

The Diet Problem: Homework Assignment #1

Allison Lawler

Dr. Thomas Miller

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Nutrition and fitness are multi-billion-dollar industries in the United States, making it difficult to distinguish what is healthy and what is just savvy advertising. This assignment is an opportunity to use linear programming to research my own personal diet and understand nutrition information and how to optimize nutrition intake and minimize costs. Due to health concerns and food allergies, I do not eat a lot of processed foods and mostly stick to organic foods from local farms or my own garden if possible! For this reason, I provided recipes that I frequently make in the appendix and found similar ones online with nutritional value information. For the cost estimates, I looked up organic products online at Fred Meyer, a pacific northwest grocery store, and provided calculations for single serving sizes.

To set up a standard linear programming problem with the given constraints on nutrition components, the first step is to define decision variables, an objective function, and constraints. The decision variables are pre-determined in the assignment as seven nutritional values including sodium, calories, protein, vitamin D, calcium, iron, and potassium. All decision variables are nonnegative. The objective function is where one would want to either minimize or maximize a certain aspect of the diet. In this example, it is the least cost per serving that satisfies the seven decision variables, so this problem is minimizing. The objective function is as follows with each cost per serving for each variable:

$$\text{lp2} += 3.22 * x1 + 1.02 * x2 + 14.62 * x3 + 5.42 * x4 + 5.40 * x5$$

The constraints are then calculated for each variable and set to meet the nutritional requirements. See python text file for definition of variables, constraints, and further explanation on setting up the linear programming calculation. This allows you to formulate the assigned problem and solve for results.

The results give you solution one, meaning this is the optimal solution to adjust the servings to give you the meet all the nutritional requirements at the lowest cost. The results suggest that you are able to eat 4 servings of egg white bites, 2.3 servings of quinoa salad, and 1.2 servings of salmon to meet requirements. The results also found that it is not necessary to have any lentil soup or lettuce wraps to meet nutritional requirements. That is a shame! The minimum cost solution is represented by OPT at \$33.74. This is how much you would need to spend each day to meet nutritional requirements with these five recipes.

Two more decision variables as well as constraints were added for Vitamin A and Vitamin C. Surprisingly, this did not change the results from the original problem. This could be because considerable amounts of Vitamin C and A are in quinoa salad that would meet requirements, so no need to change the serving sizes. Lastly, I added a decision variable for sugar and added a constraint for less than 50 grams. This also did not change the results as many of these recipes are homemade so no added sugars and the most sugar found in the recipes was 11.8 grams. No food items need to be added to meet the additional constraints.

In summary, I formulated a liner programming problem with seven defined decision variables and constraints to meet nutritional requirements at the lowest cost. I found that out of the five recipes I provided, two are not needed to meet requirements and you would only need to eat egg bites, quinoa salad, and salmon but it will cost you \$33.74 per day. The servings did not change when adding additional constraints. Overall, I have worked on my diet in the past few years and have tried to cut out gluten and added sugars, therefore I am not surprised at the results although I am sure it is more expensive than eating packaged/processed foods. Now, if only I could stick to eating egg bites, quinoa salad, and salmon everyday!

Appendix

1.) Lentil Soup- Serves 6

Ingredients and Cost Per Ingredient:

2 tablespoons olive oil (\$0.47), 1 medium onion (\$0.40), 1 cup carrots (\$0.45),
2 celery ribs (\$1.22), 3 cloves garlic(\$0.22), 1 cup green beans(\$1.50), 1 can
(14oz) diced tomatoes with juices (\$2.00), 1 lb. baby potatoes (\$3.99), 1
1/2 cups dried brown lentils (\$1.34), 1 1/2 teaspoons paprika (\$0.69), 1/2
teaspoon cumin (\$0.40), 1/2 teaspoon curry (\$0.43), 6 cups of vegetable broth
(\$3.29), 2 handfuls of baby spinach or kale (\$1.50), juice of 1 lemon (\$0.79),
1/2 cup parsley(\$0.60)

Total cost per serving: $\$19.29/6 = \3.22

Nutritional Information per serving:

