Georgia Tech - CS6750 - Yummly Advanced Ingredient Search
Team: UXplorers

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***Abstract*—**This project enhances Yummly's search functionality by enabling users to input specific ingredients, aiming to yield more personalized and relevant recipe results. Traditional search methods often overlook individual pantry contents, leading to broad and unsatisfactory outcomes. By incorporating user-centered design and advanced filtering algorithms, our improvement focuses on tailoring search results to fit unique user profiles. Through a streamlined design process involving needfinding, prototyping, and user testing, we anticipate a significant improvement in user engagement and satisfaction. The upgraded search feature promises to cater to Yummly's diverse audience, encouraging culinary exploration and adherence to dietary restrictions with greater ease and accuracy.

1 INTRODUCTION

In the realm of digital culinary exploration, the quest for the perfect recipe is often hampered by the overwhelming abundance of options and the challenge of aligning these with individual dietary preferences, pantry stocks, and nutritional goals. Yummly, a beacon for food enthusiasts and home chefs, stands at the precipice of innovation, poised to revolutionize how users engage with its search functionality. The project aims to improve the search feature on Yummly by allowing users to input preferences and ingredients to get more relevant results. This enhancement is not merely an upgrade; it is a paradigm shift towards a more personalized, efficient, and user-centric culinary discovery experience.

The journey begins with a comprehensive needfinding phase, engaging with a broad spectrum of Yummly's users - from the novice cook seeking simple, healthy meals to the experienced gastronome exploring complex culinary challenges. This phase will uncover the nuanced preferences, common frustrations, and unmet needs within the current search ecosystem. Following this, our team will embark on designing high-fidelity prototypes that embody our vision of an intuitive,

adaptable, and empowering search interface. These prototypes will then undergo rigorous evaluation through user testing, ensuring that the solutions we propose resonate with our diverse audience and elevate their cooking journey to new heights.

By focusing on this specific task of enhancing the search functionality, we aim not only to improve the user experience on Yummly but also to set a new standard for recipe discovery platforms. This project represents a confluence of technology, culinary arts, and user-centered design, illustrating the transformative power of empathetic design in the digital age.

2 NEEDFINDING PLAN

The needfinding plan begins with desk research aimed at providing a comprehensive view of Yummly's features, goals, and user demographics. This phase will involve analyzing Yummly's official documentation, user reviews, competitors, and relevant industry reports to gain a robust understanding of market conditions.

Given that Yummly boasts over 23 million users possessing a broad spectrum of culinary interests and backgrounds, the strategy involves structuring the user base into a modular hierarchy using criteria such as frequency of use, demographic variables, and cooking preferences (Yummly, 2024). This will enable a more refined understanding of user needs and experiences.

In the next phase, a heuristic evaluation of the existing interface will be conducted to assess its usability. Three of Jakob Nielson's 10 usability heuristics are applied to assess usability of the interface (Moran and Gordon, 2024). The following heuristics were selected based on relevance to the Yummly interface: *consistency and standards*, *flexibility and efficiency of use*, and *Error Prevention*.

Next, online surveys are deployed to students enrolled in the Georgia Institute of Technology Online programs. Surveys are distributed via Microsoft Forms and promoted through university student group channels. Surveys are designed to uncover details and insights into users' unique experiences with the Yummly interface. The survey will include a mix of scale, multiple-choice, and open-ended question types. Participants will be encouraged to complete the survey through the academic incentives. Given the diverse student body, this approach will allow us to capture insights across multiple socioeconomic demographics.

It's important to note that using Georgia Tech students for quantitative analysis could introduce a sampling bias. As these students are enrolled in a graduate-level Human-Computer Interaction course, they may possess a higher degree of technological proficiency in comparison to the broader Yummly user base. Consequently, this may lead to results that do not fully capture the experiences of individuals who are less technologically savvy.

Finally, three personal participatory design interviews will be conducted with users who are considered subject matter experts (SMEs) in the culinary field. These three SMEs will be maintained throughout the course of the design lifecycle. They will be treated as stakeholders throughout the process, as they maintain active involvement. Utilizing a participatory design process will assist us in implementing a user-centered design, and mitigate sampling bias which may be introduced in survey results.

3 NEEDFINDING RESULTS

The needfinding plan closely resembled the planned methodology. First, the Heuristic Evaluation was conducted to identify usability issues. After a collaborative discussion, the team conducted desk research and quickly issued online surveys to Georgia Tech Students via the school's online survey portal. Issuing surveys expediently allowed the team to continue to focus on its third needfinding activity - personal interviews. Conducting and analyzing our heuristic evaluation and personal interviews prior to analyzing survey data provided a unique approach. Deliberately structuring the order of needfinding activities allowed the team to view the problem through a predictive lens before user testing began.

3.1 Heuristic Evaluation Results

Utilizing Jakob Nielsen's usability heuristics, the Yummly search functionality was evaluated against *Flexibility and Efficiency of Use*, (Appendix B, Figure 17), *Consistency and Standards* (Appendix B, Figure 18), and *Error Prevention* (Appendix B, Figure 19).

Flexibility and Efficiency of Use: The current Yummly filter functionality is inaccessible from the home screen. To access the filter screen, a user must input an ingredient recognized by Yummly first. This implementation may present challenges for novice users whose goal may be to filter by ingredient without prior input. A recommendation for improvement is to include the filter functionality on

the home page adjacent to the search bar, allowing users to directly navigate to the filter screen without entering an initial ingredient.

Consistency and Standards: Yummly's filter interface allows the input of multiple filters from the same food group, potentially causing confusion. For example, a user trying to filter by scallions might encounter issues displayed in Figure 1. A recommended change is to consolidate ingredients by similar terms, thereby eliminating duplicate entries.

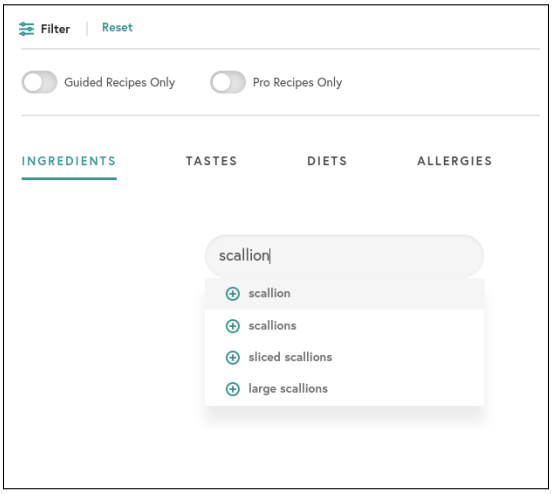

Figure 1—Yummly search filters allow the user to filter by multiple same category type ingredients.

Error Prevention: Users who attempt to input an ingredient unrecognized by Yummly are met with an unresponsive interface. There is no user feedback after pressing enter, leaving users unsure of what happened. A recommended change is to introduce error handling that provides feedback when the desired ingredient is not found, thus improving user interaction and preventing confusion.

3.2 Interview Results

Three personal interviews were conducted with participants representing a spectrum of cooking experience. For anonymity, pseudonyms are assigned to each participant.

Rachel Interview: Rachel, a novice chef and frequent Yummly user, enjoys cooking but finds the platform not very intuitive for inexperienced users. Her main concern is the filtering algorithm's specificity; a slight variation in an ingredient name

could exclude thousands of relevant recipes. Therefore, one must be very familiar with the filtering process to take full advantage of the tool.

Tristan Interview: Tristan, an experienced chef with culinary school training, uses Yummly for inspiration. He shares Rachel's concerns about the platform's filtering feature, noting the difficulty in using the ingredient filter effectively. The challenge of filtering by more than one ingredient without losing relevant recipes is his primary issue.

Devin Interview: Devin, a self-proclaimed food lover with over 40 years of cooking experience, seldom uses Yummly, preferring to search for recipes via search engines. A walkthrough of Yummly's filtering process highlighted several frustrations:

- Unawareness of the filtering option until it was demonstrated.
- Lack of feedback when typing unrecognized ingredients into the search bar.
- Overwhelmed by the initial display of a large number of recipes.

3.3 Survey Results

A total of 35 students from Georgia Tech provided needfinding survey responses – uncovering critical insights and shortening knowledge gaps.

Based on the needfinding survey conducted among a diverse group of users, the results section reveals significant insights into user preferences and the challenges they encounter while navigating recipe websites like Yummly. This comprehensive analysis, derived from the survey responses, highlights several key themes pivotal for understanding and improving the user experience on recipe websites.

The survey uncovered a wide range of usage frequencies among participants, from daily to never, showcasing a broad spectrum of engagement levels with recipe websites. This variety in usage patterns underscores the diverse nature of user interaction with such platforms. The primary objectives of users vary significantly, encompassing the utilization of specific ingredients at hand, the exploration of new recipes, the search for dishes that accommodate dietary restrictions, and the desire to learn new cooking techniques. These goals highlight the multifaceted demands users have, from practicality and exploration to adherence to dietary needs, emphasizing the need for recipe websites to cater to a wide array of user requirements.

When evaluating satisfaction with search functionalities, responses varied from "Somewhat dissatisfied" to "Very satisfied," with a notable number of participants expressing neutrality. The range of satisfaction levels as shown in Figure 2, points to specific unmet needs that, if addressed, could significantly enhance user satisfaction. A considerable portion of respondents reported challenges in finding recipes that align with their dietary preferences, indicating a gap in the search functionality's ability to filter effectively based on dietary restrictions.

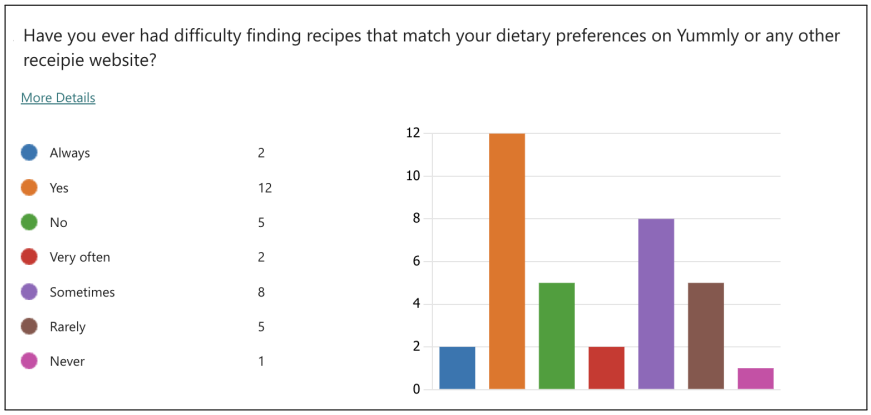

Figure 2—Current user dissatisfaction

The survey also revealed a strong interest in specific features that could improve user experience. The concept of inputting specific ingredients for recipe searches received widespread support, reflecting a demand for personalized recipe suggestions and efficient utilization of available ingredients as shown in Figure 3. The importance of filtering recipes by dietary restrictions was underscored by many responses, ranging from "Extremely important" to lesser degrees of importance, highlighting the necessity for recipe websites to offer nuanced search capabilities that cater to diverse dietary needs. Additional features suggested by respondents, such as filters for user ratings and reviews, the ability to exclude certain ingredients, more detailed nutritional information, and cooking time filters, suggest a preference for more personalized, detailed, and convenient search options.

