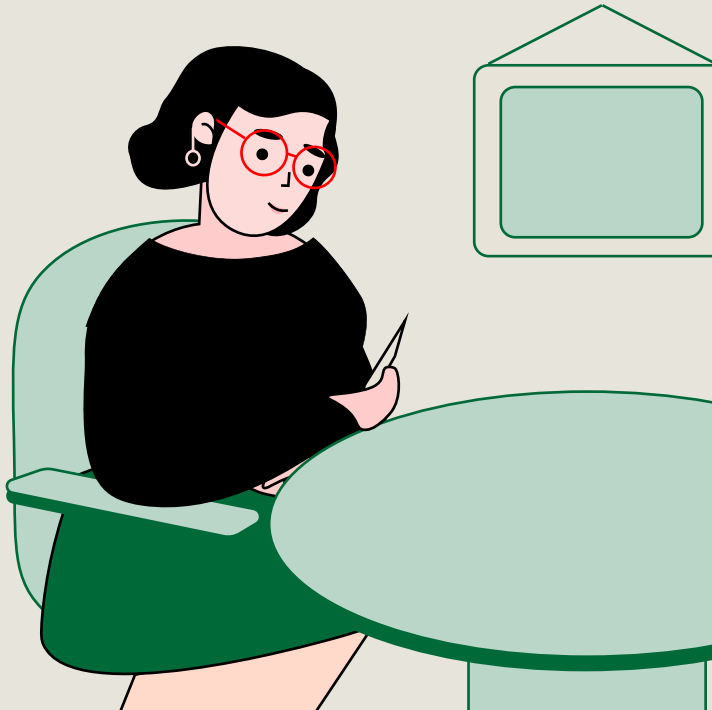
Hi! ✨

I'm your **Food Tracking Chat Bot** for cardiac rehabilitation.

Hello!



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Prologue

My project this semester has been twofold: leading the design of a researcher friendly chatbot ecosystem for TU/e's NUTRI_Lab working group, while simultaneously designing Foodsy, a chatbot based nutrition intervention for cardiac rehabilitation. Over the course of the semester, the Foodsy Chatbot became the first use case of the NUTRI_Lab project, offering the perfect scenario for rapid testing and iteration.

This project has built upon the systematic literature review I conducted in my design research semester, which focused on design recommendations for food intake tracking mobile applications. Grounding my work in academic literature and intimately understanding the design space I am working in has allowed me to gain substantial competence in the areas of design for nutrition. With the extensive work I put in last semester to map and understand design for nutrition, I have felt confident holding my own with nutrition researchers, dieticians, doctors and specialists, while at the same time being able to connect their input with that of designers, developers and academics. In this project, I have seen my vision on the role of the designer come to life; bringing expertise from across disciplines together in order to tackle a multifaceted and complex challenge. In this project, I have shown that I have the expertise, language and sensitivity to bridge the disciplines, and have built competence in managing design processes that not only include myself, but also others.

Working on these two streams simultaneously does not owe itself to straightforward reporting however. In this report, I first present the NUTRI_Lab chatbot ecosystem, and then dive into the Foodsy use case, concluding with a discussion on the project as a whole.

Happy Reading!

-Daisy

Introduction

Cardiovascular diseases (CVD) are currently the global leading cause of death, accounting for 31% of all deaths worldwide (World Health Organization, 2017). An estimated 80% of these deaths are preventable through the adoption of a healthy lifestyle (Virani et al., 2020), which among other factors includes exercising regularly, stopping smoking, reducing stress and eating a heart healthy diet (Virani et al., 2020; Ambrosetti et al., 2020). To support patients in establishing these healthy habits, lifestyle management interventions are increasingly common in preventative cardiovascular healthcare. Cardiac rehabilitation programs specifically developed to improve a patient's cardiovascular risk profile have become a standard component of treatment guidelines for cardiovascular diseases in most Western countries (Knuuti et al., 2019; Abreu et al., 2019). In the Netherlands, guidelines recommend a multidisciplinary cardiac rehabilitation program of up to 12 weeks, which incorporates "patient assessment, management and control of cardiovascular risk factors, physical activity counselling, prescription of exercise training, dietary advice, psychosocial management and vocational support" (Ambrosetti et al., 2020). These programs have been shown to be a cost effective treatment (Shields et al., 2018; Edwards et al., 2017), positively impacting survival rates of participants (Suaya et al., 2009; Anderson et al., 2016), with Dutch patients seeing a survival benefit of up to 4 years after participation (de Vries et al., 2015).

Nutrition is an integral part of cardiac rehabilitation, with most guidelines recommending that nutrition education and guidance be included in cardiac rehabilitation programs (Ambrosetti et al., 2020; Mehra et al., 2020). However, despite this, not all patients are referred to the dietician. In a review of cardiac rehabilitation programs, Zullo et al. (2012) found that only 54% of surveyed cardiac rehabilitation programs assessed the dietary habits of patients upon beginning a rehabilitation program. While Brouwers et al. (2020) found that only 25% of patients visited a dietician during cardiac rehabilitation. Dietary assessment in cardiac rehabilitation is important for health professionals to make more accurate judgements of a patient's diet (England et al., 2015; Aberegg et al., 2020), while also raising the self awareness of the patient if they are engaged in the process and provided with an overview of results (NVVC-CCPH, 2010; Davies et al., 2010). Zullo et al. (2012) also found that only 27% of the participating programs provided personalized nutritional advice to all cardiac patients enrolled in cardiac rehabilitaiton. Personalized nutrition advice has been found to improve dietary change (Speed et al., 2019), however when this advice is generated on a one-to-one basis by healthcare professionals, it is cost and labour intensive to provide (Lacroix et al, 2017; Zullo et al., 2012). Digital interventions offer opportunity to personalize and tailor dietary advice, while being more cost effective (Celis-Morales et al., 2017).

Despite the proven benefits of cardiac rehabilitation, patient enrollment is still extremely low (Kotseva et al., 2018; Peters & Keeley, 2018). Low patient enrollment has been widely attributed to a low rate of referrals, especially for women (Kotseva et al., 2017, Supervía et al., 2017). However successful referral interventions have not remedied the problem entirely, with 50% of referred patients still not completing cardiac rehabilitation (Brouwers et al., 2020). The length of waiting time between discharge from hospital and admission into the rehabilitation program has been shown to highly influence enrollment, with enrollment dropping by 1% for every day a patient must wait (Pack et al., 2013; Russell et al., 2011). Patients often have little to no contact with health care professionals during the waiting time (Santiago de Araújo Pio et al., 2019; Tod et al., 2002), however this is a missed opportunity since cardiac patients are motivated to change their health behaviour after a health event (Back et al., 2017).

Digital technologies offer unique possibilities for cardiac rehabilitation patients to begin working on behaviour change at home during the waiting time, without placing further burden on care staff. In this project, I explore the possibilities for a chatbot intervention during this waiting time to empower patients to begin making healthy changes to their diet right away, and encourage them to enroll in the cardiac rehabilitation program. A secure and researcher friendly chatbot ecosystem has been developed, and simultaneously applied in a first use case: Foodsy, a nutrition tracking chatbot for cardiac rehabilitation. The Foodsy chatbot was developed iteratively, based on literature and four expert interviews. It was received positively by care professionals, and warrants further testing with cardiac patients in the future.

Related Work

Food Tracking

Research suggests that manually recording food intake raises awareness of consumption behaviours (Burke et al., 2011) and promotes individuals to adopt healthier eating practices (Nahum-Shani et al., 2018; Thomas & Bond, 2015). However, manually tracking detailed food intake is also time consuming, tedious and burdensome (Cordeiro et al., 2015). This burden has led to underreporting of intake in various studies (Ahmad et al., 2016; Subar et al., 2003; Tooze et al., 2004). In recent years, technology based interventions have been adopted with hopes of reducing the inaccuracy and user burden (Cordeiro et al., 2015; Thomaz et al., 2015). In particular, the proliferation of smartphones, and their pervasive nature in everyday life have made mobile application based food tracking a popular choice for nutrition researchers, healthcare professionals, designers and commercial app developers. Mobile food tracking apps are considered a low-cost solution (Lee & Cho, 2017; Molina & Sundar, 2020) with the potential to support a variety of health goals (Azar et al., 2013; Chen et al., 2015; Fakih El Khoury et al., 2019, Plow & Golding, 2017). Prior research in HCI has focused heavily on reducing tracking burden (Cordeiro et al., 2015; Epstein et al., 2016; Noronha et al., 2011) since it is considered to be a key component of making health apps successful (Lazar et al., 2015; Rooksby et al., 2014). This includes the introduction of extensive nutritional data bases (Cordeiro et al., 2015), food scanners (Andrew et al., 2013), natural language processing (Oh et al., 2018) and a variety of capture methods (Andrew et al., 2013).

Nutrition Interventions in Cardiac Rehabilitation

Guidelines for cardiac rehabilitation include nutrition education and guidance (Ambrosetti et al., 2020; Mehra et al., 2020). The exact delivery of nutritional guidance varies by program and hospital (Abreu et al., 2019), with most beginning only after cardiac rehabilitation has started. Patients are often discharged within a week after a cardiac event, leaving very little time for health professionals to offer in-depth nutritional counselling (Martinsen & Moen, 2010). This leaves patients waiting for recommendations on proper eating until cardiac rehabilitation starts (Elbrond et al., 2019), which can be many weeks (Pack et al., 2013).

Ma et al. (2008) found that unless patients receive dietary intervention, they will maintain their habitual intake. Nutritional advice during cardiac rehabilitation can range from generic educational information given out on paper, to tailored, personalized recommendations from dieticians. The quality and duration of the dietary intervention has been shown to impact behaviour change, with tailored sessions with a clinical dietician leading to healthier eating behaviour, compared to a brief dietary advice which showed no impact to dietary habits (Dalgard et al., 2001, Luisi et al., 2015). While personalized nutrition advice has been shown to stimulate dietary behaviour change (Speed et al., 2019), it is cost and labour intensive to provide when it is generated on a one-to-one basis by healthcare professionals(Lacroix et al., 2017; Zullo et al., 2012). To address this, digital interventions offer promising opportunities to personalize and tailor dietary advice, while being more cost effective (Celis-Morales et al., 2017).

In cardiac rehabilitation, digital technologies are increasingly being introduced. Athilingam and Jenkins's (2018) systematic review of mobile applications to support self-care following heart failure showed that they had a positive impact, were cost-effectiveness, and promoted patient engagement at home. Another review by Piette et al. (2015) on mobile health technologies for cardiovascular disease management found that mHealth interventions improved cardiovascular-related lifestyle behaviors and disease management. Kwon et al., (2020) developed a quality-focused

diet tracking application to improve heart disease risk, focusing on logging food categories rather than detailed serving sizes. The logging tool significantly improved dietary choices relevant to cardiovascular risk, and they suggest incorporating behaviour change goals that matter to users in the future (Kwon et al., 2020). Jörntén-Karlsson et al. (2016) also found positive impact of mobile applications on cardiovascular patients but highlighted that digital interventions must be easy to use, personalized, and user-friendly.

To sustain user engagement and behaviour change, programs based on self-regulation theory have been shown to have more lasting effects (Huisman et al., 2011; Michie et al., 2009). Self regulation theory is goal-driven and feedback-controlled, which fits well with cardiac rehabilitation, and many studies have linked goal setting with better outcomes for cardiac patients (Smeulders et al., 2009; Conn et al., 2009). Moreover, Janssen et al. (2013) demonstrated that self-monitoring has a positive long term impact on post-cardiac rehabilitation exercise adherence and suggested that future interventions could sustain more treatment benefits by encouraging patients to also continue self-monitoring their dietary habits.

Chatbots in Healthcare

Messaging platforms, such as Telegram (Durov & Durov, 2013), WhatsApp (WhatsApp Inc., 2009) and Facebook Messenger (Facebook Inc., 2011) are extremely popular, and users tend to spend more time chatting than they do engaging with other applications (Do et al., 2011). Integrating chatbots into these familiar, well-established conversational interaction flows takes advantage of the already existing skills of the user and avoids asking them to open yet another app. Effort expectancy is an important factor in whether individuals adopt using conversational agents: the more effort a user expects to be required, the lower the intention to adopt the conversational agents (Laumer et al. 2019, Bickmore et al. 2009; Coskun-Setirek & Mardikyan, 2017).

Within the healthcare domain, chatbots have been deployed and researched in various capacities and areas, such as cancer (Belfin et al., 2019), asthma self-management (Kadariya et al., 2019), smoking cessation (Calvaresi et al., 2019; Wang et al. 2018), as well as for weight loss (Holmes et al. 2018; Huang et al., 2018) and mental health counselling (Elmasri & Maeder, 2016). They have shown promising contribution toward relieving the burden on healthcare professionals (Jadhav & Thorat, 2019). Furthermore, chatbots bring several other benefits, including 24 hour access, personalization, and scalability (Jadhav & Thorat, 2019).

The following are closely related projects to this report, as they include a chatbot and focus on food consumption. First, Fadhil & Gabrielli (2017) propose a chatbot system which promotes healthy eating behaviour to prevent weight gain with functionalities ranging from food recommendation to helping users shop in a sustainable way. Second, Casas et al., (2018), propose a food diary coaching chatbot, with two simple goals of eating less meat or eating more vegetables. They take a very lightweight approach, only asking the user to record how many times he ate the goal-related food that day (e.g. how many times did you eat meat today?). 65% of users (n=36) found that the simple logging improved their consumption, with 82% saying that the logging improved their awareness. Last, Foodbot by Kokoh Prasetyo et al. (2020) reports on a goal oriented healthy eating chatbot with natural language processing to log food.

