Diet Optimization with Linear Programming

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Introduction

Diet optimization has become an increasingly relevant topic as technology and awareness converge to shape healthier and more sustainable lifestyles. In this project, we focused on designing a recommender system that suggests a diverse weekly meal plan, that either maximizes protein intake or minimizes the environmental impact (considering the CO_2 emissions and water usage for each dish), always meeting minimum nutritional requirements. Our model was formulated as a multi-objective optimization problem to meet multiple user profiles and preferences.

The popularity of diet applications has surged in recent years, as individuals increasingly turn to technology for personalized food tracking, weight management, and health improvement. This trend is particularly significant in Canada, where the economic burden of diet-related illnesses amounts to $26 billion annually. Furthermore, the global food system (mainly production and transportation) is a major contributor to greenhouse gas emissions, accounting for up to 37% of CO_2 emissions. These challenges are compounded by the rapid growth of the personalized nutrition industry, with venture capital investments in 2023 reaching $3.5 billion in AI-driven meal planning, dietary coaching, and nutrition tracking technologies.

Our interest in applying optimization techniques to diet planning was driven by the intersection of these challenges and opportunities (improve nutrition and minimize environmental impact). Our model incorporated diverse parameters, including nutritional content, cost, and environmental impact metrics such as CO_2 footprint and water usage. Implementing multi-objective optimization allowed us to balance these factors and offer customized recommendations considering different user goals and constraints. By prioritizing meal planning, our solution not only supports individual health goals but also promotes healthier and environmentally friendly eating habits by encouraging the preparation of nutritious meals at home.

This project not only highlights the potential of data-driven approaches to improve health outcomes but also contributes to the broader discourse on sustainable living. By integrating health and environmental objectives, this project attempts to use optimization to solve a real-world challenge.

Problem Description and Formulation

Every day, millions of meals are prepared globally, whether in households or restaurants. Food is a fundamental part of daily life, yet determining the most suitable diet can be challenging, as dietary needs vary widely depending on an individual's health, goals, and circumstances. For example, some individuals may focus on muscle gain as part of an active lifestyle, while others aim to lose weight. Regardless of these goals, it is crucial to ensure that the food consumed meets the body's minimum nutritional requirements to maintain long-term health.

While many people have a general understanding of dietary requirements, real-world factors often complicate decision-making. A primary consideration is cost, which frequently dictates access to specific foods. Families may base their meal plans on financial constraints rather than nutritional value. However, higher costs do not always equate to higher nutritional value, and it can be difficult to discern which options provide the best balance of affordability and health. In addition to cost, individual characteristics play a significant role in meal planning. Nutritional requirements vary based on factors such as age, weight, and activity level.

Another growing consideration is the environmental impact of food choices. Consumers are increasingly aware that producing food—whether vegetables, grains, or meat—requires significant resources, including water, and contributes to greenhouse gas emissions. For example, beef production generates approximately 27 kg of CO_2 and consumes 15,000 liters of water per kilogram, whereas poultry production has a considerably smaller footprint of 6.9 kg of CO_2 and 4,300 liters of water per kilogram. These disparities drive many individuals to choose meals with lower CO_2 and water footprints, incorporating sustainability into their dietary decisions.

The central challenge in meal planning lies in a multitude of factors influencing the optimal dietary plan for everyone. These factors include, but are not limited to, nutritional needs, budget constraints, environmental impact, and personal preferences. This complexity calls for solutions that balance these competing priorities.

This project proposes a simplified model to assist individuals in designing an optimal meal plan that aligns with their budget, dietary preferences, and physical (fitness) goals. Preferences, in this context, may emphasize either minimizing environmental impacts—such as CO_2 emissions and water usage—or maximizing specific nutritional values, such as protein intake. While individual preferences are inherently diverse, the tools and methodologies introduced here can be expanded to accommodate a broader range of considerations, offering a scalable approach to personalized meal planning.

The model's recommendation will vary according to the inputs from the users, which will be explained in the following sections. Also, in table 1 and table 2, there is a more detailed description about the indices and variables used in the model.