The process of selecting recipes is influenced by various factors, including the availability of ingredients, recipe photos, user ratings/reviews, and, for some, detailed nutritional information or preparation/cooking time. This mix of practical considerations and visual appeal in the recipe selection process underscores the

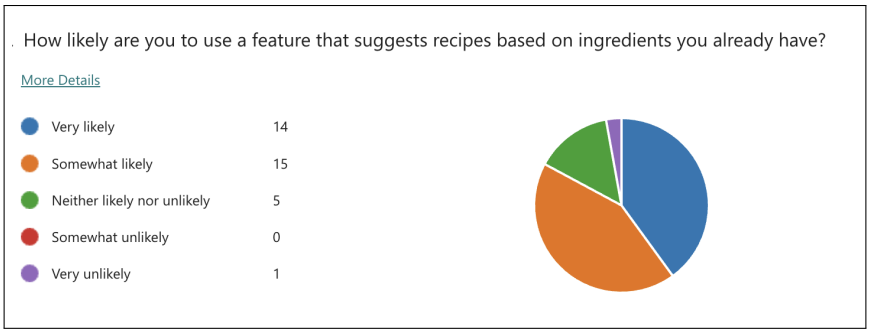

Figure 3—User interest in ingredient based search

complexity of user preferences and the importance of addressing these factors in search functionalities.

There is a notable trend towards an interest in enhanced search features for more personalized recipe suggestions, with many respondents believing that such features would likely increase their usage of recipe websites. This indicates a demand for improved personalization in recipe discovery, leveraging specific ingredients, dietary restrictions, and other preferences to enhance the user experience.

The needfinding survey results offer a treasure trove of insights into user expectations and preferences regarding recipe websites. By focusing on personalization, efficiency, and comprehensive information delivery, recipe websites can significantly improve the user experience, meeting and exceeding the needs of their diverse user base. Implementing the recommendations derived from these insights will not only address the current gaps in search functionality but also set a new standard for culinary discovery platforms. This approach promises a more engaging, satisfying, and user-centric culinary exploration experience, encouraging users to engage more deeply with the platform and, ultimately, enriching their cooking and dining experiences.

4 BRAINSTORMING PLAN

Alex Osborne is widely accepted and referred to as the father of brainstorming. In his book entitled Applied Imagination, he divided the processes into three distinct phases – Fact-finding, Idea-finding, and Solution-finding (Faste, Rachmel, Essary, Sheehan, 2013, as cited in Osborne 1950). The teams strategy for brainstorming will emulate this framework. The team will utilize chunking by separating brainstorming sessions to occur on three separate days. This will allow the group the

opportunity to reflect on session results, and maximize productivity in subsequent sessions. Additionally, the sessions will occur on simultaneous days to prevent the occurrence of recall bias. Throughout all phases, meeting times are flexible, and backup communication plans will be in place.

The first session will focus on ideation and fact-finding. This session will occur asynchronously to ensure group bias does not occur. Members will seclude themselves to a quiet area and focus on the generation of a problem statement and analysis of relevant data. Following the asynchronous session, the group will convene and discuss results via conference call.

The second session will focus on prototyping and idea finding. This phase will be conducted via conference call. The group will utilize Discord's video, voice, and collaboration tools to ensure a comprehensive brainstorming session. Group members will block off at least two hours to conduct this phase, as we anticipate a detailed and collaborative conversation concerning tentative ideas and possible leads to occur.

The final phase will focus on feedback integration and solution finding. In this phase, we focus on evaluating our initial ideas and prototypes, and offer a tangible way forward for implementation.

5 BRAINSTORMING RESULTS

The team embarked on a structured brainstorming journey aimed at redefining Yummly's search functionality. The team utilized a combination of remote collaboration tools for brainstorming and document sharing, ensuring a seamless and productive ideation process despite geographical separations. Upon conclusion of our three iterative brainstorming sessions, the group refined our task into a clear and concise problem statement, generated three design alternatives with which to move forward, and came up with a clear path towards implementation.

The brainstorming was organized into three distinct stages: ideation, prototyping, and feedback integration, spread over three days of sessions to refresh and realign. The initial stage was dedicated to unfettered ideation, with the team allocating one hour to generate a wide array of ideas aimed at enhancing Yummly's search algorithm, user interface, and overall user experience. This brainstorming phase emphasized the importance of creativity and innovation, with team members encouraged to think broadly about potential improvements without constraints. Upon conclu-

sion of this session, the team produced a problem statement that captures the context of our task:

Through iterative design processes, our three-person team aims to identify and address key usability issues within the Yummly food web application's search functionality. By integrating principles of distributed cognition, we seek to enhance the user experience for cooking and recipe enthusiasts, making recipe discovery more efficient and enjoyable while minimizing user effort.

The following session, the team shifted focus to prototyping and fact finding, selecting the most promising ideas from the ideation phase to develop low-fidelity prototypes. This stage was marked by a hands-on approach, with each member tackling different aspects of the solution. The team generated several user profiles, depicted in Figure 4, to facilitate prototype development. This approach allowed for a creative outlet to identify use case scenarios, and identify a targeted demographic for future design.

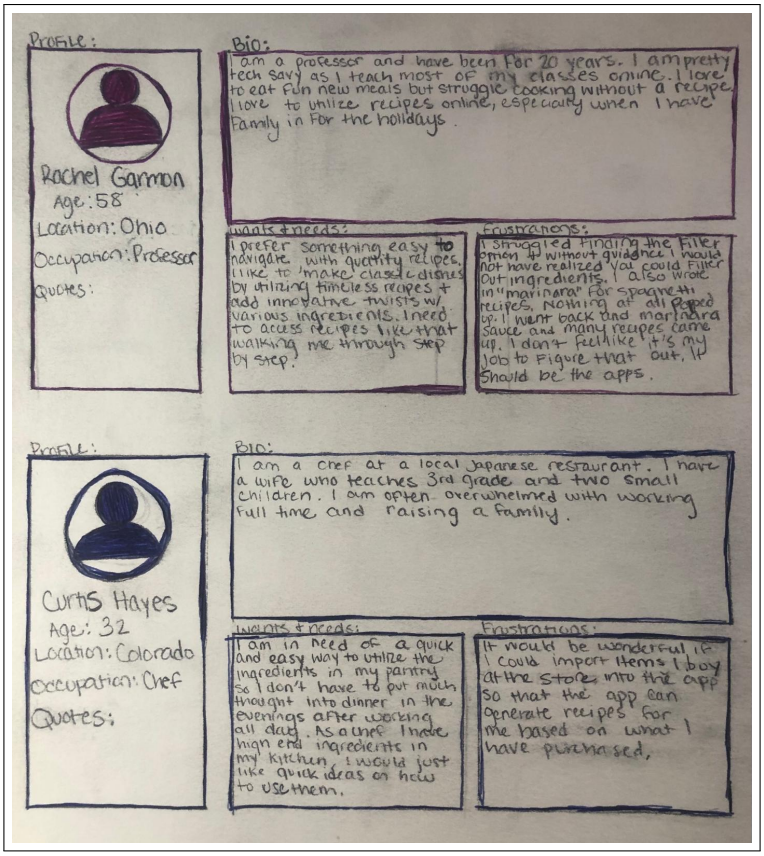

Figure 4—User profiles representing two common use cases

The final stage of the brainstorming process centered on refining these initial prototypes based on team self-assessment and quick feedback sessions with potential users. This iterative approach culminated in the development of more refined prototypes that embodied the team's vision for a more intuitive, personalized, and user-centric search functionality on Yummly.

Alternative One: Enhances the home screen with a refined filtering tool and an optimized ingredient filtering algorithm. Users expressed frustrations over the current tool's inability to accurately filter recipes based on simple criteria, often returning variations of similar ingredients. Our improvement consolidates similar ingredients into unified categories – significantly improving filtering functionality.

Alternative Two: Introduces error handling to improve the filtering interface. The absence of user feedback for incorrect data entries leads to user confusion and frustration. Through the implementation of user constraints and feedback mechanisms, we aim to enhance usability by preventing errors and clarifying input requirements.

Alternative Three: Adds an import tool allowing users to import grocery lists into Yummly, offering recipe suggestions based on pantry and refrigerator items. This targets the common challenge of meal planning with available ingredients. Additionally, this alternative aims to reduce the cognitive effort required to find suitable recipes and addresses a key user frustration.

The evaluation of ideas and prototypes was guided by criteria such as relevance to user needs, technical feasibility, innovation, and potential to improve user engagement and satisfaction.

Looking ahead, the team plans to conduct comprehensive user testing with the low-fidelity prototype, targeting a diverse cohort of users to gather actionable insights. The feedback obtained will inform further refinements to the prototype, ensuring that the high-fidelity and final implementation meets the high standards of personalization, efficiency, and user satisfaction the team strives for.

6 INITIAL PROTOTYPING

6.1 Prototype 1

Filter Modification: The first prototype, a medium-fidelity wireframe, introduces two significant improvements to the original design. First, a large orange button

has been integrated directly on the home screen as a prominent call to action. This design choice serves as an affordance, enhances visibility, and actively encourages users to explore the search functionality. Survey results and qualitative interviews showed that users struggled to locate the filter button; this modification addresses that issue by improving the interface's usability.

Second, changes have been made internally to the filtering algorithm. Unlike the original version, Prototype 1 aims to refine how results are filtered by grouping similar ingredient types together instead of excluding relevant results due to nearly identical ingredients. This adjustment is in response to feedback from 84% of survey respondents who expressed a preference for filtering recipes by specific ingredients, as illustrated in Figure 24. However, 68% of those interviewed reported difficulties with using the existing search function of Yummly, as noted in Figure 23. A consistent qualitative observation from all three interviews highlighted users' frustrations with the search algorithm, underscoring the need for this enhancement.

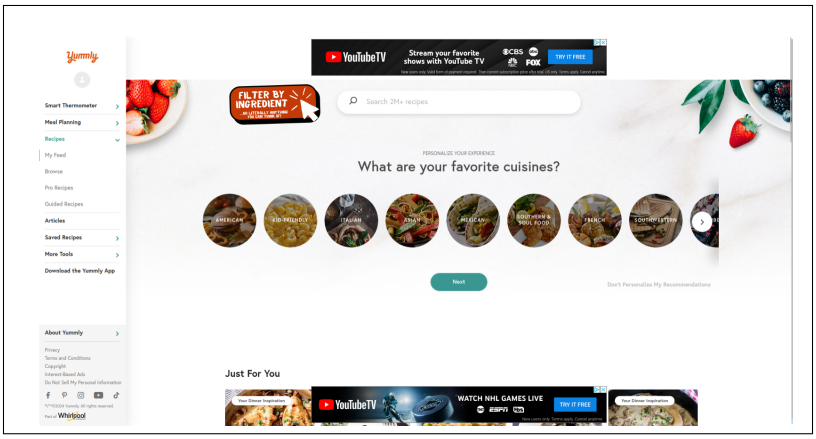

Figure 5—**Prototype 1**: Filter modifications. Improved appearance of the filter button located on the home screen draws attention to the refined filter algorithm.

6.2 Prototype 2

Error handling: Prototype 2 focuses on enhancing user experience by preventing common issues related to the entry of unrecognized ingredients during the search process. This prototype introduces a robust error handling system that provides immediate feedback to users when they input incorrect ingredients. By actively identifying and alerting users to errors as they occur, as shown in Figure 6, this

design minimizes user frustration and prevents the common problem of searches yielding no results.

