SOUS: Co-Creative Cooking Application

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ABSTRACT

We report a study in which [**nine**] users were asked to evaluate our *prototype app* in terms of interaction with the system, usability, novelty, and overall liking. The interview questions were evaluated using qualitative and mixed methods data analysis.

This work examines the potential for computational creativity in assisting in cooking. In particular, we present the outcome of our efforts to create an artificial chef that produces novel recipes with limited human assistance and assists in cooking as well.

INTRODUCTION

In this paper, we explore artificial creativity and its effectiveness in a domain that has been mostly overlooked — cooking**.** At its core, *cooking* is defined as the practice of food preparation, which consists of "combining, mixing, and heating ingredients." Cooks can have any level of expertise. Some have little to no experience; some have moderate experience, and others cook all the time and are very comfortable (they may even be professional chefs).

Creativity is one of the most important components in cooking, namely in the combination of ingredients, flavor pairing, and creating recipes. In particular, we investigate the feasibility of creating a system that combines user input and culinary expertise to generate flavorful, sometimes unlikely, ingredient pairings and recipes suggestions.

Elizabeth Sanderson and Pieter Jan Stappers discuss different levels of creativity in their 2008 publication, *"Co-creation and the new landscapes of design."* They argue that while all people are creative, not all creativity is the same. A person's expertise, interest/passion, and effort are important factors to consider when evaluating creativity. They discuss four levels of creativity: *doing, adapting, making,* and *creating*, and use cooking to describe examples of each level (see Table 2, and Sanders 2006b).

Defining what it means to be creative while cooking may vary depending on the user. But, in any case and at any level, the user is a key component of the creative process. Building upon their expertise (or lack thereof), inspiring new ideas, and motivating them to cook are all important factors to stimulate creativity.

Motivation and Goals

Creativity is a common problem in the kitchen; people tend to make or eat the same things all the time. This can get boring, but for those who may have less experience in the kitchen (beginner to intermediate level), it can be challenging to get outside of one's comfort zone and try new things. For this reason, our primary goal is to inspire users to be more creative in the kitchen.

DESIGN GOALS

In this paper, we introduce a prototype for a new co-creative mobile application called SOUS. The SOUS prototype is a mobile application created with *Sketch*, a MAC OS prototyping application. It is designed to be highly interactive, and will be programmed to be an expert in culinary sciences such as flavor profiles and pairings. SOUS is designed to be a smart system, and aims to inspire users to be more creative when cooking by uncovering new ingredients and recipes, and expanding their knowledge of flavor pairing and profiles.

Supporting Creativity

There are many digital cooking tools and resources available, but our research found that most are designed to be instructional and/or informative. Referring back to Sanderson and Stappers's levels of creativity, improving user's confidence and knowledge of cooking certainly can stimulate creativity. While education and instruction is part of our system, it was not the main goal of SOUS. We set out to design a

system that inspired users to not only cook more or cook better, but explore new ingredients, flavor pairings, and recipes. A challenge we faced was uncovering ways to make SOUS a *co-creative* application, where both users and SOUS contribute and build upon each other's ideas. We chose to make SOUS interactive, requiring users to provide their own input and feedback on SOUS' output. This is done for two reasons:

1. User-agent engagement: we considered what an interaction between two humans would look like in a similar conversation about cooking. For example: when creating a grocery list or deciding what meal to cook for dinner, the conversation shifts from one person to the other several times. We aimed to mimic this exchange and consideration of ideas with SOUS. Though SOUS is an "expert", it still relies on the user's contributions. This helps our application break away from the instructional ("how-to") cooking space, and into a more collaborative environment, where SOUS will learn from its users.

2. SOUS analyzes all user input to recognize behavioral patterns over time. As a result, SOUS can provide smarter recommendations based on user preferences, making the experience more personalized to each user.

Measuring Design Goals

We plan to measure our design goals with the help of qualitative methods, specially individual surveys where participants observations and feedback will be gathered.

PRIMARY CONTRIBUTIONS

There are several cooking applications that act as recommender systems, where the system gives users a list of recipes, and users can filter on results in various ways. However, these applications are missing one crucial element: *co-creativity*. SOUS incorporates co-creativity by interacting with the user one-on-one to bounce ideas back and forth regarding ingredients to produce recipes. The user sparks the conversation by picking a few ingredients to start with. Then, SOUS recommends ingredients based on the best flavor pairings with the ingredients the user selected.

