Newtrition – Visualizing Nutrition Data

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ABSTRACT

Information about the nutritional value of food is not easily accessible. Nutrition labels attempt to convey this information, however they are difficult to comprehend in relation to the larger context of a consumer's diet and do not offer the information in a very simple and accessible view. We propose a visualization that is simple to comprehend yet powerful in its analytical capability. Most importantly, we have found that it engages users and fulfills our ultimate goal – influencing dietary introspection. The visualization software can be found at:

http://stanford.edu/~nikil/cgi-bin/cs448b/project/index.html

Author Keywords

Nutrition Facts, nutrition label, diet

INTRODUCTION

As obesity in America continues to skyrocket, we suffer from many cascading effects of the disease. Obesity largely contributes to diabetes, heart disease, hypertension, dyslipidemia and other disorders. Apart from obesity, many other health problems that can arise later in life may be prevented by an improved diet. Better food choices, especially early in life, can help reverse some of these growing trends. In this project, we try to influence diet decisions by providing good visualizations of food data.

Current nutrition facts labels hold a wealth of information about the health of a given food product. However, almost a third of Americans continue to make poor diet decisions leading to obesity. There are several issues contributing to this issue, but nutrition labels play a part in the epidemic. People are used to being presented with information in a simple and passive way and most nutritional labels fail to do this because of the following reasons:

1. ***Serving sizes are poorly chosen.*** As a result, the user's evaluation of a food is impaired by the cognitive impediment of making calculations for how much they might consume. Additionally, it is too easy to underestimate nutrition values as they are often presented in half servings, when readers expect full servings.

2. ***Quantities chosen in standardized values of grams/mg/calories are hard to relate to.*** Can a user visualize how much 24 grams is? How about 229 calories?

3. ***It is difficult to judge nutritional composition at a glance.*** Merely glancing at a nutrition label does not tell you about the nutritional composition, a consumer has to read the label's numbers and figure out for themselves, every time they read a label, whether the values are acceptable.

4. *Large quantities of unhealthy ingredients* ***are obscured among the other information.*** Additionally, unhealthy and healthy information are displayed side by side, objectively. The nutrition facts label can be used as an opportunity to educate about healthy or harmful ingredients rather than just being informative.

With our project, Newtrition, we attempt to solve the above problems and engage users to think more seriously about their diet choices by providing a more accessible visualization of what they eat.

RELATED WORK

Commercial Products

Nutrition and fitness websites and commercial services have become a well-developed and mature industry. Some examples of this are online, integrated nutrition and fitness logs like LiveStrong.com MyPlate; food nutrition browsers and visualizers such as *Self* NutritionData; and mobile applications for easy access to product scanning and logging, such as Lose It! and Fooducate. Generally, the audience of these products is particular users who plan on devoting time to plan out how they are going to meet personal nutritional and fitness goals.

However, none of the major players in this industry seek to change the way users fundamentally perceive or experience nutrition data. Since these websites are meant to aid users with specific goals, they design their product to be a tool to

help users review what they have eaten, how they have exercised, and how to plan meals in the future at a high level. To use these interfaces effectively, users must exhaustively enter in data about what they have eaten, at what time, and when they worked out. The specificity of the products' use cases and tedious input requirements make these products unsuitable for general-use as a supplement or replacement for nutrition labeling.

Additionally, none of the major players in the industry take an engineering-oriented or interface-oriented approach to their work. They focus on building a simple system that tracks data and marketing it to users. No products are attempting to work at a low level with nutrition data, or are making interfaces that mirror the core experience a consumer has with nutrition labels that aid in the decision-making process.

Research

There is little research in the intersection of visualization and nutrition. Visualization research focuses on visualization methods, rather than specific applications. Nutrition research is usually in the area of public health, marketing, or sociology, not technology or design.

However, it is important to examine how the findings of papers in the areas of nutrition research suggest a need for more technology-oriented approaches to nutrition.

A study in 1997 was concerned about the balance between implied health claims and nutrition facts labels (Keller 1997). The results of their study was that with nutrition labeling, implied health claims on the front of packages had little effect on consumers' perception of food; but consumers mostly paid attention to fat content, not sodium or cholesterol content, to gauge the healthiness of food. This shows that consumers are good at using nutrition labels to make decisions, and having more detailed information on specific nutrients, or other nutrients of interest, could be helpful.