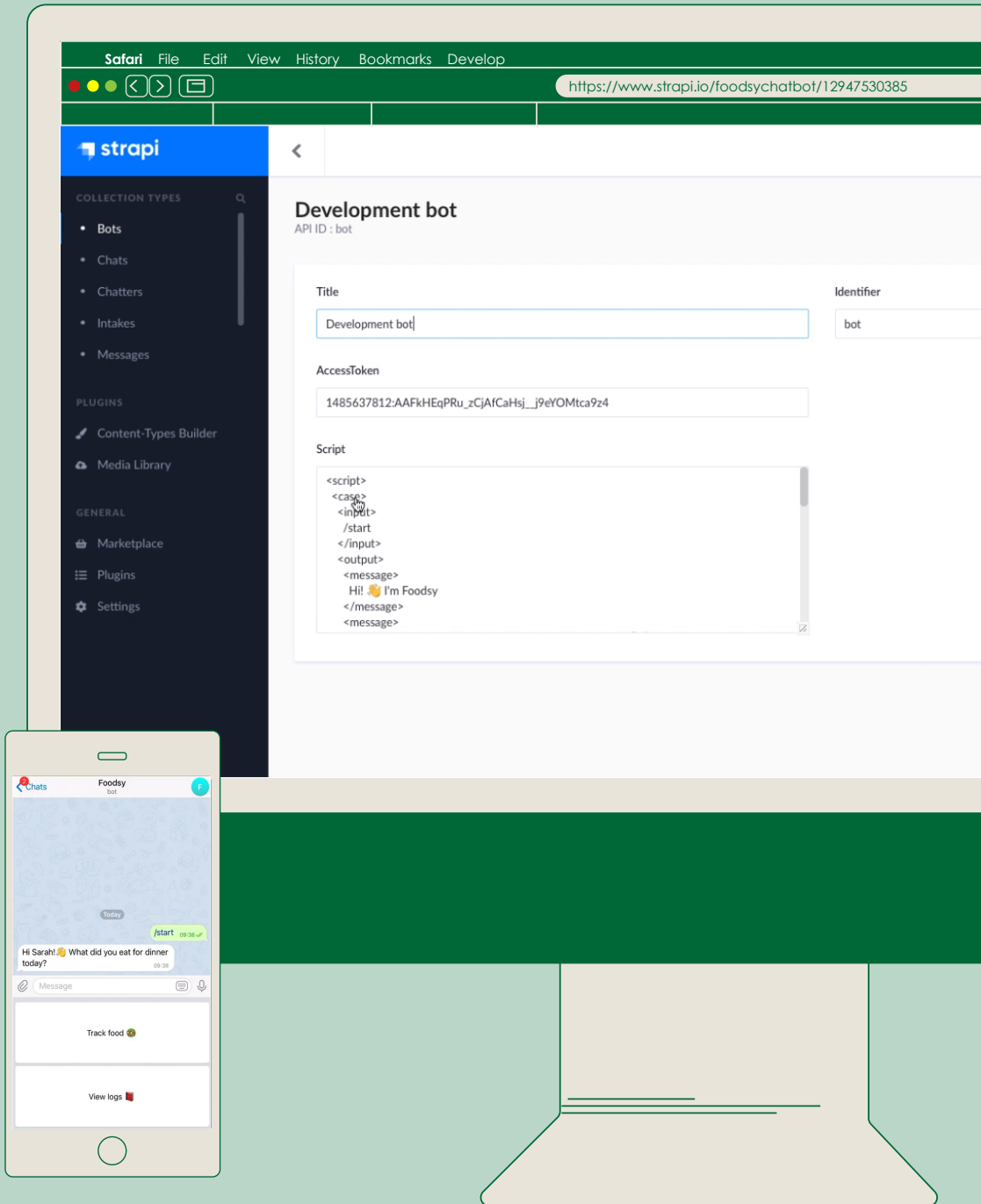
Outcomes

NUTRI_Lab Chatbot Ecosystem

Within the HCI and design community, as well as more locally at the department of Industrial Design, chatbot technologies are increasingly being proposed for application within the (cardiovascular) healthcare context. If we want the work we are doing to make a meaningful impact, there must be a way to safely and efficiently bring these chatbot centred prototypes into testing and practice. This means that there is a need to develop a chatbot ecosystem that considers privacy requirements, and that is flexible enough to accommodate various input and output technologies and their design explorations. Currently available commercial chatbot builders such as Google's DialogFlow CX (Google, 2010), Chatfuel (Chatfuel, 2015), or Chatbot for Slack (LiveChat, Inc. 2015) are, despite being easy to use, insufficient for our purposes since they are expensive to access, do not offer the flexibility required by design researchers, nor do they allow control over data sharing and storage.

In this project, I took the design lead developing the NUTRI_lab chatbot working together with Luuc Verburgh, an experienced front and back-end developer. My role entailed research-informed interface design, infrastructural decision making concerning application in the care path and future research, and user-focused interaction design to assure easy input from a range of participants. Luuc focused on the technological development of the ecosystem, including developing NLP models and implementing the chatbot infrastructure.

Together, we have built the NUTRI_Lab Chatbot: a technological ecosystem that enables designers and researchers to create chatbots with varying complexity, for various user groups in the clinical context.



NUTRI_Lab Chatbot Ecosystem

Database

To store the data collected from users, we are using a database called MongoDB (MongoDB Inc., 2009). Since we are facilitating multiple instances of the chat bot (different researchers using the same infrastructure for different projects at the same time), there are various needs for structuring data. Using the MongoDB database means that we have more flexibility to accommodate the data needs of the researchers.

User Interface

The user interface in the current ecosystem is Telegram (Durov & Durov, 2013), a cloud-based messenger application. We have chosen Telegram for this iteration because it is free for users to download, supports all the most popular operating systems, and can be accessed from phone, tablet or computer. They also have an open chatbot API which allows us to easily run our chatbot using Telegram as the user interface. In the future, the user interface could also include other messaging apps, a web-based application or a native application.

Additional Services

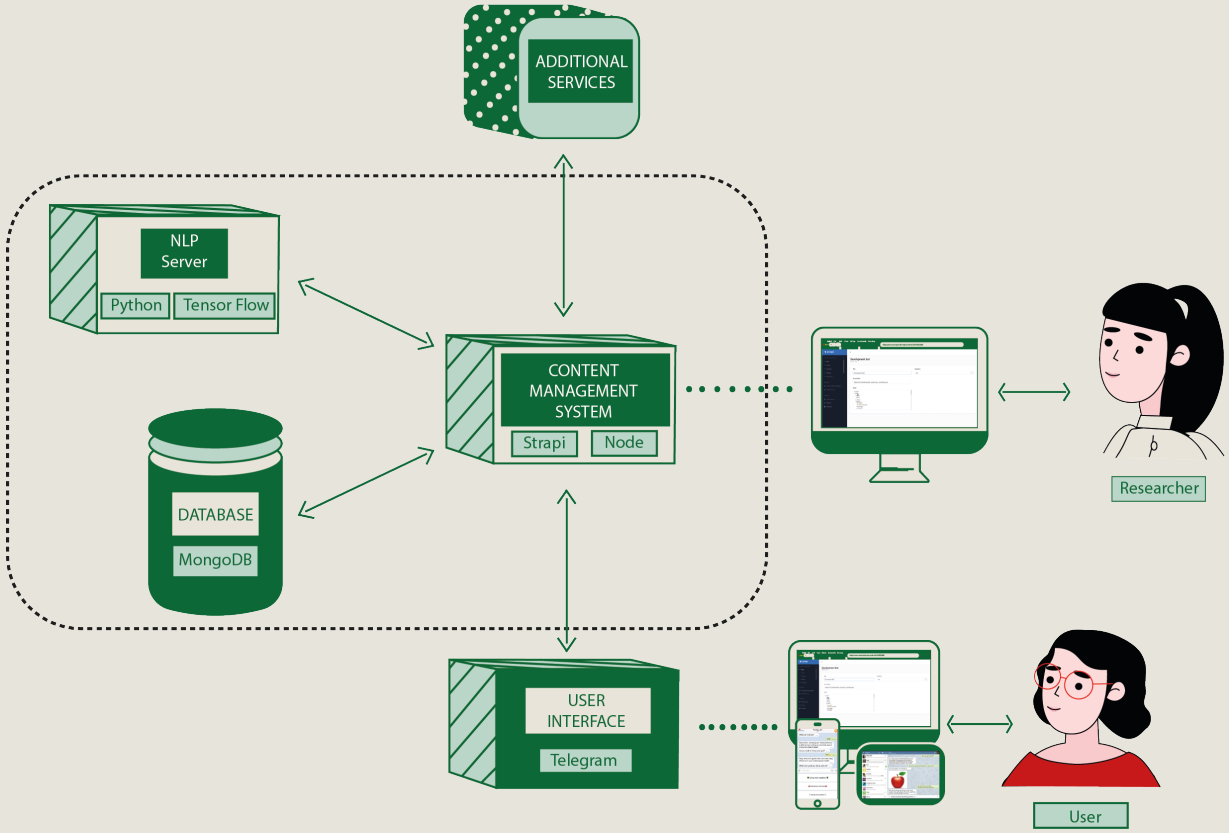
Within the ecosystem, it must be possible to connect additional systems that researchers have developed. For example, this could include automatic image recognition processing, sensors collecting user data, or a pipeline to send images received by the chatbot to crowd workers for labelling. While it is difficult to create a "plug and play" for every scenario, the possibilities have been considered during development.

Content Management System

The content management system (or researcher dashboard) is an online interface using the Strapi framework (Strapi Solutions, 2015), where researchers can edit the chatbot copy, manage patients and testing groups, and set scheduled messages and notifications. It also handles all the communication between the chatbot ecosystem and Telegram. This is an integral part of the system for NUTRI_Lab as it reduces researcher's reliance on developers, and allows them to edit the chat bot with little knowledge of coding.

NLP Server

This is the server which hosts various different Natural Language Processing (NLP) models which researchers can access and implement when they are writing their chatbot scripts. This facilitates users being able to interact with the chatbot using their natural conversational flow. When a model is called via the chatbot script, the content management system reaches out to the NLP server to fulfill the request.



NUTRI_Lab Chatbot Ecosystem

1 Input

Easy user input is one of the biggest advantages to chat bot technology. Not only is chatting via messengers already integrated into users' normal phone usage (Do et al., 2011), chatbots also afford various ways to interact including text, voice to text, buttons, multimedia and more. The NUTRI_Lab chatbot ecosystem allows researchers to choose which input mechanisms are valid and interesting for their studies, as well as tailor them to the most appropriate for their target users.

The most widely associated input mechanism with chat bots is natural language processing. Implementing natural language processing allows for the user to respond using their normal, conversational phrasing which has been shown to reduce burden (Holmes et al. 2018; Huang et al., 2018). For users who cannot, or prefer not to type, the speech to text function available on most smartphones has been shown to be a successful input mechanism, for example for those with a sight impairment (Azenkot & Lee, 2013), issues with dexterity (Hawley et al., 2015), and for the elderly (Wulf et al., 2014). Another option is using predefined buttons as input which guide the user in responding and can be useful for accommodating lower-literacy users (Summers et al., 2006), as well as making input faster. The chatbot can also receive multimedia as an input, including photos, videos or voice clips, depending on what is valuable and interesting for researchers.

2 Processing

Processing is the core component of chatbot technology, allowing the chatbot to "understand" the conversation with the user. There are multiple levels of processing possible. When the chatbot is menu or buttons based, allowing for a user to respond by choosing a menu item or button with a predetermined answer, the processing is based on decision tree hierarchies. The advantage of a menu/button based chat bot is that all possible answers can be anticipated and users are visually guided through the conversation flow.

If the Chatbot is using natural language processing, then the processing relies on machine learning models. There are many machine learning models for natural processing ranging from local scripting to more sophisticated pre-trained models such as OpenAI's GPT-3 (OpenAI, 2020). The NUTRI_Lab chatbot system currently uses a trivial convolutional neural network, with 5 layers, but others could be implemented. In the future,if the user uses a text based input, the sentence will be parsed by the model and using relevant dictionaries, meaning can be associated with a word. User responses are stored on a secure database, which is queryable. Since responses are tagged by the scripting, insights into the data can be more easily retrieved.

3 Output

The NUTRI_Lab chatbot also supports a variety of output functionalities which can be tailored to the researcher's needs. The bots responses, or the "chatbot copy" can be tailored to the researcher's needs and is where the "personality" of the chatbot comes from. The bot can respond in text, but also through emojis, gifs, images or videos depending on the situation. Messages can be sent in response to a query from users, or at a scheduled time. A researcher can also program if and when to send notifications or reminders to engage users when they are not actively chatting with the bot.

Output can be controlled via the researcher dashboard as shown on the following page. Here, the researcher can also create new participant identification and groups, and see an overview of active chatters and their responses.

The output interface is also interchangeable, whether that be through a messaging app such as Telegram or WhatsApp, a browser-based platform or incorporated in a native app. This allows researchers to choose the best method of delivery for their study.

NUTRI_Lab Researcher Dashboard

Bots

Here you find the different bots that are running.

Chats

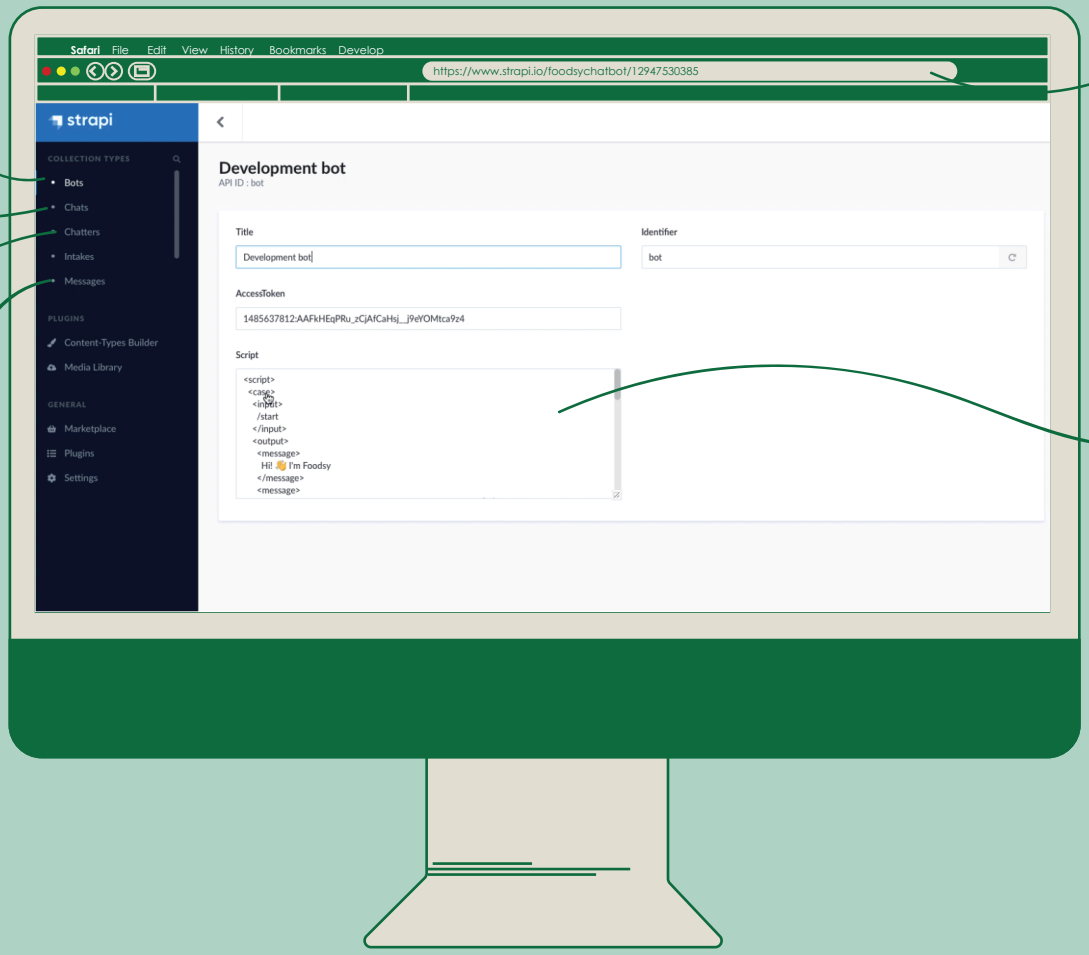
Here you set and store the relation between a chatter, and a bot.

