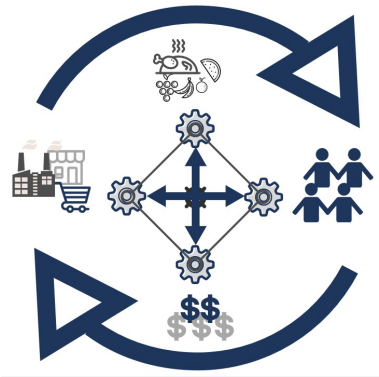
Amending the Food Distribution Cycle in Highland Park

A proposal to implement a Markov Decision Process algorithm to alter the current distribution model of the food pantry in Highland Park, New Jersey



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Abstract

This is a research-supported proposal that outlines an apparent inadequacy in the Highland Park (HP), New Jersey (NJ) Food Pantry distribution system. The current implementation of the food pantry system prevents nutritive food and drink items from dispersing equally throughout the annum for all who need it simply due to a lack of planning. The current model's shortfalls lie in the fact that it adopts an outdated paradigm of thinking. Using a new, more refreshed algorithmic process to distribute food among those who need at not only a more efficient rate, but also more equally throughout the year would decrease the food insecurity issues in Highland Park.

Included is the sufficient background information neccessary to understand why a machine learning algorithm is required to improve the conditions of the food pantry. By making an example of this particular development in this borough of NJ, we can continue to improve the nation's food pantry and food bank distribution system, thereby aiding the food insecurity problem in the nation.

Table of Contents

Table of figures

Executive Summary

Food Banks and Food Pantries seem to be a cure-all for the food insecurity issue plaguing the United States. Despite some success in varying states and cities all over the country, there are many highly populated cities and towns facing no improvement over food insecurity despite the existence of food banks and food pantries. More than one million of the forty-one million individuals in America that are food insecure live in New Jersey (FeedingAmerica.com). Those one million people rely upon the food banks to provide them with the necessary meals to survive and according to the Community Food Bank of New Jersey, around fifty-million pounds of food was distributed in the year 2017 to these one million people. However, as the years go on, this number will reduce.

Many food banks all over the country are facing "droughts", where donations don't come in for a stretch of months at a time, or fresh produce comes in all at once in a span of a few months and by the time a plan is made to send out the food to those who need it, the fresh produce becomes inedible. According to the Community Food Bank of New Jersey, most of the Food Bank resources come from donations (sixty-two percent), while the rest is just about evenly divided between purchases and government support. Because donations are such a flimsy source of revenue, it's extremely difficult for food banks to stay afloat. Also, with the dire straits of the current economic and financial situation of the country, it's rather understandable that many individuals don't want to give away or donate their extra cans and groceries, but one must realize that the more they don't think about those that are food insecure, the worse the situation is going to become.

In some cases, because of the lack of success from the food banks, the government may stop providing proper funding altogether. For instance, in Springfield Ohio, the Ohio House of Representatives state budget bill amendment will change about one million in funding from food banks to many "smaller agencies" over the next few years. This could be absolutely devastating to the food banks of Ohio. The cut of one million dollars is equal to about 5.5 million pounds of food that's just lost because of the change in the bill. The Springfield News Sun sees clearly how crucial the food bank is to the residents of Springfield, OH.

Not only is government funding a tense issue for food banks, but donations are very difficult to come by. People tend to donate food whenever it's convenient for them. Statistics show that food donations are are very high during November and December, that is around the American holidays of Christmas and Thanksgiving, and quite slow during the months of January through May. The latter end of the year is when much of the food comes in, and it's not in any specific order. Much of the donations aren't well thought out and ends up having to be thrown out anyways due to food and drink safety regulations. During the earlier part of the year, it's rather difficult to get anything nutritive for those who need it because donations are so few.

