Math 214 Final Project Proposal

What is the topic?
Our team will be working on solving the Diet Problem. The goal of the project is to select a set of foods that will satisfy a set of daily nutritional requirement at minimum cost. The problem is formulated as a linear program where the objective is to minimize cost and the constraints are to satisfy the specified nutritional requirements.

Why is the topic mathematically interesting?
This is an interesting topic from a mathematical standpoint because of the many variables that are part of the equation. We must consider both the many nutritional properties of the food and the cost. Moreover, we have to consider the minimum and maximum of every nutrient for a person, which can become complex. The problem is also interesting because the number of servings does not have to be exact integers; the problem can pick out a third of a serving for a specific food, or 0.74 of a serving, etc. This makes the problem much more challenging and exact as to the amount of each food the mathematical equation must pick.

Why is the topic interesting outside of mathematics?
This problem is exceptionally interesting and poses interesting implications for societies across the world. For example, this was a problem created out of real-world motivations: the US army wanted a way to efficiently feed GIs during WWII. Additionally, providing food for people in impoverished areas is the focus of many world relief organizations. Organizations like this that would like to distribute food in the healthiest and cheapest ways will benefit from this problem. Solving this problem means more efficiently feeding people in need.

What areas of linear algebra will be involved? You should use some non-trivial aspect of linear algebra in an essential way
We will be using linear optimization and systems of equations on a large scale to solve this problem.

What data will you use?
For each food item chosen, we will be using the cost per serving, and the minimum and maximum servings allowed. We will also be choosing the type and amount of nutrients (e.g. calories, iron, carbohydrates) to tailor our food serving calculations to. The amount of each nutrient in each serving of all the different foods will also be used.

We will have two sets of data, the food and nutrients. Below are tables which display these values.

Food Component	DV
Total Fat	65 grams (g)

Saturated Fat	20 g
Cholesterol	300 milligrams (mg)
Sodium	2,400 mg
Potassium	3,500 mg
Total Carbohydrate	300 g
Dietary Fiber	25 g
Protein	50 g
Vitamin A	5,000 International Units (IU)
Vitamin C	60 mg
Calcium	1,000 mg
Iron	18 mg
Vitamin D	400 IU

http://www.fda.gov/Food/GuidanceRegulation/GuidanceDocumentsRegulatoryInformation/LabelingNutrition/ucm064928.htm

As far as food variables go, we took the top most common foods from different food groups to create a reasonable selection of healthy foods to provide nutrients:

Vegetables	**Fruits**	**Nuts/Legumes**	**Grains**	**Meat/Fish**	**Dairy**
potato	orange	pinto bean	bread	chicken	milk
tomato	apple	green pea	rice	beef	cheese
sweet corn	banana	black bean	pasta	pork	butter

onion	melon	peanut	quinoa	fish	
lettuce	grape	almond		turkey	
cucumber	pineapple	pecan		lamb	
bell pepper	strawberry	walnut		veal	
carrot	peach				
cabbage	grapefruit				
broccoli	lemon				

For each of these 41 food products, we will extract from a food database the 13 nutritional content variables as specified above.

http://supplementsos.com/nutrition-stats/most-consumed-foods/

Assumptions

We are going to assume that you do not place most emphasis on the taste or the variety of the food. Instead, we assume you care the most about paying the lowest cost and getting all the required nutrients. We are assuming the preparation of these foods doesn't fundamentally augment the nutritional content. We also assume that there will not be any food shortages and you would be able to acquire all of the food.

Relevant Resources

There are many resources about the Diet Problem online. So far we have looked at an online Diet Problem Solver, which we will eventually be able to use as a checker against our code. This has helped us get a better understanding of the problem and how we should approach it. We have also found extensive food nutrients databases online that the government has released which we will use in our calculations.

https://neos-guide.org/content/diet-problem-solver

Computations

For our computations, we want to minimize the total cost of food while paying attention to specific nutritional constraints of several diets.

We have two sets, the nutrients N, and the foods, F.

Our parameters are the amount of each nutrient for each food, as well as the unit cost for a serving of that food. We'll have a maximum servings for each food, as well as maximum/minimum nutrient requirements.

We say **x** is a vector representing the amount of each food type to buy, and **c** is a vector representing the cost for each food. So we say we would like to minimize the value of the dot product of **x** and **c**.

By imposing the following constraints, we can arrive at a solution:

- We'll constrain each nutrient to a maximum value,
- each nutrient will have a minimum value,
- each food will have a maximum number of servings,

and an additional component to our project:

- We'll create additional min/max nutritional constraints based on the person's diet and goals, for example an athlete looking to improve muscle mass vs. an office worker trying to lose weight.

Background skills (each member)

Abigail Grobbel
Computer science background, Matlab experience

Claire Rehfuss
Data Science background with experience working with Matlab and databases

Jarred McDuffey
Computer Science background, Matlab and c++ experience

Minsung Kwon
Computer Science background, skills are Python and Matlab

Sources

https://neos-guide.org/content/diet-problem