

## Option 2. Diet Planning Problem

In the small town of Starlight, which was once vibrant but has since struggled economically, the closure of a local factory left many families without stable incomes. This hit the town's children the hardest, as many began to suffer from poor nutrition, affecting their health and school performance.

Seeing the problem, Sally Harper, the local school principal, along with a group of teachers, started the "Feeding Hope" project. Their mission was simple: to make sure every child received nutritious meals, no matter their family's financial situation. Despite limited resources and a tight budget, they knew nutrition was key to helping the children succeed.

Principal Harper, who had an economics background, decided to use a linear programming model to optimize the school's meal plan. The goal was to provide the necessary nutrients at the lowest possible cost while keeping meals varied and within budget.

The project quickly gained local support, with farmers and former factory workers contributing produce and volunteering time. However, challenges like seasonal food availability and a tight budget remained. With the help of a local university, Principal Harper developed an efficient model that considered all variables—food availability, nutrient needs, budget, and even children's preferences—calling it the "Starlight Meal Optimizer."

The plan was ambitious, but it had the potential to make a real impact. As the first week of the new meal plan began, the results were clear. Children who had been tired and unfocused became more energetic and attentive. Parents, many of whom had felt hopeless, were relieved to know their kids were getting proper nutrition. The project became a symbol of what a united community could achieve with determination and creativity. The Starlight Project now stands as proof of the power of teamwork and the importance of ensuring every child, no matter their circumstances, has access to healthy meals. As the town continues to recover, the "Feeding Hope" initiative remains central to Starlight's journey toward a better future. It was also a major success story of "Analytics for Good," and the town plans to identify other opportunities for applying optimization modeling for improving community outcomes.

Principal Harper has hired you as a consultant to independently come up with your own solution to this problem, which she will check against hers. Your goal is to design a weekly meal plan that provides the necessary nutrients for children living in poverty, at the lowest possible cost. The nutritionists involved in the project also recommend that to ensure a balanced diet, no single food item should make up more than 30% of the total calories or protein intake.

Table 3 provides children's target daily ranges for various nutrients.

### Daily Nutritional Requirements:

Nutrient	Min	Max
Calories (kcal)	1800	2400
Fat (g)	60	95
Sodium (mg)	1200	2200
Carbs (g)	240	400
Fiber (g)	30	35
Protein (g)	40	55
Vitamin A (IU)	2000	6000
Vitamin C (mg)	45	1200
Calcium (mg)	1300	3000
Iron (mg)	8	40

**Table 3:** Nutritional Requirements. “Min” and “Max” denote the minimum and maximum recommended daily intake for a particular nutrient.

Table 4 provides a snapshot of the table of foods, their nutritional values, and their cost/serving provided in “food\_data.xlsx”

### Available Food Items and Their Nutritional Content:

Food	Serving	Calories (kcal)	Fat (g)	...	Iron (mg)	Cost (\$/serving)
Broccoli	10 Oz Pkg	73.8	0.8	...	2.3	0.16
Carrots, Raw	1/2 Cup Shredded	23.7	0.1	...	0.3	0.07
Corn	1/2 Cup	72.2	0.6	...	0.3	0.18
Lettuce, Iceberg, Raw	1 Leaf	2.6	0	...	0.1	0.02
...	...	...	...	...	...	...

**Table 4:** Nutritional content and cost of some common foods. “Serving” refers to the quantity of one portion of each food item (e.g., one serving of broccoli is equivalent to a 10 oz package of broccoli). The complete version is stored in the excel file.

- Formulate (algebraically) an optimization problem to make a daily diet plan for each child, with the goal of minimizing the total cost of the food while satisfying the general nutritional requirements and additional considerations stated above.
- Solve your formulation from part a) using Python/Gurobi to come up with a recommendation for the daily meal plan. Indicate the daily cost and the amount of each ingredient.
- Discuss whether you think the recommendation from part b) sounds reasonable for a single day of food intake for a child. If not, suggest some changes you would make to the model to make the recommendation for the day more realistic. Implement your change and discuss the new solution.

- d. Whereas part c) asked you to consider whether the meal plan for the one day is sensible or not and how you might get to a reasonable plan for even one day. However, Principal Harper also knows that kids don't like to eat the same exact thing every day, so for part d) she asks you to come up with a reasonable dietary plan for each day of an entire week. Present a 7-day dietary plan, and indicate any model changes that went into constructing each day's plan.