Chatters

Here you set and store the users and their identifications.

Messages

Here you see the messages that are being sent and recieved between users and bots.



Web Based

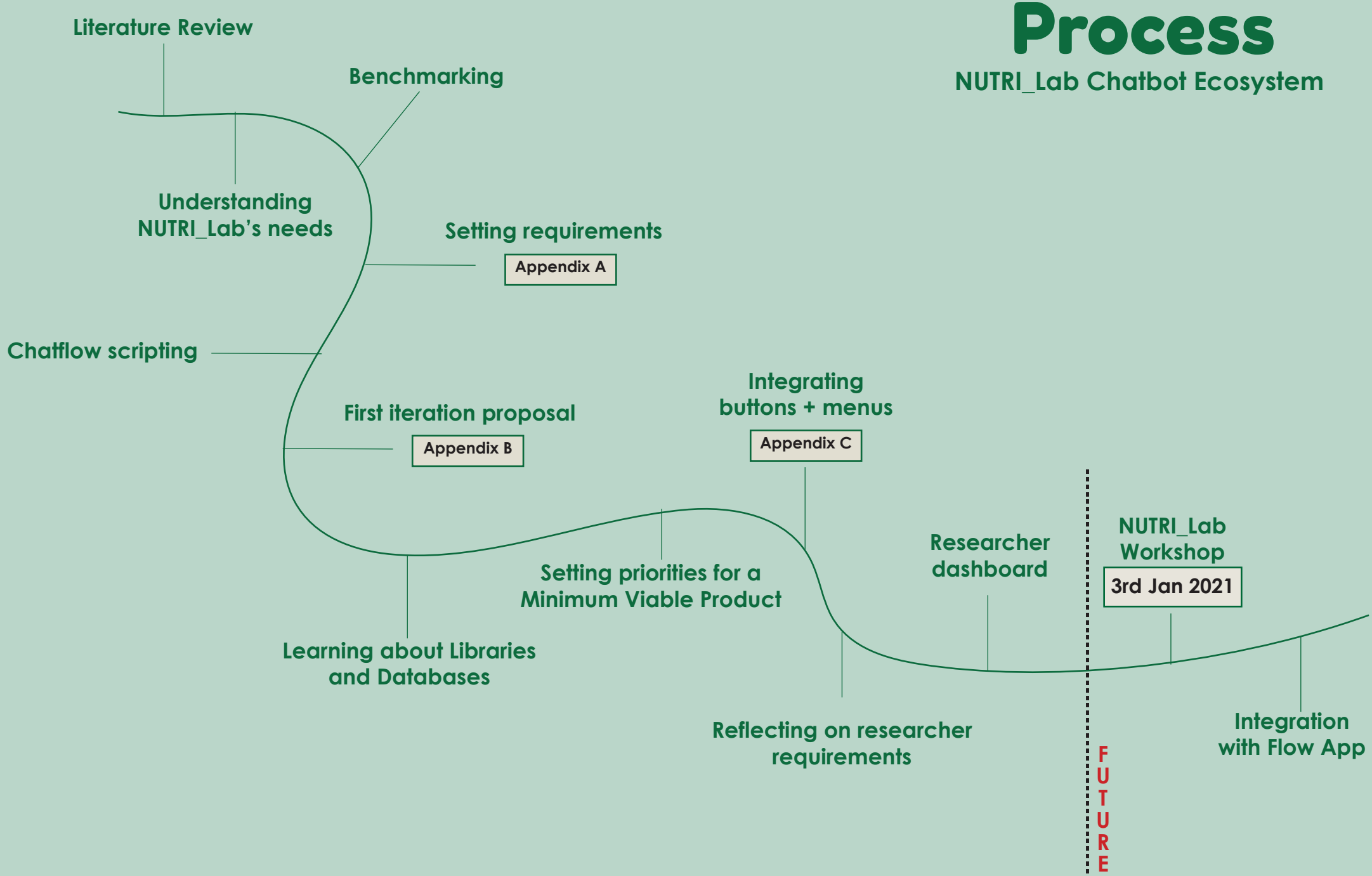
Researchers can access the dashboard through their browsers.

Chat Editor

This is where researchers can change the chatbot copy with the provided syntax.

Process

NUTRI_Lab Chatbot Ecosystem

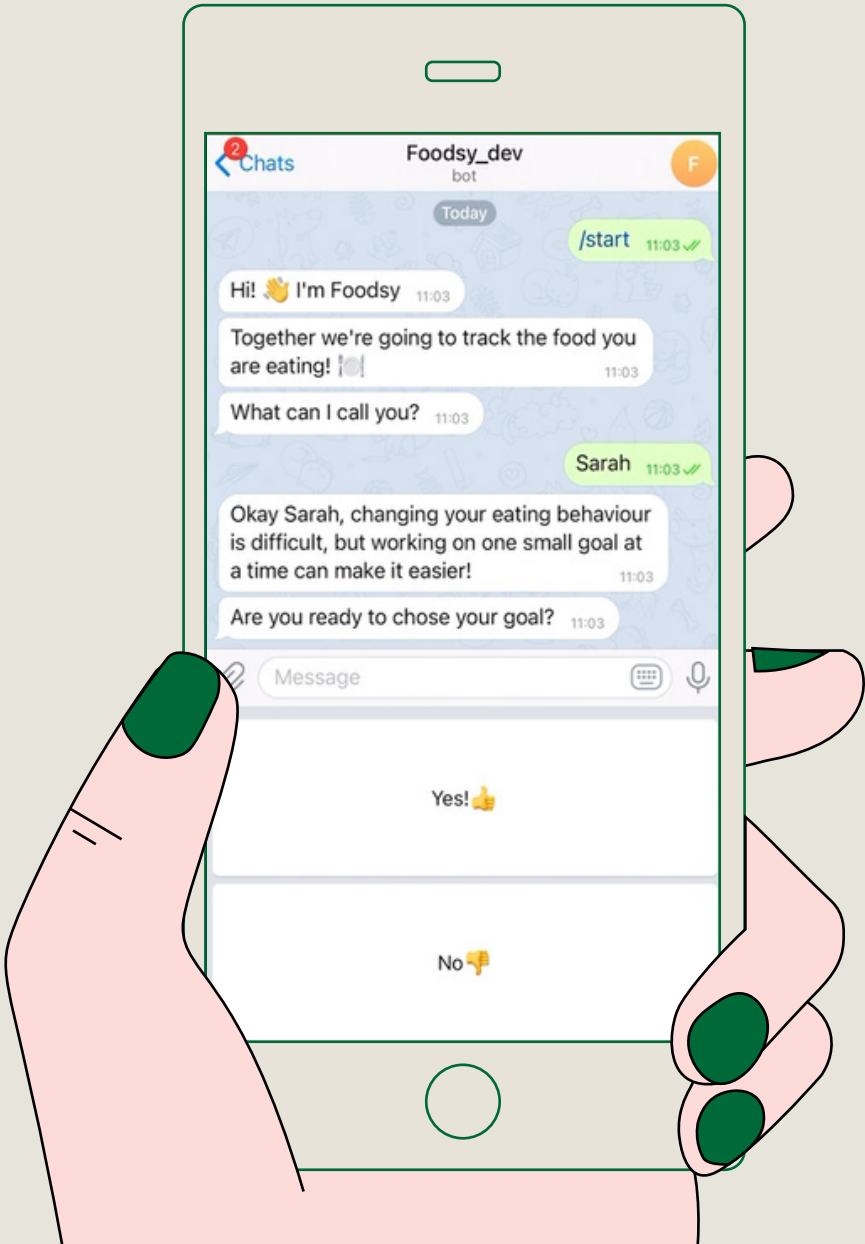


Use Case: Foodsy

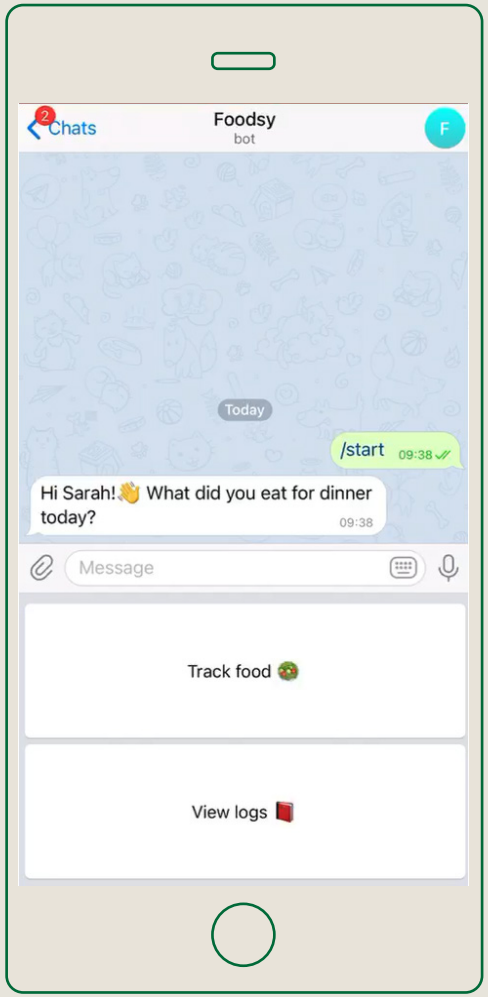
The first use case of the NUTRI_Lab chatbot is Foodsy, the food tracking chatbot for cardiac rehabilitation. Foodsy offers a low-burden way for a variety of patients to track their food consumption. By positioning the use of chat bot in the ≈ 2 week waiting period before rehabilitation starts, patients can already begin making changes to their diet while their motivation is high. Using emojis to track food intake at the level of food groups is a simple way for patients to keep track of their progress towards their goal.

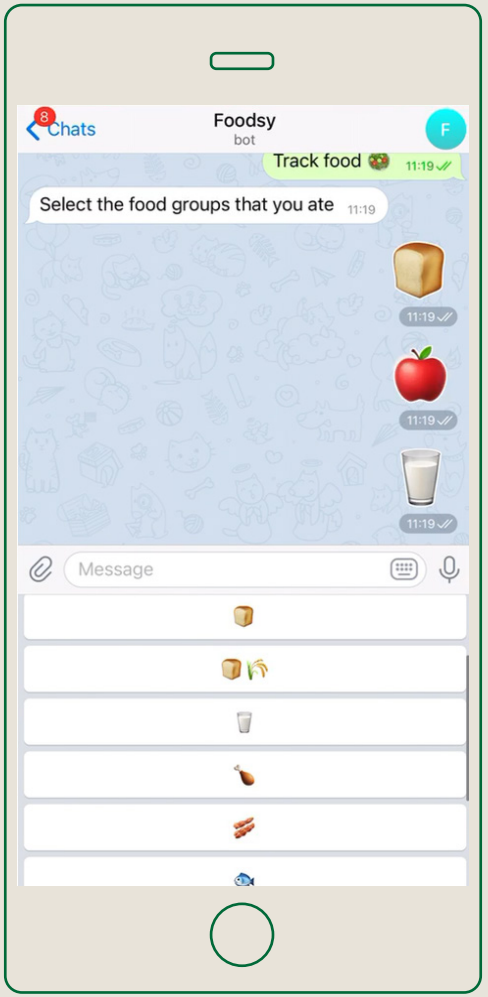
While designing Foodsy, I have worked closely with the Maxima Medical Centre's rehabilitation program "Flow", focusing specifically on the cardiac rehabilitation program that they offer. The program takes a multidisciplinary 12 week approach, offering support for both physiological and psychological rehabilitation. Flow tries to offer a personalized approach, working together with the patients to create a rehabilitation program which takes a patient's unique situation and goals into account. They are particularly interested in the possibilities to support patients nutritional behaviour change with digital tools. Foodsy is designed with a wide range of cardiac rehabilitation patients who own a smartphone in mind.

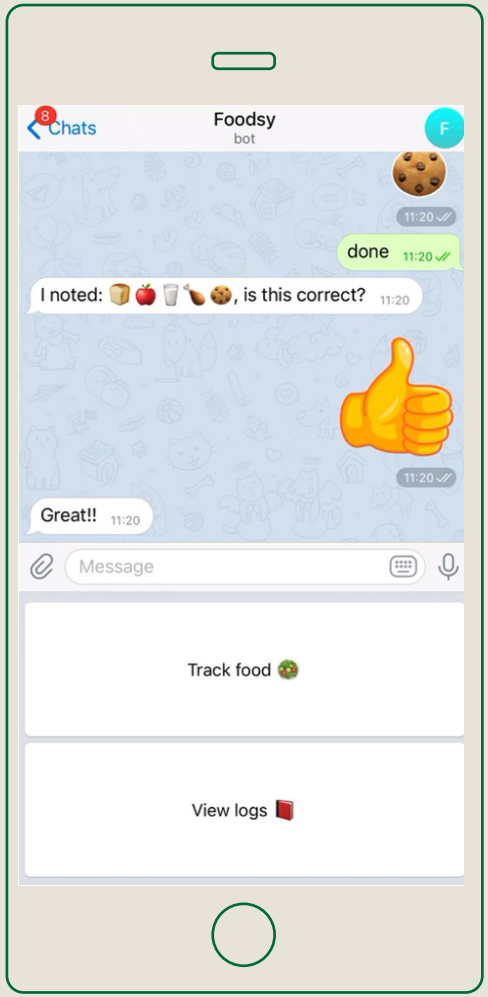
Watch my demoday video *here*



Use Case: Foodsy







Interviews

For this project, I interviewed 2 experts from the field of nutrition research and 2 experts from the field of cardiac health. This was extremely helpful to understand their perspective and use their expertise and lived experience in the development of the chatbot. All interviews were semi-structured: a combination of prepared questions with room for elaboration or expression of related topics when necessary. The prepared questions differed based on the interviewee's expertise area, and ranged from specifc questions such as "how much time to does each patient have to spend with a dietician during rehabilitaiton?" to more open ended questions such as "what strategies, in your experience, work positively for nutrition interventions in practice/cardiac rehabilitation?". Interviews took place over Microsoft Teams or over the telephone. The questions built off of my existing knowledge of nutrition, cardiac health and the Flow rehabilitation care pathway. During the interviews, I briefly presented my existing background knowledge to demonstrate that I was familiar with the subject matter, while leaving space for the experts to correct any incorrect assumptions. This allowed the interviews to progress faster to the specifics of the questions I was asking. Extensive notes were taken during each interview and the key insights were extracted, summarized and considered during the design process as can be seen below. All expert opinions which were considered in the design process were also supported by published academic literature.