Sets

$$I\text{: } Set\ of\ Dishes$$

$$J\text{: } Set\ of\ meals\ (breakfast,\ lunch,\ dinner)$$

$$K\text{: } Set\ of\ days\ of\ the\ week$$

Decision Variables

Decision Variables	
x_{ijk}	Quantity of portions of 100gr from dish i for meal j and in day k
y_{ijk}	Auxiliary binary variable to determinate if dish i for meal j and in day k will be used

Objective Functions

Minimize the environmental impact or maximize the protein value of the meal plan; this choice will be decided by the user. Depending on the priority, the optimization will vary solving first the top priority and then, the second priority. For the footprint, the model has a score of sustainability that combines the CO_2 emissions and water usage, both with the same weight. However, these metrics have been standardized before, using the method of Min-Max scale, to avoid problems of scale. In the case of Protein Maximization, the model is multiplied by -1 to convert it into a minimization problem. The objective is to minimize the total environmental impact or maximize the protein value of the meal plan for a week (see Table 2 in Appendix for information about the model's parameters).

$$Sustainability\ Score_i = 0.5\ \times CO2_i +\ 0.5\ \times H2O_i$$

$$Min \sum_{i=1}^{502} \sum_{j=1}^{3} \sum_{k=1}^{7} X_{ijk} \times Sustainability\ Score_i$$

$$Min \sum_{i=1}^{502} \sum_{j=1}^{3} \sum_{k=1}^{7} - X_{ijk} \times\ P_i$$

Constraints

1. The model has to ensure to select only one dish per meal. If y=1 then X can take a value above 0; but if y=0 then X is zero, therefore only one dish will be possible per meal. M=1000 helps ensure this.

$$X_{ijk} \leq M \times y_{ijk} \quad \forall \text{ i} \in \text{I} \,;\, \forall\, j \;\in\; J \,;\, \forall\, k \in K$$

$$\sum_{i=1}^{512} y_{ijk} = 1 \quad \forall\, j \;\in\; J \,;\, \forall\, k \;\in\; K$$

2. For each day, the meal plan should provide 3 dishes.

$$y_{ijk} \leq X_{ijk} \quad \forall\, i \;\in\; I \,;\, \forall\, j \;\in\; J \;;\, \forall\, k \;\in\; K$$

3. All dishes must be different for the weekly mean plan, to avoid repeating dishes.

$$\sum_{j=1}^{3}\sum_{k=1}^{7} y_{ijk} \leq 1 \quad \forall\, i \;\in\; I$$

4. Selected dishes should belong to their meal category (breakfast, lunch, dinner). This is because some dishes are only available at breakfast, while others are only for lunch and dinner.

$$X_{ijk} \;\leq\; M \cdot B_i \quad \forall\, i \;\in\; I;\; j \;= 1;\; \forall\, k \;\in\; K$$

$$X_{ijk} \leq M \cdot (1 - B_i) \quad \forall\, i \;\in\; I;\;\; j \;=\; \{2{,}3\};\; \forall\, k \;\in\; K$$

5. Vegetarians should receive suggestions of only vegetarian dishes in their meal plan.

$$\text{if vegetarian option is selected: } X_{ijk} \leq M \times V_i \quad \forall\, i \in I;\ \forall\, j \in J;\ \forall\, k \in K$$

6. The maximum number of portions (100gr) in each meal will depend on two choices:

- **Vegetarian preference:** vegetarian plans require more portions to fulfill minimum protein requirements.
- **Fitness Goal:** a person who wants to lose weight should restrict more the number of portions than someone who wants to gain muscle.

$$\sum_{i=1}^{512} X_{ijk} \leq \max \text{Portions}_{\text{i}} \quad \forall\, j \in J;\ \forall\, k \in K$$

$$\text{if vegetarian option and muscle gain is selected: max\_portions}_1 = 4$$

$$\text{if vegetarian option and weight loss is selected: max\_portions}_2 = 3$$

$$\text{if only weight loss is selected: max\_portions}_3 = 2$$

$$\text{if only muscle gain is selected: max\_portions}_4 = 3$$

7. Minimum (Maximum) daily requirements (suggestion): The project will only consider two important factors (protein and sugar, but the same logic can expand to other micronutrients and micronutrients). These thresholds have been chosen according to the user's goal (weight loss or muscle gain). Also, the thresholds depend on the user’s weight, for the case of the protein requirement, and on the user’s sex, for the case of the sugar suggestion.

