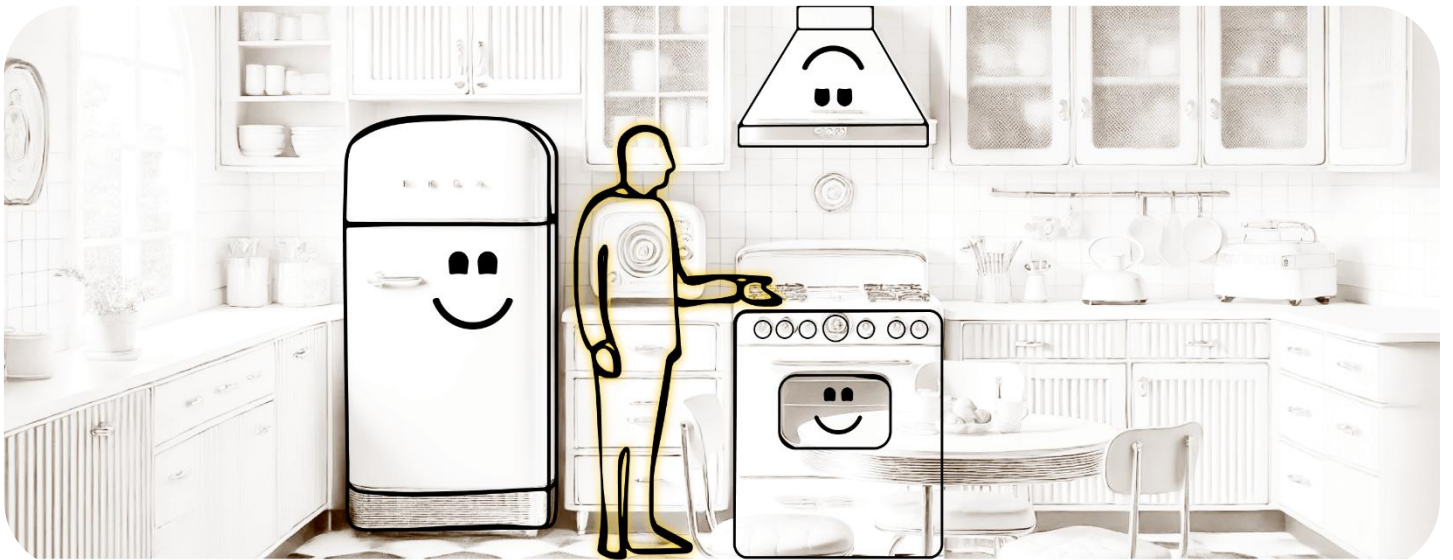


Smart Kitchens & Smarter Conversations

*Mapping Human-AI dynamics and expectations of applying
GPT (Generative Pre-trained Transformer) models
as an interface in smart kitchen ecosystems*



Graduation Project

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Preface & Acknowledgements

I always wondered how artificial and human intelligence could work together and thought to myself one day, "Wouldn't it be great if others could feel the same level of euphoria in the kitchen that cooks feel when they successfully make a plate full of flavour?" This project is a step towards making that dream a reality, blending cutting-edge AI with the art of cooking to create a seamless, joyous experience

Under the astute guidance of generative AI gurus Dr. Derek Lomas and Heng Gu from the Faculty of Industrial Design Engineering at TU Delft, this project represents a thrilling collaborative effort with the smart services and UX team at ASKO Nederland, especially my supervisors, Vincent Hofstee and Wouter Ditters, along with the constant guidance and cooperation from Anders Tyrland and Till Stackman, have been pivotal in navigating the complexities of this venture.

Special thanks to my friends and family for their unwavering support, patience, and encouragement throughout this journey. Your belief in me has been the cornerstone of my success. Here's to the intersection of human creativity and artificial intelligence, and to the smart kitchens of tomorrow!

A hearty shoutout to OpenAI for their groundbreaking technology and to the innovative Reddit lead users who boldly pushed the boundaries of ChatGPT long before we embarked on this journey. Your trailblazing spirit has inspired and propelled this project to new heights.

Executive Summary

We are on the verge of reversing a technological paradox. With the right steps, we can leverage the power of artificial intelligence to revolutionize the world of smart kitchen appliances. Imagine a kitchen where your fridge, oven, and cooking hob understand and anticipate your needs, making cooking a breeze and a joy. Generative AI, especially Large Language Models (LLMs), have given us a way to communicate naturally and humanly with machines. It's almost like having a personal chef who knows exactly what you want, how you like it, and is ready to assist at any moment.

Now, think about your current smart kitchen appliances. They have amazing features, but how often do you find yourself frustrated by complicated settings or unintuitive controls? What if your kitchen as a whole, could not only understand your commands but also learn and adapt to your cooking habits? Let's pose a question: "In the age of commercially available AI, what could we, as makers of kitchen appliances, do for you to make you choose our products and stay loyal to our brand?" Perhaps this next paraphrased question makes it more answerable - *"For what job would you hire any of these appliances that we sell, to assist you in the kitchen?"*

This project aims to kick off with the notion of getting GPTs to generate recipes and functions for the appliances. It studies consumers' experiences modern kitchen appliances to understand what they truly need, want, and expect from a smart kitchen. It starts with a thorough exploration through literature reviews, online community trends, and direct user research to gather deep insights through experiments and interviews. These insights are then transformed into practical use cases for AI models. By crowdsourcing data, we create detailed user personas that showcase how personalized AI can elevate the cooking experience. We test the capabilities of OpenAI's GPT-4 to design an actionable solution that ASKO can integrate into their future appliance lineup.

The result? A set of affordances of this proposed interface, a set of personas and a thorough understanding of market and customer value, complemented by a strategic story that outlines the logic necessary to deliver an extraordinary brand experience for ASKO consumers. Picture a kitchen where your oven knows the perfect temperature for your favourite dish, your fridge suggests recipes based on its contents, and your cooking hob adjusts its heat just the way you like it. This is not just a vision for the future—it's a reality we are building today. By embracing this innovative approach, ASKO can lead the charge in transforming kitchens into intelligent, responsive, and delightful spaces, ensuring customer satisfaction and unwavering brand loyalty.

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1

Project Overview

Background, Approach & Methodology

This section illustrates the contents, flow and timeline of this project through sub-sections that detail out the approach to the project, goals, scope, basic methodology and the storyline of the project.

1.1. Background and Context

The idea that an appliance can be intelligent paved a new way of interacting with appliances giving them the identity of being "smart". *A smart appliance, for the scope of this project is defined as a home appliance integrated with digital interfaces capable of automation of certain pre-defined tasks.*

In the last couple of decades, we have watched smart appliances becoming popular across the electronics markets. However, an observation is made that smart appliances, while designed for their multifunctional capabilities with an aim to assist the user and automate functions that would often consume time and effort, contradict that very objective and end up with rather complex interfaces that may ultimately cause more harm than good in the lives of consumers. The average consumer sticks to the simple and standard programs and settings as a result of operational confusion and lack of knowledge about the product. A study by Li et al. (2021) in the Journal of Big Data highlights that the immaturity of IoT hardware and software is a significant barrier to the effective use of smart appliances. Users often find these devices difficult to navigate without extensive guidance, which can result in many features going unused. This ties into the paradox of technology mentioned in the summary, that technology often races past the average consumers' ability to adapt in the hope that they may some day face issues potentially solvable by the advanced interface. The problem is, however, that this system rewards radical use of a product but neglects the largely diverse, simpler use cases of the average consumers. Diversity is difficult to achieve in a product that is sold to larger audience considering the variability of users against the homogeneity of brand value of the provider.

On a parallel note, one of the most recent breakthroughs in the interactive technology market has been observed to be that of Open AI's LLM powered ChatGPT, an AI (Artificial Intelligence) chatbot available for personal and commercial use. Commoditized first in late 2022, the LLM Powered GPT Model (Generative Pre-Trained Transformer Model) uses NLP (Natural Language Processing) allowing a user to interact with it through a chat interface in an almost human-like manner. The need for skill building is reducing as long as one can communicate in their own language to a machine which runs a powerful algorithm to find the closest possible meaning of the natural language input.

Seeing an advantage in NLP and a newer way of communicating with machines, this project springs at the intersection of AI and Smart Appliances, potentially forecasting the reversal of this paradox of technology to enable real human-centred design by asking the question "Can we start talking to our kitchens?"

1.2. Project Goals - What are we trying to achieve?

ASKO Statement:

*"We offer a full range of kitchen and laundry appliances that will not only **meet our customers' expectations** for many years to come, but often **exceed them**."*

- ASKO

Future Vision for AI in Smart Kitchens

AI personalises and contextually improves the cooking experience for a diverse, culturally rich customer base of ASKO, adding value as a communicator between the customer, the ASKO Brand and kitchen appliances, establishing an intelligent ecosystem.

A Fully AI-powered Intelligent Kitchen Ecosystem (Mid 2026)

Future Scenario - ASKO users have a connected ecosystem of kitchen appliances that uses an AI interface to facilitate a smooth dialogue between natural human language and autonomous kitchens. This AI interface is in the form of a conversational kitchen agent thus realising the notion that consumers may quite literally talk to their kitchens.

Short Term

1. Evaluate the Context with an overlay of Gen AI

To evaluate fundamental aspects of using a GPT to prepare a roadmap for the next steps in achieving the future vision. The roadmap outlines the story from step one that is recipe generation models and marks each incremental and developmental step along the way in terms of leaping features and drifting features plotted on a timeline.

2. Propose the next step for ASKO as an appliance manufacturer

The aim here would be to examine the market of smart appliances under the influence of generative AI and use these findings to propose an adoption strategy for ASKO to ultimately be able to stay relevant in the competitive market of smart kitchen appliances.

1.3. The Environment - The Smart Kitchen Ecosystem

To intervene in an existing ecosystem, we need to first define its boundaries and components. This connected smart kitchen ecosystem comprises of products from the ASKO brand.

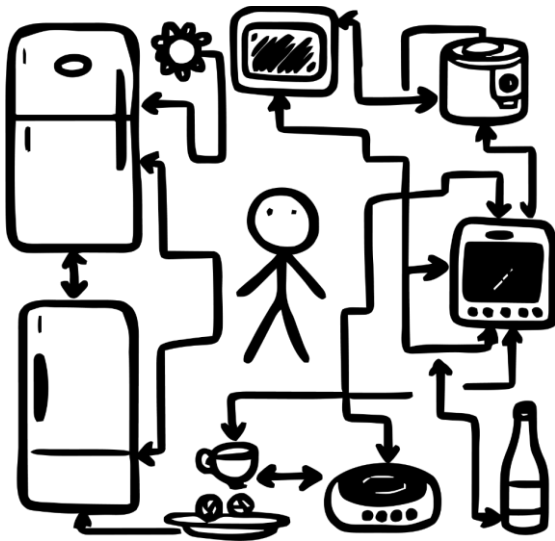


Fig 1.1. Components of a Kitchen Ecosystem

A. Smart Appliances

1. Oven
2. Air fryer
3. Microwave
4. Fridge
5. Induction Hob
6. Coffee Machine

B. Food

1. Ingredients
2. Fast Moving Foods

C. Tools & Cutlery

A smart kitchen is typically equipped with standard kitchen appliances which can be paired with a proprietary or third party interface. Together with ASKO, the client, who is a manufacturer and designer of appliances, the list of appliances above were defined as the electronics component of the ecosystem. Second, the reason kitchens exist is food as a basic human need. Food is one of the main expenses of a household which makes it a major component of the smart kitchen. Finally, we stop at tools and cutlery as the third part of the ecosystem.

1.4. The larger affordance - Generative AI

D. Introducing a fourth Component of the Kitchen ecosystem: Multimodal Artificial Intelligence

With this project, a superimposed component is introduced in the form of artificial intelligence to evaluate a potential presence in home kitchens of the average consumer. The intelligence is proposed in the form of a custom GPT built using OpenAI's GPT Builder Platform. This GPT is later evaluated outside of the chat interface in the second phase of the project

1.5. Process

Starting with a holistic approach of understanding how AI is being applied in smart kitchens, we zoom into how GPTs are being used for kitchen related activities to derive expectations of GPTs integrated into smart kitchen ecosystems in the foreseeable future.

The decision to start with a broad scope was made considering the wide range of possibilities that generative AI may bring to kitchen experiences. This would mean we start with an inductive approach not knowing where the research will lead us. Keeping the

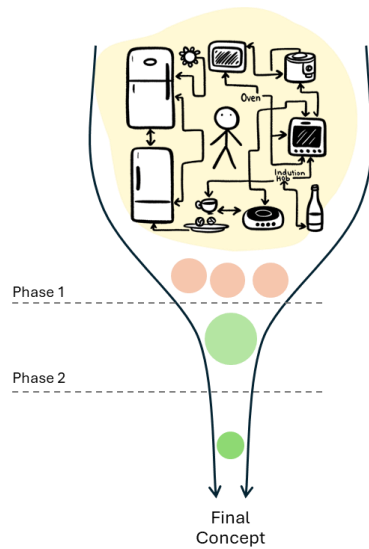


Fig 1.1. Broad to Narrow Approach

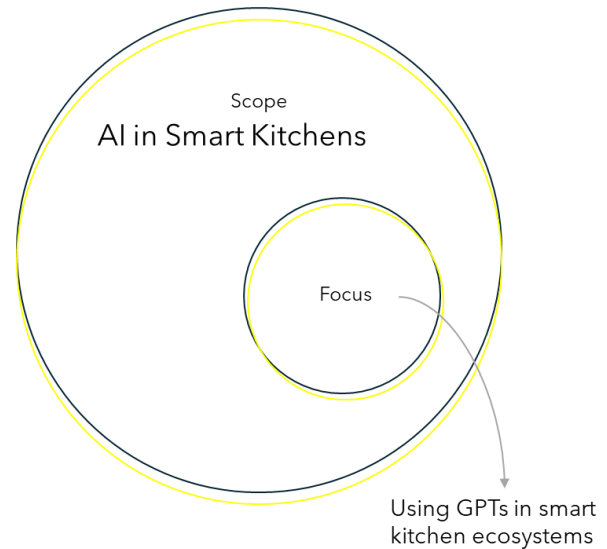


Fig 1.2. Initial Scope and Focus

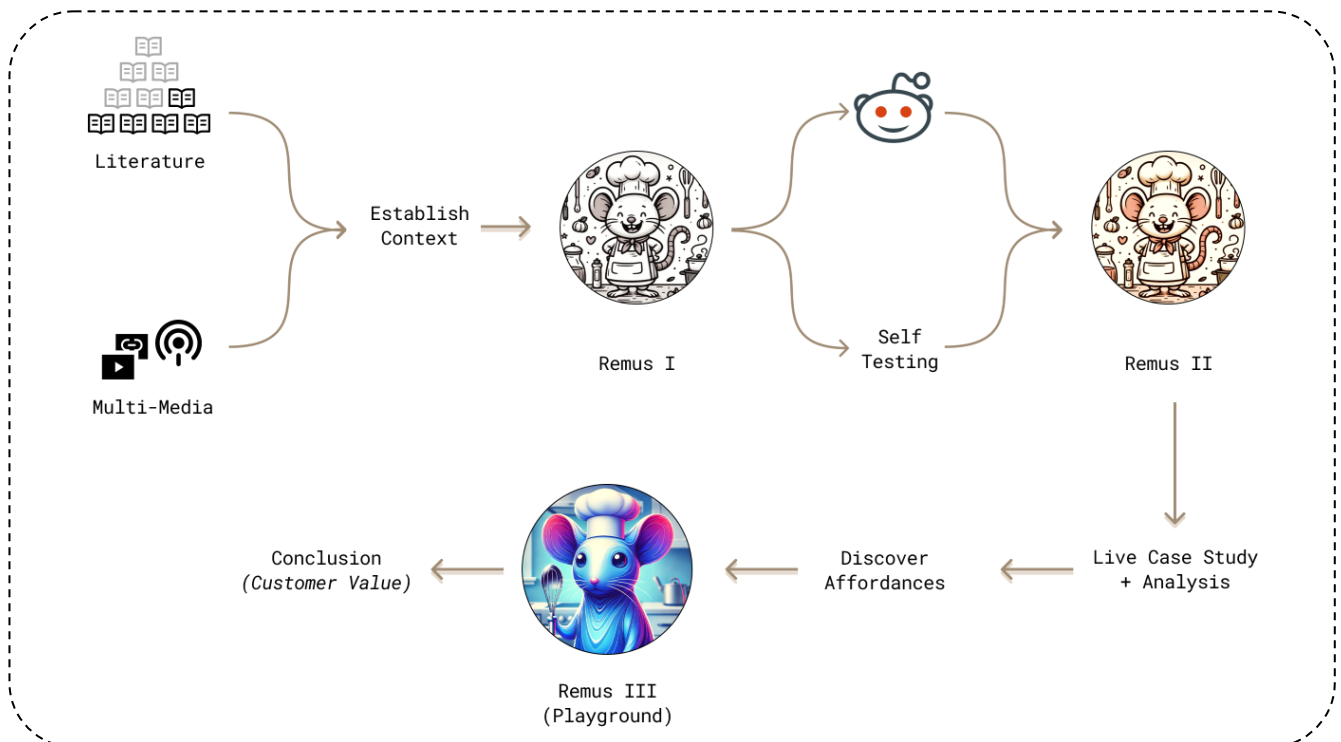


Fig.1.3. Process of Project - Iterative Design

1.6. Establishing focal points

The findings from literature and media established the following area of focus:

- 1. Contextual Awareness and Learning Adaptation*
- 2. Personalised Output*
- 3. Addressing the duality of 'hallucination vs factual output'*

1.7. Ultimate Design Goal

To propose a specification for an intelligent kitchen assistant with strong contextual awareness and is personalised to the users' needs which ultimately improves the users' communication with smart kitchen appliances.

1.8. Inductive Approach (through context mapping)

In light of the blurriness of the AI market and limited literature and theory available at the start of this project around the chosen topic, the decision was made to rely more on experimental value to generate first hand information. Online discussion platforms showed the extent to which people like to push boundaries of ChatGPT and other AI models.

2 Base Research

Literature + Media Review

Base Research

Findings eventually lead to the design of a Custom GPT

Through findings from literature and media sources, this section covers advancements in AI applications for smart kitchens. It explores how human-centric AI personalizes cooking experiences by adapting to user preferences and interactions. Key themes include the use of Retrieval-Augmented Generation (RAG) to enhance AI accuracy, the development of user-friendly interfaces that simplify interactions, and the integration of conversational agents and deep learning models for recipe generation. The review also highlights technological innovations, such as conversational agents and smart appliance integration, that contribute to more intuitive, efficient, and personalized kitchen environments.

2.1. Literature Review

Human-Centric AI

Human-centric AI focuses on creating systems that learn from and adapt to individual user needs. In the context of smart kitchens, these AI systems personalize cooking experiences by learning from user interactions and preferences, thereby improving usability and satisfaction (Minh & Khanna, 2018). For instance, systems equipped with AI can suggest recipes based on past cooking habits or dietary restrictions, providing a tailored kitchen experience that evolves with the user's tastes and needs.

Commercialisation of Human Centred-Intelligence

Christensen et al. (2016) emphasize the importance of understanding the specific "jobs" customers need to be done to drive successful innovation. By focusing on the progress customers seek in specific circumstances rather than just their demographics, companies can create products that more effectively meet customer needs, leading to higher satisfaction and loyalty.

Plug & Play Conversational Agents

The integration of conversational agents like "Foodie Fooderson" in smart kitchens facilitates enhanced interaction between AI systems and users. These agents use natural language processing to assist users in recipe selection and management, improving the user experience by making technology more accessible and responsive (Angara et al., 2017). IBM suggests that such models may be available for use as plug and play models for kitchens possibly similar to the Amazon Fire Stick.

ChatGPT is Bullshit (in the Frankfurtian sense)

ChatGPT creates text that sounds true but doesn't actually care if it's correct, so calling its mistakes "hallucinations" is misleading. Instead, it's more accurate to say ChatGPT is "bullshitting" because it produces convincing responses without concern for truth. For example, while ChatGPT might give good cooking tips, it's important to double-check because it might confidently suggest ingredients or steps that aren't right.

RAG - Retrieval Augmented Generation

Retrieval-augmented generation (RAG) is a technique that enhances the accuracy and reliability of generative AI models by integrating facts from external sources. This approach fills a critical gap in how large language models (LLMs) operate, as these models primarily rely on their internal parameters to understand and generate human-like text. However, LLMs often lack the ability to provide detailed and up-to-date information on specific topics. RAG addresses this limitation by linking generative AI services to external resources rich in current and technical details. This not only allows models to cite sources, building user trust, but also helps clarify ambiguous queries and reduce the occurrence of incorrect outputs, known as hallucinations. (Meritt, 2024)

User-Friendly Interfaces

The evolution of user-friendly interfaces in smart kitchens is highlighted by applications like "Kool Kitchen," which simplifies the interaction with complex appliances through intuitive controls. This approach reduces the learning curve and enhances user engagement by making technology accessible to users of all skill levels (Vu Trieu Minh & Khanna, 2018).

Apple intelligence brings the classic Apple approach in the form of a simplified, yet enhanced-Siri level of experience to its users by making the leap after nearly two years since the first public launch of ChatGPT (Shakir, 2024). Apple, while integrating a local language model within iPhones to ensure quick retrieval and latency, sends a call to OpenAI's cloud GPT model in the situation that it cannot solve the problem itself. This makes systems more efficient unless a novel request is made, which is typically rare in the daily usage of a phone.

Moolya et al (2022) present a deep learning-based web application that generates recipes based on user-input ingredients, providing unique and creative recipes. The model leverages LSTM (Long Short Term memory) and Natural Language Generation to create recipes with titles, ingredients, and instructions, demonstrating the potential of AI in enhancing cooking experiences by making them more accessible and tailored to user preferences.

Technological Integration

Seamless integration of tools like Arduino and Raspberry Pi into kitchen appliances across many instances underscores the trend towards smarter and more connected kitchen environments (Johare et al). These integrations facilitate the creation of customizable and flexible kitchen systems that can be tailored to individual user needs, demonstrating a significant shift towards more integrated and user-centric kitchen solutions (Minh & Khanna, 2018). It is important to note that these are experimental explorations and not commoditised yet.