These food banks and food pantries may be facing these types of drought at this time due to both lack of funding and planning. A proper food distribution algorithm in place could really change the state of the food banks' lack of finesse in distributing food to those in need. The core of the problem can be relayed in two parts: (1) The donations are distributed without a proper

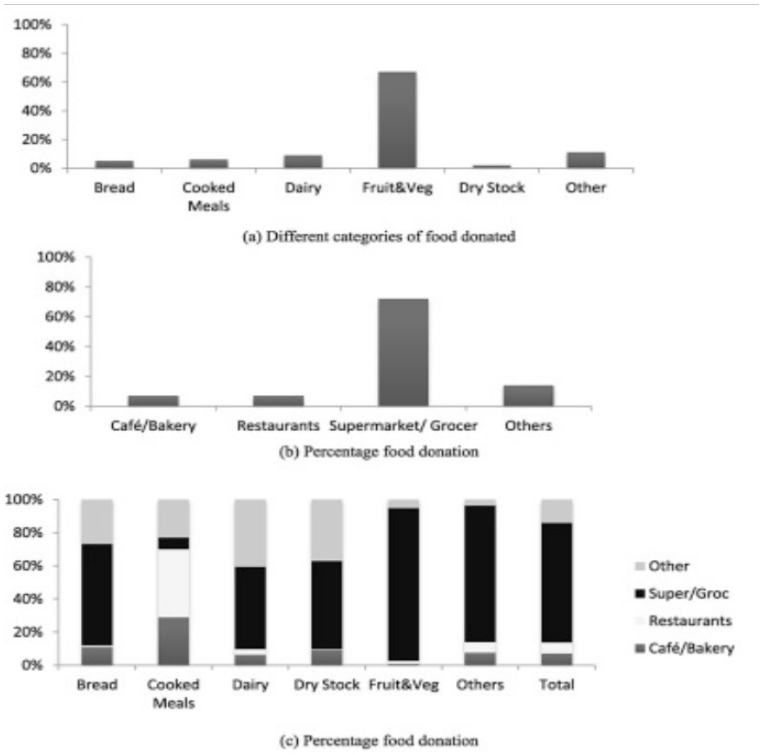

Figure 1: Figure of the lack of donations

time-plan. Donations that have been sitting on shelves way past their expiry dates are given to people and all the nutritive food goes out first without a second thought by any of the food pantry managers. The timings of the distribution itself and planning and how much to serve each individual is distinctly lacking in these organizations. (2) The meals that are distributed to those in need are far from nutritive and well-balanced. During my time as a volunteer, I saw that many times during holidays such as Thanksgiving or Christmas, more unhealthy foods were given out to those in need, creating other health concerns and spikes not generated before.

Unlike the make of the problem, the solution is rather simple. Changing the algorithm of how the food pantry operates as a whole could solve both of these problems. In order to make such a change, research on how the food pantry currently operates and the exact data for the food items, the workers, the management and management-style all have to be taken into account to revamp the food pantry distribution system. Implementing a Markov decision process would help in indicating the best way to allocate supplies based on the inventory levels of the food bank.

Introduction

One of the most popular Sustainable Development Goals (SDGs) that the United Nations set is Food Insecurity. Food Insecurity is defined as "consistent access to adequate food is limited by a lack of money and other resources at times during the year" (usda.gov). Food insecurity is defined

as the situation where people are not able to access enough food at all times for an active, healthy life (USDAERS, 2006).

The occurrence of food insecurity in the United States (U.S.) is significant, affecting approximately 48.1 million Americans, 15.3 million children and 32.8 million adults.Food Insecurity itself is too large a problem to solve with one solution, but major steps are being taken towards making it a smaller problem by the whole world. One of those solutions have to do with food banks and food pantries.

