2000 cal
- Protein: Min 50000 mg
- Vitamin D: Min 20 mcg
- Calcium: Min 1300 mg
- Iron: Min 18 mg
- Potassium: Min 4700 mg

Appendix B: Food Items and Nutrients per Serving

Item	Sodium	Energy	Protein	Vit-D	Calcium	Iron	Potassium	Cost
Cheese	170	100	7000	0.1	200	0.1	30	0.56
Salad	70	70	4000	0	130	0.9	260	1.33
Chicken	196	122	23000	0.1	6	0.4	376	2.25
Salmon	540	0	12000	18.4	0	0.1	190	3.5
Oatmeal	0	170	6000	0	20	1.7	170	0.2