Key features of this prototype include real-time feedback, which notifies users of errors instantly, guided corrections that suggest correct or similar ingredient names, and an optimized search bar that recognizes and auto-corrects common typos. The aim is to enhance the recipe search process by ensuring users can quickly and accurately adjust their inputs, leading to a more efficient and satisfying user experience on the Yummly platform.

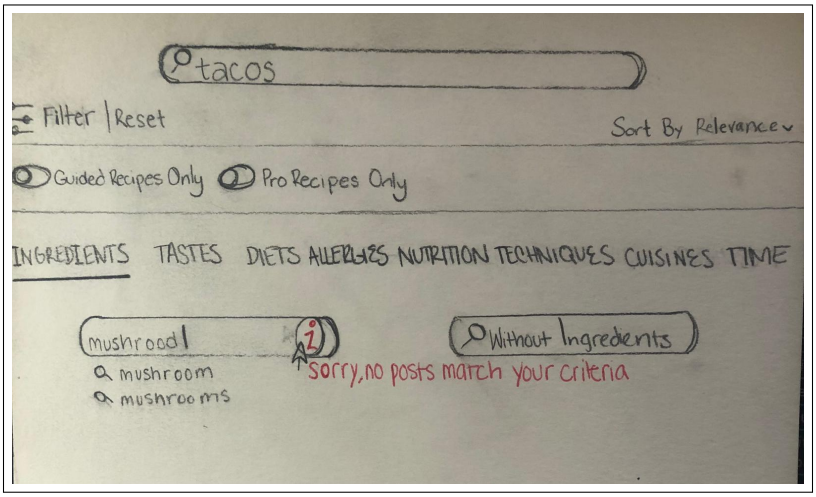

***Figure 6*—Prototype 2**: *Error Handling.* This prototype provides user feedback by constraining users ability to input incorrect ingredients

6.3 Prototype 3

Pantry Import: Prototype 3 is meant to revolutionize how Yummly users manage their grocery shopping and pantry inventory. This tool enables users to automatically upload and integrate their grocery purchases into a Yummly database via a user-friendly graphical user interface (GUI), as depicted in Figure 7. This interface displays the transition of items from the grocery store to Yummly's database, with each item cataloged by type, quantity, purchase date, and expiration date. Upon checkout, the purchased items are uploaded to the database where they are readily accessible for users to view and manage. Although this function is designed to self maintain expiration dates, users may wish to edit when items are consumed or added from their inventory.

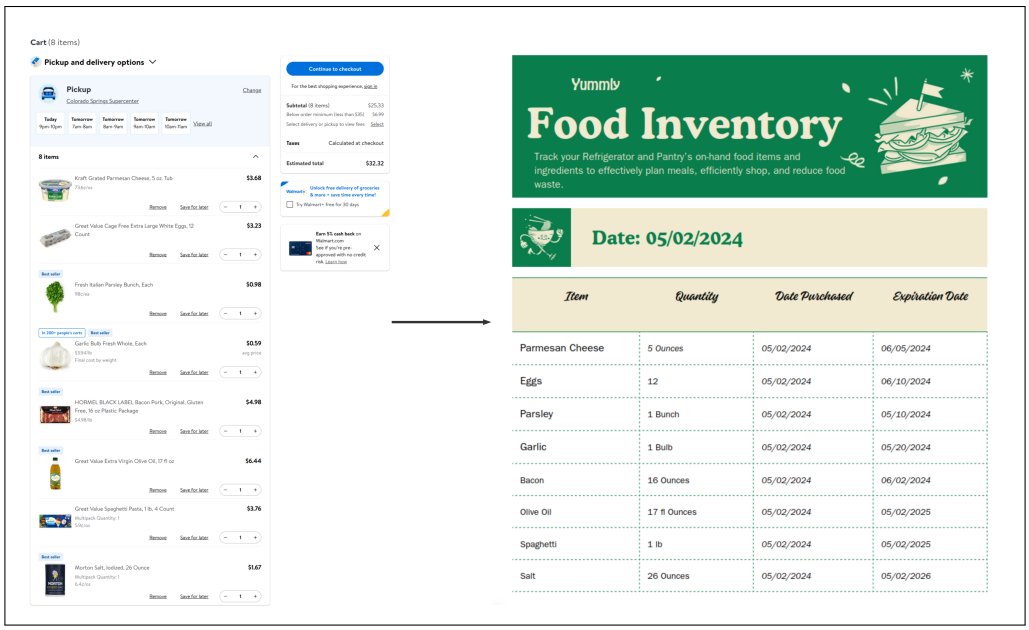

***Figure 7*—Prototype 3:** *Grocery Store Import.* Images represent the relationship between the store and Yummly's customer database. Items purchased are automatically available in a user's profile

Two options exist within the filter menu that allows users to manually view and edit their current pantry or refrigerator inventory (displayed in Figure 8).

Inventory Management: Users are able to manually view and edit their current pantry or refrigerator inventory. This feature is designed to automatically track expiration dates, although users have the flexibility to update the database when items are consumed or new items are added.

Recipe Filtering: A second button enables users to filter recipes based on the ingredients currently available in their inventory. This functionality ensures that users can easily find recipes that utilize what they already have, reducing food waste and simplifying meal preparation. These enhancements aim to provide a more intuitive and efficient way for users to manage their groceries and meal planning directly through Yummly.

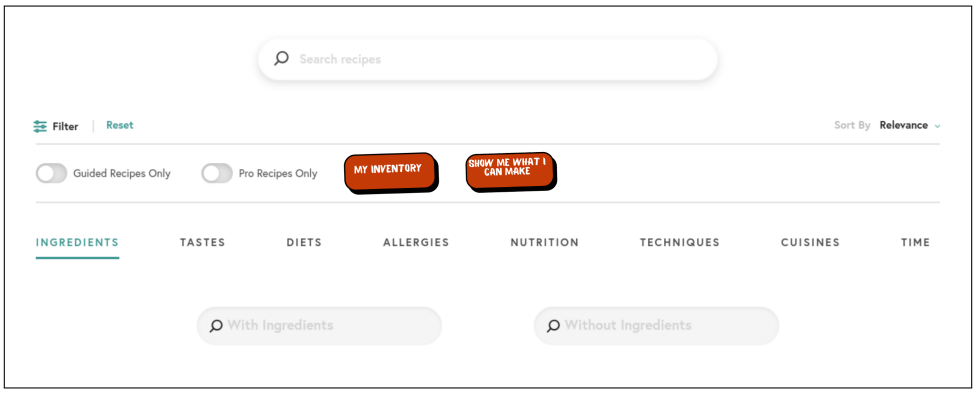

***Figure 8*—Prototype 3**: *Pantry Import:* This prototype allows users to directly import items purchased at the grocery store into a Yummly database. Yummly then makes recipe suggestions based on users' pantry inventory

7 EVALUATION PLANNING

7.1 Quantitative Planning

To assess the effectiveness of the three prototypes, we will deploy a survey to Georgia Tech OMSCS students via the PeerSurvey tool. The survey uses targeted language to assess each of the prototypes based on the following criteria:

- Usability
- Satisfaction
- Efficiency in recipe discovery
- Personalization of search results

The questions are specifically tailored to address distinct aspects of each interface, ensuring that we gather valuable feedback, even in scenarios with potentially reduced precision. Our goal is to determine whether there is a statistically significant difference between prototypes based on the four criteria mentioned above. To accomplish our task, we will conduct a Chi-square Test for Independence. Prototypes

will be directly assessed against the four criteria, with participants choosing which prototype is most preferable.

7.2 Qualitative Planning

In addition to the quantitative evaluation, qualitative data will play a large role in collecting data-points for our prototype evaluation. Data collected from our three previously identified participants will greatly inform our transition into the second iteration of the design lifecycle. Specifically, the interviews will consist of a think-aloud session where we will demonstrate the low-fidelity prototypes and ask the user to talk through their thought process while "using" the interface. The goal is to understand where the users recognize the biggest benefit or where they are confused or underwhelmed. Once the participant has walked through each prototype, they will be asked their favorite and least favorite element(s) of each. This quantitative subset will be compared with the data from the survey responses; the goal is to see positive correlation, so we know that our sampling population roughly represents a larger body of users, which will serve as a validity check for our qualitative data.

We will use the interviews in conjunction with the quantitative survey results to select, combine, or refine our prototypes before selecting a single prototype with which to move forward.

General Findings: Next, we will collect general observations gleaned from the survey, utilizing targeted language to explore several key aspects:

- The extent to which the prototypes exemplify our required heuristics, as defined in Section 2
- Users' perceptions of how each prototype would improve their recipe search experience
- Speed and ease with which users find recipes with the enhanced algorithm
- Whether the proposed interfaces increase user engagement with Yummly software

It is important to acknowledge the proposed convenience sample may not be free from social desirability bias. As such, we will take the following steps to reduce the impact of this (and other) biases in our qualitative data collection processes:

1. Having the team members that did not recruit the participant perform the interview

2. Using a structured interview process that refrains from leading questions or any other "nudging" of the respondent

8 EVALUATION RESULTS

The evaluation phase played a large role in determining the efficacy of the newly designed Yummly prototypes. Based on comprehensive feedback through user testing, several key insights were uncovered that guided further iterations and refinements of the prototypes.

The evaluation was conducted using a combination of surveys and interviews with users who interacted with the prototypes. Results of the quantitative evaluation focused on analysis of Georgia Tech OMSCS student responses. Our qualitative analysis utilizes the participatory design strategy identified during needfinding. The re-engagement of the same four key individuals represents this strategy. The participants were selected to represent a diverse user base of Yummly, with varying levels of culinary experience and dietary needs. We received 30 responses to our prototype evaluation survey. Survey results, in combination with three personal interviews, allowed us to perform a comprehensive evaluation that focused on four key outcomes: usability, satisfaction, efficiency in recipe discovery, and personalization of search results.

8.1 Quantitative Evaluation

The evaluation of our survey data was aimed towards determining statistical significance based on the following metrics:

- Usability
- Satisfaction
- Efficiency in recipe discovery
- Personalization of search results

To evaluate our three prototypes based on these metrics, we conducted a Chi-square Test for Independence. Our results allowed us to determine if the variation in responses were significant enough to determine if one of our prototypes was preferred over another.

Null Hypothesis: There is no difference among prototypes concerning the metrics of Usability, Satisfaction, Efficiency in Recipe Discovery, and Personalization of Search results.

Assumptions:

- Uniform expected distributions
- p-threshold of 0.05

Metric Examined	Prototype 1	Prototype 2	Prototype 3	Chi Squared	Degrees of Freedom	P-Value
Usability	15	7	8	3.800	2	.1496
Satisfaction	11	9	10	0.200	2	0.9048
Efficiency in Recipe Discovery	18	6	6	9.600	2	0.0082
Personalization of Search Results	18	8	4	10.400	2	0.0055

Table 1—Results of Chi-Squared Test.

Key Findings:

Usability and Satisfaction: The p-values for *usability* and *satisfaction* were 0.1496 and 0.9048 respectively. This suggests that there are no statistically significant differences among the prototypes. This indicates that no single prototype consistently outperformed the others in these areas under the conditions of our test.

Efficiency in Recipe Discovery: The significantly low p-value of 0.0082 for *efficiency in recipe discovery* indicates a statistically significant preference for *Prototype 1: filter modification*. This suggests that the improved filtering algorithm allowed users to find recipes more efficiently than the others, which is statistically significant at the 1% level.