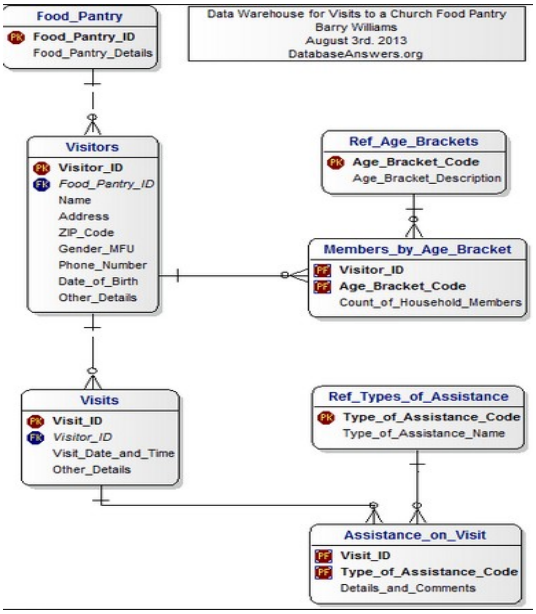

Figure 2: Figure of a simple Food Pantry Database Model

A food bank is defined as a non-profit organization that collects and distributes food to hunger relief organizations. Food banks are typically operated out of warehouses where they store and distribute the food. Food banks also receive salvageable products which are items such as dented cans and crumpled boxes that grocery stores tend to push aside.

A food pantry provides food to those directly in need. These facilities receive, buy, store and distribute food to low-income individuals in their community. Large amounts of food that are received by pantries come from food banks only after they become an agency member. Once the food pantry receives its supply of food, it is then distributed to individuals and families at no cost (foodbankst.org).

The Problem

This seemingly splendid plan to reduce food insecurity within the nation has two core parts to the problem, the first being that the local, low-income individual is in fact not likely to be given a

healthy, nutritive, well-balanced meal from the food pantry, because the food pantry managers may have no real, proper system of food distribution. In fact, some pantries impose strict regulations upon those who do use the food pantry resources, regulations so strict that they pose a health risk for those who require the food pantry services and some encourage long-term food distribution to certain patrons.

The other core problem with the current plan for the food distribution in the nation is that the donations the food pantry receives can be sparse and relatively useless depending on the time of the year. This almost random donation pattern makes it difficult for the pantry to store food properly and give a well balanced nutritive meal to the people who need it equally throughout the year.

Both these problems contribute to the main problem, which the fact that these food distribution models do not account for the quality of the meal being given to the food pantry customer, which is arguably one of the most important concepts to cover when making a model as important as this.

Effects of a Poor Model

The effects of such a poor food distribution stretch far and wide, past the United States itself. For instance, in the UK, there are many who believe that if levels of poverty continue to rise, then the level of support given to food banks may have to be increased so there isn't a situation where families are prevented from accessing nutritious food. Over longer periods eating donated food that is often refined could result in nutritional deficiencies.

A senior lecturer in health and nutrition at Birmingham City University, warned that families forced into prolonged use of food banks may not be eating a balanced diet. She analysed food typically on offer at food banks and drew up menus based on the items available. "We found that it's very much processed food being donated, with little fresh produce," said Wakeman. "The meal plans we came up with revealed that in the long term there is a real risk of children and families becoming deficient in fibre, calcium, iron and a variety of vitamins. "We're not criticizing what food banks are doing and, of course, only food that is safe to eat should be available, which limits the handling of perishable food" (theguardian.com).

Another study found that emergency food services are a potentially crucial resource for the large numbers of food-insecure people. However, they are often inaccessible to or have very limited food choices. Almost a quarter of the pantries studied were unreachable by phone, more than half had incorrect hours of service or location listed on their website, and most had limited weekly hours, during which it was quite difficult to reach the managers and workers. In addition, limited English has been shown to act as a barrier to public assistance programs, including food services. Almost a quarter of the pantries surveyed did not offer assistance in any language other than English, while a majority offered assistance in Spanish, meeting the language needs of many of our patients, but not those who speak other languages, namely Chinese and Creole. With all these issues, it's not difficult to see that the food pantry models do not provide enough assistance to those who need it (ncbi.nlm.nih.gov).

Why It Is Important to Act Now

Due to the current economic climate, in particular, the bout of the inequality of income that the United States is plagued with, it is difficult to imagine how those who are financially unlucky can manage all their financial obligations and responsibilities. It is the responsibility of the community to come together and aid those in need. That already is the noble goal of the food banks and the food pantry.