Interviews

Nutrition Researcher (Expert 1)

Positions:

- PhD(c) Division of Human Nutrition and Health at WUR
- Postdoc at Industrial Design TU/e

Key Insights

- In practice, health care professionals are more interested in having a global idea of what a person is eating.
- Focus only on the changes which are most interesting for the target group, in this case, heart healthy food groups. This can also reduce burden.
- One big overhaul of the diet doesn't work, you need to take smaller steps.
- To be motivated, patients need to get something back from the food tracking experience, such as linking goals they set to an overview of their behaviour.
- Overviews of intake today, vs intake yesterday can be used to show in a simple way that if it increases or decreases, they're doing good.

Research Dietician (Expert 2)

Positions:

- Research dietician at WUR
- Coordinator controlled dietary trials at WUR

Key Insights

- Portion size is extremely difficult for people to accurately report. Portion size and serving size are also two different measures which can confuse people
- Some foods within a food group would require distinction when reporting, such as within the dairy group, milk and yogurt have very different impacts on health than hard cheese.
- Dieticians also struggle to teach about portion size as it varies massively per food.
- This level of granularity is probably sufficient for working towards a goal (beating your own baseline).

Nursing Specialist (Expert 3)

Positions:

- Nursing Specialist at FLOW rehabilitation MMC Eindhoven
- Doctoral Candidate

Key Insights

- Patients do not currently speak about diet or goals before being discharged from hospital, only at the beginning of the rehabilitation program. However at this point they are very motivated to change.
- There is often a disconnect between how healthy people think their diet is, and the situation in real life.
- Nurse specialists lack time go beyond basic questions, and it would be valuable if patients track their food intake before the appointment so the nurse can have some insights into the real situation.
- The personal goal is the most important and progress should be shown
- It is important to let patients know about the chance of patients to get healthier by themselves!

Cardiologist (Expert 4)

Positions:

- Cardiologist at FLOW rehabilitation MMC Eindhoven
- Associate Professor at Industrial Design TU/e

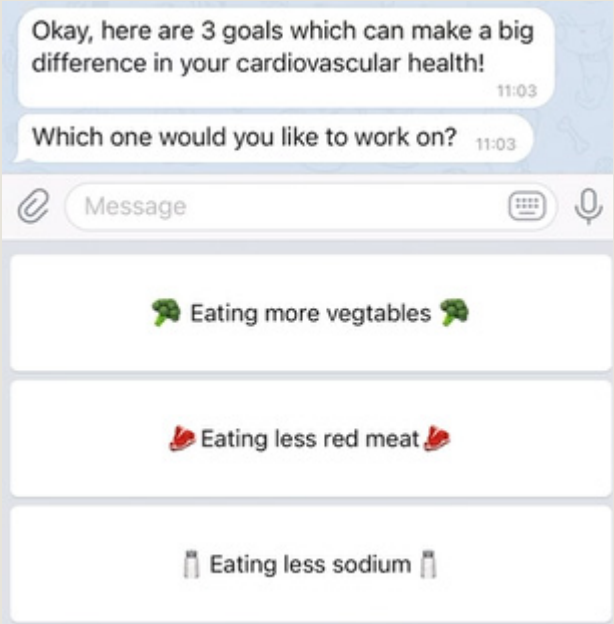
Key Insights

- Not all patients currently speak to the dietician, despite nutrition being a very important part of cardiac rehabilitation.
- Nutrition tracking would provide valuable insight for dieticians and nurse specialists.
- The food groups and the goals can be derived from the stablished nutrition guidelines. In the future, it would be interesting to generate the top three suggestions automatically based on results.
- There are possibilities for the chatbot to be integrated into the Flow rehabilitation application.

Use Case: Foodsy

1 Positioning

Between discharge from hospital after a cardiac event, and the start of the rehabilitation program at Flow, there is an approximate two week wait. During this time, participants become demotivated and fail to enrol in the program. Currently, patients are not sent home with nutritional guidance, although this is something they can realistically begin working on right away (Expert 3). The Foodsy chatbot is designed to be introduced to patients by a nurse specialist or dietician before they are discharged from hospital. Currently patients receive direction to install the Flow app at this stage which has been successful, this suggests that installing the chat bot would also be possible at this moment (Expert 3). Having the technology introduced by a care professional can increase user's trust and motivation to use the intervention, and supports those less familiar with technology to get started. The user then has actionable steps to take towards behaviour change to keep them motivated to enroll during the two weeks. Motivational text messages and letters during the waiting period have been shown to increase participation (Wyer et al., 2001; Ades et al., 2017), which suggests that a motivational message delivered via the chatbot could also have a positive effect on enrollment.



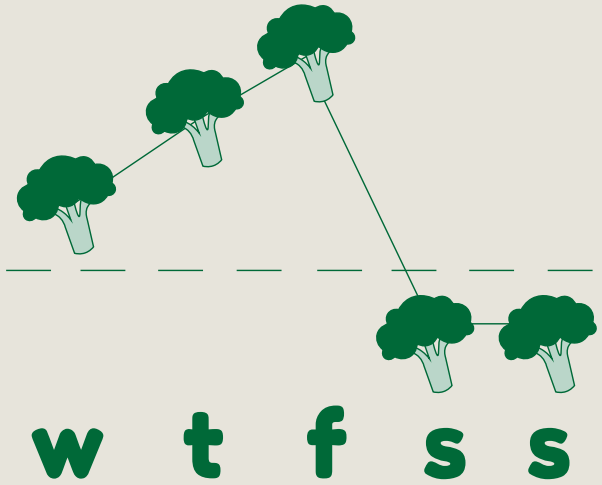
2 Goal Setting

The core of the Foodsy chatbot focuses on setting a healthy eating goal related to one of the food groups important for a heart healthy diet. Goal setting has been shown to have a positive impact on behaviour change for cardiac rehabilitation (Smeulders et al., 2009; Conn et al., 2009), and combining realistic goal setting with self monitoring has been shown to improve nutritional behaviour (Schnoll & Zimmerman, 2001). A user enters their current baseline of consumption, and tries to beat it each day. For example if a patient identifies that they currently only eat vegetables once a day, and would like to improve this, the goal would be to eat vegetables more than once a day. In this iteration, allowing the user to compare their daily consumption against their baseline consumption avoids that the chatbot is giving "medical advice" which would require much more rigorous approval. In this proposed iteration of the chat bot, a nurse specialist or dietician helps a user to decide on which goal to work on, however a future iteration could integrate existing dietary assessment tools to help decide which goal to work on at this stage.

Use Case: Foodsy

3 Tracking

Using the foodsy chatbot, users track their intake by clicking on the emoji associated with that food group each time they consume it. Current tracking only asks users to track the occurrence of a food group per consumption moment, rather than number of servings. This was a deliberately chosen decision as training people to estimate serving size is very difficult (Expert 2) and would require much more validation and training which was outside the scope of this project. We can be fairly certain that the current tracking (occurrence per consumption moment) reflects reality, whereas serving size would have been an unreliable report. Using emojis provides an easy, low burden input mechanism to keep track of consumption. This is important, since research shows that detailed manual tracking is too burdensome(Cordeiro et al., 2015), and can lead to people stopping tracking all together(Ahmad et al.,2016; Subar et al., 2003)(Expert 1). However, we know that consistent diet tracking has been shown to increase self awareness and help to achieve healthy eating goals (Burke et al., 2011; Nahum-Shani et al., 2018; Thomas & Bond, 2015). Especially in older user groups, simple interfaces are found to lower barriers to use (Barnard et al., 2013) and replacing text with emojis also has the potential to accommodate users with low literacy levels. After the user submits the entry, the chat bot asks for confirmation after which the entry can be edited if necessary.



4 Progress

Users are shown their progress at the end of each day through a graph showing whether their consumption was above or below their baseline. Showing patients their progress associated with their behaviour was stressed as important in interviews with the research dietician and the nurse specialist, as well as found to be important by Proper (2020). Displaying progress has been shown to increase motivation (Cheema et al., 2010) while showing progress history also allows patients to focus on the bigger picture and notice patterns, such as having a harder time reaching their goals on the weekends. These progress overviews can also provide at-a-glance overviews for care professionals, and provide some hooks to discuss concrete tips (Expert 3).

Process

Foodsy Chatbot

1 Literature Review + Understanding the Context

As the field of cardiac rehabilitation was new to me, I began this project by diving into the literature on digital interventions for cardiac health as well as nutrition specific to cardiac health. I then learnt about chatbots in healthcare settings and began to benchmark existing chatbots for health care and nutrition tracking purposes.

Understanding the care pathway at the Flow rehabilitation program first hand was a priority for me. Unfortunately, my planned visits to the hospital were all cancelled due to the ongoing COVID-19 regulations, the healthcare professionals were extremely busy and I was not able to contact patients. As a solution, I contacted Emma Rieling and Marit Proper who have worked on nutrition projects at Flow in previous semesters. Emma had extensively documented the care pathway (Figure 1) and created validated personas (Appendix D), which I used as the foundation of my work. To be sure I interpreted it correctly, I discussed my assumptions with a cardiologist from the rehabilitation program. Marit Proper also interviewed three patients about a digital, goal setting platform she was designing for Flow. After getting permission from her mentor, I was able to read the anonymized interview transcripts to gain further insight into the opinions of the patients on goal setting and digital platforms.

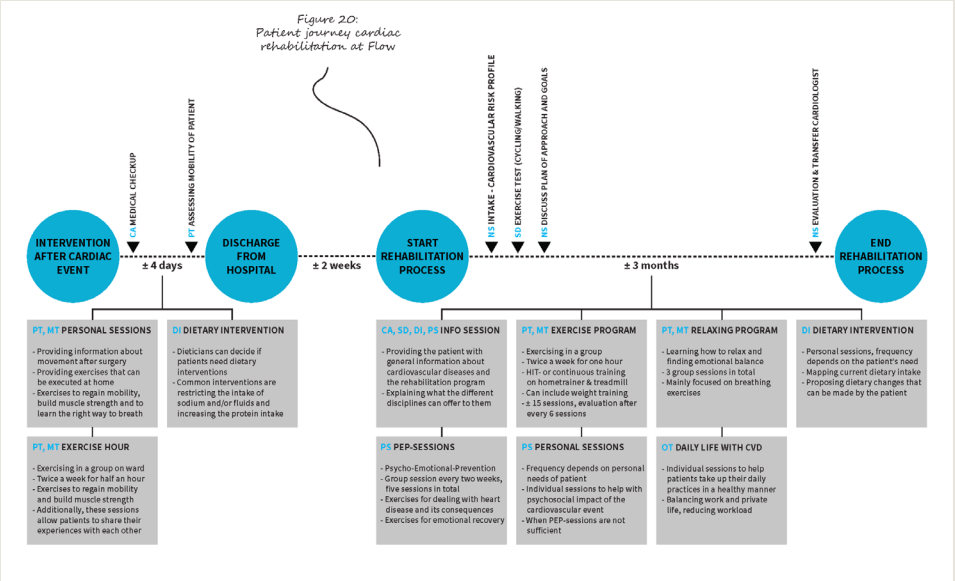


Figure 1: Flow care pathway (Emma Rieling, 2019)

Key Insights
From Patient Journey (Reiling, 2019)

- There is a two week waiting period between discharge from hospital and the start of the rehabilitation process.
- The "Dietary Intervention" before discharge mentioned in Emma's patient journey was only for the most seriously ill patients who needed to adjust their protein, sodium or fluid intake due to immediate health concerns. There is no dietary intervention or advice from a dietician on healthy behaviour for most patients.

Key Insights
From Interviews (Proper, 2020)

- It is important for patients to first learn how the platform works in the hospital.
- Goal setting is considered as important and motivating by the patients.
- Progress should be tracked and shown since there are naturally ups and downs in the rehabilitation process, but seeing progress over a longer time offers better perspective.

2 Designing Iteration 1

The first iteration of the chatbot translated most existing functionalities of a traditional food tracking application into a chatbot conversational flow. An overview of the first imagined chatbot functionalities can be found in Appendix B. This first iteration took into consideration the development priorities and researcher requirements (Appendix A) of the NUTRI_Lab chatbot, which included setting up natural language processing.

This iteration centred around patients reporting their food intake in a conversational structure, for example "I had 2 slices of toast with cheese for breakfast". The chatbot would then process the sentence using the natural language model extracting that the user ate 2 x bread, 2 x cheese. Then, the chatbot would ultimately be able to connect the names of foods with their nutritional values. To achieve this, I discussed with the nutrition researchers how to find and implement the relevant Dutch nutritional databases such as NEVO (RIVM, 2019), a Dutch nutritional information database and Portie Online (RIVM, 2020) a portion size database. I also learned how to write a chat flow script, as pictured in Figure 2. and Appendix F.

