Math 441 Proposal: Calories Tracker

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1 Overview

Many individuals struggle to eat an optimal diet in at the ideal cost. Creating a nutritional diet can be very expensive and unappealing to some, depending on taste preferences. Other items that may need to be considered are dietary restrictions such as allergies.

2 Research Question

The general objective in this project will be to: **Minimize costs**. Or in more detail: Given a set of nutritional constraints and possible groceries. What diet could minimize the costs while still meeting the constraints?

Certain constraints and parameters can be varied while answering this question to create insight in the correlation between the minimize of the objective function and the varying constraints. We will consider the following changes in constraints in this project.

1. *How to penalize eating to much of a certain food?*
   We will attempt to create a linear program that generates a solution in which the amounts of certain foods that are evenly distributed over the different available foods (i.e. more variety). One way to do this is to add a certain penalty to high amounts of food (this will probably require QP). Another way to include this in a program would be to include lower and/or upper boundaries to the amounts of certain foods that are in the diet.

2. *What are the effects of changing import costs on the minimum cost of the diet and the diet itself?*
   This question can be answered by varying the costs of certain products. In particular the costs of all products that are considered to be imported can be increased to effect the diet. The parameter that denotes the ratio of increasing costs caused by changing import rates is α. Where $\alpha = 1$ will denote the current situation.

3. *How do different seasons influence the diet and the costs of this diet?*
   For this question we assume that all products are available throughout the year, however as seasons change the costs of these products might vary. This will be modeled by using a sinusoidal relation between time and costs. For example the costs of a certain fruit could be:

   $$c = k + \beta sin(t)$$

   In this example c denotes the total price of the food, k the average price during the year, t the time of the year (the length of a year in this case would be 2π) and β is a parameter that denotes how much the costs are influenced by seasons. β then, is higher for fruits or vegetables compared to oats.

4. *How much more expansive would the diet be if a person would change its nutritional needs?*
   If, for example, a person would want to exercise more than he/she did before extra proteins might be demanded for in the diet. This variation will probably bring about extra costs for this person. Determining these costs can help to assess the total costs of engaging in physical activity.

3 The Linear Programming Model

Let:
c be the cost of a particular food
x be the amount of a particular food
a be the nutritional value of a particular food
b be the minimum value of a particular nutrition
(i.e b_1 = protein[g], b_2 = carbohydrates[g], b_3 = fat[g])
LP for general objective:

$$Objective: \ minimize\, c_1x_1 + c_2x_2 + ... + c_nx_n$$

$$b_1 < a_{11}x_1 + a_{12}x_2 + ... + a_{1n}x_n$$
$$b_2 < a_{21}x_1 + a_{22}x_2 + ... + a_{2n}x_n$$
$$b_3 < a_{31}x_1 + a_{32}x_2 + ... + a_{3n}x_n$$

LP for research question 2:
Assume that x_1 to x_3 are summer products, while now is in winter.
α is the new tax rate.

$$Objective: \ minimize\, \alpha(c_1x_1 + c_2x_2 + c_3x_3) + c_4x_4... + c_nx_n$$
$$b_1 < a_{11}x_1 + a_{12}x_2 + ... + a_{1n}x_n$$
$$b_2 < a_{21}x_1 + a_{22}x_2 + ... + a_{2n}x_n$$
$$b_3 < a_{31}x_1 + a_{32}x_2 + ... + a_{3n}x_n$$

LP for research question 3:
c_n is the average price.
$\beta_n sin(t)$ is the seasonal influence at time t. Not

$$Objective: \ minimize\, (c_1 + \beta_1 sin(t))x_1 + (c_2 + \beta_2 sin(t))x_2 + ... + (c_2 + \beta_n sin(t))x_n$$

$$b_1 < a_{11}x_1 + a_{12}x_2 + ... + a_{1n}x_n$$
$$b_2 < a_{21}x_1 + a_{22}x_2 + ... + a_{2n}x_n$$
$$b_3 < a_{31}x_1 + a_{32}x_2 + ... + a_{3n}x_n$$

LP for research question 4:
Assume that b_n is the average amount of nutrition per kilogram an individual needs.
γ_n means what an individual's special needs, like want to increase his or her muscle or want to lose weight.
ϵ_n is the current weight of an individual.

$$Objective: \ minimize\, c_1x_1 + c_2x_2 + ... + c_nx_n$$

$$\gamma_1 + \epsilon_1 b_1 < a_{11}x_1 + a_{12}x_2 + ... + a_{1n}x_n$$
$$\gamma_2 + \epsilon_2 b_2 < a_{21}x_1 + a_{22}x_2 + ... + a_{2n}x_n$$
$$\gamma_3 + \epsilon_3 b_3 < a_{31}x_1 + a_{32}x_2 + ... + a_{3n}x_n$$

4 Data and Algorithms

1. **Data**: Using a CSV to keep information of about 40-100 of foods: (1) calories, (2) fat (3). protein nutrition parsed from MyFitnessPal. The costs will be retrieved from a local grocery store and websites. The user can input body information (i.e. Body, weight, Height, Diet) with which we can abstract daily nutritional needs with the Katch-MCardle formula. Using this data we can optimize for an individual's daily, weekly or monthly financial goals.

2. **Algorithms**: We will use Gurobi libraries in Python or Java to solve linear programs.

3. **Program**: The program will be solved as an *linear program*. Reason for this is that most of the products that are considered in this program can only be bought in integer quantities, e.g. one cannot buy half a banana.

5 Responsibilities

Leslie will be responsible for getting the food data and programming the application.
Danielle will be responsible for research question ...
Xun will be responsible for research question ...
Nout will be responsible for research question ...