$$\text{min\_protein}_1 = 1 \times \text{weight\_kg} \quad \text{if the target is weight loss}$$

$$\text{min\_protein}_2 = 1.7 \times \text{weight\_kg} \quad \text{if the target is muscle gain}$$

$$\sum_{j=1}^{3}\sum_{i=1}^{502} X_{ijk} \times P_i \geq \text{minProtein} \quad \forall\, k \in K$$

max_sugar = 25, if sex = women; else, max_sugar= 36

$$\sum_{j=1}^{3}\sum_{i=1}^{502} X_{ijk} \times S_i \leq \text{max\_}sugar \quad \forall\, k \in K$$

8. Budget constraint: The user will provide its budget to ensure that the cost of the meal plan is below or equal to its budget

$$\sum_{i=1}^{502}\sum_{j=1}^{3}\sum_{k=1}^{7} X_{ijk} \times C_i \leq Budget$$

Numerical Implementation and Results

Description of the dataset

We utilized a dataset of dishes, including their category names, and detailed nutritional values such as proteins, sugar, fiber, and more. To enhance the dataset, we added columns that specify whether a dish is vegetarian and whether it is suitable for breakfast, lunch, or dinner, based on its category and keywords in its description.

For cost analysis, we included the prices of all dishes in CAD, based on average costs in Montreal as of 2024. We reviewed the cost ratios across different categories to ensure consistency and made necessary adjustments.

To incorporate environmental impact, we estimated the CO2 footprint and water usage for each dish based on its ingredients. We validated these estimates by comparing the average CO2 emissions and water usage across different categories to ensure the data aligns with logical benchmarks. This provided a reliable and well-rounded dataset for analysis.

Interpretation of the results

Our solution offers a customized plan for different profiles based on their unique inputs. In this section, we examine how variations in individual factors influence the outcomes for each profile, along with the budget range within the feasible region. The key metrics assessed include:

1. **Total Cost (CAD):** A key financial consideration for the plan.
2. **Total Protein Intake (grams):** One of the objective functions (for nutritional adequacy)
3. **Environmental Impact:** The analysis considers both:
    a. **Total CO2 Emissions (grams):** Reflecting the plan's carbon footprint.
    b. **Total Water Usage (liters):** Indicating the water consumption required.

Profile 1:

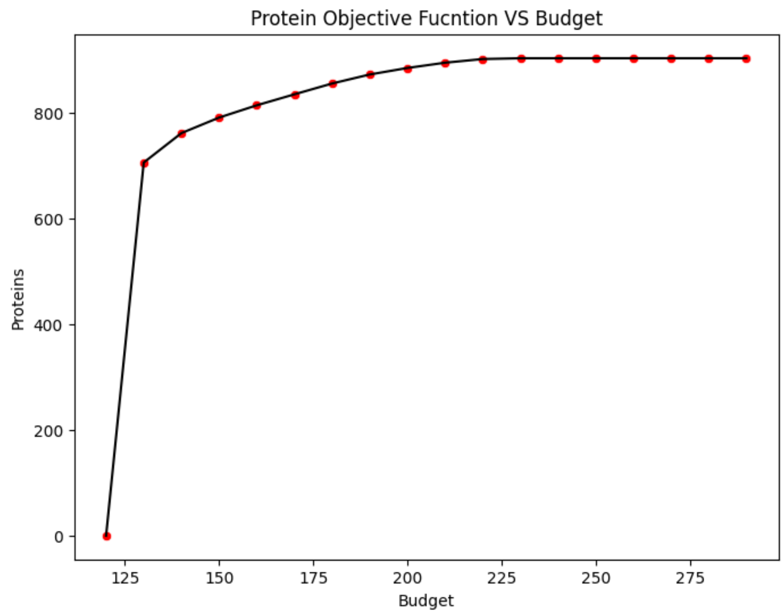
- **A man who wants to lose weight, not vegetarian, weight: 100 Kg**
- **Priority: Maximize proteins intake**
- **Budget: 200 CAD**

The plan designed for this profile includes a variety of dishes featuring eggs and different types of meat to ensure maximum protein intake (Appendix, Table 3). The average portion size is 200g, which is the maximum allowed for a non-vegetarian aiming to lose weight.