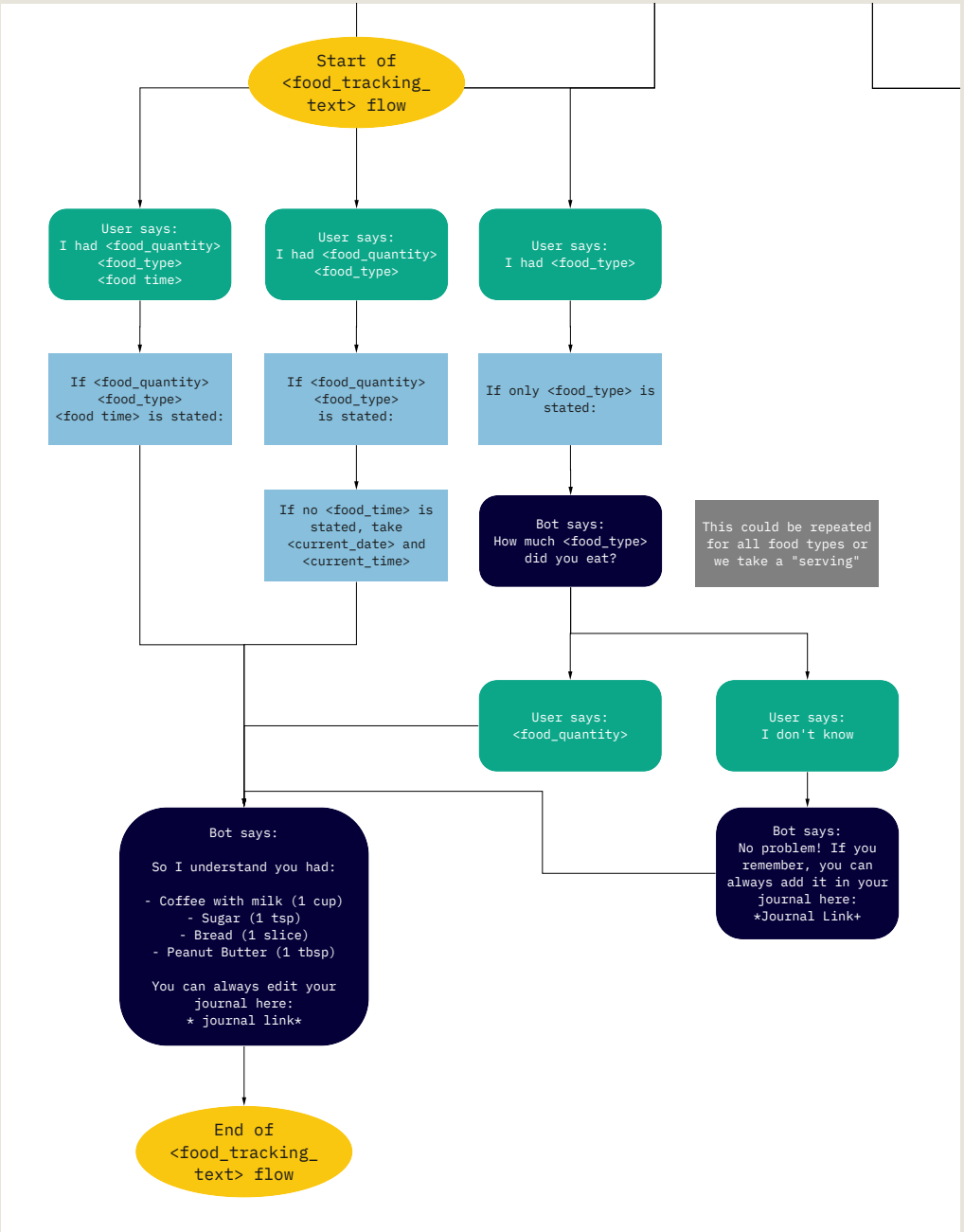
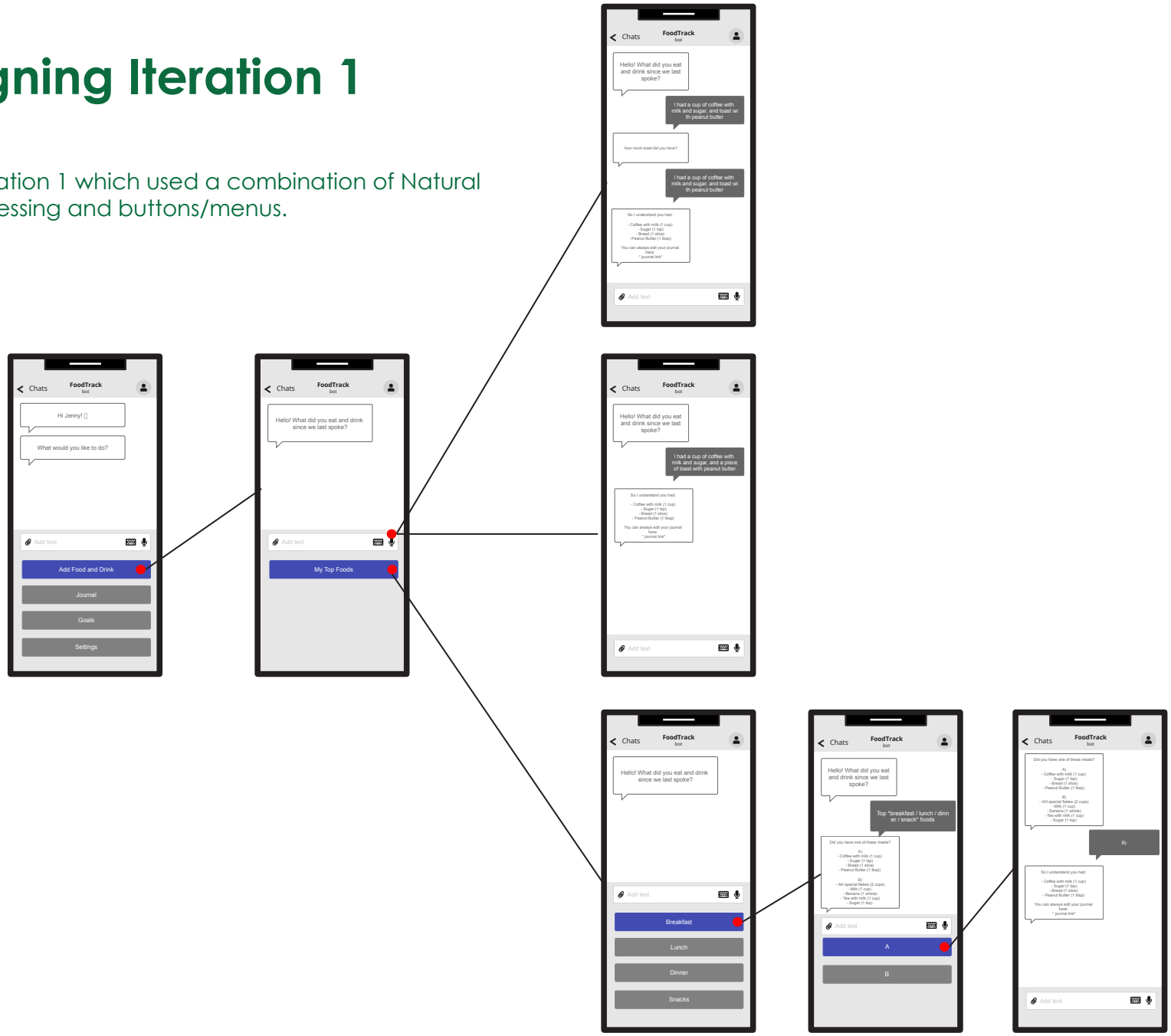


Figure 2: Part of Chat Flow Diagram for Iteration 1

2 Designing Iteration 1

Mockups of Iteration 1 which used a combination of Natural Language Processing and buttons/menus.

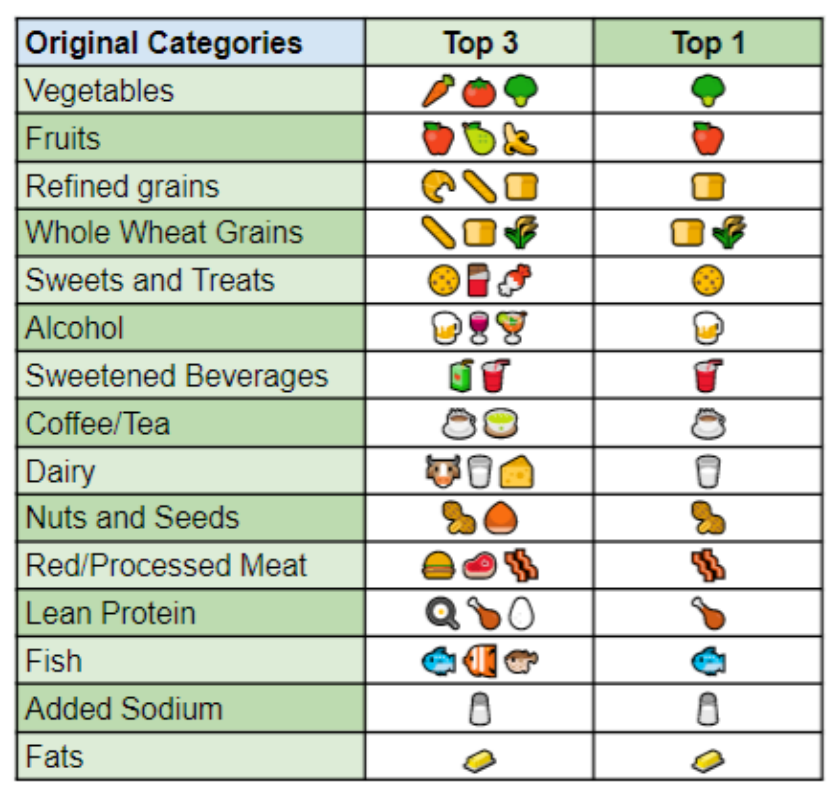


Process

3 Reflecting on Iteration 1 + Pivoting

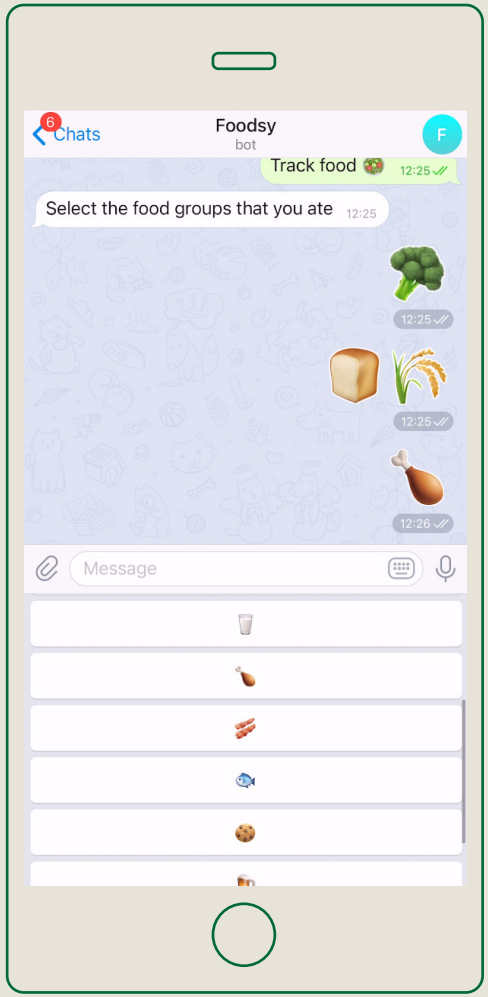
After the first design cycle of iteration 1, I took some time to reflect on whether I had achieved what I wanted to do. Throughout the first design cycle I had experienced some dissonance between trying to achieve in-detail nutrition tracking, while also trying to design for the cardiac care pathway and reduce burden. I realized that the current iteration was more representative of the nutrition assessment purposes expected from the NUTRII_Lab chatbot, while the burden was still quite high for patients in the cardiac care pathway where the goal was to motivate behaviour change.

I discussed this dissonance during my interview with the nutrition researcher, and they gave the suggestion that to reduce burden for tracking, and to also reduce the complexity of the chatbot to be achievable in one semester, I could focus on tracking only the food groups which were important for a heart healthy diet. After reflecting I pivoted my design and decided to go this direction for the second iteration of the chatbot using the button based emoji tracking.



Original Categories	Top 3	Top 1
Vegetables		
Fruits		
Refined grains		
Whole Wheat Grains		
Sweets and Treats		
Alcohol		
Sweetened Beverages		
Coffee/Tea		
Dairy		
Nuts and Seeds		
Red/Processed Meat		
Lean Protein		
Fish		
Added Sodium		
Fats		

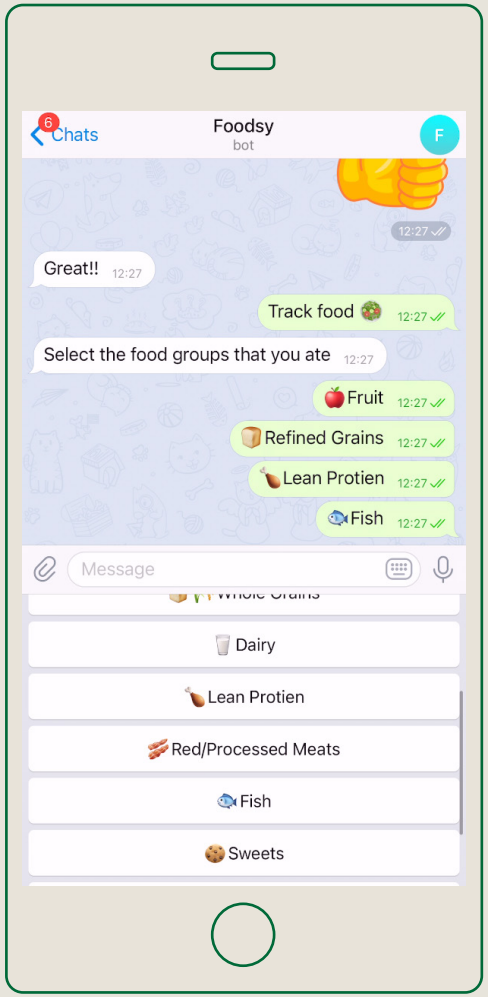
Figure 3: Emoji Exploration



I noted: 🥦🍞🌾🍗🐟, is this correct? 12:26

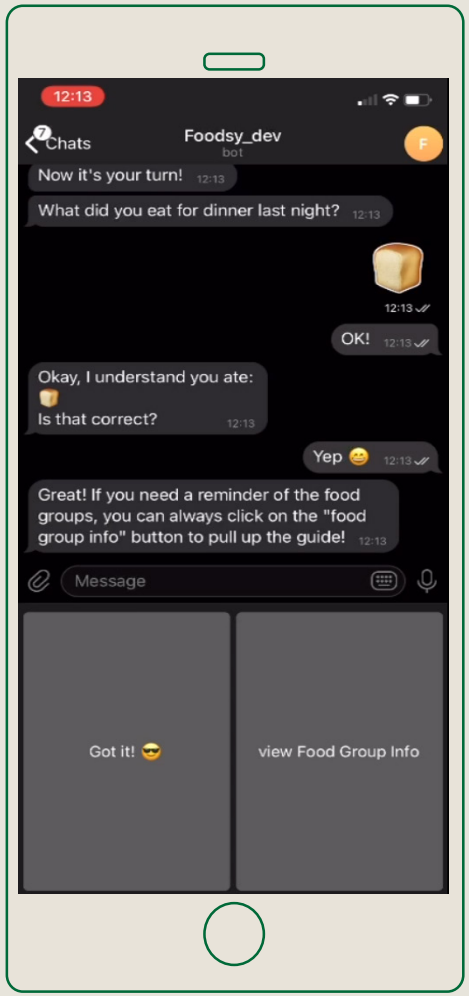
This was chosen as the clearest and easiest to understand iteration.