Level	Type	Motivated by	Purpose	Example
4	Creating	Inspiration	'express my creativity'	Dreaming up a new dish
3	Making	Asserting my ability or skill	'make with my own hands'	Cooking with a recipe
2	Adapting	Appropriation	'make things my own'	Embellishing a ready-made meal
1	Doing	Productivity	'getting something done'	Organising my herbs and spices

Table 2. Four levels of creativity.

Figure 1: Levels of Creativity

In short, the key elements used by the SOUS cooking app include its co-creative element to work with the user to find recipes, as well as the use of *flavor profiles* and *flavor pairings* to find the best ingredients that would work together. Finally, SOUS uses *novelty* to provide the user a certain level of uniqueness and complexity to their meals.

Outline

The rest of the paper will proceed in the following order. First, we will review related work to our project and how they compare to our work done. In the *System Design* section, we will discuss the system design of the SOUS cooking app. This includes how it functions, its use cases (how it is used and in what circumstances / scenarios), a system diagram to visualize how it works, and photos of the prototype. Next, we will discuss the evaluation method and process taken (in the *Evaluation* section). Then, we will review the results from our user studies in the *Results* section, and we will interpret those results in the *Discussion* section. Finally, we will explain our conclusions (in the *Conclusions* section).

RELATED WORK

(To be finished)

Whilst there is not much work carried out that investigates computational recipe generation, there is an extensive body of literature focussed on the problem of recommending recipes. Typically, these systems recommend recipes to users based on parameters such as their past feedback (Freyne and Berkovsky 2010b; 2010a; Forbes and Zhu 2011),ingredient availability and nutritional needs (Shidochi et al. 2009; Kamieth, Braun, and Schlehuber 2011). However, none of these systems produce novel recipes that do not already exist.
The relation between creativity and cooking are as old as cooking itself. Recipe-generating programs already exist, but they are generally simple and case based,

substituting new ingredients based on flavors that have worked well in other dishes

SYSTEM DESIGN
Overall System Functions

Sketch allowed us to showcase different features and stimulate how SOUS could be navigated as a mobile application. Functions and features available to the user include:

- User account and preference management
- Ingredients list where users can add, edit, and view their current list
- Favor/ingredients suggestions and information
- Browse recipes: users can view full recipes through SOUS, add ingredients from recipes to their list, and save recipes
- View saved recipes and provide ratings (thumbs up or thumbs down)

On the system side, SOUS will utilize APIs and web scraping to find ingredients, flavor pairings, and recipes. For example, [Foodpairing's](#) API, *flavor.id,* which "combines the scientific aromatic profile and nutritional values of ingredients, with consumer flavor preferences." SOUS learns from resources as *flavor.id* in order to provide culinary expertise to users. Additionally, as SOUS adapts to users' preferences and learns their behavior over time, it continuously improves its suggestions to be specific to each user.

We considered the different skill levels and what a co-creative application would need to satisfy a variety of users. We recognize that experienced cooks, who are already familiar with flavor profiles and pairings, may not find the flavor expertise of SOUS useful or creative. Thus, another design goal was to incorporate a feature that focuses on novelty, allowing users to filter content based on their skill level and how creative they wanted to be. We incorporate this idea with our *Novelty Filter,* which allows users to explore recipes based on their uniqueness. This feature is designed as a sliding scale from zero to ten, with zero being very basic and common recipes and ten being unique, more complicated recipes.

A. **Popularity**: how common is this recipe on cooking domains? Popular, common recipes will have significantly more options available when compared to uncommon, usually more-complicated recipes. Using the examples in the prototype filter above, a quick Google search results in roughly 20 million peanut butter and jelly sandwich recipes. In comparison, a search for Pâté en Croûte recipes produces only 211,000 results.

B. **Ingredients**: how many ingredients are required for the recipe, and how unique is each ingredient? Both are factored into the novelty rating of ingredients. The more ingredients required, the more "novel" (or complex) that recipe is. Similar to the popularity factor in recipes, our system also analyzes how unique each ingredient is, based on how often it appears in different recipes. This way, common ingredients such as oil or salt do not inflate the overall rating.

C. **Techniques**: what cooking techniques are required for the recipe, and how complicated are these cooking techniques? Techniques such as poaching, blanching, and braising are technical and more complicated than common techniques such as boiling or microwaving. For each recipes, our system detects keywords related to techniques, then analyzes the number of techniques required and the difficulty of each.