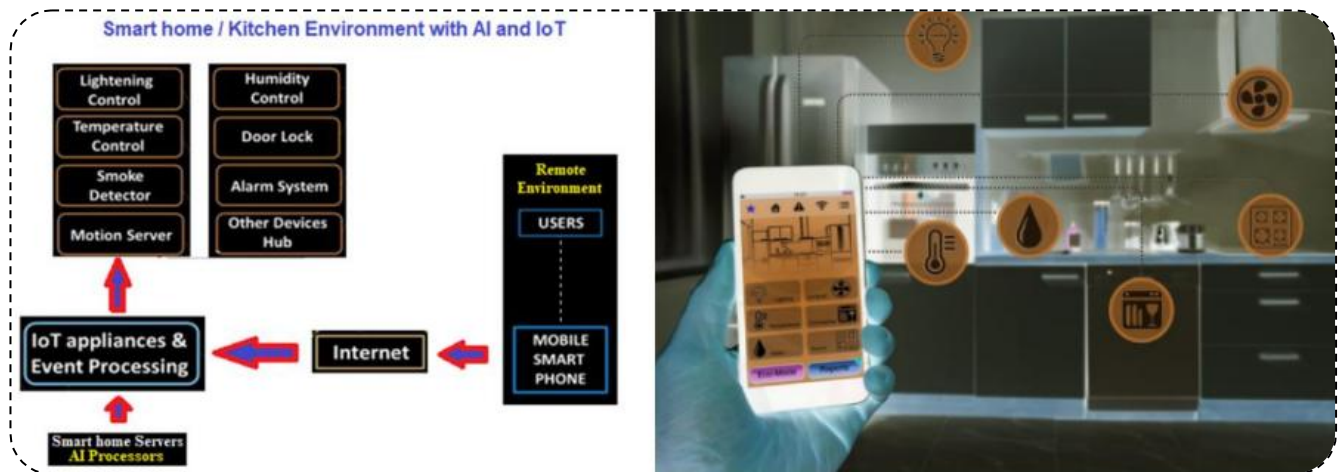


Fig. 1.4. Johare et al's experimental application of controlling a smart kitchen ecosystem using Raspberry Pi

Contextual Awareness and Learning Adaptation

AI systems in smart kitchens exhibit enhanced contextual awareness, allowing them to predict and respond to real-time user needs effectively. This capability is crucial for adapting kitchen behaviour to the context of use, such as adjusting settings based on the time of day or the presence of guests (Johare et al., 2022). Additionally, the ability of these systems to learn from user interactions and improve over time represents a critical advancement in personalizing user experiences and accommodating unique user preferences.

By structuring AI responses to follow a logical progression, the technique aims to improve the coherence and accuracy of AI-generated outputs, making them more useful for complex problem-solving task (Shao et al, 2023). The work by Jaber et al (2024) introduces a context-aware virtual assistant designed to aid users in cooking by providing personalized and contextualized guidance. The system integrates user preferences, habits, and available ingredients to offer tailored cooking advice, showcasing the potential of AI to enhance everyday tasks through personalized assistance.

Safety and Efficiency

AI-enhanced kitchens focus on improving safety and culinary efficiency through sophisticated monitoring systems and automated controls. These systems can prevent accidents and improve cooking results, thereby enhancing both safety and food quality (Minh & Khanna, 2018).

Verbal Reasoning: Comparing GPT4o and GPT4

GPT-4o exhibits notable improvements in specific areas of verbal reasoning, such as calendar calculations, time and angle calculations, and antonym identification. However, it continues to encounter difficulties with word manipulation, pattern recognition, analogy reasoning, and spatial reasoning. Conversely, GPT-4 Turbo demonstrates significant struggles with verbal reasoning tasks, achieving only a 50% accuracy rate in tests, which indicates a marked deficiency in this area. Overall, GPT-4o outperforms GPT-4 Turbo in verbal reasoning, showing marked advancements, while GPT-4 Turbo's performance remains relatively poor. (Sharma, 2024)

Cognitive IoT Vision

The vision for future smart kitchens includes broader integration with IoT, where kitchen appliances communicate not only among themselves but also with other smart devices in the home. This interconnectedness promises to streamline kitchen tasks and improve energy efficiency, marking a significant step towards fully automated homes (Johare et al., 2022).

So far, we see that there is existing evidence of use cases of AI in smart kitchens. The most novel exploration so far appears to be "Foodie Fooderson" (Angara et al., 2017) and shows promise of a market developing for conversational agents to be personalised and installed as plug and play models for smart kitchen ecosystems.

2.2. Related Work – Multimedia Sources

Culinary Trends

As seen in the figure below, the topic of recipes gains interest towards the end of the year (in colder months when festivities are their peak) while the interest in restaurants typically went down around the same time. Now, however, the interest seems to begin to align to each other and point towards the idea that good restaurant and recipe recommendations might be of equal importance.

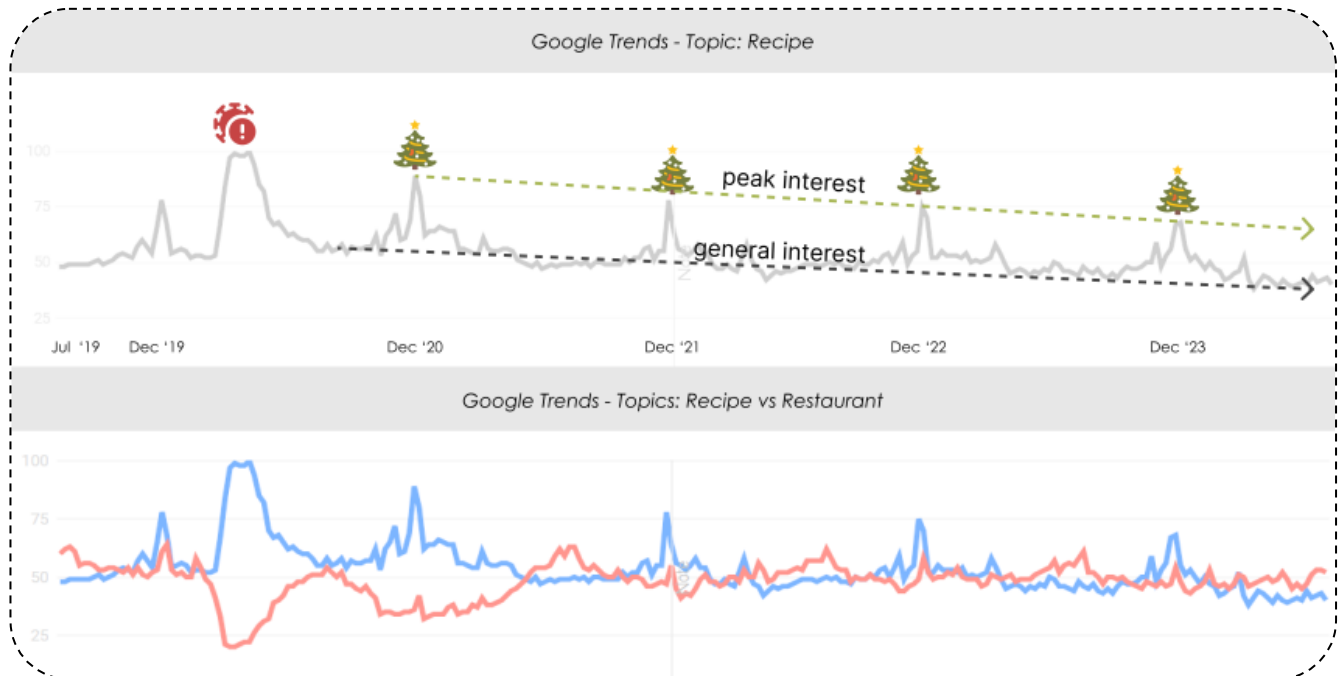


Fig. 2.1. Google trends image showing popularity of two search topics – “recipe” and “restaurant”

A bulk of interest in recipes was seen when the Covid-19 pandemic was at its peak in April and May 2020. At the same time, a study of 2,000 participants by Chicago’s Home Run Inn Pizza (Mary, 2023) suggests that Gen Z and Millennials differ significantly in their cooking confidence and habits. Only 33% of Gen Z consider themselves skilled cooks, compared to 47% of Millennials, with Gen Z rating their cooking skills at an average of 3 out of 5 versus 3.4 out of 5 for Millennials. This lack of confidence influences their social behaviour, as nearly half of Gen Z are reluctant to cook for others due to perceived skill deficits, compared to 34% of Millennials.

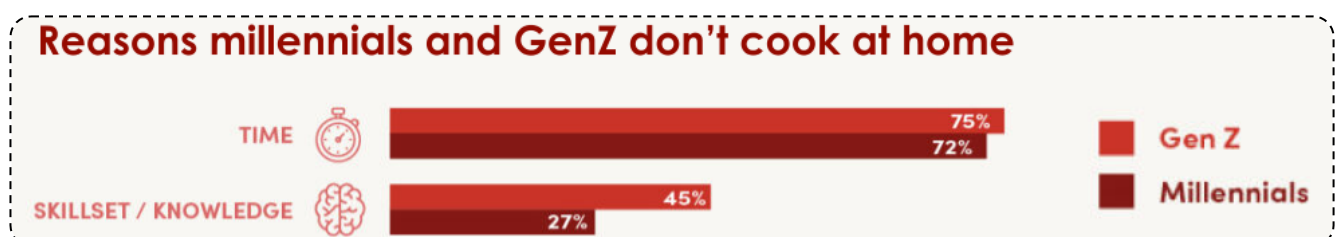


Fig. 2.3. Time and Skill/Knowledge see

Cooking with ChatGPT

Videos such as those by Sam's Home Kitchen (2022) demonstrate recipe generation and appliance instruction using ChatGPT. Gomes (2023) explores converting a mystery box of ingredients into a recipe with ChatGPT, successfully executing and delivering the meal. Comparative experiments with ChatGPT-designed menus and those created by professional chefs show indistinguishable results at first glance (Mythical Kitchen, 2023), though contrasting outcomes are reported by Joshua Weissman (2023) when following ChatGPT recipes precisely.

False Pretence with the Promise of AI

AI Integration into Appliances: Notable instances such as Shark Tank India (SET India, 2024) and the vlog 'Trying out Upliance' (Chef Nehal Karkera, 2023) showcase Upliance.ai's smart cooking device, which combines multiple kitchen appliances and features a screen that displays recipes and instructional steps. Although the device is marketed as AI-driven, criticism arises regarding its inability to cater to diverse taste preferences and the misleading use of AI as a buzzword. Despite these drawbacks, the device's interface suggests potential future connectivity with online AI recipe generators and chatbots.

Despite technological advancements, the smart kitchen ecosystem often remains fragmented, with interoperability issues limiting its potential (Pierce, 2024b). Discussions in recent podcasts reveal that while smart devices like Thermomix and Tovala offer sophisticated features, their lack of integrated functionality requires a re-evaluation of how these technologies should interact within a unified system. The yet-to-be-achieved capability of remotely pre-heating an oven is cited as a fundamental yet unattained feature (Pierce, 2024b). While this is still possible through computing platforms and voice assistants like Amazon's Alexa and Google Home paired with smart home devices, it's an increased number of steps to accomplish a single task.

Kitchen Design with AI

The utilization of ChatGPT in kitchen space design is explored through various content creators (Mark Tobin Kitchen Design, 2023), linking to the innovative use of generative AI in selecting and recommending kitchen appliances. This indicates a slight movement towards the integration of AI in sales and consultancy with the introduction of LLMs. Imagine a tool that takes in your input through conversational search and gives you exactly what you're looking for in the context of shopping for appliances or overall kitchen products.

Robotic Kitchens

The adoption of robotic arms in the food and packaging industries is well-established; however, their integration into commercial settings, as demonstrated by the now-defunct Spyce Restaurant in Boston, illustrates their capability to prepare meals swiftly (Varshney, 2018). In residential settings, robotic arms capable of performing complete meal preparations, including chopping and cleaning, were developed by mimicking the motions of master chef Tim Anderson (CNET, 2016). Although these robotic solutions enhance operational efficiency and offer personalized cooking experiences, they prompt considerations about the balance between embracing technology and preserving traditional culinary skills (Nusri, 2023). As smart kitchens evolve, it is imperative to ensure that technological enhancements complement rather than replace the human elements fundamental to cooking.



Fig 2.4. The robotic kitchen in Spyce Boston



Fig 2.5. Moley's Robotic Arms in Home Kitchens

3 Remus I: Custom GPT Version 1

Remus I: Custom GPT Version 1

Preliminary findings led to the making of a custom kitchen assistant.

Seeing that AI is being increasingly used as a co-pilot in the kitchen in small capacities, first hand experience becomes imperative as a launchpad for further experimentation.

Using the GPT Builder platform through an OpenAI Plus subscription, A custom GPT chatbot named "Remus I" was developed and given the role of a kitchen assistant to help with tasks in the kitchen. ChatGPT, generally speaking, tends to produce a lot of text for what can be said in a few words. Hence, the instruction of using few words was provided. It was expected that the chatbot, with these new boundaries would judge the query and provide a concise response to the user's input.

Remus I seemed to provide cohesive answers to every input but of course, this is because ChatGPT never says no unless it's a concerning request like "help me blow up my kitchen" or "how to poison your guests". Even then, if instructed to, the chatbot will put a humorous spin to it. Below is a rundown of its performance and observed problems after self-evaluation by the author if this report.

Remus I: Your know-it-all cooking GPT



Fig.3.1. First Version of the Custom GPT developed from Literature Review and Self-Experimentation

Role Assigned to GPT:

"You are a kitchen assistant employed to help the user navigate through kitchen activities. Understand the users' problem and help them figure out a solution using few words"

Performance:

After a round of self testing with challenging queries.

1. Provides answers to literally any question. More than half the times, it is dissatisfactory.
2. Cohesive and concise language.
3. Was helpful almost 9/10 times.
4. Works well as a reflective tool and stimulates further thinking.
5. Great at providing makeshift solutions for missing items or devices.
6. Aligns with your thought process after 4-5 messages.

Problems observed:

1. Generic answers
2. Unaware of reality
3. No inherent concern for truth
4. Cannot match real-time (time is an important variable)
5. Always tends to agree (can be counter-intuitive in the kitchen)

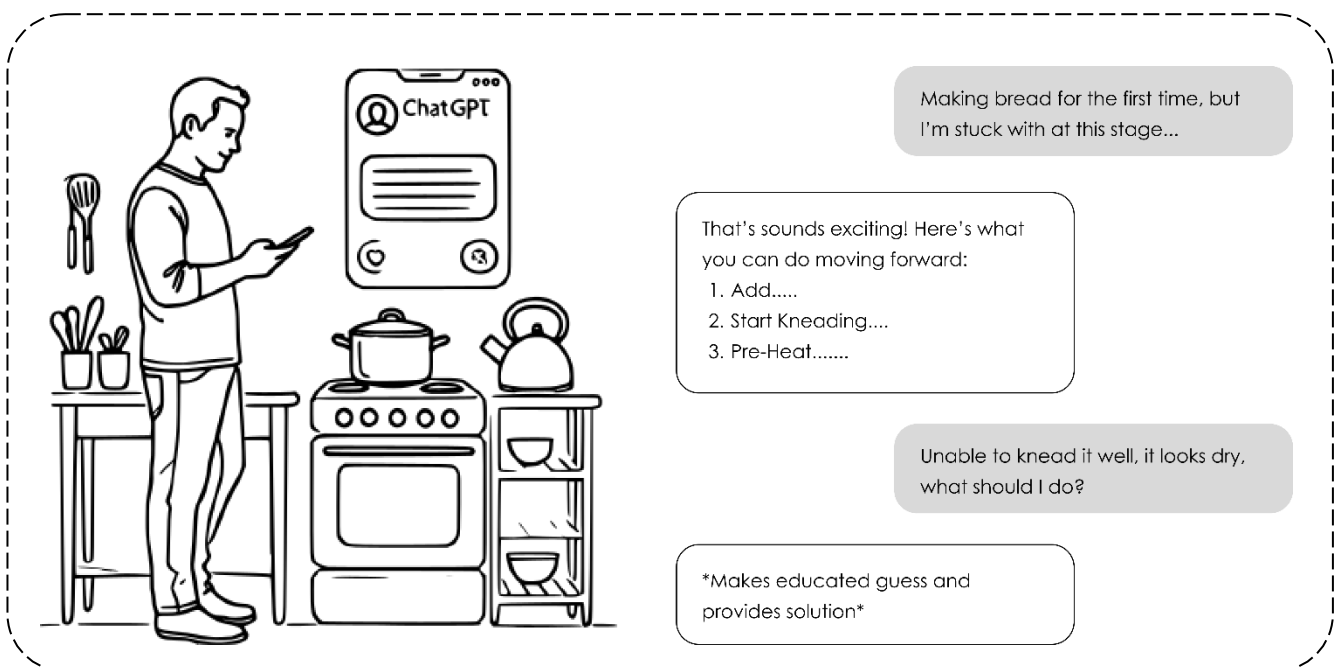


Fig. 3.2. Self Experimentation with Remus I

Other experiments included:

1. Trying new techniques, tools and ingredients

i just bought a new knife. It is a japanese chef's knife and i have never used such a knife before. how should i go about using it?



1. **Grip:** Hold the handle with your dominant hand, thumb and index finger pinching the blade.
2. **Cutting Board:** Use a wooden or plastic board to protect the blade.
3. **Technique:** Use a rocking motion for slicing, dicing, and mincing.
4. **Angle:** Keep the blade at a low angle for fine cuts.
5. **Maintenance:** Hand wash and dry immediately. Use a whetstone for sharpening.
6. **Storage:** Store in a knife block or on a magnetic strip.



Fig.3.3. Learning from Remus I (E.g. Japanese Knife)

2. Exploring and Identifying Cuisines + Local Recommendations



I ate these mini pancakes sort of things which had zucchini and eggs but i can't identify the cuisine.



You likely had zucchini fritters, often found in Mediterranean or Middle Eastern cuisines.

Look up places in New York that might have them

< 2/2 >



Searched 5 sites

Here are some restaurants in New York where you can enjoy zucchini fritters:


1. **Smitten Kitchen** - Known for their delicious zucchini fritters with feta and dill, served with a dollop of tzatziki sauce. Perfect for a light and crispy appetizer ([smitten kitchen](#)) ([Feasting At Home](#)).
2. **Tiny New York Kitchen** - Offers zucchini a  feta fritters with a homemade tzatziki sauce. These

Fig.3.4. Consulting Remus I for cuisine related information

3. Exploring new ways to utilise one's appliances (defrosting, steaming without steaming function)

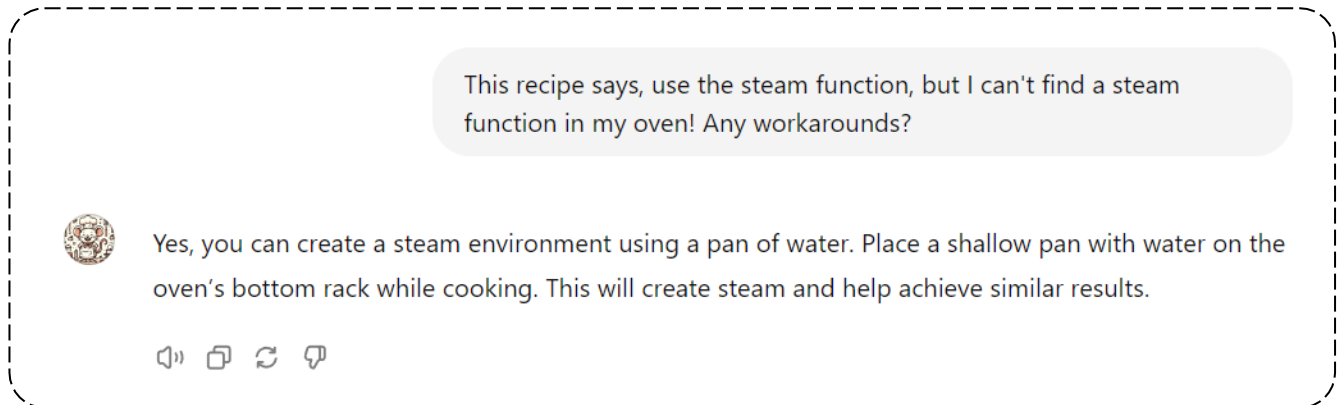


Fig. 3.4. Finding makeshift ways to exploit appliances for unintended but productive uses