Metric	Value
Total Cost for the Week	$199.82
Total CO2 Emissions	57,356.24g
Total Water Usage	33,844.71l
Total Protein Intake for the Week	885.91g

Below, you can observe how protein intake changes with different budget levels. The budget increases by 10 CAD in each iteration. A budget of 120 CAD is infeasible (zero protein intake), while a budget of 130 CAD is the minimum required to prepare a weekly meal plan for this person, meeting the minimum requirements.

As seen in the graph, around 220 CAD, the line becomes flat (diminishing returns), indicating that further increases in the budget no longer result in a higher protein intake. In other words, the model becomes insensitive to the budget beyond this point. Here we are not seeing a fully linear relationship and the shadow price is not consistent in the range. This happens because the optimization shifts focus to balance other objectives (e.g., minimizing environmental impact).



Profile 1: Man, Not Vgetarian, 100 kg, Objective: Weight loss, Priority: Max. Protein

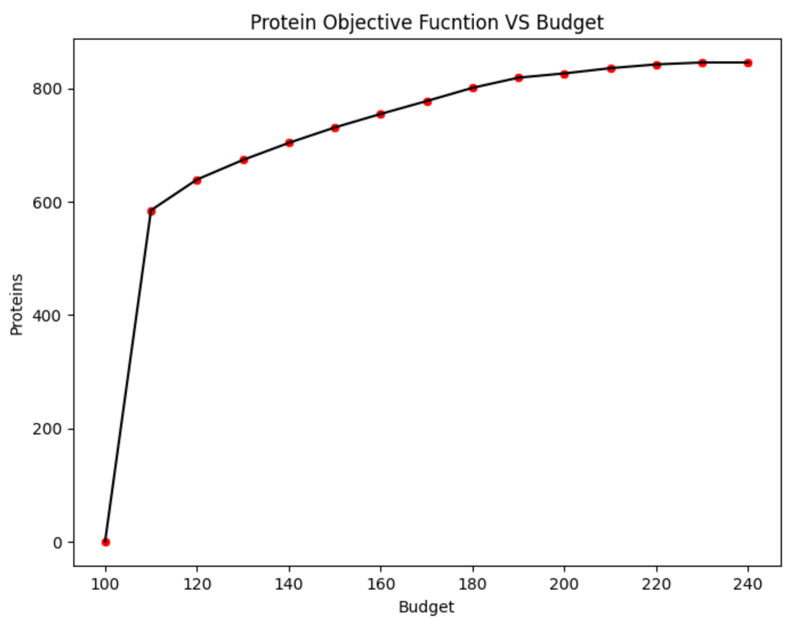
Profile 2: 1st scenario

- **A man who wants to lose weight, Vegetarian, Weight: 80 Kg**
- **Priority: Maximize proteins**
- **Budget: 200 CAD**

Metric	Value
Total Cost for the Week	\$196.68
Total CO2 Emissions	41,383.85g
Total Water Usage	26,860.95l
Total Protein Intake for the Week	826.25g

Here we are preparing a weekly plan of all vegetarian dishes with protein-rich ingredients like egg, cheese, meat substitute products, soybean (Appendix Table 4). The person will consume 296g on average per meal.

In this scenario, if the individual reduces his weekly budget to 100 CAD, the solution becomes infeasible. The minimum budget required to create a weekly meal plan focused on weight loss and maximizing protein intake is 110 CAD. At 230 CAD, the model becomes insensitive to further budget increases, as additional funds no longer lead to a significant increase in protein intake or changes in the weekly plan.