Unfortunately, it is not enough to just donate food whenever one "can donate". Due to human nature, it's usually when something is wrong or mislabeled or unusable to the owner that the item gets donated. Human nature cannot be changed, but the model used to collect and distribute the food can be changed. This is the time to act on the changes in the model because if the model doesn't change now, the repercussions of long-term food bank users and the continual gaps between donations will hit a hard bump on the road. The food distribution will break down at it's core and eventually stop being helpful altogether.

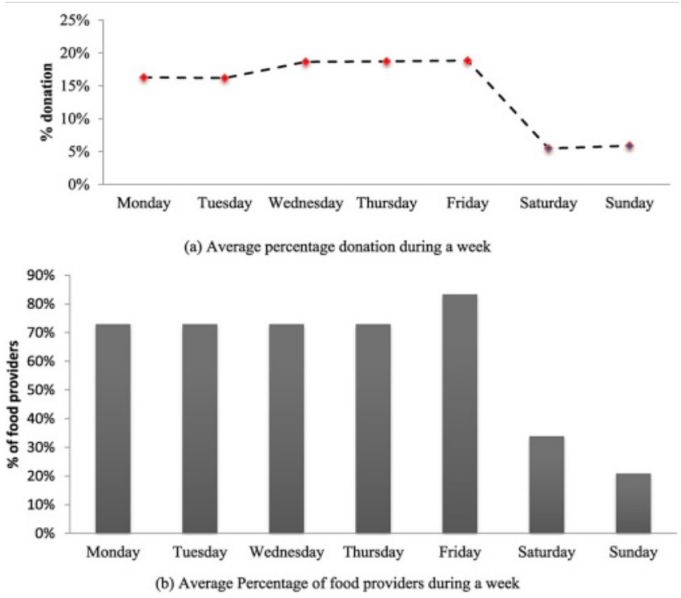

Figure 3: Figure of lack of donation

Those in need, those who rely on the food pantry to get along with their lives will no longer have the staple in their lives. The food insecurity rate in Highland Park and other boroughs and cities rises, starting the vicious cycle again. At that point even if a change is brought to the model, it's too late because the effects would have already hit home.

The state government would then have to intervene to get the food pantry going again, the food pantry would have to become a member of a different food bank and start off again, this time at the expense of tax payers. This can be stopped if we intervene at the right time. The right time would be before any of the long-term effects take place. Altering the model would prevent the food pantry

and banks from eventually collapsing, the food insecurity rate from rising and generally save the borough.

Literature Review

Estimating available supermarket commodities for food bank collection in the absence of information

We already clearly understand that food insecurity is a widespread concern in the United States. This article emphasizes that addressing this concern is a chief goal of many non-profit organizations, especially. This article says that understanding the availability of donations is beneficial when addressing the demand in local communities, especially when their collection requires food bank-managed vehicles. The article discusses the idea that high-volume donors such as supermarkets, however, do not provide information in regards to what items are available.

The author, Brock purports that this can negatively impact inventory management capabilities and cause unnecessary transportation costs. Her and her partner's research evaluates four approximation methods based on their ability to estimate food availability at supermarkets including the multiple layer perceptron artificial neural network, multiple linear regression, and two naïve estimates for the average collection amount. Using a subset of the historic data provided by the Food Bank of Central and Eastern North Carolina (FBCENC), the four approximation methods are evaluated in terms of their ability to estimate collection amounts in the next planning period (Brock, Davis). Transportation cost estimates are then calculated using projections made using each approximation method and compared to those calculated using the actual transportation costs. Results suggest that the MLP-NN (Multi-Layered Perception – Neural Network) model provide the best approximations for each food type and provide closer estimations for transportation cost than other approximation methods.

However the methods for research and implementation presented by this article are out of scope in terms of the area being covered. Highland Park is a smallish borough and in order to test out a model like this, one would need to work with a smaller model. The MLP-NN model requires larger area covered (Brock, Davis).