Figure 2: Novelty Filter on SOUS Prototype

Each category is rated between 0-10, and the mean of the three is used as the novelty rating for a recipe. A novelty rating is displayed for each recipe displayed on SOUS, and users can utilize the sliding scale to filter recipes based on their rating.
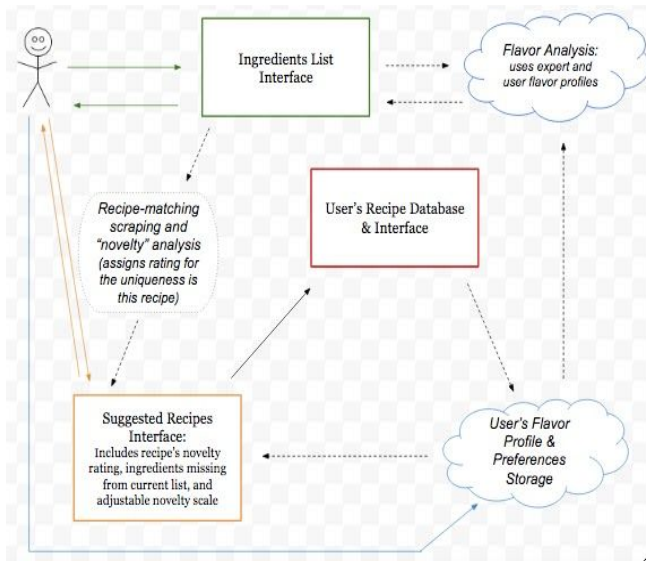
Figure 3: Interactive Diagram

Use Cases

Use Case 1: Encourage novice users to cook more often and be more creative in their cooking practices.

- **Motivation**: To help less experienced cooks to get used to cooking more frequently, and to use the flavor pairings and novelty filters to gradually increase / blossom their creativity when cooking. The spark of creativity could ignite the desire to cook more.
- **What part of the application supports this?** The concept of working with SOUS to bounce ideas back and forth on what ingredients to cook with can make the user more interested in cooking, especially if they have trouble coming up with what to make on their own. With less pressure on figuring out what to cook, the user can be more inclined to want to cook.
- **How do people interact with it?** A user can first input some ingredients they have (like a meat) that they have currently. Once he or she continues, SOUS will give recommended ingredients for the user to explore and add if desired. Once the user has added all the desired ingredients, he or she can search recipes to find what he or she is in the mood for. The Novelty scale lets the user get more creative by trying more unique recipes.

Use Case 2: Educate on how and why different flavors work well together.

- **Motivation**: To make it easier for users (namely those who are less skilled in cooking) to understand why SOUS is recommending certain ingredients based on the ingredients selected by the user. This will, in turn, better explain to the user why he or she may want to accept some of SOUS suggestions.
- **What part of the application supports this?** Where SOUS recommends ingredients after the user has provided some ingredients, it explains the reasoning behind each recommended ingredient (like *hot pepper* adds *spicy* to the mix). It is also on the page where it shows the **Flavor Profile** graphic.
- **How do people interact with it?** Once the user has provided initial ingredients and SOUS has recommended some ingredients to pair with them, the user can click the eye icon on each ingredient to see the explanation as to why this ingredient pairs with the flavor of the user's input. The user can also go to the page where it shows the **Flavor Profile** graphic, where it maps out the flavor pairings for the user to easily view.

Use Case 3: Continually learn user preferences and adjust output accordingly.

- **Motivation**: To make the application more individualized, and therefore of better service to the user.
- **What part of the application supports this?** When the user accepts or rejects certain recommended ingredients, SOUS will learn from this. SOUS will learn user preference as it sees over time what novelty scale the user typically uses, what ingredients the user inputs more frequently, as well as the user settings where the user lists anything they dislike or have an allergy to.
- **How do people interact with it?** When SOUS gives suggested ingredients to the user and he/she accepts or rejects certain ingredients. When the user also updates his or her preferences under user settings on the Profile page. When the user chooses a point in the novelty scale to search (**note**: this is on the Recipes page after the user clicks *Explore Recipes* once they have selected ingredients).

Use Case 4: Allow users to discover recipes based on novelty.