Profile 2-1: Man, Vgetarian, 80 kg, Objective: Weight loss, Priority: Max. Protein

Profile 2: 2nd scenario

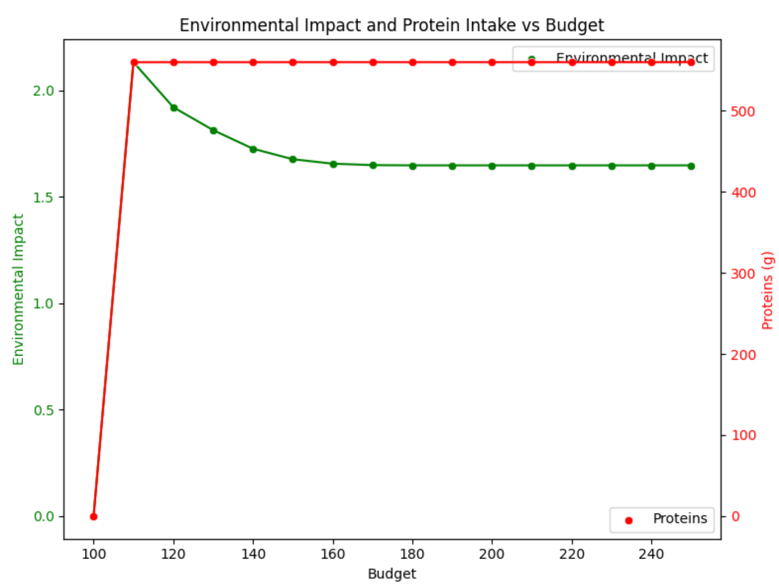
- **A man who wants to lose weight, Vegetarian, Weight: 80 Kg**
- **Priority: Sustainability**
- **Budget: 200 CAD**

Metric	Value
Total Cost for the Week	$173.40
Total CO2 Emissions	21,972.05g
Total Water Usage	13,809.28l
Total Protein Intake for the Week	560.10g

The person needs to eat 238g per meal. More green foods, such as salads, were introduced in the weekly meal plan (see Appendix Table 5).

Since we are minimizing environmental impact, the reason for not achieving very low values in the results is the constraint on minimum nutritional requirements. Specifically, the minimum protein intake serves as the binding constraint, as the individual must consume at least 80g of protein daily (In this scenario minimum protein daily (in grams) is equal to their weight).

The minimum acceptable budget for this scenario is 100 CAD. Increasing the budget up to 160 CAD reduces the environmental impact while ensuring the protein intake meets the minimum required level, as mandated by the model's constraints.



Profile 2-2: Man, Vgetarian, 80 kg, Objective: Weight loss, Priority: Sustainability

What were the effects of changing the priority of the objective function?

- Adjusting the priority from “Maximizing Protein” to “Minimizing Environmental Impact” resulted in a reduction of protein intake by 266.15 g, CO2 emissions by 19.4 kg, and water usage by 13 k liters. CO2 emissions and water usage were almost halved as a result of minimizing environmental impact.

- The cost was decreased by 23.28 CAD, as dishes with higher protein content, such as meat, tend to be more expensive.
- Additionally, the average portion size decreased by approximately 20% due to the reduced emphasis on protein maximization in the multi-objective function.

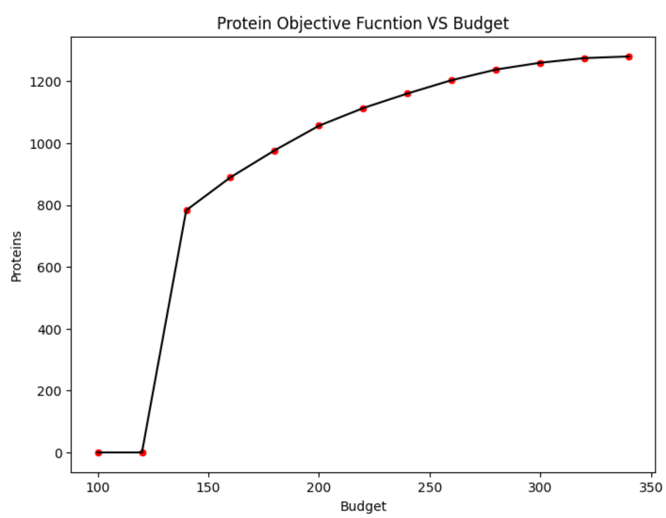
Profile 3: 1st scenario

- **A woman who wants to gain muscle, Not Vegetarian, Weight: 60 Kg**
- **Priority: Maximize proteins**
- **Budget: 290 CAD**

Metric	Value
Total Cost for the Week	$280.00
Total CO2 Emissions	74,655.17g
Total Water Usage	43,821.95l
Total Protein Intake for the Week	1,238.16g

In the weekly planned the model prepared for her, average gram per meal is 292 and the maximum per portion was 300 grams for this scenario. The total cost is high in comparison to other scenarios, but it did not become binding.

