

The Diet Problem Revisited

**Sally Lee
Northwestern University
MSDS 460 Decision Analytics
Thomas W. Miller
January 16, 2025**

Part 1: Determining the diet and cost

For my five food items I chose: eggs, granola, yogurt, shrimp, and a frozen vegetable mix. I chose items that I ate the most routinely. Initially I had selected other items, but after finding out some were nutritionally empty at least in terms of the seven nutrients from the assignment e.g rice, I chose to replace them. I purchased all of these items from Costco with the exception of the frozen vegetable mix which I bought from Trader Joe's. Please see the appendix at the end of the paper for images of the nutritional labels of each item.

The method of calculating the price per serving was simply to divide the cost of the food item by the number of servings provided by the item's nutrition label. The price calculations for a serving of each food item is shown below:

- 18 servings of eggs for \$5.49 → 1 egg per serving for \$0.31
- 1 bag of Nutrail Blueberry Cinnamon Nut Granola with 20 servings for \$9.99 → 1 serving for \$0.50
- Greek yogurt with 8 servings per container for \$6.99 → 1 serving for \$0.87
- Frozen shrimp with 7 servings per bag for \$12.99 → 1 serving for \$1.86
- 1 bag of Asian Style Vegetables with Stir Fry Sauce with 4 servings for \$3.99 → 1 serving for \$1.00

Part 2: Setting up the optimization problem

Nutrition	Eggs	Granola	Greek Yogurt	Shrimp	Vegetable Stir Fry Mix	Constraints
Calories	70	160	100	90	120	≥ 14000
Sodium (mg)	70	25	60	310	860	≤ 35000
Protein (g)	6	4	18	22	6	≥ 350
Vitamin D (mcg)	1	0	0	0	0	≥ 140
Calcium (mg)	30	30	190	50	60	≥ 9100
Iron (mg)	0.9	1.1	0	0	1.6	≥ 126
Potassium (mg)	70	150	190	125	220	≥ 32900
Cost per serving (\$)	0.31	0.5	0.87	1.86	1	

The decision variables are each of the food items. We are trying to minimize the cost of our diet while fulfilling the weekly nutritional recommendation. The objective is therefore the sum of each food item multiplied by their single serving cost. Our constraints are the nutritional content of one serving of each food item. There is a constraint equation for each of the seven components of nutrition.

Part 3: Solving the optimization problem

The recommended weekly diet is as follows: 140 eggs, 151.67 servings of granola, no shrimp, no vegetables, and 1.84 servings of yogurt. Following this recommendation, my weekly food cost will be \$120.84.

Part 4: Revising the optimization problem

For the revised diet problem, I decided to implement additional constraints to find a solution that is a little more reasonable. When defining the decision variables, I specified the variables as integers because realistically I am not going to measure out 0.67 servings of granola. I also set the lower bound to 1 to indicate that I need to eat at least one serving of each item per week. I also added an additional constraint where the servings of granola must equal the servings of yogurt because I don't eat either of these without the other. The revised recommended weekly diet is as follows: 140 eggs, 67 servings of granola, 67 servings of yogurt, 1 serving of shrimp, and 1 serving of vegetables. Following this recommendation, the cost of my weekly diet would be \$138.05. Adding additional constraints increased my weekly food cost by \$17.21.

To add further variety I could both add additional variables and components of nutrition. I could add different food items to reflect a more realistic weekly food consumption and nutrition. I would want to take into consideration other nutrients like sugar, fiber, fat, etc. Another adjustment I could make is to reduce the calorie minimum because I don't eat 2000 calories a day routinely. Another way to add variety would be to add an upper limit to some food items. For example, I doubt I am able to consume 140 eggs in a week so I could limit how much is recommended a week.

Part 5: Solving the optimization problem with AI


I used ChatGPT to try and solve the diet problem. The conversation can be found [here](https://chatgpt.com/share/6789379d-46a4-8005-b010-172238ecc4f4) (https://chatgpt.com/share/6789379d-46a4-8005-b010-172238ecc4f4). My conversation with ChatGPT was to the point. I began by letting ChatGPT know I wanted to minimize cost for a linear programming problem and that I would list the details of the problem before asking it to solve. I then listed the items I used, their nutritional content, cost, and the weekly recommended values of each nutrition. ChatGPT was able to solve the problem that matched the solution I had found in part 3 using PuLP and Python. Since it only provided me with the output, I built upon the conversation by asking ChatGPT to write Python code using PuLP to solve this problem. The resulting code was very similar to the code I had written to obtain my solution. ChatGPT was successful in solving the problem and could definitely be used as a tool to complete this assignment.

Appendix:

SAFE HANDLING INSTRUCTIONS: To prevent illness from bacteria, keep eggs refrigerated, cook eggs until yolks are firm, and cook foods containing eggs thoroughly.