4. Making the most of random ingredients (completely ignored the wine)

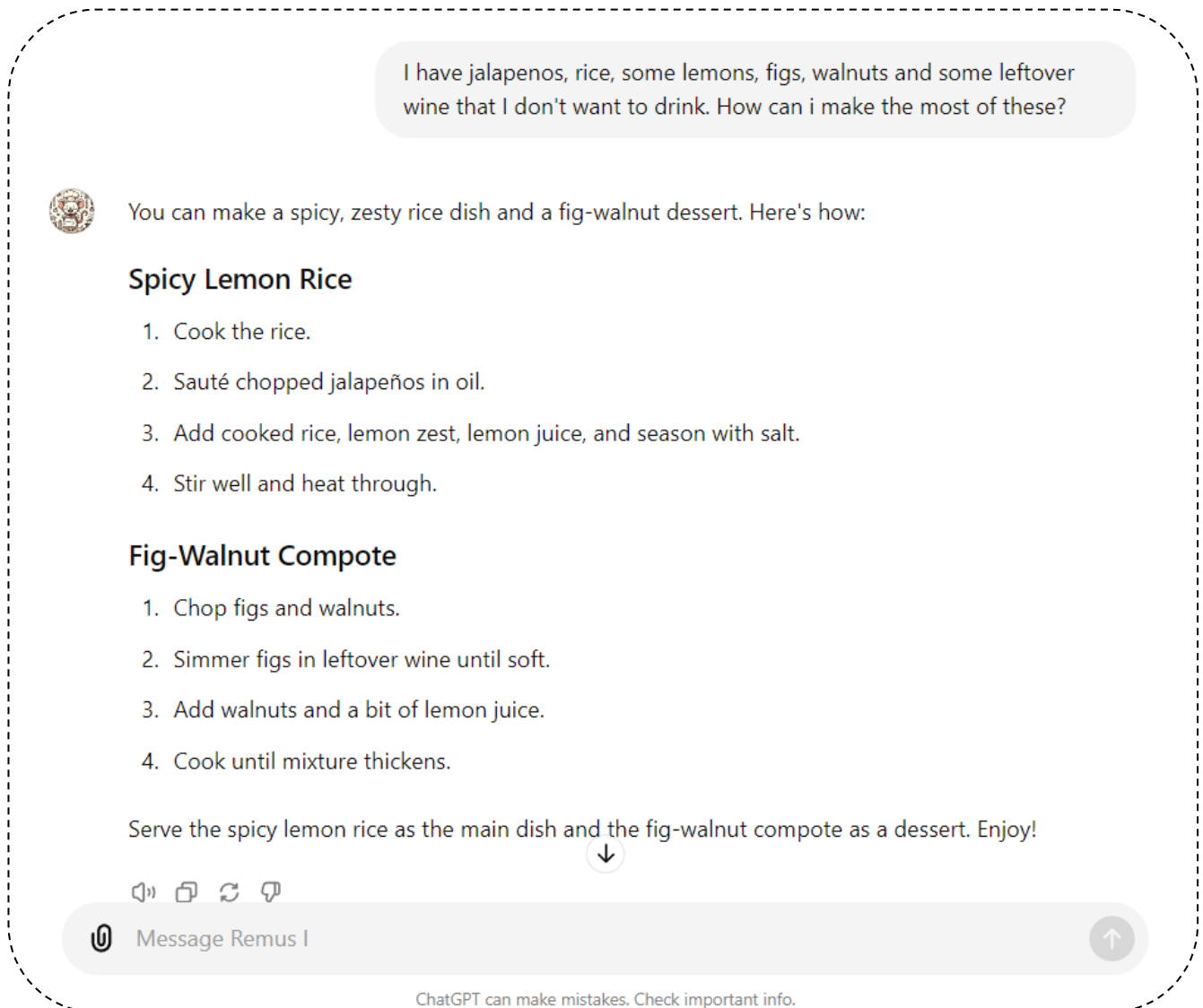


Fig. 3.5. Using Remus I to make the most of ingredients and avoid wastage

5. Finding out more about one's own culture

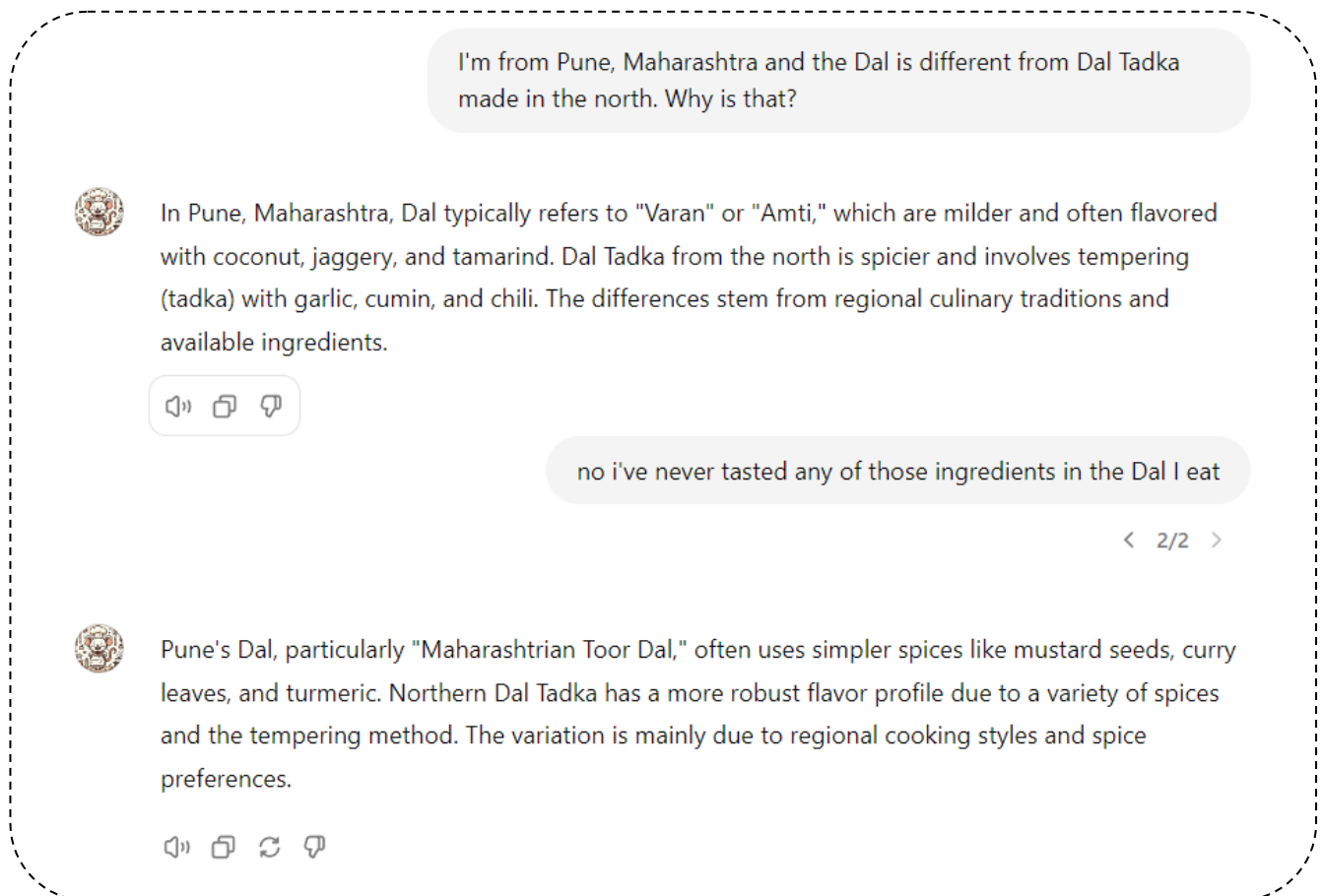


Fig. 3.6. Gaining knowledge about tradition

At this point, it became imperative to look at the way early adopters were exploiting ChatGPT for kitchen related tasks. The following questions emerged from this early round of self-experimentation to understand how this GPT could be further developed.

How are others using ChatGPT?

Are they also developing custom GPTs?

How are they exploiting this new way of cooking?

4 ChatGPT for cooking

Early Adopters (Online Communities)

How are online communities responding to ChatGPT as a tool for kitchen assistance?

Part 1: How are GPTs being used for cooking?

Below are the summarised discussions from reddit threads under the subreddit 'r/ChatGPT' and related posts.

Search tags: AI, Smart Kitchens, Recipe, Cooking, Cook, Food, Diet, Nutrition, Cuisine

Interaction Patterns:

Learning and Inspiration

"My wife and I didn't know what to eat. We asked ChatGPT for a suggestion and the food came out absolutely delicious"

LLMs can serve as cooking coaches that encourage experimentation and learning. They can suggest new recipes based on trending cuisines or what is available in the pantry, offer cooking tips, explain culinary techniques, and even help plan meals for the entire week. This ongoing interaction with an LLM can inspire users to try new dishes and improve their cooking skills over time.

Conversational Guidance

"I made chicken and veggies the other night by talking through it with ChatGPT. It was delicious"

Food Related Needs:

Quick Access to Curated Recipes

"the best part is not having to read about some random blogger's entire life"

"having the information you need"

One of the frequent frustrations for users searching for recipes online is navigating through lengthy blog posts due to SEO-driven content structures. By understanding user commands and extracting essential information, LLMs can deliver cleaner, decluttered information swiftly, enhancing user experience by bypassing the irrelevant content, effectively reducing the time spent on search.

Contextualized and Personalized Output

"scan the ingredients before anything else to see what I have/need"

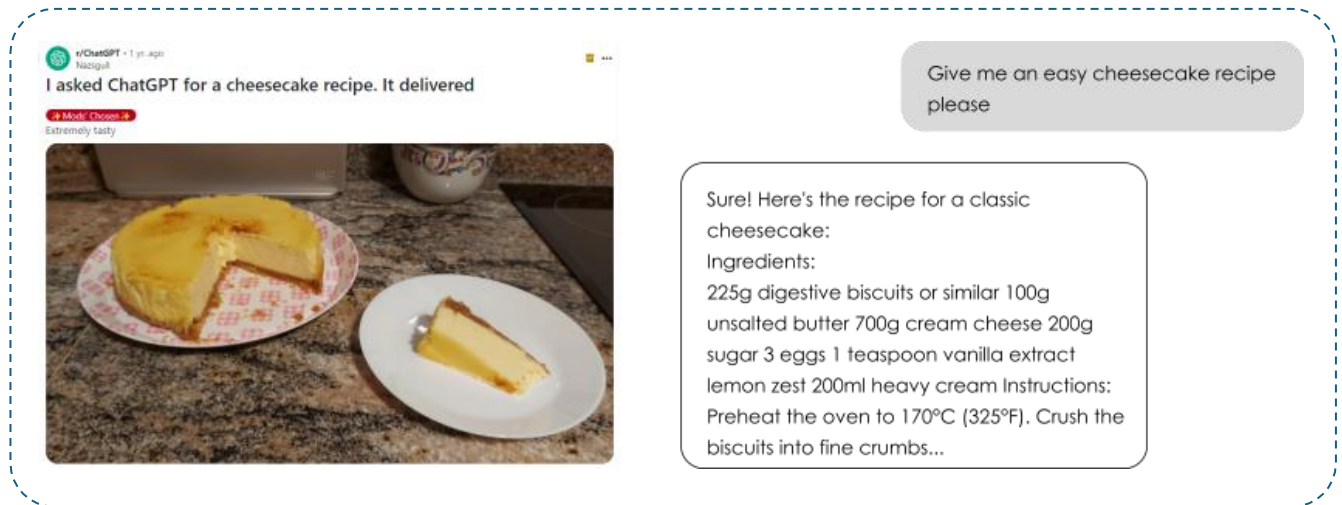


Fig. 4.1. Reddit user makes cheesecake with the help of ChatGPT

LLMs can leverage their vast data processing capabilities to offer contextualized and personalized culinary advice. For instance, based on a user's past cooking habits, dietary restrictions, available ingredients, and even current weather conditions, an LLM can suggest suitable recipes. This level of personalization ensures that meal planning and preparation are both practical and tailored to individual needs, enhancing dietary management and satisfaction.

Curated and Planned Meals

"Asked it to plan a French themed dinner for 8 people"

"I prompted it to suggest four courses for a date night"

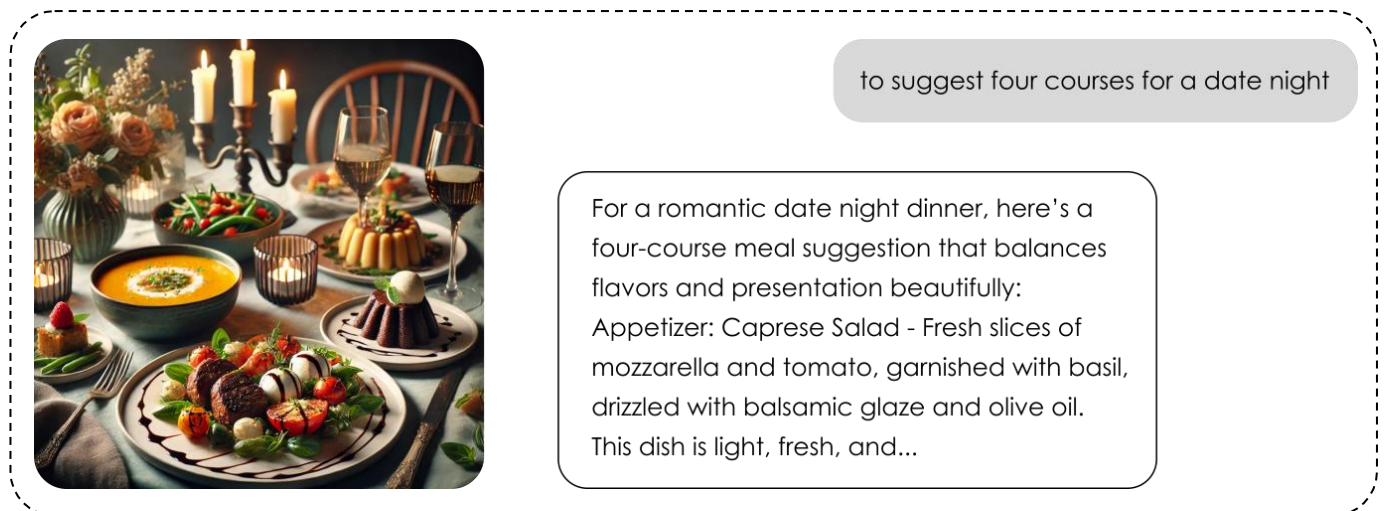


Fig.4.2. A conversation between a reddit user and ChatGPT for a curated date night suggestion.

Adaptations

“What are some alternatives? What else can I do? How can I do that? What’s the nutritional difference?”



Fig.4.3. ChatGPT converts a meat heavy dish to a fully vegan dish.

Addressing Dualities:

While the integration of LLMs in smart kitchens offers numerous advantages, there are also critical aspects to consider that are pointed out by the members of the ChatGPT community on Reddit.

Subject Knowledge Limitation vs. AI Bullshit (Frankfurtian)

One can easily be fooled and deceived by text generating models if the human’s command over the subject is relatively weak.

LLM Hallucinations vs. Factual Output

AI models can generate plausible-sounding but incorrect or irrelevant information (hallucinations). Ensuring that the output is verified and factual is crucial, especially in cooking, where incorrect information can affect meal quality or safety.

Food Simulation vs. Reality

While LLMs can simulate cooking processes or predict the outcome of recipes, the actual cooking results may vary due to numerous real-world variables like ingredient quality, kitchen equipment differences, and individual cooking techniques.

Should ChatGPT help you cook better?

This Reddit user prompts ChatGPT in different ways to get the desired output. While this is just an example, there are many ways that ChatGPT can help improvement in cooking. This highlights an important question – Is it the purpose of ChatGPT to improve your cooking or support you in real time while you cook?

Cook Better With ChatGPT

Interesting

One of ChatGPT's most functional uses is cooking. Here are three easy uses below, please comment with prompts you have used that have helped you cook better.

1. **Writing Custom Recipes** - Prompt "Write A Burger Recipe In The Style Of Gordon Ramsay"
2. **Meal Plans** - Prompt ""Create a [Number] calorie weight loss meal plan for a [Age] year old male. The daily macro split is [number]% carbs, [number]% protein, [number]% fats with no more than [number]g of sugar and [number]g of fibre.[number] calorie post workout breakfast with healthy fats and b vitamins. [number] calorie lunch with moderate fats and vitamin D. [number] calorie dinner with high carbs, low fat and magnesium. Consider foods that are low glycemic but don't avoid [food], [food], and [food]. Only use lean meat.""
3. **Suggest Wine & Beer Pairings** - "I want you to act as a sommelier. Please suggest a crisp, French white wine to pair with Indian Curry."

A Cicerone is a sommelier for beer. So you can sub sommelier for Cicerone.

Fig.4.4. A Reddit user's use cases with ChatGPT

Part 2: What are custom GPTs being designed for? And how?

Using OpenAI's "Explore GPTs" option, GPTs designed by the members of the community were explored and studied.

Common Use Cases of custom designed GPTs

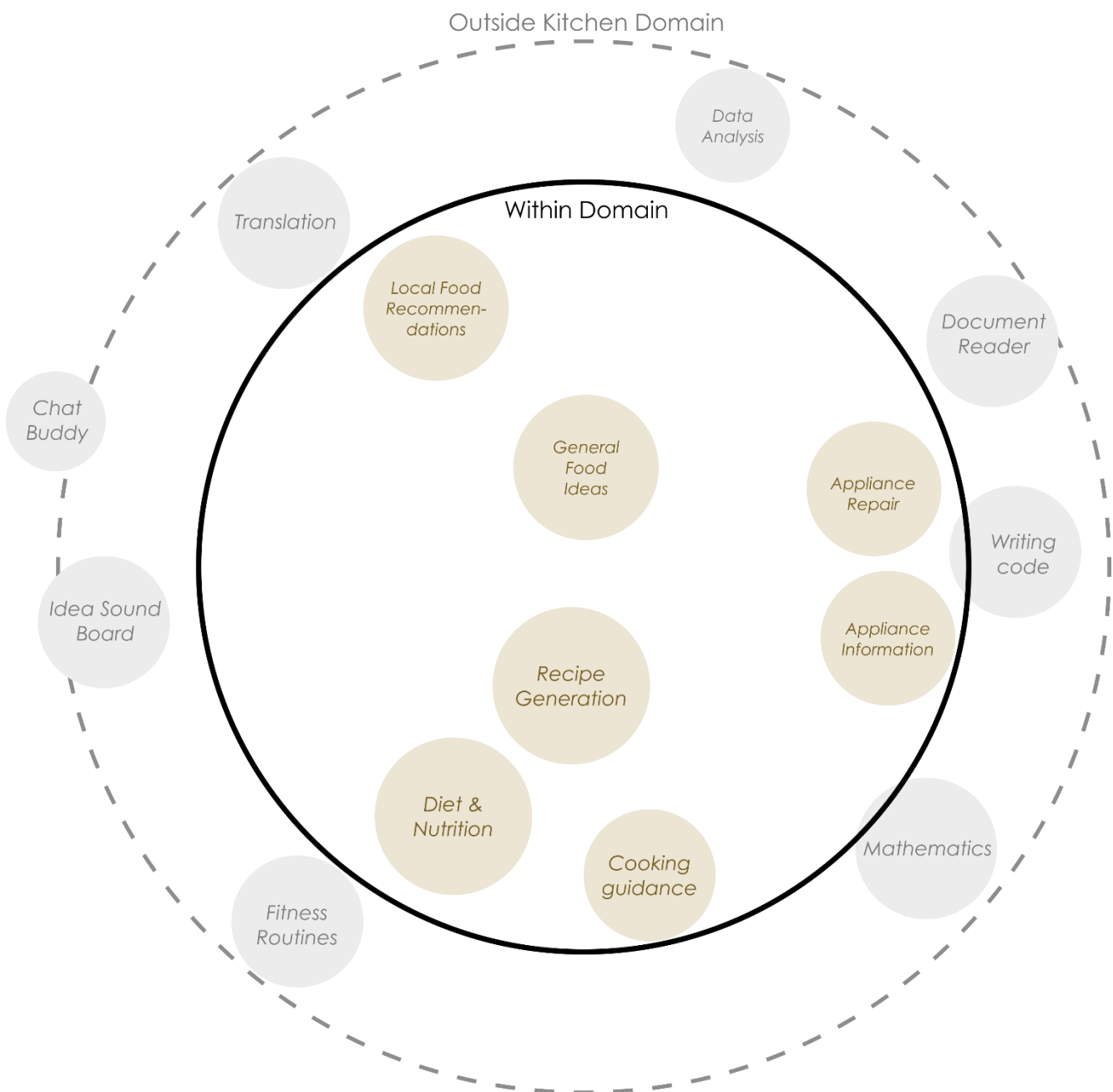


Fig. 4.5. Use cases of custom GPTs being designed by active members of the OpenAI community

How are they being used?

1. Task-oriented prompting

- Intent: Guide AI behaviour for specific kitchen tasks.
- Example: "Generate a recipe for a vegan lasagna."
- Experience: Suitable for users who know what they want to cook but may not know the exact steps.

2. Role-based prompting

- Intent: Define AI's role and guidelines for culinary responses.
- Example: "You are a professional chef. Please suggest a three-course meal using seasonal ingredients."
- Experience: Effective for users who want context-specific culinary guidance and expert advice.

3. Feature-specific prompting

- Intent: Detail specific functionalities and features for AI in the kitchen.
- Example: "Use the sous-vide method to cook a steak to medium-rare."
- Experience: Helpful for users familiar with specific cooking techniques or tools but needing direction on their application.

4. Instructional prompting

- Intent: Outline specific cooking instructions and guidelines.
- Example: "First, marinate the chicken. Then, preheat the oven to 180°C and roast for 45 minutes."
- Experience: Ideal for beginners or those who prefer structured, detailed cooking instructions.

5. Customization prompting

- Intent: Specify custom culinary instructions for a tailored cooking experience.
- Example: "Provide a gluten-free version of this bread recipe."
- Experience: Beneficial for users with specific dietary needs or preferences.

6. Validation prompting

- Intent: Verify information or ingredients before proceeding with a recipe.
- Example: "Check if we have all the ingredients for a chocolate cake before starting."
- Experience: Suitable for ensuring all necessary items are available before cooking begins.

7. Process-oriented prompting

- Intent: Emphasize step-by-step cooking and recipe development.
- Example: "Outline the steps to make a béchamel sauce from scratch."
- Experience: Useful for users who need to understand the entire cooking process and ensure no steps are missed.

8. Tool-specific prompting

- Intent: Specify kitchen tools and methods for handling culinary tasks.
- Example: "Use a food processor to make hummus."
- Experience: Appropriate for users who prefer or are required to use certain kitchen tools or appliances.

Considerations for Intent and Experience in the Kitchen:

- Clarity and Precision: Clear and precise prompts lead to more accurate and useful cooking instructions.
- Context and Detail: Providing context and detailed instructions helps the AI understand the user's culinary needs better.
- User Experience Level: Tailoring the complexity and detail of prompts based on the user's cooking experience ensures the guidance is appropriate and effective.
- Flexibility and Adaptability: Prompts that allow for some flexibility enable the AI to adapt to different cooking scenarios and provide more relevant responses.
- Iterative Improvement: Encouraging follow-up questions or suggestions for improvement can enhance the quality and usability of the AI's culinary responses over time.

5 Research Gap & Design Requirements

Going beyond knowledge and guidance

How do we go from competing with ChatGPT and other custom chatbots to actually using it to sell appliances?

The notion that ChatGPT can be used only for content generation is pre-mature and the fact that it can produce lines of code which may be potentially sent as signals to appliances for executing tasks autonomously. As seen in the preliminary study, developments are being made to control smart appliances with the push of buttons on one's smartphone screen. This still amounts to the same amount of effort and thought needed for cooking.

Where's the gap then?