In the chart below you can see that in this scenario, the range of acceptable budget is wider. The minimum acceptable budget is 140 CAD and increasing the budget above 320 CAD does not have an effect on the optimal solution.



Profile 3-1: Woman, Not Vgetarian, 60 kg, Objective: Muscle gain, Priority: Max. Proteins

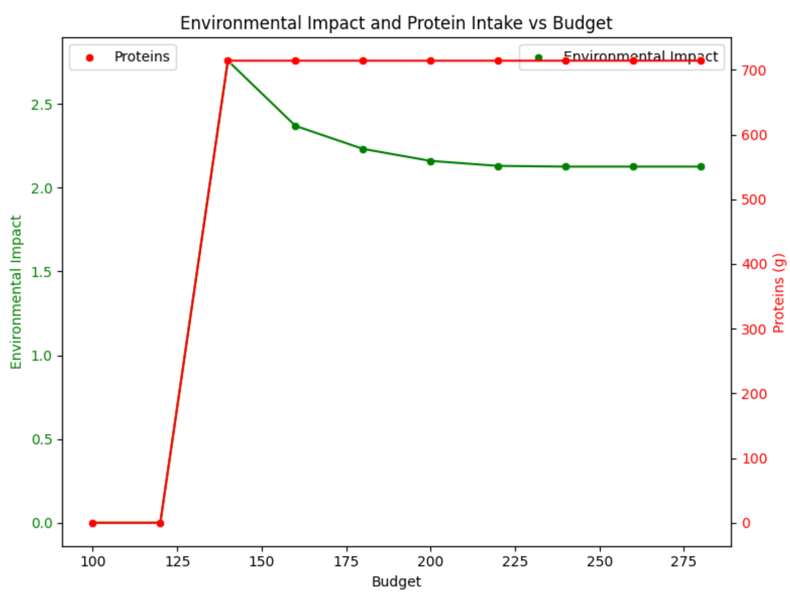
Profile 3: 2nd scenario

- **A woman who wants to gain muscle, <u>Vegetarian,</u> Weight: 60 Kg**
- **Priority: <u>Sustainability</u>**
- **Budget: 290 CAD**

Metric	Value
Total Cost for the Week	\$225.34
Total CO2 Emissions	28,203.29g
Total Water Usage	17,795.46l
Total Protein Intake for the Week	714.07g

In this scenario, the model aims to minimize CO2 emissions and water usage, reaching its optimal solution when it meets the minimum protein constraint. For a muscle gain objective, the daily protein requirement is calculated as 1.7* weight of the person, which equals 1.7*60 = 102 g.

With the priority set to minimizing environmental impact, we will analyze how budget affects this objective. 140 CAD is the minimum budget required to achieve an optimal solution which has the highest Environmental Impact score. Increasing the budget up to 220 CAD allows the model to further reduce environmental impact, while minimum protein remains a binding constraint.



Profile 3-2: Woman, Vgetarian, 60 kg, Objective: Muscle gain, Priority: Sustainability

What were the effects of becoming vegetarian and changing priority?

- Switching to a vegetarian diet resulted in a savings of $54.55, a reduction of 524.1 g in protein consumption, a decrease of 46.5 kg in the carbon footprint, and a 26,000-liter drop in water usage.
- To meet the minimum nutritional requirements, the average portion size increased by 13%, as vegetarian dishes generally contain less protein.
- The range within which the budget has an impact is narrower in the second scenario.

Problem Extensions and Future Recommendations

The meal optimization model provides a meal planning approach by optimizing nutrition and environmental sustainability. By expanding the model with possible improvements and future implementations, it will offer extra insights and user satisfaction.

