RECIPE RECOMMENDER WITH GROCERY SHOPPING APP

Team170 - Sara Brenneman, Shivani Garg, Harikrishnan Murali, Austin Nifong

Introduction

During the pandemic last year, we saw multiple businesses forced to shut down to curb the spread of the virus. Amongst those affected was the restaurant industry. This compelled people to have more home cooked meals. As they had to spend most of their time at home, cooking became an activity of choice and they started expanding their taste through new flavors. Eating more home cooked meals has shown to improve dietary quality and lower adiposity. [1] Improvement in the grocery delivery system also made it easier for them to order these recipe ingredients from the comfort and security of their homes.

It is likely that people will continue making more home cooked meals that they used to prior to the pandemic [2]. On the other hand, more people have migrated towards purchasing groceries online in US [3] and in other parts of the world [4].

Problem definition

Manually calculating the nutritional information and finding the list of necessary ingredients when making a meal can be confusing, time consuming, and lead to errors. Currently, people will typically select a recipe from an app or website based on their preferences, note the necessary ingredients needed, and buy them from a grocery app or store. Further if people want meals that fit their dietary constraints, they must manually calculate the nutritional information of all their meals. This entire process usually involves switching between many apps and websites and doing tedious calculations which can be time-consuming and can lead to errors.

Our idea for the project is to create a meal plan recommender app that places health first. The app would be designed to provide a set of daily meal plan options based on user constraints such as his or her health profile, dietary restrictions, number of servings, etc. all in one simple application. To provide the user with greater convenience, we would also like to connect the app to Amazon Fresh in order to automatically place ingredients into an Amazon cart which can then be scheduled for delivery or pickup.

Survey

Diet plans have been worked on since the 1930s. The initial problem was motivated by the Army's desire to reduce costs while feeding soldiers a healthy diet. Most famous of these solutions were those of Stigler [5] using a heuristic method and Dantzig [6] using a simple method to predict ingredients that satisfy nutritional requirements. But these resulted in odd combinations of food that wouldn't be appreciated by most individuals. Since then, more research has been done in developing better recipe recommendations. Recipe recommendation today is done by predicting relevant ingredients in networks, content and collaborative filtering, and detecting cuisine [7], [8], [9], [10], [11] [12]. This is moderately useful to our project because we also need to recommend recipes based on nutritional and other factors but not solely on ingredients used and cuisine. However, there are some shortcomings to consider, such as the limited amounts of cuisine and ingredient predictors studied. Ueda et al. [13] looked at recommending recipes to users based on their cooking browsing history. One shortcoming of this approach is that cooking browsing history may not be indicative of the user's preferences. We would like to tailor this and add it later as we have developed our user base. Popular recipe apps such as all recipes, simplify foods, etc. provide a lot of benefit to their users but have the potential to be more efficient. Currently, the user chooses the desired recipe from an app based on their preference, notes the required ingredients, and buys it from a grocery app or store. The user must manually calculate necessary nutritional information, cost, and consolidate grocery lists. Switching between apps can be time consuming and can lead to confusion or errors.

Proposed method

Why is it better than the state of the art?

1. Our approach will utilize a constrained optimization to provide a combination of food recipes that provide the taste, dietary restrictions, and nutrients needed in a day for the user.
2. We are streamlining the process to find daily meal plan recipes, aggregate ingredients, and buy them on Amazon on one application.
3. It allows for a greater variety of user preferences including height, weight, age, gender, dietary restrictions, desired meals, serving size, etc. than what is currently offered.

Describe the algorithm and the workflow

First the user enters personal information such as height, weight, age, gender, and activity level into the website. Using this information and the Harris-Benedict [14] algorithm, we can estimate the Active Metabolic Rate (AMR) of the individual. Along with this, the user has the option of selecting the number of meals he/she would like these calories to be split over and other personal preferences such as if he or she is vegan or has any specific allergies, and how long they would like the preparation time to be. For a single recipe, they would also have the option to search by keyword. Using these preferences, we first filter the recipes based on the user's vegan and allergy preferences (and search keywords) – the search functionality uses pandas string contains with the regex option. Then we further filter out the recipes that do not satisfy the calorie and macronutrient requirements per meal calculated by the Harris-Benedict algorithm. Once we have filtered out recipes that do not meet all these constraints, we then rank the recipes using the proposed scoring function:

$$f(\bar{r}, R, T, k) = \bar{r}\,\log_{10}(R) - (Tk/60)$$

$\bar{r}$ = average rating

R = total number of ratings

T = preparation time in minutes

k = importance of preparation time to the user: (1, 3, 5: low, medium, high)

Providing an optimal solution is quite hard considering a user would not want to consume the same recipe over and over. Hence, we choose to provide multiple feasible solutions based on the above constraints for the user to choose from. For a single recipe, the top 15 recipes are retrieved, and the user is provided 5 options at random to choose from. For a mealplan, 5n recipes are retrieved, where n is the number of meals specified by the user. Of these, 3 mealplans options are provided consisting of n recipes each.