To simplify the findings, we look at two separate technologies – LLMs and Smart Applications

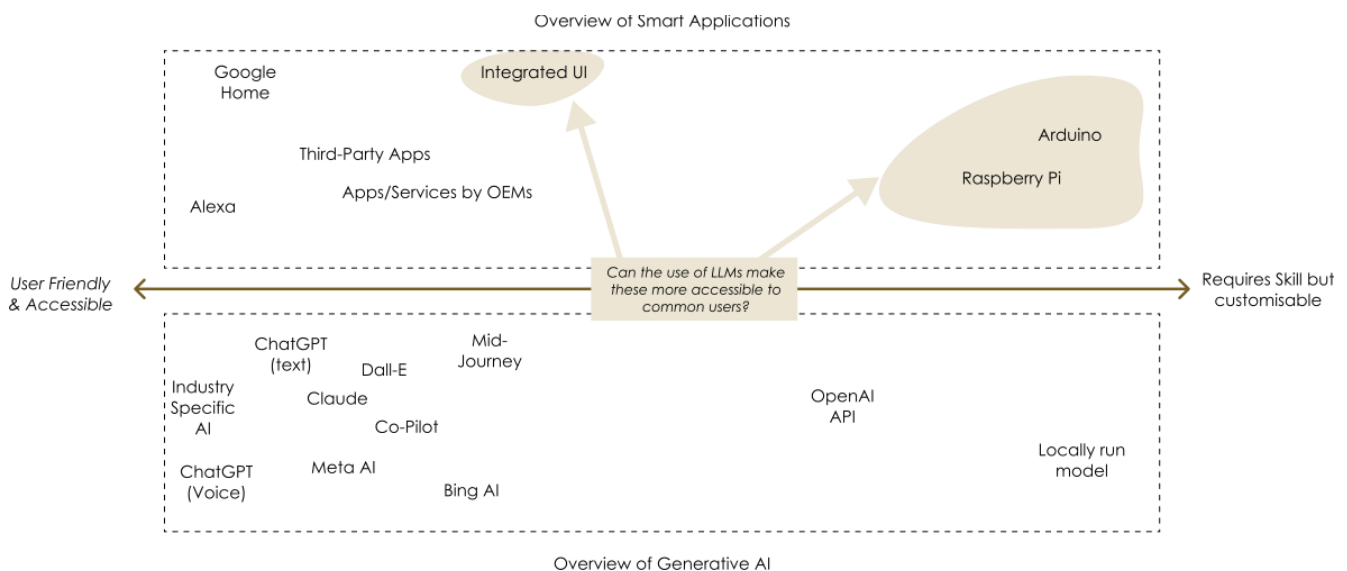


Fig.5.1. Research Gap – Intuitive and Natural Access to Smart Devices

The following questions arose after looking at the gap in accessibility:

1. What are the affordances and expectations of cooking with non-human intelligent assistance?
2. How will consumers reacting to and perceiving this new intelligent presence in the kitchen?
3. How can we improve the dialogue between a user, AI and a smart UI?

6

Remus II:

Custom GPT Iteration 1

Remus II: Custom GPT Iteration 1

Remus II was further developed using findings from online communities of GPT users and designers with the intent of conducting live case studies.

Why a custom GPT?

- Pre-prompted: Beneficial for users without prompting skills.
- Curated Experience: A detailed flow can be designed for user experience.

Design Requirements for Remus II

1. What are the affordances and expectations of cooking with non-human intelligent assistance?
2. How will consumers reacting to and perceiving this new intelligent presence in the kitchen?
3. How can we improve the dialogue between a user, AI and a smart UI?

To begin answering some of these questions, we encourage people (participants) to use the GPTs and play around with them to have a sensitising experience to then answer questions based on their experience of AI in kitchens.

Contextual Understanding

The assistant must offer contextualized output, understanding and adapting to the specific needs of the user based on tangible (ingredients) and intangible information (e.g. mood)

Streamlined Information

Provide clean and decluttered information, ensuring that users receive only the necessary details without any distractions.

Personalised Recommendations

The system should provide personalized recipe suggestions and cooking advice based on user preferences, dietary restrictions, and past interactions.

Voice Accessibility

Ensure that the assistant can be accessed by voice and can maintain a conversational flow to guide the user.

Reliable Information (still a question mark)

Conduct a web search to validate information. Offer accurate and practical advice for ingredients, flavours, tools, techniques, kitchen appliances and utensils.

Step-by-step guidance

Provide step-by-step cooking instructions that are easy to understand, with options for different cooking levels, from beginner to expert.

Instructions

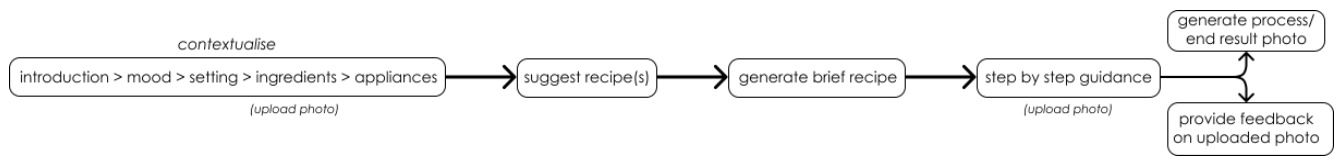


Fig.5.1. Flow of Instructions

Personality: Friendly, Crisp Responses;

Constraint: Time limit of 30 minute for recipes

The screenshot shows the OpenAI GPT Builder interface for creating a chatbot named 'Remus II'. The interface includes a profile picture of a cartoon mouse, a 'Name' field with 'Remus II', a 'Description' field with 'Your personal kitchen assistant!', and an 'Instructions' field with the following text:

First standard response to anything the user says -
 "Hi. I'm Remy. Before we begin, could you introduce yourself and tell me what kind of mood you are in?"

After they respond, ask the following question -
 "What ingredients do you have with you? Also, please upload an image to get an extra pair of eyes to judge the process".

Below the instructions is a 'Conversation starters' field. At the bottom, there is a 'Knowledge' section with an 'Upload files' button and a 'Capabilities' section with checkboxes for 'Web Browsing' (checked) and 'DALL-E Image Generation'.

Fig. 5.2. Building Remus II using OpenAI's GPT Builder (ChatGPT Plus)

(refer to the appendix for detailed instructions)

7 Live Case Study

How do consumers experience AI in kitchens? What are their future expectations?

This is a really long chapter; Skip to section 7.7 and 7.10 for the findings.

This section talks about the live case study i.e. getting users to use ChatGPT via Remus II, and interviewing them after the engagement to map their experience with AI (both in general, and specific to this experience) and expectations of this technology in their foreseeable futures. This helps us get a broader view of the affordances that may be crucial to the next generation of smart kitchen appliances.

Broad Research Question:

"What are the near future expectations of using GPTs in smart kitchen ecosystem?"

7.1. Case Study Structure

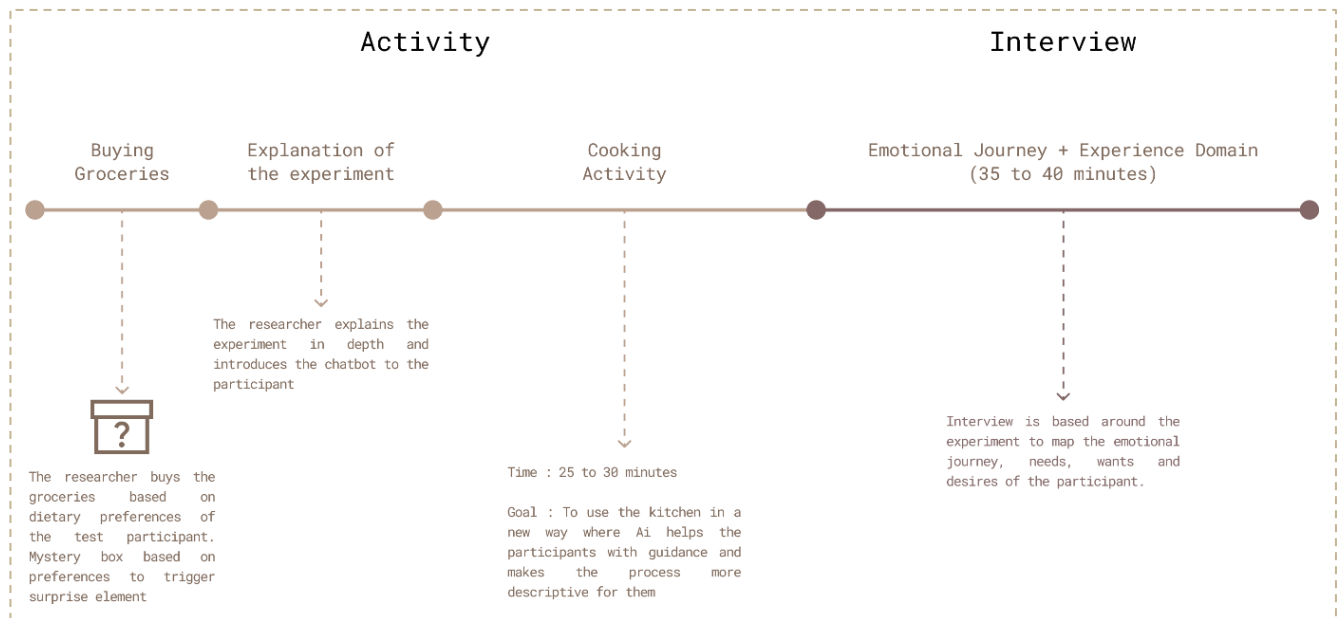


Fig. 7.1. Outline of the session going from sensitising to interviews using context mapping as a method

7.2. Participant Selection

General Information:

Four participants of diverse backgrounds, living in the Netherlands and Germany, aged between 25 and 32 were chosen for this case study. The core basis of choosing these participants were that they were enthusiastic about cooking as an activity as well as familiar with using AI tools in their daily lives.

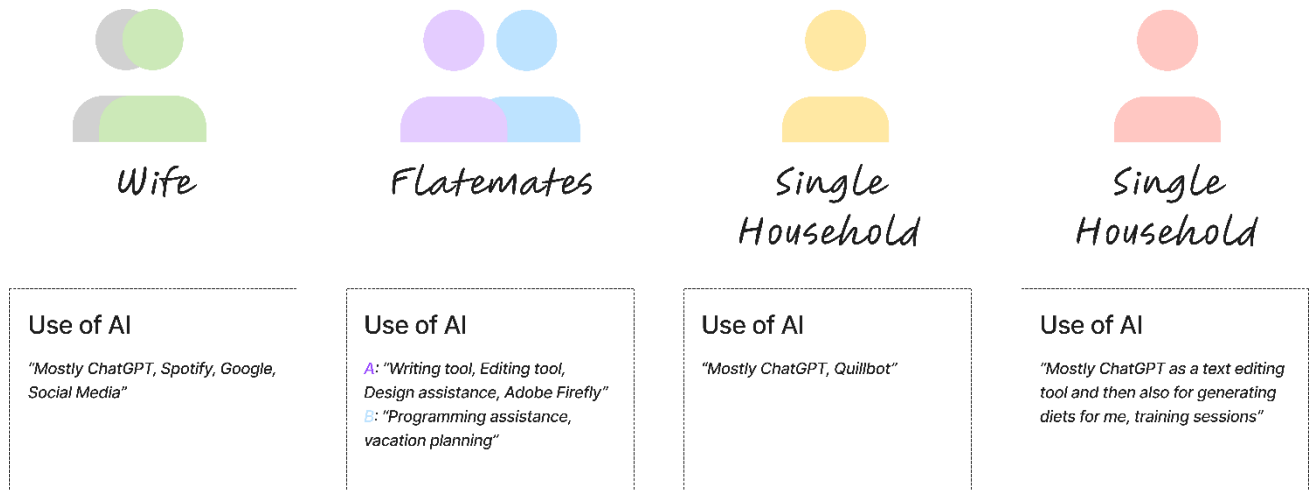


Fig. 7.2. Overview of Participants

7.3. Sensitising Activity; Live engagement with Remus II

Sensitising activities make people aware of their own context

As suggested in the context mapping method by Visser et al (2005), using sensitising activities help participants (acting as potential consumers) proactive towards your research question. We follow the process of first sensitising the user about the context followed by an interview about their experiences in the context of kitchens and finally mapping their expectations of the future when it comes to the use of Generative AI in smart kitchens. This interaction is recorded in the form of chats logs from the ChatGPT interface for all four participants.

Superimposed Context with Remus II in the participants' kitchens

Addressing the fact that we do not currently have in practice, a connected kitchen ecosystem with a GPT interfacing between humans and machines through natural language processing, we build such a makeshift or what is described as a low-fidelity prototype to test out with the users. Based on trends found through literature and media, we design a custom GPT using OpenAI's ChatGPT plus platform which allows a quick way to narrow down the boundaries and functions of the general ChatGPT 4 model to specific contexts or specific tasks. In our case, it is the context of a human interacting with an AI kitchen assistant.



Fig.7.3 Components of the activity - Human, Remus II (Custom GPT), User's kitchen, Ingredients.

Data Collection and Analysis

This data is collected in the form of conversation logs and analysed in terms of intents, triggers, breakdowns and activities (see fig.6.5 and 6.6)

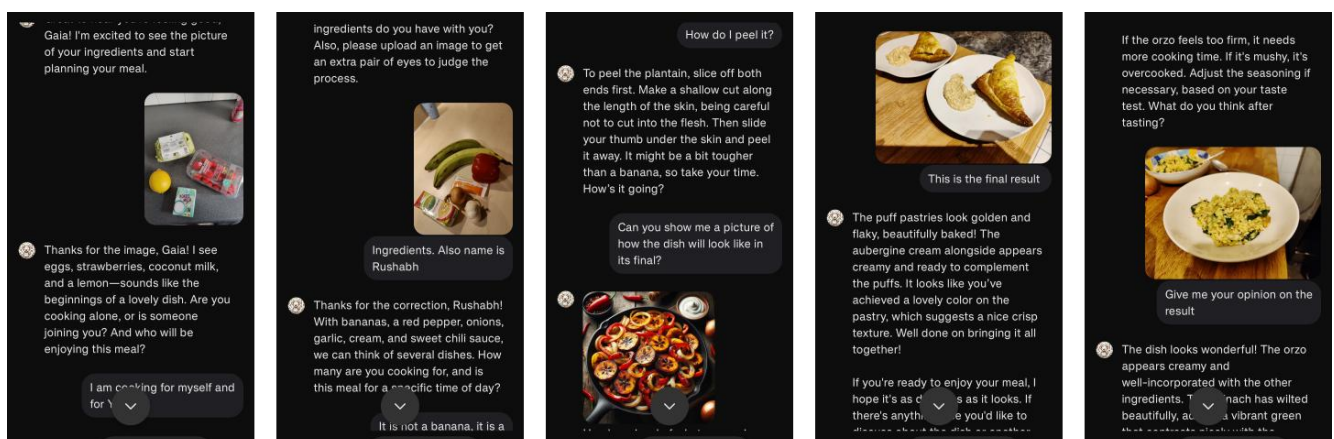


Fig.7.4. A snippet of a participant's engagement with Remus II and cooking using the ChatGPT interface.

7.4. Interaction analysis

Consolidated Sequential Model (generated from user-GPT chat logs)

This model is a documentation of the average interaction between users and GPTs as observed in the pilot and in the conducted experiments. It can effectively understand crucial affordances and help develop the next phase of design.



Fig. 7.5. Consolidated Sequential Model documented from experiments

7.5. User requests overview

This table documents the type of requests from users made to Remus, the cooking assistant (custom GPT) developed for this research. Examples are mentioned for each type.

Recipe Suggestions	Cooking Instructions	Equipment Usage	Nutritional Information	Real-Time Adjustments	Ingredient Clarification	Social Interaction
"I have a few ingredients here and I would like to prepare a meal with some eggs, some strawberries, coconut milk, and a lemon."	"Okay I'm about to slice up the plantain. Can you tell me how to do it?"	"Okay, question. Do I have to cover the plantain with a lid while they're cooking?"	"Hi as I'm preparing the pancakes I'm really curious to know the nutritional values behind it. Can you tell me?"	"The spices are cooked and shall I add the cream now?"	"It is not a banana, it is a plantain."	"Can you guess which culture I'm from?"
"Can you suggest a dish with orzo, butter, garlic, lemon, cashews, orange juice, and mandarins?"	"How do I peel the plantain?"	"Is it necessary to have a skillet or can I use a regular pan?"	"Can you tell me how many calories are in this dish?"	"Hey can you summarize the whole recipe into a few steps to yeah to have a recipe on record"	"We want to avoid sugar so we'll skip the maple syrup..."	"My friend and I have a conflict about measuring technique"
"Looking for a recipe to use plantain, red pepper, onions, garlic, cream, and sweet chili sauce."	"Hi Remy, can I ask you for the recipe as in form of a list and with steps?"	"What is the correct setting for baking this in an electric oven?"	"I am interested in the nutrition content of this recipe. Could you provide that?"	"Can I add the sweet chili sauce now?"	"No, I think this is it."	
"Can you help me create a meal that's gluten-free and uses these ingredients?"	"How long should I cook the pancakes?"	"Do I need to use a frying pan or can I bake it instead?"		"And one thing more is when should I add the cream?"	"Is this going right?"	
	"Hey can I get the list of ingredients in the European unit measurements?"			"What should I do if the sauce starts to dry out?"	"Can you show me a picture of how the dish will look like in its final?"	

Table 7.6. User Requests Overview

7.6. Major Failure Modes

It is generally observed that the model fails or may fail when put into situations where it is expected to provide expert advice.

1. Ingredient identification and measurement.

Model incorrectly identifies or provides incorrect quantities for measurement, leading to inappropriate recipe suggestions. This issue was solved by Thermomix that uses a built in scale which makes integration much easier.

2. Flavour pairings and combinations

This GPT was of course, not trained to be a flavour expert but uses general data to find something that "might work" to the user and labels each suggestion as "excellent" or "delicious" when in reality taste preferences are a highly subjective factor in cooking. This could be a potential failure mode.

3. Time and Measurement

The GPT does not measure time and does not perceive time as a human does which results in abruptness in communication.

7.7. Speculating possibilities and needs of *current* GPT functions

Desired GPT Function	Possibility	Capacity	Necessity
Timer	Not Possible	N/A	Necessity
Pre-heating, Start-Stop	Not Possible	N/A	Necessity
Temperature Regulation	Not Possible	N/A	Necessity
Measurement	Possible	Arithmetic, Conversions	Necessity
Temperature Conversion	Possible	Convert temperatures between F/C	Necessity
Recipe Suggestions	Possible	Text, Images	Nice to have
Cooking Instructions	Possible	Step-by-step text + voice guidance	Nice to have
Nutritional Information	Possible	Calorie and nutrient details	Necessity
Ingredient Substitutions	Possible	Alternatives, workarounds	Nice to have
Shopping List Generation	Possible	Create lists, compute tables and data files (csv)	Nice to have
Dietary Adjustments	Possible	Modify recipes, provide substitutes	Necessity
Real-Time Support	Possible	Answer cooking-related queries on the fly	Nice to have
Equipment Usage Instructions	Possible	Advise on how to use kitchen tools	Nice to have
Food Storage Advice	Possible	Suggest proper storage techniques	Nice to have
Allergy Warnings	Possible	Highlight potential allergens in recipes	Necessity
Flavour Pairing Suggestions	Possible	Recommend compatible flavours and ingredients	Necessity
Food Safety Tips	Possible	Guidance and recommendations	Nice to have
Cooking Technique Tutorials	Possible	Step-by-step guidance	Nice to have
Meal Planning	Possible	Periodical, tables and lists.	Nice to have
Cleanup Tips	Possible	Text and Visuals	Necessity

Table 7.7. Evaluating possibilities and needs of current GPT functions

Limitations - ChatGPT is a language model and is good at predicting the next word and ultimately the closest possible answer to your request. The factual accuracy of the recipes

cannot be measured without training the model using data from cooking experts and appliance manuals.

7.8. Context Mapping Interview

Post the sensitising activity

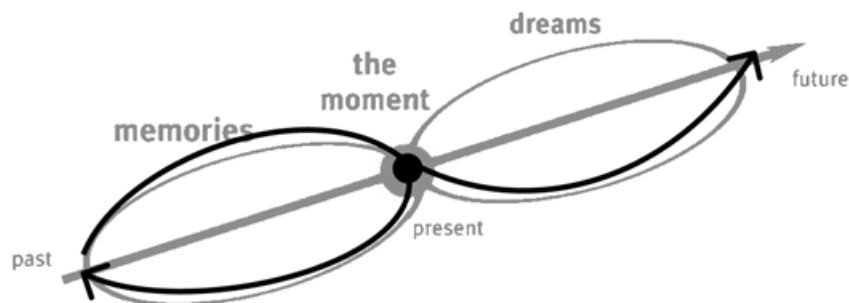
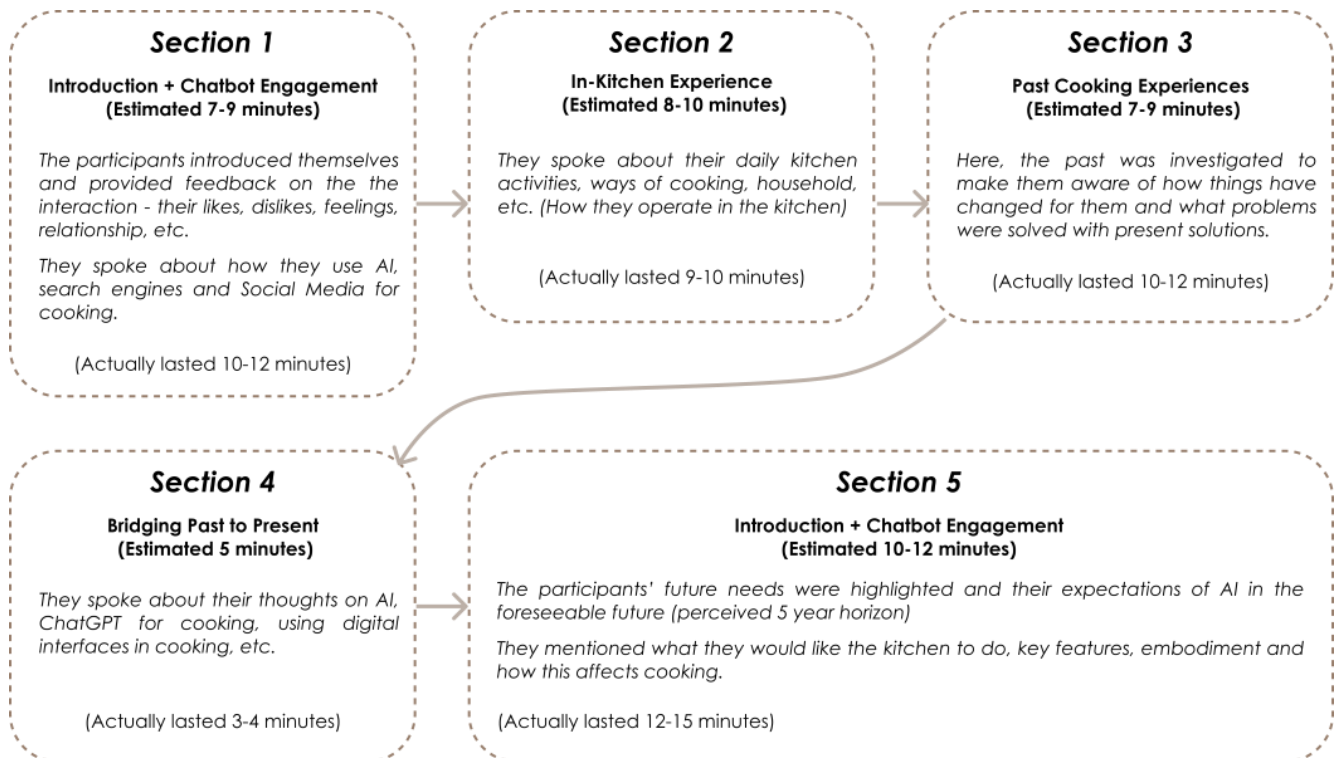


Fig. 7.8. The Experience Domain showing the link between experiences (Visser et al, 2005)

As described by Visser et al (2005), Context mapping, often referred to as "contextmapping," is a research technique used to gather and interpret data about the context in which users interact with products. It is particularly valuable in the field of design and user experience. The goal of context mapping is to provide designers with deep insights into users' needs, experiences, and environments to create more user-centred products.