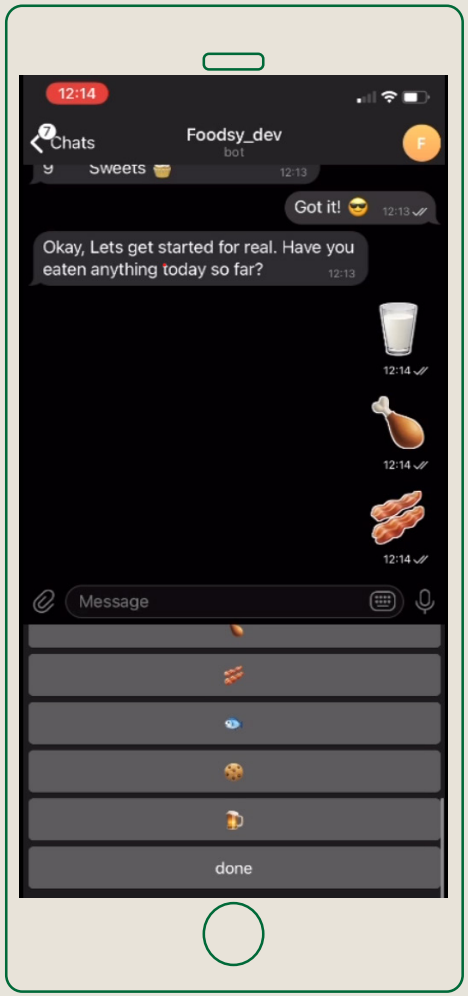
I noted: 🥕🍅🥦🥐🥖🍞🥛🧀🐮🍔🥩🥓, is this correct? 12:27



I noted: 🍎Fruit🍞Refined Grains🍗Lean Protien🐟Fish, is this correct? 12:27

Process





An exploration of a welcome script for those who are just getting started with the Foodsy Chatbot.

Process

4 Emoji Iterations

In this iteration, I chose to use emojis to represent the food groups, facilitating a one-touch interaction to record eating an item from the food group. Using emojis offers a novel interaction which is simple and does not require the user to type out extensive names of food and beverages. I began this iteration by exploring the available emojis (Appendix G), choosing a smaller selection of emojis which best represented popular food in the Netherlands (Figure 3), and iterating on them. Some of my iterations can be seen on the following page, such as deciding whether to use 1, multiple, or emojis + words for the tracking flow. I also iterated on the start script, which would welcome users to the app when they began using it, and on deciding whether to track occurrences by eating moment or tracking serving sizes. Some interesting insights from asking my peers to validate if they understood what each emoji included the red apple being mistaken for a tomato, and vegetarians not identifying with the meat emojis when they wanted to track protein sources not from animals such as veggie burgers or eggs.

In an interview with a nutrition researcher, it was noted that not all of the original food groups were congruent with food groups recognized by Dutch people. This makes sense as the original food groups were chosen based on Canada's Food Guide (Health Canada 2019). This shows the importance of localization. The food groups used in the "Eetscore" (Eetscore, 2017), a Dutch nutritional assessment questionnaire were suggested to base the next iteration of food groups on. It was also recommended to separate some key food groups which are extremely prevalent in the Dutch diet such as potatoes, bread and cheese (Figure 5 and 6). These iterations led to the final design.

Eet Scoren Categories	Top 3	Top 1
Vegetables		
Fruits		
Whole-Grain Products		
Legumes	???	?
Nuts		
Dairy		
Fish		
Tea	??	
Fats and Oils	??	
Coffee	??	
Red Meat	??	
Processed Meat		
Sweetened Beverages + Fruit Juices	?	
Alcohol		
Added Sodium	??	

Figure 5: Emoji Exploration - Eetscore

Suggestions for Seperate Categories		Emoji
Refined Grain Products	Bread	
	Other Refined Grain Products	
Whole-Grain Products	Whole-Grain Bread	
	Other Whole-Grain Products	
Dairy	Milk , Yogurt, Soft Cheeses	
	Hard Cheeses	
Eggs		
Meat Alternatives		?
Potatoes		
White Meat		
Other		?

Figure 6: Emoji Exploration - Seperate Categories

Process

Discussion

This project was the first step in establishing the NUTRI_Lab Chatbot ecosystem, and exploring it's implementation with a first use case: the Foodsy Chatbot. For the NUTRI_Lab ecosystem, being simultaneously implemented during development has resulted in a more accessible system, which will benefit future researchers and students. The gap between designers, developers and practice can be a challenging one to bridge, needing to achieve a balance between technical development, user experience design and the real world implications in practice. In healthcare, this gap is particularly prominent. The area of nutritional intake tracking in particular demonstrates a wide range of technological advancements, with technology based interventions promising to reduce inaccuracy and burden for patients and doctors, while increasing the quality and effectiveness of care. However, many of the current approaches used in the cardiac care pathway are low-tech, ultimately resulting in suboptimal care for patients. To close the gap between technological availability and preventative care practice, and for our work to make a meaningful impact, we have found that innovations must be robust in terms of privacy and infrastructure. By considering this while building the NUTRI_Lab Chatbot Ecosystem, future prototypes can be tested more quickly in practice, which will ultimately lead to better innovations.

The Foodsy Chatbot is an example of implementing emerging technology into a care pathway, which has not been without difficulties. Ideally, the development of the chatbot would have included more involvement from cardiac care patients who were going through, or had recently finished rehabilitation. While the insights from previous interviews, published research and other projects aimed at nutrition interventions in the space were used in the design process, the Foodsy Chatbot was not tested first hand with patients due to the COVID-19 situation. This means that there is potential for key insights to have been missed, especially in regard to the age group and demographics of cardiac care patients. Validation with the target user is needed to further determine the effectiveness and acceptability of the Foodsy Chat Bot. Despite this, the concept has been positively received by care professionals in the cardiac rehabilitation pathway, and has laid the foundation for future iterations within the space.

In future iterations of chatbots within the cardiac rehabilitation space, the implementation of natural language processing offers exciting opportunities. While it was not realistic to implement during the time frame of this project, it is important to note that the development is ongoing. This illustrates the value of the NUTRI_Lab chat bot, as future students will not need to devote the majority of their semester to trying to learn advanced programming skills, but rather the possibilities of the technology will be available to them.

The NUTRI_Lab Chatbot has been well recieved by healthcare professionals, who are interested in implementing the chatbot system into an upcoming clinical trial focused on behaviour change for cardiac rehabilitation.

Future work should focus on better identifying barriers to implementing chatbot technology within the healthcare space, as well as considerations for more specific user groups such as women.

Conclusion

This report has presented the development of the NUTRI_Lab Chatbot Ecosystem, and its first use case: Foodsy, the food tracking chatbot for cardiac rehabilitation. The NUTRI_Lab Chatbot ecosystem offers a flexible, researcher friendly, chat bot infrastructure for future work. With Foodsy, patients who are waiting to enroll in a cardiac rehabilitation program can independently begin to take action to improve their diet while their motivation for behaviour change is high. Using chatbot technology, Foodsy has the potential to reduce the burden on patients to track their food intake, and help them work towards their healthy eating goals. Chatbot technology offers exciting possibilities for the future of cardiac rehabilitation, which is now one step closer.

Thank you!

This semester, I am very grateful to the people surrounding me.

A big thank you to my graduation mentor, Max Birk, who's willingness and enthusiam to engage with students has changed the game.

I am also thankful for the NUTRI_Lab working group, who are passionate about what they do and are always open to sharing their knowledge.

and finally, I am very appreciative of the professionals who shared their expertise with me this semester, especially those working in healthcare during a very difficult year.

Reflection

This past semester has been both challenging and rewarding (as the best ones usually are). Like everyone else in the world, it has been a period of constant adjustment and readjustment towards finding what works in our new reality, while also trying to keep the momentum I've been building towards my Final Master Project going. While it has not been easy, the litmus test I set for a project is whether I am proud to present it, and I am proud of this one.

This semester felt different than others, upon reflecting why, I realized that it is because of the groundwork laid in my m1.2 research project. The extensive work I put in last semester to map and understand design for nutrition has allowed me to feel confident holding my own with nutrition researchers, dieticians, doctors and specialists, while at the same time being able to connect their input with that of designers, developers and academics. It has shown me for the first time that I enjoy taking a deep dive, grounding my work in academic literature and intimately getting to know a design space, which is valuable to know going forward into my career. I have also noticed that I must set a deadline for myself to reimerge from the lit-review depths as I like it down there and tend to stay a week too long.

This is also the first project where I have really experienced my vision statement in action, bringing expertise from across disciplines together in order to tackle a multifaceted and complex challenge. It is one thing to say that you see the role of the designer as a connector, but actually being that connector has confirmed that the personal strengths of my identity fit well with this role. My natural strengths, such as communicating and presenting my ideas clearly, leading a group, and being actively inclusive have been complemented by the skills I have needed to build during this project, such as project management and building professional relationships. Throughout this project, I have shown myself that I have the expertise, language and sensitivity to bridge the disciplines, and have built competence in managing design processes that not only include myself, but also others.

Not only have I grounded my work in my chosen expertise areas of *Creativity & Aesthetics* and *User & Society,* but the expertise I have been encouraged to build in *Technology & Realization,* and *Math, Data & Computing* have paid off by enabling my collaboration with a developer, while my knowledge of Business & Entrepreneurship has allowed me communicate why the development of the NUTRI_Lab chatbot ecosystem is beneficial to the department, and why digital interventions are more cost effective in cardiac care.

My biggest challenge this semester has been managing two simultaneous design processes. The design processes I know and love needed to be adjusted to accommodate the two which sometimes branched off in different directions. With many stakeholders' interests to keep in mind, I had to constantly re-assess and identify dissonance that was happening between the NUTRI_Lab Chatbot development, and the Foodsy use case. I have learned that a project like this can quickly become sprawling and that it is important to prioritize and manage expectations, even if that means saying no sometimes. This is something that I got better at over the course of the project, but that I wish I had felt more confident in earlier. In my final master project, I will re-visit my priorities frequently to make sure the things I devote my energy to bring me further towards my personal goals.

This project has prepared me well for my final masters project. At moments in the beginning of the project I worried whether I was on the right path, "*I'm not a chatbot developer, I don't want to write chat bot copy for the rest of my life! What am I doing?*" I thought. But it is now clear that I have done much more than that, after all if you want to change a system, it is much easier from the inside. Previously, I was very focused on social and inclusive design, but I have grown to realize that I can actually make the most impact by using these practices as a basis for all work that I do. This project has given me a solid foundation and an entry point to move forward with work I think is extremely important, in a field I am passionate about: implementing these technologies in practice for women's health and making them accessible for those who can benefit the most from what they offer!

I am excited and ready to apply what I have learned over the past semester into the final masters project I've been waiting for.

Stay tuned!

Daisy

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Appendix

Appendix A

NUTRI_Lab Chatbot Requirements

Stakeholders	What are *their* goals?	What does the Chatbot need to do?
Primary User: Older Adults		
>60 years old	Track food easily and quickly	Explain functionalities clearly
Basic experience with mobile devices	Acheive diet goals	Record food intake via natural language
	Gain meaningful insight into diet quality	Record food intake via picture
	Gain meaningful knowledge to improve diet quality	Help user to set goals
		Remind user of goals
		Provide insight into 1 meal
		Provide insight into 1 day of meals
		Provide insight into multiple days of meals
		Provide meaningful overview of 1 day of meals
		Provide meaningful overview of multiple days of meals
		Provide meaningful new knowledge pertaining to goals
		Remind user to track intake
		Prompt user to review entries
Secondary User: Caregiver		
Professional or family caregiver	Gain insight into diet quality of user	Provide meaningful overview of multiple days of meals
Healthcare professionals	Support better nutrition of user	Provide meaningful new knowledge pertaining to user's goals
Dieticians	Understand user's diet quickly and easily	
Researchers: Nutrition		
Nutrition researchers	Gain as detailed as possible insight into user's diet	Store food logs for research
	Retain study participants	Allowing for feature customization
	Have as few errors as possible	Lower the burden of the tracking experience
	Have the chat bot support study effectively	Identify impossible entries
	Support better nutrition of user	Prompt user to review entries
		Collect relevant user data
Researchers: Design + HCI		
Designers	Understand the impact of design/features on diet trac	Store food logs for research
Design Researchers	Have the chat bot support study effectively	Allowing for feature customization
	Support better nutrition of user	Lower the burden of the tracking experience
		Collect relevant user data

Appendix B

Initial Proposal

Food Tracking Chatbot

Chatbots offer a simple interface, and can guide users to track their food intake consistently and accurately. They are a particularly good option for the elderly as browsing extensive databases and manually inputting food quantities can be difficult and tedious. A chatbot offers the benefits of a more conversation-like approach, often used by dietitians during recall interviews. The chatbot reduces burden through a number of approaches outlined below.

The functions include:

Tracking food

1) **Natural language Input**
   Implementing natural language processing allows for the user to record their food using their normal, conversational phrasing. For example, “Today I had two slices of toast with peanut butter, an apple and a coffee with milk for breakfast.” This is particularly helpful for older adults, as it allows for a variety of input phrasing and does not require extensive database searching or manual input.

   Natural language can be used to achieve a variety of granularities, depending on the wishes of the researchers. The chatbot can prompt more information from the user, for example asking “how much peanut butter did you have?” when a quantity is missed out. This process could mirror the questions traditionally asked by a dietician when conducting a 24 hour recall interview.

   Using natural language, the user can also use the speech-to-text function available on most smartphones.

2) **Pictures**
   The user can take a photo of their meal and send it to the chat bot. This one step interaction is quick and easy. The photo is then sent to m-turk where it can be evaluated and compared against online recipe data bases. There is also a possibility for M-turkers to compare a user’s photo against previous, confirmed images and classifications from the user’s journal as people often repeat meals.

3) **“Top foods”**
   Over time, the chatbot can learn the foods which a user consumes most frequently. By not only showing “most popular” or “most recent”, but further dividing those top foods over specifical meals, for example “top three breakfast foods”, the user is shown information which is most likely to be relevant.

4) **Patterns**
   People often consume similar things each day. For example, 2 coffees with milk every day between 8:00 and 13:00, or a piece of fruit on their 10am break. By recognizing the patterns, the chatbot can give personalized prompts. For example, if it is 14:00 and no coffee has been tracked for that day, the bot could ask “did you drink your coffee this morning?”.

Food intake overview journal

1) **View the journal - entire**
   The user will be able to view their food journal entries, as will researchers. Such a long and detailed journal is not suitable for a chat setting, so a web based journal will be available for viewing tracking over a longer period of time.

2) **View the journal - one day**
   Food tracked for one day (example: “today” or “Tuesday the 12th of June” can be viewed in the chatbot.

3) **Edit the journal**
   Users need to be able to edit their food intake if they notice an error or remember an item they have forgotten. For the current day, the meal log can be edited from the chatbot interface, while previous days will be need to be edited from the web-based journal.

   Noticing impossible/improbable inputs (such as 100 pieces of toast for breakfast) is also a possible feature to include later in the chat bot. This would increase the accuracy.

Overview and suggestions

1) Making meaningful and insightful, real-time suggestions based on what users have eaten is a possible and desired functionality. For example, noticing which food groups are missing in that day’s breakfast and lunch, and making a suggestion to include more at dinner. More input from experts is needed here to make this functionality meaningful.