Meals for Good: An innovative community project to provide healthy meals to children in early care and education programs through food bank catering

This article takes a completely different approach to food-bank solutions in that it attempts to tackle childhood obesity as well. The objective of the Meals for Good was to explore feasibility of implementing a food bank-based catering model to certain programs to provide more nutritious meals, compared to meals brought from home (a parent-prepared model). In 2014–2015, a 12-month project was implemented by a food bank in central Florida in four privately-owned early care and education(ECE) programs. Using a mixed-methods evaluation approach was utilized.(Carpenter) The article mentioned a menu analysis comparing nutrition of the food-bank based meals with the parent-cooked meals.

The menu analysis of lunches showed daily reductions in calories, fat, and saturated fat, but an increase in sodium in catered meals when compared to parent-prepared meals (Carpenter). Interviews with ECE directors, teachers, parents, and food bank project staff, identified several benefits of the catered meals, including healthfulness of meals, convenience to parents, and the ECE program's ability to market this meal service. This pilot demonstrated potential feasibility of a food bank-ECE program partnership, by capitalizing on the food bank's existing facilities and culinary programming, and interest in implementing strategies focused on younger children. The food bank has since leveraged lessons learned and expanded to additional ECE programs.

Figure 4: Figure of the connections between Community and Food Bank services

One major benefit from this pilot is the advertising it gave the food-bank. With this alternative, there's no way the food-bank would be allowed to go on without nutritious meals. Not only would the children be taken care of, those who need the nutritious meals and are in financial trouble can also thrive. The only visible downside to this plan is the clear cost of budgeting and gathering the community to accept this change in plan. Many parents are protective of what their children eat and this may cause town uproar.

Comparative analysis of food bank systems in Korea and the USA

In this article, the author, Kim S. explores the endogenous governance model for alleviating food insecurity. The author states more or less that comparative analysis of food bank systems in Korea and the USA Food security is one of the most important dimensions in reducing poverty. Food bank governance is a key system for increasing food security. Even if thousands of food banks operate around the world by importing the standard US model, a universal standard of governance

cannot always be applied to all countries, because networks, and institutions embedded in unique social, economic, and political contexts retain their endogenous properties. Hence, the governance model must reflect the endogeneity each society has. (Kim) The article suggests that the endogenous governance model and to empirically demonstrate the validity of this model by comparing the governance of food banks in the USA and Korea. Although Korea introduced the US food bank model, the Korean model has been adapted and changed, evolving its own system. To find the difference in endogenous food bank governance between the two countries, the variety of governance models, the institutional context, mode of network, actors' attributes, and time perspective were compared. Although Korea imitated the US food bank model, the Korean model ended up seeming to take a different approach from the USA's approach. In the USA (community-based model) food banks with strong autonomy actively cooperate with other actors in a diverse network mode, whereas Korea has a state-centered model under which food banks have weak autonomy and interact sparely with other stakeholders in a more standardized mode (Kim).