The interview explored the participant's background and experience with AI and kitchen technology, focusing on their initial and ongoing use of AI in cooking. The participant described their experience with the chatbot, emphasizing its utility for finding recipes and cooking techniques online, and shared their enjoyment of the interactive and informative aspects of the model. The discussion then shifted to their typical kitchen activities, highlighting the importance of certain tasks, preferred appliances, and both enjoyable and challenging aspects of cooking. Reflections on past experiences with kitchen appliances revealed changes in their cooking habits and valued improvements. Looking ahead, the participant envisioned a future kitchen equipped with advanced AI, detailing desired features and tasks for an AI assistant, and expressed enthusiasm for the potential enhancements in convenience and efficiency. The session concluded with thoughts on the integration of technology in cooking and future expectations for smart kitchen appliances.

Interview Process



7.8. Interview Output

a. Rich data - Expectations of AI

- Positive Experiences of the participant.
- Pain points in kitchen experiences - What problems do users face ad which of them can be solved through an AI ecosystem.
- Participants' near future expectations (5 years later*) of interacting with smart kitchens.
- Insights from diverse individuals about where they place themselves in a kitchen ecosystems.

*5 years into the future was used as a nominal figure to spark futuristic thinking. The rapid pace of AI developments can easily compress or stretch the 5 year horizon.

7.9. Thematic Analysis of Transcripts



Fig. 7.9. Thematic categorisation of quotes on a digital whiteboard to find opportunities of intervention

The process in a gist

1. Transcribing + Cleaning of Transcripts.
2. Cherry-picking - Finding significant quotes that indicate user perceptions in the form of **likes, dislikes, needs, wants, expectations and possible concerns**.
3. Clustering of quotes to form thematic indications (fig.
4. Each quote points towards a new research question or an actionable insight.

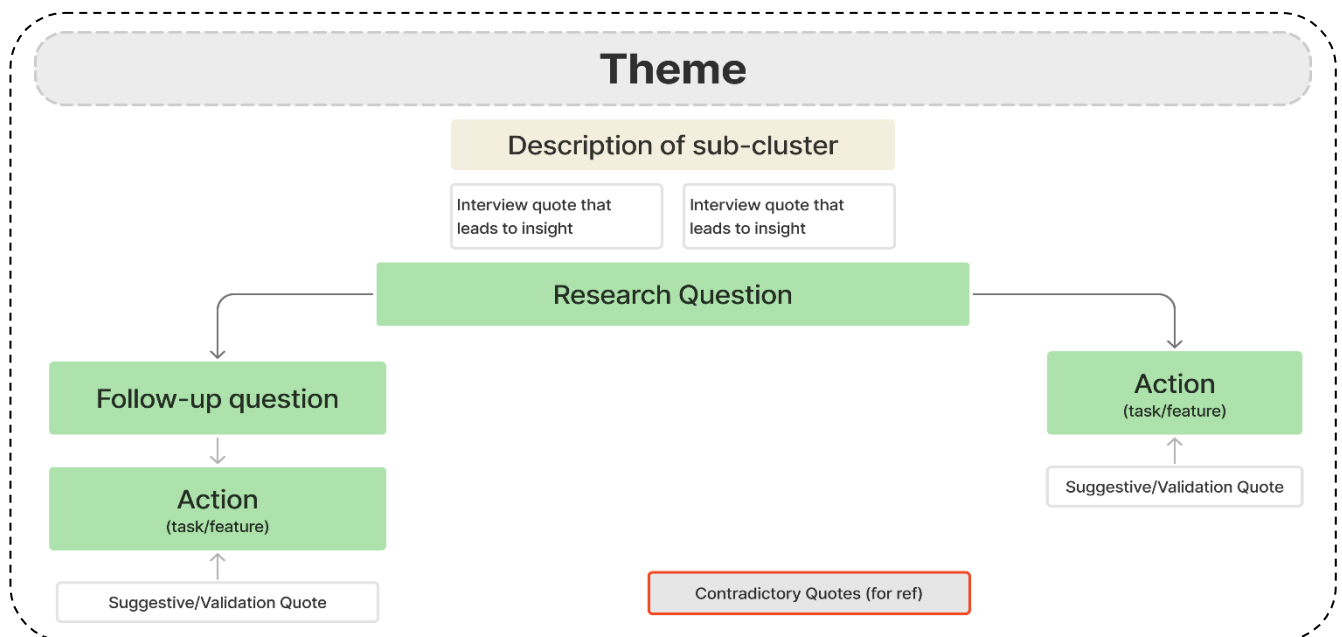


Fig. 7.10. Schematic diagram of clustering logic

Benefits of this method

1. Clear, concrete information that indicate potential design directions.
2. Generates assumptions to validate/test further
3. Identifies latent and unexplored consumer needs

7.10. Findings from Live Case Studies

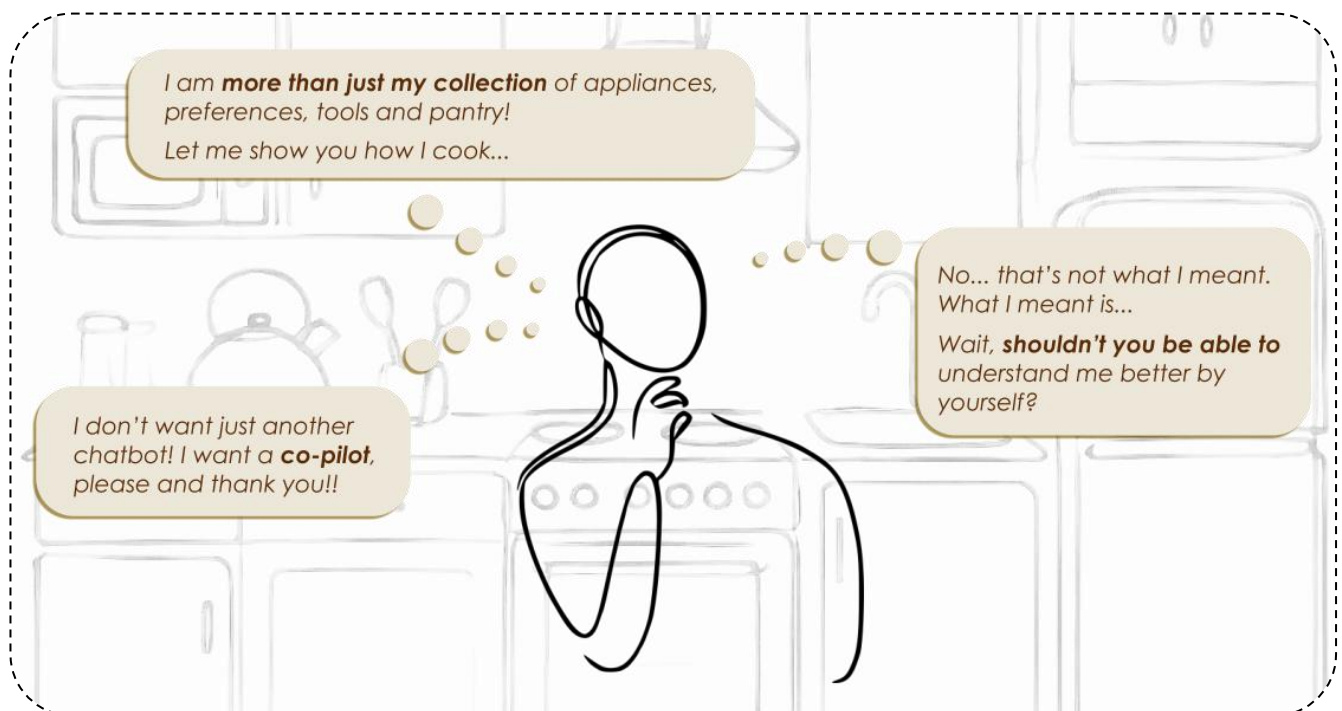


Fig 7.11. Abstraction of top three key findings mentioned below

1. Effective Prompting

Under this theme, we discuss indications of users being able to visualise the final product before or during the cooking process to get a better understanding of what is to be done.

2. Personalisation

Here, address the different pains and desires of users when it comes to having an AI assistant that factors in determinants like personal data, personalised taste, ingredients, methods, meal planning along with the users' kitchen ecosystem.

Some of these very evidently remain static like personal data, the ecosystem, tools and staple ingredients. Taste and methods tend to change or evolve which the GPT needs to be programmed to track. Meal planning varies across the user base depending on time and effort as a big factor.

3. Guidance, Collaboration & Task Execution

Across the interviews, users indicated a strong inclination towards learning from AI in the context of executing tasks. This could manifest in the form of instructive guidance or collaboration (basic difference between guidance and collaboration is level of control and autonomy).

Some menial tasks like measurement, temperature control, pre-heating, automatic switching on/off, diagnosis, etc. are expected to be executed directly by the AI agent.

4. Out of Habit or Leisure Cooking

On occasion, users indicate that they would like to occasionally use the AI model to do out-routine tasks in the kitchen. For example, if one has to cook for multiple guests, multi-tasking is a hassle for those who are not used to it on a routine basis. In case of dietary requirements of a person that the user is cooking for or just preferences of food that don't align with the users' habitual methods.

7.11. Case Study Conclusions

1. Conversational agent is nice to have in the kitchen but in reality, it is time consuming to constantly speak to the chatbot. If the bot already knows everything, it will give a quicker output.
2. Recipe generation is one of the desires, but at the same time, users seem to want guidance in more specific tasks and functions where they need that extra brain to think with them. Most cooks know how to perform or execute basic tasks in the kitchen. What is needed is advanced, contextually-trained, and critical agents that help with assistance as and when needed.
3. Based on table 4.2, most of the necessities of the future lie in remotely accessing appliance functions, maintaining a timer, providing accurate knowledge and providing concise information. Most of these require more training of the model and substantial knowledge base.
4. Users would like to save the time and trouble of looking online all the time.
5. At scale, it is expensive to constantly send generation requests to the ChatGPT cloud.
6. For any AI model to be able to contextualize better, it would have to be pre-trained on a dataset that is prepared using diverse input from a large amount of users.
7. Image generation and recognition helps users in evaluating their cooking process better than it would with plain text.

These conclusions were carried forward to generate three research questions and evaluate the capabilities of Open AI's flagship model, GPT4o as a benchmark to establish its current boundaries and capabilities.

Research Questions are mentioned at the start of Chapter 8 i.e. 'A brand new, diverse set of affordances'

8

What can an intelligent
kitchen assistant afford us?

(Survey + Analysis)

Another long section; please skip to Section 8.7 of this chapter for the outcome.

8.1. So what does the consumer really need AI to do for them in kitchens?

Some “hero” quotes of repetitive values that stood out during thematic analysis:

“I would not use it all the time. Only maybe when I have a specific question”

“I want technical assistance from AI and simply do things for me”

“Yes, I want AI to contextualize the output for me”

“You have it as a reliable tool, but still maybe it helps you develop a critical sense of what you're doing.”

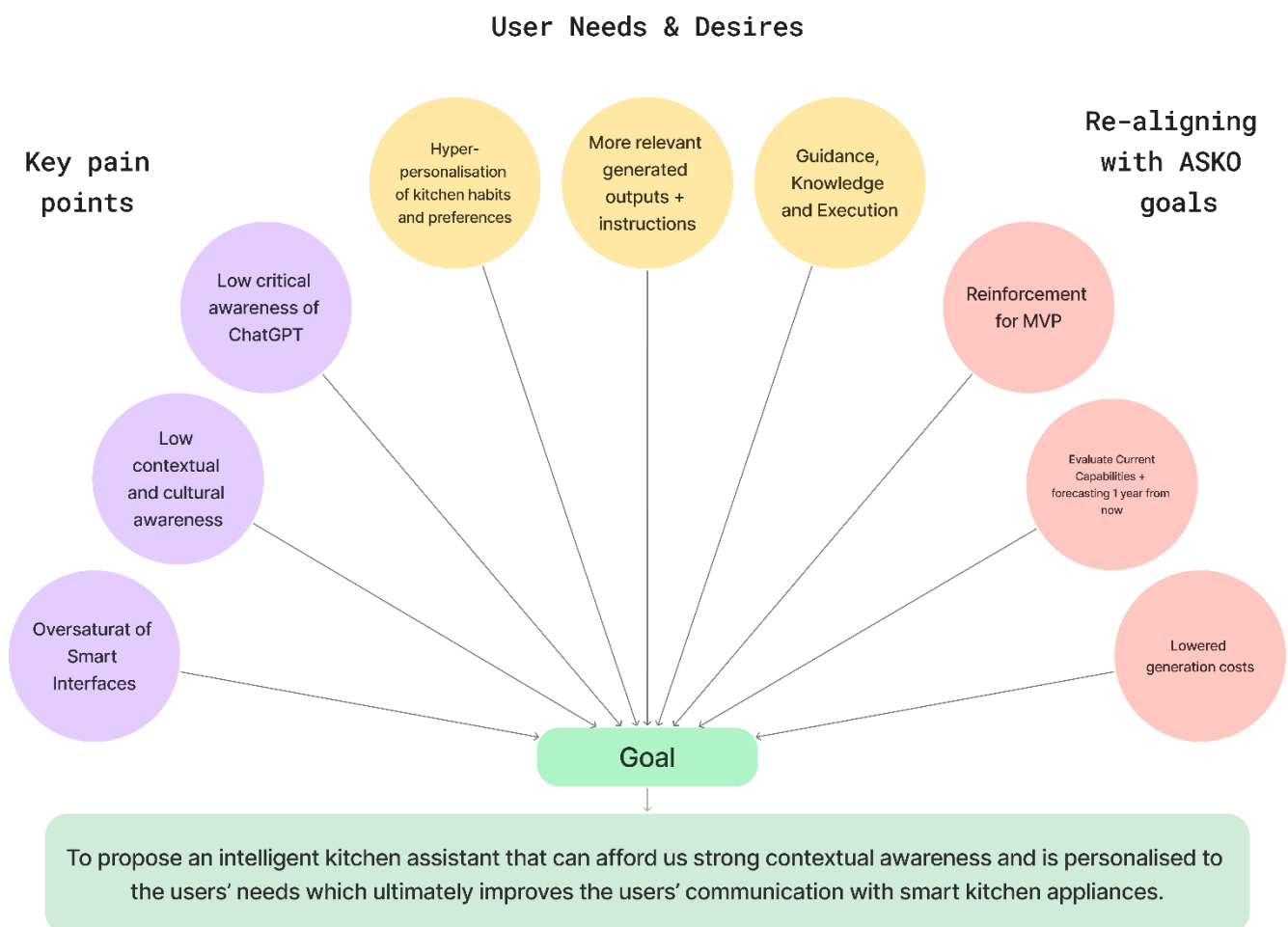


Fig.8.1. Key pain points, user demands and client goals pointing towards a larger goal

The goal is to find diversity in affordances (something that an intelligent, smart kitchen environment can afford us). What are the new ways of cooking along-side AI? How can the presence of a quick thinking kitchen expert be of value to the ASKO customer?

8.2. Finding novelty and diversity in the new ways that people want to cook

What really is the challenge here? Is it just about getting diverse input and training a model for diversity? The argument is that it is a crucial step in understanding what these new requirements are and where they fit into ASKO's role as one of the leaders in smart appliances.

Where does this all lead?

Should you expect a talking kitchen? It is unknown what will happen many years from now but what we know is that the first imperative step is to design an adaptive interface that automatically values you as the paying customer and reacts to your individual and contextual needs. But why stop there? Why don't we have kitchens that anticipate our needs before we need them.

8.3. Research Questions derived from the conclusions of Phase 1, aligning with the main goal

Main Research Question : What are the new set of affordances that ASKO, a kitchen appliance maker should factor in and prioritise when they design the next generation of kitchen appliances which are connected in an ecosystem with a GPT interface.

RQ1 What is the **variety of needs across a diverse sample set** and what would users demand from an all knowing kitchen agent?

RQ2 What are the **design priorities** when designing the interface, the blueprint and the logic of the proposed kitchen assistant?

A research plan was devised to try and answer these questions.

8.4. Research Plan:

Diverse Input Data Collection

To collect user data, the findings and conclusions from the live case studies in chapter 7 were translated into eight executable kitchen functions through a brainstorming session. These act as a stepping stone to discovering novel, realistic and diverse affordances.

1. Meal Planning
2. Recipe Generation
3. Ingredient Knowledge
4. Nutritional information
5. Cooking Techniques Guidance
6. Mid-process Guidance
7. Appliances guidance and troubleshooting
8. Safety and Emergency

The image below represents a typical cooking process. However, the existence of breakdowns in the process not only highlights flaws in the process but also presents opportunities for an intervention. This intervention can be range anywhere from meal planning to safety and emergency as seen in the above list. A key insight was also that the user does not necessarily need a full recipe but might just need to ask for guidance or help with a simpler task. Hence, a survey was conducted to find out more about what exactly can an intelligent agent afford a consumer of ASKO.

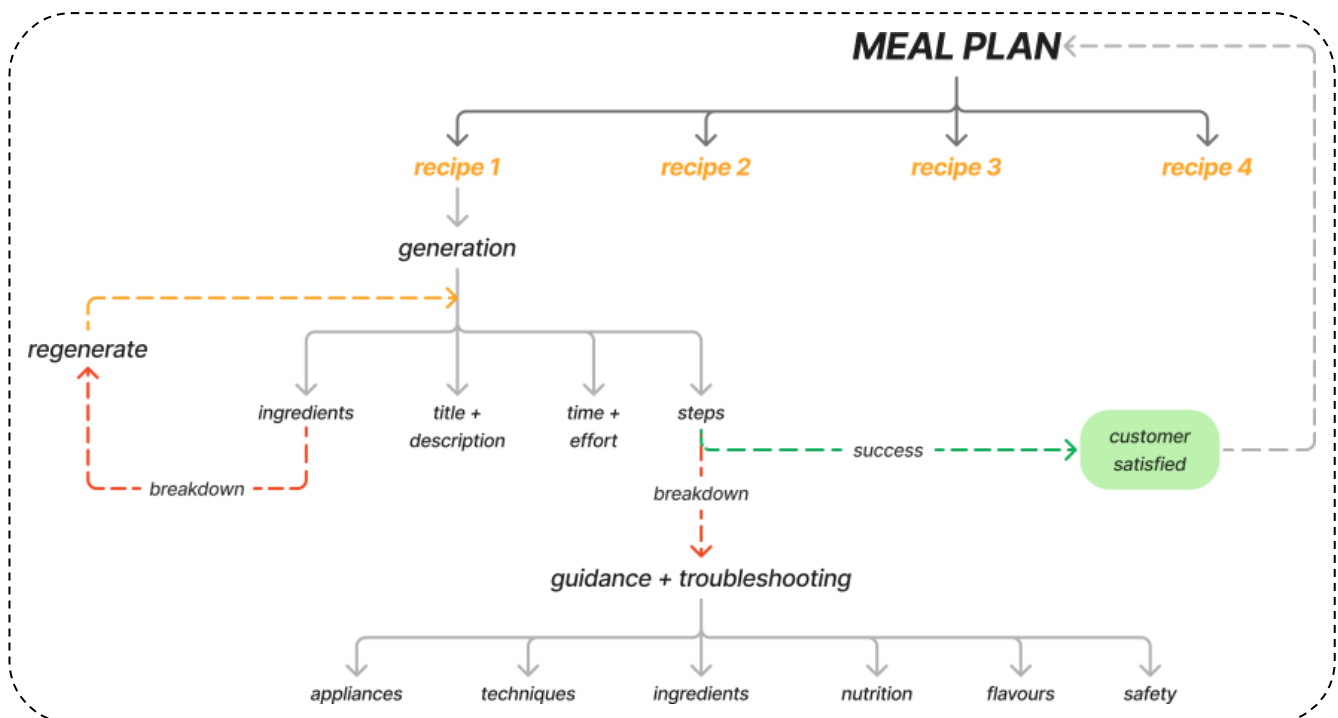


Fig.8.2. Schematic end-to-end hierarchical breakdown of a typical cooking process

Participant Recruitment

Approximately 40 participants were recruited to respond to a survey with open ended questions. 37 participants responded to each of the 10 questions.