- **Motivation**: To encourage the user to make recipes that are less common, and are more unique and complex. This will push the user's comfort in the kitchen and cause them to potentially reach outside their comfort zone.
- **What part of the application supports this?** On the Recipes page, the Novelty scale lets the user find more or less novel (unique) recipes.
- **How do people interact with it?** On the Recipes page, after the user has decided on their own ingredients and which ingredients they want to use that SOUS recommended, the user can drag the circle on the Novelty Filter scale to search for recipes that are less (far left on the scale) to more (far right on the scale) novel or unique.

EVALUATION
Goals
<mark>[need to add - what do we want to know about users and system?]</mark>

Method
Our experiments were conducted as individual studies, where each participants has a one-on-one interaction with a researcher. The researcher has complete control over the extraneous variables. First in the study, we will gather information from participants in the form of a *pre-study questionnaire*, which will tell us a little about the participants.

In the one-on-one study, we will briefly explain the motivation behind the application and the application's goals. We will instruct the participant to speak aloud as they have thoughts / feedback throughout their interaction with the application (comments, questions, concerns, etc.). After the study, we will ask some *interview questions*.

At the end, we will ask for any additional feedback. This will be in the form of a *post-survey questionnaire*, which will allow the participant to provide feedback after the study. Allowing the participant to log this will let them think through their thoughts and feel more comfortable providing feedback.

Experiment Design

Experiment Protocol
- Pre-study survey
  - The facilitator will greet the participant. The participant will then take the pre-study survey.
- Explanation of the application and the study procedure
  - Once the participant has finished the pre-study survey, the facilitator will explain the goal of the application to the user. The facilitator lets the user know that this is a prototype, so it is not fully functioning at this time. For this reason, the path taken through the app is an orchestrated one.
- The participant walks through / interacts with the application, according to the guidance provided by the facilitator.
  - The facilitator remains beside the participant as he or she is going through the application. The facilitator guides the participant through each page to describe the purpose of each. Interview questions will be asked throughout the walkthrough.
- Post-study survey
  - When the participant has finished going through the walkthrough, he or she will take the post-study survey to give his or her feedback on the experience.
- Compiling user feedback and results, evaluating statistics and correlations
  - The facilitator will take notes to jot down all user input that the user may not write down himself or herself, so that the team can collectively compile results and evaluate statistics and correlations based on the user sessions.

Pre-Study Questionnaire:
1. What is your level of cooking ability/skill level? Please select one answer: **Beginner, Intermediate; Advanced,** or **Expert.**

Hint: this is how each level is defined:
- **Beginner**: Users with little to no experience with cooking, perhaps stick to very basic recipes if/when cooking, and are not familiar

with basic cooking techniques. These users do not usually cook for themselves or for others, and mainly rely on prepared foods and/or restaurants.

- **Intermediate**: Users that have experience with cooking using recipes, books, videos, etc. They are familiar with most basic cooking techniques (such as steaming, boiling, roasting, braising, browning, frying and sauteing). These users prepare full meals for themselves or others regularly or semi-regularly (three or more meals a week).
- **Advanced**: users that have significant experience and a strong, self-taught foundation from other advanced cooks and/or culinary resources (such as books, videos, recipes)These users cook for themselves or others regularly, but not professionally.
- **Expert**: Users that have trained or studied in a culinary environment (such as a restaurant or culinary institute). These users have cooked for others *professionally*, and are (or have previously been) considered chefs by trade.

2. On average, how often do you cook? Please select one answer.
    - At least one meal per day
    - Two-six meals a week
    - One or two meals a week
    - A few times a month
    - Rarely (one meal a month or every other month)
    - Very rarely to never

3. How adventurous are you when cooking? (How often do you try new, unfamiliar recipes/ingredients?) Please select one answer.
    - Very adventurous
    - Moderately adventurous
    - Neutral
    - Not very adventurous
    - Not adventurous at all

4. How often do you use websites and videos before to help you find recipes and learn cooking techniques? Please select one answer.
    - On a regular basis
    - Semi-regularly / As-needed
    - Rarely to never

5. Have you previously used web or mobile cooking applications? (E.g., a smartphone app dedicated to cooking?) Please select one answer.
    - Yes
    - No

6. What is your overall level of comfort using technology (more specifically, web and/or mobile applications)? Please select one answer.
    - Very comfortable
    - Moderately comfortable
    - Neutral
    - Not very comfortable
    - Not comfortable at all

Post-Study Questionnaire
Scale: 1: Strongly Disagree; 2: Disagree; 3: Neutral; 4: Agree; 5: Strongly Agree.

