CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Cynthia Chen

Project Number

S1504

Project Title

Fighting Malnutrition: Automated Optimization of Nutrition Using a Novel n-Dimensional Linear Programming Algorithm

Abstract

Objectives/Goals

Malnutrition is prevalent issue in this world: it accounts for 58 percent of all mortality. As a result, my project aims to solve the problem of malnutrition using the method of linear programming (LP) optimization. Mathematically, the problem of nutrition can be modeled using a n-dimensional integer linear program (ILP). My main objective for my project was to develop and create a novel ILP algorithm which returns an accurate and optimal solution while minimizing cost.

Methods/Materials

Previously, other mathematicians have developed algorithms such as the Simplex or Interior Point algorithms to solve a LP problem. However, I found that a big disadvantage of using those algorithms is that there exists the case where the algorithm yields infeasibility and a null solution, but an optimal solution exists and is not found. Consequently, I focused on increasing the feasibility of the LP by developing a novel algorithm which is able to resolve the no solution (infeasibility) case mentioned above while still maintaining the accuracy of the returned optimal cost-effective solution. After analysis, I found that previous algorithms were unable to relax the constraints when they are too restrictive. When developing a new algorithm to address this problem, I used a novel method of weighted constraints that I implemented myself. I created an n-level deep recursive algorithm that was able to successfully decrease the probability of infeasibility decreases, and return an accurate optimal solution. Also, I was able to integrate my model with Wolfram Mathematica in order to receive form input for user info (age/gender), as well as use its built-in ILP function.

Results

In this project, I was able to successfully create an improved model with a novel algorithm which is able to reduce to probability of infeasibility and optimize the n-dimensional linear program more accurately. Overall, the model is able to successfully optimize nutrition while minimizing cost in order to help solve malnutrition.

Conclusions/Discussion

The model that I developed can serve as a primitive model for other ILP problems, such as transportation networks, production planning optimization, or any problem which involves a cost-benefit analysis. In the future, I would like to generalize the model and algorithm I developed in this project, and integrate the model into a mobile software application.

Summary Statement

In my project, I developed a novel n-level deep recursive linear programming algorithm in order to solve the problem of nutrition.

Help Received

I completed most of the work myself. My math teacher, Mr. Bradley Stoll, helped me with using Wolfram Mathematica. Also, Dr. Gary Blickenstaff was the official sponsor for my project.