Reminders

1) Setting custom reminder times
   Being reminded at the correct moment to track food greatly increases the chance that a user will do it successfully and consistently. The chatbot allows for customized reminder times to be set. The bot could also walk the user through thinking about when would really be the best time for them to track.

Opportunities for research

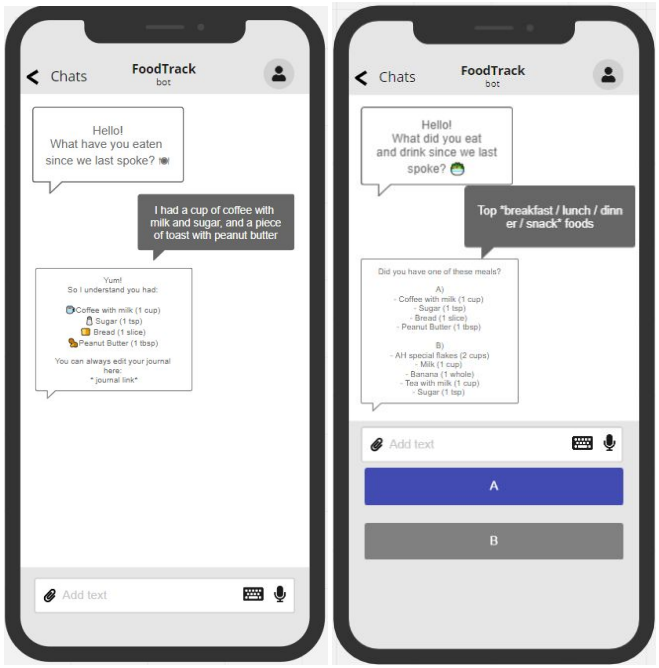
There are many interesting variables which can be further researched using the chatbot system, especially in regards to how to use this technology to facilitate life tracking, and also how older adults wish to interact with chat-bot technology. Interesting areas include the tone and personality of the chat bot, the onboarding processes, the impact of various reminder types, etc.

A researcher should be also able to decide which features to enable for each study, thus a researcher-facing interface is also being considered.

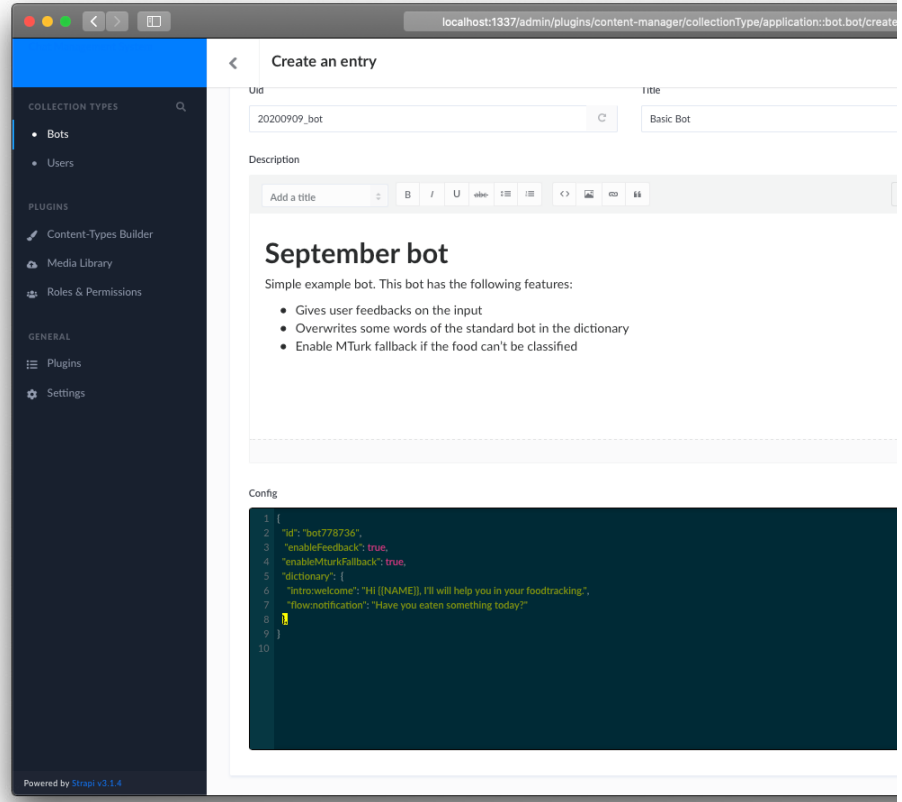
The food intake data should be available for research (identified with a unique user ID), and will be stored for use, review and diet research.

The use data and chat logs should also be stored and reviewable for design research.

Platform
Telegram has been chosen as the chatbot delivery method. It is a free, easy to use platform which also offers custom keyboard buttons. Some basic mock-ups are included below.



Chatbot management system



Appendix C

Example of buttons and menus

START SCRIPT

Chat bot says	Human Says		Chat bot says
Hi! I'm Foodsy			
Together we're going to track which food groups you eat			
Are you ready to learn more?			
	Button [Yes!]	Button [No]	Okay, I'll ask again later
I'll start with an example... Last night I ate a stir-fry			
I made it with chicken, whole wheat noodles, vegetables and soya sauce on top			
To track it, I would enter:			
	Button [Got it!]		
deleted			
Now it's your turn!			
What did you eat for dinner last night?			
Okay, I understand you ate: Is that correct?			
	Button [Yep]	Button [Nope]	Okay, let's try again. What did you eat?
Great! If you need a reminder of the food groups, you can always click on the "food group info" button to pull up the guide!			
	Button [Got it!]	Food Group Info	1 Vegetables 2 Fruit 3 Dairy 4 Fish 5 Whole Grains 6 Refined Grains 7 Red or Processed Meats 8 Lean Protien 9 Added Sodium 9 Sweets
Okay, Lets get started for real. Have you eaten anything today so far?			
Okay, I understand you ate: Is that correct?			
	Button [ ]	Button [ ]	Okay, let's try again. What did you eat?
Thanks! I'll remind you to track again later!			

Appendix D

Personas developed by Emma Rieling (2019)

ARTHUR VAN DE BEEMD

GENERAL INFORMATION

Gender:	Male
Age:	55
Occupation:	App developer
Family:	Single, no children
Cardiac event:	Chronic Coronary Syndrome
Intervention:	Percutaneous Coronary Artery Intervention

CARDIOVASCULAR RISK PROFILE

CVD in family:	Yes
Smoking:	No
Diet:	Lives on microwave meals
Physical activity:	Low
Stress level:	Moderate

PERSONAL GOALS REHABILITATION

- Replace microwave meals for healthy home-cooked meals
- Be physically active for at least one hour a day
- Go to work by bike
- Find a suitable sports club to keep exercising after CR is done

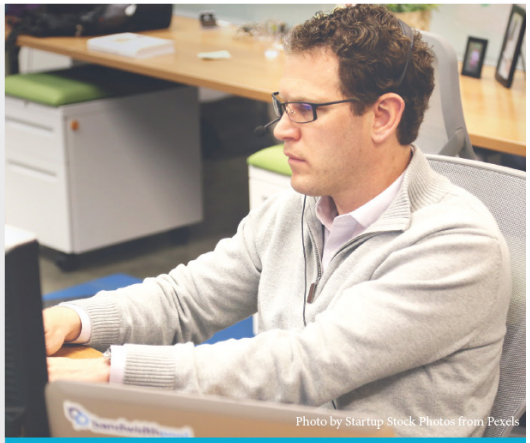


Photo by Startup Stock Photos from Pexels

"I knew that cardiovascular diseases run in the family, but I never expected getting those problems myself. The doctor asked me about my lifestyle and explained that a healthy lifestyle can lower the risk of going through this again. After reading all the leaflets the doctor gave me, I realized that I am not living as healthy as I should and that it's about time to change that. I searched the internet for advice and came across the home-delivered meal boxes including a recipe and all fresh ingredients to prepare my own meal. I got rid of my microwave meals – after all, they were not even tasty - and I am cooking for myself now. I did not expect to enjoy it so much. Neither were my friends, they were quite surprised when I invited them for dinner! I am also searching for a sports club and I scheduled a meeting with my boss next week to talk about the bicycle plan. Maybe I can even propose to develop an app to help colleagues live more healthy as well."

MAARTEN RIJSWIJK

GENERAL INFORMATION

Gender:	Male
Age:	48
Occupation:	Entrepreneur
Family:	Girlfriend Fiona, 3 children aged between 7 and 12
Cardiac event:	Chronic Coronary Syndrome
Intervention:	Coronary Artery Bypass Graft Surgery

CARDIOVASCULAR RISK PROFILE

CVD in family:	Yes
Smoking:	No
Diet:	Very healthy
Physical activity:	At least one high-intensity workout per day
Stress level:	High

PERSONAL GOALS REHABILITATION

- Leave work on time
- Consider that mindfulness class Coby proposed
- Wine only in the weekends and try to keep in mind the difference between half a glass and half a bottle
- Take lunch from home
- Spend more time with Fiona and the kids
- Try using 'Pomidoro' technique for efficiency
- Delegate more
- Running the New York Marathon in 2020
- Never get into this situation again

Photo by Patrick Hendry from Unsplash

"I never ever thought this would happen to me. I thought I lost it all. I feel frightened and awake now. At the same time, I keep having these dreams that I lost it all.. That I didn't make it. At night I wake up sweating, pinching myself to proof that I am still alive. I don't know how I got into this situation and I don't know what to do now. I know that my mom and sister had the same issues, but I eat so healthy and exercise all the time. What else can I do to prevent this? I guess it is stress. I experience a lot of tension at work, it is all on my shoulders. Speaking of that, I really need to get back to work to take care of everything. Work needs me. Fiona and the kids need me too. So much to take care off, but I am so scared. I have to be a good father, a husband, a son, an entrepreneur. I thought I could do it all. I guess I have to try harder and exercise even more. I will take classes on how to work more efficiently and I will set running the New York marathon in 2020 as a goal for myself to make sure I exercise enough. Maybe that helps."

JOLANDA PETERS - VAN BEEK

GENERAL INFORMATION

Gender:	Female
Age:	60
Occupation:	Senior consultant policy making
Family:	Widow, 1 adult child
Cardiac event:	Chronic Coronary Syndrome
Intervention:	Coronary Artery Bypass Graft Surgery

CARDIOVASCULAR RISK PROFILE

CVD in family:	No
Smoking:	Yes
Diet:	Generally take-away meals containing a lot of salt
Physical activity:	Inactive
Stress level:	High

PERSONAL GOALS REHABILITATION

- Quit smoking
- Exercise more
- Cook healthy meals
- Lose weight
- Get enough rest
- Lose worries
- Spend more time with Janneke (daughter)

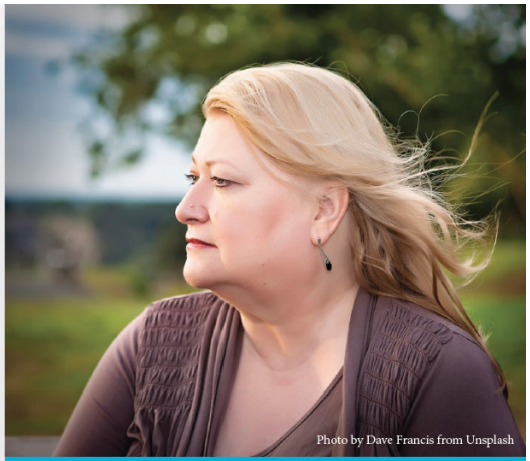
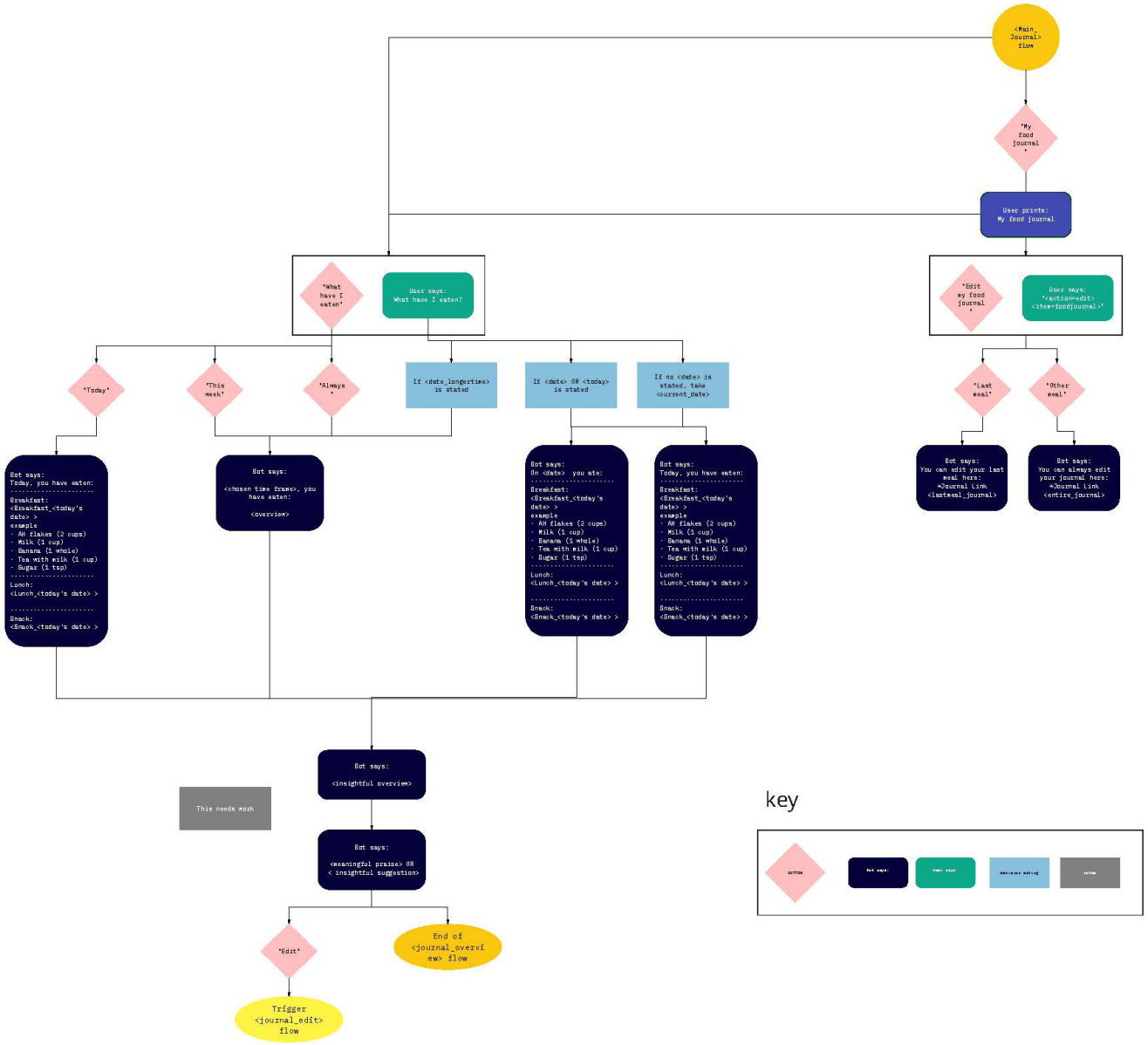