A later study in 1999 was concerned about the balance between implied health claims and nutrition facts labels and how educationally disadvantaged populations might be at risk to make poor decisions (Mitra 1999). They had similar results to the above study, but they did not measure intent to buy food (only the perceived assessment of a food), and they still noted that users who read implied health claims but no nutrition facts were liable to believe the health claims. Since this study is based on the concern that nutrition facts might be insufficient to debunk health claims made for marketing purposes, it demonstrates a need for more comprehensive analyses of nutritional components in nutrition labeling, which our product provides.

The article "Nutrition and health informatics" (Kouris-Blazos 2001) points out the growth of the online nutrition service industry and predicts that it will allow users more access to reliable and detailed health information.

As nutritional health is becoming an increasingly problematic and costly facet of the US's public health, we believe it is important to bring techniques from engineering and design into nutrition. Due to the current market share of web-enabled mobile phones and broadband Internet connections, and the decreased cost of storing information in the cloud, information technology is increasingly capable of reaching a nationwide audience in the context of shopping and eating, addressing this widespread nutrition crisis, and creating an interface much richer and more useful than current nutritional labeling.

METHODS

Design

Building off of the problems we identified, we began our design by brainstorming several different rough prototype visualizations. Some ideas are shown below.

In the food network layout (Fig. 1), we emphasized educational exploration of foods to influence the user's decision.

Foods were grouped together based on similar composition and ratios of fat, carbohydrates, and proteins in a force-directed graph. However, there was a significant overhead describing relationships between foods in the diagram to users, but once users understood the layout, they thought it was an interesting idea worth pursuing. Users liked to see the context of a food in relation to other foods.

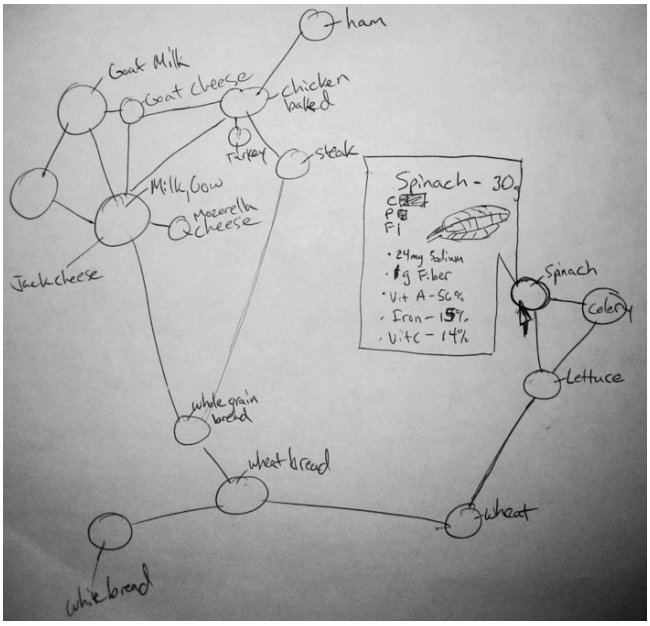

Figure 1- Network layout of food relationships.

The simple and clear bar chart representation (Figure 2) was also very popular. With this diagram, we focused on trying to make nutrient values easier to relate to, allowing users to compare choices to popular foods. Users liked how they could aggregate different products to create meals and compare these combinations. It was also simpler for users to understand relationships among foods. One user identified a useful application of the stacked bar graph, asserting, "this one gets all the information down at once...if I'm trying to count carbs, this is more helpful than the others." Users also liked the feature for adding and removing foods for quick comparisons.