Personalization of Search Results: The low p-value of 0.0055 for *personalization of search results* demonstrates a statistically significant preference for *Prototype 1: filter modification*. These results indicate users opinions' that prototype one notably enhances the *personalization of search results* compared to the others.

8.2 Qualitative Evaluation

Three personal interviews were conducted with the original stakeholders identified during the needfinding process. As previously mentioned, each individual selected for the interview represents a spectrum of experience with Yummly.

Personal Interview — Rachel: Rachel expressed significant happiness with the advanced filtering algorithm demonstrated in *Prototype 1: Filter Modification*. Initially, Rachel's main concern was the level of specificity required by the search to display relevant recipes. As a novice chef, she does not require niche ingredients to filter recipes. She also expressed happiness with *Prototype 2: Error Handling*, specifically noting the prototype's ability to make the interface more intuitive and user-friendly.

Personal Interview — Tristan: Tristan represents Yummly's user base of experienced chefs. He expressed significant approval of *Prototype 3: Pantry Import*, as he often uses Yummly purely for inspiration. This prototype would allow him the opportunity for endless creations based on Yummly's extensive database of recipes. Additionally, Tristan appreciated the advanced algorithm displayed in *Prototype 1: Filter Modification*.

Personal Interview — Devin: Similarly, Devin expressed approval of *Prototype 1: Filter Modification*. Her main concern was the site's lack of intuitiveness and the learned helplessness experienced due to the large number of recipes. The improved filtering algorithm allows her to precisely filter relevant recipes without the confusion of locating the feature. She also enjoyed the error handling feature afforded by *Prototype 2: Error Handling*. This is consistent with our quantitative data results, which suggest that novice users desire additional error protection.

8.3 General Findings

Prototype 1: Filter Modification: Users appreciated the improved visibility and accessibility of the filter options directly on the home screen. The enhanced algo-

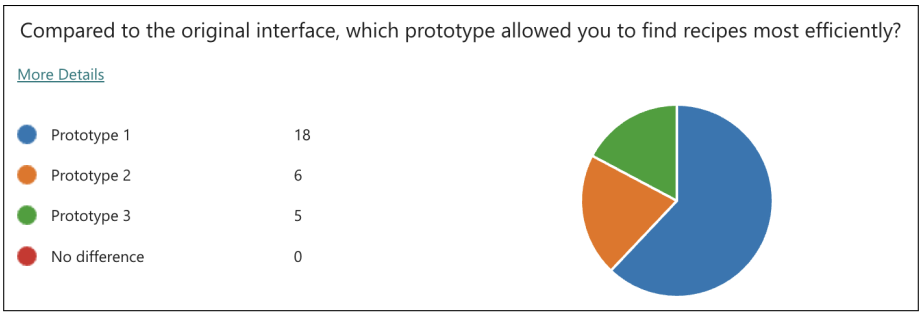

Figure 9—Results for ingredient search

rithm which consolidated similar ingredients into unified categories was praised for reducing confusion and improving search accuracy as shown in Figure 9.

While the response to the filter modifications was largely positive, some users suggested further refinements in the categorization of ingredients to cover more diverse dietary needs and culinary preferences.

8.4 Prototype 2: Error Handling

This prototype was highlighted for its robust error handling capabilities. Users found the real-time feedback on incorrect ingredient entries extremely useful, which helped them correct errors instantly and continue with their search without frustrations.

Despite the positive feedback, there was a suggestion to include more intuitive suggestions for common typos and similar ingredient names to further ease the search process.

8.5 Prototype 3: Pantry Import

The Pantry Import prototype received acclaim for its innovative approach to recipe suggestion based on available pantry items. Users felt this feature significantly streamlined their meal planning process by utilizing existing ingredients, reducing food wastage.

Users suggested enhancements in the user interface for managing pantry items more effectively and a more dynamic update system that reflects real-time changes in pantry stock.

8.6 Summary of General Findings

There was a notable increase in user engagement with the prototypes, particularly with features that offered more direct control over the search parameters.

Most users reported a higher satisfaction level with the prototypes compared to the original interface, citing improved efficiency in finding suitable recipes as a major factor.

The personalized search results were well-received, with many users stating that this would likely increase their frequency of using Yummly.

8.7 Future Recommendations

The evaluation results suggest a strong user approval of the prototypes, but also highlight areas for improvement. Moving forward, the focus will be on refining these prototypes based on user feedback, particularly enhancing the intuitiveness of the interfaces and expanding the personalization aspects to cater to an even broader range of dietary preferences and culinary interests.

This comprehensive evaluation has set the stage for the next iteration of prototypes, which will aim to address the noted deficiencies and further enhance the user experience on Yummly's platform. By continuing to focus on user-centered design, the project seeks to achieve a more satisfying, efficient, and personalized culinary discovery experience.

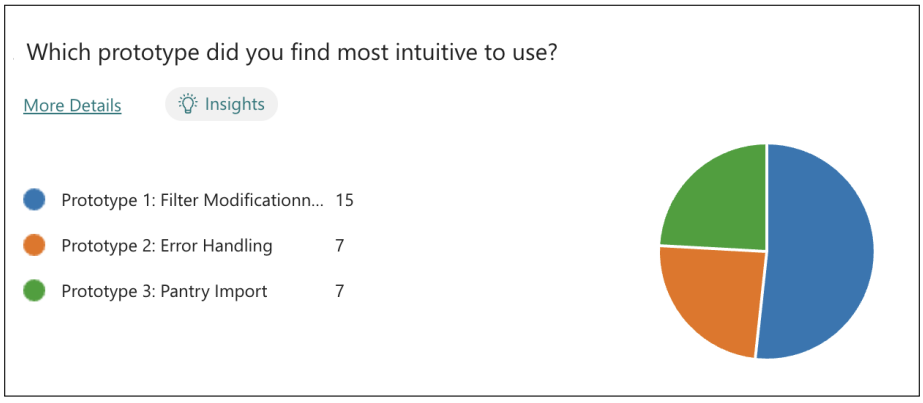

Figure 10—Prototype intuitiveness

In the evaluation of the newly designed Yummly prototypes, Prototype 1 emerged as the clear favorite among users as shown in Figure 10. This preference was evident across various dimensions of user feedback, highlighting its effectiveness

and strong alignment with user needs. Users particularly appreciated the enhanced accessibility and visibility of the filter options directly on the home screen, which facilitated easier access and more intuitive navigation. The prominent placement of the filter button significantly improved user interaction, making the search process smoother and more user-friendly.

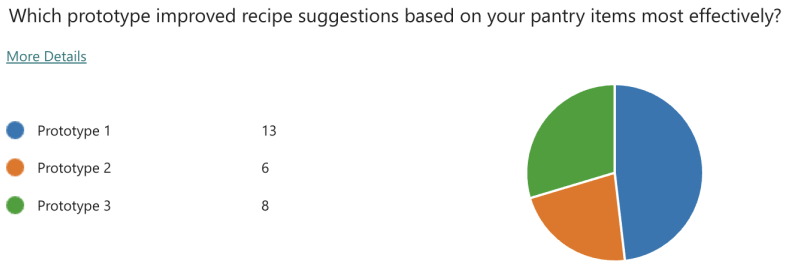

Figure 11—Recipe suggestion efficiency

The refined algorithm in Prototype 1, which grouped similar ingredients into unified categories, also received high praise for improving search accuracy as shown in Figure 11. This modification addressed a common user issue with multiple entries for similar ingredients, which previously led to confusion and inefficient searches. As a result, users experienced a significant increase in satisfaction with their search outcomes, noting that they could find recipes more quickly and accurately. This increase in efficiency has made the search process more enjoyable and less frustrating, contributing to a better overall user experience.

Given the overwhelmingly positive response to Prototype 1, future development efforts will focus on enhancing and refining this prototype. Plans include expanding the categories and filters to incorporate a broader range of dietary restrictions and preferences, ensuring that Yummly can cater to an even more diverse audience. This focus on continuous improvement and user-centered design is poised to set a new standard in the recipe discovery platform industry, reinforcing Yummly's commitment to providing a superior culinary discovery experience for all users.

9 SECOND ITERATION PLANNING

Building on the insights and feedback gathered from the initial prototyping and evaluation phase, our second iteration will focus on refining and expanding the capabilities of Prototype 1, which has been selected as the primary candidate for further development. This decision is based on its positive reception regarding its

intuitive design and potential for significantly enhancing the user experience on Yummly's platform.

9.1 New Insights

The evaluation results from Prototype 1 indicated that while the prototype was highly effective at improving search functionality, there were several areas where user feedback suggested potential for improvement:

Search Precision: Users appreciated the enhanced filtering capabilities but desired more granular control over search parameters to better align with specific dietary needs and preferences.

User Interface Simplification: Although the interface was well-received, there was feedback about overwhelming options for new or casual users, suggesting a need for a more streamlined experience.

Performance Optimization: Feedback highlighted the need for faster response times during searches, especially when multiple filters are applied simultaneously.

9.2 Goals for the Second Iteration

The second iteration of the Yummly prototype development focuses on key areas of improvement identified during the initial evaluation phase. Our overarching aim is to elevate the user experience by refining the platform's core functionalities. The goals for this iteration are structured to address specific aspects of the Yummly search interface, ensuring it not only meets but exceeds the expectations of the diverse user base.

Enhance Search Precision: Integrate more sophisticated algorithms to handle complex queries and introduce machine learning techniques to predict user preferences based on past interactions.

Simplify User Interface: Redesign the interface to accommodate both novice and advanced users with a 'Basic' and 'Advanced' mode toggle, reducing cognitive load while retaining functionality.

Improve Performance: Optimize backend processes to enhance the speed and responsiveness of the search functionality.

9.3 Methodology

Based on the feedback, the user interface will be adjusted to introduce a toggle feature that simplifies the complexity of advanced search options. This aims to cater to a broader range of users by allowing them to select a view that best suits their needs.

We aim to conduct a series of user tests to evaluate the new changes in real-world scenarios, ensuring the adjustments meet the needs highlighted in the initial feedback.

The second iteration aims to build on the strengths of Prototype 1, addressing specific areas for improvement identified through user feedback. By focusing on refining the search precision, simplifying the user interface, and improving performance, we aim to enhance the overall user experience on Yummly's platform.

10 FINAL PROTOTYPE

The final iteration of our Yummly search functionality prototype marks a significant leap towards enhancing user interaction and personalizing the recipe discovery process. This prototype was designed to accommodate the insights gained from previous evaluations and integrates functionalities that reflect a deep understanding of the user's culinary journey from ingredient selection to meal preparation.