Next we generate the ingredients list from the selected meal or meals. From this list, a JSON string is created that has the ingredients and amounts required. The JSON is inserted into the interaction with the Amazon API.[15] The user does not see this interaction on their screen but sees the Amazon window load in their browser which displays a shopping list including items and required amounts.

Data Collection

Recipe information is primarily from an online Kaggle dataset [16]. The recipeIDs, average rating and number of ratings are taken from the dataset. This is supplemented with information obtained through web scraping allrecipes.com. The web scraping is done using a pre developed python package. [17]

The ingredients in each is split into quantity, units and name. Regex was leveraged to determine the quantity and units from the ingredient strings, whereas Spacy's Named entity recognition algorithm [18] was used to grab the ingredient name. The algorithm was trained on 60000 ingredients from a NY time's ingredient parser dataset [19]. Using a regex search, the accuracy of the returned name vs the true name was determined to be 92% (we search for at least a sub string of the ingredient name to be grabbed – example: onion in place of red onion is considered a good match)

Once the all the necessary attributes were obtained, the data was split into 3 schema. The detailed schema design and the entity relation diagram are shown below.

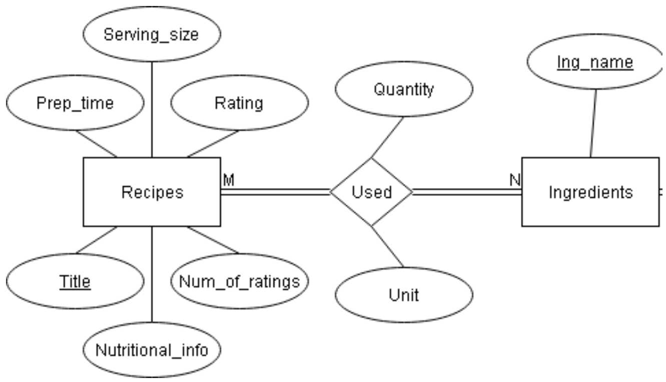

Figure 1. EER diagram

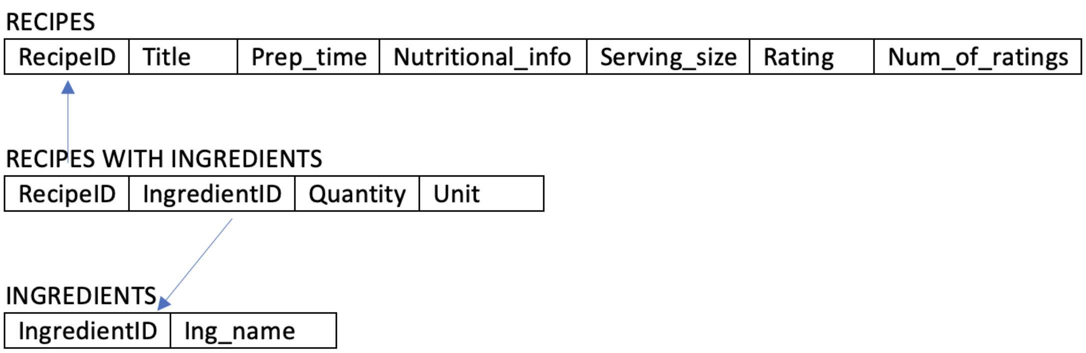

Figure 2. Schema design

Arrows indicate foreign key to primary key connections. Recipes contained 40156 records with 14 attributes, ingredients contained 4046 records with 2 attributes and the recipes to ingredients connection stored the foreign keys along with the quantities and units which amounted to 356385 records. This, along with using integers for primary and foreign keys, helped significantly reduced computational time.