When adapting to user behaviors, it would be helpful to incorporate general appetite specification and custom on portion adjustments. The model assumes a fixed portion size based on dietary goals. By including appetite specification, it will add flexibility for users to indicate their typical portion size preferences and make the model more realistic, as consumption varies for each person. For example, light, moderate or heavy appetite. Indeed, users that have higher appetites will experience an increase in total costs and sustainability scores since they require an increase in the overall portion. This extension will match the hunger levels and reduce overeating or undernourishment. On the other hand, by including customization on portion adjustments, it will allow users to specify the portion ranges for individual meals. For example, a smaller breakfast and a larger dinner. Indeed, this will introduce additional variables and optimize different sizes of the meal while balancing the daily requirements of the protein distributions.

When shifting to enhanced metrics, it would be helpful to incorporate household-level diet planning and broadening the nutritional scope. The model focuses on individual meal plans. Therefore, an extension of household diet planning will account for the varied dietary needs in a family. This step will introduce individual constraints then aggregate them into a household optimization problem. Moreover, the numerical impact will be higher in weekly cost since it accounts for two or more people. This demonstrates how household planning affects cost and sustainability. When there are shared ingredients, it can also reduce waste and transportation impacts. On the other hand, the model only optimizes some macronutrients. It would be helpful to add other micronutrients (e.g., calcium, iron, etc.) and vitamins to diversify the diet recommendations for specific groups of individuals (e.g., athletes). Even though it will require additional constraints, it increases the model complexity to provide balanced diets that enhance health impact.

When addressing environmental footprints, it would be helpful to prioritize locally available ingredients and reduce long distance transportation for a sustainable diet. Indeed, incorporating locally available ingredients will ensure that the meals align with local resources and support local farms. Moreover, a complementary extension would be reducing long distance transportation by penalizing meals with high transportation footprints. This requires additional constraints that assign a higher sustainability score to local ingredients (e.g., seasonal greens) and reduce emissions by replacing imported foods (long distance transportation) and ingredients. Thus, promoting sustainable eating habits and supporting regional agriculture without compromising nutritional quality.

When including dynamic user inputs, it would be helpful to include taste preferences, allergy considerations, and meal substitutions. Indeed, allowing users to specify their taste preferences (e.g., spicy, bitter, sweet, etc.) will customize the meal plans. This step will add flavor attributes to the dishes to match them with user preferences and it will not have significant changes to cost or sustainability scores. Moreover, including substitutions and allergy considerations will add robustness to the model and users will receive more customized alternatives. Additionally, for users that do not consume certain food/ingredients it will allow them to substitute the food/ingredient for a similar one. For example, if the user is nut-allergic, the nut-based food options will be replaced by a similar food/ingredient while preserving protein levels. Therefore, costs might be increased due to less availability. This highlights how the model balances its adaptability under real-world constraints.

These extensions and future implementations can improve the model’s flexibility, and it brings a more holistic approach to meal optimization.

Conclusions

Our project on diet optimization successfully demonstrated the trade-offs between a nutritious meal plan and a sustainable meal plan, highlighting their implications for individual fitness objectives. By focusing on protein as the primary macronutrient, we simplified the complex process of meal planning to make it accessible and actionable. However, we acknowledge that a truly comprehensive meal plan should incorporate other essential macronutrients and micronutrients to ensure a balanced diet. This refinement would enhance the nutritional value of the meal plans and align more closely with dietary guidelines.

To improve the accuracy and relevance of the optimized meal plans, future iterations should consider datasets tailored to the specific geography of the user. This adjustment would account for the availability and affordability of local food products, making the meal plans more practical and realistic. Additionally, incorporating more detailed environmental impact data could provide users with deeper insights into the sustainability of their dietary choices. Expanding the dataset in these ways would make the optimization more robust and impactful.

Finally, the business opportunities in diet optimization are vast and varied. Beyond partnerships with fitness companies and integrations with fitness apps, there is potential to create subscription-based services offering personalized meal plans that adjust dynamically based on users' fitness goals, seasonal food availability, and dietary preferences. Integration with grocery delivery platforms could enable users to purchase ingredients directly from their meal plans, streamlining the process and enhancing convenience. Collaborations with environmental organizations or certifications for "eco-friendly diets" could attract environmentally conscious consumers. Additionally, incorporating diet optimization into corporate wellness programs could provide companies with tools to improve employee health and productivity, further broadening the market. These opportunities demonstrate that diet optimization can transcend individual health, becoming a holistic service that intersects with technology, environmental sustainability, and business innovation.