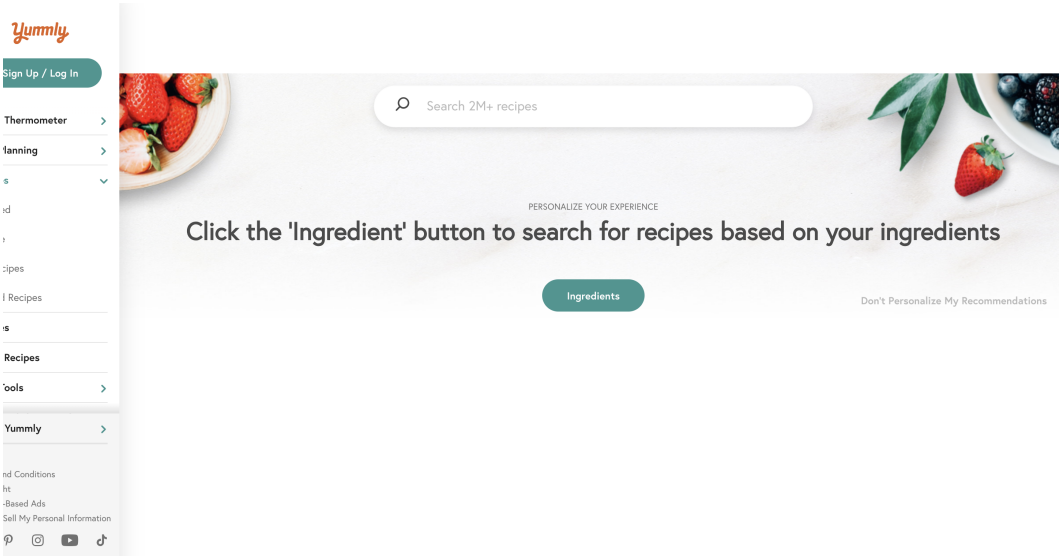

Figure 12—Re-imagined Yummly home page

10.1 Enhanced Ingredient Entry

The prototype introduces an "Ingredients" button prominently positioned on the home page as shown in Figure 12, facilitating immediate and intuitive access for users wishing to start their recipe exploration. Clicking this button triggers a modal window where users can input their available ingredients. This feature addresses the need for a more personalized search process, allowing users to utilize specific pantry items in their recipe discovery.

10.2 Dynamic Ingredient Management

Within the modal, as users enter ingredients, they can press 'enter' on their keyboard to add each new item to a list panel displayed below the input field as shown in Figure 13.

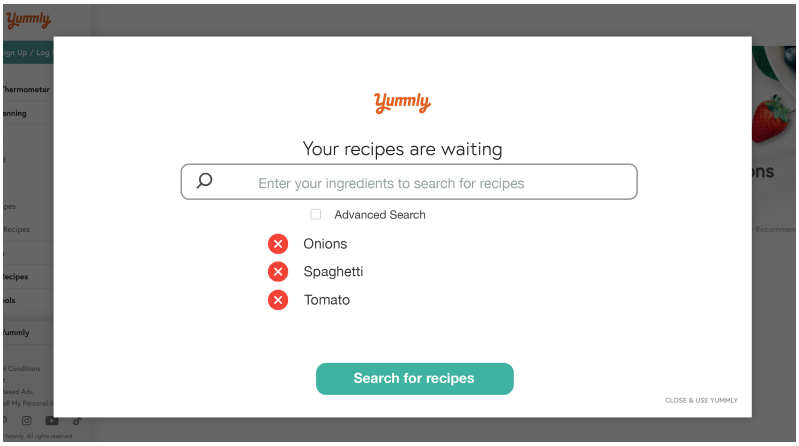

Figure 13—Ingredient modal with a few ingredients entered by a user

This list enhances user control by incorporating an option to remove ingredients. Each listed ingredient is accompanied by a deletion icon, offering users the flexibility to refine their ingredient list continuously as shown in Figure 14.

10.3 Advanced Search Functionality

To cater to diverse culinary skills and preferences, the prototype includes an "Advanced Search" toggle. This feature adjusts the search algorithm to filter recipes that match the user's cooking proficiency—whether they seek simple dishes or more complex culinary challenges. This toggle ensures that all users, from novices to experienced cooks, find recipes that suit their needs.

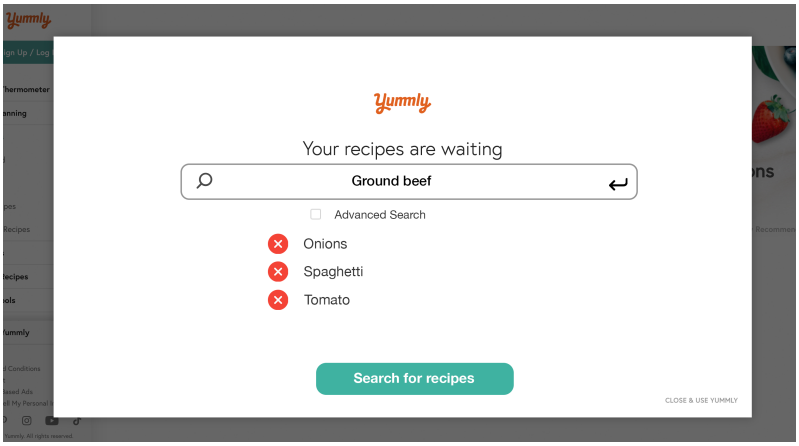

Figure 14—User entering ingredients into the modal window

10.4 Streamlined Recipe Discovery

Upon finalizing their ingredients list, users can initiate a search by clicking the 'Search' button, which dismisses the ingredient modal and displays a curated list of recipes as shown in Figure 15. These recipes are specifically tailored to the ingredients provided, simplifying the decision-making process and ensuring a seamless transition from planning to cooking.

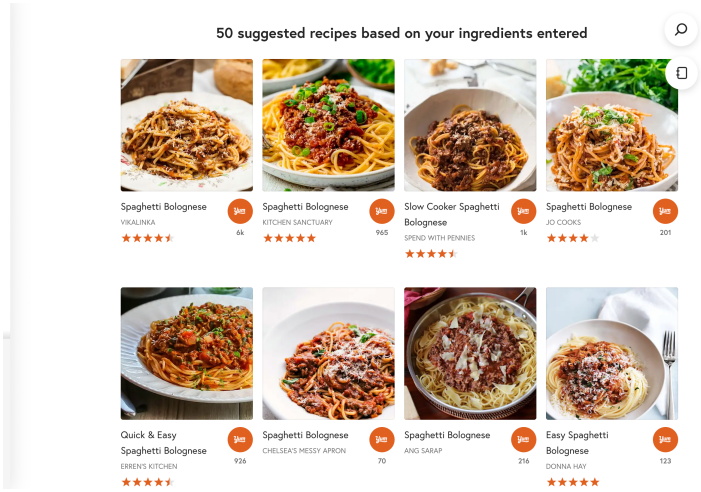

Figure 15—Recipes suggested by ingredients

10.5 Interactive Error Correction

Recognizing the common issue of typos or misspelled ingredients, the prototype is equipped with a smart suggestion system as shown in Figure 16. If a user

enters an unrecognized ingredient, the system prompts a correction suggestion immediately. For instance, entering "Mushrood" triggers a response: "Sorry, no ingredients match your criteria. Did you mean 'Mushroom'?" Users can select the correct suggestion with a click, replacing the erroneous entry, thereby enhancing the user experience with real-time assistance and reducing frustration.

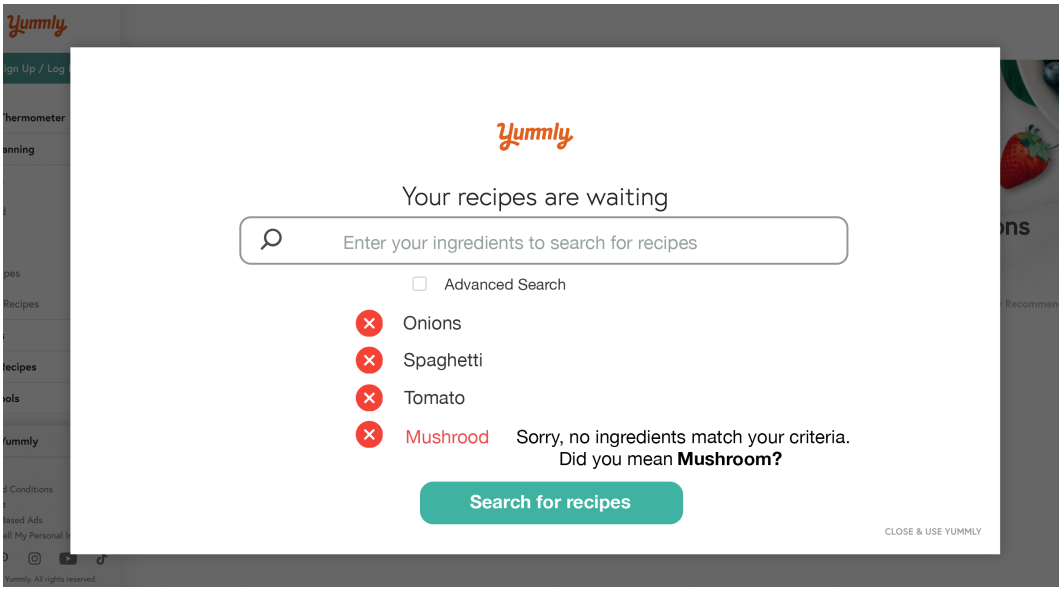

Figure 16—Interactive error correction

The final prototype embodies a blend of user-centric design principles and advanced technological integration, addressing core user needs while promoting an engaging and supportive cooking exploration environment. This development not only streamlines the recipe discovery process but also empowers users by making their interaction with Yummly more intuitive, efficient, and enjoyable. As we continue to refine and expand our platform, the insights and technologies demonstrated in this prototype will serve as foundational elements in our ongoing commitment to revolutionize the culinary discovery experience. This prototype not only anticipates user needs but actively responds to them, setting a new standard for digital culinary platforms.

11 VIDEO PROTOTYPE

Video demonstration of final prototype available at the following link: https://youtu.be/X2-WxzxeFnQ

12 FINAL EVALUATION PLANNING

The primary aim of our final evaluation is to determine not only whether we have achieved our initial goal of enhancing the recipe search task but also to identify which features of our interface have had the most significant impact.

Qualitative Evaluation Planning:

The qualitative evaluation will be conducted via participant interviews. Interviews will be conducted via Zoom video conference calls with our three participants identified during needfinding: Rachel, Tristan, and Devin. The interviewer will facilitate the user to various screen selection choices as they navigate the prototype. An additional interviewer will be present during the conference call to record results. Prior to the interview, individuals will be informed they will be ranking each metric on a scale of 1 to 10 based on the following criteria:

- Intuitiveness
- Satisfaction
- Efficiency in recipe discovery
- Personalization of search results

The mean and standard deviation will be calculated for each category. A score of 8 or higher would represent a positively statistically significant rating for the specified category; whereas, a score of 3 or below denotes a statistically significant negative rating.

Quantitative Evaluation Planning:

The quantitative evaluation involves a two step process.

Part 1: Survey Analysis

We will evaluate the results of our peer survey based on the following criteria:

1. Collecting measurable data from users related to the speed with which they can find a recipe using our interface

2. Collecting measurable data from users as to the intuitiveness and required learning curve associated with our interface
3. Collecting measurable data from users with regards to their satisfaction with our interface
4. Collecting qualitative data from users and performing analysis to determine what aspects of our interface had a particular impact on the task

The ideal number of respondents for our analysis is between 20 and 30. This affords us sufficient data-points to perform accurate quantitative analysis and manageability for an in-depth qualitative analysis.

We will use a Chi-squared test to determine whether our results are sufficiently better than random using a p-threshold of 0.05. Furthermore, we will check the standard deviation of each survey question dataset to determine user consensus; a smaller standard deviation implies a greater degree of agreement across surveyed users.