1. I feel Sous will encourage me to cook more often.
2. I feel Sous will encourage me to try new recipes and be more creative with cooking.
3. Sous can help make me a more confident cook.
4. The Sous application is easy to navigate and understand.
5. I would feel comfortable using Sous when cooking.
6. I find the flavor pairings feature useful and/or helpful.
7. The novelty feature would motivate me to find more creative and/or unique recipes.

Interview Questions

1. What are your initial/overall thoughts on the Sous application?
2. Do you have any recommendations or features you would like to see with Sous? If yes, are these features you have seen in other cooking applications or sites?
3. Additional comments, questions, feedback.

RESULTS
Participant Information
We conducted single-condition observational studies on nine individuals. This will provide the opportunity to be more engaged with users one on one and have time to ask individual questions to the participant at the

end, without wasting too much of the participants' time.

Five of the subjects were between 20 to 28 years old; two were between 30 to 35 years old; and two were between 55 and 60 years old.

Analysis Method

We will conduct qualitative analysis of the data collected from the questionnaires (surveys) given to participants before and after the study, as well as from the interview questions asked during the application walkthrough. *Grounded Theory* will be used in qualitative research.

- *Grounded Theory*: this method will be used to uncover any emerging patterns from the feedback gathered from participants. Because our study is heavily based on the user experience and interaction with the AI, their feedback will be key for improving for identifying common pain points related to cooking and cooking-related technology, as well as improving and developing features of our application.

Descriptive Statistics

Descriptive statistics are used to describe the basic features of the data in a study. They provide simple summaries about the sample and the measures.

Demographics: men and women, between the ages of 18 and 65 years old.

Participants will fall into one of three categories based on their cooking ability and culinary knowledge (users choose based on the descriptions):

1. *Beginner*: Users with little to no experience with cooking, perhaps stick to very basic recipes if/when cooking, and are not familiar with basic cooking techniques. These users do not usually cook for themselves or for others, and mainly rely on prepared foods and/or restaurants for their meals.
2. *Intermediate*: Users that have experience with cooking using recipes, books, videos, etc. They are familiar with most basic cooking techniques (such as steaming, boiling, roasting, braising, browning, frying and sauteing). These users prepare full meals for themselves or others regularly or semi-regularly (three or more meals a week).
3. *Advanced*:

4. *Expert*: Users that have trained or studied in a culinary environment (like a restaurant or school), or users that have significant experience and a strong foundation from culinary resources (such as books, videos, recipes). These users cook for themselves or others regularly (this could be *professionally*, if they are a chef by trade).

Inferential Statistics

Inferential statistics are a function of the sample data that assists us to draw an inference regarding a hypothesis about a population parameter.

Measuring correlations:
- Does the user's cooking ability affect their likelihood of using the application?
- Comparing each individual's ratings and comments with how helpful they find the applications: are there significant variances among the individual studies that were conducted?
- Does the user's cooking ability affect their likelihood of using the Novelty Filter? Is there any correlation between the ranges users initially select and their cooking ability?
- Outside of cooking ability, did we uncover any common factors or reoccuring feedback that significantly contributed to the results? *For instance, were there any correlations between users age, gender, technical capabilities, across different groups?*

Hypotheses: based on the application's current prototype and features, we believe the statistics will confirm:

1. Beginner and intermediate groups will find the application more beneficial when compared to the expert group.
2. The novelty filter will be more beneficial to the intermediate and expert groups when compared to the beginner groups.

**RESULTS**
- **6: Results**:
  - Participant Information
    - **Example**: we had 10 participants, half male and half female…
  - Analysis method