Appendix

Table 1. Indices of the decision variable

Indices	
i	Indicate the index of dishes (1, 2, 3 … 502)
j	Indicate the meal (1: breakfast, 2: lunch, 3 dinner)
k	Indicate the index of day (1: Monday, 2: Tuesday, 3: Wednesday, 4: Thursday, 5: Friday, 6: Saturday, 7: Sunday)

Table 2. Parameters

Parameters	
Ci	Cost of one portion of 100gr from dish i
Pi	Protein(g) of one portion of 100gr from dish i
Si	Sugars(g) of one portion of 100gr from dish i
Bi	Binary variable for dish i (1: breakfast, 0: lunch or dinner)
Vi	Binary variable for dish i (1: Vegetarian, 0: Not vegetarian)
$CO2i$	Carbon footprint of CO2 of one portion of 100gr from dish i
$H2Oi$	Water footprint of one portion of 100gr from dish i

Table 3. Weekly meal plan of Profile 1

Meals / Days	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Breakfast	Egg casserole with bread	Breakfast pizza with egg	Quail egg	Breakfast link (meat alternative)	Egg white	Bacon biscuit sandwich	Egg omelet or scrambled egg
Lunch	Venison or deer with gravy	Beef with mushroom sauce	Veal cordon bleu	Textured vegetable protein	Chicken or turkey with cheese sauce	Meat with tomato-based sauce	Stuffed chicken
Dinner	Hot dog (meat alternative)	Stewed goat	Cheese steak sandwich or sub on wheat	Beef with cream or white sauce	Beef with tomato-based sauce	Venison or deer with tomato-based sauce	Chicken or turkey cordon bleu

Table 4. Weekly meal plan of Profile 2- 1st scenario

Meals / Days	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Breakfast	Breakfast link (meat alternative products)	Quail egg	Egg white	Egg white omelet	Goose egg	Egg omelet or scrambled egg	Egg casserole with bread

Lunch	Textured vegetable protein	Grilled cheese sandwich	Soybean curd cheese	Veggie burger	Tomato sandwich on white	Spinach and cheese casserole	Cake with glutinous rice and dried beans
Dinner	Hot dog (meat alternative products)	Soybean curd	Cheese sandwich	Vegetarian stroganoff	Tomato sandwich on wheat	Falafel	Veggie burger patty

Table 5. Weekly meal plan of Profile 2: 2nd scenario

Meals / Days	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Breakfast	Oatmeal	Quail egg	Egg white omelet	Egg salad	Egg white	Breakfast link (meat alternative)	Egg omelet or scrambled egg
Lunch	Textured vegetable protein	Broccoli casserole with rice	Congee	Veggie burger	Greek Salad	Soybean curd cheese	Stew (Vegetable dishes)
Dinner	Green bean casserole	Eggplant with cheese and tomato	Spinach salad	Black bean salad	Soybean curd	Vegetarian stew	Hot dog (meat alternative)

Table 6. Weekly meal plan of Profile 3: 1st scenario

Meals / Days	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Breakfast	Egg white	Breakfast link	Breakfast pizza with egg	Egg casserole with bread	Bacon biscuit sandwich	Egg omelet or scrambled egg	Quail egg
Lunch	Cheese steak sandwich or sub on wheat	Hot dog (meat alternative products)	Chicken or turkey with cheese sauce	Ham or pork with mushroom sauce	Meat with tomato-based sauce	Stuffed chicken	Chicken or turkey cordon bleu
Dinner	Stewed goat	Textured vegetable protein	Veal cordon bleu	Venison or deer with gravy	Beef with mushroom sauce	Beef with cream or white sauce	Deer with tomato-based sauce

Table 7. Weekly meal plan of Profile 3: 2nd scenario

Meals / Days	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Breakfast	Goose egg	Egg white omelet	Egg white	Quail egg	Egg omelet	Breakfast link(meat alternative products)	Egg salad
Lunch	Hot dog (meat alternative products)	Broccoli casserole	Soybean curd cheese	Eggplant casserole	Congee	Eggplant parmesan	Veggie burger
Dinner	Greek salad	Soybean curd	Vegetable sandwich	Spinach salad	Textured veg protein	Stew (Vegetable dishes)	Vegetarian stew

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