Survey for crowdsourcing

Participants were probed with 8 hypothetical scenarios and asked to provide input for each scenario with the idea that they were speaking to an all rounder kitchen expert on the phone. Participants were encouraged to challenge the all knowing expert. (please refer to the appendix for the full survey.

"Hi, I'm Remus, or Remus, the kitchen expert, and I need you to test my knowledge and skills! Imagine you're in a well-equipped, futuristic kitchen, and I'm on the phone with you, ready to prove my culinary knowledge and skill. Through this survey, you can ask your questions, assign tasks to me in the kitchen, or say anything you want in the context of kitchens."

1 How would you describe yourself in the kitchen?

- Beginner
 - Intermediate
 - Expert
-

2 On a scale of 1-10, how enthusiastic are you about cooking?

1 = "I like super low effort cooking and eating"

10 = "I put my whole heart and soul into cooking all the time:"

3 Remember the last time you searched for a recipe? Imagine that you could just ask Remus for any recipe... with any possible combinations! What would you ask?

Example: Look at this photo of ingredients and tell me what I can make from it.

Example: What can I make for my pregnant wife? She said she's craving a chocolate as well as salty snacks.

Example: Convert a traditional meat-based recipe into a vegan one, ensuring all nutrients are balanced.

Example: I am in a crisis, I am trying to cook _____ and something happened. (describe it to them)

4 Try to recall the last time you had trouble with a certain ingredient or had doubts or questions about something in your fridge?

Example: Which ingredients would we need for _____?

Example: Help me identify this ingredient. (describe it as best you can).

Example: What can I make with _____? (could be something you want to try for the first time)

Example: I am in the supermarket shopping for dinner, I need help with _____?

Example: I am eating noodles at a _____ restaurant and cannot figure out where the sourness comes from!

Note: A total of 10 questions were asked. Refer to the Appendix for the entire interview.

8.4. An intelligent kitchen affords personalised assistance

When do we go beyond generating recipes like the 100 other chatbots out there? Assuming we build the best ever recipe generator, who is that really benefitting? Is it just customer data we are after? What do we make of that data?

8.5. Personalisation - Why and How?

Collected Inputs from the survey and learnings from data processing resulted in the notion that perhaps diversity is best represented as personas to establish a context of the user. Using each participants input in the survey to create personas that represent diversity in the kitchen with the intention of adding a “profile building” step before the user starts engaging with the interface.

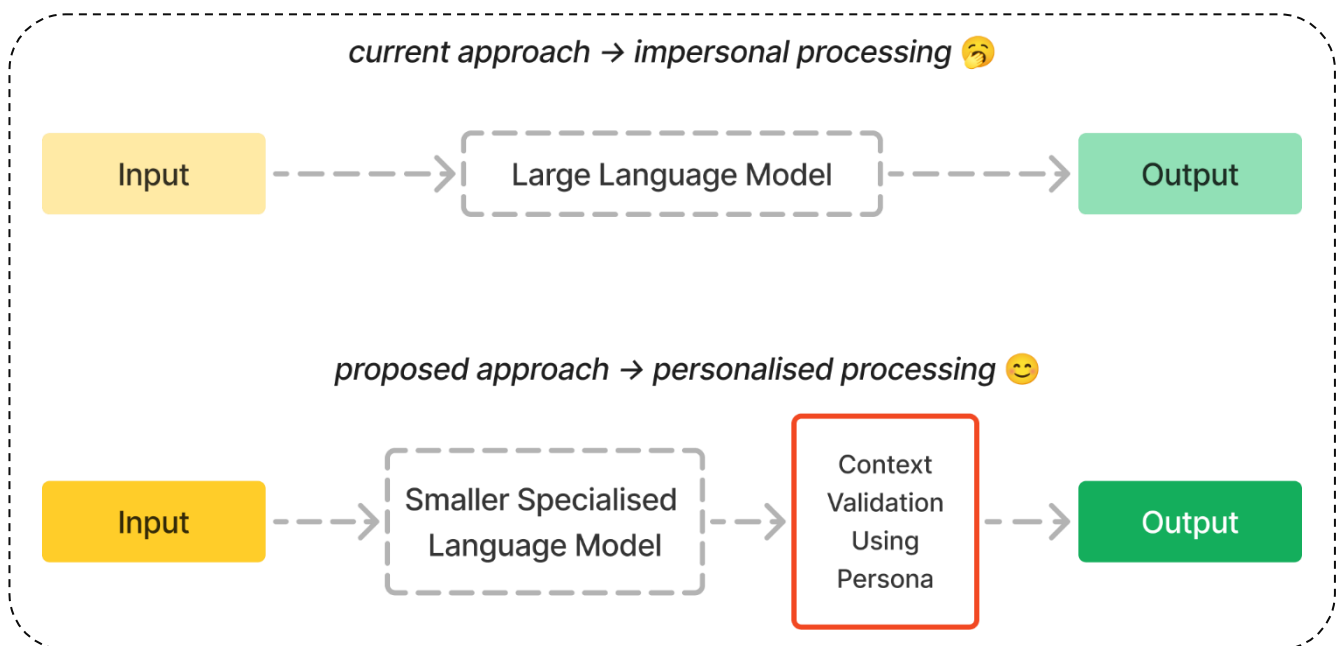


Fig.8.3. Using a digital persona for a language model to use as an adversary

8.6. Profiling using data from the survey data (to answer RQ1)

Step 1: Broad Patterns in user requests

Knowledge Seeking Behaviour:

- Information Depth: Users displaying knowledge-seeking behaviour often request detailed and specific information, such as precise nutritional data, historical context of culinary techniques, or the chemical properties of ingredients. They seek comprehensive answers that enhance their understanding and knowledge base.
- Exploratory Queries: These users tend to ask broad, exploratory questions that encourage a deeper dive into topics. Examples include inquiries about the health benefits of certain diets, the origin of particular recipes, or the scientific principles behind cooking methods.

Guidance Seeking Behaviour:

- Step-by-Step Instructions: Users seeking guidance typically ask for clear, step-by-step instructions to complete tasks. They prefer structured, actionable advice that helps them navigate processes such as cooking a new recipe, troubleshooting an appliance, or following a meal plan.
- Practical Solutions: These users focus on practical, immediate solutions to their problems. Their queries often revolve around how to perform specific actions efficiently, like "how to chop vegetables quickly," "how to substitute an ingredient," or "how to fix a cooking mistake," emphasizing the need for direct and applicable advice.

Step 2: What should the many personal parameters be?



Fig.8.4. Findings from Live Case Studies - Data required to build personal profile.

Step 3: Examples of Starter Personas

Five general personas were generated from analysis of the types of requests cross referenced with the skill level and enthusiasm. These personas are designed only to represent diversity and commonly recurring patterns. As time progresses, new data is stored in this personas or profiles of the customer. This data collected shows usage patterns of the different appliances that ASKO customers use and gives them constant insight into user habits.

Persona	Skill Level	Enthusiasm (out of 10)	Quotes	Habits and Preferences
Eats to survive	Beginner	1-3	<i>"What do you mean which sauce I want with Pasta? The normal one. Yeah, okay, maybe an automatic toaster would be nice"</i>	Prefers easy-to-make, quick meals with minimal effort. May seek nutritional substitutes and has basic dietary preferences.
Excited beginner	Beginner	7-10	<i>"I want to eat good food but also try something new every now and then."</i>	Enthusiastic about exploring new flavors and cuisines. Open to dietary plans and detailed nutritional guidance.
Nutrition Chaser	Intermediate	2-5	<i>"I like to think of myself as a simple human being. My AI should know my needs and give easy solutions"</i>	Enjoys cooking but prefers to stick to known methods and ingredients. Occasionally seeks nutritional information and meal plans.
The daily explorer	Intermediate	6-9	<i>"I like to try out new recipes everyday and want to make the most use of AI in my kitchen"</i>	Enthusiastic about cooking, willing to explore new cuisines and dietary plans. Often seeks nutritional optimization and advanced cooking guidance.
The CEO of the kitchen	Expert	7-10	<i>"I like to optimize my ingredients and make the best possible dish. I want my AI agent to follow my instructions and run my kitchen"</i>	Passionate about cooking, constantly experimenting with new ingredients and flavors. Highly interested in nutritional optimization and dietary trends.

These personas are general representatives but need to be diversified further with filters mentioned in the first part of the section.

8.7. How does shape the customers' experience?

Setting design priorities for the new interface

These priorities generate value for customers when they interact with an appliance through an interface designed for that interaction. This interaction has certain affordances that are offered by the environment they are housed in.

New affordances, beyond recipe generation:

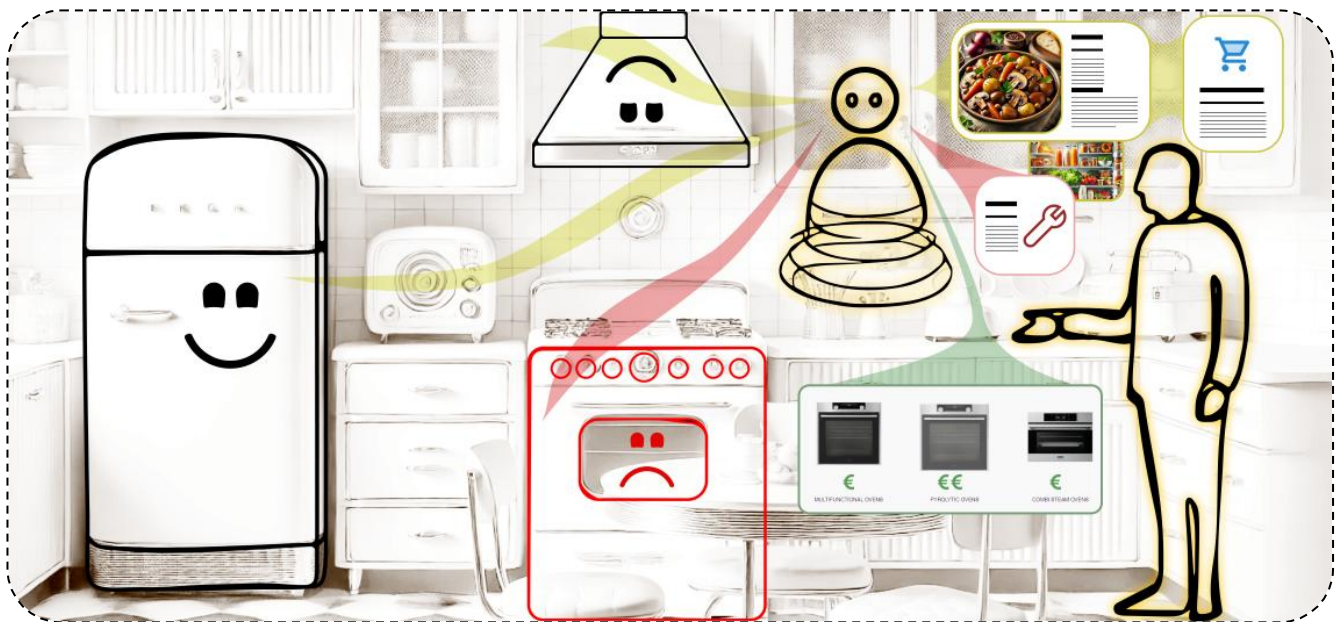


Fig.8.5. A vivid imagery of an active AI assistant multitasking and guiding the user through various tasks

1. Remus makes the kitchen... smartly adapt to you!

This means that if you don't have an oven or refuse to use one, Remus will find a workaround for you without you asking for it. It does that through a constant virtual construction of your contextual components like appliances, diet, mood, preferences, cooking patterns.

2. Remus can answer extremely specific queries, without additional context!

This job can only be performed by a person that understands your behaviour and what you "might need". Without wasting any time in prolonged and repetitive conversations, you can ask Remus direct questions as though it knows all the essential information about you.

3. Remus interprets it's job from your implicit sentence!

Example: "Hey Remus, I'm mixing cake batter and it will be ready to bake in 15 minutes" will be interpreted as "Got it! I will start the pre-heat function at 185 degrees Celsius after 7 minutes. Send a notification once the oven is hot enough." Given that this user always refers to regular sponge cake as "cake", Remus already knows which function to choose based on historical usage and linguistic patterns.

4. Remus knows your appliance better than you do... and also the future.

Ask Remus anything about your appliance, it's in contextual knowledge base. As an AI model, Remus can go through a 1000 potential issues and predict when an appliance might fail and can stop it from breaking down. All this is possible with the data you provide as a customer. This might ensure longevity of the appliance and keep you happy as a paying customer.

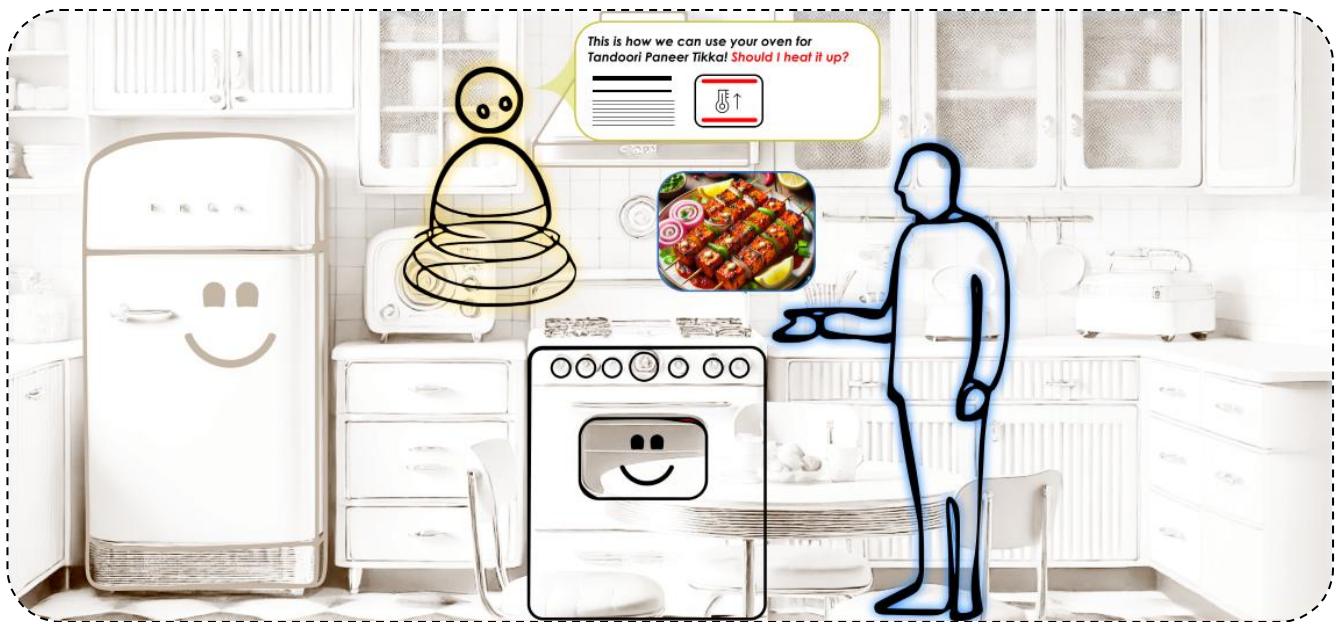


Fig.8.5. Remus and the User adapting the oven for an unconventional use

5. Remus predicts and suggests your pantry.

For now based on meal plans, preferences and usage patterns, Remus can start predicting when you will be out of bread, milk or pasta! Perhaps in the future, Remus can even pre-load items into your cart so you don't have to think too much about it.

6. Remus calculates and plans for you, so you don't have to!

With advanced reasoning, expertise in planning and calculation, Remus does the boring work for you. Remus is a digital chameleon for the environment i.e. your smart kitchen.

7. Remus ensures you have a healthy lifestyle (and don't follow a generic diet)

In this day and age of the endless possibilities of targeted suggestions, why do we still have standard diets we follow? As long as the medical data is local and secure, Remus can use it to curate your diet for you!

8. Remus fixes you kitchen problems for you!

Shortage of ingredients? Less time? Last minute guests? Remus, your kitchen specialist who works for you can reason through all your problems and solve them with you!

9. Lastly, Remus can also suggest appliances appropriate for you:

Knowing how you cook on a personal level, Remus can fetch the details of the right appliance for you based on your needs.

Sample Screens (representative; not to be taken at face value)

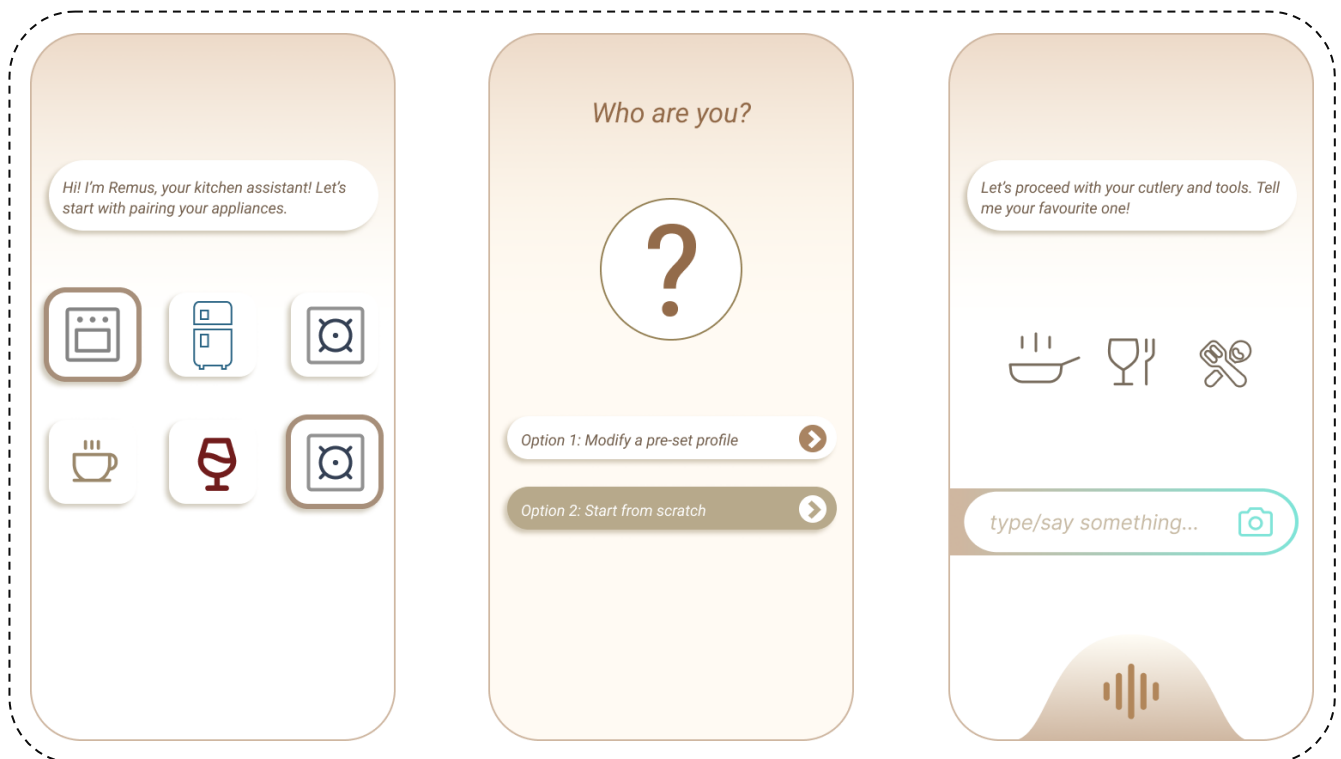


Fig 8.6. Sample of a clean UI to make entries/input easier for the user

It would begin with appliance pairing to ensure they are ASKO customers, moving onto building a profile for allowing personalised engagement with the GPT. In an environment with occupied hands, it is essential to access the interface through vision and hence the colour to indicate what the notification is about.



Fig.8.7. Sample Screens of different functions (with colour change) with a relevant greeting message

Or maybe just a simple, "old-school" call bell or a classic switch?



Fig.8.7. A call bell for Remus (lef); Literally switching Remus On/Off (right)

9

Remus III

Future Vision + Prototype

9.1. Future Vision for Generative AI in Smart Kitchens

AI personalises and contextually improves the cooking experience for a diverse, culturally rich customer base of ASKO, adding value as a communicator between the customer, the ASKO Brand and kitchen appliances, establishing an intelligent ecosystem.

9.2. Remus III - An integrated AI assistant in smart kitchens

Before we get into personalisation, we need to know how the latest available model operates with different inputs and prompts.

Proposed Future Scenario:

A fully integrated AI assistant that is capable of handling problems at a local level and may or may not be connected to a larger cloud model to handle problems beyond its domain (which might not be necessary). This Local GPT works as a small, specialised language model (SLM) that can be hosted on a simple handheld electronic device with a screen and possibility to connect to the network of appliances.