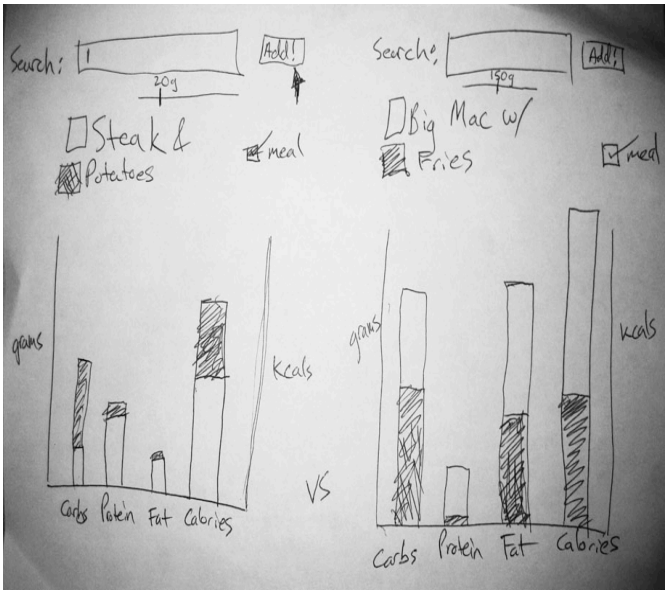

Figure 2 – Stacked Bar Chart

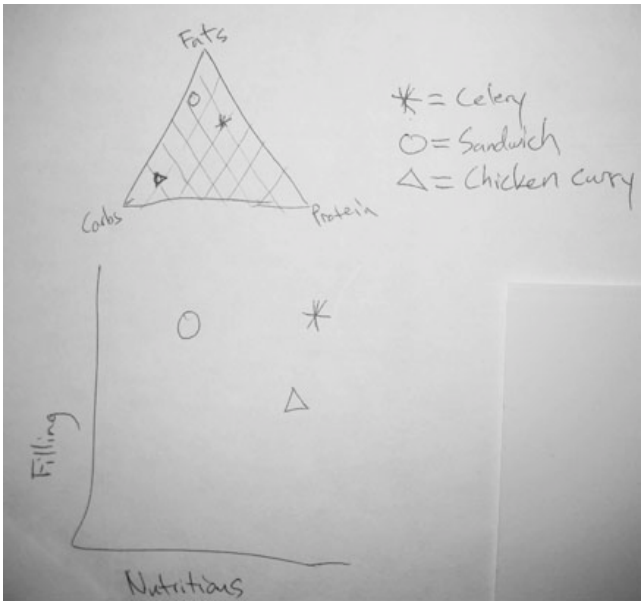

Figure 3 – Food Composition Graph

Finally, in the food composition graph (Figure 3), we tried to focus on making nutritional information condensed and easy to judge at a glance, but it was not amenable to users. Because of its overly simplistic design, it doesn't actually display anything very quantitative. It only represents a qualitative view of a food's content, and users are not accustomed to the design enough to judge food composition. Additionally, most users were looking for some more specific values rather than a general estimate.

We focused on the simple bar chart (Figure 2) as a template for our product because it is simple, clear, and most accessible to users. Figure 1 could make a great educational tool, but it requires too much active interaction and cognition to navigate and interpret easily.

Data Input

Our next hurdle was acquiring the data. Our original idea was to have a mobile app that could take a picture of a nutrition label and use optical character recognition (OCR) technology to parse the information. After some initial attempts, we realized that this would actually be much harder than expected. The scope of this project focuses on the visualization, not the input mechanism, so we used the USDA database for our nutrition data. To provide easy access to the food we designed a multi-tiered lookup system, which first searches for exact matches, then prefix matches, then any substring matches, for easy data access. Additionally, to enable users to simply and easily explore our application, we provided immediate access links to sample foods at the bottom. For the sample foods, we chose the most popular fast foods to provide an interesting comparison between foods within a typical American diet, and between foods that are generally thought of as healthy and unhealthy.

Finally, drawing from user feedback and in-class comments from our initial presentation, we added a warnings panel for abnormally high sugar, trans fat, saturated fat, cholesterol, and sodium of food products. Users can click on warnings to learn about the potential health risks of these ingredients.

Figure 4: An unintended use case. A user compares a burger to itself, viewing by raw grams on the left graph Daily Value on the right graph. While the meal appears to be balanced among the three major nutrients on the left, we can see that on the right that it is a significant source of fat—74 percent of daily value, while not nearly as much for carbohydrates.