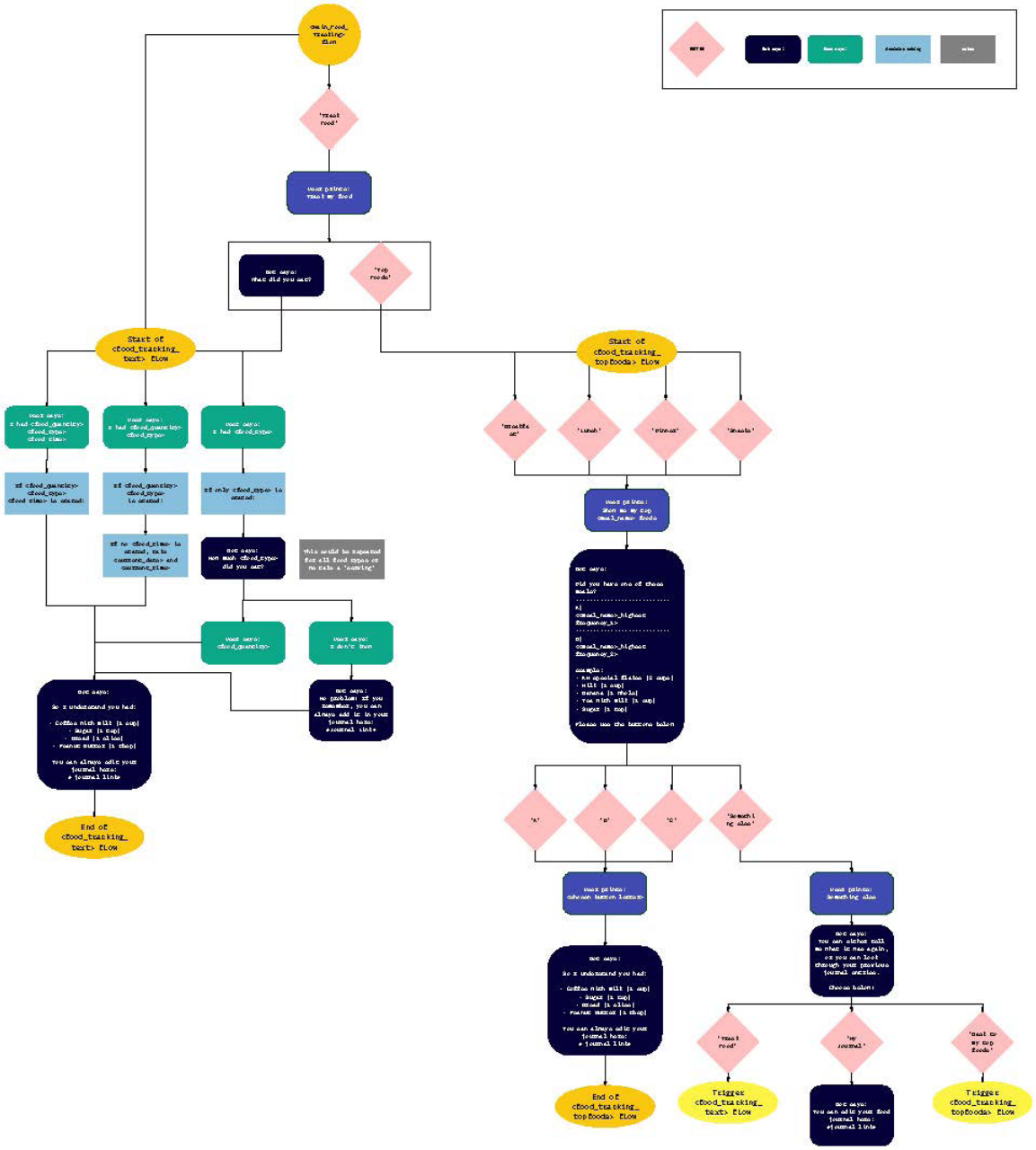
Photo by Dave Francis from Unsplash

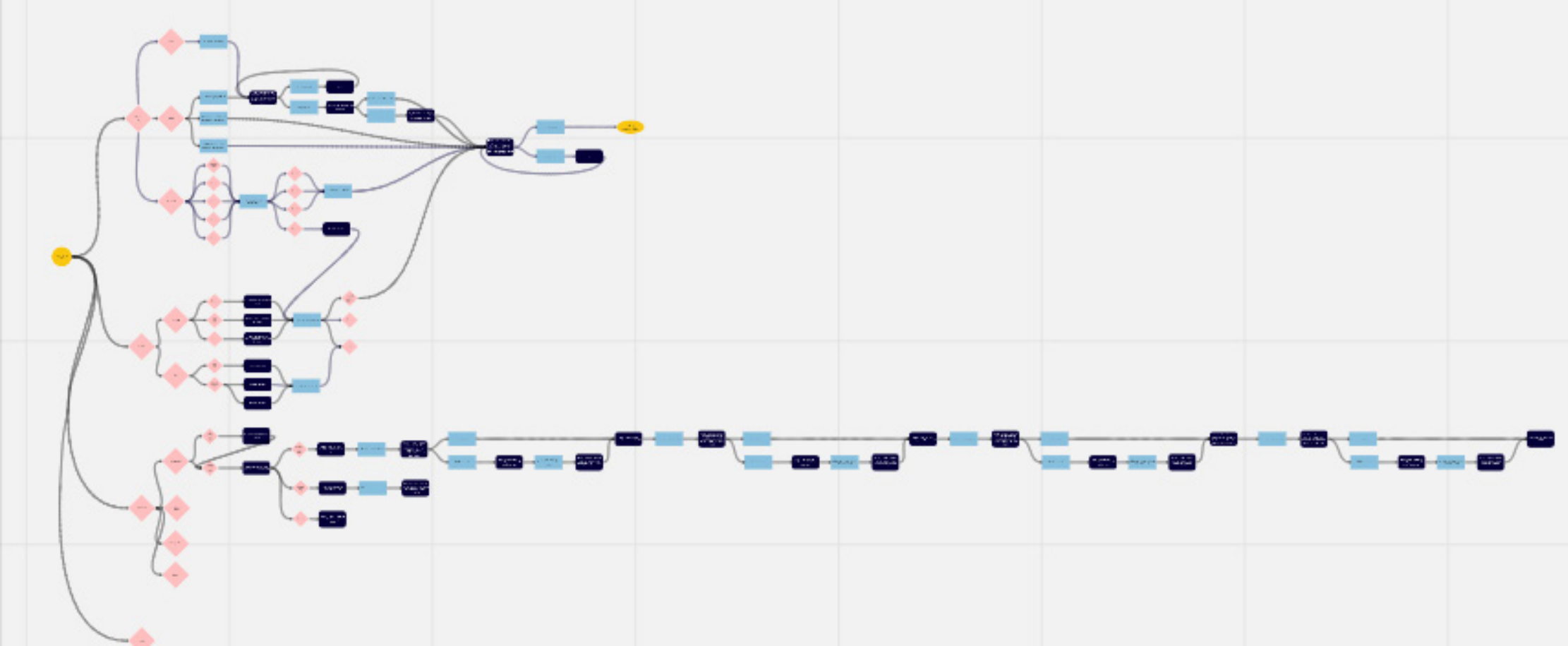
"Never thought it could happen to me, honestly. I live to enjoy life. This is how I cope with obstacles that are thrown my way. When Joost died, I thought that was it, but I found myself again. Friends, going out, drinks, I like to socialize. What if I cannot do that again? The doctor proposed changing my lifestyle to prevent a cardiac event in the future. He told me it would be better to quit smoking, start cooking healthy meals for myself and exercise more to lose some weight. I will give it a try as the doctor knows best, but I am skeptical about the results. The last time I tried those things, it went well for a while but I started smoking and gained even more weight after a couple of drinks and setbacks at work."

Appendix E

Chatbot Flowcharts




main_food_tracking_flow
'track food'
user prompt: track my food
bot says: what did you eat?
'top foods'
Start of <food_tracking_text> flow
user says: I had <food_quantity> <food_type> <food time>
user says: I had <food_quantity> <food_type>
user says: I had <food_type>
if <food_quantity> <food_type> <food time> is stated:
if <food_quantity> <food_type> is stated:
if only <food_type> is stated:
if no <food_time> is stated, calc <current_date> and <current_time>
bot says: how much <food_type> did you eat?
this would be repeated for all food types or we make a 'loading'
user says: <food_quantity>
user says: I don't know
bot says: no problem! if you remember, you can always add it in your journal here: #journal link#
bot says: so I understand you had: · Coffee with milk [1 cup] · sugar [1 tsp] · bread [1 slice] · Peanut butter [1 tbsp] you can always edit your journal here: #journal link
End of <food_tracking_text> flow
Start of <food_tracking_topfoods> flow
'breakfast'
'lunch'
'dinner'
'snacks'
user prompt: show me my top <meal_name> foods
bot says: did you have one of these meals? ..... a) <meal_name>_highest_frequency_1> ..... b) <meal_name>_highest_frequency_2> example: · An omelet flatbread [2 eggs] · milk [1 cup] · banana [1 whole] · low fat milk [1 cup] · sugar [1 tsp] Please use the buttons below
'a'
'b'
'c'
'something else'
user prompt: <choose button letter>
bot says: so I understand you had: · Coffee with milk [1 cup] · sugar [1 tsp] · bread [1 slice] · Peanut butter [1 tbsp] you can always edit your journal here: #journal link
End of <food_tracking_topfoods> flow
user prompt: something else
bot says: you can either call me that in the again, or you can look through your previous journal entries. Choose below:
'track food'
'my journal'
'back to my top foods'
Trigger <food_tracking_text> flow
bot says: you can edit your food journal here: #journal link
Trigger <food_tracking_topfoods> flow



Appendix F

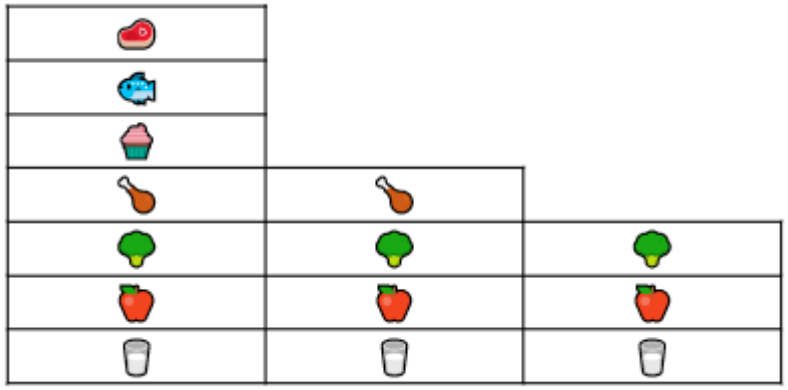
Emoji exploration and example overview based on different diets

Vegetables	Fruits	Refined grains	Sweets and Treats	Alcohol
Eggplant	Grapes	Bread	Doughnut	Bottle
Potato	Melon	Croissant	Cookie	Wine Glass
Carrot	Watermelon	Baguette Bread	Birthday Cake	Cocktail Glass
Ear of Corn	Tangerine	Pretzel	Shortcake	Tropical Drink
Hot Pepper	Lemon	Bagel	Cupcake	Beer Mug
Cucumber	Banana	Pancakes	Pie	Beer Mugs
Leafy Green	Pineapple	Waffle	Chocolate Bar	Glasses
Broccoli	Mango	Dumpling	Candy	Tumbler Glass
Garlic	Red Apple	Cooked Rice	Lollipop	
Onion	Green Apple	Spaghetti	Custard	**Sweetened Beverages**
Mushroom	Pear		Soft Ice Cream	Cup with Straw
Green Salad	Peach	**Whole Wheat Grains**	Ice Cream	Beverage Box
Sweet Potato	Cherries	Wheat		
Tomato	Strawberry			**Coffee/Tea**
	Kiwi Fruit			Hot Beverage
				Teacup
Dairy	**Nuts and Seeds**	**Red/Processed Meat**	**Lean Protein**	**Added Sodium**
Baby Bottle	Peanuts	Meat on Bone	Poultry Leg	Salt
Glass of Milk	Chestnut	Cut of Meat	Egg	
Cheese Wedge		Bacon		
		Hamburger	**Fish**	**Fats**
		Hot Dog	Fish	Butter
			Tropical Fish	
			Blowfish	

Example overview of a healthy diet

Monday	Vegetables	Fruit	Dairy	Fish	Whole Grains	Refined Grains	Red or Processed Meats	Lean Protien	Added Sodium	Sweets and Treats	Example meal (healthy)
Breakfast											1 cup cooked oatmeal, sprinkled with 1 tablespoon chopped walnuts and 1 teaspoon cinnamon 1 banana 1 cup skim milk
Snack											1 cup skim milk 10 whole wheat crackers
Lunch											1 cup low-fat (1 percent or lower), plain yogurt with 1 teaspoon ground flaxseed 1/2 cup peach halves, canned in juice 5 Melba toast crackers 1 cup raw broccoli and cauliflower 2 tablespoons low-fat cream cheese, plain or vegetable flavor (as a spread for crackers or vegetable dip) Sparkling water
Snack											pepperoni stick Sliced Cucumber 2 cookies
Dinner											4 ounces salmon 1/2 cup green beans with 1 tablespoon toasted almonds 2 cups mixed salad greens 2 tablespoons low-fat salad dressing 1 tablespoon sunflower seeds 1 cup skim milk
Snack											1 small orange

Example overview of a healthy diet



Example overview of an unhealthy diet

Monday	Vegetables	Potatoes	Fruit	Dairy	Fish	Whole Grains	Refined Grains	Red or Processed Meats	Lean Protien	Added Sodium	Sweets and Treats	Example Meal (unhealthy)
Breakfast												3 cups of sugared cereal 1 cup of milk
Snack												3 chocolate biscuits 2 cups of coffee with 2 sugars
Lunch												4 slices white bread 4 slices lunch meat 2 Tablespoons mayonaise 1 bag of plain chips
Snack												1 Mars Bar 1 can of Coke
Dinner												3 hot dogs 3 white hot dog buns French Fries with salt 1 Tablespoon Kethchup
Snack												1 bowl of icecream

Example overview of an unhealthy diet