Nutrition Facts		Amount/serving	% Daily Value*	Amount/serving	% Daily Value*
18 servings per container		Total Fat 5g	6%	Sodium 70mg	3%
Serving size 1 egg (50g)		Saturated Fat 1.5g	8%	Total Carbohydrate 0g	0%
Calories per serving 70		Trans Fat 0g		Dietary Fiber 0g	0%
		Polyunsaturated Fat 1g		Total Sugars 0g	
		Monounsaturated Fat 2g		Incl. 0g Added Sugars	0%
		Cholesterol 185mg	63%	Protein 6g	12%
<small>Vitamin D 1mcg 6% • Calcium 50mg 2% • Iron 0.5mg 4% • Potassium 70mg 6% Vitamin A 0mcg 0% • Vitamin E 0.5mg 4% • Riboflavin 0.2mg 15% • Niacin 1.4mg 6% Vitamin B5 0.1mg 6% • Folate 25mcg DFE 6% • Vitamin B12 0.5mcg 20% Biotin 11mcg 25% • Pantothenic Acid 0.6mg 15% • Phosphorus 100mg 8% Iodine 20mcg 20% • Zinc 0.7mg 6% • Selenium 15mcg 25% • Choline 150mg 25%</small>					
<small>*The % Daily Value tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.</small>					

LARGE EGG

 Produced in Compliance with United Egg Producers' Animal Husbandry Guidelines www.usesertified.com

Nutrition Facts for Large Eggs

Nutrition Facts

20 servings per container

Serving size 1/3 cup (30g)

Amount per serving

Calories **160**

	% Daily Value*
Total Fat 15g	
Saturated Fat 5g	19%
Trans Fat 0g	25%
Cholesterol 5mg	2%
Sodium 25mg	1%
Total Carbohydrate 9g	3%
Dietary Fiber 3g	11%
Total Sugars 2g	
Includes 0g Added Sugars	0%
Sugar Alcohol 4g	
Protein 4g	
Vitamin D 0mcg	0%
Calcium 30mg	2%
Iron 1.1mg	6%
Potassium 150mg	4%

*The % Daily Value tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

Nutrition Facts for Nutrail Blueberry Cinnamon Nut Granola

Nutrition Facts	
8 servings per container	
Serving size	2/3 cup (170g)
Amount per serving	
Calories	100
% Daily Value*	
Total Fat 0g	0%
Saturated Fat 0g	0%
Trans Fat 0g	
Cholesterol 10mg	3%
Sodium 60mg	3%
Total Carbohydrate 7g	3%
Dietary Fiber 0g	0%
Total Sugars 3g	
Includes 0g Added Sugars	0%
Protein 18g	36%
Vit. D 0mcg 0% • Calcium 190mg 15%	
Iron 0mg 0% • Potas. 190mg 4%	
*The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.	

Nutrition Facts for Greek Yogurt

Nutrition Facts

About 7 servings per container
Serving size about 7 shrimp (4 oz/112g)

Amount per serving

Calories

90

% Daily Value*

Total Fat 0.5g **1%**

Saturated Fat 0g **0%**

Trans Fat 0g

Cholesterol 175mg **58%**

Sodium 310mg **13%**

Total Carbohydrate 0g **0%**

Dietary Fiber 0g **0%**

Total Sugars 0g

Includes 0g Added Sugars **0%**

Protein 22g

Vitamin D 0mcg **0%**

Calcium 60mg **6%**

Iron 0mg **0%**

Potassium 125mg **4%**

*The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

INGREDIENTS: Shrimp
CONTAINS: Shrimp

Distributed by: Costco Wholesale
P.O. Box 34535, Seattle, WA 98134
1-800-774-2678 • www.costco.com

FARM-RAISED

TO PROPERLY THAW
Drain and use in your favorite recipe.

DO NOT FORCE THAW

KEEP FROZEN

DO NOT REFREEZE

KIRKLAND
Signature

If you're not completely satisfied,
Signature products, your money is guaranteed.

Nutrition Facts for Frozen Jumbo Shrimp

Nutrition Facts	
4 servings per container	
Serving size 4 oz (112g/ 1/4 package)†	
Amount per serving	
Calories	60
% Daily Value*	
Total Fat 0g	0%
Saturated Fat 0g	0%
Trans Fat 0g	
Cholesterol 0mg	0%
Sodium 430mg	19%
Total Carbohydrate 7g	3%
Dietary Fiber 2g	7%
Total Sugars 7g	
Includes 5g Added Sugars	10%
Protein 3g	
Vitamin D 0mcg	0%
Calcium 30mg	2%
Iron 0.8mg	4%
Potassium 110mg	2%
†Per serving sauce contributes 30 calories, 410mg sodium, 7g total carbohydrate, 5g total sugars, 5g added sugars, 1.2mg iron, 30mg potassium.	
*The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.	

Nutrition Facts for Asian Style Vegetables with Stir Fry Sauce