Describe the UI

The GUI is developed using the PyQT5 package in python

FRONT TAB (FORM)

1. Collect user information such as age, gender, height, activity level, weight, single recipe/meal plan, time spent cooking, meal per day, allergies, vegan, and preferred ingredients.
2. Upon submission of user input, the required number of calories, grams of protein, and grams of fat are displayed (for daily consumption and per meal).

SECOND TAB (RECOMMENDATIONS)

1. Recommendations
    a. If a single recipe is desired, 5 recipes are recommended that align with your required nutritional consumption per meal. Serving size, preparation time, average rating, number of reviews, and number of calories are displayed for each recipe.
    b. If a meal plan is desired, 3 meal plans (each with the number of meals you desire per day) are recommended that align with your required nutritional consumption per meal. Serving size, preparation time, average rating, number of reviews, and number of calories are displayed for each recipe.
2. There is an option to refresh/shuffle the recommended recipes/meal plans that were suggested to you using the "refresh" button at the bottom.
3. Upon selection of a recipe/meal plan, the links to the selected recipes are provided for the user to browse through.

THIRD TAB (INGREDIENTS)

1. A consolidated list of ingredients based on the selected recipe/meal plan is displayed.
2. There is a "Buy on Amazon" button at the bottom of the list that will take you to an Amazon webpage.

AMAZON CART

1. The Amazon webpage has all the ingredients from the list in your Amazon shopping list so that you can easily purchase the necessary ingredients.

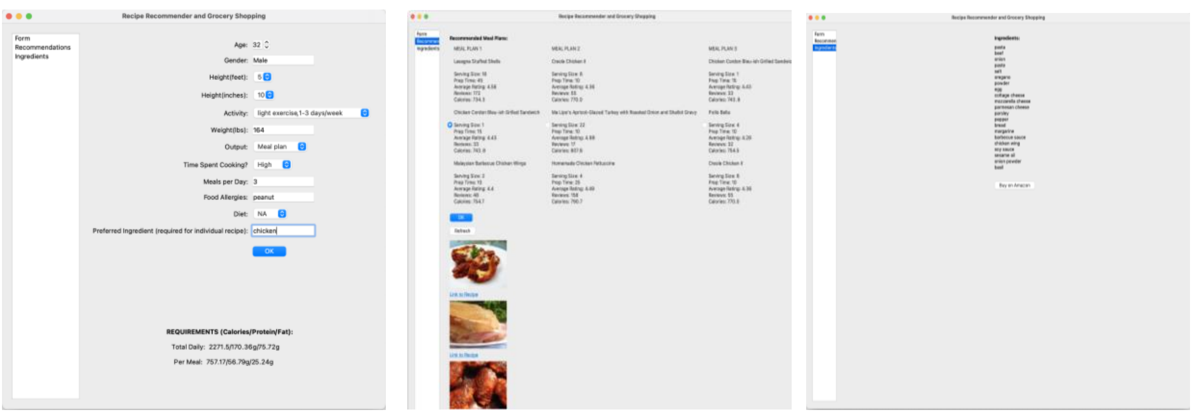

Figure 3. UI pages

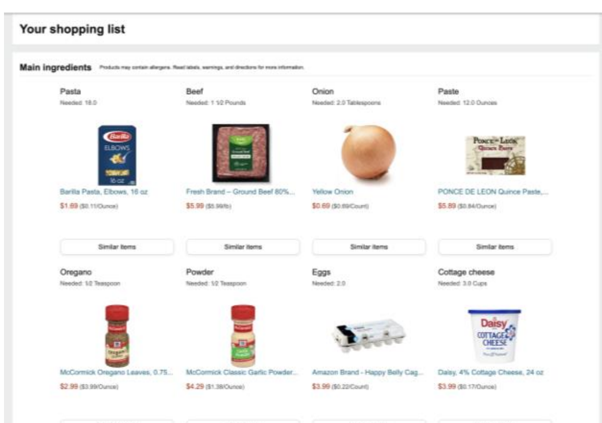

Figure 4. Connected Amazon cart

Experiments and Evaluation

List of questions users will answer and why

1. What do you like most? (Text)
    a. Gather positive information about the app
2. What do you dislike? What would you like to add? (Text)
    a. Focus attention on features that need to be added/adjusted and the general improvement of the app
3. Do you use it often? (Choice)
    a. If it works as intended, user would use it more often
4. Is the navigation sensible? (Choice)
    a. Helps better design the UI
5. Does it suggest recipes that satisfy your requirements? (Choice)
    a. Gets more insight into the suggestion algorithm
6. Is the connection to Amazon useful? (Choice)
    a. Identify if this is in fact as useful as we expect it to be. If so provide additional online shopping options
7. Would you recommend it to a friend? (Choice)
    a. Better the app more the chances of user recommending it

We designed a list of questions to survey the users of our application. The answers to this survey give us an idea of what the users like about the application, what the users do not like about the application, what they would like to see changed, and their usage habits. In the future, we can use this information to improve upon and assess users' impressions.