Part 2: Qualitative Survey Analysis

We will use survey results to perform several additional quantitative evaluations on qualitative data. We will manually analyze all responses for common themes and sentiments. If necessary, we will summarize and clean recorded data before feeding it into a Natural Language Toolkit (NLTK) for sentiment and tone analysis. This kind of analysis will be most effective for the survey questions where the user is not prompted to provided specific likes or dislikes. The NLTK can also identify common words and their contexts across responses, which will be helpful in identifying more specific areas of our interface that are helpful or underwhelming.

Sentiment analysis allows us to "hijack" the "all or nothing" cognitive bias and understand more accurately what a user's most- or least-favorite aspect of our interface truly is. Instead of relying solely on selected quantitative responses, we can cross-check a user's selection with what they provide in the free-response questions. We will use the derived data to cross-reference a user's perceptions about a specific feature, with different survey questions as an internal validity test.

13 FINAL EVALUATION RESULTS

Our evaluation plan included analyzing survey results and conducting personal interviews with individuals who represent Yummly's typical user base. One notable deviation from the evaluation plan highlighted in Section 12 was the group's

decision to conduct an additional survey to bolster our results. Specifically, a survey was created and distributed to individuals external to Georgia Institute of Technology students in a targeted effort to avoid convenience sample bias as much as possible. The additional survey produced 35 responses. Survey questions are included in Appendix E, and the collected and formatted results are available in CSV format in Appendix F.

Our qualitative findings as a result of three personal interviews revealed major patterns and themes, which are summarized in bullet points below each interview header. We interpreted participant results using a combination of design principles.

It is crucial to recognize the potential limitations due to the small sample size. Typically, a larger sample size helps in reducing variance and minimizing the influence of outliers. To counteract potential biases, participants were carefully selected based on their representation of Yummly's most frequent users, following a participatory design strategy. This approach not only facilitated user buy-in but also treated participants as stakeholders, enabling us to extract valuable insights throughout the design lifecycle.

However, extensive user involvement could lead to confirmation bias, particularly if the ideas selected reflect user preferences. To address this, interviewers maintained a transparent and unbiased interaction with participants, ensuring responses were neutral without any indication of preference. Emphasizing the importance of unbiased feedback, interviewers provided no emotional reactions to either positive or negative comments.

13.1 Qualitative Evaluation: Interview Results

Personal Interview — Rachel:

Intuitiveness:

- Single button on the home screen is highly intuitive
- Error handling for incorrect input increases user feedback - and shortens Gulf of Evaluation

Satisfaction:

- Prototype changes drastically reduce user's cognitive load by increasing discoverability principle

Efficiency in recipe discovery:

- Enhanced algorithm significantly increases principle of Ease and Comfort
- Increases usability by improving search algorithm

Personalization of search results:

- Advanced toggle switch may not benefit novice users

Table 2—Rachel Ratings Rachel's ratings compared to group consensus

Metric Examined	Rachel Rating	Combined Mean	Variance	Standard Deviation
Intuitiveness	9	9	0.0000	0.00
Satisfaction	9	7.67	1.7689	1.33
Discovery	10	8	4.0000	2.00
Personalization	8	8.33	0.1089	0.33

Rachel Results Interpretation Based on Established Criteria: Rachel's evaluation indicates a high level of approval for the prototype's features. Her rating of 9 for both Intuitiveness and Satisfaction aligns with the benchmark for positive significance. Rachel's satisfaction rating of 9 stands out due to its higher variance from the group mean (1.7689), indicating exceptional personal satisfaction. Additionally, a perfect score of 10 for Efficiency in Recipe Discovery surpasses the positive threshold by a significant margin. This also suggests her appreciation for the usability improvements. Personalization is also rated positively at 8, closely matching the group mean. Rachel's feedback underscores the prototype's successful design, specifically in intuitiveness and recipe discovery efficiency.

Personal Interview — Tristan:

Intuitiveness:

- Deliberate design improves structure of the site

Satisfaction:

- Design may tailor more towards novice users

Efficiency in recipe discovery:

- Unique button location in the center of the screen offers increased discoverability
- Error Handling for incorrect recipe input provides effective constraints

Personalization of search results:

- Option to include advanced search parameters improves flexibility by providing useful customization, while still catering to novice users

Table 3—Tristan Ratings Tristan's ratings compared to group consensus

Metric Examined	Tristan Rating	Combined Mean	Variance	Standard Deviation
Intuitiveness	10	9.00	1.0000	1.00
Satisfaction	6	7.67	2.7889	1.67
Discovery	7	8	1.0000	1.00
Personalization	9	8.33	0.4489	0.67

Tristan Results Interpretation: Tristan's rating of 10 for intuitiveness, with a standard deviation of 1, ranks significantly higher in relation to the group's mean consensus. This metric is within statistical significance for providing an intuitive design. However, his satisfaction rating of 6 was notably below the statistically significant positive mark and the group's higher mean. During the interview, Tristan was noticeably disappointed with the group's decision to not include functionality included in the Pantry Import Prototype. This suggests the potential existence of confirmation bias, and a potential misalignment with his expectations. His score of 7 for efficiency in recipe discovery was above average, but fell short of the positive significance benchmark. This suggests that there may be room for enhancing this criteria to achieve a more favorable outcome. Finally, his personalization rating of 9 exceeds the pre-established criteria threshold of 8, reflecting his satisfaction with the feature's adaptability to both novice and experienced users. Tristan's feedback suggests high intuitiveness and personalization of the final prototype, but denotes concern to optimizing satisfaction and discovery efficiency.

Personal Interview — Devin:

Intuitiveness:

- Discovery of key buttons improved through relocation of filter option to home screen
- Clear distinctive visual cues increases user perceptibility

Satisfaction:

- Significant improvement in structure - allows user to efficiently navigate from screen to screen

Efficiency in recipe discovery:

- Improved algorithm provides a more equitable result for individuals who are not tech-savvy
- Improved algorithm makes filtering recipes easier - improving simplicity

Personalization of search results:

- Toggle switch for advanced filter may present a challenge for extremely novice users

Table 4—Devin Ratings Devin's ratings compared to group consensus

Metric Examined	Devin Rating	Combined Mean	Variance	Standard Deviation
Intuitiveness	8	9.00	1.0000	0.00
Satisfaction	8	7.67	0.1089	0.33
Discovery	7	8.00	1.0000	1.00
Personalization	8	8.33	0.1089	0.33

Devin Results Interpretation: Devin's assessments reflect a generally positive experience with the final prototype. She ranked intuitiveness with a score of 8. This meets the threshold for positive significance and suggests her appreciation for the improved button discovery and visual cues. Additionally, her satisfaction rating of 8 aligns with a positive experience. Devin ranked discovery at 7, just below the positive benchmark. While not significant, it may suggest the improvements in the enhanced search bar, along with simplicity, meet her expectations for ease of use. Overall, Devin's feedback signals that the design performs well in intuitiveness and satisfaction. Her slightly lower than average rank for intuitiveness suggests there may be a slight room for improvement when it comes to less tech-savvy users.

13.2 Quantitative Evaluation

Part 1 - Survey Analysis: In accordance with our plan discussed in Section 12, we performed quantitative analysis to determine if our survey results significantly surpass those expected from a true-random sample, and to what extent. The Python

code for this analysis is available in Appendix G. The results are summarized in Table 5.

Factor	χ^2 p-value	χ^2 Statistic	Std. Dev.	Mean
Intuitiveness	1.32×10^{-8}	36.286	0.919	4.314
Satisfaction with Ingredient Entry	1.993×10^{-7}	30.857	0.960	4.143
Effectiveness of Advanced Search	1.298×10^{-7}	31.714	0.988	4.229
Efficiency in Recipe Discovery	1.276×10^{-6}	27.143	0.979	4.114
Efficiency Comparison (vs Yummly)	1.276×10^{-6}	27.143	0.990	4.143
Overall Experience Improvement	2.299×10^{-7}	30.571	0.971	4.171

Table 5—Final evaluation quantitative results, $n = 35$

As shown, all rows present a p-value considerably less than our recognized threshold of 0.05, meaning that every factor in our final prototype greatly improved the recipe search experience.

For the Mean and Standard Deviation results, all survey response options were assigned a value of 1-5, where 1 was the "worst" outcome and 5 the "best." All of the means are concentrated around 4, which corresponds to the answer choice commensurate with an "Improved" option, further cementing the results from our χ^2 tests. A standard deviation of < 1 implies that most respondents never felt that our interface was ever worse than the existing one.

In conclusion, we can reject the null hypothesis H_0 and assert that the design changes we implemented are an improvement over the current recipe search process, at least based on the quantitative results.

Part 2: Qualitative Survey Analysis: Qualitative analysis was performed on the survey responses where the respondents provided a meaningful sentence, although not all responses were substantive. Out of all respondents, 10 provided substantial answers to the free-response questions. We opted not to make these questions mandatory to maximize response rates for quantitative analysis.

The first step of the qualitative analysis was to run the substantive responses through the Valence Aware Dictionary and Sentiment Reasoner (VADER) provided by the Natural Language Toolkit (NLTK) Python implementation (see Appendix G). VADER sentiment analysis is described in Hutto and Gilbert, 2014. The results from this analysis are provided in Table 6.

Prompt	Positive μ	Negative μ	Compound μ
Biggest Improvement ($n = 9$)	0.285	0.046	0.461
Underwhelming Changes ($n = 7$)	0.048	0.095	-0.085
Additional Thoughts ($n = 4$)	0.308	0.000	0.329

Table 6—Averaged VADER qualitative analysis results

The Positive, Negative, and Compound VADER results were averaged across the reported n per Prompt. While we attempted to avoid social desirability bias by not leading the respondents, we may not have been fully successful. Nonetheless, the response sentiment is overwhelmingly positive. Even on the question asking which changes were not as impressive, the negative sentiment score never exceeded 0.1. Furthermore, on the Additional Thoughts prompt, the negative sentiment score was 0 to three significant figures, meaning of all respondents who answered the question, none had a negative answer.

The final step was to process the free-response questions through a keyword extraction process called Rapid Automated Keyword Extraction (RAKE) in an attempt to identify what exactly prompted user sentiment to skew as shown above. The algorithm behind RAKE is described in Rose et al., 2010. We initially attempted to perform this process using keyword or bigram frequency distributions, but the responses were not long enough for there to be any appreciable overlap, rendering such analysis fruitless. The RAKE process was done per prompt and yielded the results in Table 7.

The scores in Table 7 may seem ambiguous—the RAKE process measures the impact a bigram (or phrase) has on a piece of text. A drawback of using this procedure is that our samples are shorter in length than most documents described in the process via Rose et al., 2010. However, it is clear that most of the high-impact phrases collected in our final evaluation are positive. This is consistent with the results achieved quantitatively, and there is even a high-impact reference to all major features we implemented in our redesign.

13.2.1 *Bias Analysis*

We took substantial steps to attempt to reduce bias that could affect our results, including a different survey delivery process and structured interviews. Despite these efforts, it is important to acknowledge that without using a formal participant

Score	Phrase
56.5	based search could really help find recipes faster
28.0	immediately find matching recipes makes
26.5	interactive suggestions seem really helpful
24.5	culinary skill search helps beginners
16.5	helps fix mistakes quickly
16.0	directlyd [sic] reduces food waste
11.5	enhanced ingredient entry feature

(a) Biggest Improvement

Score	Phrase
$41.\overline{6}$	unusual ingredients cooking style search seems limited
$25.\overline{6}$	makes navigation difficult search could
$25.\overline{6}$	less complicated advanced search feels
16	bit overwhelming iadvanced [sic] searching

(b) Underwhelming Changes

Score	Phrase
9.0	nice job overall
4.0	tooooo [sic] complex
4.0	personalized experience
4.0	mostly pleased

(c) Additional Thoughts

Table 7—Significant RAKE results per free-response prompt

collection method that does not involve social circles, there will always be some degree of social desirability bias.

