Assignment 1

The Diet Problem: A Linear Programming Approach

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10/01/2023

1 Documentation of Food Items

For the assignment, five packaged food items were selected: Whole Grain Bread, Banana, Yogurt, Nuts, and Salmon. The Nutrition Facts labels were photographed and analyzed to extract nutritional values per serving size. The cost per serving was calculated based on the retail prices of these items, normalized to the serving sizes provided on the labels.

1.1 Cost Per Serving:

- Whole_Grain_Bread: $0.25
- Banana: $0.15
- Yogurt: $0.50
- Nuts: $0.55
- Salmon: $1.30

1.2 Labels:

Nutrition Facts

7 servings per container

Serving size **2 oz (49g)**

Amount Per Serving

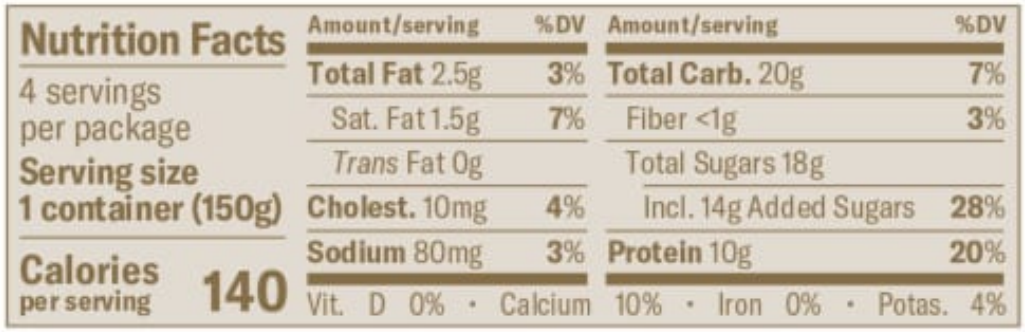
Calories **140**

	% Daily Value*
Total Fat 4.5g	**6%**
Saturated Fat 0g	**0%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 260mg	**11%**
Total Carbohydrate 24g	**9%**
Dietary Fiber 1g	**4%**
Total Sugars 3g	
Includes 3g Added Sugars	**6%**
Protein 4g	**8%**
Vitamin D 0mcg	0%
Calcium 52mg	4%
Iron 0mg	0%
Potassium 0mg	0%

*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.

Figure 1: Whole_Grain_Bread

Figure 2: Banana



Nutrition Facts

4 servings per package

Serving size
1 container (150g)

Calories per serving **140**

Amount/serving	%DV	Amount/serving	%DV
Total Fat 2.5g	3%	**Total Carb.** 20g	7%
Sat. Fat 1.5g	7%	Fiber <1g	3%
Trans Fat 0g		Total Sugars 18g	
Cholest. 10mg	4%	Incl. 14g Added Sugars	28%
Sodium 80mg	3%	**Protein** 10g	20%

Vit. D 0% · Calcium 10% · Iron 0% · Potas. 4%

Figure 3: Yogurt

Nutrition Facts

8 servings per container

Serving size 1 package/ 1.25oz (35g)

Amount per serving

Calories 170

	% Daily Value*
Total Fat 11g	**14%**
Saturated Fat 3g	**15%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 75mg	**3%**
Total Carbohydrate 17g	**6%**
Dietary Fiber 2g	**7%**
Total Sugars 13g	
Includes 6g Added Sugars	**12%**
Protein 5g	

Vit. D 0mcg 0% • Calcium 30mg 2%

Iron 0.9mg 6% • Potas. 190mg 4%

Vit. E 2.3mg 15%

*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.

Figure 4: Nuts

Nutrition Facts

2 servings per container

Serving Size	**Fillets (225 g)**
Amount per serving	
Calories	**510**
	% Daily Value *
Total Fat 33g	**43%**
Saturated Fat 7g	**35%**
Trans Fat 0g	
Cholesterol 110mg	**36%**
Sodium 710mg	**31%**
Total Carbohydrate 10g	**4%**
Dietary Fiber 0g	**0%**
Total Sugars 9g	
Includes 9g Added Sugars	**17%**
Protein 41g	**82%**
Vitamin D 22mcg	109%
Calcium 20mg	0%
Iron 0.91mg	5%
Potassium 800mg	16%

*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.

Figure 5: Salmon

2 Linear Programming Problem Specification

The diet problem was specified in standard linear programming form:

- Decision Variables: The quantity of each food item to consume.
- Objective Function: Minimize the total cost of the diet.
- Constraints: Nutritional requirements set by the FDA.

3 Implementation Using Python PuLP

The problem was implemented using the Python PuLP library. It was solved using the CBC MILP Solver, and the results were output to a text file.

4 Solution Description

The optimal solution determined the following daily intake:

- Whole Grain Bread: 0 servings
- Banana: 0 servings
- Yogurt: 5.457 servings
- Nuts: 19.081 servings
- Salmon: 0.909 servings
- The new total daily cost of the optimal diet with additional constraints is: $14.40

5 Part 5:Expanded Nutritional Constraints

I will add in the constraints of vitamin E (it was already in my dataset) and zinc which I was able to find on google in these amounts converted for serving size:

- Whole Grain Bread: 3.5
- Banana: 0.31
- Yogurt: 0.9
- Nuts: 2
- Salmon: 0.31

The addition of Vitamin E and Zinc constraints to the linear programming model represents a more comprehensive approach to meeting dietary recommendations. The revised constraints are based on the FDA's nutritional guidelines, which recommend a minimum intake of 15 milligrams of Vitamin E and 11 milligrams of Zinc for adults.

Upon incorporating these additional nutritional constraints, the optimal diet plan remained unchanged in the variety and amount of each item. This means that the added constraints were already met in the prior solution. The updated optimal diet is unchanged at:

- Whole Grain Bread: 0 servings
- Banana: 0 servings
- Yogurt: 5.457 servings
- Nuts: 19.081 servings
- Salmon: 0.909 servings

- The new total daily cost of the optimal diet with additional constraints is: $14.40