Details of Experiments

A questionnaire was sent out to a series of our family and friends who tested the apps to get their feedback on this. As expected, the results are slightly biased but we did receive some valuable feedback on how to improve the features of the app.

The results of the survey are as follows:

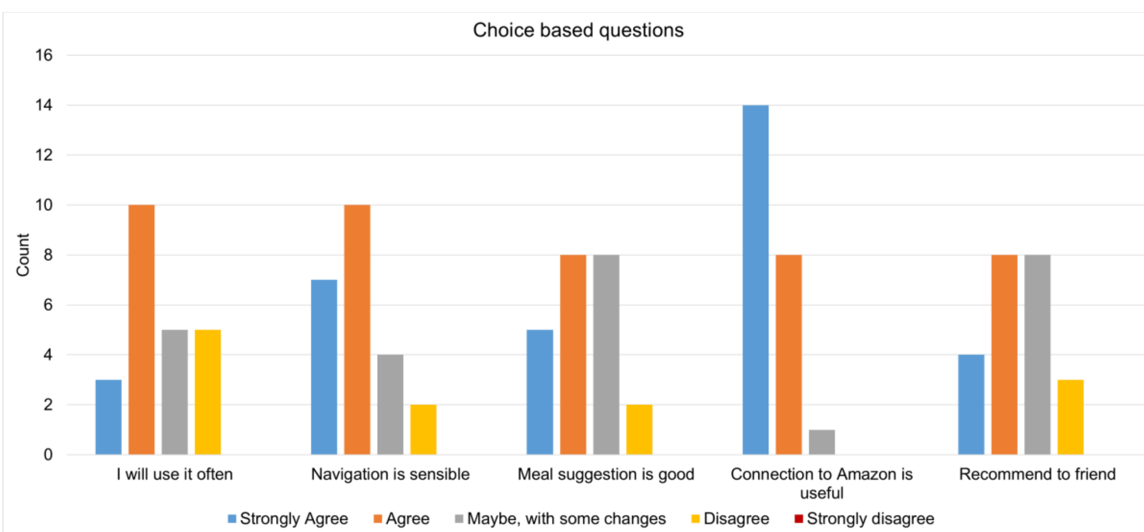

Figure 4. Results of choice based questions

Figure 4. Results of text based questions

From the results it's clear that everyone appreciated the addition of the Amazon Fresh API. It provided the ease of shopping that we were after. The app in itself was reported to have significantly reduced time to search healthy recipes and order necessary ingredients. The reported reduced was over 100% as it halved the time needed to find the necessary macro nutrient information, search recipes, collect ingredient information and order them online. Other positives include, simple UI, focus on user health and the option to filter by preparation time.

No one strongly dislike a feature in the app, but did happen to point out area that we could improve upon. We did receive some feedback on UI bugs. Although it was simple to navigate, it did cause some problems while working. Apart from that, users preferred having additional options to filter recipes, and most importantly provide the cost of the recipe based on the Amazon ingredients. This wasn't added in our implementation as it was hard to convert certain volumetric units in mass units from Amazon.

Distribution of Team Effort

All team members have contributed a similar amount of effort to this proposal.

Conclusions and discussion

Overall, our app is designed to save time and help people maintain a diet that fits their individual needs. By considering each user's information and preferences such as height, weight, gender, and dietary requirements, our app will automatically generate meal plan recommendations that fit the user's needs and optimizes the rating and meal prep time of the meal plans. In the app, the user can choose to generate choices for a single recipe or a meal plan that fit their needs based on their input. From the selection, the user can get the ingredients from Amazon Fresh when selecting the "Buy on Amazon" button.

We performed a study with 23 users and found that most found the app to be more useful than the traditional way of searching for healthy recipes. Their useful feedback would go into improving the app and adding more functionalities like – storing user information to suggest better recipes based on patterns, and connecting to health devices to improve AMR tracking. In the future, we will test this app with more users and continue to update the user interface to promote continued usability and responsiveness to user's needs.

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