To study the use of our SOUS CHEF cooking app, we had nine subjects who used the app and completed the questionnaire. Of the nine, ⅓ were females and ⅔ were males. Five of the subjects were between 20 to 28 years old; two were between 30 to 35 years old; and two were between 55 and 60 years old.
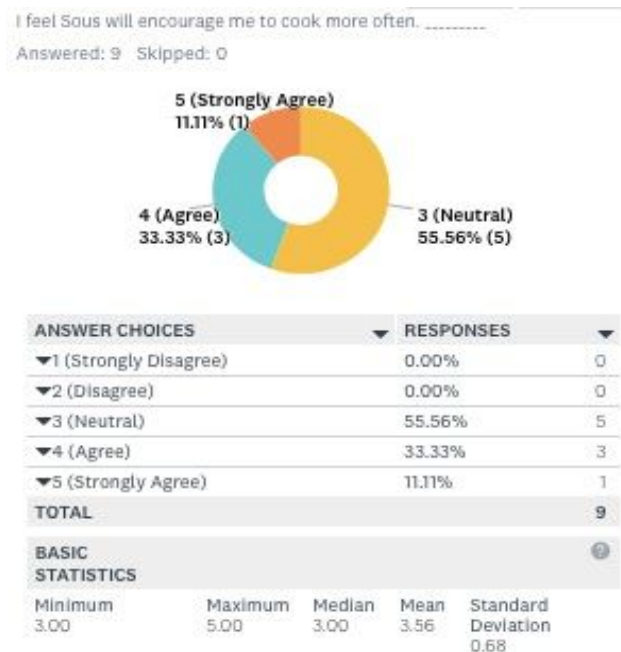
As you can see from *Figure 3*, of the nine participants, four identified as *Advanced Cooks*, i.e. users who have significant experience and a strong, self-taught foundation from other advanced cooks and/or culinary resources (such as books, videos, recipes).
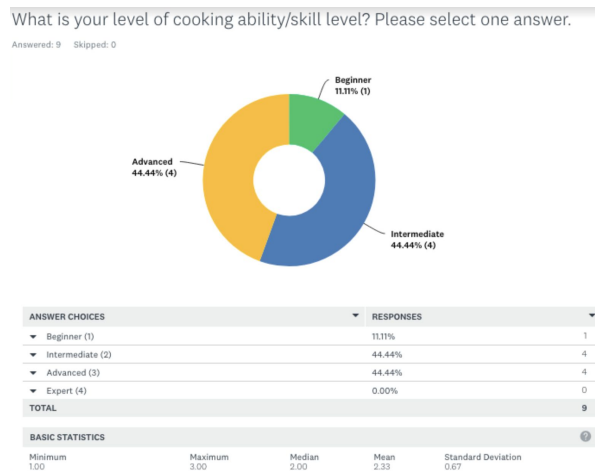
These users cook for themselves or others regularly, but not professionally. Four identified as *Intermediate Cooks*, i.e. those who have experience with cooking using recipes, books, videos, etc. They are familiar with most basic cooking techniques (like steaming, boiling, roasting, braising, browning, frying, and sauteing). These users prepare full meals for themselves or others regularly or semi-regularly (three or more meals a week). Only one participant identified as a *Beginner*. *Beginners* are those with little to no experience with cooking. They perhaps stick to very basic recipes if/when cooking, and are not familiar with basic cooking techniques. These users do not usually cook for themselves or for others, and mainly rely on prepared foods and/or restaurants.

What was surprising was, all nine participants responded "Agree" when asked to rate the following statement: "I feel Sous will encourage me to try new recipes and be more creative with cooking." However, as you can see in *Figure 4*, only three (33.33%) participants responded "Agree" when asked if the application will encourage them to cook more often.

Evidently, there is no correlation between the novelty of the recipes and its effect on the users to cook more often.
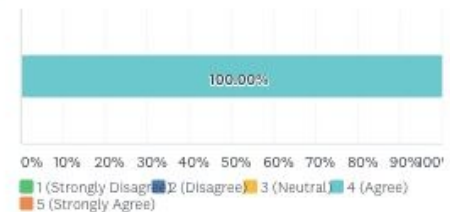
To determine whether the association between the variables Level of Cooking and is statistically significant

Discussion

<mark>
- **7: Discussion**:
    - Interpret results
    - ***Implications for future work
        - (Very important)
</mark>

Conclusions

<mark>
- **8: Conclusions**:
    - Re-state the major contributions
    - This paper showed…
    - The application did …
    - …
    - The results showed …
</mark>

This paper investigated the possibility of building applications that could exhibit creativity and assist humans in the domain of cooking. We envision multiple ways in which this work can be extended.

Challenges

- Mocking the AI interaction.
- Measuring Co-creativity of the system.
- Evaluating the effect of the use of the co-creative system.

Acknowledgements

The authors would like to thank Dr. Davis and his class for insightful discussions and support.

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