Plan

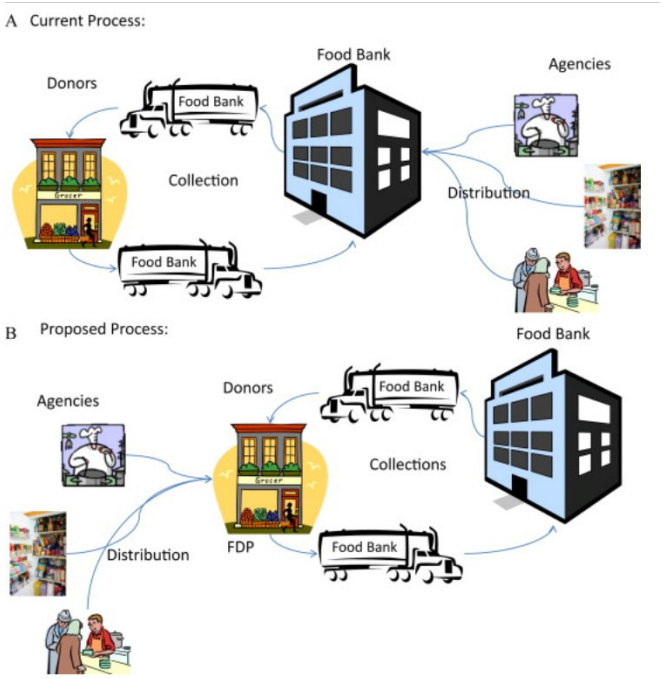

Figure 5: Figure of the Proposed Model

The new model that I am proposing is a little tricky to understand but relatively simple to implement. This model mostly works with Food Banks and Food Pantries. Using the indicators and data gathered from the food bank, FeedingAmerica (FA), one can create a Markov Decision Process to track the food bank's inventory system, which will aid in indicating the best way to allocate supplies based on the inventory levels (states) of the food bank. Highland Park is the perfect borough for this to begin because the model should be tested in a small county. Done right, this model would assist food banks in equitable allocation of uncertain, donated supplies.

FA uses the term 'equity' as a function of the pounds distributed per person in poverty (PPIP) as an indicator of the performance of its members. The benchmark for this model is distributing seventy-five pounds of food per person per annum. The MDP model is used to identify an optimal allocation policy that maxes equity in the distribution of supplies as estimated by PPIP indicator, provide estimates of unmet need in each county as a function of the PPIP, and determine the probability the probability distribution associated with the number of underserved counties.

Modeling the food bank's inventory system using MDPs has the advantage of indicating the best way to allocate supplies based on the inventory levels (states) of the food bank. Then, finding a unique approach to represent the large, continuous inventory levels of the food bank (such as discretizing them) can help identify desirable inventory states to assist them in proactive planning. The model would investigate the impact of donations and transfers on the constrained states and identify the amount of additional donations needed to move to a completely unconstrained inventory state. The model also provides some bounds on the deviations from equity that can occur when the optimal allocation rule is not selected.

Budget

The implementation of this model and testing stage for this model would cost absolutely nothing. However, to develop the model, there may be some professional costs. It would be difficult to get people to help develop a stochastic Markov Decision Process algorithmic model for free. Using professional mathematicians and graduate students from this university and who are invested in the town Highland Park could develop the right model just under three months for $5,000. This includes the collection of data before the creation of the model, the process of creating the model, the testing stage of the model and collecting the results of the model.

The only cost of implementing this model is a little time. However, spending three months now to save decades in the future seems like a better deal.

Discussion

The U.S. Government has established several public assistance programs to address the problem of food insecurity. These programs provide financial assistance, supplemental food, and nutrition support to individuals and states to increase access to healthy food for low-income households. Some of the most well-known programs are the Supplemental Nutrition Assistance Program (SNAP), the Women, Infants, and Children (WIC) program, and The Emergency Food Assistance Program (TEFAP). In addition to government funded programs, non-profit organizations, such as Feeding America, also help to address the food insecurity problem. However, many individuals suffering from food insecurity obtain assistance from governmental programs and nonprofit agencies such as food banks. Much of the food distributed by food banks come from donations which are received from various sources in uncertain quantities at random points in time.

Based on the proposed model and the experimental analysis, the new model will provide guidance on how to set inventory targets (and indirectly donation targets) in order to ensure counties will be well served. In the absence of being able to meet those target inventory levels, the policy obtained from the MDP model indicates how food distribution efforts should be conducted in order to ensure each county gets their fair share.

Irrespective of the work that will be done for this model, there is always still room for improvement. The model could be extended to all other branches in the food distribution network to study branch to branch variability. One may model the donation and transfer-in with other probability distributions and analyze the associated prediction errors. Likewise, another parameter such as transfer-out can also be added and modeled, perishable items can be considered since this research only investigated the case of dry goods. Warehouse capacity constraints can also be investigated to see how that may affect the optimal policy. Furthermore, a continuous state Markov decision process can be investigated to avoid discretization and the errors that may be associated with it. One must also keep in mind that in practice, while the proportional allocation rule may be optimal to achieve perfect equity, there are other constraints not incorporated in the model that may make this difficult to achieve.

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