13.2.2 *Conclusion*

After navigating through the design lifecycle, completing multiple iterations, and conducting thorough evaluations, we are confident that our redesign of the Yummly recipe search tool is, by all standards, a successful improvement over their current interface. The extensive data collected and analyzed across various statistical tests, in-depth interviews, and other evaluation methods, provide both qualitative and quantitative evidence to attest to the success and effectiveness of the redesign.

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APPENDIX

A NEEDFINDING SURVEY QUESTIONS

How frequently do you use Yummly or any other recipe website for finding recipes?

- Daily
- Weekly
- Monthly
- Rarely

What is your primary goal when searching for recipes online?

- Discovering new recipes
- Finding recipes to fit dietary restrictions
- Using specific ingredients I have
- Learning new cooking techniques

How satisfied are you with the current search functionality on recipe websites?

- Very satisfied
- Somewhat satisfied
- Neutral
- Somewhat dissatisfied
- Very dissatisfied

Have you ever had difficulty finding recipes that match your dietary preferences on Yummly or any other recipe website?

- Always
- Often
- Sometimes
- Rarely
- Never

Would you find it useful to input specific ingredients you want to use in your recipe search?

- Yes
- No

- Maybe

How important is it for you to filter recipes by dietary restrictions (e.g., gluten-free, vegan, keto)?

- Very important
- Somewhat important
- Not important

What additional features would you like to see in a recipe websites search functionality?

- Ability to exclude certain ingredients
- More detailed nutritional information
- User ratings and reviews filter
- Cooking time filter
- Other (please specify)

How likely are you to use a feature that suggests recipes based on ingredients you already have?

- Very likely
- Somewhat likely
- Not likely

How do you currently decide which recipes to try from your search results?

- Based on ingredients I have
- Based on the recipe photo
- Based on user ratings/reviews
- Based on preparation/cooking time

Would an enhanced search feature that allows for more personalized recipe suggestions increase your usage of Yummly or any other recipe website?

- Definitely yes
- Probably yes
- Might or might not
- Probably not
- Definitely not

B HEURISTIC EVALUATION RESULTS

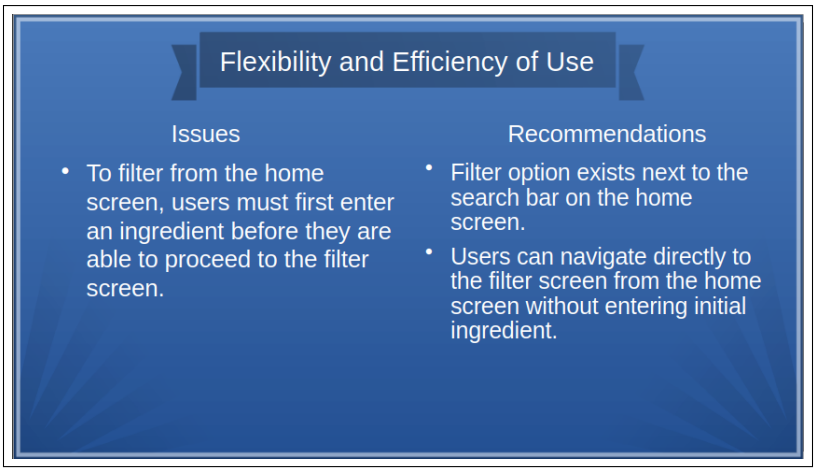

Figure 17—Flexibility and Efficiency of Use Heuristic

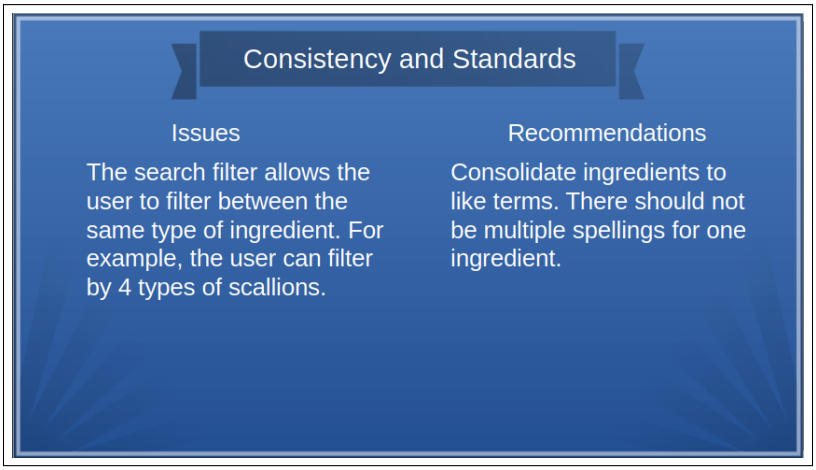

Figure 18—Consistency and Standards Heuristic

C RAW SURVEY DATA

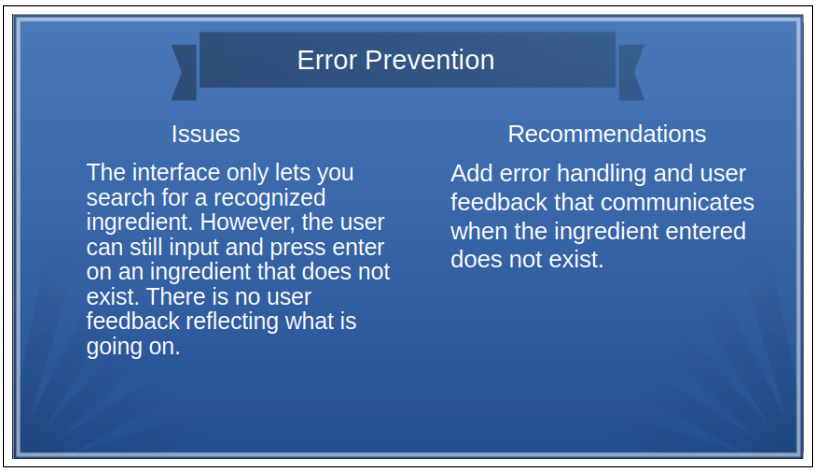

Figure 19—Error Prevention Heuristic

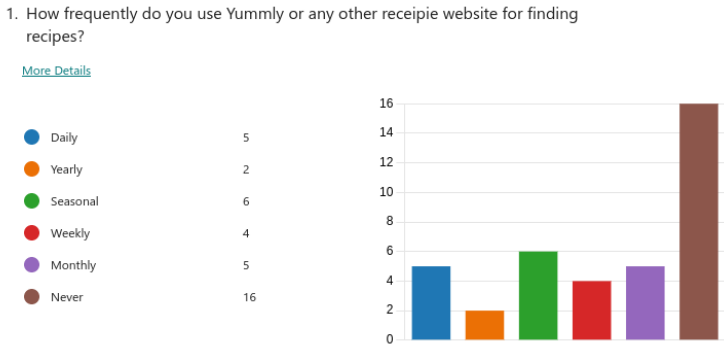

Figure 20—**Raw Survey Data**. Question 1

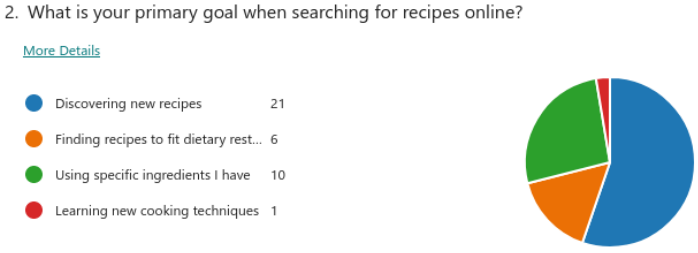

Figure 21—**Raw Survey Data**. Question 2

3. How satisfied are you with the current search functionality on recipe websites?

More Details

Very satisfied	5
Somewhat satisfied	18
Neither satisfied nor dissatisfied	11
Somewhat dissatisfied	4
Very dissatisfied	0

Figure 22—**Raw Survey Data**. Question 3

4. Have you ever had difficulty finding recipes that match your dietary preferences on Yummly or any other receipie website?

More Details

Always	2
Yes	12
No	6
Very often	2
Sometimes	10
Rarely	5
Never	1

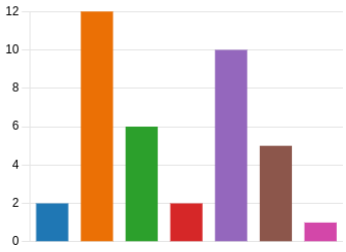

Figure 23—**Raw Survey Data**. Question 4

5. Would you find it useful to input specific ingredients you want to use in your recipe search?

More Details

Yes	31
No	3
Maybe	3

Figure 24—**Raw Survey Data**. Question 5

6. How important is it for you to filter recipes by dietary restrictions (e.g., gluten-free, vegan, keto)?

More Details

Extremely important	5
Somewhat important	15
Neutral	11
Somewhat not important	4
Extremely not important	3

Figure 25—**Raw Survey Data**. Question 6

7. What additional features would you like to see in a recipe websites search functionality?

More Details Insights

Figure 26—**Raw Survey Data**. Question 7

8. How likely are you to use a feature that suggests recipes based on ingredients you already have?

More Details

Figure 27—**Raw Survey Data**. Question 8

9. How do you currently decide which recipes to try from your search results?

More Details Insights

Figure 28—**Raw Survey Data**. Question 9

10. Would an enhanced search feature that allows for more personalized recipe suggestions increase your usage of Yummly or any other receipie website?

More Details

Figure 29—**Raw Survey Data**. Question 10

D PROTOTYPE EVALUATION SURVEY QUESTIONS

1. Which prototype did you find most intuitive to use?

- Prototype 1: Filter Modification
- Prototype 2: Error Handling
- Prototype 3: Pantry Import

2. How would you rate the usability of the filter modification in Prototype 1 compared to the error handling in Prototype 2?

