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Utilizing Linear Programming to Optimize a Personal Diet

Methods

I used linear programming to construct a personalized diet that satisfies nutritional necessities, while also minimizing cost. By implementing constraints on the nutritional values based on what is recommended by the FDA, I was able to calculate how many servings of each type of food in my diet list I should be consuming each week. Utilizing Python and the programming modeler PuLP, I first defined the five items in my diet list with their corresponding costs per serving and their nutritional values. The nutritional constraints were then added to calculate the diet with the maximum nutritional value and minimum cost. Another constraint was added to calculate the optimal diet while ensuring at least one serving of each type of food in the diet list was included.

Part 1 - Please see pdf file "Food Items Documentation.pdf" in the repository for documentation on the food items selected for this study.

Part 2

In this section, I defined the linear programming model. The number of servings of each food item per week was calculated and served as a decision variable. I then defined the objective function, which calculates the lowest possible cost while satisfying the nutritional constraints.

Part 3

I was able to put the linear programming model to the test. Through the solver, I was able to calculate the optimal diet. The model output the number of servings for each food item as well as the overall cost per week. Rice and granola were both excluded from the diet completely, as the model did not find these necessary to optimize the diet under the current constraints. While the cost was low at $18.45, there was a severe lack in variety within the diet.

Part 4

The same base linear programming model was used, but a new constraint was added. This time, I wanted to minimize costs, while ensuring that the diet still had variety and no food items were left out. The new constraint required the diet to include at least one serving of each type of food per week. While the weekly cost was a bit higher at $18.54, every item in my diet list was included. With the weekly cost only being less than $0.10 more, this new diet seems much more optimal from a real-life perspective. With only five food items, it's obvious why the solver may not favor variety over costs. By incorporating a maximum to the number of servings for each type of food, this further constrains the model to include more of the expensive foods. Another constraint that could be included to improve on variety within the diet could be ensuring that each of the bigger nutritional factors are more balanced, rather than just lying within the current constraints.

Part 5

I utilized Google's LLM, Gemini 2.0, to test if it was capable of helping set up an LP model. The LLM successfully created a model for this problem, with only a bit of explanation from me. By asking the chat bot to create an LP and feeding it the constraint values and the requirements for optimization, it successfully created a baseline LP that was similar to the one I came up with. I even was able to get it to revise the code in order to implement the variety constraint. The LLM was very clear and even tried explaining the process prior to just giving the Python script. Due to this success, I believe that an LLM agent can be utilized for this assignment. However, this assignment was very straightforward and had minimal constraints. For this reason, I believe that the LLM would need more prompting when working with more complicated topics.

Conclusion

This assignment successfully portrays how a linear programming approach can be taken to optimize diets based on nutritional criteria and cost. While the model can be improved to encourage more variety, the basic problem being calculated shows potential for various usage purposes.

Appendix

Table 1: The optimal number of servings for each food item.

Eggs	140 servings
Instant Sundubu kit	57.06 servings
Rice	0 servings
Granola	0 servings
Yogurt	12.79 servings
Total cost per week:	$18.45

Table 2: The optimal number of servings for each food item with at least one serving of each item per week.

Eggs	140 servings
Instant sundubu kit	56.47 servings
Rice	1 serving
Granola	1 serving
Yogurt	12.65 servings
Total cost per week:	$18.54