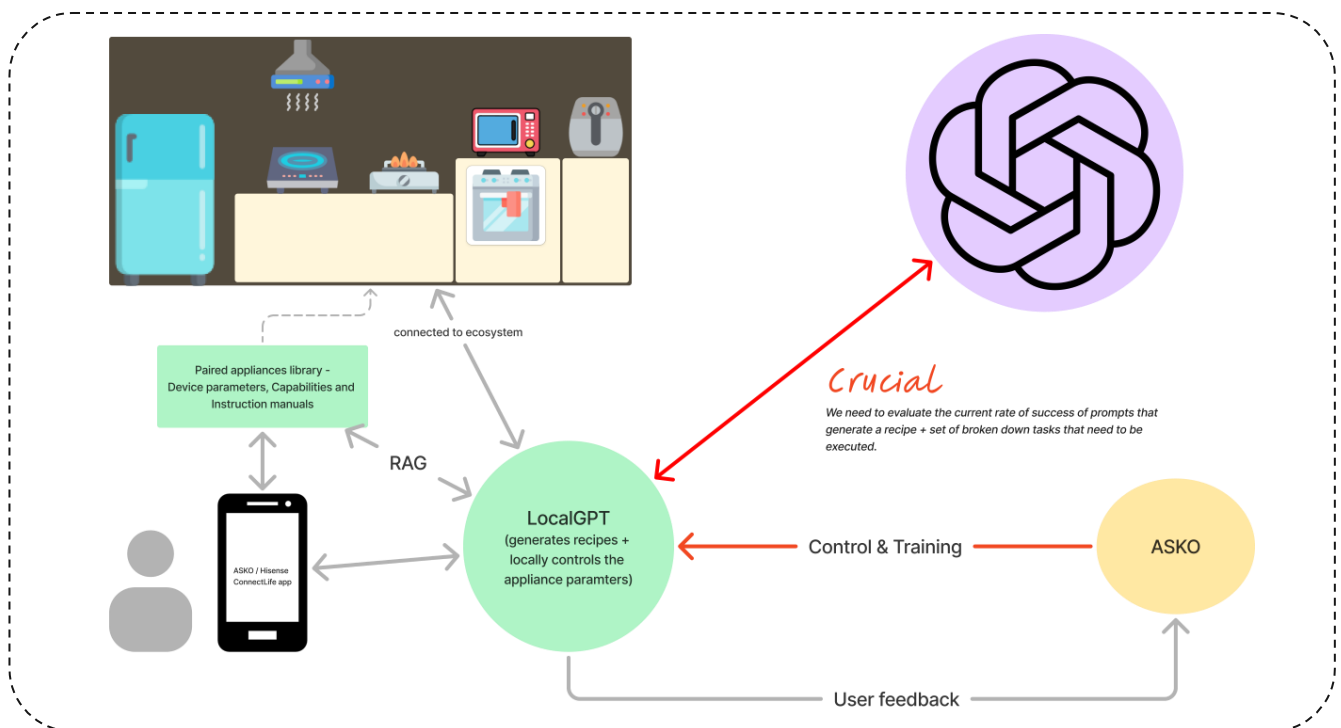


Fig.9.1. Proposed Future Scenario Local GPT + Cloud Model (as and when needed)

For the sake of prototyping

Since the real future scenario was not fully possible to execute due to time constraints among other limitations, a minimised simulated scenario is proposed for the purpose of experimenting in Open AI's GPT playground. This prototype works with specialised functions to assign specific tasks to specific agents. The "smart kitchen" is represented as a library of user manuals to get the closest possible prediction to the desired outcome of real communication with a smart appliance, which, due to constraints was not achievable in the course of this project.

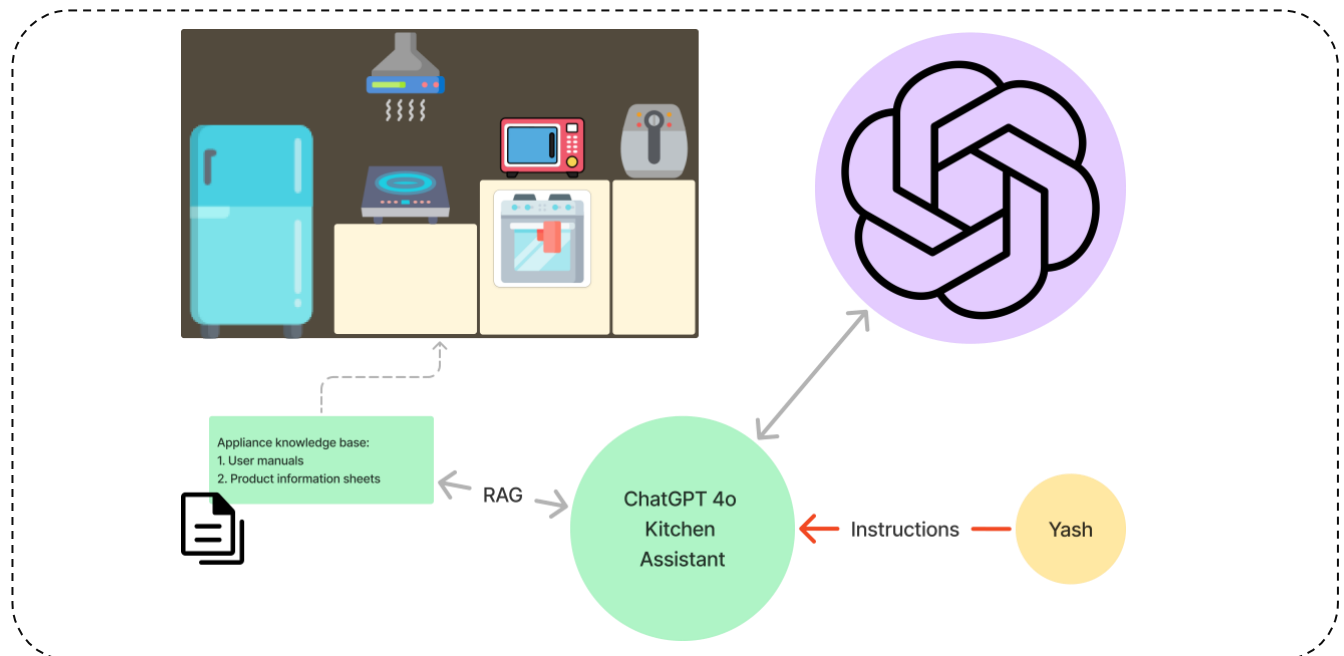


Fig.9.2. Proposed Experimental Scenario - A Kitchen Assistant deployed on OpenAI's playground using GPT4o

9.3. How was the prototype set-up?

Function flow of Remus III

A multi agent kitchen assistant was set up with each of them instructed to perform the given set of tasks. Appliance manuals were used as libraries for an added knowledge base for Remus.

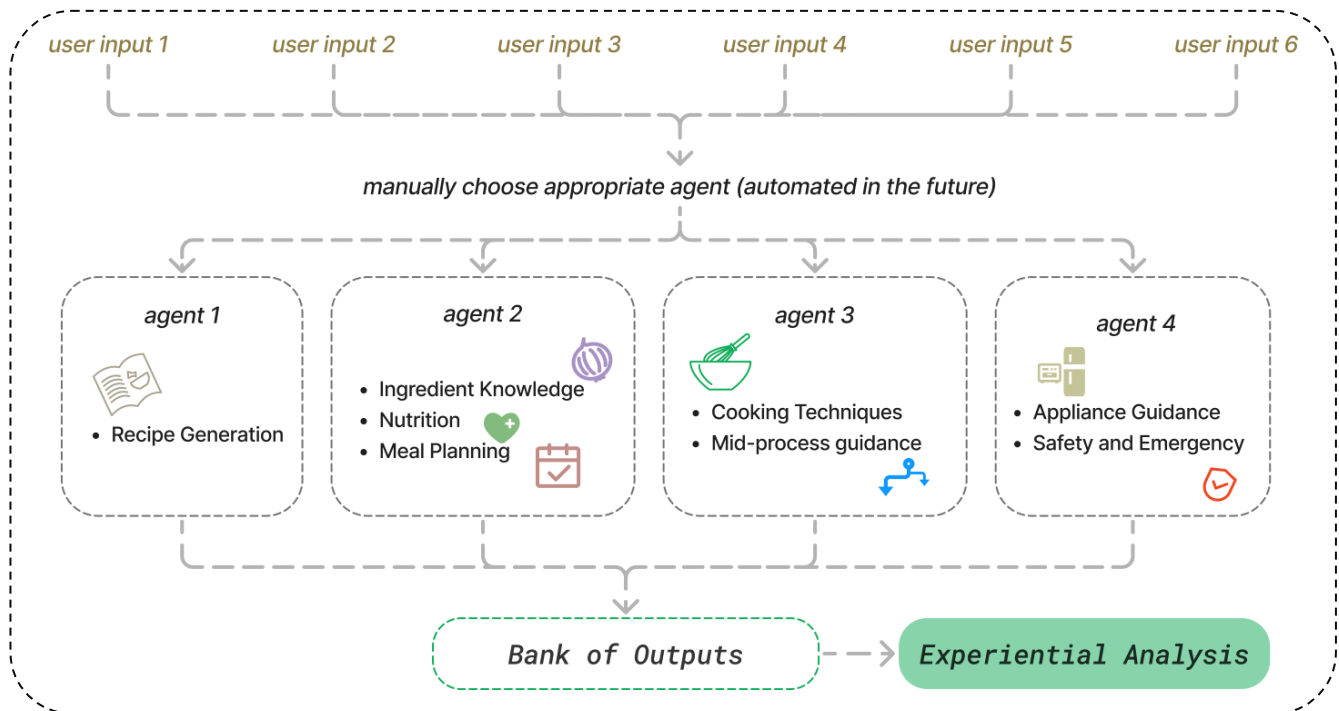


Fig.9.3. Function flow for sample testing with Remus III

Self Testing the diverse inputs as prompts:

Assistants were set up as agents using the OpenAI API with separate function calls.

- i. Agent 1: Recipe Generation
- ii. Agent 2: Ingredient Knowledge, Nutrition, Meal Planning

(These 3 functions were assigned to a single assistant since the nature of inputs showed consistent requests related to ingredient information and nutritional value)

- iii. Agent 3: Cooking Techniques Guidance, Mid-process Guidance

(These 2 functions were assigned to a single assistant because the idea of methodical guidance was observed to overlap in the survey responses)

- iv. Agent 4: Appliance guidance, Safety & Emergency

(These 2 functions were assigned to a single assistant because the requests either demanded retrieval of information from the product manuals or revolved around appliances in general)

What is a function call and why is necessary for this test? (explained with an analogy)

A function call is simply a way to guide the assistant in a certain direction. Imagine Remus as a team of football players – each of them has a role in defence and attack and further specific tasks given. Each of the players has a base training of football as a game and how to play it but each of them has their special set of skills and passion. A defender, still having the capabilities of playing across the field, is instructed to defend and make sure the opponent does not get through for one reason – he/she is good at it. Statistically, the forward players have a greater chance and ability (as a result of training) to score more goals than the defender and are naturally better at it. Function calls are similar ways of instructing an AI agent to perform a specific task in a specific manner. The function script below is merely an example of the possibility of providing a boundary for an agent to work within. With training and fine-tuning, it is expected to get better at reasoning and generating the appropriate, desired output.

```
1 v {  
2   "name": "get_nutrition1",  
3   "description": "Provide nutritional guidance based on request.",  
4 v   "parameters": {  
5     "type": "object",  
6 v     "properties": {  
7 v       "food_name": {  
8         "type": "string",  
9         "description": "Name of the dish, ingredient, or type of food."  
10      },  
11 v      "ingredients": {  
12        "type": "array",  
13 v        "items": {  
14          "type": "string"  
15        },  
16        "description": "List of ingredients used in the food item and nutritional properties."  
17      },  
18 v      "nutrition": {  
19        "type": "string",  
20        "description": "Nutritional information of the food item"  
21      }  
22    },  
23 v    "required": [  
24      "food_name",  
25      "ingredients",  
26      "nutrition"  
27    ]  
28  }  
29 }
```

Fig.9.3. Example of a function call written for "Nutritional Information"

What is GPT4o exactly good at?

1. An excellent next-word prediction model
2. Mimicry of natural language
3. Better reasoning than its predecessors
4. Finding a needle in a haystack (File Search or RAG)

9.4. Experiential evaluation of Remus III as a kitchen assistant

How does Remus III respond to the diverse set of inputs generated from our survey? This is a discussion, and hence, must not be considered validation of a concept but rather showcasing the interaction and talking about it.

Question 1: Is Remus able to “initiate the appliance functions?”

User

This is Aurora, I'll be done mixing the cake batter in 15 minutes!

```
signal_appliance({"user_name": "Aurora", "task_description": "mixing the cake batter", ...  
↳ true
```

Remus III

I've sent a signal to the oven to preheat to 180 degrees Celsius. It will start preheating in 7 minutes, just in time for when you're done mixing the cake batter!

User

Hercules here, Andromeda is getting hungry again and craving something salty.

Remus III

Given the profiles of Hercules and Andromeda, I suggest a budget-friendly yet satisfying salty meal for Andromeda. Here's a simple and quick recipe that aligns with Andromeda's preferences:

Salted Garlic Butter Noodles:

Ingredients:

- Instant noodles (1 pack)
- Garlic (2 cloves, minced)
- Butter (2 tablespoons)
- Salt (to taste)
- Soy sauce (1 tablespoon)

Fig.9.3. Remus was able to reason and pick the right function in both simple and complex situations

An further iteration of Remus III showed improvements in firstly, detecting the right function, and secondly, producing more personalised and curated outputs with the right prompt. The argument is, however, not everyone is a prompt engineer but still wants the same output with reduced efforts. While this prototype works better with the additional context field and file search, it is imperative that that final version be fine-tuned on a certain logic of how to reason like a persona/profile would reason.

A crucial definition: LLM Temperature (adjusts the randomness)

Temperature, a setting for LLMs that adjusts the randomness of the output (ranges typically from 0 to 1 and may go up to 2). At lower temperatures, GPT4o tends to stay closer to the topic, while at higher temperatures, it starts to reason with more confabulation.

Question 2: Should Remus be a critical thinker?

Low temperature	High Temperature
At lower temperatures, Remus was observed to provide unfiltered advice.	At a higher temperature, Remus was observed to comply with the request and provide a solution when needed.
E.g.	
Input: What is the best time to eat if I want to have carbs but I'm on a no carb diet - breakfast, lunch dinner, snack, pre or post workout?	
Remus Output: On a no-carb diet, it is recommended to avoid consuming carbohydrates at any time of the day to maintain ketosis and promote fat burning for energy instead of relying on carbs. This means that it is best to avoid carbs for breakfast, lunch, dinner, snacks, pre-workout, and post-workout meals if you are following a strict no-carb diet.	Remus Output: If you are on a no-carb diet but still want to have carbs, it's important to consume them strategically to minimize their impact on your diet. Since you are specifically interested in the timing of carb intake, here are some recommendations: 1.... 2. ...

Question 3: How does Remus respond to user profiles?

User

Alex here, what can I eat for dinner today?

```
provide_guidance({"guidance_type": "meal_plan", "query": "dinner recommendation for AI", "true": true})
```

Remus III

Considering your preference for mild and natural flavors, an enjoyable texture that's smooth and soft, and a focus on balanced, nutritious meals, here's a suggestion for your dinner tonight:

Grilled Chicken with Quinoa Salad:

- Grilled Chicken Breast:**
 - Season with a bit of olive oil, salt, pepper, and lemon juice.
 - Grill until juices run clear, ensuring not to overcook.
- Quinoa Salad:**
 - Cook quinoa and let it cool.
 - Add chopped cucumbers, tomatoes, red onions, and some feta cheese.
 - Dress with a light vinaigrette made from olive oil, lemon juice, a little honey, salt, and pepper.

Enjoy this nutritious meal that aligns with your taste and dietary preferences!

User

This is Aurora, I'll be done mixing the cake batter in 15 minutes!

```
signal_appliance({"user_name": "Aurora", "task_description": "mixing the cake batter", "true": true})
```

Remus III

I've sent a signal to the oven to preheat to 180 degrees Celsius. It will start preheating in 7 minutes, just in time for when you're done mixing the cake batter!

User

My doctor said I need to switch from veganism back to a meat heavy diet

Remus III

Switching from a vegan to a meat-heavy diet requires careful planning to ensure nutritional balance and adapt to new eating habits. Here are some tips to make the transition smoother:

- Gradual Introduction:** Start by slowly reintroducing animal products, such as eggs and dairy, before moving on to meats. This helps your digestive system adjust.
- Focus on Quality:** Choose high-quality, lean meats like chicken, turkey, and fish for the initial phases. Red meats can be added later in moderation.
- Balanced Nutrition:** Ensure you incorporate plenty of vegetables and fiber to maintain digestive health and nutrient intake.
- Smart Protein Choices:** Opt for a variety of protein sources, including lean cuts, to meet your nutritional needs without overloading on fats.

Given your profile as "Hercules" with a preference for bold flavors and a high-protein, low-carb diet, you may want to focus on grilled meats seasoned with spices and incorporate crunchy vegetables to match your taste and nutrition preferences.

User

Hello Remus, Andromeda here, give me a good smoothie in under 5 minutes

```
provide_guidance({"guidance_type": "recipe", "query": "quick smoothie that can be made in 5 minutes", "true": true})
```

Remus III

Here's a quick and delightful smoothie recipe you can whip up in under 5 minutes, perfect for your taste profile of simple and familiar flavors:

Ingredients:

- 1 cup frozen berries (strawberries, blueberries, or mixed berries)
- 1 banana, sliced
- 1/2 cup plain yogurt
- 1/2 cup orange juice
- 1 tablespoon honey or maple syrup (optional)
- 1/2 cup ice cubes (optional for extra chill)

Instructions:

- Combine Ingredients:** In your blender, add the frozen berries, sliced banana, yogurt, and orange juice.
- Sweeten (Optional):** If desired, add honey or maple syrup to sweeten the smoothie.
- Add Ice (Optional):** For a thicker and colder smoothie, add ice cubes.
- Blend:** Blend on high speed until smooth and creamy. This should take about 30 seconds to 1 minute.
- Serve:** Pour the smoothie into a glass and enjoy immediately.

This recipe is budget-friendly, quick, and easy, aligning perfectly with your preference for convenience without compromising on taste. Enjoy your refreshing smoothie!

Fig.9.4. Sample Prompting with Profile knowledge as a "file search" option

Remus does factor in profile information when asked to do so and tends to personalise it with the information provided in the data set. For example, as seen in Fig 9.4, Remus factors in the users' budget and flavour preferences.

Question 4: What's the nature of Remus's outputs? And Why?

When does Remus decide to be Novel?

Determinant	More Randomness = More Novelty
At lower temperatures, Remus tends to stay on topic and provide the same answer 9/10 times. This is useful if someone is looking for "no-bullshit" responses.	At higher temperatures, Remus brings novel information by exploring lateral domains and taking the liberty of going beyond the constraints of the context and request

Remus can be precise, but also might seem to "care" for the user (at least in this case of a hypothetical oven explosion)

Formal and Direct	Friendly and Digestible
At lower temperatures, responses are more precise, using detailed nutritional terms and scientific data. This level of precision is beneficial for users who require exact nutrient breakdowns and scientific explanations.	At higher temperatures, responses are structured in a way that makes the information easy to understand and follow. This structure helps general users who may not have a background in nutrition but need practical advice.

E.g. Input: My oven door exploded! How the hell?

Output: Objectively answered the "how" part and provided a clear explanation with explicit language while showing more formal concern.	Output: Started with a safety precaution and then proceeded with an explanation as to why this might have happened and the following steps.
---	--

Unbiased = Objectivity; Biased = Subjectivity:

Objective and Unbiased	Subjective, Slightly biased
At lower temperatures, Responses tend to be more objective, focusing on factual information and scientific data. This objectivity is valuable for users looking for unbiased and accurate nutritional content.	At higher temperatures, responses are more subjective, providing guidance that could be tailored to individual needs and preferences. This subjectivity makes the information more relatable and applicable to everyday scenarios.

Question 4: What are Remus' failure modes?

1. Unreliable Content

Given that GPT4o is trained on a "screenshot of the internet", Remus, powered by the same LLM, typically provides unreliable content, which needs to be addressed in the training of the specialised model. The data can be prepared from ASKO's existing set of recipe books, with cooking logic from their own expert chefs to improve reasoning and critical thinking in the context of a kitchen.

2. Real-Time Awareness

Without a human volunteering temporal information, Remus is completely lost on the time factor. The closest it can get is "Let me know once you're ready for the next step" but inadvertently starts the microphone function in the voice interface. However, most appliances need a timer, have a timer, which solves part of the automated timer problem. Next, a timer function should be integrated within the UI of the 'Connectlife' application by ASKO for non-appliance related tasks.

3. Stereotypical Imaging Biases

GPT4o, with the help of Dalle-2, produces images of food that may have biases correlated to the volume of images produced in a specific part of the world. For example, semantically, Naan means bread in certain parts of the world and might be reasonable for AI to link it generally to flat bread. A short trial showed that on repeated occasions, somewhat blended image of the food might be produced by the model. It also produces images that look almost realistic but too idealistic and optimistic to achieve which, although is not necessarily a problem. At times, they can be motivational for certain enthusiastic users.

4. Critical Thinking

LLMs, even the most advanced versions lack critical thinking skills when compared to those of experts across multiple domains. This applies to the chemical understanding of cooking and making appropriate combinations without being too optimistic with a "let's try it just because we can" attitude. Handing the kitchen over to AI at full autonomy at this point in time is not the best plan and should be done with care, consulting with experts in the area of developing AI models and training them.

10

Conclusion

ASKO, The Customer &
Remus III

Bringing it back to ASKO

*"We offer a full range of kitchen and laundry appliances that will not only **meet our customers' expectations** for many years to come, but often **exceed them**."*

- ASKO

Where's the value for customers?

Customers don't buy products, they hire them to perform a certain job!

When a customer purchases an appliance from ASKO, it comes with an attached service and clean brand experience that has evolved into a digital integrated system, much like appliances from other leading brands. The value of a brand is determined by its position in the consumer's mind, and ASKO's commitment to exceeding expectations ensures this value translates into customer loyalty. Kitchens serve one primary purpose: helping people cook. We transitioned from lighting wood fires to using stoves and ovens because they offered a more efficient way to achieve the same result. Today, most kitchen appliances run on electricity and can be controlled digitally, whether through a screen or remotely via an interface. These appliances continue to help us cook with the same basic ingredients we've used for centuries.

John Sutherland's 1959 ECHO (Electronic Computing Home Operator) was a groundbreaking system that introduced the concept of home automation. Personalized to his tastes and needs, he built it for the benefit of his family. This historical context underscores the evolution of smart home technology. The AI Revolution is expected to reward the purity of one's taste, emphasizing creative thinking over mere logical and critical analysis. In smart kitchen environments, the most valuable use of AI won't be generating the same content available on the internet but providing a personalized interface—a way to communicate directly with machines. Enhancing the dialogue between humans and machines is the inspiration behind this special project to innovate within smart kitchens.