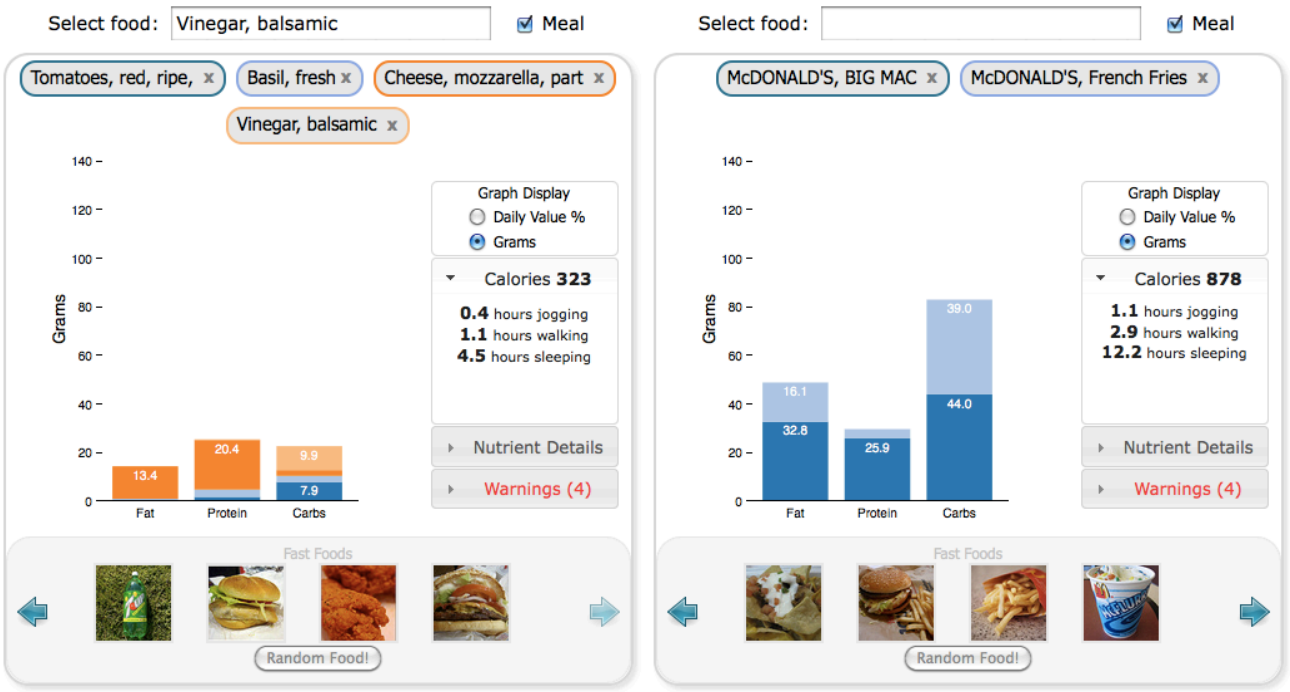

Figure 5: Comparison of healthy and fast-food meals. In this screenshot, a user constructed a salad on the left-side graph by using the meal feature, and added a hamburger and fries on the right-side graph. With the complex meal on the left, the user used the color coding of the graph to look up the qualities of individual ingredients. The user selected the fast food to compare due to its easy accessibility, and the differences in calories are apparent.

RESULTS

Here are the results from the user tests we conducted with the product as we were finishing development.

Our application was a success in engaging users to analyze their diet patterns. After an exploration of food portions extremes, for example, a serving of pineapple compared to 3 Big Macs with fries, many users would analyze their diet and remark on certain characteristics. There was universal acclaim for the warnings panel, and users enjoyed the subjective nature of the application in contrast to a normal objective nutrition label. Users also approved of the toggling feature between daily value and serving size in grams. Some users preferred one or the other, but all sought the option to toggle between the two.

Some notable examples of uses are highlighted in Figure 4 and Figure 5. In Figure 4, a user compared the gram value and daily value of nutrients in the same meal. In Figure 5, a user compared two full meals, one constructed from our meal builder, and another constructed from the pre-defined fast food options.

We tried to make calories actionable by giving users a task to complete, rather than just a value (Figure 6). In doing this, we map calories to the sorts of physical activities that are equivalent to them. Note that calorie calculations may have up to 20 minutes of error, as the estimates are based on calculations for a 160-pound person. We thought it was important enough to influence activity and diet choices by giving a ballpark estimate to include this as a major component of our visualization.

A shortcoming of our visualization is that color encodings were not displayed prominently enough. Some users struggled at first to derive the meaning of the stacked colors in relation to specific foods.

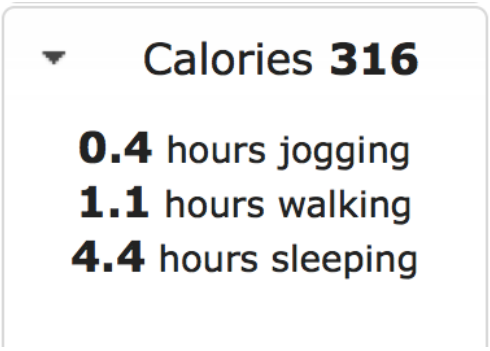

Figure 6: Interface element for viewing the calories and calculated hours of exercise for the meal displayed in a graph.