- Significantly better
- Somewhat better
- About the same
- Somewhat worse
- Significantly worse

3. Compared to the original interface, which prototype allowed you to find recipes most efficiently?

1. Prototype 1
2. Prototype 2
3. Prototype 3
4. No difference

4. Which prototype provided the most helpful error feedback when an incorrect ingredient was entered?

1. Prototype 1
2. Prototype 2
3. Prototype 3
4. None were helpful

5. Which prototype best supported searches based on dietary restrictions?

1. Prototype 1
2. Prototype 2
3. Prototype 3
4. None were effective

6. How satisfied are you with the ingredient input feature across the prototypes?

1. Prototype 1
2. Prototype 2
3. Prototype 3
4. Equally satisfied with all

7. Which prototype improved recipe suggestions based on your pantry items most effectively?

1. Prototype 1
2. Prototype 2
3. Prototype 3

8. How would you rate your overall experience with Prototype 1?

1. Very Satisfied
2. Somewhat Satisfied
3. Neutral
4. Somewhat Dissatisfied
5. Very Dissatisfied

9. How would you rate your overall experience with Prototype 1?

1. Very Satisfied
2. Somewhat Satisfied
3. Neutral
4. Somewhat Dissatisfied
5. Very Dissatisfied

10. How would you rate your overall experience with Prototype 3?

1. Very Satisfied
2. Somewhat Satisfied
3. Neutral
4. Somewhat Dissatisfied
5. Very Dissatisfied

11. Which prototype are you most likely to recommend to others?

1. Prototype 1
2. Prototype 2
3. Prototype 3

12. What improvements would you suggest for Prototype 1 to enhance its functionality and user satisfaction?

13. What improvements would you suggest for Prototype 2 to enhance its functionality and user satisfaction?

14. What improvements would you suggest for Prototype 3 to enhance its functionality and user satisfaction?

E FINAL PROTOTYPE SURVEY QUESTIONS

1. How intuitive did you find the navigation and features of the updated search functionality?

- Very intuitive
- Somewhat intuitive
- Neutral
- Somewhat difficult
- Very difficult

2. How satisfied are you with the enhanced ingredient entry feature?

- Very satisfied
- Somewhat satisfied
- Neutral
- Somewhat dissatisfied
- Very dissatisfied

3. How effective are the 'Advanced Search' options in catering to your recipe search needs?

- Extremely effective
- Very effective
- Moderately effective
- Slightly effective
- Not effective at all

4. How efficiently does the final prototype help you discover recipes based on the ingredients you have?

- Very efficiently
- Efficiently

- Neutral
- Inefficiently
- Very inefficiently

5. Compared to the original interface, is the recipe discovery process more or less efficient?

- Much more efficient
- Somewhat more efficient
- About the same
- Less efficient

6. Has the final prototype improved your overall experience on Yummly?

- Very likely
- Likely
- Unsure
- Unlikely
- Very unlikely

7. What change(s) make the biggest improvement, if any, and why?

8. Which change(s) are undwhelming, if any, and why?

9. Share more thoughts about the proposed changes, if you have any.

F FINAL SURVEY RESULTS

```
Intuitiveness,Satisfaction with Ingredient Entry,Effectiveness of Advanced Search,Efficiency
in Recipe Discovery,Efficiency Comparison,Overall Experience Improvement,Biggest Improvement,Underwhelming
Changes,Additional Thoughts
Somewhat intuitive,Very satisfied,Very effective,Very efficiently,Much more efficient,Greatly
improved„,
Very intuitive,Very satisfied,Very effective,Very efficiently,Much more efficient,Greatly
improved,The biggest improvements come from the enhanced ingredient entry feature as it al-
lows for a personalized and efficient search.,sorting by cooking style might not be neces-
sary for all users,
Somewhat intuitive,Somewhat satisfied,Somewhat effective,Efficiently,Somewhat more efficient,Improved,"the
ingredient on hand feature is pretty neat, it feels like it customizes the experience.",search
could be less complicated,nice job overall!
Very intuitive,Somewhat satisfied,Very effective,Efficiently,Much more efficient,Improved„,
Very intuitive,Somewhat satisfied,Somewhat effective,Efficiently,Somewhat more efficient,Improved,"Love
the error correction, helps fix mistakes quickly",ingredients entry can be tedious with un-
```

```
usual ingredients,no
Very intuitive,Somewhat satisfied,Very effective,Very efficiently,Much more efficient,Greatly
improved„,
Very intuitive,Very satisfied,Somewhat effective,Very efficiently,Much more efficient,Greatly
improved„,
Very intuitive,Somewhat satisfied,Somewhat effective,Efficiently,Somewhat more efficient,Greatly
improved„,
Somewhat intuitive,Somewhat satisfied,Somewhat effective,Efficiently,Somewhat more efficient,Improved„,
Very intuitive,Very satisfied,Somewhat effective,Efficiently,Somewhat more efficient,Greatly
improved„,
Very difficult,Very dissatisfied,Very ineffective,Very inefficiently,Much less efficient,Greatly
worsened„,
Very intuitive,Somewhat satisfied,Very effective,Efficiently,Much more efficient,Greatly im-
proved„,
Very intuitive,Somewhat satisfied,Very effective,Efficiently,Somewhat more efficient,Improved„,
Somewhat intuitive,Somewhat satisfied,Somewhat effective,Efficiently,Somewhat more efficient,Improved,The
addition of culinary skill search helps beginners.,N/a,nope :)
Very intuitive,Very satisfied,Very effective,Very efficiently,Much more efficient,Improved„,
Somewhat intuitive,Somewhat satisfied,Very effective,Very efficiently,Somewhat more efficient,Greatly
improved„,
Somewhat intuitive,Very satisfied,Very effective,Very efficiently,Much more efficient,Improved„,
Very intuitive,Very satisfied,Very effective,Very efficiently,Much more efficient,Improved„,
Very intuitive,Very satisfied,Very effective,Very efficiently,Much more efficient,Greatly
improved,Ingredient-based search could really help find recipes faster.,Cooking style search
seems limited.,
Somewhat intuitive,Somewhat satisfied,Neither effective nor ineffective,Neutral,The same,Improved„,
Somewhat intuitive,Somewhat dissatisfied,Somewhat ineffective,Inefficiently,Less efficient,Worsened,entry
of ingredients is quick,Advanced search feels a bit overwhelming,Might be tooooo complex for
casual searching
Neutral,Neither satisfied nor dissatisfied,Somewhat effective,Neutral,The same,No change„,
Somewhat difficult,Somewhat dissatisfied,Somewhat ineffective,Inefficiently,Less efficient,Worsened„,
Very intuitive,Very satisfied,Somewhat effective,Very efficiently,Somewhat more efficient,Improved„,
Neutral,Neither satisfied nor dissatisfied,Neither effective nor ineffective,Neutral,The same,No
change,"Adding ingredients is useful, but not revolutionary",The interface can feel cluttered
which makes navigation difficult,none
Very intuitive,Somewhat satisfied,Somewhat effective,Efficiently,Somewhat more efficient,Improved„,
Very intuitive,Very satisfied,Very effective,Very efficiently,Much more efficient,Greatly
improved,The interactive suggestions seem really helpful for refining searches.,N/a,The changes
could make for a much more personalized experience.
Somewhat intuitive,Somewhat satisfied,Very effective,Efficiently,Somewhat more efficient,Greatly
improved„,
Somewhat intuitive,Somewhat satisfied,Somewhat effective,Efficiently,Somewhat more efficient,Greatly
improved„,
Somewhat intuitive,Very satisfied,Very effective,Very efficiently,Much more efficient,Greatly
```

```
improved„,"I’m mostly pleased with the improvements, makes cooking more accessible"
Very intuitive,Very satisfied,Very effective,Very efficiently,Much more efficient,Greatly
improved„,
Somewhat intuitive,Very satisfied,Somewhat effective,Efficiently,Somewhat more efficient,Improved„,
Very intuitive,Somewhat satisfied,Very effective,Very efficiently,Much more efficient,Greatly
improved,The ability to enter ingredients I have on hand and immediately find matching recipes
makes the biggest improvement because it directlyd reduces food waste.,Iadvanced searching
by culinary skill is slightly underwhelming because it may not offer real value to inexpe-
rienced cooks.,No
Very intuitive,Very satisfied,Somewhat effective,Efficiently,Much more efficient,Improved„,
Somewhat intuitive,Somewhat satisfied,Very effective,Efficiently,Somewhat more efficient,Improved„,
```

G FINAL EVALUATION CODE

```
import nltk
nltk.download('popular')
nltk.download('vader_lexicon')

from nltk import ngrams, FreqDist
from nltk.sentiment import SentimentIntensityAnalyzer
from nltk.tokenize import word_tokenize
import numpy as np
import pandas as pd
from rake_nltk import Rake
import scipy.stats

df = pd.read_csv('survey_results.csv', quotechar='"', skipinitialspace=True).fillna('')

quant_intuitiveness = {
    'Very intuitive':5,
    'Somewhat intuitive':4,
    'Neutral':3,
    'Somewhat difficult': 2,
    'Very difficult': 1,
}

quant_ie = {
    'Very satisfied': 5,
    'Somewhat satisfied': 4,
    'Neither satisfied nor dissatisfied': 3,
    'Somewhat dissatisfied': 2,
    'Very dissatisfied': 1,
}
```

```
quant_as = {
    'Very effective': 5,
    'Somewhat effective': 4,
    'Neither effective nor ineffective': 3,
    'Somewhat ineffective': 2,
    'Very ineffective': 1,
}

quant_eff_rd = {
    'Very efficiently': 5,
    'Efficiently': 4,
    'Neutral': 3,
    'Inefficiently': 2,
    'Very inefficiently': 1,
}

quant_eff_vsy = {
    'Much more efficient': 5,
    'Somewhat more efficient': 4,
    'The same': 3,
    'Less efficient': 2,
    'Much less efficient': 1
}

quant_eff_oei = {
    'Greatly improved': 5,
    'Improved': 4,
    'No change': 3,
    'Worsened': 2,
    'Greatly worsened': 1,
}

quant_df = df.copy().replace({
    'Intuitiveness': quant_intuitiveness,
    'Satisfaction with Ingredient Entry': quant_ie,
    'Effectiveness of Advanced Search': quant_as,
    'Efficiency in Recipe Discovery': quant_eff_rd,
    'Efficiency Comparison': quant_eff_vsy,
    'Overall Experience Improvement': quant_eff_oei
})

quant_df = quant_df[quant_df.columns[:6]]
qual_df = df[df.columns[6:]]
```

```
def process_quant():
    global quant_df
    f_exp = np.ones(5) * len(quant_df) / 5
    df = pd.DataFrame(columns=('Factor', 'X2 p-value', 'X2 statistic', 'sigma', 'mu'))
    for col in quant_df.columns:
        col_bucketized = quant_df[col].value_counts()
        for i in range(1, 6):
            if col_bucketized.get(i) is None:
                col_bucketized[i] = 0
        c2_res = scipy.stats.chisquare(col_bucketized, f_exp=f_exp, ddof=2)
        sigma = np.std(quant_df[col])
        mu = np.mean(quant_df[col])
        df = pd.concat((pd.DataFrame([[col, c2_res.pvalue, c2_res.statistic, sigma, mu]],
        ↪  columns=df.columns), df), ignore_index=True)
    print(df)

def process_qual():
    global qual_df
    df = pd.DataFrame(columns=('Factor', 'Count', 'Positive', 'Negative', 'Compound'))
    vader = SentimentIntensityAnalyzer()
    for col in qual_df.columns:
        col = qual_df[col]
        all_resp = ''
        pos = 0
        neg = 0
        compound = 0
        count = 0
        for row in col:
            if len(row) > 7:
                sentiment = vader.polarity_scores(row)
                pos += sentiment.get('pos', 0)
                neg += sentiment.get('neg', 0)
                compound += sentiment.get('compound', 0)
                all_resp += row.lower() + ' '
                count += 1
        df = pd.concat((pd.DataFrame([[col.name, count, pos / count, neg / count,
        ↪  compound / count]], columns=df.columns), df), ignore_index=True)
        rake = Rake()
        rake.extract_keywords_from_text(all_resp)
        scores = rake.get_ranked_phrases_with_scores()
        print(col.name)
        for score, phrase in scores:
            if score > 1:
```

```
                print(score, phrase)
    print(df)


if __name__ == '__main__':
    process_quant()
    process_qual()
```