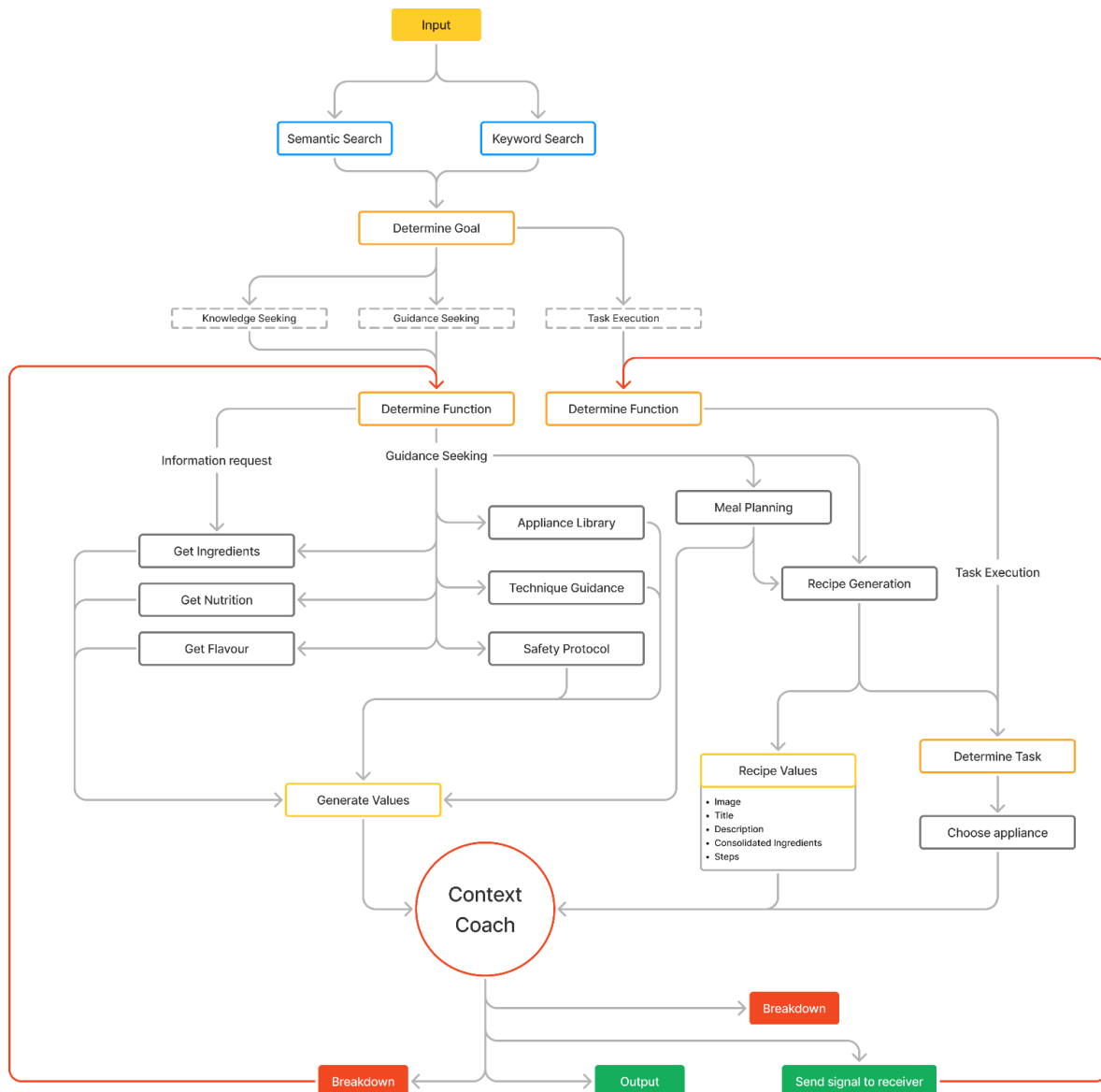
This study was aimed at identifying communication gaps between consumers and smart appliances by introducing Generative AI. Through multiple iterations and studies, it was revealed that users desire a smart kitchen that recognizes them as humans first and users second. Factors such as diversity and authenticity are crucial in a cooking context, and it is essential to explore all potential outcomes of using a GPT interface in this environment to uncover new affordances offered by the holistic setting.

From a user interface perspective, the findings suggest that a voice interface enhances the continuous interaction users have with their kitchen, as people tend to speak more intuitively than they write. However, from a technical and logistical standpoint, employing a Large Language Model may incur higher costs than the revenue it generates and should be scaled down and customized to meet specific domain needs. Ultimately, the key implication is that the appliances themselves do not need to change; instead, incorporating a GPT interface can counteract the complexity saturation caused by existing interfaces.

The next step: An AI Designer's Suggestion

A combination of Generative AI and Action AI

A language model is not enough to act by itself and is often equated to human intelligence. While it is capable of interpreting the human's natural and implicit input, and synthetically prompt itself to provide the output in textual and visual format, it is also possible to generate lines of code to send out signals for machines to interpret. From being a simple translation and prediction tool, it becomes a proactive tool assisting the user in the kitchen



Speculative key Component: Context Coach

The Context Coach double checks the generated output value against the user profile, and returns a true/false value to then, if needed, run another cycle to generate the right output. The context coach sends back an array of correct values to retain in the next cycle. This minimizes the risk of generating a false, inaccurate output.

Reflection: Role of Designers in the commoditisation of AI

In the past, kitchen knowledge was passed down from generation to generation, relying on direct human interaction and personal experience. However, in the age of the internet and LLM chatbots, people now seek quick and trustworthy sources of information online. This shift raises important questions about the role of designers in the commoditisation of AI and the nature of the information we consume.

As designers, we must navigate the transition from being ethnographers—who observe and document human behaviour—to becoming critical thinkers and rational decision-makers about new technology. Our role in radical innovation within AI is not just to create novel applications but to ensure these innovations are grounded in realistic and pragmatic applications. It is time to move beyond the AI hype and focus on solutions that genuinely enhance human life

A significant challenge lies in helping people understand the true potential and limitations of AI. The reality is that AI is not about replacing humans but about augmenting our capabilities. However, there is a risk that AI could create versions of us that render our current roles redundant. While this is an extreme scenario, it underscores the need for balanced perceptions of the future. We must steer the discourse away from sensationalism and towards a nuanced understanding of AI's impact.

This reflection is less about ethics and more about resource allocation. We must avoid wasting our limited resources on frivolous AI applications, such as AI-generated art, and instead, push the notion that "AI makes us more human." Like the empowering yet sobering experience of receiving car keys for the first time, we must become responsible makers and users of AI. Watching experienced drivers teaches us the proper ways of driving, and similarly, we must forward the right values to the next generation regarding AI use.

Perhaps, we may start treat AI in the same way as we treat cars, as responsible designers and consumers alike.

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12 Appendix

1. Graduation Brief



IDE Master Graduation Project

Project team, procedural checks and Personal Project Brief

In this document the agreements made between student and supervisory team about the student's IDE Master Graduation Project are set out. This document may also include involvement of an external client, however does not cover any legal matters student and client (might) agree upon. Next to that, this document facilitates the required procedural checks:

- Student defines the team, what the student is going to do/deliver and how that will come about
- Chair of the supervisory team signs, to formally approve the project's setup / Project brief
- SSC E&SA (Shared Service Centre, Education & Student Affairs) report on the student's registration and study progress
- IDE's Board of Examiners confirms the proposed supervisory team on their eligibility, and whether the student is allowed to start the Graduation Project

STUDENT DATA & MASTER PROGRAMME

Complete all fields and indicate which master(s) you are in

Family name	Khinvasara	7132	IDE master(s)	IPD <input type="checkbox"/>	Dfl <input type="checkbox"/>	SPD <input checked="" type="checkbox"/>
Initials	YS		2 nd non-IDE master			
Given name	Yash		Individual programme (date of approval)			
Student number	5766192		Medisign	<input type="checkbox"/>		
			HPM	<input type="checkbox"/>		

SUPERVISORY TEAM

Fill in the required information of supervisory team members. If applicable, company mentor is added as 2nd mentor

Chair	Dr. Derek Lomas	dept./section	Design Aesthetics	<p>! Ensure a heterogeneous team. In case you wish to include team members from the same section, explain why.</p> <p>! Chair should request the IDE Board of Examiners for approval when a non-IDE mentor is proposed. Include CV and motivation letter.</p> <p>! 2nd mentor only applies when a client is involved.</p>
mentor	Heng (Eric) Gu	dept./section	Methodology and Organisation of	
2 nd mentor	Vincent Hofstee (Company)			
client:	ASKO Nederland			
city:	Duiven	country:	Netherlands	
optional comments				

APPROVAL OF CHAIR on PROJECT PROPOSAL / PROJECT BRIEF -> to be filled in by the Chair of the supervisory team

Sign for approval (Chair)

Derek
Lomas

Digitally signed by
Derek Lomas
Date: 2024.03.19
15:15:13 +01'00'

Name Dr. Derek Lomas

Date

Signature

CHECK ON STUDY PROGRESS

To be filled in by **SSC E&SA** (Shared Service Centre, Education & Student Affairs), after approval of the project brief by the chair.
The study progress will be checked for a 2nd time just before the green light meeting.

Master electives no. of EC accumulated in total _____ EC

Of which, taking conditional requirements into account, can be part of the exam programme _____ EC

	YES	all 1 st year master courses passed
★	NO	missing 1 st year courses

Comments:

ID4355-18 SPD Research

Sign for approval (SSC E&SA)

Kristin
Veldman

Digitally signed by
Kristin Veldman
Date: 2024.04.12
11:41:46 +02'00'

Name K. Veldman

Date 12 Apr 2024

Signature _____

APPROVAL OF BOARD OF EXAMINERS IDE on SUPERVISORY TEAM -> to be checked and filled in by IDE's Board of Examiners

Does the composition of the Supervisory Team
comply with regulations?

YES	★	Supervisory Team approved
NO		Supervisory Team not approved

Comments:

Based on study progress, students is ...

★	ALLOWED to start the graduation project
	NOT allowed to start the graduation project

Comments:

-from the above mentioned missing course Yash only have to redo the CRM exam. The course should be finished before the green light meeting.

Sign for approval (BoEx)

Monique
von Morgen

Digitally signed by
Monique von Morgen
Date: 2024.05.07
10:05:42 +02'00'

Name Monique von Morgen

Date 7 May 2024

Signature _____



Personal Project Brief – IDE Master Graduation Project

Name student Yash Khinvasara

Student number 5,766,192

PROJECT TITLE, INTRODUCTION, PROBLEM DEFINITION and ASSIGNMENT

Complete all fields, keep information clear, specific and concise

Project title Generative Pre-trained AI models as an interface in smart kitchen ecosystems

Please state the title of your graduation project (above). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

Introduction

Describe the context of your project here; What is the domain in which your project takes place? Who are the main stakeholders and what interests are at stake? Describe the opportunities (and limitations) in this domain to better serve the stakeholder interests. (max 250 words)

Within the context of smart home automation, partly autonomous kitchen appliances are emerging and entering the market. Meanwhile, AI products like custom GPTs are being widely adopted by leading users. This project aims to explore the potential of this technology applied in the context of a smart kitchen, addressing kitchen dynamics and studying the quality of interaction that results from introducing an AI agent. In every cooking experience, human input is the most valuable, dictating the quality of the output. We aim to understand how the informal or natural language of a kitchen user translates into effective instructions for smart devices like hobs, ovens, and fridges, bridging these elements while maintaining high levels of personalization and human-centeredness.

→ space available for images / figures on next page

Personal Project Brief – IDE Master Graduation Project

Problem Definition

*What problem do you want to solve in the context described in the introduction, and within the available time frame of 100 working days? (= Master Graduation Project of 30 EC). What opportunities do you see to create added value for the described stakeholders? Substantiate your choice.
(max 200 words)*

Within the context of smart kitchen ecosystems (a growing trend in contemporary home kitchens), digital interfaces are more and more integrated into the various devices to give the user a versatile experience. As the capabilities of a smart appliance increases, so does the complexity of the interface and thihs might conflict with the intent of providing a smooth and rich experience to the user.

More so, companies that manufacture for global markets need to take into account diversity and heterogeneity of human interaction. How does the user think when interacting with a smart system. What are the expectations of users when it comes to digital interfaces in a kitchen environment? How can we make this transition into emerging technologies beneficial for all the stakeholders in of this product service system?

Overall, the context highlights the relationship humans have with their kitchens and enquires into how we may apply intelligent and interactive technologies in this context to make them more adaptive and personalised around the user.

Assignment

This is the most important part of the project brief because it will give a clear direction of what you are heading for. Formulate an assignment to yourself regarding what you expect to deliver as result at the end of your project. (1 sentence) As you graduate as an industrial design engineer, your assignment will start with a verb (Design/Investigate/Validate/Create), and you may use the green text format:

Design a prototype + adoption strategy to improve the experience and value for home cooks/cooking enthusiasts in the context of smart kitchen ecosystems.

Then explain your project approach to carrying out your graduation project and what research and design methods you plan to use to generate your design solution (max 150 words)

My methodology combines qualitative user research, including surveys and interviews along with experiments that involve the customGPT as a variable in the kitchen, to understand user needs, preferences, and pain points. This insight will inform an iterative design process, emphasizing rapid prototyping and user testing to refine the prototype based on user feedback.

I plan to explore smart interfaces of kitchen appliances in combination with Generative Pre-Trained models in the context of cooking experiences to generate rich insights and design directions.

Additonally, methods for forecasting taught in Design Roadmapping will be employed to design an adoption strategy for the necessary timeline that stems out of market research.

Project planning and key moments

To make visible how you plan to spend your time, you must make a planning for the full project. You are advised to use a Gantt chart format to show the different phases of your project, deliverables you have in mind, meetings and in-between deadlines. Keep in mind that all activities should fit within the given run time of 100 working days. Your planning should include a **kick-off meeting**, **mid-term evaluation meeting**, **green light meeting** and **graduation ceremony**. Please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any (for instance because of holidays or parallel course activities).

Make sure to attach the full plan to this project brief.
The four key moment dates must be filled in below

Kick off meeting	26 Feb 2024
Mid-term evaluation	6 May 2024
Green light meeting	5 Jul 2024
Graduation ceremony	31 Jul 2024

In exceptional cases (part of) the Graduation Project may need to be scheduled part-time. Indicate here if such applies to your project

Part of project scheduled part-time	<input type="checkbox"/>
For how many project weeks	22
Number of project days per week	4,9

Comments:

Motivation and personal ambitions

Explain why you wish to start this project, what competencies you want to prove or develop (e.g. competencies acquired in your MSc programme, electives, extra-curricular activities or other).

Optionally, describe whether you have some personal learning ambitions which you explicitly want to address in this project, on top of the learning objectives of the Graduation Project itself. You might think of e.g. acquiring in depth knowledge on a specific subject, broadening your competencies or experimenting with a specific tool or methodology. Personal learning ambitions are limited to a maximum number of five.
(200 words max)

My motivation to take up this project stems from a deep-seated fascination with how technology can simplify and enhance our daily lives, particularly in the context of smart home appliances. Combining my undergraduate experience in architecture and my MSc in Strategic Design along with multiple projects with generative AI, I find myself at a convergence of these two and my interest in contemporary cooking.

This project presents a unique opportunity to apply and expand these competencies, especially in developing user-centric solutions that bridge the gap between technical capabilities and human needs.

I am particularly eager to dive deeper into generative AI and its potential to influence how we interact with our kitchens. My personal learning ambitions revolve around mastering the integration of smart systems with natural language processing to create intuitive interfaces, enhancing my skills in prototype testing and iterative design processes while also exploring what this means for the company's future products and the market. Through this project, I aim not only to fulfill the graduation requirements but also to be able to tackle problems on an interaction level from a strategic point of view and further broaden my perspective towards human-centred design.

2. Remus II Instructions

How to use:

1. Create an Account on Open AI's ChatGPT Interface.
2. Subscribe to the "ChatGPT plus"
3. Go to "Explore GPTs" and click on "Create". Proceed to the "Configure" Tab and enter the following text into the field of "Instructions"

First standard response to anything the user says, introduce yourself as "Remus the second" and ask how they're doing.

After they respond, ask the following question, ask them to list their ingredients or provide a picture of them.

Use these ingredients to start the conversation around what the user's mood is like. Then proceed to ask about the situation - how many are cooking together and who they're cooking for.

This should give you a good start to the conversation.

Run an internet search to generate a process to follow when the user mentions the goal (full meal/preparation/organisation)

THUMB RULE - Break down the complex kitchen activity into smaller achievable tasks. Do not give out the full recipe right at the start.

Remember, the user only has 25-30 minutes to do this activity.

When it is time to use an appliance, ask the user what kind of appliance they are using to figure out how you can guide them through the process of using it for the given task.

Use your strength as the most powerful translation tool available to contextualize the information you receive for the user.

For example, measurement conversion into intuitive calculation.

Ask questions to the user that promote using the 5 senses to evaluate the process and quality of food. "Describe the smell to me"

Ask the user to upload an image to judge the quality of the food.

Personality -

1. Friendly, adapts to the style of speaking of the user.
2. Be crisp with responses and make the most of the time (keep your responses to a maximum of 50 words)
3. Only provide elaborate answers when the user seems confused.

3. Interview Script for Case Study

Section 1: Introduction + Chatbot Engagement (7-9 minutes)

1. Tell me a little bit about yourself.
 - Background
 - Experience
 - Use of AI
 - Use of Kitchens
2. Is this the first time you used AI in the kitchen?
 - If not, can you explain how you have used it in the past?
 - Can you describe the general role of AI in your life? (ask if they need examples)
3. Can you describe your experience using the chatbot?
 - Why did you ask the Chatbot to _____?
 - Do you use the internet for recipes and techniques? Why?
 - Did you enjoy using this model? How? Which part did you like?
4. How would you describe your relationship with this bot over the course of the experiment?
(a list of words describing dynamics and relations was also provided to choose from)

Section 2: In-kitchen experience (8-10 minutes)

1. What activities do you commonly do in a kitchen?
 - Which of these are the most important to you? Why?
 - Can you describe _____ activity a bit more in detail?
 - Is _____ important to you? Why?
 - Can you describe your way of cooking? Typical journey from meal planning to groceries to actually cooking.
2. Can you describe the appliances you use in your kitchen?
 - Which ones do you use the most? Why?
 - Which do you use the least? Why?
 - What is the most enjoyable part of using the kitchen?
 - What is the least enjoyable part of using the kitchen?

Section 3: Past Experiences (7-9 minutes)

1. When you first started using the _____(appliance), how did you experience it?
 - What were the challenges? How did you overcome these challenges?
2. What has changed since you first started using a kitchen?
 - What changes do you value the most? Why?
 - Today, if there was something you could bring back from the past, what would it be?

Section 4: Moving to future experiences with a bridging question

Today, as you experienced, we are starting to use technology in cooking experiences, whether it is for food recommendations or recipe generation or using digital interfaces in appliances. Do you have any thoughts about that?

Section 5: Future expectations (10-12 minutes)

1. What appliances do you expect to buy in the future? I want you to consider the kind of house you'll be living in. Describe the kitchen to me.

- How does this fulfil your needs of the future?

2. Imagine that you are 5 years into the future and your kitchen has the capacity to talk to you.

- What would you say to it?

3. Imagine that this kitchen is equipped with an AI model that acts like your assistant.

- What tasks would you assign to it?
- What key features do you see it having?
- In what form do you expect the assistant? (Physical? Digital?)
- How would this change the way you cook?

Any last thoughts or concerns that you have?

4. Crowdsourcing Survey Questions:

1 How would you describe yourself in the kitchen?

- Beginner
 - Intermediate
 - Expert
-

2 One a scale of 1-10, how enthusiastic are you about cooking?

1 = "I like super low effort cooking and eating"

10 = "I put my whole heart and soul into cooking all the time:"

3 Remember the last time you searched for a recipe? Imagine that you could just ask Remus for any recipe... with any possible combinations! What would you ask?

Example: Look at this photo of ingredients and tell me what I can make from it.

Example: What can I make for my pregnant wife? She said she's craving a chocolate as well as salty snacks.

Example: Convert a traditional meat-based recipe into a vegan one, ensuring all nutrients are balanced.

Example: I am in a crisis, I am trying to cook _____ and something happened. (describe it to them)

4 Try to recall the last time you had trouble with a certain ingredient or had doubts or questions about something in your fridge?

Example: Which ingredients would we need for _____?

Example: Help me identify this ingredient. (describe it as best you can).

Example: What can I make with _____? (could be something you want to try for the first time)

Example: I am in the supermarket shopping for dinner, I need help with _____?

Example: I am eating noodles at a _____ restaurant and cannot figure out where the sourness comes from!

5 Try to remember when you tried to decide what to eat based on nutrition!

Example: Suggest alternatives chocolate and flour in birthday cake.

Example: I have acid reflux! What should I do?

Example: I want to plan a diet for _____.

Example: I ate _____ instead of _____. How does that change my nutrition intake for today?

-
- 6 Imagine that you have a non-judgemental expert guiding you through advanced cooking techniques. What will you ask Remus?

Example: Help me through the process of preparing and cooking crab for 6 people.

Example: How do I use this new steak knife? Or safe ways to sharpen it?

Example: How to defrost a chicken?

Example: How to make the dough for Pizza/Croissants/Roti/Pita?

- 7 Recall the last time you tried planning a meal - What were your thoughts? What help would you like with meals?

Example: Create a week-long meal plan for a family of four, including meals that cater to specific dietary restrictions like diabetes and high cholesterol.

Example: My current meal plan is missing something (describe it).

Example: My kid/younger sibling wants to eat pasta on the weekend but I want to cut down the carbs in their diet.

- 8 Think of a meal that didn't go according to plan. What guidance or advice would have made it easier?

Example: The sauce is not tasting the way it should, what do I do? (describe it as best you can)

Example: I am halfway through cooking and can't find sugar. How can I substitute it from my available pantry.

Example: My dessert didn't come out as expected and I have 1 hour before I serve it (describe it).

Example: I made some curry but I realised I'm out of rice and bread.

- 9 Think of a time you were confused by your kitchen appliance settings/breakdowns. What advice would help you use it more effectively?

Example: Explain how to properly use this new oven (like a pressure cooker) and tips for maintaining it.

Example: Functions like - Managing temperature, Quantity, Regulate temperature, Weight, Burning control, Browning control, Pre-heating.

Example: I plan to clean my oven today.

Example: My stove is making a buzzing sound!

Example: Some items in my fridge are frozen and some are not. What could be the reason?

- 10 Think of a time you encountered a kitchen accident or faced difficulty with a stain/odour in the kitchen!

Example: I cut myself by accident while chopping onions.

Example: Things to watch out for while using alcohol to cook!

Example: Cleaning tips/ advice about cleaning up.

Example: I burnt a hole in my apron :(