DISCUSSION

When initially designing the product we looked at what the current solutions offered. After talking to our users, we found out that our real competition is not the other sites but apathy, intuition, and "guesstimation" which guided the current eating habits. We found out that the users all mostly had a very positive view of the software and that they could all identify personal uses of it. The daily value view was very popular and before we had implemented (though we had plans to) we received several requests for it.

A main observation we made from user studies was that most people have not encountered an application like this of any kind. Our hypothesis is that the existing solutions are too complex, not applicable for their needs, and not visually appealing. We feel that there is a huge opportunity for a product that serves as a general awareness and decision-making tool. Any logging or personalization features that we add on to this will enable the users to tailor the application to a wide range of uses. The feedback was positive.

We probably should rethink the "sleep" exercise metric as users seemed to enjoy it, but it actually provides a misleading view since the human body uses more energy when it is awake than sleeping. However, everyone we showed it to would have a common response of "Oh, I can just sleep for 48 hours and burn off my Big Mac," implying that they think sleeping will result in an increase in the amount of calories they are burning. Though it is entertaining to have the sleep calculation shown and we noticed that it drags people into the application because they are intrigued with it, we need to further evaluate the validity of the impression this creates in the users. We were also considering adding "talking" as an exercise to make the application have a touch of humor, which we noticed greatly increases the amount of engagement a user has with the application.

Some users were unclear how the application would work its way into the decision flow when purchasing a product. We anticipate that users would view our visualization upon scanning products, or they could have the option to search manually. Easy, reliable input of products continues to be a significant challenge in this space, but it is outside the scope of our project.

FUTURE WORK

The main way that we can improve our product is to improve the input methods employed by our interface. The main problem facing products that compete with ours, such as nutrition planners, is that it is tedious to input what a person has eaten or will eat and get back the nutrition data. This can be solved by having a good database of pre-existing food, but it is difficult to provide data that is simultaneously thorough, accurate, and easy to navigate.

The USDA database is thorough, but the names of food stored in the database are unintuitive to average consumers. Web products solve this problem by allowing users to add to the data, although this creates problems of data accuracy, since the data is often not moderated.

Ultimately, if this product were to replace the nutrition-label-reading experience for all U.S. consumers, then every single snack, meal, and beverage produced commercially would have to have nutrition data that a user could quickly retrieve. Restaurants, cafeterias, and grocery stores could have pre-defined meals that a user could browse through when they are present at that location and about to eat a meal. For consumption of packaged foods, a user could capture a nutrition facts label with a camera and our program could scan the nutrition data from it; recipe websites and recipe books could come with nutritional metadata that could easily be plugged into our program. Since these challenges were outside of the scope of creating an effective visualization, we did not create them for this project, but they certainly would expand the use cases and improve the user experience of our product.

Another important way to make our interface an improvement from current nutrition labeling is to make it fully personalized and adaptable. One shortcoming of current labeling, which it explicitly acknowledges, is that daily values for nutrients differ from person to person. A mobile interface that remembers the preferences of its users would solve this problem, and it would only require each user to enter their height, weight, age, and activity level once to provide an accurate configuration. Not only could a user enter their information to help our product determine how to calculate daily values, but a user can also enter in information about what "warning" ingredients they are interested in being notified about. Lastly, with user accounts, we can record what a single user eats throughout a day, and stack up their past meals with their current meal to see if they have reached or exceeded their daily value for nutrients such as calories, fat, and protein. This aspect of memory would make this interface significantly more compelling than existing nutrition labels.

A less important, but equally compelling potential improvement to our product is adding social tools to the interface. For example, allowing a user to see top searches for the day, week, or year will encourage them to explore data that other users have explored, instead of having them start with a blank state. Another social tool idea is to allow users to comment on individual results that they observe. Users can comment on data that confused, surprised, or inspired them and start conversations about food, just like how the existing interface NameVoyager allows users to chat about interesting and surprising patterns on baby names.

We believe that our product provides a unique glimpse into the future of how consumers will browse nutritional data and make decisions on that data. With a complete set of features to assist users in data input, social sharing, and personalization, we could reach our goals of increasing consumer interest in good nutrition, and combating obesity and other nutrition-related social issues.

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