Calories: 269, Sodium 274.7mg, Protein 15g, Vitamin D 0mcg, Calcium 60mg, Iron
4.68mg, Potassium 1269, Vitamin C 23.4mg, Magnesium 62mg, Vitamin A 261mg,
Sugar 6.8g

2.) Breakfast Egg White Bites- Makes 12

Ingredients and Cost Per Ingredient:

2 cups egg whites (\$3.99), 1 cup cottage cheese (\$1.75), 1/2 cup monterey jack
cheese (\$0.63), 1/2 cup feta cheese (\$3.50), 1/2 cup red bell pepper (\$0.75),
1/2 cup spinach (\$0.75), 3 tbsp green onion (\$0.29), 1 tbsp olive oil (\$0.24), 1 tsp hot
sauce (\$0.33)

Total cost per serving: $\$12.23/12 = \1.02

Nutritional Information per serving:

Calories: 85, Sodium 381mg, Protein 9g, Vitamin D 0mcg, Calcium 9mg, Iron 0.2mg,
Potassium 116, Vitamin C 9mg, Magnesium 0mg, Vitamin A 414mcg, Sugar 1g

3.) Blackened Salmon with Asparagus- Serves 1

Ingredients and Cost Per Ingredient:

5 oz Salmon fillet (\$8.75), 8 asparagus spears (\$2.40), 1 egg yolk (\$0.50), 1
tablespoon of olive oil (\$0.24), 2 tablespoons old bay Cajun seasoning (\$1.08), 1
lemon, (\$0.79), 2 tablespoons of butter (\$0.62), 1 tablespoon of cayenne pepper
(\$0.24)

Total cost per serving: \$14.62

Nutritional Information per serving:

Calories: 593, Sodium 506mg, Protein 35g, Vitamin D 16.9mcg, Calcium 59.3mg,
Iron 2.5mg, Potassium 648.6, Vitamin C 5.1mg, Magnesium 53.5mg, Vitamin A
368.1mcg, Sugar 1.5g

4.) Thai Lettuce Wraps- Serves 3

Ingredients and Cost Per Ingredient:

1 can (15 oz) chickpeas (\$1.25), 1/2 cup cooked quinoa (\$2.40), 1/3 cup coconut
sugar (\$0.44), 2 tablespoons peanut butter (\$0.50), 4 tablespoons soy sauce (\$0.47),
1/2 cup finely chopped fresh cilantro (\$0.84), 1/4 cup green onions (\$0.87),
2 teaspoon chili garlic sauce (\$0.29), 1/2 cup roasted salted peanuts (\$0.32), 1/3 cup
natural peanut butter (\$2.67), 3 limes, (\$2.07), 1 head butter or bibb lettuce (\$2.99),
handful of shredded carrots (\$1.15),

Total cost per serving: $\$16.26/3 = \5.42

Nutritional Information per serving:

Calories: 505, Sodium 1225.9mg, Protein 22.8g, Vitamin D 0mcg, Calcium 110mg,
Iron 4.1mg, Potassium 799, Vitamin C 0mg, Magnesium 62mg, Vitamin A 324mcg,
Sugar 11.8g

5.) Southwest Quinoa Salad- Serves 4

Ingredients and Cost Per Ingredient:

1 cup dried quinoa (\$2.40), 1 3/4 cup water, 1 can (15oz) black beans (\$2.19),
1 can (15oz) chickpeas (\$1.25), 2 sweet potatoes (\$2.30) 1 can (15oz) sweet corn
(\$0.99), large handful cherry tomatoes (\$3.00), 1/2 cup diced red onion (\$1.00),
1 small can of diced black olives (\$2.29), 2 limes (\$1.38), 2 tablespoons extra
virgin olive oil (\$0.47), 1 tsp cumin (\$0.80), 1/2 teaspoon chili powder (\$0.30),
1/4 cup cilantro, chopped (\$0.42), avocado (\$2.79)

Total cost per serving: $\$21.58/4 = \5.40

Nutritional Information per serving:

Calories: 829, Sodium 1257.9mg, Protein 28g, Vitamin D 0mcg, Calcium 387mg,
Iron 12mg, Potassium 2345mg, Vitamin C 55mg, Vitamin A 17811mcg, Sugar 11g

Sources

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