SCC-IRG Track 1: Food Information Networks (FINs):Building data-driven supports for increasing access and healthy food choices in low-income neighborhoods

Designing an APP and Building an Optimization Algorithm

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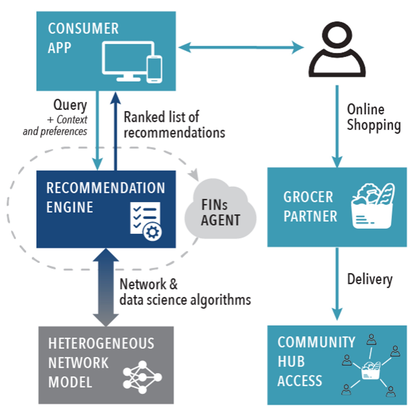
Project Challenge

Healthy eating is a critical problem in numerous communities across the country, particularly in low-income neighborhoods often described as food deserts. There, the combination of economic constraints, distance to full-service supermarkets, and unreliable access to transportation make it difficult to acquire healthy, affordable foods. Research has dispelled the myth that education is the primary barrier to healthy eating in food-insecure areas. However, the limitations introduced by poverty and lack of access make it difficult to prioritize nutrition within purchase optimization. Individuals in these food environments must not only consider dietary quality when making food choices, but also overcome a combination of other compounding factors. These factors include: fewer retailers where low-cost foods can be purchased; access to consistent and reliable transportation; transportation time; and other contextual constraints, such as available food preparation appliances.

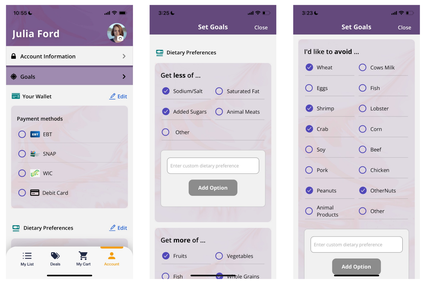


Major Outcomes/Progress: The Food Information Networks App

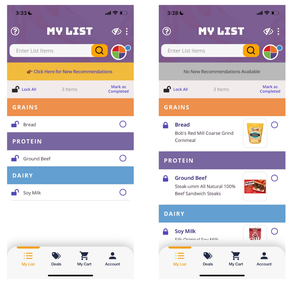
We conducted an ethnographic study to understand household food decisions, from food selection to meal-planning, and navigating logistical and technological challenges. Our findings emphasize the importance of designing technology that takes into account multiple competing factors (price, ingredients, dietary preferences) and reduces the cognitive burden and the time required to make these calculations manually. We emphasize our design considerations for the app below:

- *List as a Planning Device* ***(A)***
- *Amplify Optimization Behaviors* ***(B)***
- *Leverage Substitutions* ***(C)***
- *Design for Nutritional Awareness* ***(D)***

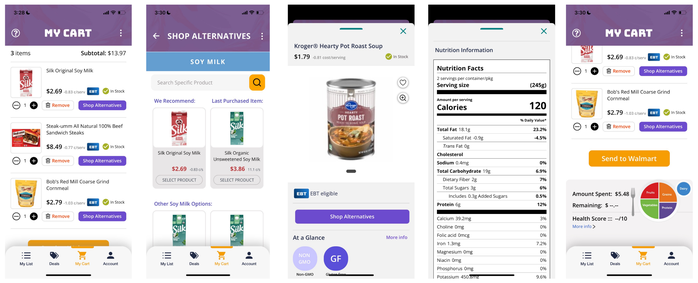
Setting User Goals (B, D)



Building Shopping List (A, B, D)

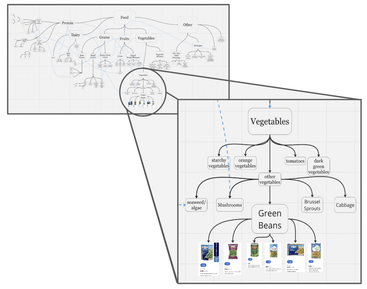


Opt-In to Recommendations or Product Alternatives (B, C, D)
Send Cart Items to Walmart for Delivery (B)



Providing Effective Substitutions with the Food Hierarchy:

To encourage healthier and cost-effective eating habits, we introduce a multi-level food hierarchy for efficient substitution recommendations. This hierarchy is based on the five MyPlate food groups and the USDA What We Eat in America food categories. Our food hierarchy serves as a tree-like structure designed for efficient substitution search. This hierarchy and the accompanying optimization algorithm work collaboratively to offer users a range of potential substitutions—from healthier versions of selected items to alternatives in entirely different food categories.



Implementing Food Hubs in Food-Insecure Areas

We conducted a review of existing food hub scholarship and a case study analysis of a food hub delivery system in South Bend, IN.

We identified best practices to consider when implementing a food hub in food-insecure areas:

- **Community Engagement and Partnership**: Involve local community members and organizations in the research and development process.
- **Understanding Community Needs and Values:** Acknowledge the diverse ways community members engage with food systems.
- **Addressing Systemic Barriers:** In collaboration with key stakeholders, mitigate obstacles that limit participation in food hubs including transportation, affordability, and accessibility issues.

Moving forward, we plan to research opportunities to implement a food delivery system in Detroit, MI to support local farmers, drawing from these best practices.

Intellectual Merit

We will leverage and innovate on existing recommendation engine technologies in direct support of healthy food access, accounting for both the information necessary to make informed decisions as well as physical access to healthy food options. This integration of social science, computer science, nutrition science, and industrial design will result in a smart, cyber-physical system for Food Information Networks (FINs) designed to improve food access and health in low-SES communities in South Bend, Indiana, and Detroit, Michigan, with the potential to be applied in many similar communities. Through this past year, we have designed and developed our FINs app, and and will be running an intervention with the South Bend community this upcoming year.

Amplifying Optimization Behaviors

We implement a weighted sum method for multi-objective optimization, targeting the reduction of a food basket's total cost and achieving dietary objectives within user-specified constraints. Users can personalize dietary goals, such as lowering sodium, saturated fat, or added sugars, which are integrated into the objective function. This approach simplifies optimization by combining goals into a single objective function, with weights assigned based on user preferences.

$$\text{Minimize } Z = w1*(C1X1 + C2X2 + C3X3) + w2(S1X1 + S2X2 + S3X3) + w3(F1X1 + F2X2 + F3X3) + w4(A1X1 + A2X2 + A3X3)$$

Z is the objective function that the model aims to minimize; Xi represents the quantity or number of servings of an item 'i'; Ci is the cost per serving of item 'i'; Si, Fi, Ai represent the amount of sodium, saturated fat, and added sugars per serving of item 'i', respectively; w1, w2, w3, w4 are weights that reflect the user's preferences

Broader Impacts:

Immediate term:

- Understand how app could change food foraging/eating behaviors
- Increase neighborhood awareness of local food resources
- Promote greater community cohesion
- Bolster existing programs and services

Middle to long-term:

- Advocate for specific program funding (e.g., for delivery funds to be included in WIC or SNAP benefits)
- Advocate for local policy change (e.g., for public transportation hours to be increased, or stops more frequent)

Future Goals:

- Launch fully functional app
- Complete an 8-week intervention with the South Bend, IN Community
- Collect and analyzing results from intervention study
- Increase community engagement with small local food providers
- Design to amplify social engagement
- Understand how to integrate into the food system (e.g. integrated into an app)

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